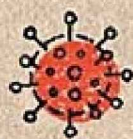


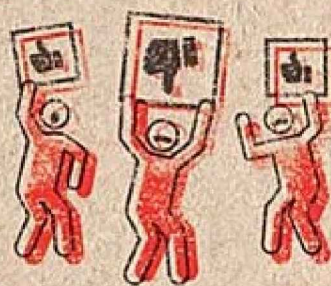


TOMMASO VENTURINI &
ANDERS KRISTIAN MUNK

CONTROVERSY MAPPING



A
FIELD GUIDE



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Dedication

To our teachers and our students

Controversy Mapping

A Field Guide

Tommaso Venturini and Anders Kristian Munk

polity

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Acknowledgments

It was in Paris, in the fall of 2013, that Tommaso first suggested the idea for this book. Anders had begun a two-year stint as a visiting researcher at the Sciences Po médialab, where Tommaso was the research coordinator, and we had both been teaching controversy mapping for some years. At the time, no explicit guidance was available and the pedagogy of controversy mapping was learned by trying, possibly through apprenticeship with colleagues ahead of the curve. The atmosphere was playful and experimental with a high level of engagement and substantial contributions from the students, yet the need was felt to compile the teaching resources that we were all working on into more structured formats.

Several initiatives were taken in those years to consolidate the ongoing experiments with controversy mapping. One was the curation of a collection of websites that students around the world were producing as part of their coursework, another was the FORCCAST project (FORmation par la Cartographie des Controverses à l'Analyse des Sciences et des Techniques) which had been launched in France to establish a research-based understanding of the pedagogy of controversy mapping. What was missing, we thought, was a book. Tommaso had compiled his teaching materials into a portfolio which became the first draft for a manuscript that has since developed and transformed through more iterations than we would care to think of. We are proud to see it emerge now as a fully-fledged field guide to controversy mapping, not just for teaching, but also for research and democratic inquiry. This would not have been possible without the help and support of an ever-expanding and highly committed network of fellow controversy mappers that we want to credit and thank.

Controversy mapping has existed as a pedagogic practice in Science and Technology Studies (STS) since the early 1990s, and Bruno Latour has played a pivotal role all the way from its inception at a time when mapping projects were still handed in on paper through to its later digital adaptations. He is also the reason why the authors of this book first met and we can safely say that it would not have been written without him. We first got in touch more than a decade ago while working at different ends of Bruno's MACOSPOL project (Mapping CONtroversies in Science for POLitics – the first large-scale research project dedicated to the approach). Anders was teaching controversy mapping on the MSc program in Nature, Society, and Environmental Politics at the University of Oxford, which was one of five test beds, while Tommaso was working on the digital part of the project and himself teaching controversy mapping at SciencesPo (the three remaining test beds were MIT, the EPFL – École Polytechnique Fédérale de Lausanne, and the École des Mines). From that early collaboration we were able to take inspiration from the vanguard of controversy analysis in STS, including Andrew Barry, Sarah Whatmore, Valerie November, Albená Yaneva, who went on to write the first book on controversy mapping in architecture (Yaneva, 2011), and not least Noortje Marres, who was already a leading figure in digital methods and has since published a seminal book on digital sociology (Marres, 2017) and established one of the key research groups in the field at the University of Warwick.

Noortje's role is particularly interesting because she embodies the crosspollination that went on in the early 2000s between Richard Rogers and his Digital Methods Initiative (DMI) in Amsterdam, and Bruno Latour and his STS group in Paris. As a doctoral student

in both places, her work was the first real example of what could happen at the interface between actor-network theory and new digital methods for studying issues online. As junior researchers at the time, we took inspiration from her example. Indeed, digital methods would be as impossible to imagine without Richard and Noortje as controversy mapping would be without Bruno. Richard's books on digital methods are already classics (Rogers, 2013a, 2019). The summer and winter schools convened by his team in Amsterdam (Esther Weltevrede, Liliana Bounegru, Natalia Sanchez Querubin, Carolin Gerlitz, Anne Helmond, Fernando van der Vlist, Sabine Niederer, Marc Tuters, to name a few) have become the go-to place for a generation of young social cartographers. Arguably, the game-changing role of the DMI came about through its early focus on toolmaking. Building research instruments to repurpose digital records and reflecting on the implication of such an operation, people like Erik Borra and Bernhard Rieder have enabled controversy mappers to develop their craft in critical proximity to its more technical sides. This cannot be acknowledged enough and deserves far more credit than is typically allotted.

A similar story can be told about the Sciences Po médialab which was, when we first met, coming into its own as a hub for digital methods toolmaking. Bruno had made it a precondition for his move from the École des Mines to Sciences Po Paris that he could set up a lab with research engineers capable of developing new tools for quali-quantitative research. Many of these engineers came from Franck Ghitalla's group at the University of Compiègne and brought with them a focus on visual network analysis. Mathieu Jacomy, in particular, has become a very close collaborator and an invaluable sparring partner for both of us. He was also the initiator of the Gephi software which has become synonymous with visual network exploration for everyone in digital methods and quite a few people beyond. In general, the importance of the médialab for our formation as controversy mappers cannot be overstated, to a large extent thanks to the unique atmosphere created by and around toolmakers like Paul Girard, Benjamin Ooghe-Tabanou, Daniele Guido, Guillaume Plique, Alexis Jacomy, Audrey Banneyx, and Jean-Philippe Cointet.

After MACOSPOL came a period of expansion. Anders went back to Copenhagen to set up the first Danish controversy mapping course with Torben Elgaard Jensen at the Danish Technical University. That same year, in 2010, Anders Blok, Martin Skrydstrup, and Ayo Wahlberg started a similar course at the University of Copenhagen, followed a couple of years later by a course at the Danish IT University run by Britt Ross Winthereik and Michael Hockenhull, and a course in Aarhus run by Peter Danholt and Kristian Hvidtfelt Nielsen. There was now a basis for a local Danish research environment centered around controversy mapping teaching, which resulted in the now obsolete server community Copenhagen Association for Digital Methods. We were both involved, together with Torben Elgaard Jensen and Mathieu Jacomy, when Mark Elam and Åsa Mäkitalo began an ambitious project to teach STS through controversy mapping in high schools in Gothenburg. A similar idea was pursued by the FORCCAST project under the direction of Dominique Boullier, and later of Nicolas Benvegna and Thomas Tari, in collaboration with researchers from the École nationale supérieure des Arts Décoratifs, the École de Mines, Télécom ParisTech and the Institutes of Complex Systems of the Île de France and Rhône-Alpes regions. In the same years, Tommaso was giving seminars on controversy mapping at the Politecnico di Milano and at the Universidade Federal do Rio de Janeiro with Fernanda Bruno and the team at her lab. As the network grew larger, so did the sense that we needed to write a book.

At the médialab, Tommaso had been working with Axel Meunier to develop the successor project to MACOSPOL. When EMAPS (Electronic Maps to Assist Public Science) received funding, it was an opportunity to not only teach controversy mapping but also to develop it as a proper research method and assess its ability to make a difference in the world beyond the classroom. Anders moved to Paris and for two years we were both working with Axel and many of the people mentioned above to show that we could map the controversy on climate adaptation in ways that actually mattered to its protagonists. EMAPS foregrounded the key role of data visualization in controversy mapping projects and cemented a burgeoning collaboration with the information designers at the Density Design lab in Milan. Today, it would be hard to imagine controversy mapping without a strong visual component and the contributions of people like Donato Ricci, Daniele Guido, Michele Mauri, Angeles Briones, Paolo Ciuccarelli, and their many dedicated students. Indeed, Federica Bardelli, to whom we owe immense gratitude as the designer of the illustrations in this book, is herself a product of Density Design and embodies the difference that the Milan crowd continues to make to the practice of controversy mapping.

When EMAPS ended in 2015, many of us took up new positions. Tommaso went first to the Digital Humanities Department of King's College London to work with Tobias Blanke, Marc Coté, and Jennifer Pybus, and then to Lyon to collaborate with Pablo Jensen and further develop the technique of visual network analysis. Anders went back to Copenhagen to establish the Techno-Anthropology Lab together with Anders Koed Madsen, Andreas Birkbak, Torben Elgaard Jensen, and Morten Krogh Petersen. The group there, which was later joined by Mathieu Jacomy, Mette Simonsen Abildgaard, and Asger Gehrt Olesen, has provided an intellectual home base for much of the writing process. Together with the prodigious organizational talents of Jonathan Gray and Liliana Bounegru, Tommaso devised the concept for the Public Data Lab which now convenes much of the old EMAPS group and a whole bunch of great new acquaintances in a fantastically engaging and interest-driven network, the activities of which have been another key intellectual anchor point and a place to spar on drafts and ideas throughout the past five years.

Some people have not found their way into the above narrative despite contributing ideas, providing feedback and in general being part of an ongoing conversation about controversy mapping: Kari De Pryck, David Moats, Nicolas Baya-Laffite, Francesca Musiani, Timothée Collignon, Ian Gray, Niranjana Sivakumar, Trevor Pinch, Thomas Turnbull, Vincent Lépinay, Oscar Coromina, Oscar Maldonado, Liam Heaphy, Massimiano Bucchi, Federico Neresini, Andrea Lorenzet, David Chavalarias, Eric Fleury, Marc Barbier, Astrid Oberborbeck Andersen, Tobias Bornakke, Jean-Paul Vanderlinden, Vivian Depoues, Didier Bigo, François Gemenne, and, not least, all our amazing students.

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Finally, there is one person whose contribution warrants its own section, namely Michael Flower, who has meticulously read and reread many consecutive versions of the manuscript, and provided not only constructive commentary and critique but incessant and unyielding support. Thanks, Michael: your encouragement has meant a lot to us.

Preface: The politics of association on display

Richard Rogers

As this book aptly demonstrates, there is a certain fit between Actor-Network Theory (ANT), controversy mapping, and digital methods. From the outset, digital methods were informed by ANT and sought to operationalize controversy mapping, for the purpose of investigating imbroglios such as the ones described in the book. They did so in at least three ways: putting actor association on display through link mapping, furnishing a coarse view of actor partisanship through mention mapping, and inserting the maps into the issue space, as they are part of it rather than only representations.

As Venturini and Munk discuss, associations are the main focus of ANT and the prime way in which controversies are fought and societal arrangements established. In order to put actor association on display, colleagues and I would capture how websites link to one another. Long before the industrialization, automation, and eventual decline of the hyperlink (in favor of the “like,” the “follower,” and very differently the “hashtag”), each link was hand-made by a webmaster, with particular proclivities or even policies. Linking was thus noncapricious and selective. Hyperlinking practices thus reminded us of the way in which scientists use references to mark their positioning in the academic field, but we extended these associational practices to a much larger and more diverse number of actors.

Once mapped, these links could be telling. One could profile and also typify the players in a public dispute beyond their usual roles, as outlined in the chapter about controversy actors. They could be profiled through the manner in which they linked and were linked to. Who does the actor link to? Why does the actor receive those particular inlinks? Which links could be regarded as conspicuously missing?

We found certain types and styles of association. There were aspirational links, with actors desiring association with another actor, often without reciprocation. There was cordial linking, where actors link to their affiliates and colleagues in the same space. There was critical linking, with actors pointing to culprits or addressees of an issue or problem. There were other types and styles, too, such as non-linking, self-linking, kinship linking, transdiscursive linking, and so forth.

Like Google, we also discovered that the sum of one’s inlinks is worth investigating, for it could be deployed as a reputational marker. But it also could deliver signs of where an actor’s sympathies lie. We wanted to enable the study of the politics of association, which, as argued over and again in this field guide, is a key task in controversy mapping.

Links may show alignments. They may reveal the company an actor keeps, or unlikely bedfellows. Particularly when displayed through the techniques described in the sections on visual network analysis, the investigation of links could indicate actor standing. There are hierarchies in networks, and links furnish certain actors with prominence and centrality. “Orphan” websites, without inlinks, did not make it onto the maps, however, so non-association would require another technique (such as mentions mapping, discussed below).

More broadly, these webs of actor links, in other words, were considered networks. Linking actively brings networks into being. They create a space of interaction and circulation, the “magmatic” space of alliances and oppositions described in the book. They each may be characterized by the material they circulate and the activity they display.

Rather than structural, such as “old boy networks,” we found them to be dynamic, and continually in need of glue. These networks, we thought, were held together by what they principally circulate. Debate networks circulate positions, scandal networks accusations, issue networks urgency, summit networks announcements, and protest networks mobilization.

The rates at which these networks circulate the material, through the updating of their websites, could be considered a measure of dedication or care. The “health” or hardiness of the issue, protest, and so forth could be monitored. In order to do so, the maps went live.

We would build issue tickers and other displays to show an issue’s current state. In one example, we monitored NGO campaigning behavior, and when NGOs would leave an issue, in the sense of ceasing its advocacy, the issue’s state would decline. One could similarly monitor a controversy, and when it is the hottest, or in full motion, that is the occasion to map and chart it.

Second, we mapped mentions. In order to capture an actor’s partisanship or issue commitment, we learn from how actors mention each other as well as each other’s issue language. It is an issue mapping exercise, where, for example, we asked, which actors in the climate change space mention the skeptics? Here the idea is to gain a rough indication of skeptic-friendly sources. (Sources skeptical of the skeptics also appear, so close reading and annotation are essential.)

Querying search engines, and interpreting actor mentions, are not particularly slow methods, but they are not single-click operations either. Their exploitation demands a reflexive attitude, including the many methodological considerations laid out in the chapter on the collection and sorting of digital records. Research browsers are installed, settings are changed, and multiple queries are made as one reconsiders the use of search engines, transforming them from a consumer information appliance into a research device.

We considered the placement of the mentions. This is the study of what is referred to as “source distance.” How far from the top are the mentions? It is also a consideration of the significance of the actors who can be seen to sympathize or align with them.

In order to produce a coarse measure of partisanship among significant actors in an issue space, the search engine is queried, but in two steps, first, for the issue, “climate change.” The second set of queries is made for the names of skeptics or skeptical organizations in each source returned in step one. This is the point where the search engine has been repurposed for research.

We note a source’s affinity toward an actor, but we also would like to draw comparisons between the actors. Who appears to be the most sympathetic? There is a word-clouding technique, where one keeps the order of the sources returned and resizes the actor names according to the number of mentions of the other. One can have clouds (which also could be called maps) that show the results of an analysis of a single actor or a constellation of many, for example, which actors mention a set of skeptics. One can also show the most significant skeptic.

Networks also could be said to have an agenda or a set of commitments. Certain issues may be suffering, others thriving. If one demarcates a network through hyperlink analysis, relying on an authoritative list or surveying actors or funders, one can harvest each actor’s online issue list, merge the lists, and query every actor for every issue (in our repurposed search engine). The resulting “issue cloud,” whether in alphabetical order or arrayed by

mention frequency, provides both the network's overall agenda as well as the distribution of commitment. Are children's rights doing well within the global human rights issue network? Who's particularly dedicated to it, and who is much less so? Claimed commitments also may be tested. An organization may have a beefy issue list but pay attention to a few over the others listed.

Third, the maps have effects. As this field guide makes clear from the outset, to be a mapmaker is to assume some form of complicity. Link maps could make actors desirous of others' sets of inlinks. They may be envious of another actor's positioning either overall or within a particular cluster. Having viewed the maps, actors might begin to solicit links. They could consider employing the services of a link farm, just as celebrities and others purchase likes or followers to enhance their social media status. Sudden movement around the map could capture actor link optimization, or could be a sign of improved showing, however gained. Mapping becomes temporal, with a series of scheduled snapshots.

But the maps are themselves part of the issue space, certainly when actors incorporate them into their PowerPoint presentations. Just like the geographical maps discussed in the chapter on the representation of controversies, debate maps are not neutral descriptions of a territory, but instruments in the hands of social actors. In one project, working in a data sprint similar to the ones described in this book, we collaborated with FairPhone, the project originated at the Waag Society, Amsterdam, to create a "more sustainable smartphone." They had a map, or diagram, that shows the stages of life of a smartphone that emphasizes the mining and recovery of minerals. In their presentations they raise awareness of the mineral trade, also discussing "conflict minerals." They argue that there is scant information available about those raw materials in the various phases of a smartphone's life from production, sale, and use to recycling. With mineral mention mapping, we annotated their map by adding an awareness layer (see [figure 0](#)). It could be inserted into the PowerPoint presentation, after the original stages of life diagram. It empirically hardens the point made by FairPhone, but also indicates some signs of awareness, perhaps from their own dedicated efforts (though we did not test that supposition).

Finally, there are a number of precepts that the mapping of issues and networks with digital methods have followed that are decidedly Latourian (apart from having precepts in the first place): multiply the maps, instead of seeking to make the mother map and have it serve as the endpoint. Multiple map-making is the research that precedes and enables making findings or developing a narrative of the results. Make the maps reversible, so one can follow content or data points back to their origins. These key precepts of "second-degree objectivity" and "datascape navigation" (described in the chapter on representation) were imported from ANT into digital methods. A recent digital methods tool, 4CAT, for collecting and analyzing 4Chan, Reddit, TikTok, Telegram, and Instagram data, not only queries the social media platforms (or archives of them), but also saves each analytical sub-operation per map. In that sense it allows for the deconstruction of the map. The last precept to be mentioned is the retention and study of actor issue language. While the respect for actor accounts is anthropological in its origins (as argued in the chapter about actor-networks), the issue language also serves as queries. A preferred technique, among the many introduced over the years on collecting and sorting digital records, is to compare the resonance (together with its publics) of competing issue languages, also known as programs and antiprograms, which are like campaigns but without the outward campaigning.

While digital methods have learned from ANT and controversy mapping, this book represents a deepening and maturing of the relationship. It also demonstrates the refinement of many of the techniques that were at the heart of the first wave of web research, described above, when issue crawlers and Google scrapers were routinely deployed for mapping. Welcome to the new wave.

Richard Rogers

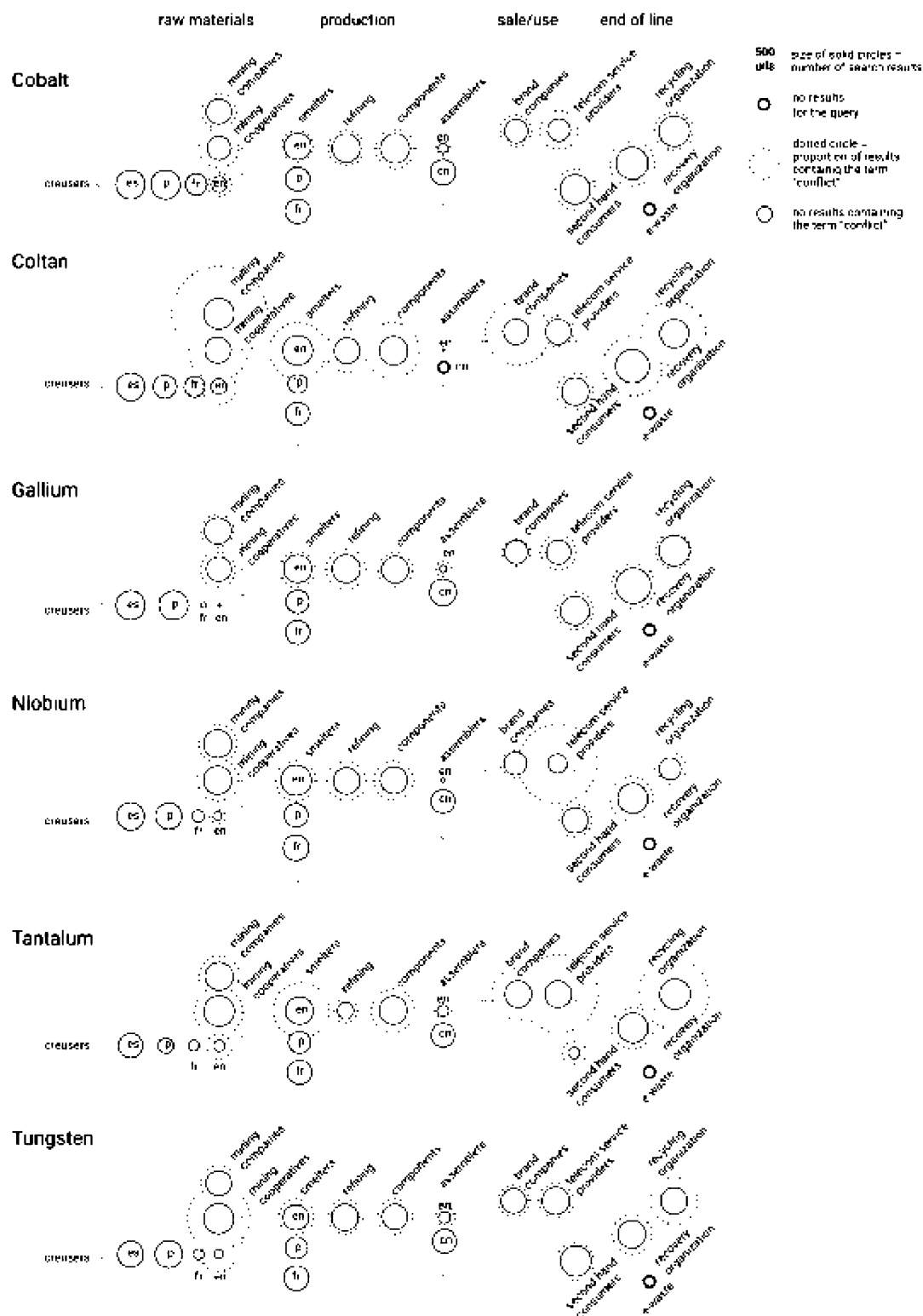


Figure 0 Mapping the online mentions of rare minerals (created by Richard Rogers and Federica Bardelli).

Introduction

Controversies, it seems, are everywhere in contemporary media. It is impossible to check the news, scroll through one's social feed, or listen to a podcast without stumbling on some controversial issue.

Sunday, it is the snapshot of a seahorse gripping a cotton-bud in its curvy tail, reigniting the debate about the effects of plastic pollution on marine ecosystems and declining biodiversity. Published by an American photographer and environmental activist, the image goes viral on social media and soon gives rise to all sorts of parodies and memes.

Monday, the havoc caused by a tropical cyclone adds fuel to a discussion about the connection between climate change and extreme weather events. TV and radio shows suddenly take an interest in climatologists who can explain how warmer oceans can lead to increased storm activity. Once on air, the discussion quickly drifts from causes to consequences, as architects and engineers suggest the destruction should be blamed on poor urban planning and not on the weather. They subsequently accuse the government of not fulfilling its commitments to adapt to climate change.

Tuesday, the Ministerial Conference of the World Trade Organization is met with a vast street protest against the adverse consequences of economic globalization in perpetuating poverty in the Global South. The demonstration takes authorities by surprise. The activists have organized for months through an encrypted messaging system and use social media to create improvised flash mobs in various parts of the city.

Wednesday, a group of endocrinologists and environmental scientists publish an open letter in a prestigious international journal urging governments to take action against a series of commonly used chemicals in agriculture and cosmetics that are accused of being carcinogenic and causing hormonal disorders. The scientists criticize the lack of regulation, but also a media campaign by industrial lobbyists trying to promote a false sense of scientific uncertainty around the effects of these substances.

Thursday, the CEO of an online platform is called to testify before Congress about a massive data leak exposing millions of its users and their personal information to fraudulent marketing schemes and deceptive political campaigns. Discussions ensue about the exceptionality of the situation, as media scholars note that selling personal data for targeted advertising is a standard business model of online platforms. A group of activist-developers seizes the opportunity to launch a peer-to-peer social network where users own their data.

Friday, a forgotten rural town makes the headlines of national newspapers after a confrontation over the construction of a new wind farm. Two unusual coalitions face each other. On the one side, inhabitants worried about noise levels, spoiled views and decreased land value, as well as a group of ecologists protesting the location of large turbines in the path of a major bird migration route. On the other side, the municipal developers, representatives of the wind industry, and another group of ecologists supporting the transition to renewable energy.

Saturday, a boat with African migrants is refused the right to dock at a Mediterranean port and a legal battle breaks out between activists who accuse the state of disregarding the Law

of the Sea and basic human rights, and the state accuses the activists of aiding and encouraging illegal migration. A quarrel also arises on the publication of the photos of the overcrowded boat. Some argue that the pictures sensitize the public to the struggles of migrants; others that they promote a sense of siege in the population of affluent countries, thus supporting the discourse of populist and nationalist parties.

Controversies between technoscience and mediatized democracy

Like most of the controversies that constitute our daily media diet, the examples above have two things in common. First, in one way or another, they are all *related to science and technology* – including, of course, the humanities, social sciences, economics and law. They are prompted by the unintended consequences of some new invention, a technical failure, an unforeseen natural hazard, or a disagreement between purported experts. Second, all these controversies are, to some extent, *public*. While they may play out partly in private, or behind closed doors in engineering offices or scientific laboratories, they are also staged in and by the media and are thus open for everyone to see and engage with. These *sociotechnical controversies* – debates that relate to science and technology and that take place in public rather than behind closed doors – constitute the object of this book.

Controversies, where facts, expertise or new technologies are contested, have been pushed to the center of our collective attention by two overlapping developments. First, they have become more salient because science and technology play an increasingly important role in our politics (Weingart, 1999; Marres, 2005b). Since the Scientific Revolution, it has been commonplace to believe that technoscience would gradually remove dangers, manage insecurities, and resolve conflicts. Yet, after five centuries of technoscientific progress, we are every bit as entangled in controversies as we have always been. Far from imposing consensus, science and technology have become the breeding grounds of many of our collective disputes. Even when born outside industry or academia, controversies almost invariably involve questions about technical infrastructures and expert knowledge. Essentially political questions, such as the 2016 Brexit referendum, are still deeply entangled with expert discussions about economic indicators, legal rules, voting systems, and even voting machines. As this field guide will exemplify over and over again, there is no outside of modern science and technology.

While many controversies stem from the failures of modern technoscientific systems, many more come from their success. While extending our control and understanding of social and natural phenomena, science and technology have also produced a wide variety of aftereffects that are increasingly impossible to ignore. These risks and externalities are not new and have been a matter of discussion since the first industrial revolution. Yet, technoscientific networks have grown so deep and wide (Ellul, 1967) that their collateral effects now result in existential crises (Mumford, 1944, 1971) and hazards to the planet (Latour, 2004b, 2017b). Because there is no outside of modern science and technology, there is also no escape from dealing with their consequences. We cannot board a plane without being reminded about our carbon footprint or the risk of moving some virus from one continent to the other; dispose of a “disposable” cup without seeing it floating back to us in an oceanic garbage patch; buy a dress without affecting the economy of some distant country; or cook a meal without considering the planetary consequences of the menu. Nothing is out of bounds or off grid. By extending our reach, the very success of science

and technology has made our collective actions more momentous and entwined with that of an expanding cast of recalcitrant others (Castells, 1996; Anderson, 2002; Bauman, 2006).

The second reason why controversies about science and technology have become more visible is the transformation of our infrastructures for public debate. Depending on how you count, technoscientific controversies are as old as the Industrial Revolution (Hobsbawm, 1952) or as technology *tout court* (Leroi-Gourhan, 1943, 1964). What is new is the way in which modern media encourage and enable a growing variety of actors to take part in them (Lippmann, 1927; Dewey, 1946). The myth of the scholar perched in an “ivory tower,” indifferent to the noise of the world, has always been false but it has become laughable as scientists and engineers are now routinely receiving media training. Likewise, political actors have always mobilized or criticized science and technology to suit their agendas, but in recent years the mediatization of expert disagreements has become a favorite political weapon as industrial lobbies have learned to amplify scientific uncertainty as a way to stall political action (Proctor & Schiebinger, 2008; Oreskes & Conway, 2010).

More recently, sociotechnical controversies have become even more conspicuous because of the amplification, fragmentation, and acceleration of media debates brought about by the advent of social platforms. Challenging the gatekeeping function of broadcast journalism (Manning White, 1950; Shoemaker & Vos, 2009), online media have allowed more people to join the public conversation, making it more democratic, but also more complex and easier to manipulate (Benkler, 2006; Benkler et al., 2018). In the case of science and technology, this transformation is all the more profound as the challenge to news monopolies has been accompanied by a challenge to knowledge monopolies (Lynch, 2017). The contestation of expert authority and the proposal of alternative knowledge systems has become so visible that some have suggested we have entered a “post-truth” era (Keyes, 2004; Sismondo, 2017). At the same time, the rise of filtering and recommendation algorithms facilitate a selective exposure to ideas close to our point of view (Sears & Freedman, 1967), raising questions about the fragmentation of public discourse (Sunstein, 2001; Pariser, 2011) and the risk of political radicalization (Gerstenfeld et al., 2003). Finally, and maybe most importantly, the increasing competition for attention has accelerated the news cycle (Downs, 1972; Hilgartner & Bosk, 1988; Leskovec et al., 2009a) forcing us to consider a growing number of issues in a shrinking span of time (Venturini, 2019a). The prophecy of Walter Lippmann, one of the fathers of modern journalism, has come true: the modern citizen is “tantalized too often by the foam of events” (1927, p. 5) or, more prosaically, “bewildered as a puppy trying to lick three bones at once” (p. 14).

This overload of issues also explains why conflict has become a favorite genre of modern media. Already in the 1970s, Herbert Simon noted that “in an information-rich world, the wealth of information means a dearth of something else: a scarcity of whatever it is information consumes. What information consumes is rather obvious: it consumes the attention of its recipients” (Simon, 1971, p. 40). Attention (and not information) is therefore the scarce resource whose pursuit increasingly drives the media market and consequently the public debate (Goldhaber, 1997; Crogan & Kinsley, 2012; Terranova, 2012; Citton, 2014). Equally important are the vanishing boundaries that used to separate news from entertainment (Prior, 2005). The convergence of all types of communication in the same digital devices and platforms means that public debates are nowadays in direct competition with all other kinds of online content, “an all-out war for the time of an audience that has more choices than at any point in history” (Klein, 2020, p. 279).

In this ruthless fight for public attention, controversies have a competitive advantage. Because they promote high-activation feelings (Feldman Barrett & Russell, 1998; Clore & Storbeck, 2014), they are very effective in capturing attention and are more likely to be passed along in online networks (Berger & Milkman, 2012; Guadagno et al., 2013). As the alt-right's slogan goes: "conflict is attention and attention is influence" (Marantz, 2019). This practice of using controversy to hijack the media agenda poses a real challenge for controversy mappers, whose cartographic efforts can offer the "oxygen of amplification" (Phillips, 2016) to actors who fuel controversies with the exclusive goal of enhancing their own visibility.

For better or worse, these techno-environmental crises and media evolutions have made controversies increasingly prominent. Ignoring them is no longer an option, but neither is fueling them by sharing them on social media in a burst of outrage or virtue signaling. Instead, we have to learn to patiently unravel their imbroglios and distribute their charges.

Controversy mapping between Actor-Network Theory and digital methods

As ubiquitous as they may be, controversies can be hard to appreciate and take seriously. The desire to avoid them or write them off as irrelevant or malignant increases the appeal of simplifying discourses and populist policies, promoting draconian and even authoritarian solutions (Latour, 2017a). Down with the experts and their subtleties! Down with public debate and its scandals! Lacking the tools and resources to sort properly through our collective disagreements, it is hard to resist the temptation for simple solutions to complicated problems (Zizek, 2008).

This book is a call against that temptation. It is a call to give controversies a chance; an invitation to resist the urge to slash the knots that tie our actions to their multiple consequences and begin caring for them instead. This does not mean sanctifying all controversies, but rather learning to distinguish the conflicts that are nothing but attempts to manipulate public attention from the ones that concern sociotechnical arrangements vital to our collective life.

This effort to unfold public debate, to care for all viewpoints while not giving everyone the same credit, to explore collective disputes and make them more legible, is a form of mapmaking, although not (or not only) in a geographical or even a graphical sense. While information visualization (Klanten & Van Heerden, 2009; Cairo, 2012; Yau, 2012) plays an important role in controversy mapping, the representation we are talking about is not only visual. Rather, the objective of controversy mapping is to unfold sociotechnical disputes in a conceptual space where its multiple actors and issues can be weighed against each other. To equip this type of civic mapmaking with a conceptual and methodological toolbox, we draw on two traditions of social research, namely *Actor-Network Theory* and *Digital Methods*.

Actor-Network Theory (ANT) is a methodological tradition in the social study of science and technology founded in the 1980s by Michel Callon, Bruno Latour, John Law and others. From an ANT perspective, the first step in understanding sociotechnical debates is to not write them off as deviations; mistakes deriving from human irrationality or from a simple shift in the balance of power. Rather, to understand controversies, we must suspend our a priori judgment and resist both *realist* and *relativist* conceptions of truth and power.

Philosophical *realism* is the assumption that the truth is “out there” waiting to be uncovered. It entails a conviction that, as our knowledge of the world extends, so does our capacity to settle controversies. This conception is as old as modern science and resonates across the centuries in the famous motto of Gottfried Leibniz: “Calculemus!” – no need for vain discussions, consensus shall follow once the problem has been rationally figured out.

Relativism, on the other hand, assumes truth to be nothing more than what is accepted at a given point in time. No matter whether such consensus is reached by persuasion or imposition: if all truths are alike, then there is no point in considering the arguments of your opponents (let alone to change your mind). If there is no truth, then there is also no point debating it.

Though diametric opposites, both positions (simplified here for the sake of argument) belittle the relevance of controversies involving science and technology as an object of public inquiry. From a purebred realist viewpoint, controversies are hallmarks of human imperfection, the constant reminder that our knowledge is flawed. Conversely, from a die-hard relativist position, controversies are mere symptoms of a transformation in the balance of forces, a sign that an emergent faction has acquired the strength to challenge the status quo. Neither realists nor relativists have reason to consider controversies as valuable in their own right.

To elude both realism and relativism, controversy mapping relies on the idea that truth and power are built together. As Steven Shapin and Simon Schaffer explain in their book on the birth of the scientific method: “solutions to the problem of knowledge are embedded within practical solutions to the problem of social order, and different practical solutions to the problem of social order encapsulate contrasting practical solutions to the problem of knowledge” (Shapin & Schaffer, 1985, p. 15). Sheila Jasanoff calls this entanglement the “co-production of science and the social order” (2004). To unravel this co-construction, ANT draws on a series of discussions that occupied the interdisciplinary field of Science and Technology Studies (STS) in the 1970s, 1980s and 1990s. These discussions provide the theoretical backbone for controversy mapping and hence for many of the chapters in this book. For readers who would like to delve deeper into the history of controversy analysis in STS, our conversation with Bruno Latour in the postscript offers some context. Trevor Pinch also provides an excellent introduction in a chapter for the *International Encyclopedia of the Social and Behavioral Sciences* (Pinch, 2015; see also Pinch & Leuenberger, 2006). Other accounts are available in the edited volume by Thomas Brante, Steve Fuller and William Lynch on *Controversial Science: From Content to Contention* (Brante et al., 1993) and in Dominique Pestre’s *Introduction aux Science Studies* (Pestre, 2006). Finally, Sheila Jasanoff’s retrospective piece on the “Genealogies of STS” (2012) looks back at controversy studies in STS and considers their role in shaping the identity of STS as an empirical investigation into science epistemology.

For the moment, we can summarize the lessons that controversy mapping takes from this literature in what we call the *cartographer’s creed*:

1. **I will follow the actors.** I will not presume to know better than the people I am studying. I will learn from them what is relevant and important, what belongs to the controversy and what does not. I will not silence the voices I do not agree with or that I find off topic.
2. **I will provide weighting.** I will grant visibility to actors in a way that is proportional to the difference they make in the debate. I will not represent all viewpoints as equally

important but take responsibility for weighting their influence and importance.

3. **I will state my position.** I will not pretend to be disinterested. I will not hide my opinion about the subject I am studying. I will make clear how my stakes in the debate influence how I explore and represent it.
4. **I will stay with the trouble.** I will not avoid the complexity of the controversy by means of methodological or theoretical shortcuts. I will not use my explanatory framework to take refuge from the incongruity and bewildering richness of social situations.
5. **I will follow the medium.** I will take advantage of the fact that controversies are made public, and thus mediated and recorded, by digital technologies. While investigating these records, I will also investigate the sociotechnical infrastructures that produce them and consider the specific ways in which they act upon the situation they mediate.
6. **I will draw legible maps.** In order to provide overview and facilitate navigation, maps are necessarily simplifications of the territory they represent. Making legible maps of sociotechnical debates is the only legitimate reason for reducing the complexity of a controversy. Yet, my simplification will be cautious, transparent, respectful, and leave others the possibility to reverse it.
7. **I will open my inquiry to others.** Whenever possible, I will make publicly available the data I collect, the code I develop, and the text and images I produce. I will share my investigation with the people that have stakes in it and invite them to participate.

The cartographer's creed is easy to swear by, but difficult to live by, and it requires research methods that are up to the task. Controversies are especially resistant to the methodological simplification imposed by the conventional divide between qualitative and quantitative methods. This divide forces scholars to choose between delving into the details of the specific interactions of a local situation (say a secluded tribe, a routinized professional practice, or a domestic scene) or contemplating the aggregated signature of vast societal trends (say electoral dynamics, fluctuations of salaries and expenses, or surveys of opinion dynamics). Controversies do not resemble either.

This is why controversy mapping has increasingly been drawing on so-called *digital methods* (Rogers, 2013a) as a reaction to the digitization of public debate. Digital media have contributed to making controversies more visible, but they have also made them more traceable. Because of both their technical infrastructures and their business models, digital media are extremely efficient in tracing collective interactions (van Dijck, 2013). Most of their records, unfortunately, remain within the platforms that produce them, but some of them are made publicly available and can be repurposed for research. Digital records offer an opportunity for bypassing the divide between qualitative and quantitative research (Venturini & Latour, 2010; Munk, 2019). The idea that digital media can become the basis for a new generation of quali-quantitative research has been put forward by Bruno Latour (Latour, 2007; Latour *et al.*, 2012) and implemented in the work of Richard Rogers (2013a), Noortje Marres (2017), and a growing number of scholars experimenting with the research affordances of digital records.

While digital methods offer exciting research opportunities and have a central place in this book, it is important to recognize that their use in controversy mapping has been informed by a research tradition that was built primarily on methods from ethnography and

semiotics. As a first example of controversy mapping, we will therefore draw on one instance of such research.

The elephant in the room

On April 4 and 5, 1995, the Serena Lodge of the Amboseli National Park in Kenya hosted a two-day stakeholder workshop for the administrators and personnel of the park, the indigenous Maasai communities, local and foreign ecologists, tour operators, local journalists and policymakers, as well as national and international donors. The goal of the meeting was to discuss the fate of the local elephant population and, in particular, the possibility of reducing their numbers in the park. Raising questions about the preservation of a landmark African species and about land management in postcolonial Africa, the workshop was predictably controversial and, in many ways, typical of public debates about science and technology. Charis Thompson's case study of the Amboseli elephants and their many stakeholders (Thompson, 2002; see also Denayer, 2013) thus provides a first example of the kind of terrain that controversy mappers are trying to chart.

What? From knowledge claims to debates

Statement one: "Elephants are a keystone species whose density is crucial to keep the Kenyan ecosystems in balance. The right concentration of elephants sustains biodiversity in the savannah, where their grazing removes shrubs and keeps the plains open for other species, and in the forest, where it creates clearings and favors revegetation. However, an excessive concentration of elephants, such as the one observed in Amboseli, can lead to the disappearance of woodland and eventually to a decline in biodiversity."

Statement two: "The African elephant is a species of exceptional conservation value. Not only are the animals majestic and unique, they are also highly intelligent and capable of sophisticated matriarchal social systems. Furthermore, the Amboseli elephants have been studied for over 20 years, which has allowed scientists to accumulate the necessary knowledge to sustain a research program on these animals and their collective organization."

Considered in isolation, neither of the statements above are controversial. Both are empirically sound, logically coherent and generally accepted by Amboseli stakeholders. The controversy, however, becomes immediately visible when the statements are read together as two opposing arguments in an ongoing conversation about wildlife management. The first suggests that, in order to enhance the biodiversity of the region, some elephants should be pushed out of the park (where their concentration is too high) to the neighboring areas (where their concentration is too low). The second maintains that elephants, because of their unique social lives, should have priority over other ecological considerations and should be allowed to remain in the park where they could be more safely protected from poaching and other threats. The first movement of controversy mapping, therefore, is to make visible how expert knowledge is never valid in itself, but always in relation to a series of claims which support or oppose each other.

The tree of disagreements shown in [figure 1](#) allows us to visualize the *battle lines* of the controversy, which are sometimes unique and relatively clear (as in the Amboseli controversy) and other times multiple and fractured. It also allows us to appreciate the way in which knowledge claims are never simple statements of fact, but attempts to prescribe how a situation should be handled. The first statement above is not only an observation on

how elephants interact with their environment, it is also a “speech act” (Austin, 1962; Searle, 1969) meant to curb the numbers of Amboseli elephants, by encouraging them to migrate from the park. Likewise, the second statement is not a generic praise of elephants; it is a specific plea for protecting Amboseli’s elephant population within the established structures of the national park. In sociotechnical controversies, statements are always connected in arguments and arguments are always set forth as proposals for action. In controversies, knowledge is always enmeshed with politics.

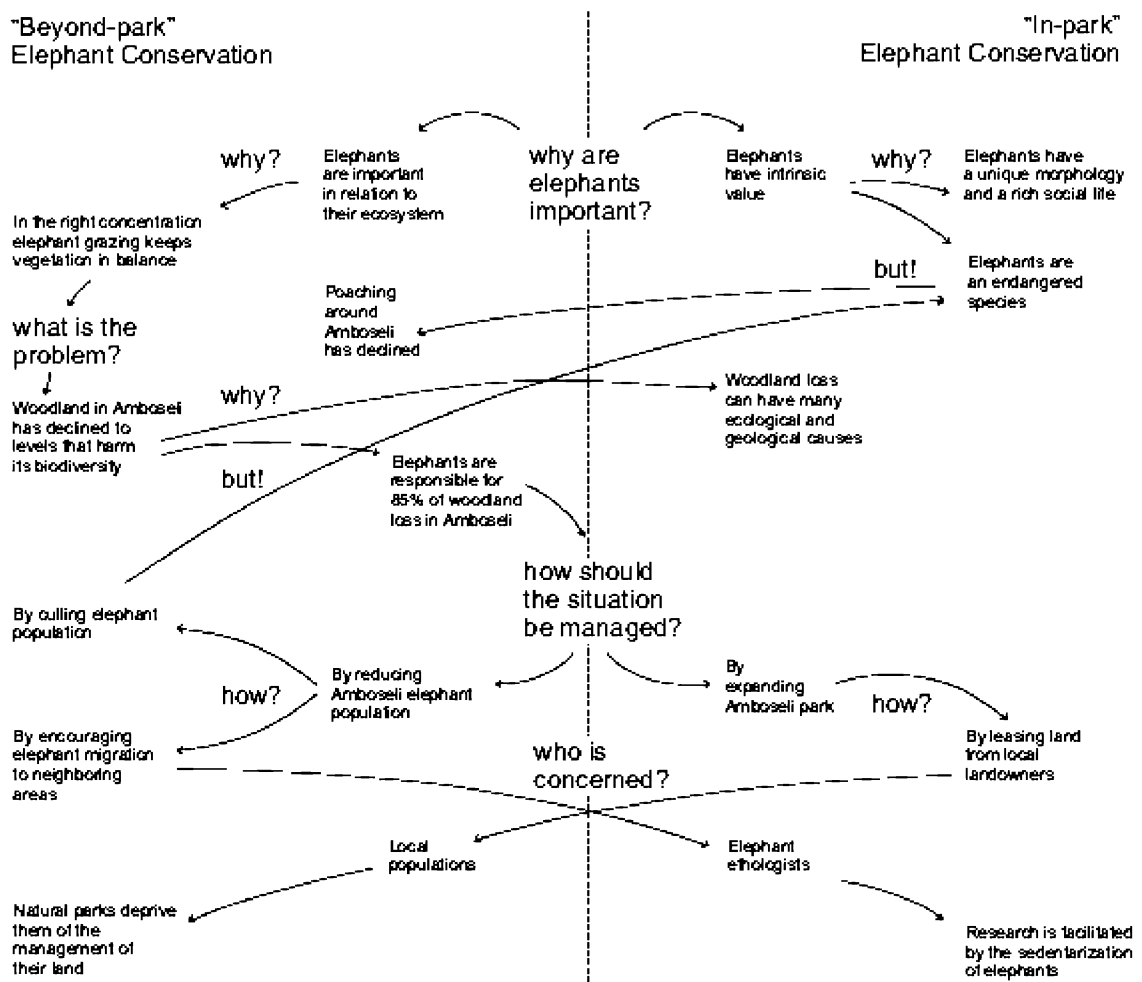


Figure 1 Tree of disagreements around the conservation of Amboseli elephants. Western’s position and its associated knowledge claims and prescribed actions on the left, Moss’s position on the right. Main battle line in the middle (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

Who? From debates to actors

Showing that a knowledge claim is always an argument in a debate and a call to action is the first step. The second is to clarify how these debates are inseparable from the actors that stage them. A trivial way to understand this connection is to simply recognize that the action-agendas enabled by specific knowledge claims tend to be connected to the position of the actors who make the claims. In Thompson’s example, it is telling that arguments similar to those summarized in the first statement above were voiced during the Amboseli

workshop by a local conservationist, David Western, who was at the time the director of the Kenyan Wildlife Service and, as such, in charge of conserving national biodiversity. And arguments similar to those summarized in the second statement were made by an American ethologist, Cynthia Moss, who was renowned for having studied the elephant population in Amboseli for more than 20 years. Associating knowledge claims with the actors that state them thus makes it easier to appreciate the opposition between a position centered on the conservation of the overall ecosystem and a position focused on safeguarding the elephant community. It also suggests that while defending different land management strategies, Western and Moss were also defending their respective careers.

Unveiling power struggles behind intellectual positions is a classic move in the sociology of science. Within controversy mapping, however, it is not enough to recognize that different experts can have different stakes in a debate. In practice, what this recognition often entails is that the very substance of what is being discussed has radically different meanings for the different actor positions. For instance, the disagreement between Western and Moss about how nature should be conserved at Amboseli can be traced back to the different meanings that each of them attached to the notions of “nature” and “conservation” – Thompson (2002) calls it “competing philosophies of nature.”

As an ecologist, David Western was trained to consider nature as the general balance between flora and fauna, while Cynthia Moss, *as an ethologist*, has built her expertise around one key species, the elephants. Beside this general disciplinary gap, the visions of nature of the two scientists were also manifested in their different observational practices and settings. Moss had a long experience observing the elephants of the park, having spent several years living with them. She had named each member of the herd and compiled the life history of many of them. The practice of naming animals is common among ethologists and extremely useful when collecting longitudinal data over extended time periods where interobserver identification must be facilitated. Yet, it is often criticized for the risk of anthropomorphizing the animals and considering them individually rather than as part of an ecosystem. On the other hand, Western’s appraisal of the situation rested on a series of experiments that he pioneered using electrical fences of different heights to selectively restrict the access of wildlife to different plots in the park. This experimental setup allowed Western and his colleagues to separate the effects of elephants, smaller mammals, invertebrates and other animals, but also encouraged the ecologists to look at animals from afar, considering only their size and their aggregated statistical effects.

Likewise, Western and Moss had radically different ideas about conservation. In the Amboseli controversy, Moss championed the older doctrine of conservation that inspired the creation of natural parks, according to which nature is best preserved when separated from local human activities and managed by national or (even better) international institutions. Western, on the other hand, advocated for the conservation of biodiversity in the whole region (not just in the park) and for the involvement of local Maasai communities. For Moss, conservation meant enforcing the boundaries of the park; for Western it meant erasing them. No wonder they ended up on opposite sides of the debate. To be sure, Western and Moss were not the only actors engaged in the controversy, just like “nature” and “conservation” were not the only issues at stake, and a proper cartography should chart this multiplicity of actors and issues to be viewed (see [figure 2](#)).

Moving from debates to actors, therefore, means accounting for the fact that, even when they discuss the same issues, actors in a controversy may well be speaking about, and acting on, very different things.

How? From actors to networks

In the same way as claims are never isolated from the actors who make them, so actors are always tangled in complex alliances with and against each other. It would be wrong, for instance, to portray the Amboseli controversy as a personal confrontation between two scientists. If anything, Western and Moss temporarily became the spokespersons for two heterogeneous coalitions, comprising not only humans, but also animals, plants, political and economic institutions, and their actions were constrained by the interests and positions of these cohorts of allies. In fact, actors are themselves coalitions that compose and decompose depending on the situation. At times, the elephants make a difference as a species; at other times, as individual, sentient beings. Sometimes, the elephant research group speaks as a whole; sometimes its individual researchers speak for themselves.

Some actors can morph and change status as the controversy evolves. The nomadic Maasai living in the area, for example, were initially opposed to the park and the way it hindered their traditional migrations. With the establishment of the park, however, some Maasai found jobs in the institution and adopted a sedentary lifestyle, thus changing sides in the controversy. As a consequence, the Maasai people cannot be considered as one unanimous actor, but need to be broken into two divergent groups – or three if you count the Maasai representatives present at the Serena Lodge, torn between the two constituencies that they needed to represent. You can begin to appreciate how this dynamic complicates the task of representing the controversy!

		"Beyond-park" Elephant Conservation				"In-park" Elephant Conservation		
		David Western	Maasai communities	Kenyan government	Local press	Tour operators	International donors	Cynthia Moss
Issues	Actors							
Nature		the overall diversity and balance of ecosystems	an inseparable element of collective existence	a national resource to be strategically managed	a topic of interest for public opinion	a touristic attraction	a world heritage	specific species with outstanding zoological value
Elephants		a keystone species crucial to keep the ecosystem in balance	affect/compulsion in the use of land & natural resources	an African landmark species	an African landmark species	a touristic attraction	a species with an exceptional morphology and social life	a community of animals with individual names and life stories
Conservation		the caution of the processes that support biodiversity	the traditional ways of living in balance with one's land	one of the components of national land use planning	a potential source of political controversies	a threat/competitors in the exploitation of natural resources	a responsibility of the international community	the preservation of wildlife
Local communities		traditional experts and potential allies in biodiversity management	the rightful owners and custodians of the region	one of the many stakeholders to be taken into consideration	a potential readership	a threat/competitors in the exploitation of natural resources	a potential threat to wildlife	a potential threat to wildlife
Natural parks		a solution that risks creating a harmful and double-sided asymmetry	a threat to traditional land use and a source of economic resources	a solution to manage natural resources and attract international funds	a potential source of political controversies	an institutional context for commercial activities	national institutions funded and monitored by the international community	an established solution to shield wildlife from humans
Scientific expertise		an activity that should be made accessible to local stakeholders	a type of knowledge that should interact with traditional culture	a guide and a justification for national policies	a source of information to understand human and natural developments	a threat/competitors in the exploitation of natural resources	a guide and a justification for international policies	a specialized activity restricted to experts and their peers

Figure 2 Actor/issue table of the Amboseli controversy. Actors in the columns and their reading of different issues in the rows. Shading indicates the level of commitment to “beyond-park” or “in-park” solutions (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

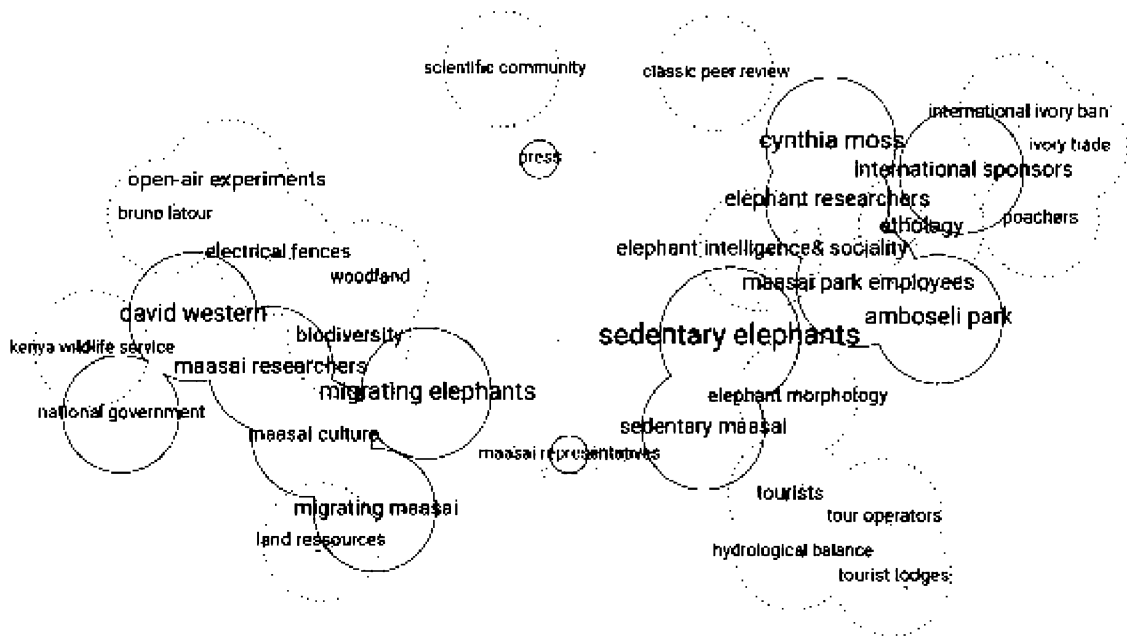


Figure 3 Network of actors in the Amboseli controversy. The alliance of actors supporting the “beyond-park” solution on the left, the alliance supporting the “in-park” solution on the right. Neutral actors are circled with dotted lines. Hesitant actors are marked with a gray halo (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

As illustrated in [figure 3](#), Western’s position was backed by the local government, which saw it as a possibility for asserting closer control over land use in the region. Moss’s ideas, on the other hand, were better aligned with international sponsors and their fear that local management of the environment would be more exposed to corruption and political instability. Other groups such as the tour operators were divided between those preferring to keep working within the established frame of national parks and those willing to explore community-based forms of tourism.

Key to tipping the scale of the controversy was the support of the representatives of the native Maasai communities and the press. The Maasai were split as different individuals had been collaborating with each scientist either by helping with the care of the park’s elephants or by contributing to developing the new paradigm of community-based conservation. Also, communities that had preserved the traditional nomadic culture were favorable to the idea of returning to their migrating habits; while communities who had embraced a more sedentary lifestyle were afraid that roaming elephants could damage their settlements around the park. In Thompson’s account we hear that the elephant research group tried until late in the night to rally the Maasai representatives to their cause. Eventually, however, the Maasai’s representatives joined Western’s position as his approach to conservation was better aligned with their ecological expertise and with the lack of opposition between human and nature at the heart of their culture.

As for the press, its sympathy initially went to Cynthia Moss who had earned a considerable reputation for her research and her devotion to elephant conservation. The support of the press, however, was eventually won by Western, through the mobilization of another actor – interestingly, a non-human one. The different experimental setups employed by Moss and Western had unequal capacities for sharing. Moss’s immersion in

elephant life produced knowledge that could not be easily exhibited in a two-day workshop. Western's fence setup, on the other hand, had been deliberately developed to facilitate the witnessing by nonexperts. During the workshop, Western staged a dramatic open-air experiment inviting all the participants to leave the conference room and travel through the park to observe fenced plots with different tree densities. The mobilization of the ecological experiments was such a coup that Moss and the other elephant ethologists ostentatiously refused to participate in the field trip, giving Western the upper hand in convincing the press.

Where? From networks to worldviews

Networks are great visual tools to explore the relationship between actors and issues, but they have the disadvantage of flattening the landscape and hiding a crucial feature of sociotechnical debates, namely the way in which they telescope larger socio-political oppositions into smaller technical details. Even if they are fought on smaller and more concrete questions, controversies almost always entail an opposition between some larger, conflicting worldviews (or "cosmoses," to use the notion of Isabelle Stengers, 1996). As noted by Thompson, African elephants stand for "competing philosophies of nature and these different philosophies are in turn metonymic for key disputes in science and epistemology, in distributive justice, and in governance" (2002, p. 167).

A first opposition in the controversy concerns the level at which nature should be defined. There was a fundamental scale difference between the ethological approach of Cynthia Moss and its zeroing in on Amboseli elephants and the ecological approach of David Western and its attention to the broader equilibrium of the ecosystem (see [figure 4](#)). Similarly, by emphasizing the importance of park borders in protecting wildlife, Moss's position was distinctively more localized than the "beyond-park" approach advocated by Western.

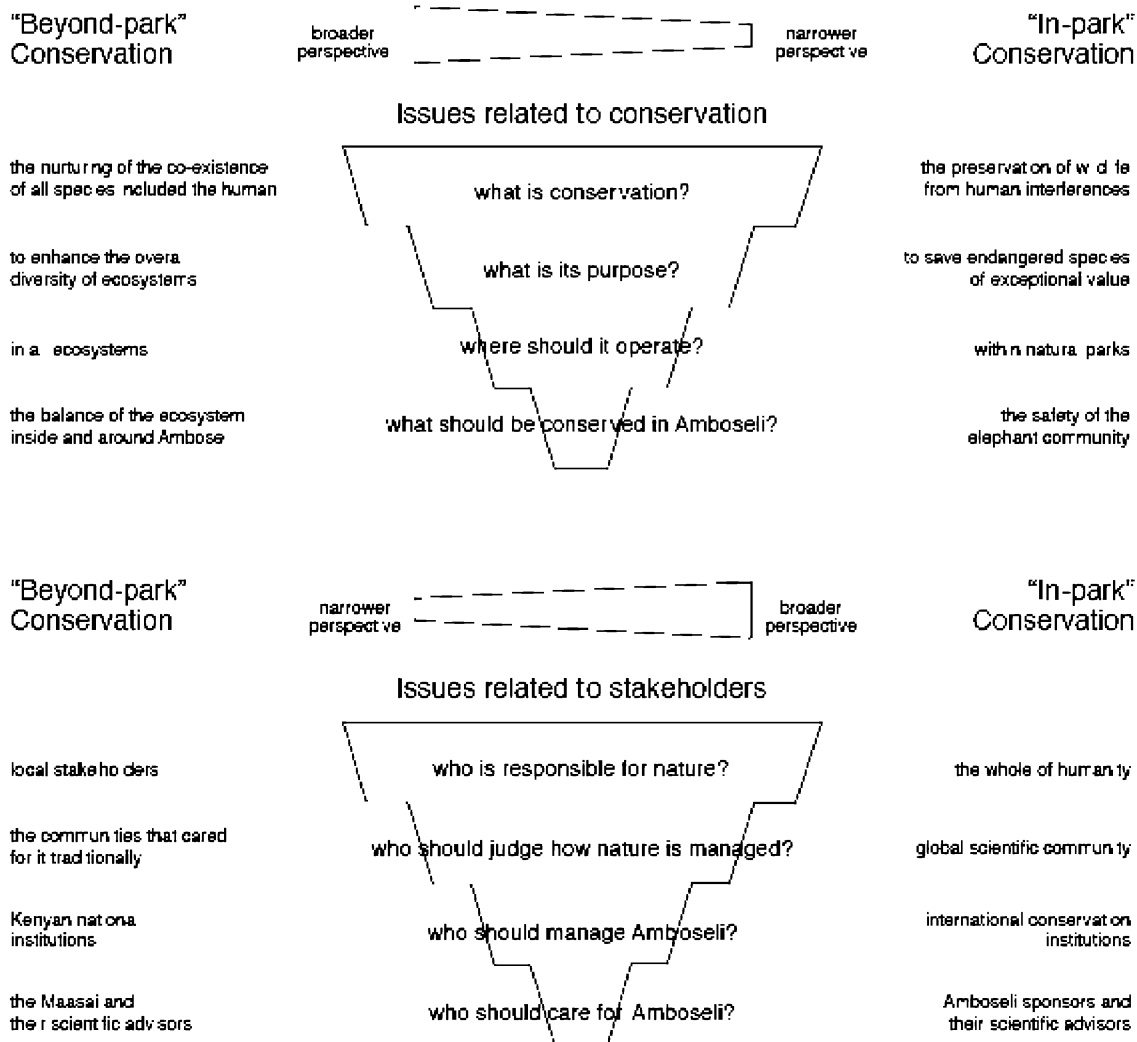


Figure 4 Debate scales and scale inversion in the Amboseli controversy. On the left, the positions of actors in favor of “beyond-park” conservation; on the right, those of actors in favor of “in-park” conservation. The upper half of the diagram focuses on questions related to nature conservation, where “beyond-park conservation” advocates for a broader perspective on most issues; the lower half focuses on questions about the role of stakeholders, where “in-park” conservation advocates for a broader perspective. In both cases, questions become more specific from the top to the bottom of the inverted pyramid (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

Yet, as often happens in controversies, the relative position of actors towards each other changes from issue to issue. When it came to the question of natural management, the stance of the protagonists was inverted, with Western arguing for the involvement of local constituents, and Moss adopting a more globalized viewpoint according to which African wildlife is a world heritage whose preservation should be the responsibility of the international community. Similarly, the model of science promoted by Western was based on direct witnessing and local participation (hence his emphasis on open-air experiments), in opposition to the more purified version of science championed by Moss. Opposing the organization of the workshop, Moss claimed that if Western and the Maasai had solid data

they should publish them in peer-reviewed international journals. She also opposed the decision of inviting the press to the workshop, claiming that its presence was irrelevant to the scientific decisions to be taken.

When? From worldviews to change

Finally, one should never forget that sociotechnical debates are dynamic situations whose configuration can vary in deep and sometimes unexpected ways. This means not only that the balance of power can change during and because of a controversy, but also that the substance of the debate can evolve and, along with it, the cast of actors and issues. The Amboseli dispute offers a good example of both (see [figure 5](#)).

Up until the 1970s, Amboseli had been a scene for various migrations. As a consequence of the hydrological influence of Mount Kilimanjaro, the native Maasai population, their livestock, and the local wildlife lived a nomadic life moving to the central swamp of the savannah in the dry season and out again in the rainy season. With the decolonization of Kenya, however, settlements began to appear in the area, limiting the mobility of the inhabitants of Amboseli. In the same period, the value of ivory skyrocketed and with it the activity of poachers in the region.

The combined threat of settlements and poachers had two consequences. It almost halved the population of elephants in the area and pushed the survivors to stop migrating and take refuge in the center of the newly established national park. It also encouraged the emergence of a wide international mobilization for the defense of wildlife and of elephants in particular. David Western and Cynthia Moss were solid allies in this fight, the first through his work in the field of nature conservation, the second with her internationally acclaimed accounts of elephant life (originally commissioned by Western himself). In 1974, this mobilization led to the establishment of Amboseli National Park itself and in 1989 to an international ban on the ivory trade.

In the 1980s, the success of the wildlife protection policies had led to a fivefold increase in the density of the elephants in Amboseli, effecting, according to some observers, a severe loss of woodland and biodiversity. The link between elephants and deforestation had been a matter of controversy for a long time. In the 1970s, Western himself had opposed this link, blaming instead the excessive salinity of water from Mount Kilimanjaro. In the 1980s, however, the results of the electric fence experiments convinced Western that resuming the elephants' migration was necessary to safeguard biodiversity. Accordingly, he asked the Wildlife Service to open a discussion on the overconcentration of elephants but was refused several times because of stiff opposition from the ethologists and the international sponsors of the park.

**"Beyond-park"
Elephant Conservation**

**"In-park"
Elephant Conservation**

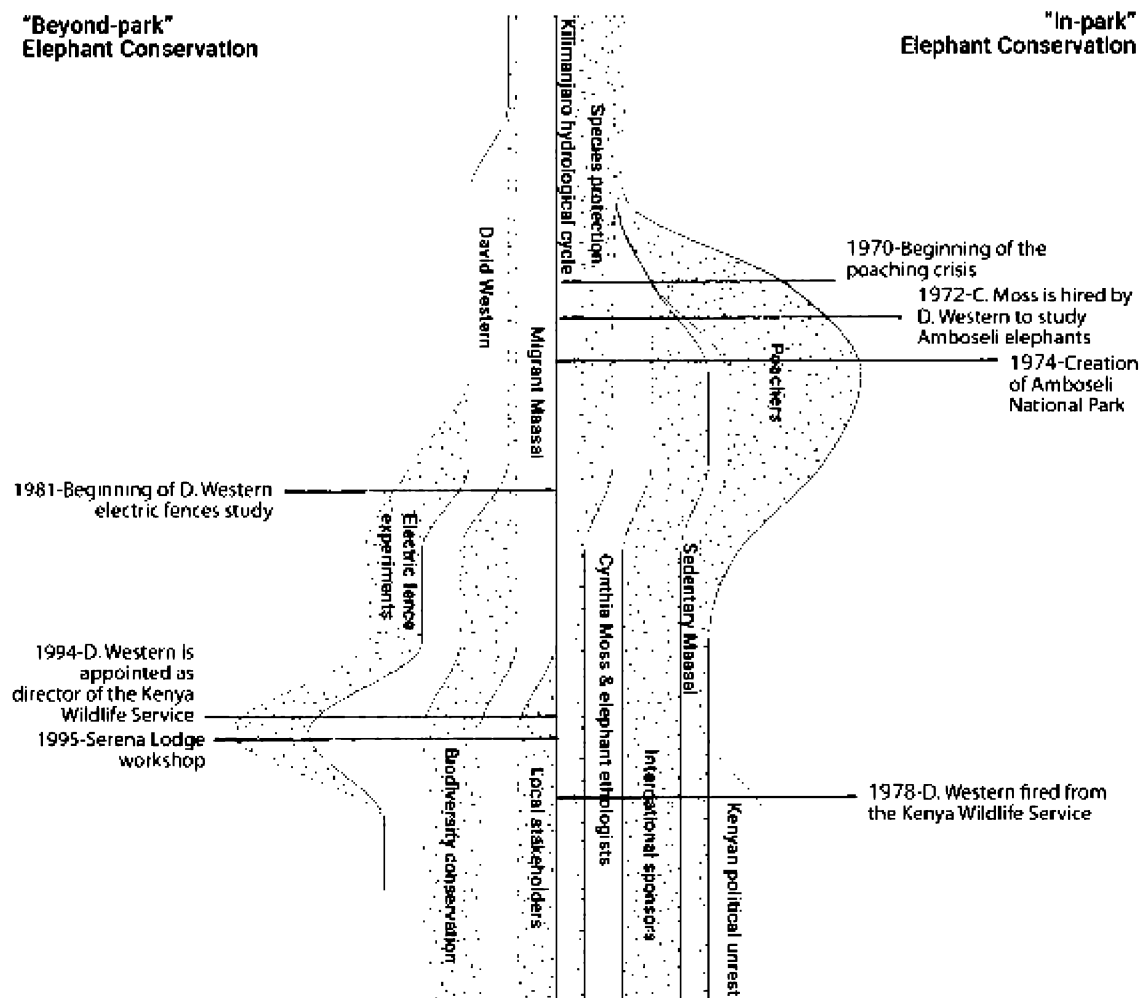


Figure 5 Stream diagram of the temporal evolution of the Amboseli controversy. Time flows from the top to the bottom of the diagram with each stream representing an actor. The size of each stream indicates the level of engagement of that particular actor at a particular moment in time according to a qualitative estimation (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

Only in 1995, after taking over the direction of the Wildlife Service, did Western manage to convene the workshop at Serena Lodge. Having full control over the agenda for the meeting, its participants (which featured prominent local stakeholders), and its schedule (which included a visit to the fenced plots in the park), Western used the occasion as a tipping point for his "beyond-parks" conservation approach. In the 1990s, such an approach had the wind in its sails thanks to a general decline in poaching, the rise of conservation biology and its focus on biodiversity, and the growing demands for more locally controlled land use management.

The success of Western's approach, however, was not irreversible and in the following years it was put under pressure by the change of circumstances in Kenya. In the late 1990s, political turbulence, droughts, floods, and disease outbreaks tested the local model of natural management to breaking point. The devolution of national institutions exposed the Kenyan Wildlife Service to political unrest and in 1998, Western was fired and replaced

with one of his most prominent critics. This change in the balance of forces illustrates how fragile the arrangement favored by Western really was and how its success was only possible in a brief period between the end of the poaching crisis and the beginning of Kenyan political unrest. Yet, that brief period did empower a series of local stakeholders (Maasai groups, regional authorities, local wildlife associations) who, thanks to the connections created in the 1990s, remained influential in the promotion of local and beyond-park natural management.

Charis Thompson's analysis of the Amboseli elephant controversy offers a brilliant example of how a well-chosen field site can allow you to study issues that span far beyond the two days of the workshop and the walls of the Serena Lodge. However, not all controversies are conveniently observable from a pivotal situation where opposing sides encounter each other and attempt to settle their scores. More often, sociotechnical debates are distributed over networks of actions extending to distant times and places. This is why conventional ethnographic methods alone are not always sufficient for controversy mapping and why, as argued in this book, digital methods can be of invaluable help.

What controversy mapping is not

Combining Actor-Network Theory and Digital Methods, controversy mapping inherits some of their strengths, but also some of their blind spots. As a research method, it is well-suited for situations where the actors explicitly challenge each other, but it can be blind to situations where power is presumed rather than questioned. Compared to other types of conflict, controversies over scientific discoveries or technological innovations have the advantage of being relatively explicit. The high level of formalization that characterizes modern technoscience (Koyré, 1948) also means that its disagreements are, in general, extensively documented (Venturini, 2007a). While these disputes can have their share of secrecy and silence, few controversies in science and technology can be closed without some exposure to the validation of the scientific community. Furthermore, the fact that current controversies are heavily mediatized and thereby exposed to public scrutiny also ensures that power is explicitly questioned and arguments made public.

As we shall see in the next chapter, controversies are convenient objects of investigation precisely because they constitute the moments in which what is usually tacit and taken for granted becomes the explicit object of discussion. But such a focus may indeed risk drawing attention away from the situations where dissent is successfully silenced by dominant actors. The habit of working with public knowledge controversies may have made our approach unsuited to study situations where domination is exerted not by pushing one's position explicitly, but by suppressing the alternatives. Controversy mapping is well-equipped to describe the tactics that the actors use to push their agenda, less so to reveal the implicit forms of power (and resistance to power) that are deeply embedded in collective institutions (Foucault, 1975), individual habits (Goffman, 1961), and bodily postures (Bourdieu, 1990).

Similarly, while digital methods can help illuminate public debates, they are incapable of documenting collective life in its entirety. Even if social media platforms and search engines are constantly expanding their reach (Bogost & Montfort, 2009; Helmond, 2015), they do not cover the entire World Wide Web, and luckily so. Every day hundreds of thousands of new webpages are created and only a fraction is reached by "likes" and search crawlers. Likewise, even if more and more information is exchanged through the Web, a

large slice of electronic traffic travels through other routes. Emails, teleconferences, chats, peer-to-peer exchanges, mobile apps, document transfers, and many other types of digital information do not circulate via Web protocols. Besides, many digital records do not circulate at all. Not every digital inscription is shared on a computer network and not all networks are connected to the Internet. Finally, even if digital devices are more and more ubiquitous, not all social interactions are digitally mediated.

Mind that this is not just a question of coverage. Digital records come with all sorts of biases connected to the conditions of their production. Sometime these biases can be taken into account (Venturini et al., 2018) and even exploited for research (Marres & Moats, 2015), but sometimes they distort observations to the point of making them useless as a proxy for the phenomena they are supposed to capture (Venturini and Rogers, 2019). Imagine that the Amboseli elephant situation had been discussed through social media rather than in an onsite workshop. Leveraging her greater media exposure, Moss might have mobilized hordes of elephant lovers to throw their weight behind her position – elephants are, after all, more instagramable than fence experiments – and by that concealed, but not necessarily outplayed, the subtle strategies employed by Western to bring the Maasai on his side by collaborating and living with them over several years.

A peek into the table of contents

Controversy mapping, like other forms of cartography, is a craft that is best acquired in practice. This is why this book is a field guide. True to its title, it is intended to accompany you in your fieldwork, when – as a researcher but also as an activist, a journalist, a decision maker, or an engaged citizen – you set out to explore a sociotechnical debate. It takes inspiration from the manuals that have assisted generations of ethnographers in their anthropological explorations, but also from popular handbooks for the identification of wildlife, edible plants, rare minerals, or celestial constellations. True to the genre and to its cartographic orientation, this field guide comes with many illustrations, many of which have been created for the purpose and are free to be reused under the license: Creative Commons Attribution-ShareAlike 4.0 International License. This applies to the following figures: 1, 2, 3, 4, 5, 9, 10, 11, 19, 20, 21, 27, 28, 34b, 43, 44, 45, 46, 47, 48, 50, 51, 52, 62, 63, 64, 65, 69, 71, 72, 78, 79, 80, 81, 82, and 83. All images are available at <https://hal.archives-ouvertes.fr/hal-03227146>.

Chapter 1, *Why map controversies?*, discusses the rationale of controversy mapping. It argues that controversies, if carefully mapped, can deliver three main contributions. First, they open up the black boxes of the scientific and technological infrastructures that invisibly but effectively shape our collective life. Second, they constitute the moments in which the design of these infrastructures can be tested before being stabilized. Third, they represent occasions in which sociotechnical arrangements may be subjected to democratic deliberation. The chapter also provides some methodological guidance on how to choose and delimit a controversy so that it can feasibly be mapped.

Chapter 2, *A proliferation of issues*, begins to unravel the complexity of sociotechnical disputes by introducing a series of examples derived from the literature in Science and Technology Studies and relevant for the exploration of controversies. The catalog we develop includes a variety of issues found within the academic community (organized skepticism; paradigmatic shifts; disputes over academic conventions and scholarly authority; clashes between theoretical and experimental knowledge) and beyond it (through

the alliances and oppositions built by laboratory work; questions about public engagement and legitimate expertise; the social consequences of technological innovations; and their ontological multiplicity).

[Chapter 3](#), *Making room for more actors*, presents some of the typical characters in the cast of sociotechnical controversies and helps you recognize them and appreciate their role. After a brief recollection of the usual protagonists of political debates (decision makers, regulators, activists), the chapter moves on to consider the actors that are more specific to sociotechnical debates. Moving from the center to the periphery of technoscience, it describes the role played by scientists and engineers, experts and lay experts, citizens and citizen-scientists, scientific campaigners and professional skeptics. But the heterogeneity of sociotechnical controversies goes further. Defying the classical distinctions of social theory (but also the separation between social and natural sciences, humanities, and engineering), controversies mobilize all sorts of non-human actors. The second half of the chapter thus discusses the importance of actors such as scientific devices and technological innovations.

We then move to present the main methodological techniques employed by controversy mapping. [Chapter 4](#), *Exploring controversies as actor-networks*, provides a hands-on introduction to Actor-Network Theory, in many ways the theoretical and methodological foundation of controversy mapping. The chapter provides practical instructions drawn from ANT's peculiar way of looking at collective action as well as the way in which its founders have imported and adapted techniques from ethnography and semiotics.

[Chapter 5](#), *Exploring controversies with digital methods*, retraces the quest for qualiquantitative methods first through scientometrics and then through digital methods. It argues that, because of the increasing diversity of records that they produce, digital media are not only a new object of study, but also an occasion to renew practices of social research. The chapter acknowledges the potential of records that are both intensive (in the details they offer) and extensive (in their spatial and temporal coverage), but also discusses the risk of naturalizing them and neglecting their multiple biases.

Diving into the details of the digital methods research chain, [chapter 6](#), *Collecting and curating digital records*, demonstrates how electronic records can be collected by querying search engines, scraping information from structured documents, and crawling the Web. The chapter concludes by considering how digital inscriptions can be transformed into a corpus for social research through a process of cleaning and enriching.

[Chapter 7](#) focuses on *Visual network analysis*, an original technique for translating relational patterns into visual features. This technique is particularly suited for controversy mapping because it implements in practice a key idea from Actor-Network Theory: the importance of being sensitive to differences in the density of associations between a variety of heterogeneous actors. The chapter discusses the conceptual implications of this method and provides a detailed presentation of its techniques.

[Chapter 8](#), *Representing controversies*, discusses how to visualize the results of a controversy mapping project. It first addresses this question from a conceptual point of view, drawing a comparison between controversy mapping and geographical cartography. The chapter proceeds to consider the notion of second-degree objectivity, that is to say the way in which controversy mapping tries to present multiple viewpoints but also to weigh them according to their relevance and importance. Finally, it provides practical guidance on the production of a controversy atlas as a vehicle for story-telling and exploration.

Chapter 9, *Mapmaking as a form of intervention*, situates controversy mapping amongst other forms of public engagement and discusses its radical openness to different types of actors and its commitment to doing inquiry in collaboration with its publics. To organize this co-construction, we suggest the use of data sprints: a research format we developed to mobilize different controversy stakeholders as part of the mapmaking process.

The conclusion acknowledges that controversy mapping comes with a distinctive political goal. As the globalization facilitated by modern technoscience proves itself more and more environmentally unsustainable and socially unjust, public opinion is increasingly tempted to match this extreme challenge with extreme political solutions. Against this temptation, this book is a call for reinvigorating democratic institutions.

Each chapter is introduced by a vignette presenting an example from a controversy that we have previously mapped, and illustrating the ideas discussed in the chapter. Like any other field guide, the book can be read from the comfort of your armchair (savoring your next journey in the perilous but fascinating realm of technoscientific controversies), but it is more useful as a travel companion. Put it in your backpack and set out for the exploration of a controversy you care about. If this guide heightens your attention to the landscape you travel and opens your mind to the encounters that await you, it will have achieved half its objectives. If it also helps you to draw up a sketch of the terrain that is useful to others, it will have succeeded in the other half. *Bon voyage.*

Part One

Features of controversial landscapes

1

Why map controversies?

In this chapter, we learn about controversies as a way to study science in society, design better technological solutions or promote democratic inquiry, but also why controversies can be hard to navigate and why mapmaking is never neutral.

Controversies tend to get cartographers caught up in their mess. This can be both awkward and laborious, and it raises the question of why one should engage with controversy mapping in the first place. If you already align with a specific viewpoint, mapping a controversy can seem like a waste of time. If you know who is right and who is wrong, why bother considering the other positions? If all you want is to tip a scale, there are more efficient ways to do it than through mapmaking. But even if you genuinely want to help actors find their way around the debate, you will find that mapping is always in the interest of some and to the detriment of others.

By treating controversies as “generative events” (Whatmore, 2009), i.e. not as problems that need fixing but as occasions to investigate public debate when the social fabric is under transformation, controversy mapping highlights their troubles rather than explaining them away. This attention is not always welcomed and the very act of calling something a controversy can itself be controversial. Indeed, making the complexity of a controversy manifest can run directly contrary to the agenda of those who rely on simplification to make their point. No matter how hard you try to be impartial, in a controversy you are either complicit or irrelevant. To become a mapmaker is to accept complicity. The question, then, is not how to keep your hands clean, but why get them dirty?

In 2013, we were working on a research project exploring the use of Electronic Maps to Assist Public Science (EMAPS) around climate change (Venturini et al., 2014b). One of the issues we worked with was vulnerability indexes, i.e. ways of measuring countries’ exposure to climate change impacts and thus decide the distribution of adaptation aid. One of the maps we produced ([figure 6](#)) illustrates how three of the most common climate vulnerability indexes diverge in their assessment. Countries like Australia, Canada, Germany, or Brazil, for example, are considered very vulnerable by some indexes and not vulnerable by others.

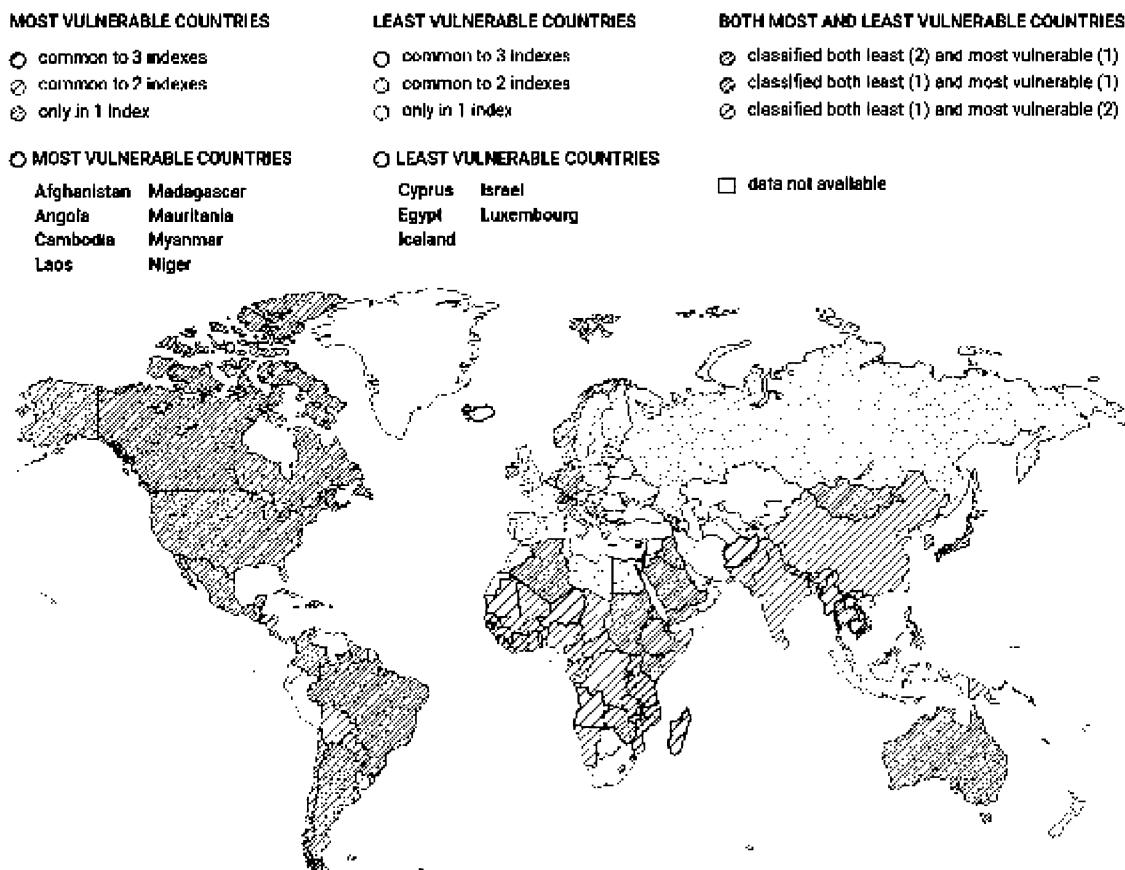


Figure 6 Map of how three different indexes of vulnerability disagree in assessing countries' vulnerability to climate change. Only countries with a bold border are classified unanimously as either most or least vulnerable by all three indexes (adapted from the EMAPS project, climaps.eu and licensed under CC BY-SA 4.0).

The map in [figure 6](#) visualizes a central aspect of the controversy, namely that climate change vulnerability can mean different things and hence be assessed in different ways. It does not, however, take sides in the matter, at least not in the sense of accusing one index as being in the pocket of a given country, or writing off another index as unscientific. Yet, the map may still run against the interest of some actors. This is a field where plenty of countries and non-governmental organizations (NGOs) have well-informed opinions about how vulnerability should be evaluated or how to guide funding. Countries that provide adaptation aid, for instance, may not welcome the occasion to question how they spend their money. Funding bodies may fear that studying the situation as a controversy will give visibility to arguments that they would rather silence or show a diversity of opinions that would make their own position less obvious.

Realizing that there is no disinterested representation of the vulnerability debate, we decided to design a new map exploring how the interests of different adaptation funders align with different indexes. In [figure 7](#), we matched the way countries distribute their adaptation aid with the vulnerability of receiving countries according to different indexes. Canada, for example, helps countries that are vulnerable according to the GAIN index, but not according to the Germanwatch index. The UK, on the other hand, spends money on countries that are not particularly vulnerable according to any of the indexes.

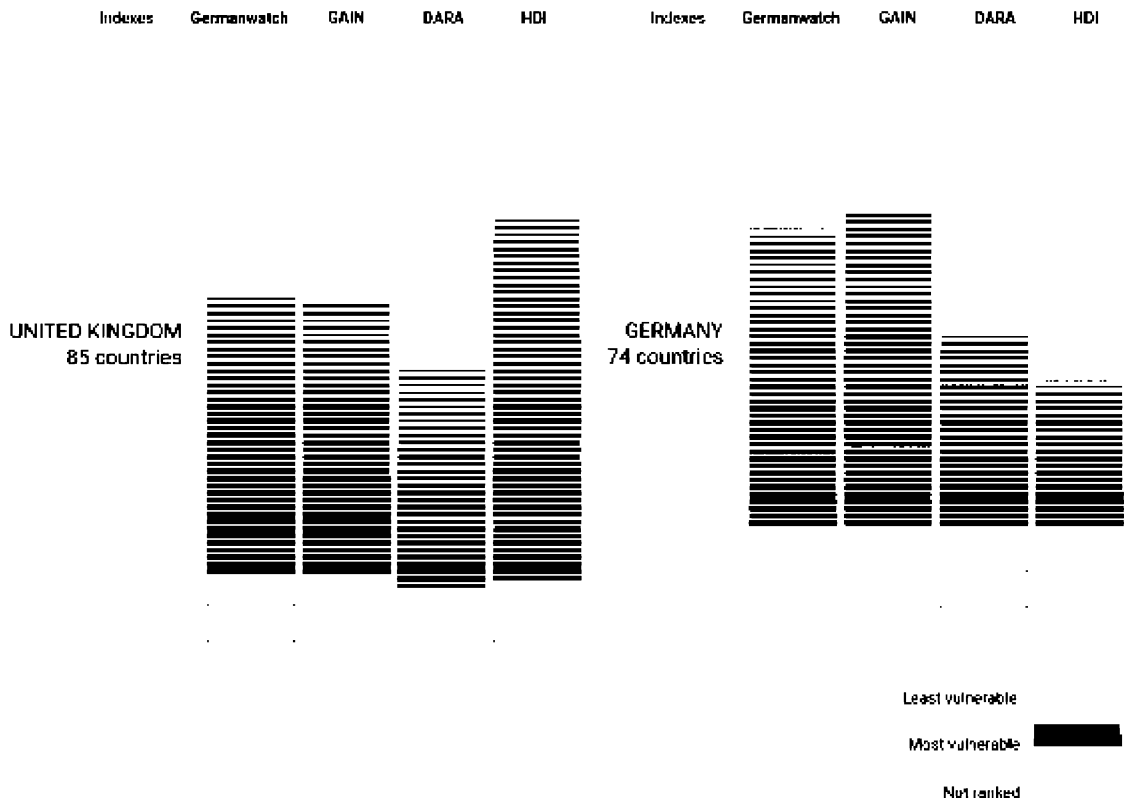


Figure 7 Bilateral adaptation funding and vulnerability indexing. The chart shows how the recipients of adaptation aid from different countries are considered vulnerable (dark) or not vulnerable (light) by different vulnerability indexes. Adaptation aid provided by the UK, for instance, aligns well with the vulnerability assessments of the Global Adaptation Index (GAIN) or the Human Development Index (HDI), much less so with DARA's. Germany's aid instead aligns more with the assessment of the Germanwatch and GAIN indexes (adapted from the EMAPS project, climaps.eu and licensed under CC BY-SA 4.0).

While some adaptation actors may prefer not to see the partiality of funders and indexes exposed in this way, there are many others, NGOs in particular, who do. It is not always easy to pry open a space for debate once national policies have been set and the visualizations in [figure 7](#) can help with that.

By following the actors and showing their stakes in particular issues, as in points 1 and 2 of the cartographic creed, controversy mapping cannot avoid serving some interest over others. Such complicity comes with responsibilities, at the very least to be reflexive and transparent about your motives, as in point 3 of the creed. You might attempt to open a space for democratic inquiry, as in the example above, or to show how different commitments produce different outlooks or how different knowledge claims have authority in different groups. You could also aim to help decision makers, journalists, or other actors to make sense of the debate or take a stance in it. The point of your mapping could be to highlight different perspectives to help those who will eventually design a solution to do so in fullest view of the concerns they have to balance. Last but not least, the point of mapping a controversy could be to exploit an opportunity to do interesting research. It is not every day that you have the possibility to observe how economic, social, and ecological indicators are balanced against each other to produce the combined assessment of a

country's vulnerability and how this is a source of struggle behind the front desk communication of international aid.

Accepting complicity as a mapmaker

In his history of cartography, John Wilford (2002) recounts how, in the early days of aerial surveying, cartographers were occasionally attacked by people on the ground who mistook the mappers for a threat and met them with spears and arrows. Critical geographer Patrick McHaffie, however, suggests a different reading:

Perhaps the “frightened Africans” who once “threw spears at an Aero Service aircraft” or the “suspicious moonshiners in Appalachia” who “took a few rifle shots” at aerial mappers did so not because the intentions of the mappers were “not always understood,” but because those intentions, and the powerful forces behind them, were understood only too well. (McHaffie, 1995, p. 122)

Maps are not just tools for navigation but also instruments of power and appropriation, subversion and resistance, leverage and negotiation. This has been demonstrated time and time again in critical geographical scholarship (Harley & Woodward, 1987; Harley, 1989; Turnbull, 1994, 1998; Pickles, 1995, 2004; Corner, 1999). As Eilean Hooper-Greenhill notes: “to be ‘on the map’ is to be acknowledged, given a position, accorded an existence or an importance” (2000, p. 17). Whether such recognition is desirable or not depends on the situation. The scientist chasing funding or the NGO striving to set the public agenda will likely want to be charted as influencers. Yet, while being left off the map can consign you to oblivion, it can also grant you protection. A group of indigenous people resisting appropriation by a state will likely prefer not to see their territory on a plan of taxable land; just like homeowners trying to obtain flood insurance do not want to see their property on a map of high-risk areas (Munk, 2010). Maps matter and this is true for geography as well as for controversies (November et al., 2010).



Denmark spies and analyzes
critical world citizens.

Posted on February 28, 2014 by Nnwc6734 • 0
Comments

A Danish study , paid by the taxpayers (€2.6+ million) has to ensure to stop protests and interruptions in the implementation of wind power projects. This study is supported by the beneficiaries of wind power under the leadership of the world's largest wind turbine manufacturer Vestas , hand in hand with Siemens and Vattenfall in Denmark.

Figure 8 Controversy mappers accused of spying on wind turbine opponents. Meme circulated worldwide by anti-wind websites, including the European Platform Against Windfarms, caricaturing a controversy mapping project carried out by one of the authors (Munk, 2014) as Nazi and authoritarian.

While working on a project on energy transitions, one of us was tasked with mapping online debates about wind farms (Munk, 2014). The sample included wind energy advocates and opponents from several countries and the project was to trace their hyperlink connections and the issues present on their websites. Some of the early maps found their way to protest groups who reacted vehemently and decried them as an example of how the wind industry was spying on them. The maps were adorned with Nazi imagery (see [figure 8](#)) and compared to the methods used by the US National Security Agency (NSA) in counter-terrorism work.

This reaction demonstrates how actors can mistrust maps, but also strategically re-frame them (in this case, as evidence of organized persecution). Maps travel and lend themselves to being used in ways that were not always intended by their makers. They are, as James Corner remarks, “not prescriptive, but infinitely promising” (1999). Being unable to fully anticipate the consequences of our mapmaking reminds us of the impossibility of keeping our hands clean. The project to map wind energy controversies was funded by the Danish Council for Strategic Research in a consortium that comprised industry partners as well as municipal developers. It was therefore reasonable to expect that any piece of research coming out of that project could be framed as partisan. And yet it is important not to confuse this situation with a resignation to doing the bidding of the wind industry. The overall objective of the project was to develop a more robust procedure for planning. In that context, doing controversy mapping meant insisting that those procedures should not misrepresent the concerns of wind energy opponents. Prior to the project, the narrative of both the wind industry and municipal developers had been that opposition was mainly coming from a small band of issue professionals, hopping from one turbine project to the next, stirring up public sentiment and orchestrating complaints. Against this narrative, the mapping revealed a large number of locally engaged actors sparked into being by a derailed public consultation or by the specifics of particular wind farm projects. According to the research, more than 81 percent of the opponents were exclusively engaged in online debates about one wind farm project. They were also the most active in the debate. Less than 2 percent were engaged in four debates or more and mostly in the same local area (Borch et al., 2020).

It is impossible to rule out the possibility that even a relatively modest intervention like compiling a list of influential opponents can be used to manipulate the debate. We cannot guarantee that our map, which ranked websites by visibility and categorized them by issue, could not be used to target adversaries in the wind energy debate more efficiently. Making the maps publicly available and being open about datasets and methods is thus a minimum requirement to ensure at least that all actors have a fair chance of interrogating the maps, if not to turn them to their advantage.

All protesters who shared the wind energy controversy maps understood that they were “on the radar,” but different groups reacted differently. Several messages circulated across the protest space: that opponents of wind energy had been spied upon; that research funding had been wasted on studying debates rather than the adverse effects of turbines; but also that the network of websites testified to the strength of the protest. In a press release, the European Platform Against Windfarms (EPAW) circulated one of the maps stating that “websites of wind power opponents worldwide will publish a graphic of the study [...] to confirm their good networking and to show that one must reckon with them.” The press release also made it clear that the map could be expanded to include several missing protest groups – a suggestion that we willingly followed. What the example shows is that different

actors turn controversy maps to their advantage in different ways, some of which can put the cartographer in a delicate situation.

Taking controversies seriously

As we have just seen, controversies can be inconvenient objects of study. The temptation is therefore strong to fall back on narratives that allow us to write them off or ignore them. These narratives come in two stereotypical versions that we could call the “corruption story” and the “deficit story.” Both presume a priori that technoscience would progress linearly if it was not derailed by cultural, economic, political, or otherwise extraneous factors. In the *deficit story* the public is in a state of ignorance because it lacks information (Wynne, 1991). Proponents of biotechnology, for example, often claim that genetically modified organisms (GMOs) are disputed only because the public does not understand the mechanism of transgenesis and is therefore irrationally afraid of it. In the *corruption story*, on the other hand, contested knowledge is written off as mere pursuit of political or economic interests. Opponents of biotechnology often argue that GMOs are promoted, despite their technical flaws and social disadvantages, because of the financial interests of the corporations who manufacture them and the career interests of the scientists who are doing research on them. Hence, in the GMO debate, both sides can point to some sort of deviation from straight technoscientific progress and deny that there is any real controversy.

While neither of these explanations are completely off the mark, they certainly do not account exhaustively for controversies. After billions spent on science education over the past decades, it is hard to explain, for instance, that a large percentage of Americans still believe in strict creationism despite recurrent attempts to sway them to the theory of evolution (Newport, 2010). And even when science education does work, why should we expect the result to be citizens who are more willing to agree? Actors, however well informed, will often have stakes in a discussion and, as empirical evidence suggests, a better understanding of science can actually increase political polarization (Kahan, 2015; Kahan et al., 2017). As for deviation by corruption, it is worth keeping in mind that plenty of researchers in theoretical physics, formal mathematics, art history, sociolinguistics, and other disciplines keep stirring fierce controversies even though the political or economic interests are minimal.

The problem with deviation stories is that they reduce controversies to skirmishes at the fringes of technoscience, as if conflict could not arise *within* science and technology and as if technoscience could be easily separated from the rest of society. As we will show in the next chapters, none of these assumptions hold up under closer inspection. The proliferation of controversies has little to do with external interference and much to do with the role of science and technology in society. This is both good and bad news.

It is good news when the rise of controversies can be ascribed to growing demand for transparency. As technoscience grew ever more omnipresent and influential, it also became a topic of intense public interest and scrutiny and luckily so. The increased visibility of controversies could therefore be read optimistically as an increase in the democratization of science and technology, even when it comes with annoying side effects. Reflecting on the raging debates about vaccination, danah boyd notices that, despite their unfortunate consequences for public health, the arguments of those who oppose the vaccines still reflect a proactive attitude:

The more that the media focused on waving away these networks of parents through scientific language, the more the public felt sympathetic to the arguments being made by anti-vaxxers. Keep in mind that anti-vaxxers aren't arguing that vaccinations definitively cause autism. They are arguing that we don't know. They are arguing that experts are forcing children to be vaccinated against their will, which sounds like oppression. What they want is choice – the choice to not vaccinate. And they want information about the risks of vaccination, which they feel are not being given to them. In essence, they are doing what we taught them to do: questioning information sources and raising doubts about the incentives of those who are pushing a single message. (boyd, 2017)

The bad news is that controversies within science and technology could also derive from the growing efforts of lobbies and interest groups to stall political action through the artificial production of uncertainty and hence a deliberate pollution of public debate. First employed by the tobacco industry to cast doubt on the connection between smoking and cancer (Oreskes & Conway, 2010), this strategy of skepticism is now employed on issues like climate change, acid rain and ozone depletion – often by the same organizations (Proctor & Schiebinger, 2008). This type of strategic skepticism, which is also used by foreign intelligence agencies, amplifies disagreements among experts making the debate opaque and undermining public trust in institutions (Asmolov, 2018; Bennett & Livingston, 2018).

The investigation of controversies, however, is not only justified by the fact that they are increasingly difficult to ignore. Inconvenient as they may be, controversies are also excellent occasions to learn about the role of technoscience in social life. In the words of Bruno Latour:

I have stopped, in the engineering school where I teach, to give a social science class: I only ask the young engineers to follow for one year, in real time, a scientific or technical controversy ... They learn more science – meaning research – and it just happens that, without even noticing it, they learn also more law, economics, sociology, ethics, psychology, science policy and so on, since all those features are associated with the piece of science they have chosen to follow. (“From the two cultures debate to cosmopolitics” contribution to a special symposium in *Zeit*, available online at www.bruno-latour.fr).

In the following pages, we will discuss three incentives for embarking on controversy mapping: (1) controversies allow the observation of scientific paradigms and technological infrastructures *in the making*; (2) they reveal the intended and unintended consequences of these paradigms and infrastructures; and (3) they help in taking more inclusive and reflexive decisions about these consequences.

Mapping as a way to study science and technology in the making

The most immediate reason for engaging with controversies is that they provide a vantage point from which to observe science and technology in action. One of the main challenges facing the study of technoscience is the self-evidence which shrouds its object of study *ex post facto*. Most of the time, we simply appropriate scientific facts and technological artifacts without caring about how they work or how they were made. This opacity is obviously convenient. Life would be very complicated if we had to think about Archimedean fluid mechanics and Roman aqueduct building every time we poured a glass

of water. For every theorem that we learn to prove in school, there are thousands of others that we just believe or use without even knowing it. Most of the time, all we need to understand about a technology is what it takes as input and what it generates as output.

The downside of this “black boxing” is that scholars interested in the social study of science and technology are faced with the problem that their objects of study are opaque in the sense that they offer few clues about the circumstances under which they came to be. Harry Collins (1975) illustrates this difficulty through the metaphor of ship models in glass bottles. If we were only able to observe the models once inside their bottles, we would have a hard time imagining how they passed through the bottleneck and thus conclude that these ships had always existed within their bottled universes:

It is as though epistemologists are concerned with the characteristics of ships (knowledge) in bottles (validity) while living in a world where all ships are already in bottles with the glue dried and the strings cut. A ship within a bottle is a natural object in this world, and because there is no way to reverse the process, it is not easy to accept that the ship was ever just a bundle of sticks. (Collins, 1975, p. 205)

“Black boxing” refers to the process by which technoscientific work is made invisible by its own success. When something works – a machine, a technology, a theory, a method – it is no longer questioned. Or rather: the fact that it is no longer questioned is the hallmark of its success. The construction is complete, the builders have left the site, and the ultimate testimony to their skill is to make us forget they were ever there. All of which is perfectly fine, as long as we just want to profit from the utility of technoscientific black boxes, but what if we are interested in knowing how they were put together or, even more poignantly, what if we need to know it?

This is where controversy becomes a methodological opportunity. To come back to Collins’ metaphor, it is not easy to learn the art of ship-bottling because ship-bottlers put considerable effort into safekeeping the tricks of the trade. There are, as we discovered while writing these pages, two main techniques to put ships in bottles. The first consists in building the ship outside the bottle; attaching the mast and the sails to the hull with a system of hinges; then inserting the ship in the bottle with the reclined mast; and finally lifting the mast by pulling on the hidden string. The second technique consists in building the ship directly inside the bottle with specially designed, long-handled tools. The reason why we can know about these differences is because ship-bottlers disagree on which method is best. Those who build the ships directly in the bottle accuse the others of cheating, and those who “cheat” reply that the ships of their opponents are just ugly. Because of their disagreement, both camps willingly explain their techniques as a way to justify their position.

Something similar is true in science. In order to convince their peers, scientists are forced to make the details of their work explicit. They must publish their datasets, spell out their methods, describe their samples, document their algorithms, cite their predecessors, acknowledge their assumptions, declare their sources of funding. Consider how much we, as outsiders, have been able to learn about GMOs because opponents of those technologies have nitpicked every risk involved, forcing transparency on every detail of transgenesis. Consider how much we have learned about the physics of nuclear fission or the technology of reactors every time a proposal for a new plant has been contested or a referendum on nuclear energy has been announced (Nelkin, 1971; Callon et al., 2009). Or consider how

intricate epidemiological discussions about herd immunity or curve flattening have become public knowledge during the Covid-19 pandemic (Munk, 2020).

When we said that we did not have to bother about hydraulics when pouring a glass of water, we were of course excluding cases where disputes about water management (and more recently shale gas extraction) force us to consider the delicate mechanisms connecting aquifers to our kitchen tap. When everything goes well, technoscientific constructions are invisible, so to observe their inner workings, we need to seek out the situations where these constructions fail and controversies becomes the “can-openers” (Law, 2010) of science and technology:

Most of the time, most of us take our technologies for granted. These work more or less adequately, so we don't inquire about why or how it is they work. We don't inquire about the design decisions that shape our artifacts. We don't think very much about the ways in which professional, political, or economic factors may have given form to those designs ... the costs of technology tend to become obvious only at the moments of catastrophic failure – when we suddenly realize that, somewhere along the line, there was something lethally wrong with a technology that we were used to taking for granted. (Bijker & Law, 1992, pp. 1, 2)

The use of controversies as research instruments has a long pedigree, dating back to ethnomethodology. Harold Garfinkel's breaching experiments are perhaps the best-known ancestors. In his experiments, Garfinkel would ask students to purposely contravene some basic social norms in order to “sustain bewilderment, consternation, and confusion; to produce the socially structured affects of anxiety, shame, guilt, and indignation; and to produce disorganized interaction that should tell us something about how the structures of everyday activities are ordinarily and routinely produced and maintained” (1967, p. 38). Here is an example:

The victim waved his hand cheerily.

(S) How are you?

(E) How am I in regard to what? My health, my finances, my school work, my peace of mind, my ...?

(S) (Red in the face and suddenly out of control) Look! I was just trying to be polite. Frankly, I don't give a damn how you are. (p. 44)

These field experiments make social norms and background expectations visible through the disruption of commonplace situations. The method was later adopted by social psychology through the work of Stanley Milgram who developed a more systematic protocol to break and thus reveal the unwritten rules of queuing or riding the subway (Milgram & Sabini, 1978). In a similar way, controversies offer a sort of breaching experiment for technoscientific phenomena.

In a classic example of how the breaching power of controversy can enable the study of science and technology, Steven Shapin and Simon Schaffer (1985) analyzed the debate between Thomas Hobbes and Robert Boyle. Shapin and Schaffer wanted to know why scientists conduct experiments, which is difficult to answer now that the experimental method has become the standard by which natural scientists readily swear. To overcome this self-evidence, Shapin and Schaffer displaced their inquiry to a time when experimental

science was still controversial and its protagonists had to defend it explicitly against its critics.

In the second half of the seventeenth century, Boyle and Hobbes were the protagonists in a clash between the burgeoning British scientific revolution and the more established continental natural philosophy. Boyle was one of the co-founders of the Society for Experimental Methods, soon to become the Royal Society, and was famous for his experiments with air pumps (which eventually led him to formulate Boyle's law, stating that the volume of a gas varies inversely to its pressure). For many of his contemporary natural philosophers, proving natural laws by way of experiment was unthinkable. Among them, Hobbes was a particularly vocal critic. He argued that Boyle's experiments were not valid because they were carried out in an artificial setting (i.e., the void created by the air pump) and thus impossible to reproduce in real life. On top of that, the air pump was an unreliable device, which made it conveniently possible for Boyle to blame an air leakage when experiments failed. Besides, the high cost of building an air pump meant that the reproduction of experiments was limited to a small elite of wealthy "gentleman scientists." This did not disturb Boyle who only recognized members of the Royal Society and his so-called "Invisible College" as a legitimate audience for his experiments. To make matters worse, given that direct witnessing of the experiments was not always practical, Boyle accepted that it could be replaced by meticulous descriptions of the research protocol and transcriptions of the results. For Hobbes, and other seventeenth-century natural philosophers, the idea that truth could in this way "travel in literary form" was simply absurd. In their view, reliability hinged on first-hand observation.

This controversy between Boyle and Hobbes, then, becomes an instrument for Shapin and Schaffer to reveal how scientific knowledge depends on established conventions. The acceptance of Boyle's findings hinged on the material technology of the laboratory (represented by the air-pump), the social technology of the peer community (represented by the Royal Society), and the discursive technology of the scientific literature (represented by Boyle's meticulous style of reporting).

Another example of the methodological power of controversy is provided by the so-called "Climategate" affair (Maibach et al., 2012). In November 2009, a group of hackers leaked thousands of emails and documents stolen from the servers of the Climate Research Unit of the University of East Anglia (a key actor in the global warming debate). By quoting a few carefully selected exchanges, climate skeptics used the leaked emails to convey the impression that climate change research was nothing more than a scientific conspiracy. Exploding a few days before the Climate Summit in Copenhagen where the international community was expected to agree on a successor of the Kyoto Protocol on CO₂ emissions, the Climategate scandal offered a convenient excuse for those wanting to stall the negotiations (Leiserowitz et al., 2012). While Climategate is a disturbing example of the use of a made-up scandal to influence the media and the diplomatic agenda, it is also an example of how every cloud has a silver lining. The leak gave social scientists access to an extraordinarily rich dataset that would otherwise likely have required a lifetime of archival work (Ryghaug & Skjølsvold, 2010).

Mapping as a method for design and innovation

Besides facilitating the study of science and technology in society, controversies can also be helpful when developing new sociotechnical arrangements. Climategate, for example,

was not only an opportunity to observe the making of climate science, but also an occasion to strengthen the procedures of the Intergovernmental Panel on Climate Change (IPCC). The scandal and other controversies on errors found in the 4th Assessment Report led to a reform of the IPCC procedures and an improvement in their quality and transparency (Beck, 2013). Something similar happens in innovation projects where objections and resistance from stakeholders can, if taken properly into account, produce more robust solutions. For those who design and develop new products and services, controversy can be an occasion to understand users and foreground issues that would otherwise be hard to anticipate.

Think of controversies as a form of *crash tests*. How do we know that we can bet our life on the brakes, safety belts, and airbags in our cars? How do we know that we can rely on car manufacturers and trust in their safety systems? In the automobile industry, such questions are answered by subjecting prototypes to impact trials. Only after having passed these crash tests are vehicles allowed into commercial production. Likewise, stress tests are common for computer hardware and software; furniture is subjected to load tests; electric appliances undergo accelerated life tests; and toys are submitted to destructive forces like those that kids can unleash on them with their teeth. In all these cases, products earn their “right to exist” by overcoming a series of trials. Controversies are, in this sense, sociotechnical crash tests. How do we know that pesticides will not break our alliance with pollinating insects or that our email provider will protect our privacy? How do we know that medical techniques are compatible with ethical principles or that the development program of our city will not destroy biodiversity? These are the kinds of questions we test in sociotechnical controversies.

A famous example of how new technologies develop in an interplay with their “relevant social groups” is provided by Trevor Pinch and Wiebe Bijker (1987) in their analysis of the controversies surrounding the introduction of the modern bicycle. Rather than a brilliant and original solution deliberately engineered for the needs of its intended users, Pinch and Bijker describe a long period of “interpretative flexibility” in which different bicycle designs competed against each other, followed by a phase of “closure and stabilization” in which the symmetrical-wheels design eventually became the unique standard. The shift from one phase to the other required the intervention of a multitude of actors: from long women’s skirts (which could not cope easily with bicycle wheels), over cycling races (which allowed comparing the speed of different designs) and safety concerns, to the pneumatic tire (which solved the vibration problems associated with the symmetrical-wheels design). These sociotechnical crash tests, you could say, forced relevant social groups to emerge and make their stakes in the design explicit. For bicycle developers at the time, controversy mapping would have been great business intelligence!

Whenever possible, trials are performed in controlled settings where they follow protocols and can be systematically evaluated. This is true for physicists examining the speed of neutrinos in a particle accelerator, for philosophers examining the foundations of ethics in a library, and for design engineers developing a new product on their drawing boards. Most ideas do not survive this stage. They are born and killed within the day and habitually by their own creators. And yet, once out of the R&D shell, even tougher trials await. Debating in society is no cotillion ball. The edited volume from which the bicycle example is taken comprises a wide selection of comparable cases ranging from dye chemistry and Bakelite processing to missiles and medical imaging techniques (Bijker et al., 1987). As part of the Social Construction of Technology (SCOT) school in STS, they illustrate how

technological development is subject to immense social pressures and demands. Going public means entering an environment where only the fittest will survive. In product design and development, controversies therefore not only slow down the pace of technological development, but can also be appreciated for their capacity to ensure that new inventions earn their place by adapting to their social environments.

Controversies constitute the high pass through which the most robust innovations exit the laboratory, but far from being perfect or definitive, their outcomes are always contingent and unpredictable. In a similar way, controversy mapping is not a form of risk management (Power, 2008), which would suppose that dangers could be anticipated and, at least in part, controlled. Controversies cannot be managed. At best, they can be channeled into spaces where their violence is partly and temporarily contained in the arenas of scientific conferences, patent offices, parliaments, markets, or citizen conferences. In some cases, this strategy has worked; in many others, it has failed. In France, for example, the organization of dozens of *conférences citoyennes* and the establishment of independent authorities (such as the Haut Conseil des Biotechnologies) has not stopped hundreds of *faucheurs volontaires* (volunteer mowers) from destroying experimental GMO fields as an act of civil disobedience (Hayes, 2007). What controversy mapping can offer in these situations is not to tame the interventions of the actors, but simply to appraise them.

In *Adversarial Design* (2012), Carl DiSalvo argues that realizing that technological artefacts cannot enter social life without interfering with the identities of existing actors, or provoking the emergence of new ones, should make designers think about their practice as a form of political intervention: “Objects already participate in political debates. Objects often function as expressions of matters of concern, encapsulating aspects of an issue to make them accessible to a broader public” (DiSalvo et al., 2014). The design of technical solutions can thus profit from taking sociotechnical crash tests seriously by crafting designs that are deliberately unfinished and open to multiple uses and appropriations. In their analysis of the Zimbabwe bush pump, Marianne de Laet and Annemarie Mol have, for example, shown how what they call a “fluid technology” can better adapt to multiple sociotechnical contexts and thus constitute a more robust, because less developed, solution (de Laet & Mol, 2000). Similarly, Giorgio De Michelis (2003) has argued that the traditional Sardinian shepherd’s knife allows for a variety of different uses, from wood carving to sheep surgery, with an elegant open-ended design that does not require the multiplication of blades and tools found, for example, in the modern Swiss army knives.

Mapping for democratic inquiry

Besides being useful to those who study technoscientific arrangements and design them, controversy mapping can also help those who, willingly or not, are affected by their consequences. As we just saw, controversies are hard to handle through the established procedures for managing matters of science and technology. They are especially impossible to manage through the so-called “linear model of expertise” (Weingart, 1999; Pielke, 2007; Beck, 2011). According to this model, sociotechnical problems should be handled by separating science and politics. First, policymakers decide which questions are worth studying and financing. Then, scientists and engineers agree on the answers in full autonomy and regardless of their social consequences. Finally, based on the answers, politicians deliberate to make an informed decision. Such a linear arrangement is not only unrealistic because it requires an impossible separation between facts and values (Jasanoff & Wynne, 1998; Durant, 2016), but also paralyzing because it defers any political decision

until scientific consensus is reached. This is clearly not an option in sociotechnical controversies that, by definition, are precisely the situations in which urgent deliberation is needed even if (and sometimes because) expert agreement is still lacking (Callon et al., 2009).

Many of the controversies troubling our collective life demand urgent action in the absence of clear and unambiguous expert advice. In dealing with biodiversity loss, pandemic outbreaks, wealth inequalities, or ethnic and gender discrimination, we just don't have the time to wait for a scientific consensus, which may in some cases never come. As noted by Harry Collins and Robert Evans, "decisions have to be made before the scientific dust has settled, because the pace of politics is faster than the pace of scientific consensus formation" (2002). This is precisely why the "precautionary principle" was introduced by the 1992 Rio Declaration on Environment and Development: to allow action *notwithstanding* scientific controversies.

Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation (principle #15).

Abandoning the dream of a science-based politics, however, raises the question of who should decide when experts fail to (or delay in) reach(ing) a consensus. One option is to refer the conflicts to political authority. Where science fails, politics could provide resolution. From Machiavelli to Schmitt, the imposition of power is the hallmark of the so-called "realist" school of political science (Korab-Karpowicz, 2018). This is especially the case for "states of exception," as Carl Schmitt calls them, situations of extraordinary tension where ordinary procedures for reaching consensus prove ineffective (Agamben, 2005). Recently, the outbreak of the Covid-19 pandemic has provided an example of such a situation, with political leaders all over the world invoking a "war against an invisible enemy" to justify extraordinary measures taken with little or no deliberation. This solution, however, can be a slippery slope and lead to authoritarian policies.

But if neither *might* nor *right* can take care of our controversies, who or what will? The answer, in short, is that we will have to resolve our controversies ourselves. In a democracy it is the privilege *and* burden of citizens to serve as the court of last resort for matters of acute public concern. To use the words of Walter Lippmann in the *The Phantom Public*:

It is controversies of this kind, the *hardest controversies to disentangle*, that the public is called in to judge. Where the facts are most obscure, where precedents are lacking, where novelty and confusion pervade everything, the public *in all its unfitness* is compelled to make its most important decisions. (Lippmann, 1927, p. 121)

"Unfitness" is the keyword here. Lippmann is a pragmatist and does not for a moment believe that the public could gather and process all the information necessary to have informed opinions and thus make knowledgeable decisions on complicated technoscientific questions:

The public does not know in most crises what specifically is the truth or the justice of the case, and men are not agreed on what is beautiful and good ... if it had seriously to crusade for justice in every issue it touches, the public would have to be dealing with all situations at the time. That is impossible. (pp. 56, 57)

This is why the public is only the court of "last resort." Whenever possible, issues should be composed by the actors directly involved. If the actors succeed in reaching a

compromise, then their disagreements can be happily ignored by the rest of the world. If they fail, then institutions should step in and facilitate a conciliation. After all, maintaining peace and order is one of the functions of public officers and administrators. However, some controversies are so thorny (and some institutions so inefficient), that no administrative solution succeeds in settling them. It is in these cases that the public, “in all its unfitness,” is called in to arbitrate (with no warranty that its arbitration will be particularly just or enlightened).

Too often such an argument is read as a case against public participation (for example in Schudson, 2008). *It is not*. It is a heartfelt acknowledgement of the paradox of democracy and of the unfair but necessary burden that it puts on its citizens. The public is a “phantom,” a cohort of men and women called in to judge not because they are in the best position to do so, but because everyone else has failed. Experts cannot agree, decision makers cannot decide, administrations are jammed by conflict. So, the public is dragged in to arbitrate. But the public cannot devote much time to each controversy. Our collective debates are too many and too complicated. It would be illusory to hope that citizens could get to the bottom of all of them. The best the public can do is align its forces behind those actors that appear less partisan and more capable of solving the crises, for “the public will arrive in the middle of the third act and will leave before the last curtain, having stayed just long enough perhaps to decide who is the hero and who the villain of the piece” (Lippmann, 1927, p. 55).

Called in to judge on the most intricate affairs without the necessary time or resources to become experts in them, citizens need brief but accurate cues to detect “the hero and the villain” of the play. According to Lippmann, providing such cues is the ultimate mission of journalism, a mission that, according to Bruno Latour, is shared by controversy mapping.

Can we organize our public life in order to facilitate, through simple and robust signals, the detection of those who, engaged in the inevitable controversies, are the most able to justify their positions or, conversely those who demand that we rely on their arbitrary judgement. If these signals exist, can we multiply them, make them more prominent, learn about them and learn how to maintain them? We have no choice: if these signals are deleted, fade or disappear, there will be no more public life. Democracy will be impossible. The very meaning of politics will disappear for good. (Latour, 2008b, pp. 21–22, our translation)

The third reason for mapping controversies is, then, to help their publics to take sides, not by proposing simple solutions, but by patiently unfolding the multitude of issues and voices that articulate them. We will discuss different political agendas for cartographic interventions in [chapter 9](#); for the moment we will just note that mapmakers can assume different postures. According to authors such as Callon (1999a), Callon et al. (2009) and Latour (2003, 2010b), a good map should facilitate the composition of divergent interests and social programs into a common world. According to others, such as Haraway (1989, 1991) and Law (2004, 2009), such an agenda is too conservative and risks favoring those already in charge instead of empowering those at the margins of the political arena (Munk & Abrahamsson, 2012). Sometimes we might want to denounce the injustices of the status quo and even put up a fight against them. Other times, the best we can do is to help actors work out a more reflexive and inclusive compromise (Dryzek, 2002).

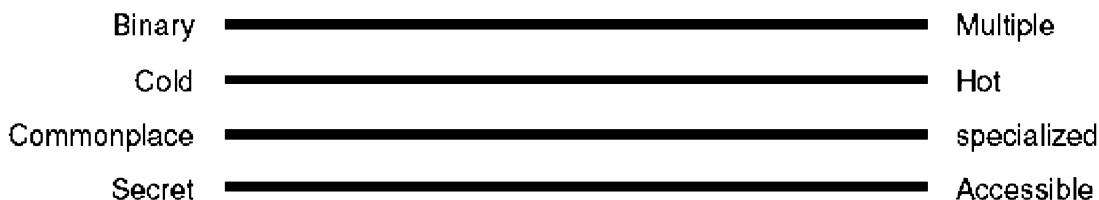


Figure 9 Four criteria for estimating the feasibility of a controversy mapping project. The slider indicates controversies that are easier to map (created by the authors; released by the authors under CC BY-SA 4.0).

Choosing a good controversy

Readers may have noticed that, apart from pointing out how contemporary controversies are related to science and technology and made public through media, we have so far abstained from providing a more precise definition. Controversy mapping is a pragmatic method. It cares less about separating what is controversial from what is not, and more about offering ways to study collective phenomena through the tensions that animate them. Anything in social life that cannot be settled by reference to matters of fact can in principle be described as a controversy and studied through controversy mapping (see, for example, Munk & Ellern, 2015). Any newspaper or scientific journal contains dozens of controversial topics and so do blogs and specialized websites, such as those of engineering associations or scientific societies. Wikipedia has several pages dedicated to controversial subjects, which list thousands of articles. It doesn't really matter if the topic has already been mapped: controversies are fertile research objects that change across different contexts, evolve over time and can be charted in multiple ways.

However, the fact that almost any situation has a controversial angle does not mean that controversy mapping is equally suited to deal with all of them. In order to choose a good controversy to map, we suggest four criteria, illustrated in [figure 9](#).

Binary and multiple controversies

A place to start when choosing a controversy is to consider the number of positions around which the actors coalesce and the balance between these positions. Sociotechnical debates span a continuum from binary and unbalanced discussions (where an established position is challenged by a skeptic minority) to proliferating debates (where a multitude of different positions oppose each other with no one gaining the upper hand). It is advisable to stay clear of both extremes, but for different reasons.

Controversies that are both binary and very unbalanced can put the map-maker in a particularly difficult position. These are situations in which a small group of actors has an interest in keeping a controversy alive and thereby prevent everyone else from reaching closure and moving on. Here, your complicity as a mapmaker involves favoring that small group of actors by giving the controversy visibility. As STS has long shown, there is no such thing as complete consensus in science and technology. No matter how solid a fact appears to be, there will always be actors contesting it. Think, for instance, of flat-earthers who stubbornly maintain their conviction even in the absence of the smallest shred of evidence (Bach, 2018). In most cases, the existence of such minority reports is happily ignored in view of the significant advantages of keeping black boxes shut. Yet, in some cases, well-organized and well-resourced groups have succeeded in keeping a discussion

alive despite the marginality of their position. We alluded to this in the introduction when we argued that the increased visibility of technoscientific controversies derives in part from the effort of industrial lobbies to stall legal regulation by the perpetual mediatization of controversies long since closed in the scientific community. The tobacco-cancer connection (Michaels, 2008) or global warming (Oreskes & Conway, 2008) are classic examples of such strategies, but other cases can be found in *Agnotology* by Robert Proctor and Londa Schiebinger (2008).

These controversies can be mapped but require special treatment. Exposing the shallowness of the arguments used by the skeptics often misses the point. Their objective is not necessarily to convince the public that they are right. Instead, it could be to create a climate of doubt in which it is difficult to distinguish right from wrong. In the representation of these controversies, the description of arguments and counter-arguments is thus less important than the investigation of the strategies through which skeptics succeed in acquiring a disproportionate visibility.

Apart from this, truly binary debates are rare. A disagreement may often *appear* binary only because we fail to appreciate how it is deployed from other perspectives. Take the issue of same-sex marriage, where an apparently simple pro/con opposition can obscure a deeper and much more complicated set of discussions. The question, for example, has different implications in different national and cultural contexts. Is it asked in Denmark, which has a liberal track record, was the first country to allow registered partnerships between same-sex couples, and has a state church controlled by parliament? Or is it asked in France, which has a secular constitution, but a far more vocal Catholic and conservative right? Or in Italy, which harbors the Vatican and the papal seat? On top of that comes the question of what you are actually for or against? Is it the legal right of gay couples to form civil unions? Is it the right to do so in a religious establishment? Is it the prospect of gay couples “qualifying” as parents for adoption? There are many intersecting ways of being for or against same-sex marriage, which is part of the reason why it is a worthwhile controversy to map.

Truly binary controversies are not really in need of mapping. They are like tugs of war with two teams opposing each other and a clear definition of when one team will have lost to the other. As controversies get more multiple, they become more like bar brawls with actors battling each other in shifting coalitions and on several different fronts at once. This is when cartography begins to make sense.

Importantly, in controversies, multiplicity does not only come from the fact that a multitude of actors with a multitude of positions are engaging a multitude of issues. Multiplicity can also be ontological (Mol, 2002), which is to say that the matter of a disagreement is actually different realities that different actors refer to by the same name. Two actors may, for example, both be talking about “a worthy end of life” in a controversy about euthanasia, or about “the risk of flooding” in a controversy about land use and urban planning, but enact those expressions in completely different ways, bringing them into being as materially different things. In the context of a hospice, a worthy end of life could be associated with the ability to uphold meaningful relationships with family and with a sense of self determination, while in a hospital emphasis might be put on a lack of emotional stress and physical pain. Importantly, those two versions are materialized and thus upheld in the equipment and procedures of the hospice and the hospital respectively. Similarly, an insurance company would typically understand flood risk in financial terms and therefore as something that depends on the size of their portfolio of flood-prone policy

holders in the same local area, which is enacted in the way they model the risk, while to the individual homeowner it is really the risk of water coming into their particular basement (Munk, 2012). If that is the case, then ontology quickly becomes political (Mol, 1999) because the ability of actors to make their case is not so much a matter of debate as it is a matter of materially constructing the world in a way that makes their position self-evident.

On the extreme end of the spectrum, exceedingly multiple controversies are certainly interesting to map, but can pose a problem in terms of time and resources. We introduced this chapter with a cartographic project that we carried out a few years ago on the climate change adaptation debate. When preparing our submission for the European agency that funded the project, it seemed to us that the topic was rich enough to require the collaboration of six research centers over three years and to justify spending 1.5 million euros (cf. climaps.eu and Venturini et al., 2014b). We were wrong. As it turned out, climate adaptation was way *too* rich for such a “small” project. Though adaptation is only one of the facets of the discussion on climate change, its complexity is breathtaking for at least four reasons.

First, adaptation is largely (although not entirely) a problem of the future. The debate does not concern how we have messed up the climate in the past or what we can do to fix it in the present, but rather what we will do when the effects of climate change eventually hit us in the future. Since we do not know exactly what these effects will be, a first set of disagreements concerns questions of prediction, modeling, and simulation, such as how bad climate change will be, how fast it will unfold, and who or where it will hit first.

Second, the adaptation debate is multiplied by the diversity of local microclimates and communities. Another set of disagreements thus concerns the priorities of adaptation: which regions will be more vulnerable to climate impacts; which sectors will be more affected; and which arrangements will make our societies more flexible and resilient.

Third, adaptation involves the transformation of existing sectors of the economy, such as agriculture, infrastructure, industrial production, rural land use, or cities, and discussions about adaptation therefore always become mixed up with pre-existing sociotechnical debates. This leads to disagreements about what should count as an adaptation action and whether they are genuinely an additional effort or merely a re-branding of pre-existing engagements.

Fourth, adaptation mobilizes an increasing amount of human and financial resources. Social and institutional actors know this all too well and use climate adaptation as leverage to advance other interests, just as they use other interests as leverage to advance climate adaptation. A last set of disagreements therefore concerns who should fund adaptation, who should benefit from the funding, through which channels these resources should flow, who should decide how to use them, and who should assess the results.

Because of these four sources of disagreement, adaptation constitutes an exceedingly multiple controversy. This, of course, does not mean that it does not deserve to be mapped. On the contrary, adaptation turned out to be one of the most interesting controversies we have ever worked on. It does mean, however, that the practicalities of the cartography are a mouthful even for a large and well-resourced project.

Cold and hot controversies

We have argued above that the main attraction of controversies is their ability to break open black boxes that would otherwise remain sealed. But opening up what is taken for granted requires work (at least as much as was invested in its black boxing) that actors are very unlikely to undertake unless forced to by the situation. Controversies serve as forges where, as Sarah Whatmore puts it, “the things on which we rely as unexamined parts of the material fabric of our everyday lives become molten and make their agential force felt” (Whatmore, 2009, pp. 588–9). Just like real forges, however, they only work if they are hot enough to unsettle existing arrangements and push actors to contest them explicitly. Callon’s definition of a “cold situation” provides a counterexample:

In “cold” situations, on the other hand, agreement regarding ongoing overflows is swiftly achieved. Actors are identified, interests are stabilized, preferences can be expressed, responsibilities are acknowledged and accepted. The possible world states are already known or easy to identify: calculated decisions can be taken. The sudden (but nevertheless foreseeable because already experienced) pollution of a watercourse by a chemical factory falls into this category: sensors are already calibrated, analytical procedures are codified; the protagonists already know how to calculate their costs and benefits and are ready to negotiate (if necessary on the basis of clearly formulated insurance contracts) in order to determine the level of compensation payable. (Callon, 1998, p. 261)

In practice, this often translates into prioritizing issues that are hot at the moment the mapping takes place. It is not impossible to study past disputes by drawing on archives and documents, but it is generally more difficult both conceptually and practically. Conceptually, because once an issue is closed it is difficult to resist the temptation to “naturalize” its outcome and believe that the dispute could not have played out differently. Practically, because the actors will be less willing to offer their testimonies: those who “won” the conflict will present the conclusion as unavoidable; those who lost may prefer to forget about it. The black boxes are closed and few people are motivated to reopen them. Cartographers, in this situation, cannot just “follow” or “monitor” their objects, but are forced to “excavate” and “reconstruct” them.

The same is true, a fortiori, for upcoming issues: everyone expects some new product to revolutionize the market; some new law to wreak havoc once adopted by parliament; some new technology to incur moral objections when developed. Yet, until this actually happens there is little for the controversy mapper to do. The temperature only rises when actors become “sufficiently affected by what is at issue” (Whatmore & Landström, 2011, p. 583).

Commonplace and specialized controversies

While one might be tempted to pick issues that are trending over the media and on everybody’s lips, it is important not to mistake the *liveliness* of a controversy with its *popularity*. The mere number of people interested in a debate is not necessarily an indicator of its quality as a mapping subject. In fact, it is often better to stay clear of debates that are too commonplace and instead seek out more specialized discussions, in particular those with an expert component.

This penchant for scientific quarrels is not only a legacy of the STS origins of controversy mapping. Controversies are easier to follow in scholarly disputes than in other arenas. The quarrel about gravitational waves (Collins, 1975) lends itself more easily to the prying eyes of a controversy mapper than, for instance, the quarrel about the complicity of paparazzi

and the sensationalist press in the death of Princess Diana (Bishop, 1999). True, one must pay the price of learning the specialized jargon of theoretical physics, but the very specificity of this jargon and the strict definitions of what counts as a valid argument can facilitate the analysis. This does not necessarily mean that scientific discussions are more *rational* or *coherent*, but it does mean they tend to abide by more formalized and disciplined rules of argumentation.

“Scientific” should here be understood in the widest possible sense and certainly not restricted to the natural sciences. Disciplines such as ecclesiology, art history, and pedagogy offer great and feasible topics for controversy analysis (see, respectively, Flesseman-van Leer, 1962 on the dispute between Thomas More and William Tyndale; Senie & Webster, 1992 for a whole anthology of controversies surrounding public art; Dworkin & Block, 1976 on the longstanding debate about IQ measures) because they mobilize specialized knowledge, a well-defined research community, and a specific set of actions and arguments. Furthermore, scientific controversies do not necessarily happen within the walls of a laboratory and are not limited to “white coats” (see Lorenzet, 2013, pp. 47–51).

The advice to privilege controversies with an expert component, therefore, is less strict than it sounds. In fact, it is difficult to find a debate that does not concern, at least in part, some field of expertise. We mentioned the coverage of Princess Diana’s death as a “commonplace controversy,” but also provided a reference – Bishop (1999) – proving that even popular debate is indeed studied (and thereby made more legible) by an academic discipline (in this case, Bishop analyzed the debate from the viewpoint of journalism studies, to show how the discussion became the occasion for mainstream journalists to distance themselves from the tabloid press).

Secret and accessible controversies

To be mapped, a dispute must be available for observation. Sensitive or classified issues that have been purposely removed from public scrutiny therefore make difficult topics. This does not mean they are not interesting. It simply means that their investigation would have to overcome some overwhelming odds (Galison, 2005). The discussions around the September 11 attacks, for instance, may be fascinating, but if you do not have access to classified sources, there is little chance that you could study them seriously. If a debate does not disclose new information, then its investigation risks degenerating into a conspiracy theory in which collective dynamics are explained through the deployment of some surreptitious plan rather than as the outcome of many diverging and mutually interfering agendas. As Karl Popper beautifully puts it:

It is one of the striking things about social life that nothing ever comes off as intended. Things always turn out a little bit differently. We hardly ever produce in social life precisely the effect that we wish to produce, and we usually get things that we do not want into the bargain ... the people who approach the social sciences with a readymade conspiracy theory thereby deny themselves the possibility of ever understanding what the task of the social sciences is, for they assume that we can explain practically everything in society by asking who wanted it, whereas the real task of the social sciences is to explain those things which nobody wants. (Popper, 2002 [1963], pp. 165–8)

On the contrary, considering controversies that are accessible because close at hand is always a smart move. Controversy mapping is a sort of “secondary analysis” of the scientific debates that other researchers are engaged in. Hence, controversy mappers who work in academia can find great subjects just by interviewing their teachers and colleagues. Likewise, local controversies (e.g., connected to architectural projects; Yaneva, 2011) are often attractive choices, especially if they take place nearby.

Finally, and for reasons directly connected to the point we just made, controversies that develop online are cartographically convenient because they leave digital traces readily at hand for everyone who has a computer. As in the advice to privilege scientific controversies, digital should here be taken in the widest possible sense, and certainly not only limited to dominant platforms. In the last few years, these platforms have grown especially popular among social scientists (and even more among commercial and political marketers) for the way in which their APIs (application programming interfaces) redistribute some of the records they collect. Yet, platforms are by no means the only digital sources that controversy mappers can and should exploit and, depending on the object of research, other datasets may be more interesting.

We are not saying that social media records are useless for social investigation. Quite the contrary! Google, for example, can be suitable for studying the cycles of online attention (Choi & Varian, 2012); Facebook can offer a decent proxy of Web sociability (Rieder, 2013); YouTube can be interesting for comparing mainstream and marginal media discourses (Arthurs et al., 2018; Rieder et al., 2018); Wikipedia is great for studying knowledge debates (Niederer & Van Dijck, 2010; Borra et al., 2014, 2015). Still, digital mapping can and should extend further than social media. It is one of our duties as critical scholars to interrogate and oppose the project of Silicon Valley giants to claim online sociality as their fiefdom. One way we can do this is by refusing to consider the data collected by these corporations as the gold standard of digital traceability and engage in other forms of digital fieldwork (Venturini & Rogers, 2019; Perriam et al., 2020), another is to critically examine the consequences of repurposing their APIs for online controversy mapping (Munk & Olesen, 2020).

On the risk of being overwhelmed

It should be clear from the discussion above that the most common pitfall in controversy mapping is the mismatch between the richness of the terrain and the resources available for its investigation. As a rule of thumb, controversies are always larger and richer than they seem at first glance and, while few mapping projects shipwreck for lack of ambition, many do for lack of modesty.

Sometimes it is possible to carve a feasibly sized topic out of an unmanageably large debate by focusing on a specific sub-controversy, but this carving does not always make sense. In studying nanotechnology, for example, there is no point in trying to single out a debate about a particular nano-molecule. Despite the diversity of such molecules, the advocacy around them tends to address them globally rather than one by one, which the cartographer must respect. The point is not to artificially tear large controversies into smaller pieces but to identify debates which are commensurate with available time and resources.

In lively controversies, actors go to every available *agora* to plead their cases. They will make documents available, offer interpretations, and even explain the arguments of their

opponents (only to contradict them, of course). If you choose a good controversy, its actors should provide most of the inquiry, leaving you with “just” the task of reporting on their work and to make sure that it sheds light on all the important aspects of the situation. Indeed, most controversies will typically open sociotechnical black boxes selectively. Consider, for instance, the Fukushima Daiichi disaster, where the 2011 Tōhoku earthquake and tsunami broke open not only a Japanese nuclear reactor, but also several of the black boxes underpinning nuclear power production – such as the safety of generation-2 reactors and the resilience of plants in seismic zones. In the aftermath of the disaster, this destabilization had consequences for energy policy across the globe, encouraging a shift away from nuclear power, in many cases towards fossil fuels. Of course, fossil alternatives have significant disaster risks in their own right, but these risks were not made available for inquiry through the Fukushima Daiichi catastrophe (though they were later brought into the debate by environmental activists). Controversies apply no “fairness” in the way they distribute scrutiny across claims and positions. They shed light on some collective phenomena but cast shadows on others.

Still, the problem of “not observing enough” tends to be secondary in controversy mapping. Imagine being a gold miner patiently sifting through the gravel of a mountain stream. At first you are not finding much, but at least you can set your own pace and control your workflow. This is the situation at the outset of most controversy mapping projects. Now imagine that every pebble in the river decides that it is going to help by jumping into your sieve. Buried under the avalanche, the mountain scenery loses most of its appeal. This is a caricature but an accurate one: controversies can be exasperating for the sheer quantity of arguments, documents, evidence, and questions that they impose on the cartographer. All controversy mapping projects therefore tend to go through their own form of “hype cycle” (see [figure 10](#)) (Fenn & Raskino, 2008). Cartographers are usually optimistic at the outset: their subject looks interesting; the simplest Web search provides tons of documents, interviews and position statements. But as the investigation proceeds, their optimism tends to fade: the more they inquire, the less they seem to make sense of the controversy. Things turn out to be far more intricate than expected. The most visible actors are not necessarily the most influential; new and unexpected characters sprout everywhere; the arguments are more subtle and charged with countless ifs and buts; simple ways of grasping the debate prove inapt, but sticking to the raw complexity produces very confusing maps. A long plateau of disillusionment must be crossed before things start to make sense again (and from there, it is still a long way to reach a satisfactory mapping).

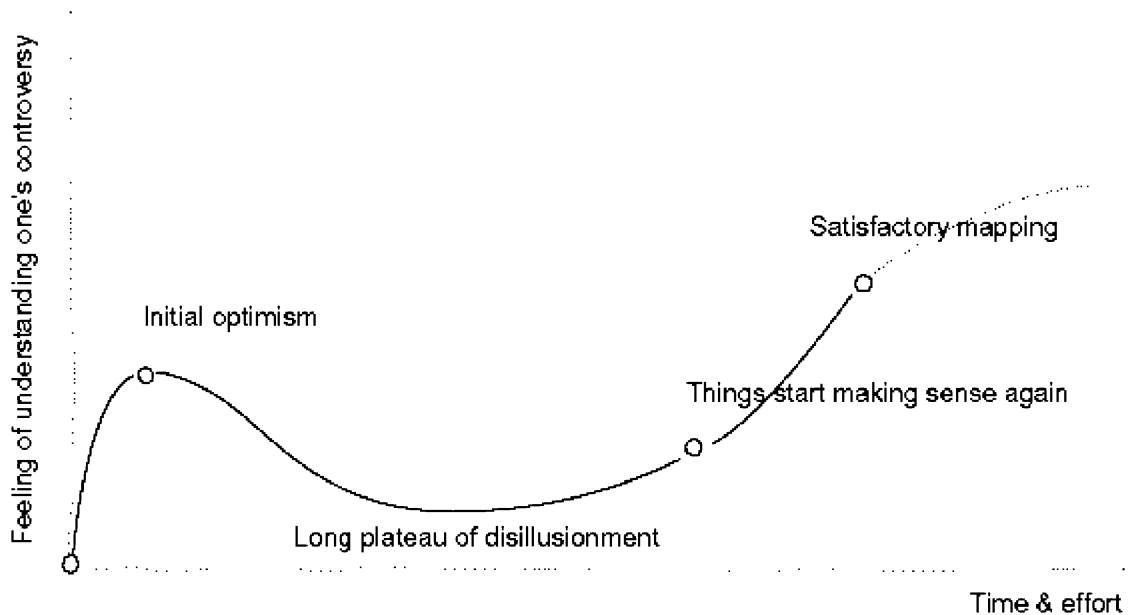


Figure 10 The hype cycle of controversy mapping (created by the authors; released by the authors under CC BY-SA 4.0).

Acknowledging the overabundant nature of controversies leads directly to the question that haunts all controversy mappers: where to stop? This question is crucial and less trivial than it may appear (Strathern, 1996). Most controversies (and most social phenomena) do not have clear-cut boundaries. If you follow the web of collective actions, you will find no obvious points to stop. The social fabric is continuous and extends indefinitely from interference to interference. Knowing where to stop is always, at least in part, a subjective decision, as observed by John Law and Evelyn Ruppert:

Where we set the boundaries is an analytical and political matter ... [it] depends on our own questions, and our own agendas. It also tells us that whatever the stories that we tell ... these will only ever be partial. There can be no exhaustive analysis of devices. There is always more to be told, more and different, about the work that they do, and about what and how they assemble, distribute and operate upon, the social. So how do we decide where we want to set our boundaries? (Law & Ruppert, 2013 p. 233)

Yet, although continuous, the social fabric is not uniform. All actors and all actions are eventually connected, but some are in a more direct way than others. Controversies could be bounded by their spatial context (global warming is not the same in Siberia as it is on a low-lying island in the Pacific); the communities they touch (the discussions in the IPCC are not the same as in the UN Framework Convention on Climate Change); the medium in which they take place (climate debate on Twitter is not the same as in the scientific literature), etc.

Consider temporal boundaries, for instance. Some controversies have a clear start date (e.g., by the publication of a contentious paper) and a clear end date (e.g., a Nobel prize acclamation), but most do not. A good example is the controversy around gravitational waves studied by Harry Collins, which has been revived every time a new measurement technique was introduced. In such a situation, cartographers can keep investigating, as Collins did in the book he published in 2004, retracing the more than four-decade quest for

gravitational waves, but could also focus on one of the “episodes” of the dispute, as Collins did in his 1975 paper discussing the debates surrounding one specific experiment.

Where to stop really depends on your resources and interests and in this sense controversy mapping is not unlike traditional cartography. Geographical territories are generally defined by natural boundaries (the shore of the sea, a major river, a mountain chain, etc.) but such boundaries are always somewhat arbitrary (Fall, 2010). So where should the mapping stop? The default solution in modern geographical cartography is simply to stop where the paper finishes. The edges of the page or of the canvas become the limits of the map. This solution acknowledges openly the arbitrariness of the cartographer’s decisions and suggests that each map is nothing but a cut of a larger atlas.

The same holds for controversy mapping. You are free to choose where to end your analysis, but you have to assume the burden of proving that your choice has practical utility (no natural boundary or theoretical framework will do this for you):

Student: But that’s exactly my problem: to stop. I have to complete this Ph.D.; I have just eight more months. You always say “more descriptions,” but this is like Freud, indefinite analysis. When do you stop? My actors are all over the place. Where should I go? What is a complete description?

Professor: Now that’s a good question because it’s a practical one. As I always say: a good thesis is a thesis that is done. But there is another way to stop than by “adding an explanation” or “putting it into a frame.”

S: Tell me it then.

P: You stop when you have written your 80,000 words or whatever is the format. (Latour, 2004a, p. 68)

2

A proliferation of issues

In this chapter, by retracing the history of STS, we learn that controversies can emerge in a variety of technoscientific situations, such as disputes about theories or experimental setups, the careers of experts or the reputation of institutions, the distribution of authority in society, or the political consequences of new knowledge and technology.

Sociotechnical controversies are seldom sparked by abstract principles or ideological affiliations. The problems that get people involved in public debates tend to be concrete and revolve around specific questions such as where a dam should be built, under which conditions a medical procedure should be allowed, or how a tax on financial gains should be designed. As argued by Noortje Marres (2005a, 2005b, 2006, 2007), our politics are object-oriented and grow from the issues at hand. Even highly academic disputes are often animated by very concrete matters of concern such as who was the first to introduce a theory or a technology, whether a particular experimental result should be discarded or confirmed, or who should be called upon as an expert on a given topic.

The distinction between controversies and issues is useful because it allows breaking down controversies into smaller questions and showing how sociotechnical debates are complex precisely because they are places where multiple issues intersect. But it is also artificial because issues are often so complex that they can be considered controversies in their own right. Similarly, most controversies can be considered issues within even wider controversies – what Andrew Barry calls “political situations” (Barry, 2012). Just as a city can be a single point on one map, but the entire territory on another one, so can a debate be a single issue in one controversy atlas, but the subject of the entire atlas in another one.

As a first example of how issues intersect in controversies, let us consider a recent and highly contentious development project. In the early 1990s, the city of Copenhagen was close to bankruptcy with a population that was skewed towards students, pensioners, and unemployed people. A daring plan was hatched between the state and the municipality to sell off public land in the old industrial harbor and in a vast stretch of common land south of the city. The profits would finance a brand-new metro system and spark development.

Twenty-five years later, the plan has dramatically turned the fortunes of the city. The metro has been built and the housing market cannot keep up with the population growth. All public land has been sold and developed, with the exception of an old beach meadow on the common south of the city center.

According to the original deal, this is the last plot of land to be sold to pay off the metro loans. The common is also the last place available for new housing close to the center. But just as the 25-year development plan approaches its completion, protest erupts. Residents of adjacent areas, environmental activists, cultural and political personalities, and members of the local branch of the Society for Nature Conservation (SNC), coalesce in a

heterogeneous opposition group under the name “Friends of the Common.” Through its Facebook page, the group organizes rallies and launches petitions. Soon they succeed in mobilizing public opposition against the plan, arguing that too many green spaces have already been lost to the city’s rapid expansion and that this piece of land is so unique that it should never have been targeted for development. Although the city council remains resolutely in favor of the project, the beach meadow issue could turn things upside down at the looming municipal election and pave the way for the city’s first “green” political majority.

The problem is that a deal was struck 25 years earlier between all the major actors at the time. The deal protects 90 percent of the common, in return for the right to develop the beach meadow. Most of the actors who were part of that deal stand by it. But not the SNC, which signed the deal, but never really liked the idea of building on the meadow as it made clear in an op-ed published just after the conclusion of the negotiations:

The master plan, which has now been agreed upon, states that the area can be developed in 30 years at the earliest and that it must be cared for as natural land until that time. *We hope that the relevant authorities will by then have gotten so much wiser that the development will never be realized.* (The director and regional manager of the Society for Nature Conservation in 1995, our emphasis and translation.)

While most actors have a general opinion on whether the development should go ahead or not, in practice they do not talk much about this overall question. Instead, their discussions revolve around a set of more particular issues, such as what part of the common we are actually talking about, how valuable it is, according to which logic, etc. To get a sense of the variety of stakes in the debate, we can begin by inventorying these issues. This will force us to realize that different issues are interdependent and that rather than a flat list, the inventory resembles a tree with multiple diverging and converging branches (see [figure 11](#)).

Most Copenhageners agree that the city is experiencing a housing crisis and that this constitutes a robust argument in favor of developing new residential areas. Opponents of the development project must therefore be careful how they make their case. Arguing that *all* undeveloped land should be left untouched, for instance, would require them to contest the existence of the housing crisis (a very uphill battle) or at least the notion that residential development can alleviate the crisis (as we shall see below). Most opponents therefore prefer to appeal to the pristine nature of the particular plot of beach meadow in question, conceding that other plots of urban nature may not be as problematic and that the planned development could be moved there. Here is one example:

I had a discussion the other day with someone who questioned if the area was really pristine nature. I could not really argue the case and decided to get the facts straight with help from the Society for Nature Conservation. According to [the landscape map] from 1981, the area is 7,000 years old. And it is untouched by humans. Cows have been grazing there since the stone ages. Since then Copenhagen has developed around the site, but left it untouched. (Excerpt from a Facebook debate in June 2016, our translation)

Build on the common?

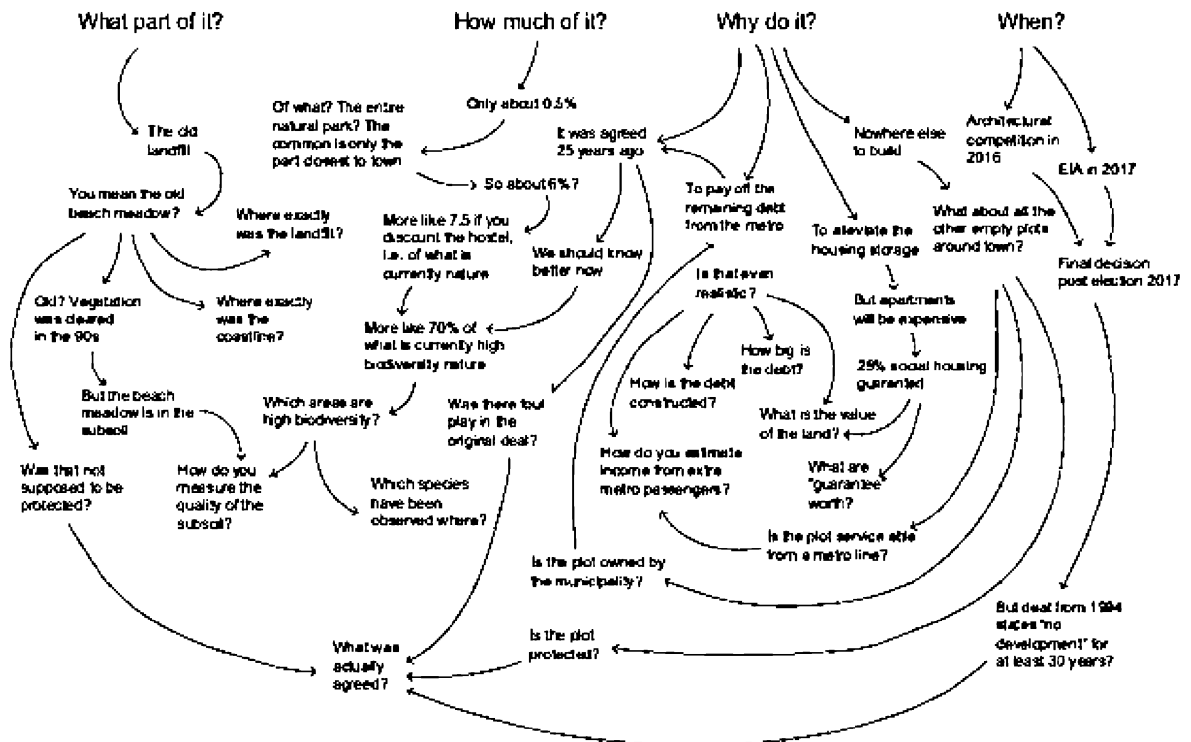


Figure 11 First attempt at inventorying the issues surrounding the plans for developing the beach meadow on the Amager Common in Copenhagen. By mapping how the overall question of whether to build on the common breaks into different sub-questions and thus leads to a range of different problems and positions, it becomes clear how issues such as nature conservation, biodiversity, housing, debt management, and urban mobility are intersecting (created by the authors; released by the authors under CC BY-SA 4.0).

Even though these unspoiled Stone Age qualities of the area have made little difference in the past – ordinary users have not come to the meadow to admire a prehistoric landscape or experience ancient grazing techniques – the issue is now at the forefront of the argumentation. Thanks to the pristinity argument, the opposition can present itself as a salvage operation to defend the last bit of an irreplaceable beach meadow.

Pristinity, however, is a delicate argument. The island of Amager, where the building site is located, barely rises above sea level and much of it has been reclaimed from the sea when Copenhagen expanded beyond its medieval fortifications. At various points in history, the plot has also been used as a practicing range for the garrison's artillery and as a landfill site. To settle the question, the SNC therefore decides to corroborate the claim in a public statement (although with a different age estimate):

The area in question has been a natural beach meadow the past 5,000 years. It has never been ploughed, built on or filled in ... Almost all other parts of Copenhagen have been created from land reclamation and land fill, both with a relatively insignificant natural value. Except in one place, namely the area where the new neighborhood has been planned. It is the last bit of original, pristine nature left in Copenhagen. (SNC press release, our translation)

This expert intervention fails to close the discussion as the developer retaliates by circulating three maps. The first (figure 12) is from 1934 and concedes on the question of land reclamation – the area is clearly on the old beach meadow and has not been reclaimed from the sea (which would have obviously challenged the claim that “cows have been grazing there since the stone ages”). It confirms, however, that the proposed building site is located right in the middle of the old artillery range. It was only very recently (and only partially) cleared of ordnance as testified by a second map (figure 13) showing the density of shells found and disarmed. When the SNC affirms that the beach meadow has “never been ploughed, built on or filled in,” it overlooks that it has been heavily shot at.

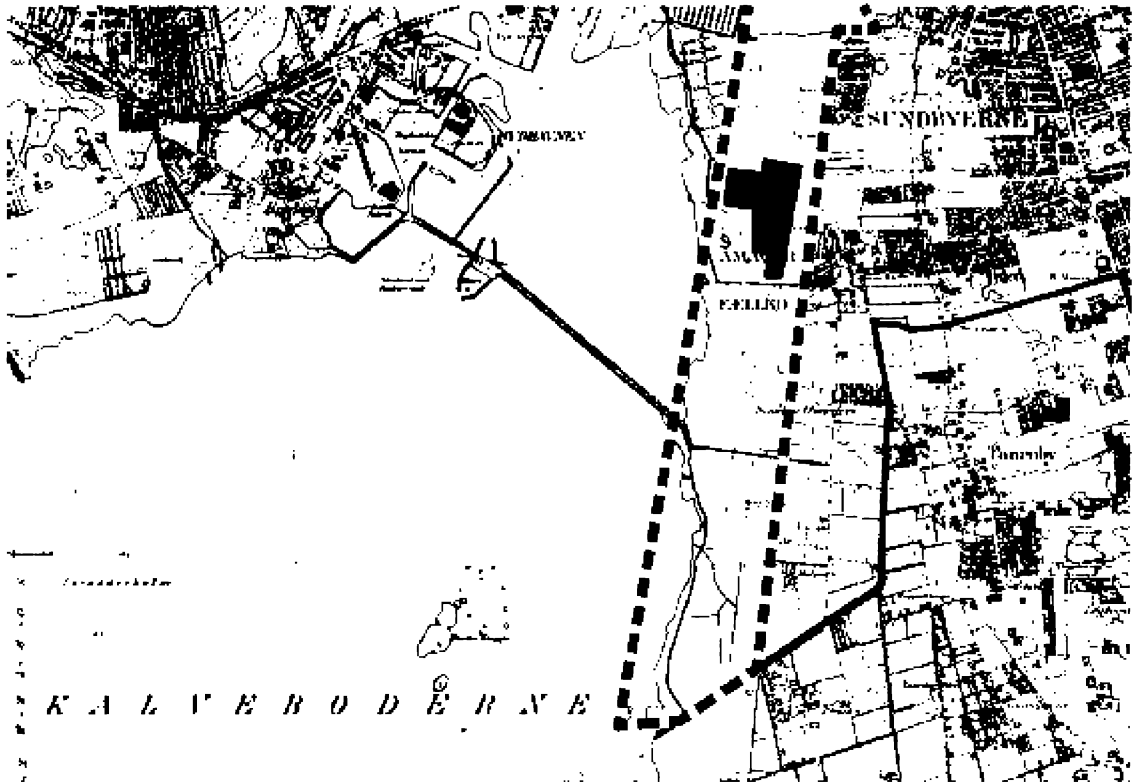


Figure 12 1934 map of Southern Copenhagen circulated by the developer as part of the debate in 2017. At this point in time there has been no land reclamation yet and the dashed outline thus documents the location of the old beach meadow. The black box shows the planned development.

Source: Geodatastyrelsen, with annotation by By & Havn.

The third map released by the developer (figure 14) shows that after the artillery range was closed, the plot was used as a landfill. Although the landfill was sealed in the 1970s, it is still at odds with claims about pristinity. This last map, however, is contested by the protesters, who note that while it displays the land *set aside* for the landfill, it does not reveal the exact location where the garbage was actually dumped.

In an attempt to deliver closure, municipal politicians release photos (figure 15) showing that when the surrounding plots were being developed in the early 2000s, the meadow was used as temporary storage for surplus earth from nearby digs and that most of the trees and vegetation were removed in the process.

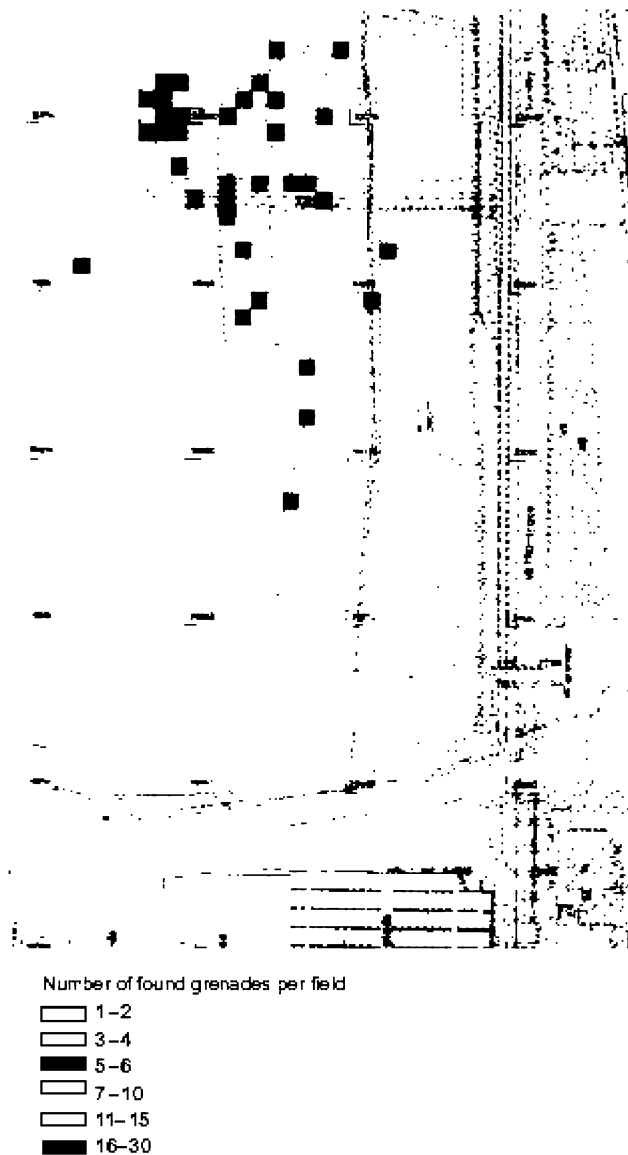


Figure 13 Map of the area where the development is planned showing the concentration of unexploded ordnance. Circulated by the developer as part of the debate in 2017 (source: Ammunitionsrydningstjenesten, produced for the Ørestad grenade localization plan in 2005).

This cartographic and photographic evidence literally moves the controversy underground. The SNC now releases an analysis of biodiversity in the area, trying to move the evaluation of pristinity from a historical analysis of land use to a biological analysis of subsoil. The analysis demonstrates that swaths of unspoiled biotope can still be found on the site.

The actors, in other words, disagree not only on the evaluation of the pristinity of the plot but also on what “pristinity” actually means (let alone on the weight that the preservation of pristine nature should have vis-à-vis other issues). On the issue of biodiversity alone, there are several complicated arguments to follow, but it only gets more complicated when you start to examine the range of partially connected issues which are also brought up in relation to the development plans.

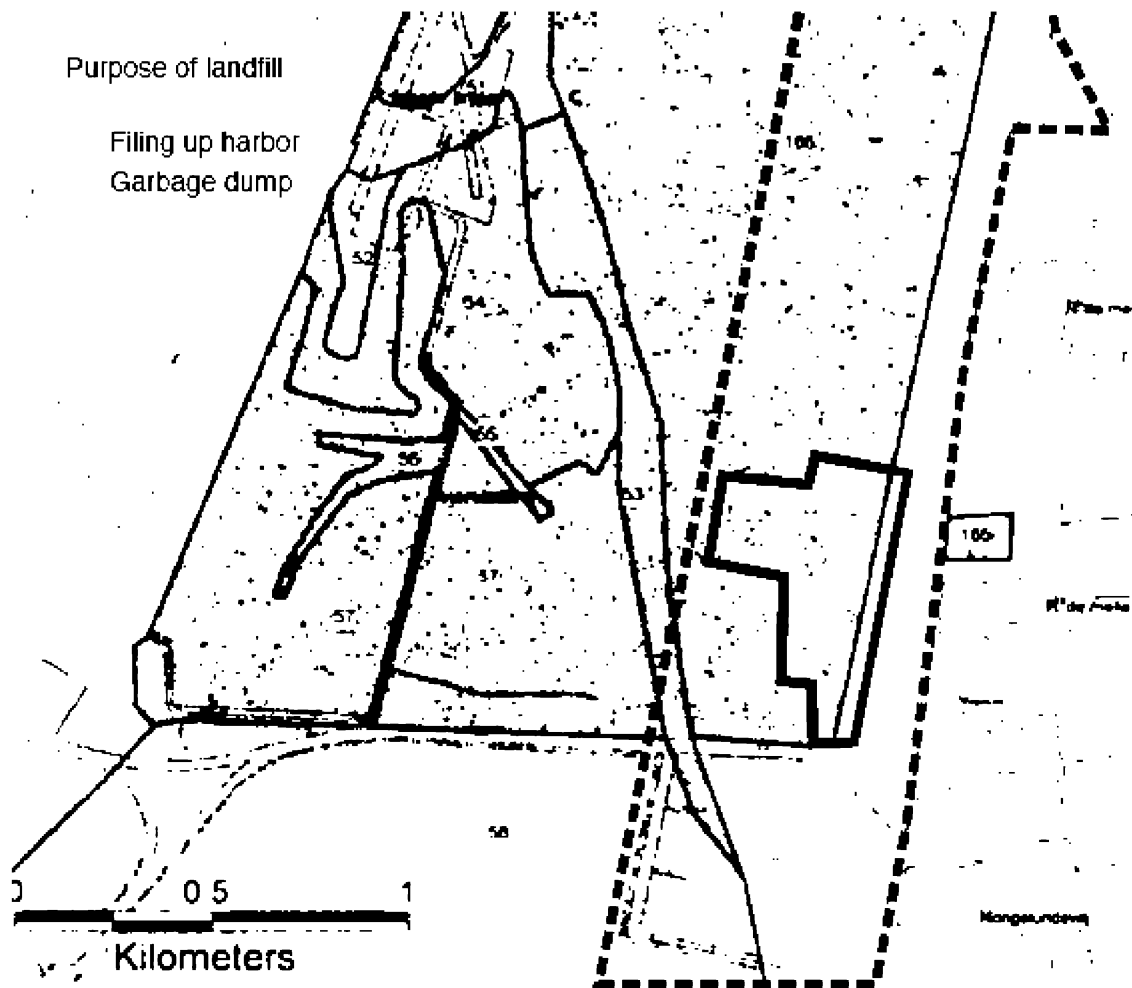


Figure 14 Map demonstrating that the construction site (marked up with fully drawn dark outline) is on the site of the old landfill (area marked up with dark gray fill – the light gray area is land reclaimed from the sea but not subsequently assigned as garbage dump). Circulated by the developer as part of the debate in 2017 (adapted from Eriksen, 1996).

Among these connected issues is the question of endangered species. At first glance, one could be tempted to lump it together with the issue of biodiversity. After all, they are both about preserving the natural environment (following Barry, 2012, we could say that they are both part of the same political situation). Here you will have to ask yourself if the two issues deal with the same questions, revolve around the same evidence, mobilize and are mobilized by the same actors, and affect the same constituencies. In doing so it becomes apparent that the issues are in fact distinct.

The most immediate difference is legal. Whereas the beach meadow and its subsoil has not been classified as protected, some of the species living there have. This produces a different dynamic because of the existence of an established legal procedure to stop projects that fail to deal with the question of nature protection. Three pieces of legislation are in play: the European Habitats Directive, which designates the moor frog and the northern crested newt as protected species; a set of national directives, which protects two types of orchid; and the International Union for Conservation of Nature *Red List* which features the Morris's wainscot, snow parsley, and 13 species of mushrooms. The mushrooms can be fairly easily written off by the developer, because the data documenting

their presence is too old and shaky, but the others must be dealt with, especially the four species protected under EU and national law.

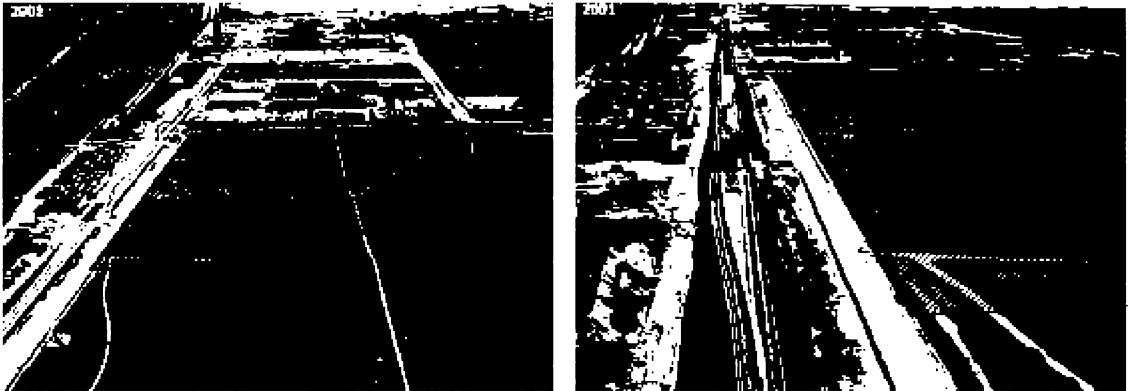


Figure 15 Two of the photos showing how in 2001 the meadows were almost completely stripped of their vegetation to be used as a storage for construction materials. Planned development marked with black shaded box. Overview on the left, close-up on the right. Original photos by Ole Malling, adapted by the developer.

The architects who competed for the development plan have taken great care to pitch a project that leaves areas of wetland nested within the built environment. They have also produced a visualization that shows the presence of red-listed species in and around the building site, which appears to confirm that buildings have been placed in consideration of the concentration of protected species (figure 16).

Opponents of the project quickly begin accruing their own photographic evidence that protected species are present within the building site in greater numbers than reported by the developer. This complicates the controversy mapping because we now have to consider the status of this additional evidence and the weight to be attributed to lay experts versus professional biologists. It also forces us to notice that, contrary to the issue of pristinity, the issue of endangered species may have significant legal ramifications. Although, on social media, the question of protected species is eclipsed by the pristinity argument, the former has the full attention of the developer who sees it as the greater threat to the project.

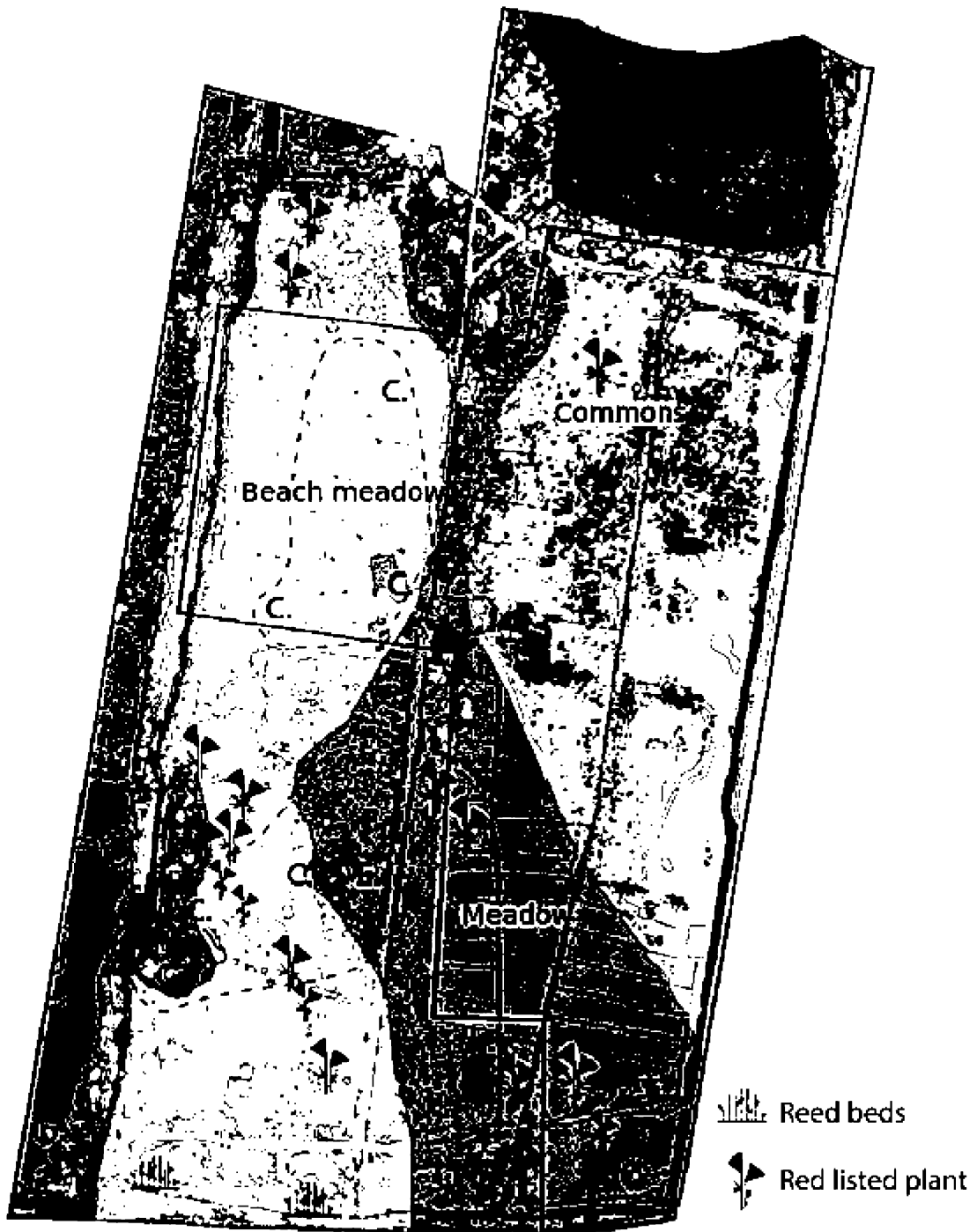


Figure 16 Map of the area showing the location of the red-listed species and the planned development (black outline). The map was produced with the assistance of biologist consultants for one of the proposals in the architectural competition (Lendager & Arkitema 2016; image courtesy of Lendager Group).

Even if everyone were to agree that the beach meadow is pristine and the protected species cannot be safely moved, we still have to deal with the issues of whether it is *possible* or *necessary* to build somewhere else. These are distinct questions. The “necessity of building” splits into two separate discussions, namely the social necessity of more

affordable housing and the financial necessity of paying for the metro system. As far as the social necessity is concerned, some actors draw on de-growth or non-growth narratives to argue that building more housing is a never-ending spiral and that at some point the city simply has to stop expanding. There is also a discussion on the percentage of subsidized housing necessary to ensure that the new development will not simply produce more high-end homes that will be unaffordable for ordinary people.

The financial necessity is a different story. Back in the early 1990s, when the building plans were first agreed on, the city decided to finance its new metro system by selling off municipal land. To pay the last bills, the municipality needs the revenue from the sale of the beach meadow. Against this necessity, opponents argue that, as a public actor the city can simply decide to delay its payments. This has in turn evolved into a discussion about the city's financial credibility and the technicalities of how far a public actor can overrule the terms and conditions of its loans. The question of displacing the development plan is also connected to these financial discussions. While the need for new housing can be addressed by building elsewhere, it would require the municipality to *buy* new land – a solution that is at odds with a national policy curbing municipal spending. One issue thus implicates the other, and while it is for the actors of the controversy to sort out how to balance them against each other, it is for the cartographer to figure out how to represent them.

Types of issues and sources of disagreement

In the next pages, we develop a series of issue types through a close reading of the way STS has encountered them in half a century of controversy analysis. While it is impossible to pigeonhole technoscientific debates into fixed categories, it is useful to draw attention to different sources of disagreement or “practices of issue formation,” as Noortje Marres (2007) calls them. Distinguishing them helps the cartographer to observe how they overlap and interfere with each other.

An example will make this point clearer. In epistemology, it is common to distinguish between epistemic and ontic questions. If all parties ask the same question, but disagree on how to answer it, the question is *epistemic*. Conversely, if their disagreements are about the scope of the problem itself and hence about what questions should be asked in the first place, then the question is *ontic*.

Consider, for instance, the quarrel about the origin of the first human migration to North America (also known as the “peopling of the Americas” debate). The question is a battleground for two competing theories, namely the *Bering Land Bridge hypothesis*, which suggests a westbound migration from Asia to Alaska and down into North America, and the *Solutrean hypothesis*, which suggests an eastbound migration from Europe along the Atlantic ice rim south of Iceland and into Newfoundland at the last glacial maximum (Bradley & Stanford, 2004; Oppenheimer et al., 2014). For a long time, the question was framed as an opposition between phrenology (supporting the Bering hypothesis on the basis of the comparison of skull shapes in archaeological records) and experimental archaeology (supporting the Solutrean hypothesis on the basis of the comparison of chipped stone implements). Such a framing is epistemic in the sense that it opposes two different methods for producing an answer to the same question (how was North America populated?).

However, when a group of geogeneticists proposed following the movement of prehistoric populations by sequencing ancient human genomes from fossilized excrement (Fagundes et al., 2008; Rasmussen et al., 2014), the controversy took an ontic turn. The prospect of being able to establish the genetic ancestry of the first Americans, and settle the question of their origin, sparked discussions that quickly overflowed the limits of academia. Native Indian reservations are legally underpinned by the principle of *first nation rights*, which would have been challenged if the Solutrean hypothesis was confirmed by the new genetic evidence. New ontic disputes then arose about the legal and political implications of the research and about its ethical risks. Eventually, the genetic tests supported the Bering Land Bridge theory, but the events demonstrate how epistemic and ontic discussions overlap and feed into each other.

Organized skepticism

A first crucial acknowledgement when studying controversies is the recognition that expert disagreement is *not* a problem or an anomaly but the normal state of affairs in science and technology and therefore also a major source of issue formation. As the founder of the sociology of science Robert K. Merton puts it: “most institutions demand unqualified faith; but the institution of science makes skepticism a virtue” (Merton, 1973 [1942]).

Indeed, one of the earliest attempts at conceptualizing disagreement in science was concerned not with individual disputes but with the inherent controversiality of the scientific enterprise. In his *Logic of Scientific Discovery*, the German philosopher Karl Popper (1934) questioned the definition of science as a set of methods to prove the truth of theoretical hypotheses. This “positive” definition, he argued, conflicts with a basic theorem of propositional logic, according to which universal statements cannot be verified empirically because the existence of counterfactuals can never be definitively ruled out. Having observed a thousand white swans does not exclude the possibility of a black swan. Universal statements, however, can be *falsified* by a single counterfactual observation (one black swan is enough to falsify, once and for all, the theory that all swans are white). Drawing on this asymmetry in the logic of predicates, Popper came up with his famous demarcation principle: theories are not scientific because they are true; they are scientific because they can be falsified (i.e., formulated in a way that allows them to be tested empirically). The Popperian demarcation not only acknowledges the existence of controversies but makes them the hallmark of scientificity.

Controversy mappers could take two things away from Popperian philosophy. First, that “scientific” is not synonymous with “true,” “settled,” or “undisputed.” What we are dealing with is rather a continuum of more or less tested hypotheses. As the spectrum of potential falsifications is narrowed down through scientific inquiry, trust in a theory can grow, but that does not entail an equivalence between what is scientific and what is true.

Second, that the possibility to question knowledge claims is an asset, not a liability for the scientific community. In line with this idea, Robert K. Merton made “organized skepticism” one of his four imperatives of the scientific ethos, summed up under the acronym CUDOS: *Communism* (nobody can own a discovery; whatever is achieved in the scientific process should be made available for all to share); *Universalism* (scientific facts and procedures should be independent from the personal or social attributes of scientists); *Disinterestedness* (the institutions of science cannot be harnessed for narrow personal interests); and *Organized Skepticism* (all new knowledge claims must be scrutinized

methodologically as well as procedurally). With the idea of organized skepticism, Merton restates the Popperian argument, but makes it an institutional rather than a logical feature. What matters to him is not that scientific statements are falsifiable, but that scientific work is organized to pursue falsification rather than validation. Reflecting such skepticism, many technoscientific issues simply derive from the habit of scientists to mistrust and challenge each other's results.

Paradigmatic shifts

While a general state of skepticism is the norm of science, some controversies are caused by more radical oppositions. In *The Structure of Scientific Revolutions* (1962), the American physicist and historian Thomas Kuhn suggested that science proceeds by oscillating between two different regimes. Most of the time, scientific progress accumulates slowly but surely in an incremental fashion. Kuhn called these periods of sustained achievement "normal science." From time to time, however, normal science exhausts its momentum and a rupture becomes unavoidable. This is what Kuhn calls "scientific revolutions."

The alternation of normal and revolutionary science depends, according to Kuhn, on the role played by *scientific paradigms*. A paradigm is the ensemble of ideas and practices that are taken for granted in a given scientific field at a given moment in time. It provides a simplified and non-problematic framework that helps researchers make sense of their observations efficiently and systematically. Since a paradigm is, by definition, a reduced vision of the world, there will always be observations that fall beyond its limits. In periods of normal science, however, such observations do not challenge the accepted paradigm. Rather, they are forced to find a place within it or simply dismissed as experimental errors. For example, the unexpected results obtained from nineteenth-century experiments conducted on the speed of light were initially dismissed by a physics community reluctant to challenge the Newtonian paradigm (instead, researchers tried to fix the anomalies mathematically through the so-called Lorentz transformations). The accumulation of anomalies eventually pushed some scientists to break with the paradigm and propose alternative theories, as Einstein did with his theory of relativity.

Paradigm shifts are therefore a source of disagreement in science, but in a different way than organized skepticism. Those who have built careers on championing certain methods and concepts, on the mastery of specific equipment, or on the recognition of a particular peer community, will inevitably put up a fight when others propose to reorient the research agenda in ways that sidetrack their competences, alliances, and achievements. Paradigms are not just theories; they are frameworks that build careers and determine the way in which scientists see the world. As a consequence, competing paradigms involve dispositions that are so radically different that it is impossible to compare their merits straightforwardly (Kuhn calls this problem the "paradigm incommensurability"). This is why paradigmatic shifts cause a rupture and why scientific revolutions cannot be settled by the mere force of empirical observation or logical deduction.

Priority disputes

Other scientific disagreements are not even about science per se, but about the way in which scientific credit is distributed. One of the first subjects studied by the burgeoning

sociology of science in the 1950s was the attribution of scientific discoveries. A classic example of these “priority disputes” is the invention of calculus – a disagreement that does not concern the proof of a theorem or its usefulness, but rather who invented it. Key elements of this technique were applied to the study of physics by Isaac Newton (in his idiosyncratic notation) as early as 1666, while a more formalized version was published two decades later by Gottfried Leibniz. The debate on whether Leibniz plagiarized Newton or developed his own parallel understanding has raged ever since (Hall, 2002; Bardi, 2009).

Priority disputes can be investigated through historical detective work (e.g., sifting through the personal correspondence of the protagonists in search for clues), but they can also be examined sociologically. Robert Merton noted that the struggles for recognition that ensue from discoveries rarely turns out in favor of those who contributed most to them (Merton, 1957). Instead, senior scientists often accrue credit at the expense of their junior colleagues (Merton, 1968). In some cases, recognition has even been credited to the one who happened to repeat a knowledge claim in the right place and time. This is captured by the so-called *Stigler's Law of Eponymy* (Stigler, 1980), which states that scientific discoveries are never named after their original discoverers (to illustrate the point, Stephen Stigler named the law after himself while acknowledging Merton as the inventor).

Take the famous example of the DNA double helix, which was first photographed by Rosalind Franklin, an expert in x-ray diffraction imagery and a young female postdoctoral researcher. Franklin was never credited for her part in the discovery. By the time the biologist James Watson and the physicist Francis Crick received the 1962 Nobel Prize for the achievement, Franklin had passed away and the laureates did not pay her much homage (compare Sayre, 1975, or Rose, 1986, to Watson, 2012). It has been suggested that Franklin's gender and lack of seniority precluded her from receiving the recognition that she deserved.

The fact that scientists are socialized into the norms and asymmetries of collective life may seem evident today. Yet, before Merton, the dynamics that turn priority disputes into complicated social affairs were simply not considered as an appropriate object of study. Controversy mapping takes from Mertonian sociology of science the understanding that the academy is part of society and that issues within the academy should be reviewed in this light. Another example is the discovery of the HIV virus, which had huge commercial stakes riding on it, and became a state-level matter between France and the United States. The contenders for scientific priority, namely Robert Gallo and Luc Montagnier, found themselves eclipsed by the interests of their governments that eventually agreed to share credit.

Instead of reducing itself to a piece of archival work that mulls over diaries and letters in search of a smoking gun (e.g., the personal correspondence proving how Leibniz got his ideas from Newton), a sociologically informed analysis of expert disagreement attempts to provide context. It tries to understand what gender-segregated college life in mid-century Britain meant for Franklin's career or how patent laws and the boom of the biomedical industry in the 1980s played into Gallo and Montagnier's race to discover HIV.

Institutional struggles

Although instrumental to the development of the sociology of science, the Mertonian style of analysis also put considerable limitations on the scope of such a sociology. These limits

became evident in the 1970s when a new breed of science studies known as the *Sociology of Scientific Knowledge* (SSK) emerged in Britain. SSK shifted the sociological attention from the careers of scientists to the substance of their scientific work. SSK showed that sociological analysis could be applied not just to the question of who gets the credit for a scientific discovery but also to the question of how that discovery is produced.

At the University of Edinburgh, David Bloor, Barry Barnes, and their colleagues advanced the so-called “Strong Program,” named in response to what they perceived as a weak sociological approach to the study of science. The social, they asserted, had been mobilized as an explanation only when events *did not* unfold in accordance with the ideals of science. Social factors were typically wheeled in to excuse mistakes or deviations from the expected behavior of the scientific community. It was normal, for example, to cite cultural traditions and Catholic institutions to explain why Renaissance astronomers stuck to geocentrism. Yet nobody had seen fit to provide a *sociological* explanation for the success of heliocentrism, presuming that it prevailed simply because it corresponded to reality. To the Strong Program, such an approach reflected a yielding sociological stance:

Knowledge is an institution and it should be analyzed as such. What people say about the world in groups, and how they come to agree, and how they found out how things are has the quality of an institution and should be analyzed the way other institutions are analyzed. That meant, for example, that it was extremely unpromising (to put it mildly) to suppose that social principles are only acting when folks get things wrong. For example, it did not look remotely plausible to say that Isaac Newton thought that there was an inverse square law of gravity acting instantly at the distance through empty space between the centers of distant bodies because *there is* an inverse square law acting instantly from the center of one body to another through empty space, and Leibniz disagreed because he was German. (Simon Schaffer interviewed by Paul Kennedy in the BBC radio program “How To Think About Science – Part 1,” www.cbc.ca/radio/ideas/how-to-think-about-science-part-1-1.464989 8:08–9:18)

In *Knowledge and Social Imagery* (1976), Bloor thus formulated the four tenets of the Strong Program that would put SSK on the same scientific footing as any other branch of sociology:

1. It would be causal, that is, concerned with the conditions which bring about belief or states of knowledge. Naturally there will be other types of causes apart from social ones which will cooperate in bringing about belief.
2. It would be impartial with respect to truth and falsity, rationality or irrationality, success or failure. Both sides of these dichotomies will require explanation.
3. It would be symmetrical in its style of explanation. The same types of cause would explain, say, true and false beliefs.
4. It would be reflexive. In principle its patterns of explanation would have to be applicable to sociology itself. (Bloor, 1976, p. 16)

The third tenet, in particular, energized a new generation of STS scholars by positing that the *outcome* of a dispute should not be used to explain its *development*. Right and wrong may seem evident *after* the closure of a dispute, but they are never obvious during the controversy. Being symmetrical means being fair with winners and losers and considering evenly the reasons of both. In controversy analysis, it means that all actors and positions should be investigated with the same methods.

Bloor illustrates his theory through examples from mathematics, one of the disciplines in which social influences seem least evident. He discusses, for instance, the case of the Euler characteristic. Formulated by the famous Swiss mathematician in 1752, the characteristic holds that, in polyhedrons, $vertices - edges + faces = 2$. The rule was long believed to be true for all polyhedrons, that is, for all solids composed of polygonal faces (according to Legendre's 1794 definition). In the nineteenth century, however, mathematicians identified various exceptions (e.g., a cube with a cubic hole at its center). In a Popperian version of science, these counterexamples should be enough to falsify the Euler characteristic. Devotion to Euler's legacy as a mathematical authority, however, weighed in and persuaded mathematicians to change the definition of polyhedrons instead of declaring that Euler was wrong. According to Jonquières' 1890 definition, polyhedrons were re-defined as *surfaces* of polygonal faces, thereby excluding most of the problematic anomalies (although not all of them).

The symmetry principle marked the final blow to the realist explanation of scientific truth as self-evident. Instead of attempting to sort true and false, SSK set out to evaluate the extent and conditions under which knowledge claims are *believed*:

That the world doesn't contain witches leaves open the question of whether it will or will not be believed to contain witches. Having chosen the true option is no less problematic than having chosen the false one: that is what methodology symmetry amounts to. (Bloor, 1976, p. 177)

Providing a social explanation for belief in scientific truth signals a radical turn in the sociology of science. It is no longer a matter of providing social context *as a supplement*. Rather, it is a matter of explaining scientific knowledge *as a fundamentally social phenomenon*.

Experimenter's regress

Through the principle of symmetry, the Edinburgh School extended the analysis of controversies to the content of scientific knowledge. However, it was their colleague in Bath, Harry Collins, who put the approach to its fullest use. Instead of drawing on historical examples, Collins turned his *Empirical Program Of Relativism* (or EPOR) to ongoing controversies. His seminal paper on "the replication of experiments in physics" (Collins, 1975; but see also Collins, 1981, 2004) illustrates how symmetry can be fruitfully pursued in a "live" controversy.

In the 1970s, one of the most prominent disputes in physics concerned the existence of gravitational waves. In his general theory of relativity, Einstein had predicted that major changes in the balances of gravitational forces (e.g., the collapse of a star) should cause gravitational radiation to spread through space. The hitch was that an experimental test of such a hypothesis seemed almost impossible because gravitational waves are extremely weak when they reach the Earth. Nonetheless, in 1969 the American physicist Joseph Weber claimed to have detected gravitational waves by measuring the oscillation of a large aluminum cylinder suspended in vacuum and insulated *as much as possible* from other sources of interference. Weber's claim attracted a lot of interest, as well as a good deal of skepticism, and several other laboratories immediately attempted to reproduce his results. Some succeeded, others did not. The seeds of controversy were sown: what actually produced the oscillations? Gravitational waves? Or some terrestrial disturbance such as a micro earthquake that the experimental setting was unable to rule out? And what about the

laboratories that were not able to replicate the results? Were their cylinders better insulated or less sensitive?

Though a majority of physicists remained unconvinced by Weber's results, they could not refuse them altogether. They were trapped in what Collins calls the "experimenter's regress": on the one hand, they could not rely on experience to confirm the theory of relativity because the results diverged; on the other, they could not use the theory to validate the experimental results because the existence of the waves was only hypothetical. When both theory and experiments are debated, as regularly happens in cutting-edge research, neither provide a stable ground to decide who is wrong and who is right.

The dispute that followed from Weber's experiment was eventually closed by the intervention of a senior scientist, Richard Garwin, who wrote a series of harsh letters to different physics journals, persistently showed up at conferences, provided a clearly voiced analysis of Weber's data, and unequivocally refuted his conclusions. It was Garwin's authority and the clarity of his discourse, Collins showed, rather than his experimental results, that convinced the scientific community to refute Weber's claims. Eventually the controversy was closed by the combined effect of style and reputation. The example reminds us that scientific controversies are rarely settled by the mere "force of evidence." The acceptance or refusal of theoretical propositions and experimental results is always the product of a cumbersome process of persuasion, riddled with uncertainties, and decided by many different factors, some of which are decidedly human and social.

Laboratory warfare

The Strong Program and the Empirical Program of Relativism paved the way for a new genre of research that would develop over the next 20 years and become known as *laboratory studies* (e.g. Latour & Woolgar, 1979; Knorr-Cetina, 1981; Zenzen & Restivo, 1982; Lynch, 1985; Traweek, 1988; Pickering, 1995). Whereas SSK had been Sociological with a big *S* (Bloor explicitly modeled the Strong Program on what he called "a Durkheimian approach to science," 1976, p. 47), many of the new lab studies were more ethnographic in style and often carried out by researchers trained in cultural and social anthropology. Taking inspiration from ethnomethodology (i.e., the study of people's methods for supporting beliefs and organizing interaction; Garfinkel, 1974), some of the early ethnographers of science carried out field studies that were markedly different from their SSK forbearers.

The novelty was methodological as well as theoretical and was characterized by *a shift from discourse to practice*. Both the traditional sociology of science and SSK relied on the accounts of scientists in the form of written reports and interviews. Ethnomethodology, on the other hand, emphasized the observation of actual scientific practices (e.g., in Garfinkel et al., 1981). In a chapter from their monograph *Laboratory Life* (1979) titled "An anthropologist enters the laboratory," Bruno Latour and Steve Woolgar give us a hint of what this means:

When an anthropological observer enters the field, one of his most fundamental preconceptions is that he might eventually be able to make sense of the observations and notes which he records ... For a total newcomer to the laboratory, we can imagine that his first encounter with his subjects would severely jeopardise such faith. The ultimate objective of systematically ordering and reporting observations must seem particularly illusory in the face of the barrage of questions which first occur to him. What are these people doing? What are they talking about? What is the purpose of these partitions or these walls? Why is this room in semidarkness whereas this bench is brightly lit? Why is everybody whispering? What part is played by the animals who squeak incessantly in ante-rooms? (Latour & Woolgar, 1979, p. 43)

Latour spent months observing Roger Guillemin and his team in their efforts to document the characteristics of gonadotropin and other hormones at the Salk Institute in California. His fieldwork demonstrated that *scientific practices* differ considerably from the *discourse on science* contained in textbooks and other written accounts. While laboratory research is observably controversial, textbook science is presented as consensual (omitting the work necessary to build such consensus). While laboratory research is observably dynamic, textbook science is described as stable (omitting that textbooks themselves are continuously changed and updated). While laboratory research is observably heterogeneous, textbook science is presented as pure (omitting its entanglements with politics, economics, law, etc.).

Laboratory Life completes the transition to first-hand observations of scientific work and marks the birth of the theoretical approach (ANT) that supports the mapping techniques described in this book. Latour and Woolgar provide evidence that it is the practical work undertaken in laboratories (and around them) that *eventually* closes controversies and decides which knowledge claims will be accepted or rejected. As Latour later put it in *Science in Action* (1987): “it is not because things are true that they hold, it is because they hold that they start becoming true” (p. 12). This recognition should encourage cartographers to not limit their investigation to what they read or what they are told and instead expand it to what actors actually do. Scientific controversies develop less through the jousts of theoretical arguments than through the practical work to build the alliances and infrastructures that reinforce and advance scientific battle lines.

Skirmishes at the border of technoscience

As the previous sections have shown, technoscience is a highly social endeavor. Not only in the weak sense that the careers of scientists and engineers are affected by all sorts of influences within and beyond their laboratories, but also in the stronger sense that scientific beliefs are shaped by the same influences. Yet, if the borders of science and technology are so permeable, why do we consider them as a separate social sphere in the first place?

According to Thomas Gieryn (1983), the image of separation enjoyed by science does not derive from any substantial feature of its activities (and certainly not from an ontological divide between the natural and the human world), but is the result of deliberate “efforts by *scientists* to distinguish their work and its products from non-scientific intellectual activities” (1983, p. 782, original emphasis). Gieryn calls such efforts “boundary work” and provides examples stretching from the fights to separate science from religion in Victorian England, to the ongoing defense of scientific autonomy from governmental control in the United States today.

Boundary work, according to Gieryn, is primarily performed in discourse through the rhetoric of purification that scientists deploy in their speech and writing. This rhetoric is often explicit, when the academic community defends the specificity of its methods or the independence of its institutions, but it is also *implicitly* conveyed by the peculiar style of scientific texts. According to Joseph Gusfield (1976), this literary genre is characterized by an objectifying style that establishes a separation between science and non-science:

To be scientific is to exercise a definite form over the language in use, to write in a particular way which shows the audience that the writer is “doing science.” The writer must persuade the audience that the results of the research are *not* literature, are *not* a product of the style of presentation. The style of non-style is itself the style of science. (p. 17, original emphasis)

Other separation strategies include creating specialized educational curricula, setting strict rules for scientific careers, and relying on exclusive journals, publishers, and conferences to set academic discussions apart from public debate.

The notion of “boundary work” is a reminder for controversy mappers that the borders that separate scientific and technological expertise from other forms of knowledge are neither natural nor peacefully established. Rather, they have been created (and continue to be recreated) through multiple struggles in which scientists have fought to distinguish their activities from those of other professions over the last five centuries (Krige & Pestre, 1997; Pestre, 2015). Like national borders, they only exist because they are constantly enforced by the work of those who occupy the territory. And like geopolitical borders, while establishing a separation, they also create incentives for crossing and opportunities for trade and smuggling.

Contested expertise

While laboratory studies were pushing for a closer observation of research practices, other STS scholars were striving to expand the notion of controversies beyond the walls of academia. Drawing inspiration from the social movements of the 1960s and 1970s (civil rights, feminism, post-colonial critiques, etc.), they became interested in developing a critical reflection on the connection between technoscience and public debate.

Initially, this reflection concerned the way in which science was conveyed to the public. In those years, scientific communication was by and large informed by the *deficit model*, i.e., the idea that ignorance is the main source of opposition to the progress of science and technology (also discussed in [chapter 1](#)). Against this model, STS scholars objected that in many cases scientific communication was not insufficient but rather misguided. Dorothy Nelkin (1971) showed, for example, how the social values of nuclear scientists collided with those of environmentalists and experts from the involved utility company in the controversy around the Cayuga Lake nuclear plant. In the mid-1980s, science communication gradually shifted away from the deficit model. In 1985, the Royal Society report on the *Public Understanding of Science* (Bodmer, 1985) argued forcefully that scientists have a responsibility to communicate their findings in ways that are relevant to their audiences.

The *Public Understanding of Science* (PUS) paradigm, however, was a timid step in the redefinition of the notion of expertise. A deeper challenge to the traditional separation between the expert and the public came from the mobilization of HIV patients in the

1980s. As described in *Impure Science: AIDS, Activism, and the Politics of Knowledge* by Steven Epstein (1996), HIV activists refused to assume the passive role of “patients” and fought to have their say in the development of a diagnosis for the disease and in the test of experimental drugs. Through their engagement, patient organizations challenged the traditional research protocols and demanded that the Food and Drug Administration (FDA) and National Institutes of Health (NIH) recognize that they could play a more active role in planning and designing the medical experiments necessary to approve new drugs.

To some extent, the success of the AIDS patient group can be explained by its socio-economic make-up. Most of the members of the group were middle- and upper-class males in their most active age (typically between 20 and 40 years old). Many were homosexual, i.e., members of a distinct and highly mobilized social group. Besides these standard sociological explanations, Epstein highlights the importance of the strategies employed by the patients to gain legitimacy. Gradually, they learned the medical jargon necessary to speak with researchers “in their own language”; they identified and allied with minority positions in the medical community that would support their cause. They also mixed scientific and ethical arguments, positing, for instance, that expanding access to experimental drugs would improve the representativeness of the testing samples *and* distribute participation more equitably to different social groups. Through these strategies, the patient-activists obtained the right to be represented in FDA and NIH deliberations and thereby an opportunity to transform their policies. As Epstein remarks, AIDS activists did not just exert an external influence on medical research, they successfully established themselves as actors of AIDS science.

An analogous case is provided by Michel Callon and Vololona Rabearisoa (2007) who studied the role played by patient associations in the research on neuromuscular diseases. In the 1950s, these diseases (relatively rare and complex in their symptoms and biological mechanisms) were largely ignored by medical research because of the difficulty of studying them and the scarce return-on-investment foreseen by pharmaceutical companies. To counter this neglect, the patients’ families organized around the *Association Française contre les Myopathies* (AFM) and gradually took charge of a series of activities normally performed by the medical community. The AFM arranged the first systematic data collection on the disease (gathering photos, videos, and logbooks); searched and circulated relevant scientific literature; carried out surveys (sometimes even publishing the results in medical journals); negotiated with public authorities and medical experts; engaged in fund raising through the organization of the Généthon; and eventually took charge of steering the direction of research on neuromuscular diseases. In this case, non-experts not only contributed to scientific research but in fact initiated and led it for many years.

Path dependence and the social construction of technology

Another type of issue concerns the process through which technoscientific objects enter (or fail to enter) collective life. The simplistic version of such a process holds that the more cost-effective technologies always prevail. The problem with this idea, however, is that the very definition of efficacy and cost is heavily dependent on the context in which it is evaluated.

A famous example of the contextual nature of technical efficacy is Paul David’s description of the QWERTY keyboard (1985). “QWERTY” refers to the disposition of the

first six letters (and of all other keys) in standard Latin keyboards. It was introduced in Remington typewriters at the end of the nineteenth century with the explicit goal of placing often used keys far apart to prevent the jamming of type bars. With the advent of computers and electronic keyboards, this disposition of keys lost its original purpose and other keyboards optimized for increased writing speed have been proposed instead. These alternatives, however, never succeeded in imposing themselves because of the inertia of succeeding generations of typists who learned to type on the QWERTY keyboard. The maintenance of the less-than-optimal QWERTY standard provides, according to David, a clear example of “path dependence”: the fact that economic and technological efficiency cannot be measured in absolutes, and are always dependent on the circumstances produced by previous choices (some of which may be entirely contingent; Mahoney, 2000).

Although later research has questioned the supposed inefficiency of the QWERTY keyboard, suggesting that spacing out keys often typed in sequence may in fact favor hand alternation and thus speed (see Liebowitz & Margolis, 1990), David’s study remains a textbook example of how the success of technological objects depends on the particular social networks in which they are embedded (David, 2005).

This idea is key to the *Social Construction Of Technology (SCOT)*, which in the 1980s and 1990s extended constructivist ideas to technical phenomena. As SSK had challenged the idea of scientific knowledge as the straightforward unveiling of natural laws, so SCOT questioned the idea of technical innovation as an answer to pre-existing societal needs. According to SCOT, technologies develop through the competition among technical artefacts and social groups. Different artefacts and their variants emerge through the exploration of the affordances of natural and technical arrangements and immediately interact with a variety of economic and social actors whose agendas are favored or hindered by the consequences of these technologies. Such a multidirectional process of “alternation of variation and selection” (Pinch & Bijker, 1987, p. 28) is fraught with controversy as different technologies are often incompatible with different groups and their diverging interests and ideas about what type of problems need to be solved. We introduced one example of these disputes in [chapter 1](#), where we discussed the opposition between different groups of bicycle users (women, competitive cyclists, elderly men, tourist cyclists) and different frame-wheel designs in the early days of biking, but similar sociotechnical struggles are described for many other technologies, including missiles, ships, electric vehicles, the cooking stove, pharmaceuticals, ultrasound, dyes, and expert systems in Bijker et al. (1987), Bijker and Law (1992) and Bijker (1995).

Large technological systems

The controversial nature of technical innovation becomes even more salient when considering that technologies are seldom introduced as independent artefacts and most often as components of larger sociotechnical systems. Bicycles, for example, stir fierce opposition not only for the internal design of their frames and wheels, but also for the way in which they compete with other means of transportation (cars and pedestrians in the first place) for road infrastructure and public space (Oldenziel & de la Bruhèze, 2011).

The idea that modern technologies are systems rather than single artifacts is illustrated in Thomas Parke Hughes’s study of the diffusion of electricity (1983). Electricity is not a single scientific invention, but a network of technical and social innovations relating to the ways in which electrical power is produced, transported, exploited in various types of

appliances, commercially charged, legally patented, and culturally accepted. According to Hughes, these “large technological systems” are characteristic of the modern age in which technical innovation does not come as individual objects but as composite infrastructures.

Drawing on the same concept to study railway networks, Alan Gras (1993, 1997) observed how the multiple interdependencies of large technological systems make their sociotechnical arrangements more rigid. Imagine, for instance, that we were to discover a perfectly clean and renewable source of energy. Switching to such a source would still require creating new production facilities, setting up transport infrastructures, replacing internal combustion engines in cars and industries, establishing conversion facilities and finding ways to dismantle the obsolete infrastructure. And these are just the technical implications. The transition would also turn the energy market upside-down, bankrupt oil and gas companies, or at least force them to find new business models and retrain their workforce. Regulations would have to be rewritten and lifestyles may radically change. All of which might be possible, but certainly would not be uncontroversial!

Ontological politics

By their infrastructuring and black-boxing power, sociotechnical systems facilitate our interactions, but also favor some actors over others (Star, 1999; Edwards, 2003). As a consequence, dominant technoscientific arrangements are regularly challenged by the actors who are disadvantaged in the particular organization of the world upheld by those arrangements. Scholars in feminist STS have provided several examples of such challenges in modern health care systems, for example in relation to diseases like anemia (Mol, 1999), atherosclerosis (Mol, 2002), and Alzheimer’s (Moser, 2008). Their argument is that the way in which we treat such illnesses depends on the way in which the human body is enacted (i.e., brought into being through different material practices and arrangements), which in turn depends on the way in which we have historically built our medical infrastructure. The body is multiple (Mol 2002), in the sense that its reality is enacted differently by different actors, but in our societies some of these enactments (typically performed by doctors and medical scientists) are privileged while others (e.g., those performed by nurses or patients) are partially silenced.

In [chapter 1](#), we touched on Annemarie Mol’s concept of “ontological politics” and remarked that, in these controversies, actors do not necessarily disagree explicitly but are instead focused on constructing the world in their image. They fight to maintain a construction of the world that enables their privileged position, or conversely to challenge that construction if it silences their position. As a controversy mapper committed to making alternative worlds visible (and to some extent thereby also possible) you are clearly intervening within such asymmetries. By revealing the multiplicity of the real, you are helping partially silenced actors run forms of “ontological interference” (Law, 2009).

3

Making room for more actors

In this chapter, we learn that, when it comes to the politics of science and technology, we should not only consider decision and opinion makers, scientists and engineers, but also acknowledge the role of lay experts, appreciate the agency of non-humans, and actively seek out the position of those who have a hard time making their voices heard.

In the previous chapter, we explored different types of issues and sources of disagreement. In this chapter, we will try a similar inventory but for controversy actors. Once again, the attempt is half conceptual and half historical. It provides an inspirational but open-ended list that cartographers can use to identify the protagonists of a controversy, but it is not exhaustive. It also gives a sense of how STS has progressively extended the notion of agency (i.e., the capacity to initiate or interfere with a course of action) to a wider variety of entities. As scholars in STS were considering new types of technoscientific conflict, they were also encountering new forms of action. Issues and actors go hand in hand, to the point that it is sometimes difficult to distinguish one from the other. It is the emergence of new issues that drag new actors into the controversy, just as it is the arrival of new actors that enables new issues to be taken into account. This is exactly what happened in the controversy on the Copenhagen beach meadow that we began to follow in the vignette introducing the previous chapter. As we will see below, it took a particular breed of actors to reopen the issue of the natural value of the beach meadow.

In May 2016, a biologist surveying the eastern edge of the old beach meadow discovers an extremely rare orchid, the *Orchis militaris*, a species that has not been seen in the country for 27 years and is officially listed as extinct by the IUCN (International Union for Conservation of Nature). The find makes it into the local news cycle and appears in a television segment. The timing and location could not be more dramatic: the architectural competition for the development project has been announced just a few months earlier and the orchid is found right inside the building plot ([figure 17](#)).

A new actor has entered the scene. But who, exactly, is this actor? While it is obvious that the controversy has changed, it is not easy to say who produced the change and how. Rare orchids, of course, do not intervene in the controversy on their own. They need botanists to identify them and document their presence. They need organizations like the IUCN to evaluate how rare and endangered they are. They need directives and regulations that impose legal consequences on those who disregard their precarious situation. And they need a level of public affection that will get them on TV when they show up after 27 years of absence. It is not just one actor who has entered the scene, then, but a whole cohort of new characters.



Figure 17 Screenshot of a post on the Friends of the Common Facebook group with the three red-listed orchids photographed in May 2016 on the beach meadow. The military orchid is the one on the bottom-right (original photos by Lars Andersen).

One of these characters is the *expert*, namely the biologist from the University of Copenhagen. What transforms the situation is the fact that he can positively identify the orchid and that he has the institutional credentials to attest that this particular species is rare and worthy of protection. Countless visitors to the meadow are likely to have seen the orchid, and some of them may even have known what it was, but that does not constitute a “find.” What sets the expert apart from the casual observer is that he can argue from authority and thus certify the presence of the orchid in a way that matters to the planning process.

It would be a mistake, however, to assume that expertise can only come from tenure at a research institution. This is not least the case in fields like botany, entomology, or ornithology where highly skilled hobbyists keep meticulous track of their findings, curate communal databases, and self-organize in clubs and associations with observation and documentation protocols. These *lay experts* are valued for their practical experience

without being institutionally vetted. Right from the beginning of the protest, hobbyists have been offering guided field trips and educational activities that encourage members of the public to document the biodiversity of the beach meadow. The military orchid may have been found by a university biologist, but a range of other orchids and protected species have been photographed, plotted and discussed by lay experts, adding to the evidence of the meadow's value.

Many of these experts, lay or not, are actively engaged in the protest. They do not wait to be consulted as impartial outsiders (the role we often imagine for experts); they take an active stance in the controversy. The biologist who found the military orchid, for example, was not commissioned by a public institution to assess the meadow's biodiversity; he did so on his own initiative. Similarly, the SNC, which is a key organizer of the protest, counts many professional biologists among its members. We can call them *scientific campaigners* for they fight a political cause by making scientific arguments in public.

Campaigners, however, are not the only actors to intervene alongside the orchids. Rare species are a problem for the development project only if their survival is inseparable from the protection of the meadow. Which explains why the developer begins experimenting with ways of moving the endangered plants and animals off the building site, taking advantage of the climate adaptation strategy just adopted by the city. The strategy calls for the use of green spaces to improve the drainage of Copenhagen and involves the relocation of some of its protected species, conveniently moving the orchids from the proposed building site to artificially designed sanctuaries. If the relocation plan turns out to be successful, the orchids will lose their ability to make a difference to the controversy and the protesters will lose an important ally.

Scientific entrepreneurs, such as the engineers who developed the artificial habitat, may not speak up in the controversy, but, through their actions, they can reconstruct its premises. A more spectacular example materializes at a later stage of the debate. A group of architects hatches a plan to solve three of Copenhagen's planning problems by constructing an artificial island outside the harbor (see [figure 18](#)). Sea-level projections suggest that a flood barrier will have to be constructed across the harbor inlet to regulate water flow. The artificial island would facilitate the construction of flood barriers, while providing 900,000 m² of new housing space. If adopted, the plan would thus undermine most of the arguments in favor of developing the beach meadow.



Figure 18 Artistic rendition of the proposed artificial island “Nordhaleøen,” which would transform the premises of the controversy over the planned development on the Amager Common (proposal by and photo courtesy of URBAN POWER).

Controversy mapping inherits from Actor-Network Theory an extremely wide definition of actors as *entities whose presence or absence makes an observable difference in the situation*:

The scope of the network being studied is determined by the existence of actors that are able to make their presence individually felt on it ... Conversely, if an element does not make its presence felt by influencing the structure of the network in a noticeable and individual way, then from the standpoint of that network the element in question does not exist. (Law, 1987, p. 131)

When faced with a potential actor, the cartographer should, then, ask the following questions: Who or what is making a difference? Who or what enables this ability to make that difference? What issues are affected? And to what extent? For example: the orchid is an actor because it makes a difference. It does so thanks to the combined efforts of the IUCN Red List, the national directives on natural protection, the botanists documenting their existence, and the media through which they become stories and acquire audiences. They make a difference in relation to the environmental impact assessment that the developer must submit (the approval of the planning application depends on it), and they make a difference as an object of engagement on social media. They make a difference to the extent that the architectural masterplan for the area takes them into account, that they are being moved to special sanctuaries, that a local television station runs a news segment when one of them is rediscovered, and that posts about them on Facebook generate high levels of engagement.

There is nothing in this way of observing action that defines a priori what will count as an actor in a controversy and no intrinsic feature assuring that something will make a

difference. The City Museum, for example, is an obvious candidate as an actor on the issue of pristinity, given its expertise in the history of the area and its influence among academics. But the museum only becomes an actor when the municipality requests its official advice to assess the historical value of the site. And even so, its degree of agency depends on its capacity and willingness to make a difference. For example, a bland recommendation to balance development and conservation might make little or no difference at all.

Similarly, nothing guarantees that something or someone will retain its actor status indefinitely or across contexts. This dynamic can be observed by exploring the posts and comments from the Friends of the Common Facebook group. In 18 months, almost 9,000 users have been active on the group producing 2,700 posts and 22,000 comments (see [figure 19](#)). To explore how the rise and fall of issues affords more or less visibility to different actors, we started by designing a set of keywords (e.g., “cheap apartments” or “continuous residence”) to use as proxies for particular issues (in this case “housing”). By counting the presence of these keywords in all the posts and comments, we get an approximate indication of the changing prevalence of actors and issues.

A close reading of [figure 19](#) suggests that the opposition to the residential development plan did not emerge from nothing, but was organized by citizens already mobilized by a protest against a tunnel below the common (still very visible at the beginning of the timeline). Right after the discussion about the tunnel, the members of the Friends of the Common set their sights on the ambition to turn another part of the common into a camping site and it was only after the city council approved the camping site in November 2016, that their attention focused on the residential development. As for the issue of endangered species, this builds over the summer of 2016, following the find of the orchids in the meadow, and reaches its peak in the first quarter of 2017.

[Figure 20](#) compares “angry” and “love” reactions week by week in the group and provides a timeline of the way in which individual and collective actors made a difference in the controversy. For example, two “human rings” were formed around the beach meadow as a demonstration in September 2016 and May 2017, which generated a lot of online engagement. Looking at the first quarter of 2017, we see several events connected to the issue of endangered species, such as the developer beginning to prepare alternative habitats and a report providing a way to assess pristinity through soil biodiversity. This is also the time when a new actor sees an opportunity to enter the stage. Nikolaj Kirk, a television chef, famous for promoting foraging, hunting, and biodiversity preservation, joins the protest. He begins sharing the petition of the Friends of the Common in March 2017 and producing reports from the beach meadow in June 2017. Through his celebrity, the chef increases the visibility of the protest and should therefore be counted among the actors making a difference to the controversy.

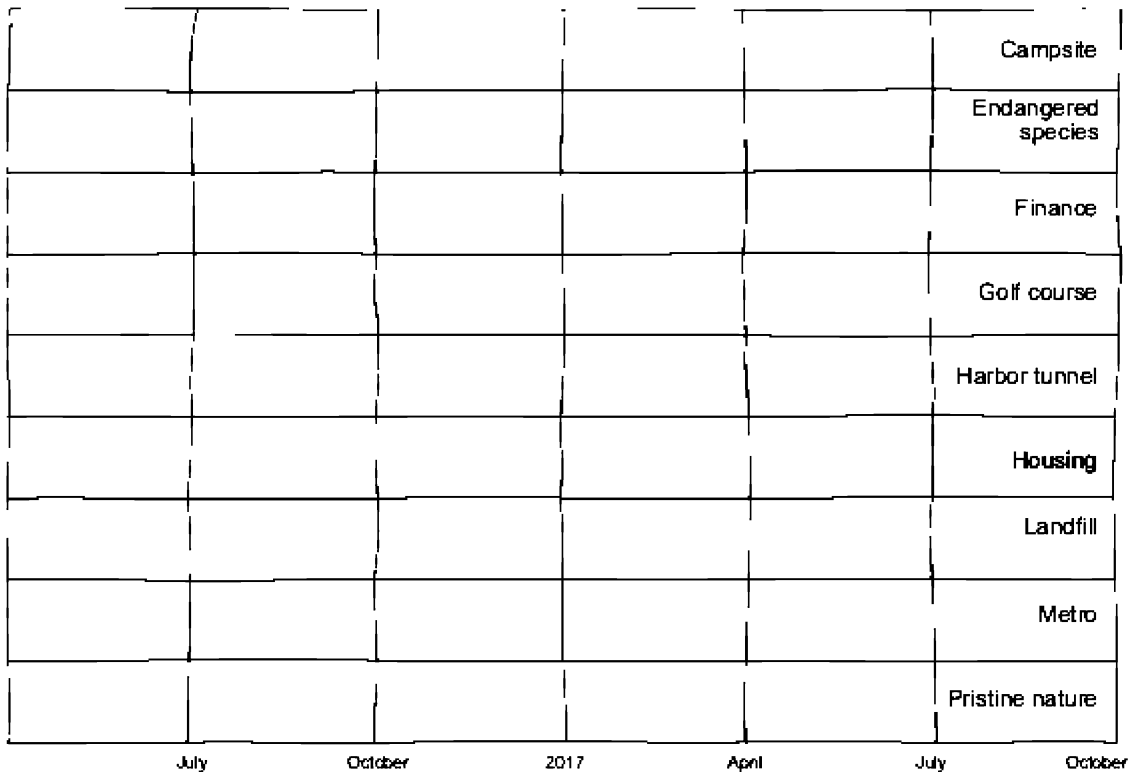


Figure 19 Area chart showing the shifting prevalence of different issues in the Friends of the Common group conversation between April 2016 and October 2017. The prevalence of an issue is computed as the percentage of posts and comments for a given month containing one or more of the query terms defined for that issue (created by the authors; released by the authors under CC BY-SA 4.0).

The scatterplot in [figure 21](#) locates Nikolaj Kirk in the space of comments and shares from the Facebook group of the Friends of the Common, and the Facebook pages of the local branches of the Outdoor Council and the Society for Nature Conservation.

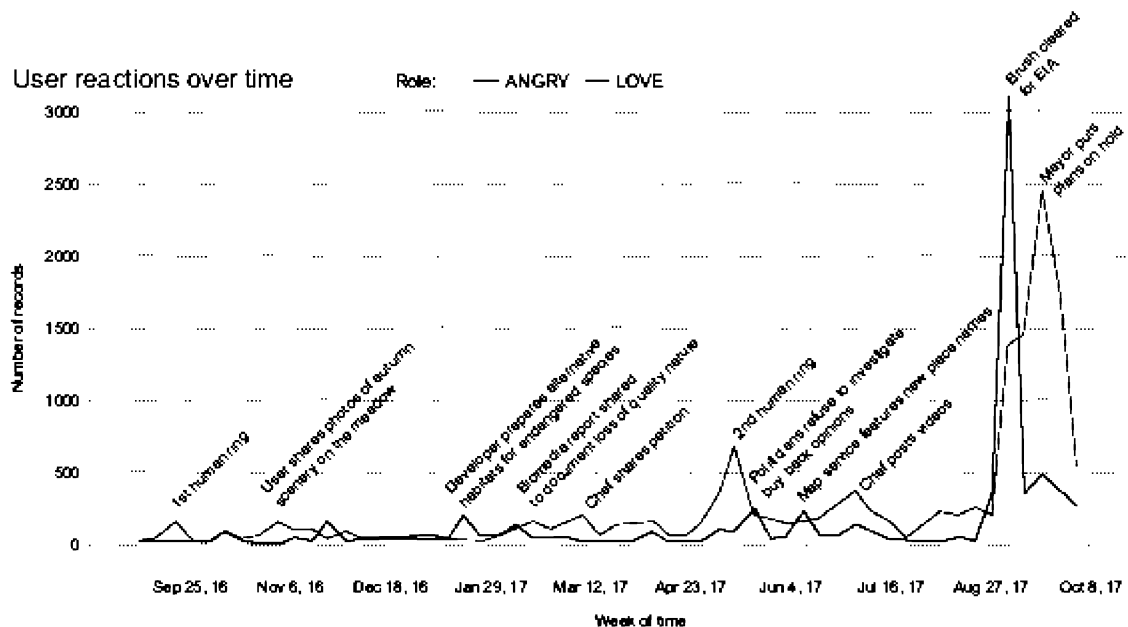


Figure 20 “Angry” (bold line) and “love” reactions to posts and comments in the Friends of the Common group week by week from September 2016 to October 2017 (created by the authors; released by the authors under CC BY-SA 4.0).

The difference made by the chef may actually be underrepresented in the scatterplot. By lending his online persona to the cause, he generates attention rather than discussion. His influence, therefore, would possibly be better measured in “likes,” rather than in the comments and shares as in [figure 21](#). This exemplifies the fact that assessing actors’ influence is never trivial and involves critical reflection on the metrics afforded by the medium. Although the engagement metrics on a platform like Facebook are easily appropriated for controversy mapping, they do not always convey the most interesting features and should be chosen carefully. Rare species, for example, act in the controversy through the mediation of national and international regulation protecting their habitats. We may be able to render their importance by visualizing how often posts about these species are shared or liked, but such metrics tell little about the specific ways in which the alliance of orchids and regulations constrains the actions of city planners.

Bureaucrats and policymakers

Among the actors who are institutionally sanctioned to intervene in a public controversy, elected representatives are perhaps the most obvious. It is hard to imagine investigating any controversial issue (say a new risky cancer treatment or a tax on financial transactions) without asking what those who make the regulations have to say and want to do about it. Many sociotechnical debates erupt as a consequence of the actions of elected officials initiating projects and setting policy agendas, or of their inaction, such as their failure to acknowledge the existence of an issue or properly act on it. Similarly, bureaucrats and other institutional decision makers make a difference to controversies when their jobs assign a role for them. A judge who is called to decide on a legal case or a drug administration official who gets to approve a new vaccine clearly become very central and powerful actors. Still, the agency of regulators cannot be taken for granted. For every bureaucrat who influences the course of a controversy there will be others with little or no

influence, even though their job description would lead you to include them in the actor gallery. Decision makers sometimes have the option to forfeit their power and defer to someone else – though this is arguably a decision in itself. In *The Divine Comedy*, for instance, Dante put Pope Celestine V in the vestibule of Hell for resigning his papacy. With his “great refusal,” Celestine V delivered the papal power into the hands of the next pope, Boniface VIII (a sworn enemy of Dante’s faction). Officials can also waive or hide their agency more subtly by conforming slavishly to the orders of their superiors or to the bureaucratic procedures, as in Hannah Arendt’s famous thesis on the “banality of evil” (1963).

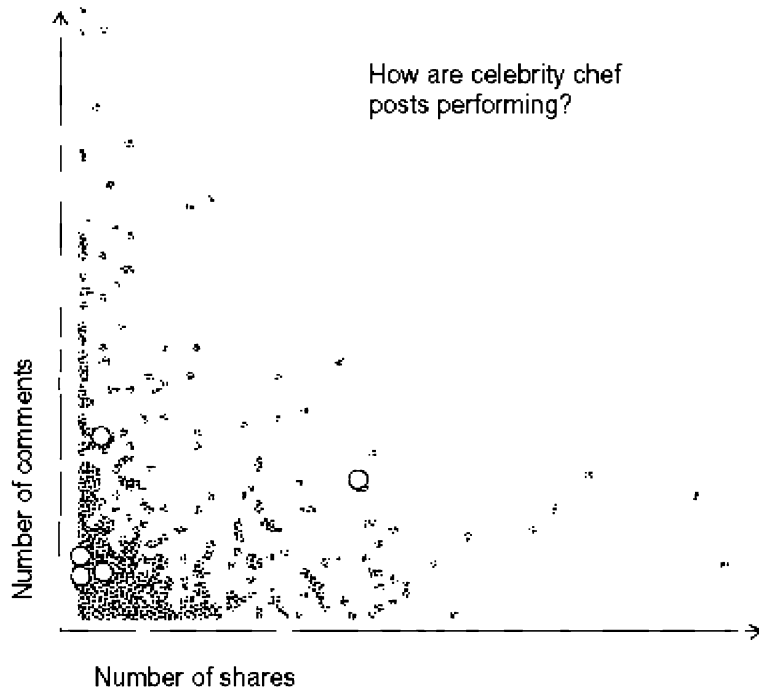


Figure 21 Facebook posts from the Friends of the Common group, and from the pages for the local branch of the Society for Nature Conservation and the Outdoor Council positioned according to the number of times they have been shared (x-axis) and commented on (y-axis). Posts that mention the celebrity chef Nikolaj Kirk are highlighted with a circle (created by the authors; released by the authors under CC BY-SA 4.0).

A similar caution should be applied before adding constituents to the list of actors simply in their capacity as voters. It is not because citizens are given a chance to express their opinion in public matters by casting their votes or petitioning their politicians that they necessarily make a difference in such matters. Citizens may choose not to exert their prerogative as voters, and even when they decide to make their voice heard through elections and referendums, nothing assures that their indications will be followed by those in charge of implementing them. The doubts about the way in which office bearers remain faithful to the agency of their constituents in many ways resemble the doubts surrounding the capability of scientists and scientific instruments to reliably represent natural phenomena. Not unlike scientific representation, representative democracy entails a chain of transformations which transport but also *translate* the phenomena that it is supposed to represent (Latour, 2005a). This is why it is not unusual for citizens to find other, more effective ways to have a say in sociotechnical debates, such as becoming lay experts, joining protest groups, starting a legal action, and so forth.

While it is sensible to begin a controversy mapping project by asking who is institutionally responsible for regulating and deciding on the questions that are being debated, we cannot let rules and procedures decide for us who should be in the actor gallery. Being nominated by an institutional procedure is neither a sufficient nor a necessary condition for being an actor. Actors have to earn their status by making an observable difference to the debate, and they can do so beyond the remit of conventional politics. Part of the generative potential of controversies lies precisely in their capacity to open spaces where alternative forms of political action are not only possible but often also more effective.

Experts and lay experts

In the previous chapter, we described the boundary work that insulates technoscience from the rest of society. Of the many ways of crossing these boundaries, expertise is generally considered the most legitimate. The status of expert grants scientists and engineers the authority to intervene in almost any socio-political problem. As Thomas Gieryn puts it, experts “are called before courts and government hearing rooms to provide putatively truthful and reliable contexts for decision making” (Gieryn, 1983, p. 784). As a consequence, of all the species of actors, the expert is perhaps the most discussed in the literature (see Renn, 2001, for an encyclopedic presentation of expertise, and Collins & Evans, 2007, and Henry et al., 2015, for a more critical analysis).

Debate about the authority of experts has raged since the 1960s, not least about the extent to which expert advice should be taken into account when setting public policy. In *Toward a Rational Society*, Jürgen Habermas (1989) famously criticizes the “technocratic model” in which “[the politician] becomes the mere agent of a scientific intelligentsia, which ... elaborates the objective implications and requirements of available techniques and resources as well as of optimal strategies and rules of control” (pp. 63, 64). Against this model, Habermas proposed a *pragmatist model* in which “the strict separation between the function of the expert and the politician is replaced by a critical interaction” (p. 66). Located at the interface between science and policymaking, the expert is generally considered as different from both and rather acting as an interpreter or “knowledge broker” (Pielke, 2007). In particular, experts are expected to digest the complexities and uncertainties of scientific results and turn them into simplified and actionable insights that politicians can work with (Shackley & Wynne, 1996).

Such translation, however, is never neutral. Rather than summarizing the state of the art in a specific scientific domain, experts contribute to shaping the way in which knowledge operates in society. In choosing what information to highlight, how to interpret ambiguous results, or how to frame the implications of a scientific breakthrough, experts unavoidably rely on their personal judgment and social values (Cozzens & Woodhouse, 1995). The discretionary nature of expertise is a classic source of contention and the recourse to experts can open more conflict than it settles, “leading to endless technical debate rather than the hoped-for consensus ... As debate continues, many long-settled technical issues are reopened for investigation, and attempts to definitely resolve one issue often succeed only in opening up many more technical issues for consideration (Collingridge & Reeve, 1986, p. 145). According to some authors (e.g., Roqueplo, 1995), the partiality of experts is not necessarily unpardonable, especially if it is accompanied by sufficient transparency. Studying the field of risk regulation, Yannick Barthe and Claude Gilbert (2005) push the argument further, observing that it is precisely because of its inherent “impurity,” that

expertise can facilitate the elaboration of the sociotechnical compromises and the settlement of controversies.

A third discussion concerns the identity of experts, not only when it comes to select particular experts for particular issues, but also in the general definition of expertise (Eyal, 2013). While some define expertise as a substantive quality, a skill acquired through education or apprenticeship (see Collins & Evans, 2002, 2007), others see it as a relational quality deriving entirely from social recognition. Some STS researchers have gone as far as arguing that we should understand expertise as a property of organizations rather than individuals. Studying the activities of the US Office of Technology Transfer, for example, David Guston (2001) claims that the role of interfacing between technoscience and society rests less on individual actors than on “boundary organizations.” Pushing this logic further, Sheila Jasanoff suggests that expertise should be understood as a network effect:

One cannot point to a single node in a complex network and say, “Expertise lodges there.” This implies, for example, that the safety of genetically modified crops cannot be assessed by the biological community alone, even if it is expanded beyond molecular biology to include medical and environmental scientists; relevant expertise also rests with farmers, food producers, supermarkets, consumers, and regulators, to name other important nodes in the network of food production. To proceed without paying attention to these diverse perspectives is to mistake a partial vision of the issue for the whole. (Jasanoff, 2003a, p. 161)

The definition of boundaries of scientific expertise has power implications. As Jasanoff puts it, “to label something ‘not science’ is to denude it of cognitive authority” (Jasanoff, 1990, p. 14). It is therefore not surprising that some of those who are excluded from the status of experts are often willing to put up a fight to see their knowledge recognized. In the previous chapter, we drew on the work of Epstein (1996) and Callon and Rabeharisoa (2007) to discuss how medical research on AIDS and neuromuscular diseases had been influenced by activist-patients and their families. These two cases reveal how expertise can be established through a series of legitimizing strategies that allow a person or a group to acquire an authoritative voice in a controversy. The case stories have happy endings, in the sense that relevant vernacular knowledge is eventually put to productive use, but the relations between experts and lay people are not always as peaceful or constructive.

A famous example of how things can go wrong is provided by Brian Wynne’s study of the Cumbrian sheep controversy (1992). In 1986, the radioactive cloud from the Chernobyl nuclear reactor explosion reached the UK and washed into the ground through rainfall, particularly in Cumbria, a rural region with an economy largely based on sheep breeding. Within days, radioactivity was absorbed by the grass and through the grass by the sheep. The potential health risk was rapidly identified and contained by the authorities through a temporary ban on selling Cumbrian sheep. The sheep breeders fiercely opposed the ban, a reaction which one might be tempted to explain through the deviation model introduced in [chapter 1](#). After all, the breeders had significant economic interests at stake and could hardly be expected to just follow expert advice. And how would you expect farmers to understand the intricacies of nuclear science anyway? But, again, the deviation model falls short.

At the onset of the ban, sheep breeders were in fact aligned with the authorities and willing to support the costs necessary to assure food safety. Yet, as the months passed and their knowledge of the situation *increased* (i.e., the opposite of a knowledge deficit), breeders

grew more and more distrustful of the official experts, as they discovered that scientific analyses were neglecting several crucial aspects of the problem. First, the scientists were mistaken about the soil. Drawing on a model of alkaline clay soils, in which radioactive elements are rapidly immobilized, they predicted that radioactivity levels would drop in a few weeks. The Cumbrian soil, however, is peaty and slower in its radioactive uptake. Second, authorities presumed that breeders could wait indefinitely to sell their lambs and that this would just delay their profit. In fact, the scarcity of grazing in Cumbrian highlands requires flocks to be sold before the fall, as a longer stay would risk destroying the grazing for the following years. Third, the scientists believed that lambs could be fenced for testing and decontamination, ignoring that Cumbrian breeding is based on roaming and open-field grazing. Finally, authorities proposed that Cumbrian breeders sell their livestock to farmers in other regions (where they could be decontaminated), failing to anticipate that the fear of radioactivity would make such a sale impossible. All these elements were voiced by Cumbrian breeders, but their complaints were ignored. The breeders' *lay expertise* was neglected by the official experts who refused to recognize them as legitimate actors. The situation degenerated into open conflict and eventually resulted in a significant loss of credibility for British scientific institutions.

The Cumbrian sheep controversy is an example of the oftentimes difficult coexistence between scientific expertise and forms of vernacular knowledge. Many such disputes concern agriculture and the management of biodiversity. Traditional cultures elaborate sophisticated knowledge systems relative to the plants and animals of their ecosystems. Such "ethnoscience" (Altieri, 1993, not to be confused with the theoretical school of ethnoscience in anthropology), however, are rarely recognized as legitimate sources of expertise in contemporary controversies as their knowledge does not comply with the protocols and formats conventionally associated with expertise (see also Ingold, 2000). The problem is pointedly illustrated by Jessica Cattelino in her analysis of land and water management in the Everglades swamplands in Florida (Cattelino, 2015). In the confrontation between real estate developers in search of new land to build on and conservationists in search of unspoiled nature to protect, the lay expertise of the native Seminole Indians, who have always inhabited the swamp, is completely ignored. The Seminole have organized their livelihood around a system where land cannot be owned (because land is never stable in the ever-changing flood zone) hence precluding them from being recognized in the debate on the protocols of land management and property rights. The recognition of traditional knowledge is also a major battleground in a series of controversies about the patenting of biological resources (Gepts, 2004). Not being formalized and sometimes not even expressed in written form, native knowledge is often discounted, thereby opening the possibility for industrial corporations to patent inventions related to traditional biological resources (Shiva, 2016). Such practices of biopiracy represent an extreme example of struggles over expertise but illustrate how the boundaries of technoscience are still vividly contested by actors producing alternative forms of knowledge.

Scientific campaigners and professional skeptics

Scientists and engineers are not just occasionally called in to act as experts in sociotechnical debates. For some, engagement with controversies is a permanent commitment to getting issues to the public's attention, an allegiance which is often discussed in the literature on technological risks. As technoscience has become a major

contributor to the hazards that societies have to mitigate and prepare for, scientists and engineers have also assumed a key role in making sure that these hazards become matters of public concern. Sometimes they do so at the request of other actors (policymakers, activists, engaged citizens), but often they do it on their own initiative and sometimes as a lifelong dedication to a cause. Hazards are not automatically acknowledged as risks. To be institutionally regulated, a potential threat must undergo a series of trials (e.g., the elaboration of possible scenarios, the estimation of their likelihood, the quantification of their damage, etc.) in a complex construction work (Johnson & Covello, 1987), which would be carried out without the impulse of a series of “alert promoters” (Chateauraynaud & Torny, 1999, 2005), who are, in many cases, researchers or technical specialists.

A well-known example is Rachel Carson, an American biologist who devoted a great part of her career to the cause of environmental protection (see Lear, 1997; Lytle, 2007). Besides doing basic research to document the adverse effects of pesticides, Carson encouraged a critical discussion among scientists (not only biologists, but also medical researchers investigating the link between cancer and chemicals); coordinated with activist groups; reached out to the press; collaborated with, but also challenged, institutions like the US Department of Agriculture or the Food and Drug Administration; and fought legal actions by the chemical industry. Her book *Silent Spring* (1962) is considered a milestone not only in the fight against dangerous chemicals, but in the rise of environmental awareness more generally.

A similar type of activism is described by Peter Haas (1989, 1992a) in international environmental regulations. According to Haas, the protection of nature has been crucially influenced by the activism of various “epistemic communities” – international networks of scientists and state officials who share similar convictions about how an environmental problem should be addressed and are ready to engage with them politically. According to Haas, these networks are influential in “articulating the cause-and-effect relationships of complex problems, helping states identify their interests, framing the issues for collective debate, proposing specific policies, and identifying salient points for negotiation” (Haas, 1992a, p. 2, see also Haas, 1992b). Following Haas, scholars have described the important part played by scientists and scientific organizations in the establishment of various international regimes such as those dealing with climate change (Gough & Shackley, 2001; De Pryck & Wanneau, 2017) and biodiversity (Hrabanski & Pesche, 2016).

These scientific campaigners are particularly interesting for controversy mapping because they are often the ones who start the debate. Controversies, of course, can result from the fallout of concrete events like natural disasters or technological failures (e.g., the tsunami at Fukushima or the explosion at Chernobyl), but are often initiated rather by whistleblowers and campaigners trying to build public awareness. Without these actors, there would be less breaching of technoscientific black boxes and fewer controversies to map.

If the influence of technoscientific actors in promoting collective action has long been ascertained, scholars have more recently suggested that these actors can also play the exact opposite role. In [chapter 1](#), we discussed the efforts of industrial lobbies to stall regulation by mediatizing controversies long since closed in the scientific community. This definition can now be amended by noting that, in these controversies, industrial lobbies often ally with selected scientists to challenge the mainstream scientific consensus in a field. Because science is a form of “organised skepticism” (Merton, 1973 [1942]), it is always possible to find scientists who disagree with their peers. With the support of these scientists, lobbies

have hampered legal regulation in a variety of controversies (Oreskes & Conway, 2010), including tobacco smoking (Proctor, 2011), pesticides, acid rain, global warming (Niederer, 2013), and other environmental issues (Jacques, 2009). The strategies used by these groups constitute a sort of nemesis to controversy mapping. They rely *both* on an ultra-realist position, according to which true scientific statements are naturally upheld by the *unanimous* agreement of the scientific community, *and* an ultra-relativist position, according to which all statements in a controversy are *equally* valid. Combining the worst of realism and the worst of relativism, professional skeptics undermine scientific consensus and then demand media and authorities give the same consideration to majority and minority positions.

Scientific entrepreneurs

While the forms of technoscientific influence described above are probably the most visible, they are not necessarily the most decisive. Rather than debating, raising awareness, lobbying decision makers, and wrestling with rules and procedures, scientists and engineers can sometimes take a shortcut through the sociotechnical arrangements they help bring about.

Thomas Parke Hughes's 1983 study of the electrification of Western society provides a perfect example. According to Hughes, the genius of Thomas Edison as an "inventor-entrepreneur" should not be measured by his inventions (most of which he derived from someone else), but by his ability to hardwire them into a cohesive network. In his quest to spread electric power, Edison had to fight controversies well beyond the walls of his laboratory in Menlo Park. He pushed his ideas less by debating them than by devising and building mechanical devices; handling chemical processes; teaming up with experts from different disciplines; setting up commercial companies; managing budgets; submitting and litigating patents; pushing public policies; promoting new consumption habits; etc. As John Law describes it, Edison's success was "an artful combination of transmission lines, generators, coal supplies, voltages, incandescent filaments, legal maneuvers, laboratory calculations, political muscle, financial instruments, technicians, laboratory assistants, and salesmen" (Law, 2009, p. 143).

An interesting example from the social sciences is the development of opinion polling, as described by Thomas Osborne and Nikolas Rose (1999; see also Blumer, 1948). From the 1920s onwards, the distrust in crowds that had characterized the turn of the twentieth century (captured by Gustave Le Bon's *Psychologie des Foules*, 1895) was replaced by an effort to build better tools for handling the emerging mass society. Such conceptual tools were first imagined by scholars such as Walter Lippmann, Harold Lasswell, and Floyd Allport, but became effective only in the late 1930s through the initiative of George Gallup. Gallup is the perfect illustration of how social scientists (and not only natural scientists and engineers) can be scientific entrepreneurs. As a professor of journalism and vice president of an advertising agency, he founded the American Institute of Public Opinion in 1935. In the following years, the Gallup Institute opened branches in the UK, France, and Australia, sold studies to a host of political and commercial clients, and published regular columns in the *Washington Post*, the *Los Angeles Times*, and more than 50 other newspapers. Gallup created "public opinion" (Gallup, 1939) as a mixture of methodological research (perfecting the techniques of surveying and sampling); marketing tactics (in 1936, he anticipated Roosevelt's election against most other predictions);

academic discussions (the journal *Public Opinion Quarterly* was founded in January 1937); and strategic alliances (serving the advertising industry during the Great Depression and the war mobilization during World War II).

Gallup and Edison remind us that scientific success and influence are not just intellectual endeavors. Sociotechnical controversies are always played on a variety of tables and always won by heterogeneous coalitions of scientists and engineers, but also experts, activists, entrepreneurs, experimental setups, research instruments, and industrial machines.

Non-human actors

There is another (much larger) group of actors that is often neglected in the gallery of sociotechnical controversies. A case in point is provided by Bruno Latour (1984, 1995b) in his analysis of the nineteenth-century dispute in which Louis Pasteur and Félix-Archimède Pouchet faced off on the question of “spontaneous generation.” At the beginning of the dispute, Pouchet, who championed the idea that life could emerge spontaneously from dead organic material, had a clear lead. Spontaneous generation had been the dominant paradigm of Western biology since Aristotle and seemed to be backed by common experience (as everyone who ever forgot to take out the trash knows all too well). Against this seemingly evident spontaneity, Pasteur posited that fermentation was rather produced by the action of a myriad of minuscule beings – “microbes” – which, unfortunately, could not be seen, heard, smelled, or otherwise directly perceived.

Defending the existence of an imperceivable entity against a well-established scientific paradigm, Pasteur needed all the allies he could get. To find them, he cleverly reformulated his thesis to make it interesting for a greater variety of social actors. For instance, he obtained support from part of the Catholic Church by pointing out that the theory of spontaneous generation implied that life could come into existence without godly intervention (an idea dangerously close to Darwinism). He also found allies in politics, and in particular in the emperor Napoleon III, by convincing his attendants that his research on microbes could help fight the contagious epidemics spreading through the French army. He persuaded the Minister of Education to finance his laboratory by claiming that his studies could shed light on the process of vinification and thereby be of use to the pride of the French agricultural sector. As a result, when the Académie des Sciences decided to resolve the controversy by nominating a special scientific commission, many observed that Pasteur, a regular of Parisian academic circles, could easily influence its composition.

Pasteur, then, had powerful allies in religion, politics, economics, and the scientific community, but was this enough to close the debate? Not necessarily, for Pouchet had also put together a solid alliance. Like Pasteur, he had courted the Catholic Church, arguing that spontaneous generation was a proof of “continuous divine creation” (and that Pasteur’s transformationism was in fact Darwinism in disguise). Additionally, he could count on the support of the city of Rouen, eager to resist Parisian centralism. He was the son of a rich industrialist and could devote significant resources to his research, and he had been an esteemed correspondent of the l’Académies de Sciences for more than 20 years (long before Pasteur).

In the account given by Latour, what eventually tipped the scale in favor of Pasteur was his ability to find allies among a group of actors that was out of Pouchet’s reach: the microbes themselves. To enroll them he mobilized another helper, this time a technical artifact – the

famous “swan-necked vase”: a glass flask with a long and curvy neck designed to let air pass through but keep microbes out. This contraption permitted an organic infusion to remain sterile for months, but after Pasteur theatrically broke the neck in front of the Académie des Sciences, contamination was visible within days. Thanks to the swan-necked vase, Pasteur was able to demonstrate that he could tame the action of the microbes and rally them to his cause – though in a way that remained temporary and unstable (Mendelsohn, 2002). To win the dispute, Pasteur mobilized divine creation, the army of Napoleon III, the French wine industry, but also the swan-necked flask and the microbes, i.e., a series of non-human actors capable of making a decisive difference.

Recognizing the role played by non-humans helps controversy mappers to remain symmetrical in considering the different positions in the debate (according to the lesson of the Strong Program of the sociology of science discussed in the previous chapter), while avoiding falling into a relativist position. If humans were the only significant actors, then scientific truth could be described as a convention, an inter-subjective agreement or a “self-fulfilling prophecy” (Merton, 1948; Watzlawick, 1984): if everyone believes that something is true then it will be true in its effects. The extension of the notion of agency to non-human actors reminds us that this is not the case: scientific truth is not just *inter-subjective*, it is also *inter-objective* (Latour, 1996a). As discussed in the previous chapter in the section on scientific entrepreneurs, controversies are not just verbal disputes opposing logical arguments, rhetorical skills, and social leverage. They are also material struggles. Taking non-human agency seriously means recognizing that we are not acting *through* non-humans; we are acting *with* them.

An exemplary case is the role played by polar bears in the global warming debate, particularly on digital media (Niederer & Weltevrede, 2008). The dramatic yet beautiful images of these animals, threatened by the melting of Arctic sea ice, have been crucial in swaying part of the public opinion to support CO₂ reduction policies (Slocum, 2004). For this, polar bears merit being considered as actors in the climate controversy. Of course, their influence has been mediated by the intervention of the scientists documenting their decline, the photographers framing their heartbreaking images, and the activists who took to their defense. But the same is true for most other actors of the debate: climate scientists are represented by the IPCC; indigenous people are represented by NGOs; countries are represented by their UN delegations, and so on.

Polar bears, with their majestic body and their shining fur, have made a difference where hundreds of other threatened species have failed – for example the Arctic krill, without which the whole polar ecosystem, bears included, would be lost (Walther et al., 2002), is still happily ignored by media and public opinion. Similarly, an analysis of the insects protected by European regulations found that “protected species were significantly larger, better known, more widespread and more multicoloured than a randomly selected set of unprotected species” (Leandro et al., 2017).

The extension of agency to non-humans has found many critics both in STS and in sociology in general. Part of this resistance derives from a misunderstanding. Insisting that both humans and non-humans should be considered actors does not mean *equating them*. On the contrary, it is precisely because they act differently that non-human actors become an asset. Consider the herding of a flock of sheep. If you watch the flock by yourself, you will only do it 10–12 hours a day (because you need to eat and rest), you will be able to watch a few sheep, and you will need to be replaced every 50 or 60 years. On the bright

side, you can move around with the flock and you are capable of handling a large variety of unexpected events. Or you can assign the job to a sheep dog. It will watch your sheep for 20 hours a day, it will be able to handle a larger flock (because it runs more and faster), and it will move around with the sheep. However, your dog will have to be replaced more often and it will fail to handle some unexpected events. Or you can build a fence. While you rest peacefully with your dog, the fence will watch your herd 24 hours a day and with enough fences, you can watch all the sheep in the world. The fence, however, is incapable of handling unexpected events (if a fire breaks out, you will have a lot of roasted lamb chops). The fence will also force your sheep to settle and wait to be fed instead of grazing, and this will turn you from a shepherd into a farmer. If the example seems trivial, think of how, during the fourteenth century, fences marked the passage from medieval open-field land management to the modern system of privatized enclosures, in turn triggering the accumulation of capital that sparked the industrial revolution. It is this ability of non-humans to make a difference in ways that human actors cannot that assigns them a key role in the actor gallery.

In [chapter 1](#), we discussed Thomas Hobbes's critique of Robert Boyle's air pump experiments and their reliance on an artificial setting made possible by instruments and technical equipment (Shapin & Schaffer, 1985). According to Hobbes, dependence on the air pump weakened the strength of the knowledge claims produced by Boyle in his laboratory. Truth, he believed, should be exclusively grounded on logical deduction and direct observation. Boyle, however, won the controversy and since then, all branches of science have relied heavily on material devices for producing truth.

Even mathematics, often considered the purest of sciences, is not and has never been a completely intellectual endeavor. In his book on ancient Greek mathematics, Reviel Netz (1999) dedicates a full chapter to the *lettered diagram* (pp. 12–68), discussing how this material device played a crucial role in the foundation of logical deduction. In modern times, the use of computers in mathematical proofs (Lanford, 1987) has raised much discussion, especially after the computer-assisted demonstration of the four-color theorem, which states that no more than four colors are needed to color any map so that no two adjacent regions have the same color. It was proved by Kenneth Appel and Wolfgang Haken in 1976 by reducing the infinitude of possible maps to 1,834 basic configurations, and then using a supercomputer to check their coloring. The now accepted proof of the four-color theorem requires the cooperation of a calculating device and its software (Tymoczko, 1979; Teller, 1980; MacKenzie, 1999)

Latour and Woolgar (1979) call the multitude of instruments that scientists employ in their work “inscription devices” because their main function is to “transform pieces of matter into written documents. More exactly, an inscription device is any item of apparatus or particular configuration of such items which can transform a material substance into a figure or diagram” (Latour & Woolgar, 1979, p. 51). Non-humans are also crucial in facilitating relations among the members of the academic community and with actors situated at the borders of technoscience. In this mediating role, Susan Leigh Star and Jim Griesemer (1989) call them “boundary objects” (see also Carlile, 2002).

Reviewing two decades of research into the materiality of scientific work, Dominique Vinck (2012) argues these inscription devices perform at least five different functions:

1. As “forms of translation,” they allow the manipulation of substances and phenomena, submitting them to tests, revealing some of their features, thereby supporting a

particular style of scientific observation.

2. As “forms of representation,” they allow the recording of findings in figures and tables that can be published in academic journals. In this written form, evidence travels more easily.
3. As “mediators,” they support collaboration within and across research teams, often among different disciplines.
4. As “operators of change,” they facilitate the alignment of the actors involved in technical projects (electrocardiograms, for example, support the coordination of researchers, cardiologists, industrialists, and doctors).
5. As “revelation agents,” they help STS scholars follow aspects of scientific work that would otherwise remain implicit (as discussed in the next chapter).

The birth of Actor-Network Theory

The inclusion of non-humans in the cast of sociotechnical phenomena marks the birth of Actor-Network Theory (or ANT) and a crucial bifurcation in the landscape of STS (Callon, 1986). Again, a controversy provides a good vantage point for observing the implications of this theoretical turn. In May 1996, a little over a decade after the principles of ANT were first coined, the journal *Social Text* published an article titled “Transgressing the boundaries: Toward a transformative hermeneutics of quantum gravity”; it was authored by Alan Sokal, a prominent physicist at New York University. In line with the editorial stance of the journal, the article contained a harsh attack on realism and the objectivity of scientific truth:

There are many natural scientists, and especially physicists, who continue to reject the notion that the disciplines concerned with social and cultural criticism can have anything to contribute, except perhaps peripherally, to their research. Still less are they receptive to the idea that the very foundations of their worldview must be revised or rebuilt in the light of such criticism. Rather, they cling to the dogma imposed by the long post-Enlightenment hegemony over the Western intellectual outlook, which can be summarized briefly as follows: that there exists an external world, whose properties are independent of any individual human being and indeed of humanity as a whole; that these properties are encoded in “eternal” physical laws; and that human beings can obtain reliable, albeit imperfect and tentative, knowledge of these laws by hewing to the “objective” procedures and epistemological structures prescribed by the so-called scientific method. (Sokal, 1996b, p. 217)

The article continued, defending a caricature of the sociology of science, claiming that quantum theory could be directly associated with progressive ideas in US politics. On the same day, Sokal published a second paper in *Lingua Franca* (a journal dedicated to academic life) where he revealed that the first article was in fact a hoax:

a modest (though admittedly uncontrolled) experiment: Would a leading North American journal of cultural studies ... publish an article liberally salted with nonsense if (a) it sounded good and (b) it flattered the editors’ ideological preconceptions? The answer, unfortunately, is yes. (Sokal, 1996a)

Although Sokal’s “experiment” did not prove much other than the bad judgment and review process of *Social Text*, it marked the beginning of the so-called “science wars,” a

vehement controversy that saw many natural scientists lining up against some of the ideas introduced by the sociology of science and technology. Although the main thrust was directed against French post-structuralist ideas more broadly, the science wars had a profound influence on STS as well. The vehement reaction of their colleagues in the natural sciences encouraged some scholars to reconsider some of the claims that STS had been pushing in the 1970s and 1980s, particularly about the influence of social factors in the construction of scientific facts.

One of the main complaints raised in the science war was the risk of presenting scientific facts as *nothing but* social effects – an interpretation that was very much in line with the posture of “sociological relativism” or “social constructivism” characterizing much sociological research (Winner, 1993; Hacking, 1999; Demeritt, 2002; Latour, 2003). A classic example of this posture can be found in *Les Formes Élémentaires de La Vie Religieuse* in which Émile Durkheim (1912) examines various indigenous religions and concludes that religious structures are nothing but mirrors of the social organization of the communities that developed them. More generally, he claims, the experience of the religious bond is *nothing but* the experience of the social:

If religion has given birth to all that is essential in society, it is because the idea of society is the soul of religion ... It is only by regarding religion from this angle that it is possible to see its real significance. If we stick closely to appearances, rites often give the effect of purely manual operations: they are anointings, washings, meals ... But these material manœuvres are only the external envelope under which the mental operations are hidden. (Durkheim, 1912, p. 419)

If religious beliefs can be reduced to echoes of the social structure, so, perhaps, could scientific facts. To be sure, the Sociology of Scientific Knowledge never claimed that scientific truth was *just* a social convention. On the contrary, the first principle of the Strong Program explicitly states that “there will be other types of causes apart from social ones which will cooperate in bringing about belief” (Bloor, 1976, p. 16). Yet, the conclusion that SSK drew from the science wars was that the purpose of STS is to show that, when observed sociologically, “science looks like any other kind of practical work. Detailed description dissolves epistemological mystery and wonder” (Collins & Yearley, 1992, pp. 308, 309). As Dominique Pestre (2006) puts it:

Sure, Bloor and Collins say again and again that “reality matters.” Yet – since they also add that reality is always trapped in forms and statements that exceed it and that it is methodologically impossible to account for the independent effects of reality – the explanations that they propose could only be sociological. (p. 29, our translation)

While natural scientists were not the first to be annoyed by sociological attempts to explain their practices and beliefs through a process of emptying and substitution (Latour & Weibel, 2002), they struck back more forcefully than the typical research subject: “For the first time, social scientists had to study something that was higher, harder and stronger than them. For the first time ... the scream of those being studied could be heard loud and clear – and they were not coming from Bali or the ghettos ... but from the departments next door, from colleagues in the very hiring and grant committees” (Latour, 2005b, p. 98).

In showing how scientific facts were influenced by social factors, STS had come dangerously close to presenting them as mere artifacts that could take any form as long as people agreed on them. Preoccupied with debunking philosophical realism, STS had drifted into a position close to sociological relativism and the Science Wars exposed the

shortcomings of such a position. Using this setback as a springboard, Actor-Network Theory matured into an alternative form of sociology by proposing an original way to reconcile the insights of STS with the grievances voiced by the natural scientists. They claimed that it is possible to define technoscientific facts as collective constructions without downgrading them to mere social artifacts. Indeed, they claimed, facts can very well be constructed *and* objective *at the same time*.

If you ever locked yourself out of your house, you have experienced the compatibility between being constructed and being real. Your front door is clearly not a naturally occurring object independent from the work that went into constructing it. Had the carpenter not built it, it would not exist. Were it poorly built, you might be able to break in. And yet, the fact of being a construction does not make the door less real or impenetrable. It is not social structures that leave you out in the cold. You can convince yourself, your neighbors, even the police that you have all the rights to get inside, but their consensus will not get you any warmer. Being constructed does not make the door a mere convention, susceptible to rhetoric and opinions. Quite the contrary, the better the door is built, the more it will resist you.

Acknowledging that technoscientific truths are constructed, ANT does not mean to diminish them but, on the contrary, to pay tribute to the hard work necessary to build and sustain them. As Sergio Sismondo puts it, “epistemic democratization does not mean a wholesale cheapening of technoscientific knowledge ... detailed accounts of the construction of scientific knowledge show that it requires infrastructure, effort, ingenuity and validation structures” (2017, p. 3; see also Sismondo, 2008). Also, and crucially, claiming that technoscience is a construction is not the same as claiming that it is *just a human construction*. As the door example reminds us, the humans are neither the only nor the most important actors at work. The cold weather, the forgotten keys, the door lock, the tools of the locksmith, or the axe of the firemen, all play a role in the situation. In fact, the situation would not exist without them. For ANT, this recognition should encourage us to rethink not only technoscience but also sociology:

Whereas [our closest STS colleagues] have decided that social theory works *even on science*, we have concluded that, overall and in details, the social theory has failed on science *so radically* that it’s safe to postulate that it had *always failed* elsewhere as well. (Latour, 2005b, p. 94)

If calling something a “social construction” felt like diminishing it, maybe it was because the idea of “the social” was too poor in the first place. After all, if one recognizes the potential role of natural elements, technical objects, cultural ideas, religious precepts, spiritual entities, and of all relevant human and non-human beings, then defining something as “social” is only a way to acknowledge its *collective* nature. In turning the spotlight to the agency of non-humans, ANT proposes an inversion of sociological explanation. It suggests that the social should be considered not as an *explanans*, that is a resource for explanation, but as an *explanandum*, something that needs to be explained, among other things, through the material supports that make it possible.

“Technology is society made durable,” exclaimed Latour (1991) positing that without non-human companions, social life would fall apart. This idea is captured by the myth of the “feral child,” the infant separated from society and raised in nature (Candland, 1995; Ellingson, 2000). Mowgli, Tarzan, Romulus and Remus, all these stories contain a turning point at which the wild child reveals his human nature by the construction of some

technological object (a weapon most of the time). In the words of Geoffrey Bowker and Susan Leigh Star, wild children illustrate how “people-and-things, which are the same as people-and-society, cannot be separated in any meaningful practical sense” (1999, p. 300). Becoming human, it seems, requires technology.

Drawing on this idea, Latour (1994a) criticizes the notion of history as an increasing separation of nature and culture and provides instead a nine-step account of the symbiotic evolution of human and non-human beings:

1. The first stage, “social complexity,” is not limited to human communities. Primate societies differ from human ones not because they are simpler, but because they have no way to inscribe and manifest their rules and hierarchies (the baboon who triumphs one day has no crown to remind the others of its alpha status the next day).
2. Then comes the “basic toolkit” stage, where human beings start negotiating not only among themselves, but also with the things around them. The Stone Age begins when humans learn that some stones (flint, quartz, and obsidian, for instance) are more tractable than others and more amenable to chipping and sharpening.
3. Next, humans apply to their own bodies what they have learnt to do to things. The form of the body itself is altered in order to inscribe (even better, “embody”) social relations. Tattoos and other forms of bodily modification become a way to make relations of supremacy, subjugation, and affiliation more visible and therefore more durable.
4. The lesson learnt on the body (that it may be transformed through the instruments of the basic toolkit) is then applied back to non-humans. Things are assembled to create “techniques”: objects with unprecedented properties (e.g., fixing a chipped stone to a stick to obtain an axe).
5. Techniques then allow embodying social relations in materials that are more durable than the human body. In hunter-gatherer communities, for instance, dominant individuals have no way to stabilize their supremacy. They can claim a larger share of the food but not much larger, as they wouldn’t know how to store it (you can claim a whole mammoth for yourself, but it will only rot in your cavern). But with agriculture, stockpiles can be accumulated. The pile itself becomes the very sign of supremacy and soon piles of bricks (the pyramids) replace the piles of cereals, creating a sign of kinship that survives the centuries. This is where “human societies” begin.
6. If social relations can be materialized, then, inversely, plants and animals can be socialized through the stage of “internalized ecology.” The domestication of the dog is famous, but all agricultural plants followed a similar transformation. Fruits are not juicy or savory by nature – they have been selected by generations of farmers to be so.
7. Like animals, humans can also be domesticated and history proved that a well-trained army, though inferior in numbers, can defeat a less disciplined enemy. Translated from military to productive organization, this domestication of humans produced the modern assembly line and what Lewis Mumford (1971) calls “megamachines.”
8. Soon people are (in part) replaced in the assembly line by machines, giving birth to modern “industry.”
9. Industry demands the construction of huge “networks of power” (trains, electricity, telephone, etc.), or macro-technical systems (Gras, 1997), connecting millions of

actors together and allowing them to move around the planet without ever leaving their channels. If “globalization” means anything, it is that you can travel through almost every place in the world without ever leaving the same planes, the same Wi-Fi connections, or the same electrical networks.

This material history of humankind is not a way to reiterate the realist argument that technology determines social evolution (a position often called “technological determinism” and associated, for instance, with the evolutionary anthropology of the nineteenth century), nor the relativist position that technologies are just willing instruments of human intention (i.e., “social determinism”). Neither of these forms of determinism is acceptable in ANT or controversy mapping. Latour (1994b) provides an illustration of their opposite fallacies in the controversy over “gun control” in the US. Those who support the right to buy and sell assault weaponry insist that guns are just instruments which can be used for good (protect oneself or one’s family) or for bad (harm and kill) depending on who wields them. Hence the slogan of the National Rifle Association: “guns don’t kill people, people kill people.” Those who fight for weapons limitation, on the contrary, observe that guns are inherently destructive, that they are made to kill and sooner or later they will realize their inbuilt function. Both are right and wrong at the same time. It is neither weapons alone nor people alone who do the killing; it is weapons *and* people *together*. Change one of the elements, replace a Molotov cocktail with a bouquet of flowers for example (as in a famous graffiti by Banksy; see [figure 22](#)), and the action changes from tragedy to comedy.



Figure 22 Banksy, *Love Is in The Air, Flower Thrower*, 2005, Ash Salon Street, Bethlehem, West Bank (photo by jensimon7, licensed under CC BY 2.0).

The voice of the voiceless

All the actors we reviewed so far have in common their capacity to make their voice heard in collective matters of concern or to influence their evolution. Yet, there are also those who suffer the consequences of sociotechnical arrangement without making much of a difference to them. In the early 1990s, this power asymmetry was highlighted by scholars inspired by feminist theory (particularly Haraway, 1988), who pointed out the drawbacks of defining actors as entities whose presence or absence makes a perceivable difference. As John Law puts it: “if an element does not make its presence felt by influencing the structure of the network in a noticeable and individual way, then from the standpoint of that network the element in question does not exist” (Law, 1987, p. 131). This definition risks favoring the actors that are already in power while hiding the entities whose agency is at stake in the controversy.

Susan Leigh Star (1990) illustrated the problem through her experience of the incompatibility of fast food and onion allergy. The well-oiled machine of fast-food restaurants demands the enrollment of the customer who must accept to place orders and receive meals in a way that disregards the needs (and thus denies the agency) of allergic clients. If the case of onion allergy seems mundane, Star argues that the same kind of simplification and exclusion is widely performed by technological infrastructure at the expense of “groups traditionally dispossessed or oppressed in some fashion: ethnic minorities, women of all colours, the old, the physically disabled, the poor” (p. 33). By describing and celebrating the ingenuity with which scientists and engineers build complex sociotechnical arrangements, early ANT forgot to highlight the way in which every act of construction is also an act of exclusion:

Every enrollment entails both a failure to enroll and a destruction of the world of the non-enrolled. Pasteur’s success meant simultaneously failure for those working in similar areas, and a loss and world-destruction for those outside the germ theory altogether. We are only now beginning to recover elements of that knowledge: immunology, herbal wisdom, acupuncture, the relationship between ecology and health. (Star, 1990, p. 49)

ANT had been so concerned with putting all social actors on the same plane, that it had neglected the asymmetry in the distribution of power (Gad & Jensen 2010). Out of political naivety, ANT had exposed itself to what Law (1991) dubbed the “perils of managerialism,” the risk of reinforcing those who are already powerful by lending them most of the attention:

An absence of ... distance has several consequences. It means, for instance, that certain distributions are likely to be invisible: those that are of no concern to the actor who is being followed tend to melt from view. Did Edison care about gender? I don’t know, but it would be surprising if he did. And, if he did, it would be surprising if he cared about gender in ways that would be inconsistent with the concerns of his enterprise. So the method is blind to the pain of gender distribution. (Law, 1991, p. 11)

Sociotechnical arrangements are also power arrangements and opening their black boxes should always entail giving voice to the voiceless, empowering those who are subjugated or, at the very least, trying to see the world from their viewpoint. In the words of Donna Haraway, “there is good reason to believe vision is better from below the brilliant space platforms of the powerful ... there is a premium on establishing the capacity to see from the peripheries and the depths” (Haraway, 1988, pp. 583, 584).

Importantly, however, and following from the point made about ontological politics in the previous chapter, the question of who is silenced by the dominant sociotechnical arrangement is always empirical. Just as ANT does not presume to know a priori what counts as an actor, neither does it presume to know what counts as a subjugated actor. Giving voice to the voiceless should always start with figuring out who they are, in the given situation, and how they have become so. While certain demographic groups tend to be consistently underprivileged and systematically oppressed, this should not be assumed regardless of the situation, as if it was an innate quality. The controversy on colonial curricula (Luckett, 2016), i.e., on the Eurocentric focus of the literature taught in higher education, is illustrative here. In a sense, it is very explicitly about giving voice to the voiceless: a course in South American politics that ignores indigenous scholars is part of a sociotechnical arrangement that subjugates native perspective. Yet in other situations, the question can get flipped on its head: if, for instance, the argument about colonial curricula is used by authoritarian leaders to purge their education system of unhealthy Western influences. This reconfigures who is subjugating and who is subjugated, and controversy mapping must be flexible enough to show it.

Part Two

Tools of social cartography

4

Exploring controversies as actor-networks

In this chapter, we learn how the power to act in controversies depends on alliances that shift over time and across issues, how ethnography can help us observe the formation of such actor-networks, and how we can draw on semiotics to organize our observations.

Controversy mapping is a method for studying collective situations through the association and opposition that compose them. The same is true of the two approaches that inform it: *actor-network theory* and *digital methods*. If the methodological aspect is manifest for the latter, it is no less crucial for the former. In fact, as argued by Richard Rogers in the preface to this book, digital methods in many ways represent an implementation of the peculiar methodological posture introduced by ANT. This posture was built as an original mix of two distinct scholarly traditions: ethnography (through ethnomethodology) and semiotics (though narratology). As Bruno Latour (2008b) puts it: “ANT is the unification and the simplification of ethnomethodology and semiotics. ANT is ethnomethodology and semiotics for dummies” (p. 22, our translation). Here is an example of this methodological posture in the case of a controversy about French wine.

In 1993 a group of winemakers from the southern French region of Languedoc wrote an application to the Institut National des Appellations d’Origine (INAO) arguing that the villages of Roquebrun and Berlou should be granted their own *appellation d’origine contrôlée* (AOC). The application was representative of how French agricultural policy was responding to the increasing competition from New World winemakers. If Argentinians and Australians could produce more cheaply and with no inhibitions in tailoring their wines for the taste of the global consumer, the French were going to protect their heritage and ensure that no one else could claim to be selling real Champagne, Meursault, or Saint-Émilien. This policy resulted in a series of lawsuits in the World Trade Organization and in a heated controversy about the concept of quality in wine and its relations to geography and place.

Observing this controversy from a distance, it would be easy to take French winemakers to be a homogeneous group with similar interests and a common agenda. But by following the actors on the ground, this turns out to be very far from the truth. Indeed, as we experienced doing fieldwork around Saint-Chinian (Høyrup & Munk, 2007a, 2007b), the controversy crystallized deep rifts between winemakers, who redefined their identities in different ways in response to the controversy about quality and local typicality, or *terroir* to use the French term.

The official narrative about *terroir* is reproduced in the offices of the AOC syndicate in Saint-Chinian where Nelly, the director, draws a pyramid on a piece of paper. At the

bottom is the *Vin de Pays d'Oc*, the regional wine which is simply allowed to carry the geographical indicator “Oc” (short for Languedoc-Roussillon) on the label. In the middle is the generic AOC for the area, the *AOC Saint Chinian*, and at the summit of the pyramid the village appellations such as the *AOC Saint-Chinian Berlou* or the *AOC Saint-Chinian Roquebrun*. The pyramid illustrates the AOC system as seen from the point of view of both the local syndicate and the INAO in Paris: quality increases and quantity decreases as wine becomes more geographically typical. This is the case because requirements on grape varieties, harvest methods, soil types, plant densities, and crop yields must be stricter for a wine to express more distinctively its local *terroir*. From this viewpoint, the ability of a wine to express a geographically localized mix of tradition, climate, and geology equals quality. Regulation that ensures adherence to these local traditions in the vineyard and in the cellar is therefore a form of quality control.

The idea of quality as a matter of local typicality has been inscribed for almost a century in the AOC system. The first French law on viticultural designations of origin was passed in 1905 and the AOC system in its current form was instituted in 1936 when regions like Bordeaux, Loire, Bourgogne, and the Rhône valley received their first appellations. The system exists not only as legislation but as a material reality that permeates geological surveys, oenological laboratories, evaluation boards, and various branches of local and national government connected by a vast paper trail and a systematized circulation of juice samples, wine samples, soil samples, etc. Indeed, it is manifest all the way down to the way wines are marketed with shelves organized by area, suggestions for food pairing focused on local gastronomy, and reviews performing geographical categories like “best Champagne for Christmas” or “refreshing rosé from Provence.” The self-evidence with which the director of the AOC syndicate in Saint-Chinian is able to mobilize quality as a matter of local typicality rests on a heterogeneous network in which certain inscriptions like sugar levels, crop yield, pruning standards, tasting notes, fermentation times, or slate content in a soil sample, are allowed to speak as translations of an otherwise diffuse and intangible localness in a wine.

From this point of observation, there are French winegrowers fighting against foreign competition in an alliance with French institutions. Because of the strength of the network, it is easy to conflate this with *the* French or *the* winegrowers’ position. Yet the conflation falls apart when the situation is observed from a different viewpoint. This becomes clear in front of the fireplace in the kitchen of Jean-Marie, one of the winegrowers in Berlou, who will soon be able to label his bottles with the new village appellation. Over the past days we have followed him on his daily routines in the mountainous vineyards surrounding the village. Many of these vineyards are so steep they can only be worked by foot or with a donkey. The old carignan vines grow as “trolls,” untrained bushes clinging to the hillside in no particular pattern, striking root wherever possible and with the slate protruding from the sparse topsoil as jagged, black flakes amidst the scrubs of the garrigue. This is the *terroir* that has secured Berlou its own village AOC, but it represents only a fraction of what Jean-Marie is pointing out when he talks about his relation to *terroir* in his winemaking. At one point he stops under a strawberry tree and gestures towards a hill crest in the distance where a castle was abandoned by the free-thinking Cathars in the thirteenth century; at another he picks mushrooms at the roadside or takes us to see the chestnut-fed wild boars from which his neighbor is making sausages for the village feast (see [figure 23](#)). Now, in his kitchen, he talks about his former career in industrial agriculture and about how he and his family came to Berlou in search of a different lifestyle.

Some of Jean-Marie's wines will be able to obtain the new village appellation, but this involves a reduction of terroir to an argument about the acidulous soil of the Caroux massive and the porous black slate that retains the heat from the sun and allows the roots of old vines to extend deep into the rock in their search for water (see [figure 25](#) right). This geological explanation of a microclimate that makes winegrowing possible at an altitude of 300 meters if paired with the right grape varieties is what counts in the world of the AOC. It seems far removed from the stories about rebellious Cathars and the wider sense of village community evoked in Jean-Marie's kitchen. It is November and out in the winery his fermentation tanks are about to go into hibernation as the temperatures drop. This is not supposed to happen according to the rules of the syndicate. "Correct" wines, as they say, must be fermented within a set timeframe which requires the winemaker to control the process. Jean-Marie wants his wines to reflect the natural rhythm of life in the mountains and refuses to heat the tanks. Likewise, he has decided to ferment some of the grapes without prior maceration and instead let the carbonic gasses burst the grapes. Given that the natural yeasts are on the outside of the peel and the sugary flesh on the inside, this process of *maceration carbonique* is slow, unreliable, and therefore not sanctioned by the syndicate.

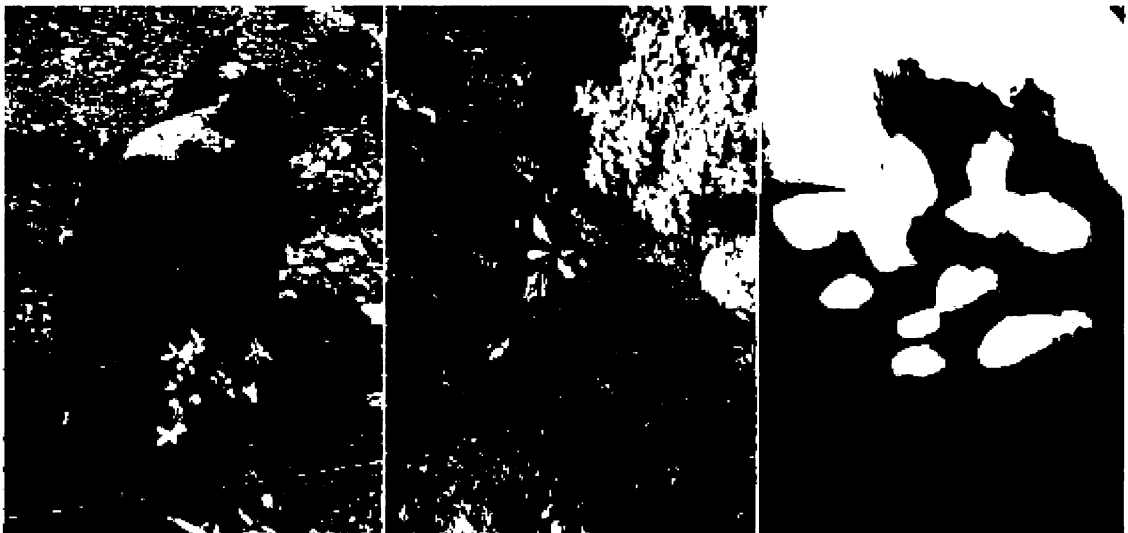


Figure 23 Elements of a terroir, as told by Jean-Marie around his vineyards in Berlou. From left to right: wild boar for sausage making; chestnuts on the ground; mushroom picking (photos by the author, adapted from Høyrup & Munk, 2007b).

It is 2005 and these are the early days of natural winemaking. In the coming decade producers like Jean-Marie will acquire the ability to valorize their experimental winemaking styles through a network of restaurants, wine bars, bloggers, critics, and merchants who will create a natural wine scene in places like Paris, Copenhagen, Melbourne, or New York. In this network it matters little if you follow the AOC convention and can exhibit it on your labels. On the contrary, what makes a difference is the personal story of the winemaker and the uncompromising commitment to natural processes in the cellar.

The divergence between some of the winemakers and the AOC is even starker when we visit the vineyards on the flat coastal plains further to the east (see [figure 24](#)). According to the official AOC maps, vines are not even supposed to grow here. Nothing about the climate or geology surrounding these windswept vineyards on the outskirts of Béziers

justifies any talk of terroir or local typicality. François, the winemaker, agrees. He is fed up with the perpetual French conflation of quality and geography and has turned to New Zealand in search of techniques that will help him make the most of his vineyards. This involves artificial irrigation, ceramic filters to extract alcohol, and planting grape varieties like Riesling or Pinot Noir that are not able to survive the heat of the plains without technological assistance (see [figure 25](#) left and [figure 26](#) left). The wines, however, are highly valued on the world market and sell at a good price, but the network through which François is able to claim the quality of his bottles is completely detached from the AOC system. There will be no geographical indications on his labels and hence no copyright protection. He has few allies in France – “on m’appelle le diable” as he says with a roguish smile, *they call me the devil*. Terroir, by the way, is the name of his dog.

The close observation of French winemaking actors reveals how they define their identities *through the opposition* to other actors and in ways that depend on the vantage point from which they engage the controversy (see [figure 27](#)). Seen from Nelly’s office at the AOC syndicate, the story of the controversy is one of terroir and tradition versus markets and blind consumer culture. The fault line is between the heritage of France and the wine industry of the New World. In this story, which resonates with the official narrative of the INAO in Paris, Jean-Marie is a winemaker with a terroir worthy of inclusion in the AOC, whereas François is an anomaly or even an enemy. On the other hand, reliance on spontaneity exposes Jean-Marie and natural winemakers to the risk (which, of course, they see as an opportunity) of producing wines that fall outside the expectations of established French precision (“justesse”) – a risk that is unacceptable for both Nelly and François.

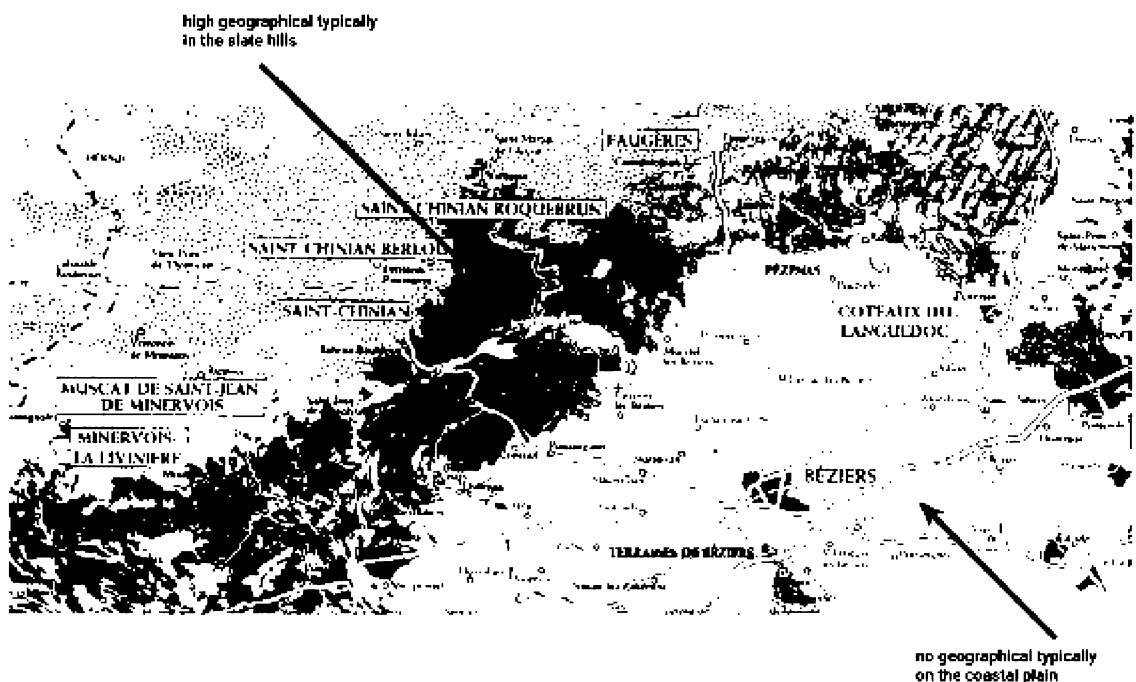


Figure 24 Extract from the official map of the Languedoc AOCs. The village appellations of Berlou and Roquebrun are marked up with labels and dark colors in the middle (top half). The coastal plains around Béziers are empty (adapted from the Syndicat AOC Languedoc).

irrigation system
near Béziers

roots of a "troll" cagnan
clinging to the slate in
Berlou

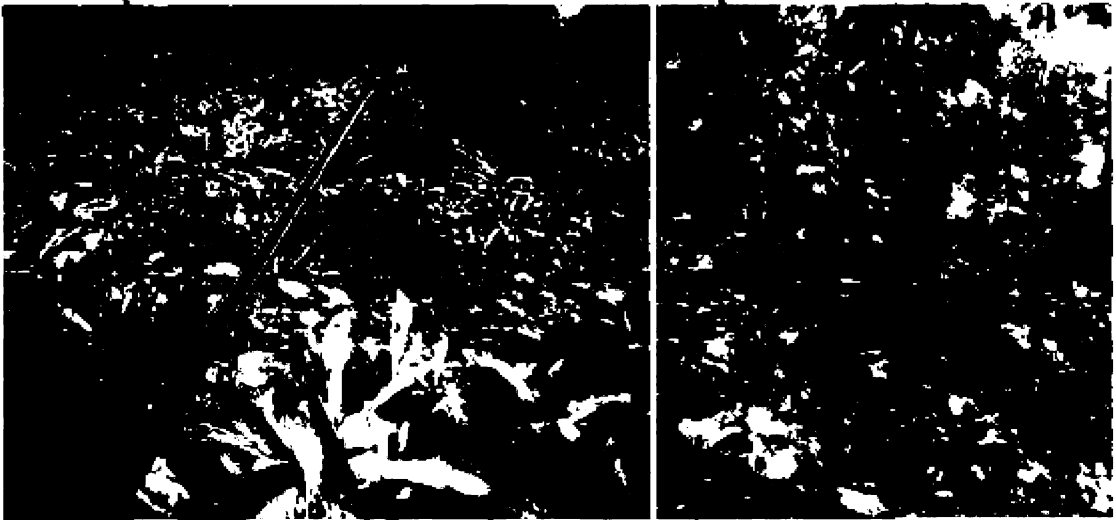


Figure 25 Trained vines with irrigation system on the plains near Béziers (left); troll vines on the slate hills above Berlou (right) (photos by the author, Høyrup & Munk, 2007b).



Figure 26 Cellar floor, fermentation tanks, and the dog named Terroir in Béziers (left); cellar floor, fermentation tank, and natural winemaker in Berlou (right) (photos by the author, Høyrup & Munk, 2007b).

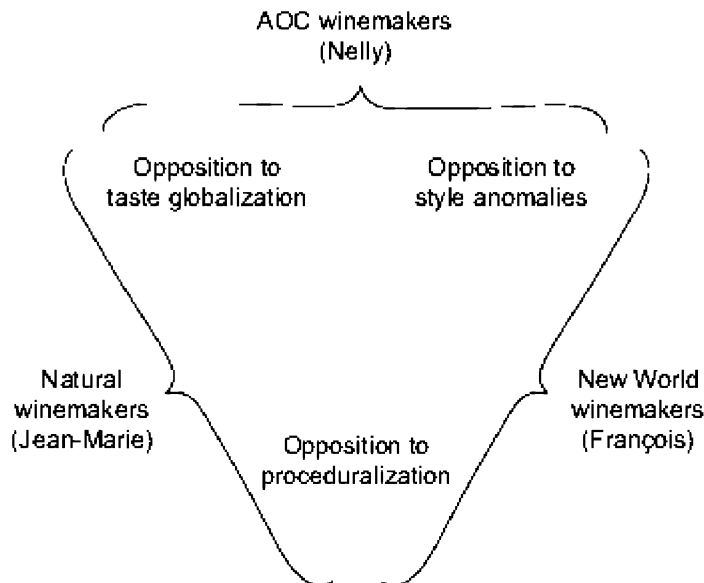


Figure 27 A semiotic triangle of French wine oppositions (created by the authors; released by the authors under CC BY-SA 4.0).

Seen from the point of view of Jean-Marie in the slate hills of Berlou, natural winemaking diverges from the AOC because of the refusal to define quality as the respect of some standard procedures. In this sense, Jean-Marie can see in François an ally against the institutionalization of quality that the AOC embodies. On the other hand, both François and the AOC represent a highly controlled style of winemaking where no room is left for nature and spontaneity.

Finally, seen from the point of view of François, Jean-Marie might be an ally in opposing the rules of the AOC and making space for alternative definitions of quality in winemaking, but he is certainly not an ally in terms of how wine should taste. In fact, if François could agree on one thing with Nelly at the AOC syndicate, it would be that Jean-Marie's unheated fermentation tanks will fail to deliver a "correct" product. Despite his antipathy towards regulations, François still subscribes to a conventional definition of when fermented grape juice can legitimately be called wine, a definition which excludes many natural wines, or at least categorizes them as "defective," as François and Nelly would concur.

Following actions with ethnography

To be able to follow a multitude of issues and actors, and to do so from a variety of perspectives, controversy mapping and ANT need flexible means of observation: "a way of thinking about method that is broader, looser, more generous" (Law, 2004, p. 4) and capable of responding "creatively to a world that is taken to be composed of an excess of generative forces and relations" (p. 9). Such a methodological attitude is the defining feature of ethnography, which since its inception has been characterized by a radical openness to the actors' own perspectives. As John Law puts it:

Ethnography lets us see the relative messiness of practice. It looks behind the official accounts of method (which are often clean and reassuring) to try to understand the often ragged ways in which knowledge is produced. (Law, 2004, p. 19)

An urban legend in anthropology recounts how Alfred Kroeber, when asked for fieldwork advice by one of his graduate students, threw him the thickest ethnographic monograph he could find and exclaimed: “Go forth and do likewise” (Axtell, 1979). Ethnographers in the field must be capable of “thinking on their feet,” not just because fieldwork is full of surprises, but especially because it involves a radical commitment to what Bronislaw Malinowski called the “native’s point of view” (1922). Given the fact that research design, methods guidelines, and neat analytical concepts are at grave risk of being culturally biased (or “ethnocentric” as anthropologists would say), ethnographers are often advised against them.

The commitment to follow the actors implies a curiosity about the native theories that the actors develop to organize their worlds. In early ethnographic works, such curiosity was sustained by the distance separating the ethnographers from the populations they studied. In his introduction to *Argonauts of the Western Pacific*, Malinowski asks his readers to imagine being “set down surrounded by all your gear, alone on a tropical beach close to a native village, while the launch or dinghy which has brought you there sails away out of sight” (Malinowski, 1922, p. 13). The same estrangement is actively employed in ethnomethodology to grant “the most commonplace activities of daily life the attention usually accorded extraordinary events” (Garfinkel, 1967, p. 1) and has been imported into STS by laboratory ethnographers treating technoscientific phenomena with the same curiosity once reserved for remote tribes (cf. Knorr-Cetina, 1981; Lynch, 1985; Latour & Woolgar, 1979; Traweek, 1988).

A similar ambition drives the commitment to follow the actors in controversy mapping, where the scene is often quite familiar, but the gaze of the mapmaker must remain estranged. Akin to ethnographic “thick descriptions” (Geertz, 1973) that help us understand how actions are imbued with collective meaning, controversy maps should show how seemingly trivial technical decisions have social and political ramifications. This is the most fundamental lesson to be learned from ethnography: the commitment to stay sensitive to the details and their potential worldmaking consequences. This commitment comes with a series of research methods that, following the classification of Harry Wolcott (2008), we can organize around the three main operations of experiencing, enquiring, and examining, roughly corresponding to participant observation, interviews, and archival work.

Experiencing

In ethnography, experiencing is generally obtained through participant observation, which consists in being present in the situation and interacting with its actors to varying degrees (Spradley, 1980, for example, proposes a scale ranging from passive to complete participation, pp. 58–62). While conventional ethnography generally assumes participant observation to involve physical presence in a situation, we prefer to define participation as the possibility to observe and intervene in collective situations *in the same way as their protagonists*. This extends ethnographic experiencing to forms of mediated interactions as in netnography (Kozinets, 2002) or virtual ethnography (Hine, 2015). For example, carrying out a participant observation of a mailing-list would require subscribing to the list and following or intervening in the discussion as it unfolds. This would allow the observer to be exposed to the rhythm and the messiness of the interaction in a way that would be lost by text-mining the archive of the same mailing-list after the discussions have concluded.

Enquiring

Enquiring, a.k.a. interviews, consists in soliciting information not otherwise available. What sets aside ethnographic interviewing from other more structured survey forms is the higher degree to which the interviewees are allowed to influence the questioning, thus acknowledging that different informants may have different ideas about what counts as relevant questions in relation to a specific issue. In controversy mapping, it is particularly important to follow the leads emerging in the discussion rather than a list of pre-determined questions as a way to respect the multiple framings proposed by informants. As James Spradley puts it, in ethnographic interviews “both questions and answers must be discovered from informants” (Spradley, 1979, p. 44).

Controversy mappers are generally helped by the fact that controversies are can-openers for sociotechnical black boxes. When actors can no longer refer to established truths or self-evident routines, they may be more willing to explain their positions to the researcher. Indeed, actors are sometimes only capable of reflecting on the practices that underpin their positions when a controversy has forced them to articulate their otherwise tacit knowledge. In some cases, however, controversies can also seal the lips of those who defend the status quo and prefer to ignore or even deny the existence of alternative viewpoints. Just evoking the term “controversy” may push such actors to close down and withdraw behind a lukewarm institutional discourse. Mappers can then broach the subject in more indirect and reassuring ways, but also nudge their interviewees in directions that they would otherwise avoid. Framing interviews as a dialogue means that the interviewers should not take a superior position compared to the interviewees, but also that they should not take an *inferior* position either. This is particularly important when questioning experts. If we straightforwardly accept the experts’ version, we lose the possibility to appreciate how, in controversies, any knowledge claim is a partisan move. There is no neutral position in a controversy, even though many experts will be inclined to present their own position in exactly that way. It therefore befalls the controversy mapper, not only to follow the actors, but also to triangulate their different accounts without affording them the luxury of imposing their own authoritative perspective. As Latour and Woolgar put it: “The adoption of scientific versions of science would teach us little that is new about science in the making; the observer would simply reiterate those accounts provided by scientists when they conduct guided tours of their laboratory for visitors” (Latour & Woolgar, 1979, p. 44). And this is why controversy mapping, like ethnography, demands a constant alternation between proximity to the informants and distance from them, between “emic” and “etic” perspectives, as the anthropologist would say.

Framing the enquiry *as a dialogue* is of course easier when interviews are carried out in person and over longer periods of time, but teleconferences, chat, and email are possible as long as the dialogic nature of the conversation is conserved. A good option is to interview several informants at the same time, so that one can react to the statements of the other, or even to organize focus groups where participants discuss with each other rather than being questioned by the researcher.

A final remark: because ethnographic interviews have to be carried out in the form of a dialogue, the use of this technique is typically limited to human beings, although it is possible to experiment with objects as elicitation devices in the interview situation (Adams & Thompson, 2011). A way around this difficulty is to carry out the interviews in the presence of the non-human beings that are most directly affected by the action under

investigation. This will not make it any easier for them to intervene in the discussion, but it may encourage the interviewees to speak in their name. For instance, interviewing scientists at their workbenches is often a good way to incite them to speak about their instruments.

Examining

Examining (a.k.a. archival work) refers to the work of collecting and sifting through written documents and other forms of material records created in the situation under investigation (Hodder, 1994). While extensively used, this type of *indirect* evidence is often met with suspicion by ethnographers. Archival work is considered as a secondary technique, which can enrich, but never replace, direct experience and enquiry. Relying exclusively or predominantly on records is frowned upon and marked with the dishonorable label of “armchair anthropology,” which originally designated the first-generation anthropology professors who relied on secondary evidence collected by missionaries, merchants, explorers, and military officers traveling the world.

While the value of embedding with your informants cannot be overstated, the difficulty with first-hand ethnographic observation is that it requires one to be in the *direct* presence of the studied phenomenon and its actors, which, if one takes ANT seriously, is strictly impossible. If collective action consists in a network of interferences through a multitude of actors across space and time, then only a small portion of it can be observed directly, in the “here and now” of the ethnographic field (Garforth, 2012). A similar realization took root inside anthropology itself during the 1980s and 1990s, evidenced, for example, in the idea of “multi-sited ethnography,” proposed by George Marcus, which takes direct inspiration from ANT. Multi-sited ethnography “moves out of the single site and local situations of conventional ethnographic research design to examine the circulation of cultural meaning, objects, and identities in diffuse time-space” (Marcus, 1995, p. 96), even if this happens at the expense of some of the depth traditionally achieved in single-sited fieldwork.

Similarly, it would be impossible for controversy mappers to follow the multiple connections of sociotechnical debates relying exclusively on participant observation and direct questioning. Luckily, it is also unnecessary, since actors in controversies make use of all sorts of intellectual and material techniques to trace their actions. Spend two days with any technoscientific dispute and you will find yourself overwhelmed by “expert reports,” “instrumental records,” “legal procedures,” etc. The observation of collective actions can never be entirely unmediated, because collective actions themselves are never entirely unmediated. Documents, inscriptions, and records are part of the fabric of our collective life as much as face-to-face interactions.

In their effort to establish social anthropology as an independent discipline (Tedlock, 1991), early field anthropologists (Bronislaw Malinowski in particular) used “armchair anthropology” as a strawman and thereby entrenched an opposition between working with *first-hand* information (be it observations, interviews, or material records) and exploiting information collected *by someone else*. In this, they exaggerated a difference that was (and is) much more gradual (Schaffer, 1994). Looking at the practices of nineteenth-century anthropologists, Efram Sera-Shriar (2014) argues that the use made by these scholars of the information received from travelers and colonial officials was anything but naive: “armchair anthropology was not a passive pursuit, with minimal analytical reflection that

simply synthesized the materials of other writers. Nor was it detached from the activities of informants who were collecting and recording data in the field” (Sera-Shriar, 2014).

This capacity to use records collected by someone else has become crucial today, as digital mediation makes it harder and harder to distinguish between direct and mediated observation. When scholars follow members of the Alt-Right movement stitching together the “pizzagate conspiracy” on 4Chan (Tuters et al., 2018), are they carrying out participant observation or doing archival research? The fieldwork/armchair distinction hides the methodological point that really matters, namely that even when they are collected by someone else (as is increasingly the case when we rely on digital technologies), records of social behavior require the same care and proximity that ethnographers dedicate to their field notes.

In the next chapters we will introduce a series of techniques for harvesting and analyzing digital material. These techniques may at first glance seem far removed from the ethnographic stance adopted in this chapter. Despite the obvious differences, however, and for the reasons we have outlined above, controversy mapping is never a form of “distant reading” (Moretti, 2013b) and always a form of “digital fieldwork” (Munk, 2013; Venturini & Rogers, 2019).

Sorting observations with semiotics

Not unlike stamps, butterflies, or coins, a collection of research observations has value only when it is meaningfully organized. Thus, besides drawing on ethnography to develop the “art of noticing” (Tsing, 2015), cartographers must also learn how to order and interpret their observations. This effort of sensemaking has been given different names – “inscription,” “transcription,” “(cultural) translation,” “textualization,” or “narration” (cf. Emerson et al., 1995) – but we prefer to call it *sorting* to emphasize how this operation relies on the manipulation of material records (Bowker & Star, 1999). Sorting cannot be confined to a specific phase of scientific investigation. It begins *before* setting foot in the field, through the selection of situations to be observed, the informants to be interviewed and the records to be examined. It is present in the way we take field notes, through the choice of which pieces of information to retain and ignore. It is crucial when notes are analyzed (Lejeune, 2010, 2014; Flick, 2014) and accompanies the researcher until the last line of the final manuscript.

In learning how to sort research observations and weave them in a coherent story, ANT is particularly indebted to semiotics, to the point that one of its founders has defined ANT as a form of “material semiotics” (Law, 2009). While this definition is quite fitting, it also needs unpacking. Crucially, the “semiotic turn” proposed by ANT does not imply reducing sociotechnical phenomena to their cultural or symbolic dimension but, quite the opposite, extending semiotic thinking beyond its literary origins. In the 1960s and 1970s, semiotics shook literary theory by claiming that the analysis of texts should care less about the social origins of their authors or the cultural context of their reception, than about the internal networks of relationships between their components (cf., among others, Eco, 1962, 1979). ANT subscribed to this *internalist* and *relational* style of accounting and extended it from texts to sociotechnical situations, which it proposes to explain through their internal networks of actions rather than through external natural or social causes (Akrich & Latour, 1992; Lenoir, 1994; Latour, 1996b; Høstaker, 2005; Beetz, 2013).

For ANT, “semiotics [is] the study of how meaning is built, but the word ‘meaning’ [“sens” in French] is taken in its original nontextual and nonlinguistic interpretation; how one privileged trajectory is built out of an indefinite number of possibilities; in that sense, semiotics is the study of order building or path building” (Akrich & Latour, 1992, p. 259). John Law expresses the same idea in a simpler way, by noting that the objective of ANT is to describe how collective situations succeed in stabilizing their configuration

Sociology is usually interested in the *whys* of the social. It grounds its explanations in somewhat stable agents or frameworks. Actor network’s material semiotics explore the *hows*. In this non-foundational world nothing is sacred and nothing is necessarily fixed. But this in turn represents a challenge: what might replace the foundations that have been so cheerfully undone? ... Actor network theory ... responded to this challenge in the only non-foundational way it could, by exploring the logics of network architecture and looking for configurations that might lead to relative stability. (Law, 2009, p. 148)

In practice, this boils down to four research operations:

1. Choosing a seemingly simple and stable object (a time-honored institution, a sound piece of technology, a successful organization, an established idea, etc.).
2. Showing that this object is in fact a network of actions and actors.
3. Describing how such a relational complexity is curbed (temporarily at least) through a series of black-boxing arrangements.
4. And reflecting how these arrangements could be modified to make them more just and inclusive.

Making lists, taking names

Besides the general tendency to rely on an internalist and relational explanations, ANT derives two specific techniques from semiotics and particularly from the narrative theory developed by Algirdas Greimas. This theory resonates with ANT and its focus on action as the elementary ingredient to describe “the syntactic form of the organization of the world” (Greimas, 1989, p. 543). Generalizing the system introduced by Russian narratologist Vladimir Propp (1968) to catalogue folktales, Greimas (1989) defined the elements of any text according to what they do rather than what they are. A classic feature of traditional tales is indeed that their protagonists are not only humans, but also animals, spirits, and animated objects. Anything that acts is a character in its own right and it can fill a role in the story in the same way in which a human being would (a magic ring can cast spells like a magician, a magic sword can fight like an army of soldiers). Extending this idea to all types of texts, Greimas introduced the notion of “actants,” defined as anything that “accomplish tasks, undergo tests, reach goals” (Ricoeur, 1989, p. 588). The openness of the notion of “actant” struck a chord in ANT, to which it offered a way to identify the ingredients of sociotechnical networks without having to bother whether they were human beings (e.g., scientists and engineers), natural elements (e.g., microbes, stars, molecules), objects (e.g., laboratory tools, technological artefacts) or something else.

From Greimas, ANT learned that the first and foremost operation when organizing the observation collected about a collective phenomenon is to identify the entities by which it is enacted. *Making lists and taking names* may sound trivial, but it is an invaluable resource for cartographic projects. Computer scientists refer to such catalogues as

“ontologies”; we may call them “issue vocabularies” or “issue dictionaries,” but their purpose is the same: to have the best record of items to follow across time, space, and contexts. As we will see, this is precisely what happens when we design a query for a search engine, using names as hook-lines to fish traces out of digital repositories. More generally, issue dictionaries help identify the characters and stage props that actors mobilize in their account of the situation. For example, in the controversy about hydraulic fracturing, the actors concerned about the risks posed to the groundwater supply by shale gas extraction tend to list the polluting substances and the names of chemical experts or publications who can testify to their effects. Conversely, the actors interested in the price of energy tend to emphasize the types of extracted fuel and the companies investing in them.

Staging characters

Making lists is useful in itself, but cartographers can go a step further and organize the elements of these lists according to the role that they play in collective action. For this, Greimas’s theory comes in handy for a second time by offering an articulated vocabulary of *narrative roles* to sort the information acquired through ethnographic or digital fieldwork.

In [figure 28](#), we combine two different but related schemas – the “actantial model” (proposed by Greimas, 1966, to categorize actors) and the “canonical narrative schema” (proposed by Greimas, 1970, to categorize actions) – to suggest a way to dissect collective “programs of actions” into their components. To exemplify the components of our diagram we use the story narrated in the vignette as seen from the point of view of its three protagonists.

The first element encountered when analyzing a program of action is the *sender* (a) – the actor (or actors) who, instead of acting directly, tries to manipulate another actor (or actors). *Manipulation* has no pejorative meaning here and only refers to the effort to deviate someone else’s action in order to align it with one’s own. In our example, Nelly is a sender because, rather than acting directly, she influences the actions of AOC Languedoc winemakers. In the case of Jean-Marie and François, no sender is in view, since the two winemakers are acting proudly on their own behalf (see [figure 28](#)).

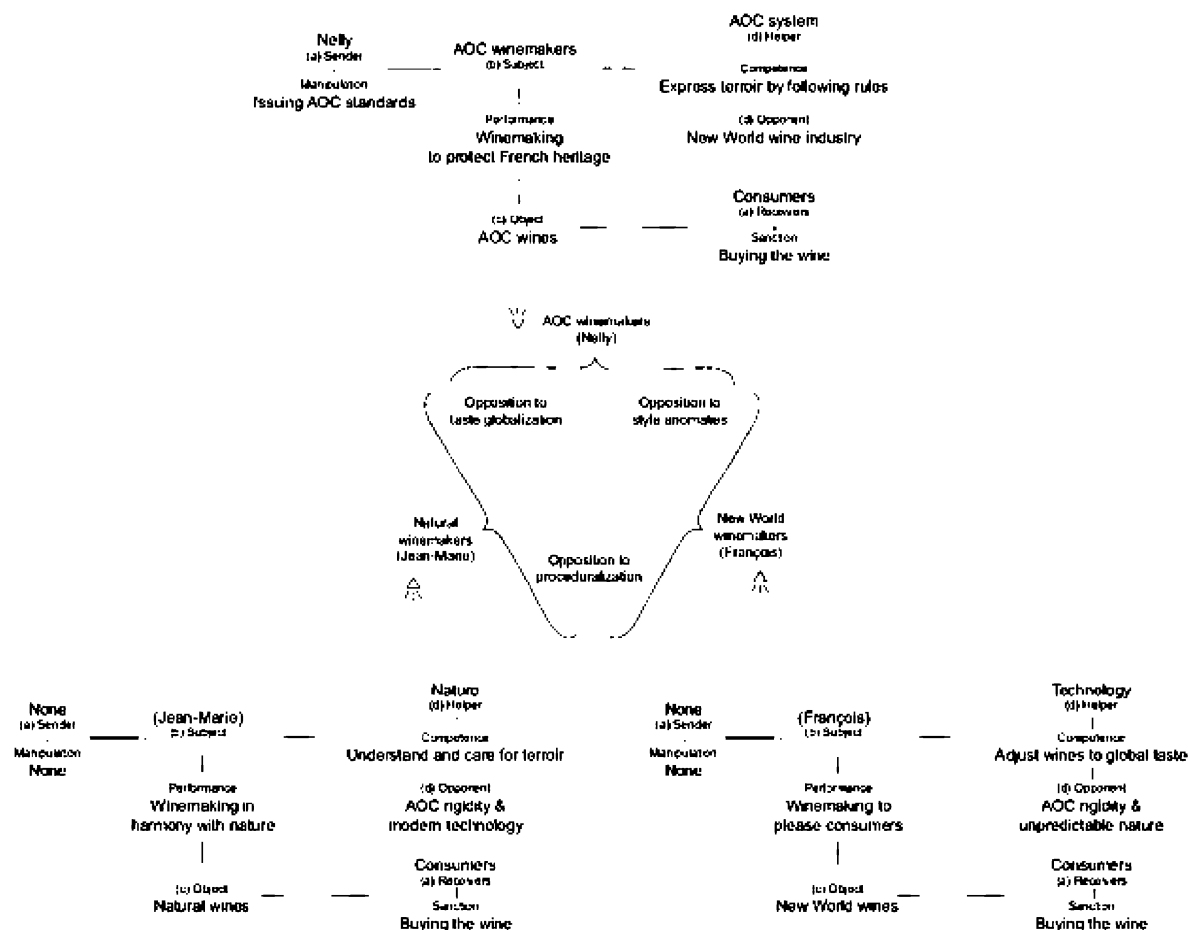


Figure 28 Three ways of telling the story of French wine and terroir using Greimas’s model and according to the viewpoints of three of its protagonists. Top, AOC winemakers attempt to protect French heritage from the onslaught of the New World winemaking through a rule-based definition of terroir; bottom left, natural winemakers oppose a rule-based definition of terroir in order to let nature take back control; bottom right, new-world winemakers oppose a rule-based definition of terroir to please the consumer (created by the authors; released by the authors under CC BY-SA 4.0).

The sender’s manipulation aims at obtaining a *performance*, the action that represents the center of the diagram and corresponds to the “quest” of traditional folk tales. The performance involves one or more *subjects* (b) who carry out the action, and the *object* (c) who bears its consequences. In our case, the performance is the production of wine according to the styles and the intentions of the different winemakers.

The performance is facilitated by *helpers* (d) who assist the subject in acquiring the *competences* that it needs to carry out the performance. In our case study, each protagonist finds a different helper (respectively the AOC system, nature, and technology) in line with the quest he or she pursues. Opposite to the helpers are the *opponents* (e) who try to strip the subject of the competences necessary to the performance. As often happens in controversies, our diagrams show that the opponents of one of the protagonists are often the helpers of the other.

Finally, the *receiver* (f) is the actor who *sanctions* the action by judging its success and possibly rewarding the sender or the subject. In our example, the receivers are always the

wine consumers who reward one or the other style of winemaking through their buying preferences.

Not all programs of actions mobilize all the roles and types of actions and often the same entity is present in more capacities (when you go for a run, for example, you are the sender, subject, object, and receiver of the action). The point of the diagram in [figure 28](#), therefore, is not to follow it slavishly, but to remind social cartographers that actions are never carried out in isolation, but always performed through a diverse cast of actions and roles in a larger network of interferences: or, as we may say, an actor-network.

ANT as an anti-theory

Drawing up the lineage of ANT, we have focused on its methodological inspirations. Despite calling itself a theory, ANT is not particularly fond of theoretical frameworks. In a book dedicated to the future of Actor-Network Theory (Law & Hassard, 1999), the founders three times deny that ANT is even a theory:

John Law: “The desire to know clearly what we are talking about, the desire to point and name, to turn what we now call ANT into a ‘theory’, I believe that all of these things have done harm as well as good. ‘Have theory, will travel’.”

Bruno Latour: “Far from being a theory of the social ... it always was, and this from its very inception, a very crude method to learn from the actors without imposing on them an a priori definition of their world-building capacities.”

Michel Callon: “ANT’s main shortcoming is that it is everything but a theory – which explains why it cannot explain anything! ... ANT is not a theory. It is this that gives it both its strength and its adaptability. Moreover, we never claimed to create a theory. In ANT the T is too much (*‘de trop’*). It is a gift from our colleagues. We have to be wary of this type of consecration especially when it is the work of our best friends. *Timeo danaos et dona ferentes*: I fear our colleagues and their fascination for theory.”

In line with this wariness of theory, the three guiding principles of ANT, as defined by Michel Callon, are meant to free the empirical investigations from constraints and expectations stemming from abiding too strictly to predefined theoretical frameworks:

1. *Agnosticism*: researchers should carefully consider all the arguments and explanations put forward by the actors that they study.

Not only is the observer impartial towards the scientific and technological arguments used by the protagonists of the controversy, but he also abstains from censoring the actors when they speak about themselves or the social environment. He refrains from judging the way in which the actors analyze the society which surrounds them. No point of view is privileged and no interpretation is censored. The observer does not fix the identity of the implicated actors if this identity is still being negotiated. (Callon, 1984, p. 200)

2. *Generalized symmetry*: researchers should not introduce any a priori distinction between human and non-human agency. Science and politics, technology and society should always be studied together. Researchers cannot abstain from taking aspects into account with the excuse that they fall outside their discipline, nor can they handle them with different methodological instruments.

We know that the ingredients of controversies are a mixture of considerations concerning both Society and Nature. For this reason we require the observer to use a single repertoire when they are described ... the rule which we must respect is not to change registers when we move from the technical to the social aspects of the problem studied. (Callon, 1984, p. 200)

3. *Free association*: researchers should respect the freedom of actors to compose their worlds out of heterogeneous elements.

the observer must consider that the repertoire of categories which he uses, the entities which are mobilized, and the relationships between these are all topics for actors' discussions. Instead of imposing a pre-established grid of analysis upon these, the observer follows the actors in order to identify the manner in which these define and associate the different elements by which they build and explain their world. (Callon, 1984, p. 201)

These instructions are largely *negative* – they tell you what to avoid rather than what to do, as acknowledged repeatedly by Bruno Latour (here in 2005):

“This lesson is negative, to be sure” (p. 42); “the key training for practicing ANT is negative at first” (p. 118); “ANT is first of all a negative argument” (p. 141) “about how to study things, or rather how not to study them (p. 142); “ANT is a method, and mostly a negative one” (p. 142); “ANT’s lessons will be only negative because clearing the way is what we are after” (p. 174); “[ANT] is a negative, empty, relativistic grid that allows us *not* to synthesize the ingredients of the social in the actor’s place”. (Latour, 2005b, p. 221, original emphasis)

The characterization of ANT as an anti-theory, however, deserves some nuancing. ANT has nothing against theories *as long as they come after and not before empirical observations*. While there is nothing more incompatible with ANT than choosing a theoretical framework *first* and *then* applying it to a case study, ANT sees nothing wrong in using conceptual tools if they are helpful in one’s fieldwork. In this sense, ANT prescribes an inversion similar to the one suggested by “grounded theory” (Glaser & Strauss, 1967), namely to start from empirical observations and finish with theory. Unlike grounded theory, however, ANT is not opposed to recycling theoretical notions developed in other contexts, as long as they are not used as interpretative frameworks, but rather as descriptive tools that researchers can cherry-pick and adapt for their own use. In a text dedicated to mixed methods, Joseph Maxwell describes this attitude as preaching “the decomposability of paradigms into separated conceptual tools that can be used somewhat independently ... as heuristics, *as tools in a toolkit*, rather than as ‘core’ or ‘foundational’ ideas” (Maxwell, 2011, p. 28, emphasis added). Latour goes one step further and proposes to consider theoretical explanations as additional actors that researchers can add to their accounts if they improve their description: “Either your explanation is relevant and, in practice, you are adding a new agent to the description ... or it’s not an actor that makes any difference and you are simply adding something irrelevant” (2005b, p. 67).

To understand what Latour means when he claims that explaining is nothing more than adding missing actors to the description, let’s consider a famous historical controversy from the field of international relations. In *Essence of Decision*, Graham Allison (1971) considers the escalation and de-escalation during the Cuban missile crisis and employs three explanatory frameworks to account for the Russian deployment of offensive missiles

in Cuba, the ensuing blockade of the island by the US Navy, and the final withdrawal of the missiles.

The first framework (dominant at the time Allison's book was published) is the so-called "rational actor model," in which policies are decided by considering all possible alternatives and choosing the one that maximizes national utility. While recognizing the interest of this model, Allison criticizes it for being too simplistic. The second framework, the "Organizational Behavior Model," considers the role of institutional inertia and procedural routines in setting the course of action. In the case of the missile crisis, this means recognizing that the availability of a pre-existing plan for a naval obstruction favored the blockade over the alternative of air-strikes. The third explanation, the "Governmental Politics Model," emphasizes the personality and styles of stateswomen and statesmen in the highest decision-making circles. In the case of the missile crisis, this entails drawing attention to the closest advisors of President Kennedy sitting in the Executive Committee of the National Security Council.

The three models, of course, are not mutually exclusive. Taken as explanations, they can seem opposed (because each provides a different justification of what happened) but taken as descriptive tools (or "lenses" as Allison calls them), they can be combined to unfold the same event. Switching from one lens to another, we are just adding more actors to our description (in Allison's case, national utility, governmental bureaucracy and political leaders) and thus performing the most basic operation of a cartographic effort: drawing the inventories of actors and issues.

Four ways of observing collective actions

In line with its "anti-theoretical" posture, ANT is interested in describing social phenomena down to their most basic ingredients – that is the actions that compose them and the consequences that they produce. Taking inspiration from the radical empiricism of William James (1912) and the sociology of Gabriel Tarde (1890, 1893), ANT "bootstraps" from the basic idea that "exister c'est differer" (Tarde, 1893), to exist is to make a difference. To this ANT adds the recognition that making a difference is far from easy. In its purest form, this is what actor-network research is all about: observing how actions succeed or fail in producing effects.

In a diagrammatic example of this struggle to make a difference, Latour takes us to the familiar setting of a hotel reception desk (Latour, 1991; but also Latour et al., 1992; Carlson & Gorman, 1992). The manager, anxious not to lose room keys, is keen to persuade her guests to leave their keys at the front desk. The guests, however, find it more convenient to keep their keys in their pockets, at the peril of forgetting to return them after their stay.

The manager represents a "program of action" (leave the keys) while the guests represent an "anti-program" (keep the keys). On her own (stage 1 in [figure 29](#)), the manager has no success with her program. Pragmatically speaking, she does not yet exist as an actor. Alone against her guests, she makes no difference and therefore cannot be said to act. To acquire agency, she begins by politely asking her guests to leave their keys, but only manages to persuade a few (stage 2). She then puts up a sign in the lobby (stage 3) that exclaims, in a slightly less polite tone, "leave your keys!" Now she is making progress; the frontline is advancing. The real shift, however, comes when the hotel manager decides to weld each key to a weighty piece of metal (stage 4). Now the guests are no longer doing her a favor

by leaving their keys. Instead, the manager is helping her guests get rid of a nuisance in their pockets. Eventually, neither the sign nor the friendly reminders will be necessary. The guests will seek to get rid of their keys all by themselves. The alliance between the manager and the weighted keys has achieved agency.

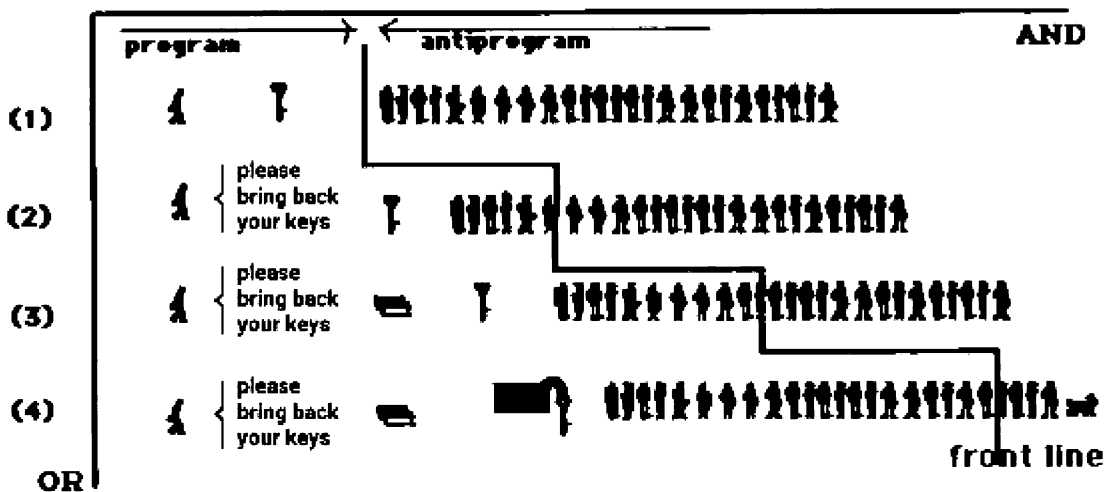


Figure 29 A diagram of programs and anti-programs of action in a hotel reception (Latour, 1991). As the hotel manager finds more allies for her program, the anti-program of the hotel guests weakens.



Figure 30 Markings on a street encouraging social distancing in front of a rotisserie kiosk in Italy. Before (left, photo courtesy of arnaldagourmet.com) and after (right, photo courtesy of Gruppo Food, foodserviceweb.it) the Covid-19 outbreak.

If this example feels trivial, think of how a very similar story could be told about the efforts of governments around the world to make a difference to the Covid-19 pandemic by convincing citizens to socially distance (see [figure 30](#)). In some countries, a simple recommendation seemed to do the trick, while in others, authorities had to go to great lengths, including legal regulation, police patrols, street marking, and forcing citizens to fill in forms and carry documentation, to convince people to give up their normal programs of action and accept the lockdown.

In a condensed form, the case of the hotel keys illustrates the four “felicity conditions” of action, which we will discuss in more detail in the following examples. For agency to be expressed and consequences produced, actions need to (1) involve several actors (acting as

collecting); (2) whose contributions must be coordinated (acting as *aligning*); (3) by bending their trajectories (acting as *detouring*); and (4) redefining their identities (acting as *being*).

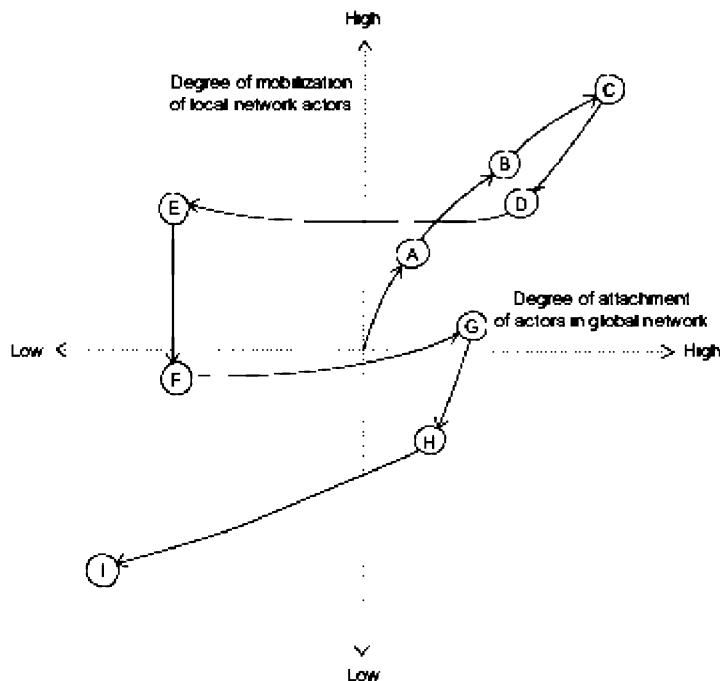


Figure 31 The trajectory of the TSR2 project (according to Law & Callon, 1992). From an initial momentum (points A to C) encouraging the mobilization of the actors internal to the project (horizontal axe) and assuring the attachment of external actors (vertical axe), to gradual decline and eventual cancellation (points D to I).

Acting as assembling

The first feature of action according to ANT is illustrated in a paper by John Law and Michel Callon (1992) analyzing the failure of a British military aircraft, the TSR2 (see also Law, 2002). The disastrous outcome of the project, cancelled only months after the maiden flight, demonstrates how the success of a technological project depends on its capacity to assemble an “internal” network of human and technical components and an “external” network of financial and political support. Using these two dimensions, Law and Callon plot the trajectory of the TSR2, revealing the shifting cohesion of its networks (see [figure 31](#)).

In the early stages of the TSR2 project, the different institutions involved had very different ideas about the aircraft. The Royal Air Force wanted a state-of-the-art plane to replace older models. The Ministry of Defence, which had just invested in ballistic missiles did not want a strategic bomber. The Treasury wanted it to be cheap. The Navy wanted the money to be spent on the Buccaneer aircraft that it was already buying for its carriers. The Ministry of Supply wanted the project to push the concentration of the national aerospace industry. These different demands were gathered (but not harmonized) in a very open call for projects (point A in [figure 31](#)). Several manufacturers answered the call, proposing very different solutions to very different problems. The most interesting came from Vickers, who proposed an aircraft with large wings and external engines adapted for short takeoff,

and from English Electric, who proposed a supersonic aircraft with short wings and engines in the fuselage.

Eventually the external network decided that the TSR2 would be a mix of the two proposals jointly manufactured by Vickers and English Electric (point B). This external push to converge, forced the two companies to increase the coherence of the internal network, by combining their projects into one supersonic, medium takeoff, in-fuselage-engined aircraft, and to merge into the British Aircraft Corporation (point C).

This internal and external consolidation, however, proved insufficient, because the management of the project failed in establishing itself as the “obligatory passage point” between the external and internal network. Different institutional sponsors started colluding with subcontractors to pull the project in different directions, thereby degrading its stability (point D). An example was the decision by the Ministry of Supply to impose an engine manufactured by Bristol Siddeley, which proved unfit for the aircraft. The engine exploded in one of the first test flights (point E). In the following years, other such events destabilized the project (points F and H) and defeated the effort of the management to assure its consistency (point G), eventually leading to the cancellation of the project (point I). The failure of the TSR2 exemplifies how making a difference is never an individual initiative and always a collective enterprise carried out by assembling a variety of actors in a coherent network.

Acting as aligning

The notion of “obligatory passage point” suggests that *assembling* different actions might not be enough to produce an effect and that the success of an action program also requires coordination and harmonization. Latour (1995a) describes this alignment in a field study following a team of French soil scientists in Brazil. The objective of the research project was to determine if the Boa Vista forest was retreating or advancing on the bordering savanna. Like most scientific phenomena, the movements of a primeval forest are invisible to the naked eye. Since their scale (in space and time) makes direct observation impossible, the scientists had to put into place a complicated sequence of translations.

The soil scientists began their research by comparing maps and aerial photographs to identify a representative area of the forest. Then, relying on already established knowledge that differences in vegetation are reflected in different soil properties, they focused on the soil of the selected area. Using a system of strings, the scientists divided the area into a grid and extracted a sample from each cell. The samples were then placed in a suitcase containing a grid of cells corresponding to the grid drawn by the strings on the ground. The soil profile could now be abstracted from the area and transferred to the laboratory (which is why the comparator comes in a suitcase). To become available to other scientists, however, the sampled terrain had to undergo further translation. To get a sense of the soil composition, the scientists compared the samples against a booklet containing hundreds of color shades organized by the Munsell color system. The color code of each specimen was then plotted on a diagram, and since this way of referencing the color of soil is an established practice for evaluating soil properties, the diagram could support an argument that the forest was advancing on the savanna.

In this account of the production of scientific knowledge, truth does not rely on a resemblance between a phenomenon and its description. The *evidence* of the diagram does not come from a straightforward connection with its referent (a 10² cm diagram does not

resemble kilometers of bushes, trees and wild animals), but from its capability to build and maintain a *chain of reference* – that is, from the possibility of retracing the sequence of translations all the way back to the original phenomenon: “if the chain is interrupted at any point, it ceases to transport truth – ceases, that is, to produce, to construct, to trace, and to conduct it” (Latour, 1999, p. 69).

Scientific reference is a “chain” (and not a substance) because its validity does not depend on a direct resemblance to the natural phenomena (the cliché realist position), but on the alignment of a series of heterogeneous transformations. The linkage is sometimes guaranteed by a previous representation, for example maps and photographs; other times by a theory, for example the vegetation-soil connection; by a calculation, for example geometrical triangulation; by a research protocol, for example sampling; by a technical tool, for example the pedocomparator; or by a scientific standard, for example the Munsell code.

Circulating reference, then, is how scientific truth is made. Equations, diagrams, charts, tables, photographs, quotations, all serve to inscribe portions of the research chain within scientific papers. The rest of the chain (the part that does not fit in the paper) remains accessible through other literary devices (e.g., the affiliations note, the research protocol description, laboratory or field notes and, of course, the bibliographic references). The chain of reference, however, is also an example of a lesson that extends beyond scientific research. All successful collective action depends not just on the contributions of many different agents, but also on the alignment of their efforts.

Acting as redirecting

Studying a controversy about fishing on the French Atlantic coast, Michel Callon (1986) illustrated the work necessary to transform a collection of heterogeneous actors into a network capable of cohesive action, and how consequential it can be when that work fails. The debate began in 1972 when, due to a decrease in scallop stocks in St. Brieuc bay, a group of scientists proposed to experiment with the cultivation of shellfish in submerged collectors.

To conduct their experiment, the scientists needed the cooperation of the local fishermen and scallops. To get it, they went through a first phase of *problematization* in which they presented the submerged collectors in a way that made sense to their allies, i.e. not just as an experiment in marine biology, but as a way to fight declining scallop stocks. The second phase of *interessement* consisted in persuading future allies to redirect their immediate courses of action in favor of longer-term objectives. The experiment was thus presented as an *obligatory point of passage*. If the scallops wanted to survive their predators, they would have to accept leaving their natural habitat and attach to the collectors. If the fishermen wanted to secure their business, they would have to abandon fishing and become breeders (see [figure 32](#)).

In the third phase of *enrollment*, the scientists negotiated their program of action with the representatives of their allies, namely the spokespersons of the fisheries association and the scallop larvae included in the first experiment. Through the enrollment of their representatives, the scientists hoped to be able to rally eventually *all* the fishermen and scallops of St. Brieuc bay. During the final phase of *mobilization*, however, the reliability of these representatives turned out to be precarious. Although some scallop larvae agreed to attach to the collectors, the majority of them refused and fell on the sea floor below.

Although the fisheries association had agreed that their members would stay clear of the protected zone where the larvae were raised, several fishermen ignored the deal and fished the area dry on Christmas Eve.

The St. Brieuc fiasco reveals how hard it is to build a cohesive network and thus perform a collective action. The durable alignment necessary for a scientific theory or a technical artifact to be brought into existence requires established courses of action to be redirected, which in turn demands a redefinition of the identities of the concerned actors. And this is precisely what went wrong for the St. Brieuc scientists, as scallops rejected domestication and fishermen refused to become breeders.

Acting as being

It is not by chance that in controversy mapping the protagonists of collective phenomena are called “actors.” To ANT, *acting is being*. This principle is illustrated by Robert Kohler’s (1999) description of how modern biology was transformed by the alliance between the laboratory of Thomas Hunt Morgan and *Drosophila melanogaster* (a.k.a. the fruit fly).

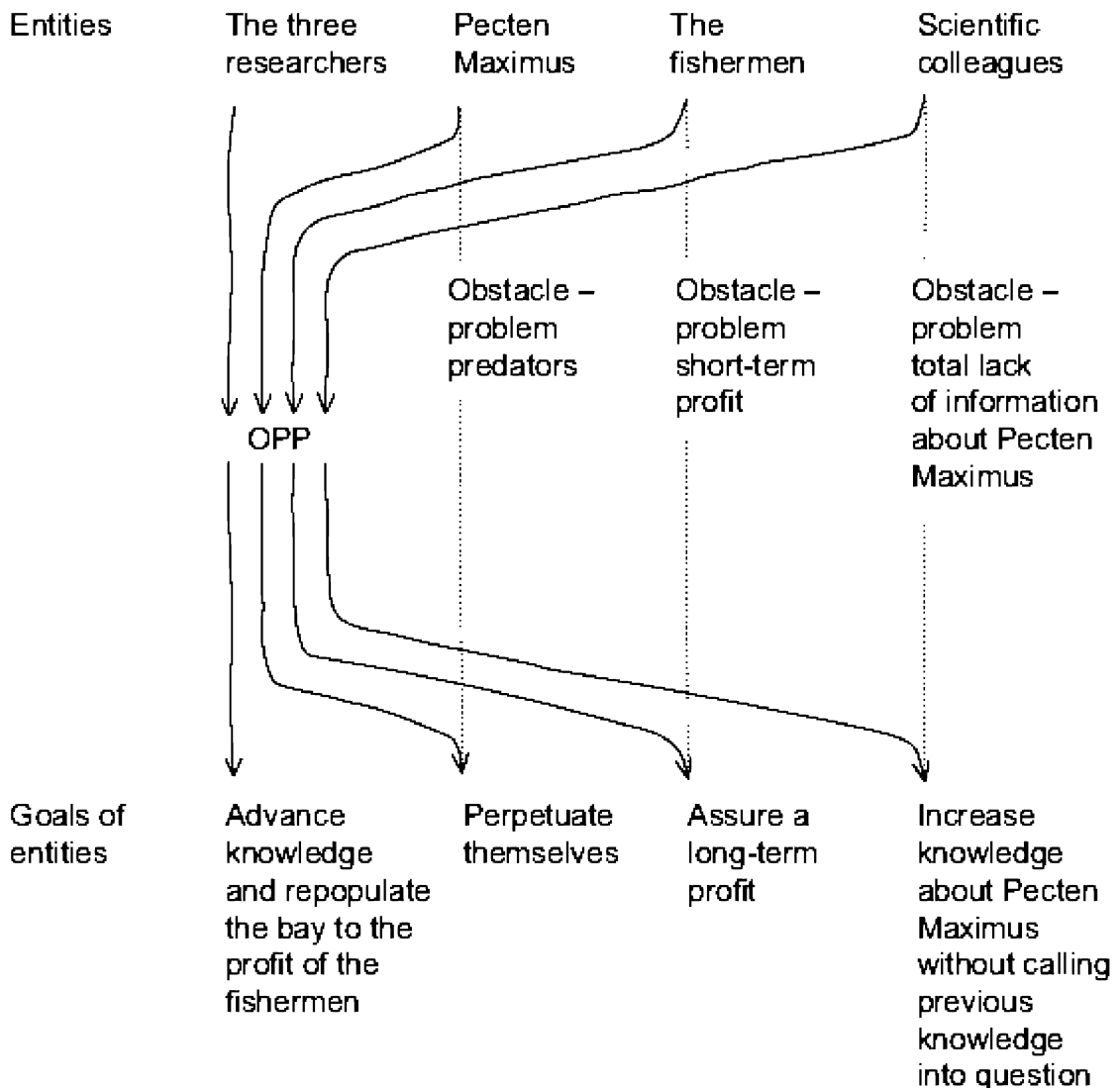


Figure 32 The redirection of actions through the obligatory passage point (OPP) proposed by the three researchers in the St. Brieuc bay case (Callon, 1986).

At the beginning of the twentieth century, Morgan was working on the theory of evolution and started using the *Drosophila* as the privileged organism for his experiments. Because of its natural characteristics (i.e., small size, short life cycle, high rate of reproduction, good tolerance for laboratory life), the fruit fly was perfectly suited for genetic research and allowed Morgan to scale up his experiments. Working with hundreds of generations and thousands of flies allowed Morgan to introduce the approach of chromosome mapping: instead of investigating the mutations of single individuals, he began to study mutations statistically, which, in turn, encouraged him to work with more and more flies. Morgan turned genetics into a quantitative science and the *Drosophila* into the first “standard organism,” i.e., a natural species selected and transformed in the laboratory to have a controlled genetic variability, well-known features, and different pure strains.

But while transforming the *Drosophila*, Morgan’s research practice was itself transformed. The abundance of flies encouraged Morgan to assume a peculiar management style. In the “fly-room” (as Morgan’s laboratory came to be called), research tools (and particularly fly strains) were freely accessible to all researchers; credit and publications were shared on the

basis of merit; and the research agenda was decided jointly. Little by little this attitude extended to the whole community of chromosome mappers. The cornerstone of this community became the principle of limited ownership of fly stocks, according to which laboratories could freely borrow fly strains from each other, simply by disclosing their research intentions. This culture of openness and reciprocity was crucial to facilitating the development of chromosome mapping, an approach that demanded studying hundreds of possible genetic recombinations.

This case illustrates the circle of influence through which the characteristics of the *Drosophila* influenced the organization of Morgan's laboratory, which transformed the fly into a standard organism, which in turn redefined the culture of modern biology. In this circle there is no beginning and no end. The identity of an actor determines its actions and its actions end up defining its identity. More importantly, since action is always collective, identity is too: we are what we do, but also what others do with us.

The truth of relation

The four case studies discussed above illustrate how scientific theories and technical artefacts are never just discovered, but always constructed through the hard work necessary to assemble, align, redirect, and redefine the actor-networks that compose them. This work is the object of controversy mapping, which, in the words of Gilles Deleuze (1988, p. 30), concerns “la vérité de la relativité et non relativité du vrai” – *the truth of relations, not the relativity of truth*. The Centre Pompidou in Paris provides an architectural illustration of what it means to expose the associations behind a construction – not to debunk them, but to reveal their importance (see [figure 33](#)). In this building, Renzo Piano and Richard Rogers inverted the canon of architecture. Instead of hiding the structural frame, the plumbing, the heating system, the electrical cables and all the other connections without which no building could exist, they exposed them on the outside where they define the identity of the edifice (Silver, 1997).

One could say that the objective of ANT is to produce the same kind of inversion for sociology. Michel Callon (1984) calls this project “sociology of translation,” John Law (2009) “material semiotics,” and Bruno Latour (2005b) “associology.” Commonly, however, the project to map collective phenomena back to the actions that constitute them is known as Actor-Network Theory, a name which can be misleading if the meaning of the *hyphen* is not properly understood. ANT is not a theory of actors *and* networks, but a way to describe actors *as* networks and vice versa. The hyphen should be taken as an equal sign, not as a plus. There is no such thing as an actor severed from the alliances that enable it to make a difference. Conversely, there is no such thing as a network separated from the actors that compose it. An actor is a network of associations and a network is an ensemble of entities acting together.

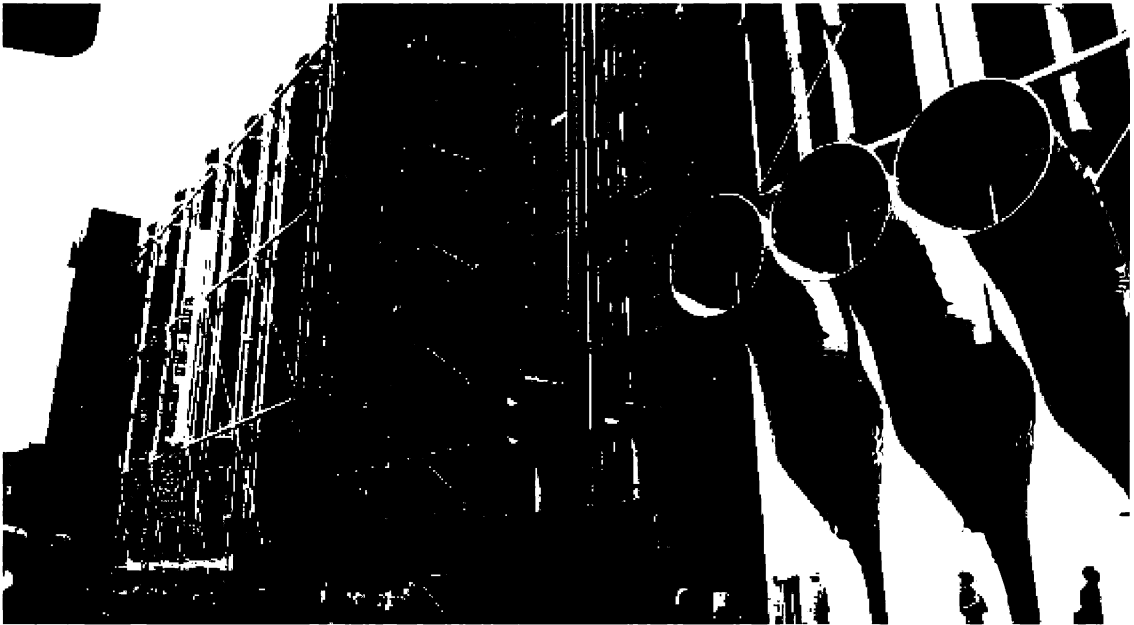


Figure 33 The Centre Pompidou in Paris. Photo courtesy of [tlessl/pixabay.com](https://pixabay.com).

In ANT, then, “actors” and “networks” are just two different ways of looking at action both as a unit and as union. If you have been part of a team, you have experienced this ambiguity: sometimes individual contributions align so well that they disappear and the collective is all that meets the eye; sometimes coordination breaks down and individual efforts stand out again. The same is true for scientific theories and technological objects. As long as your phone works, you have all the reasons to see it as *one* thing. But when it fails you, then you are obliged to consider whether the circuit broke down or just the speaker; whether you renewed your subscription or just lost the signal; where you have left your charger and why on earth you bought such a cheap model. And something similar happens when you discover that the US National Security Agency or some Russian hackers may have been tapping your calls. Your phone, which used to be an actor, has turned into a network.

It follows that ANT is deeply *anti-essentialist* in a manner that sets it apart from conventional social theory in two important ways. The first, which we have already discussed, is the refusal to limit the social to the human. The refusal derives directly from the focus on action (what things do) rather than on essence (what things are). An essentialist sociology may have good reasons to distinguish human from non-human *beings* (e.g., their use of language, reflexivity, free will, and hence greater unpredictability), but a pragmatist sociology cannot mobilize the same reasons to separate human from non-human *actions*. Yes, humans and non-humans are different. Yes, non-humans do not have “intentions” or “will” (just “instincts” or “trajectories”), but their actions are so mixed with those of humans that it would be absurd to leave them out.

The second originality of ANT is its refusal to separate *individual* and *collective* actions (Callon & Law 1997). This divide comes in different flavors and under different names (micro/macro, interaction/structure, agent/system, individual/institution, local/global, even actors/networks), but the basic idea is the same: that phenomena involving few actors in specific situations are fundamentally different from phenomena involving lots of actors and spanning through time and space. Once again, while an essentialist sociology may feel

obliged to distinguish individual from collective beings (to account for the embodiment of individuals, their possession of specific human rights, their capacity to feel emotions and pain, their particular type of mortality, etc.), a pragmatist sociology does not.

Yes, individual and collective actors are different in many ways, but their actions are constantly mixed. Micro- and macro-sociology cannot be separated (not in controversy mapping at least) the way one could separate particle physics from mechanics or molecular biology from physiology. Single atoms cannot affect solid objects and single cells cannot affect entire organisms (though nuclear reactions and metastasis provide remarkable exceptions), but in social life micro and macro entities are always in direct interaction. Think of how difficult it would be to describe yourself without reference to the family in which you were born, the city where you grew up, the schools that you attended, the country in which you live or the organization in which you work. Individuals are defined by the collectives within which they live. And the opposite is also true: if you ever tried to gather a rock band, organize a chess association, or start a knitting circle, you know how important the collaboration of each and every participant is. If the musicians are not in harmony, if the chess players do not show up or play by the same rules, if you don't provide enough yarn, these collective phenomena will just not exist. And too many civil wars and economic crises remind us that the same is true for states and markets as well.

In the next chapter, we will provide some *methodological* reasons for avoiding the micro/macro divide and, in [chapter 9](#), we will explore the divide's unfortunate *political* consequences. To conclude this chapter, however, we would like to discuss two of its *theoretical* drawbacks (see also Venturini et al., 2017).

The problem of reification

The first drawback of the micro/macro divide is that instead of taking microinteractions and macro-structures for what they are – two simplified notations to be mobilized when helpful – it presents them as the two essential levels of social reality. Individuals and collective actions, it is said, are not just different, they are *essentially* different. This idea is clearly present in one of the founding books of sociology, *Les Formes Élémentaires de La Vie Religieuse* by Émile Durkheim (1912):

The collective self is not a simple epiphenomenon of its morphologic base, precisely as the individual self is not a simple efflorescence of the nervous system. For the collective self to appear, a *sui generis* synthesis of individual self has to be produced. This synthesis creates a world of feelings, ideas, images that, once come to life, follow their own laws. (p. 424)

Durkheim used the notion of *sui generis* social facts to establish the autonomy of sociology from psychology, claiming that the explanation of durable social trends is to be found in other social configurations rather than in the individual choices from which they emerge. In his famous study on suicide (1897), for example, he argued that the stability and distinctiveness of national suicide rates cannot be explained by individual suicidal choices, but needs to be connected to features of national culture. Giving up one's life is clearly an intimate decision (possibly the most individual choice one can imagine), but suicide rates, argues Durkheim, are *essentially* social facts and can only be explained through other social facts.

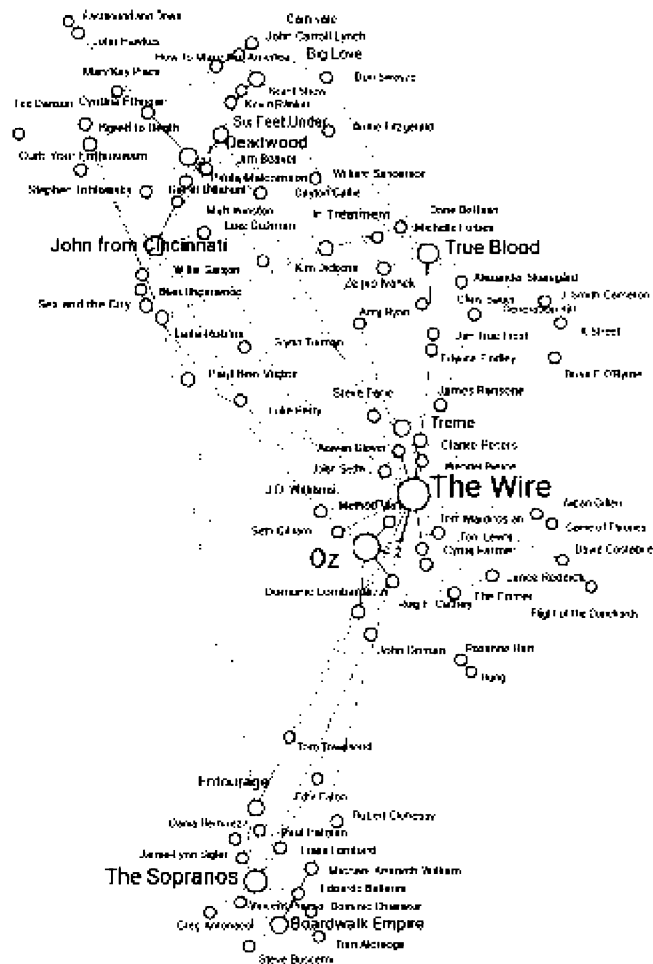


Figure 34b Network of actors cast for HBO series visualized by keeping actors and series on the same level (created by the authors; released by the authors under CC BY-SA 4.0).

The problem of exclusivity

The second drawback of the micro/macro divide is that it is *exclusive*. Local interactions and global structures are presented as if they were the only two dimensions of social existence and no action existed outside them. A classic example is the structuralist distinction between *langue* (the syntactic structures of a language) and *parole* (the actual speech acts uttered by speakers) (Saussure, 1916; Hjelmslev, 1942). Again, while such a distinction can be convenient for practical purposes – allowing linguists to discard exceptions and idiosyncrasies and concentrate on the most stable and diffused forms – it hides other linguistic actions that do not resemble one or the other. Think of the efforts invested by states to impose national languages; the resistance of linguistic minorities; the work done by linguists to purify grammar and by schools to teach it; youth slang and specialized jargon. All these phenomena do not fit in the definition of either *langue* or *parole* (nor in some middle ground between them) and yet constitute the very essence of living languages, as shown by sociolinguistics (Labov, 1972).

Another example comes from the discussion about the evolution of cities. Some urbanists suggest that the form of cities emerges spontaneously from the self-organization of citizens taking ephemeral decisions at the local level (as if citizens did not take into consideration

the global and durable trends of the housing market). Others argue for the importance of the structures imposed by the long-term and large-scale interventions of civic institutions (as if such institutions were not led by policymakers acting under specific political circumstances). This bottom-up/top-down debate seems vain: not only are both mechanisms obviously at work (Barthelemy et al., 2013), but so are countless other actors whose varied and variable influence is neither local nor global (estate agents, district councils, neighborhood associations, chambers of commerce).

Several scholars have proposed ways to make this divide less rigid (e.g., Bourdieu, 1972; Giddens, 1984; Archer, 1995). These approaches, however, maintain the importance of micro and macro and aim at revealing their mutual connections. This is *not* the case for ANT. Considering interactions and structures (actors and networks) as nothing more than convenient simplifications, ANT believes that there is nothing between them.

If you “posterize” a picture, removing most of its colors and merging different shades in larger tonal regions, you will eventually obtain an image of two complementary colors. The result is a binary simplification of the original image. Mind that the argument here is *not* anti-reductionist: reducing is a good thing – loss of details facilitates portability and replication, and a posterized image can be very compelling (as in the example in [figure 36](#)). Yet, no one would sensibly say that the two colors of the posterized version (red and blue in the original artwork in [figure 36](#)) have a special importance or that the other colors fall *between* them. The same is true for micro-interactions and macro-structures. Sometimes they reconstitute a convincing portrayal of social phenomena. Sometimes (as in the case of controversies) they do not. In the latter case, the solution is not to search for the hidden connections between them, but simply to drop the simplification and add more colors.

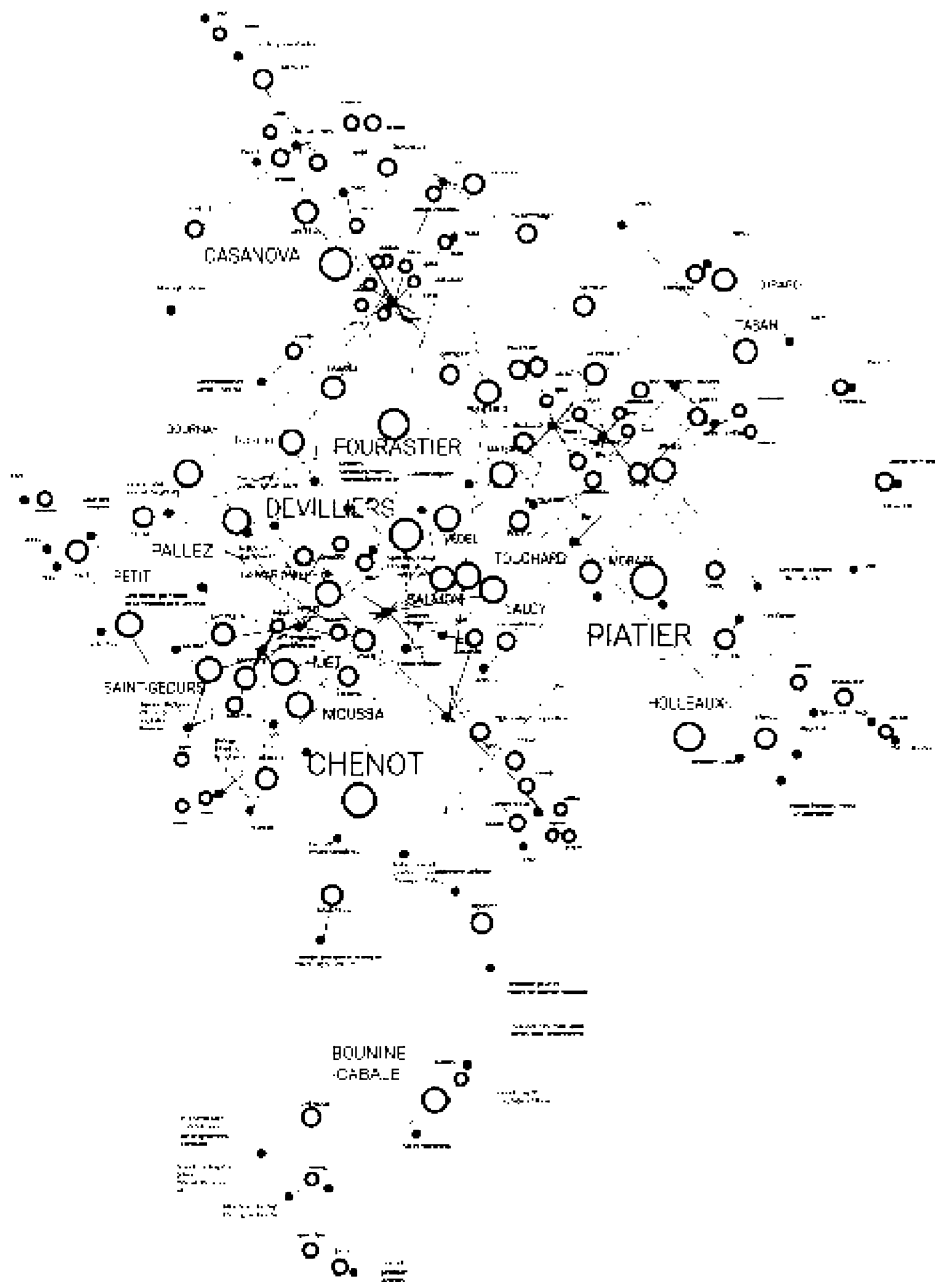


Figure 35b redesign of figure 35a as a network with institutions and individuals connected to each other in the same bipartite graph (created by the authors).



Figure 36 *Hope* by Shepard Fairey (2008) courtesy of Obey Giant (middle), flanked by the original photograph by Associated Press/Shutterstock (left), and an even more posterized two-color version (right, created by the authors).

5

Exploring controversies with digital methods

In this chapter, we learn how digital media can be repurposed for social research and help overcome the divide between quantitative and qualitative methods, but also that their records reflect the peculiar infrastructures and attention economies that produced them.

After having discussed in the previous chapter how the exploration of actor-networks can be operationalized through ethnography and semiotics, we move in this chapter to the main set of cartographic tools employed in controversy mapping: digital methods. Following Richard Rogers (2013a), these methods are defined by their ambition to “repurpose or build on the top of the dominant devices of the medium, and in doing so make derivative works” (p. 3). Digital methods thus abide by the ethnomethodological commitment to study collective phenomena through conceptual and practical tools that are native to a social world increasingly shaped by digital archives, search engines, and social media platforms (Law et al., 2011; Law & Ruppert, 2013). This chapter lays out the advantages and risks of using digital methods for controversy mapping and discusses their connection with ANT and its quest for quali-quantitative methods.

On December 29, 2019, a novel strain of coronavirus was identified in China. An outbreak of an infectious disease similar in symptoms to that of the Severe Acute Respiratory Syndrome (SARS) had been underway in the Hubei region without garnering much international attention. The latter was about to change. By the end of January, the Chinese government was imposing strict lockdown measures on Hubei and its capital Wuhan as intensive care units ran out of capacity. By the end of February, the epidemic had spread to countries like South Korea, Italy, and Iran. On March 11, 2020, the WHO declared a pandemic as Covid-19 cases began soaring in countries around the world leading to a global lockdown and unprecedented quarantine measures.

As schools, shops, and public transport were closing, and as people were being laid off or asked to work from home, epidemiology became a matter of acute public concern. Concepts like herd immunity, infection curves, containment strategies, and social distancing were suddenly on everybody’s lips. When would it end? How bad would it get? What would be the most effective mitigation strategy? Livelihoods were now depending on the answers to these questions. Accordingly, the strategies chosen by different governments, as well as the expert advice underpinning them, became the object of intense public scrutiny. As people around the world began coping with the reality of social distancing, the crisis expanded from a medical and economic emergency to include issues like hoarding, home schooling, or virtual work environments. Taken as a controversy, the Covid-19 pandemic was not just a contestation of expertise in epidemiology and disaster

management, but an ontologically multiple situation in which hitherto unrelated issues became dependent on each other in new and unforeseen ways (Munk, 2020).

While the virus spread across the world, public apprehension circulated through networks that did not involve physical contact or incubation time, but news cycles and cultural proximity. Once the Wuhan crisis had been reported, the pandemic declared, and as the need for hand sanitizer and medical ventilators became acute, publics in other countries began taking note. Mapping where, when, and to what extent the virus and the issues associated with it became matters of public concern would be a prerequisite for any further analysis of the response to Covid-19.

In this piece of social cartography, we had to deal with a situation that, while global in scale, was also subject to significant local variation. Countries had different infection rates and chose different mitigation strategies, based on specific socio-economic circumstances and political traditions. In the previous chapter we discussed how most controversies are distributed in ways that practically limit the use of conventional ethnographic approaches. Covid-19 is clearly no exception here and to map the many local variations of this global debate, we turned to digital methods for help.

With the rise of the search engine in the late 1990s, public concerns became traced in a new way. In 2006, “to google” was admitted as a verb to the *Oxford English Dictionary*, signaling how routine it had become to rely on search engines when looking for information online. Also in 2006, Google launched Google Trends which made it possible to explore search patterns on an aggregate level. Today, this service offers a fairly sophisticated set of methods for such an exploration. It is, for example, possible to focus on search interest from specific geographical areas or at specific points in time. Google also curates so-called “topics” which cover a wide range of synonymous search terms used for the same question in different languages. This offers a quick way to compare search interest in different countries without translating the search terms used.

Figure 37 shows South Korean search interest in the topics “Coronavirus,” “Mask,” and “Vaccine” from December 31, 2019 to March 24, 2020. The trend curves have been overlaid with data from the European Center for Disease Control (ECDC) on daily South Korean Covid-19 cases and deaths. Google users in South Korea, it seems, become interested in both the virus and some of the relevant protective measures more than a month before the disease started to spread in the country (we found similar patterns for topics like “Respirator,” “Hand sanitizer,” or “Severe Acute Respiratory Syndrome”). Instead, what seems to drive the first major spike in search interest is the situation in China with the beginning of the quarantine in the Hubei region on January 29 and the number of reported Chinese cases exceeding 10,000 on February 5.

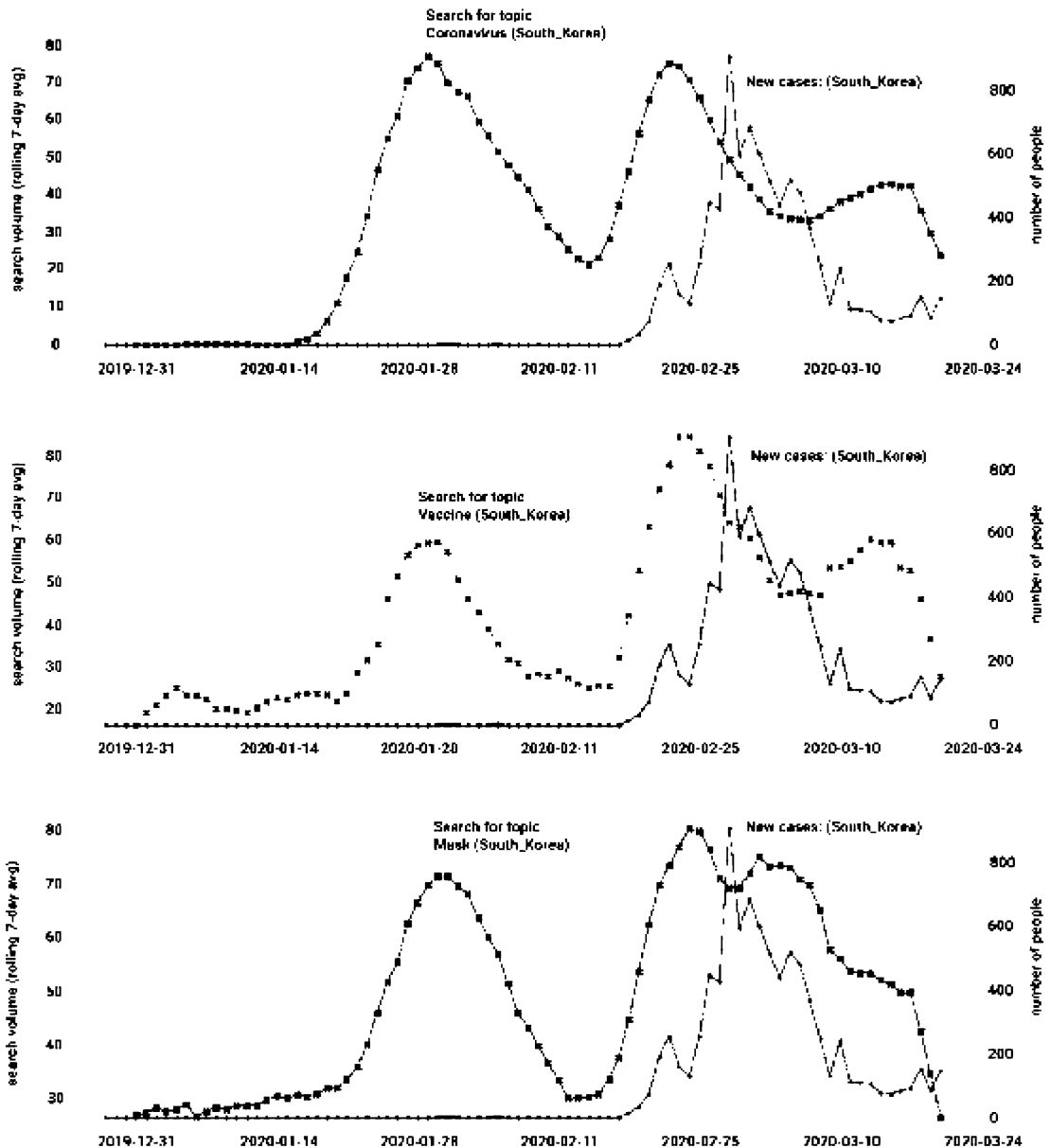


Figure 37 South Korean search interest in the topics “Coronavirus,” “Mask,” and “Vaccines” (data source: Google Trends, <https://www.google.com/trends>) overlaid with new South Korean cases of Covid-19 and new South Korean deaths day by day between December 2019 and March 2020 (data source: ECDC). Search interest is represented as a 7-day rolling average (Munk, 2020).

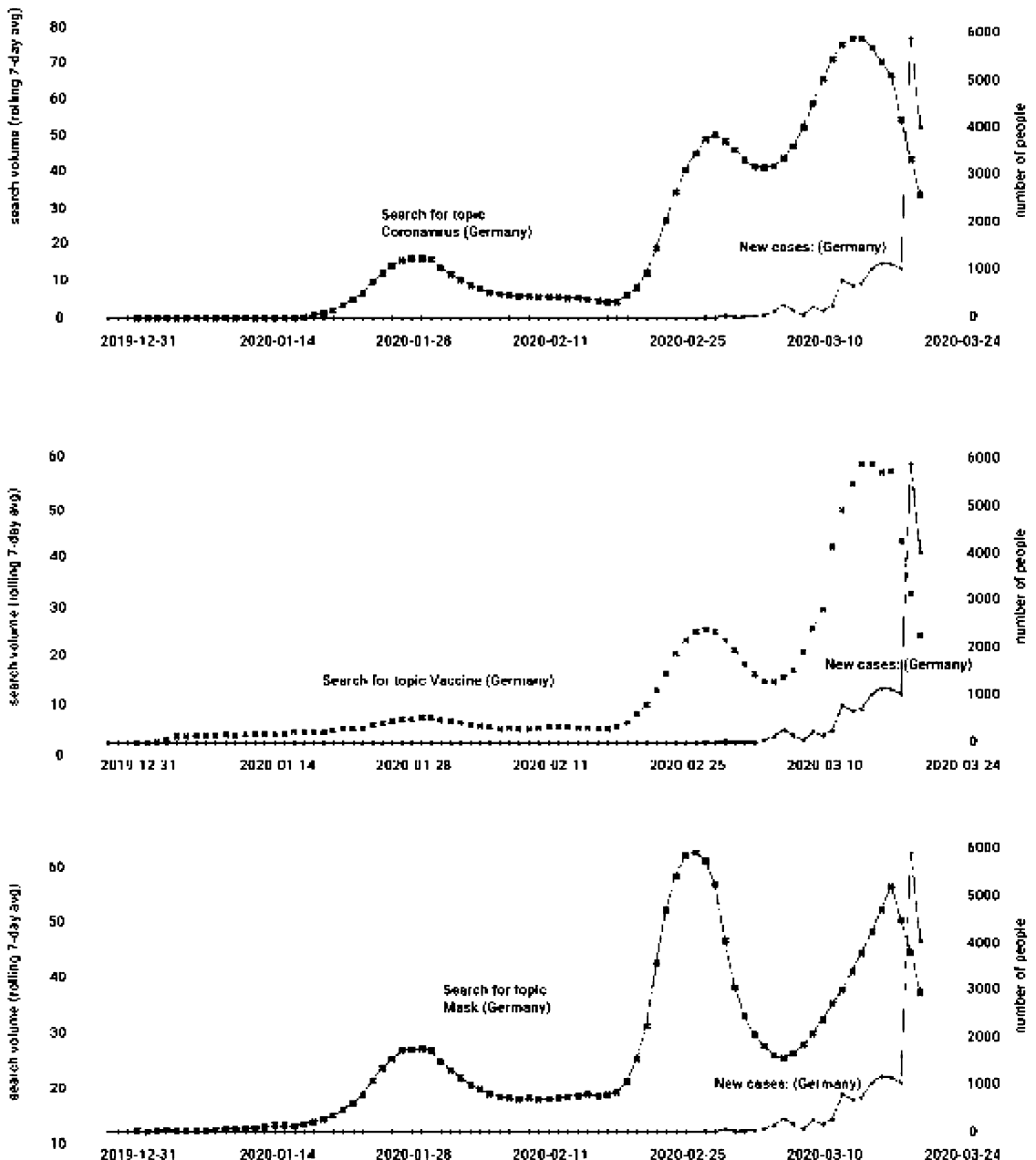


Figure 38 German search interest in the topics “Coronavirus,” “Mask,” and “Vaccines” (data source: Google Trends, <https://www.google.com/trends>) overlaid with new German cases of Covid-19 and new German deaths day by day between December 2019 and March 2020 (data source: ECDC). Search interest is represented as a 7-day rolling average (Munk, 2020).

We found similar patterns for these topics in countries across Asia, indicating that public interest does indeed travel faster than the virus. Public interest, however, has its limits, as we discovered when exploring search dynamics in Europe. **Figure 38** shows German searches for the same topics in the same period (this time overlaid with ECDC data for German Covid-19 cases). A spike in search interest is visible during the Wuhan outbreak in late January, at least for masks and coronavirus, but it is dwarfed by the spikes that happen first in late February and then again in the middle of March. Again, the late February spike

cannot be explained by a rise in domestic Covid-19 cases (the first cases being reported in early March). Instead, the cause could be the outbreak in Iran and Northern Italy, the first major clusters outside Asia.

We could thus speculate that the mitigation of Covid-19 became a matter of public concern not because of domestic or far-away outbreaks (however severe), but because of the situation in countries that are geographically close or culturally similar. This seems to be the case also for some related topics like “Respirator” or “Hand sanitizer” across Asian and European countries. Yet, it is only half the story.

Other issues became hardwired into the epidemic crisis not at distance, but through the implementation of local social mitigation measures, such as home schooling, hoarding, or long-distance work. [Figure 39](#) shows German searches for a video conferencing app (Zoom), toilet paper, and lockdowns. None of them show any sign of increase prior to Covid-19 infections becoming a domestic problem. The same is true for other video conferencing applications and in general across Asian and European countries. Some questions, it seems, only become issues when they pose a practical and immediate problem to everyday life, whereas others can become controversial at a distance.

While this remains an educated guess based on patterns of correlation, Google Trends allows us to dig deeper and explore related queries and topics which have been searched by the same users in the same period of time. We can thus identify a spike in search interest, isolate it, and ask Google Trends to tell us what the same users were also searching for in the same period. This is what we see in [figure 40](#) where we explore the first peak in German search interest for coronavirus between February 19 and 25.

On the bottom right, we see the related searches rising in this time period. They clearly substantiate the idea that the first spike in German search interest was driven by events in Northern Italy. Users who have searched for “coronavirus” have also searched for “Italia,” “Italien,” and “Südtirol” (which is the Italian region closest to Germany). If we look at the related topics on the bottom left, which is Google’s attempt to aggregate the actual search queries into topics, it becomes even clearer that Lombardy and Milan (its capital) played a key role in how coronavirus became a matter of concern for Google users in Germany.

The quest for quali-quantitative methods

Studying situated phenomena means investigating interactions in the context in which they occur and are experienced by their participants, typically with the kind of ethnographic techniques described in the previous chapter. Direct observation preserves the richness of the situation, but at the cost of dissociating it from events that have happened or will happen at other points in time and space. For example, when ethnographers observe a team of scientists at their workstations, they deliberately disregard the vast external network that supplies the laboratory with the technical, human, and financial resources that it needs to function. A classic way to extend the scope of social research has been found in aggregation, that is in approaches that focus on specific observables (e.g., not individuals in their full complexity, but their age or income class) and track them to reveal general patterns and regularities. For example, when bibliometricians measure academic production, they focus on number of publications, citations and impact factors, deliberately disregarding all other dimensions of academic success.

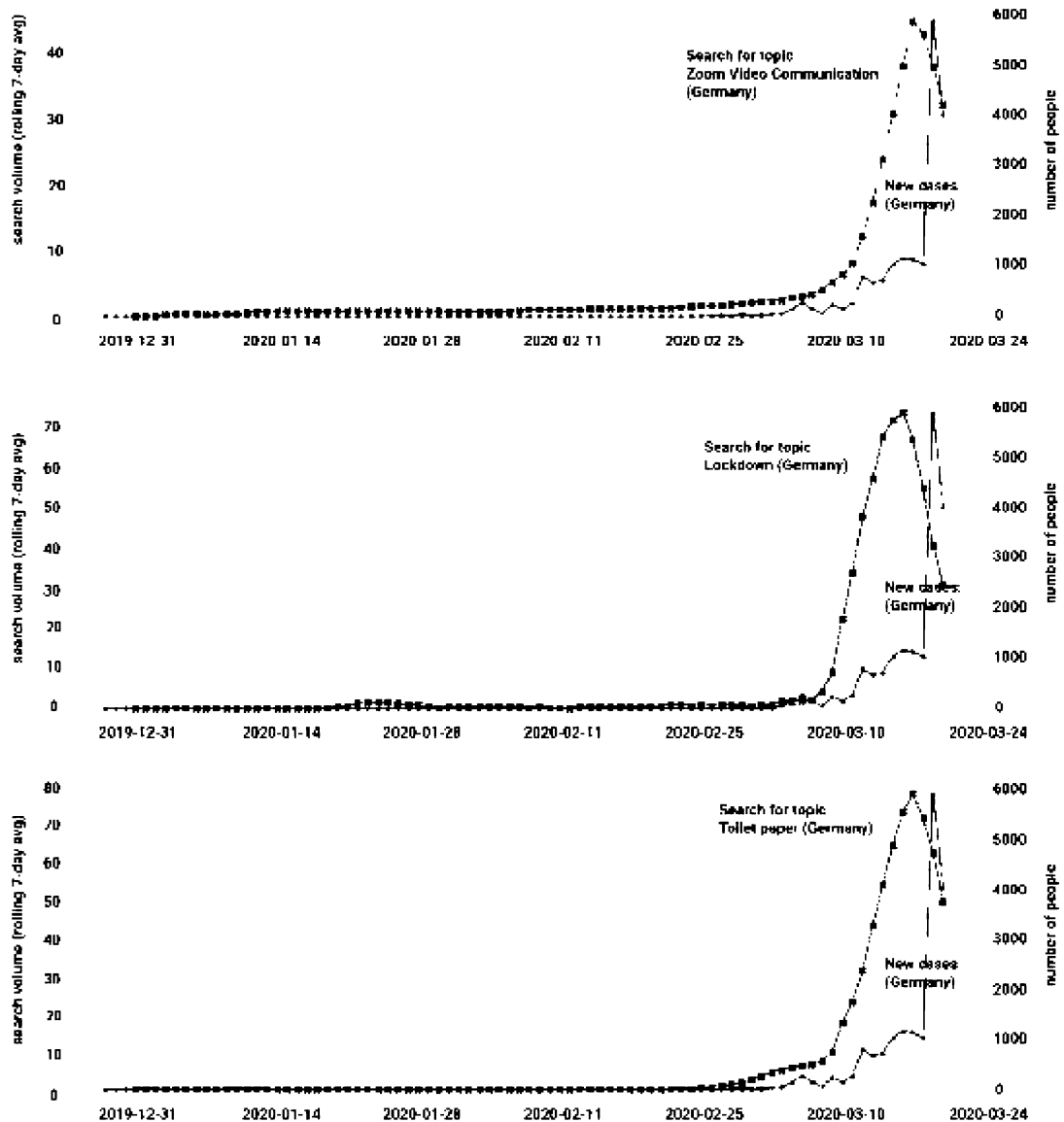


Figure 39 German search interest in the topics “Zoom Video Communications,” “Toilet Paper,” and “Lockdown” (data source: Google Trends, <https://www.google.com/trends>) overlaid with new German cases of Covid-19 and new German deaths day by day between December 2019 and March 2020 (data source: ECDC). Search interest is represented as a 7-day rolling average (Munk, 2020).

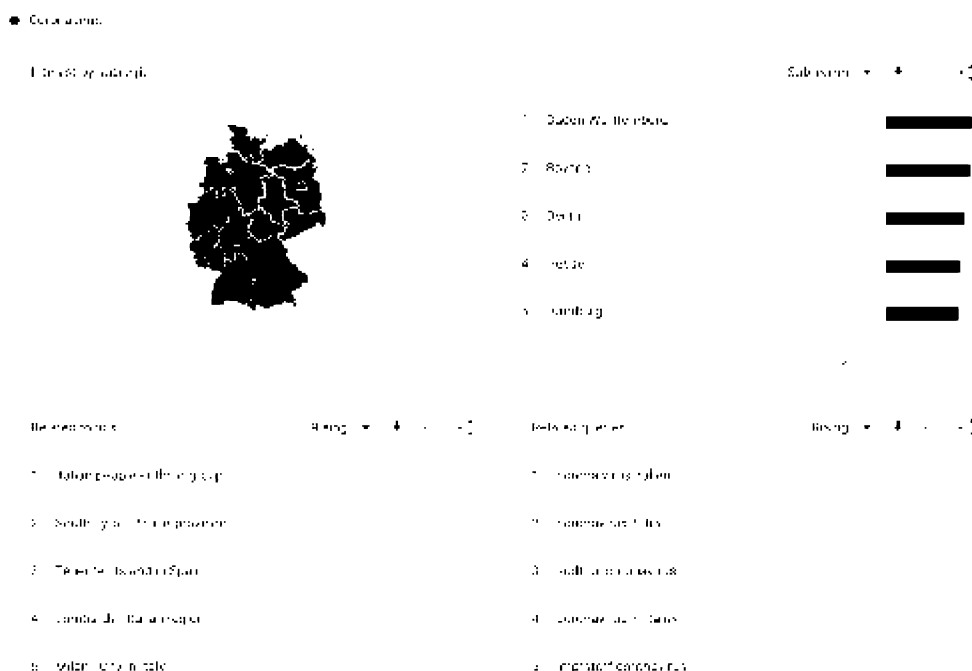


Figure 40 Search topics related to the topic “Coronavirus” in Germany between February 19 and 25, 2020 (data source: screenshot from Google Trends, <https://www.google.com/trends>).

The theoretical partition between micro and macro phenomena, discussed at the end of the previous chapter, is thus matched by a methodological partition between situated and aggregative research – a separation often referred to as the “quali/quantitative divide.” This divide is so deep-seated that a scientometrics study by Traag and Franssen (2016) revealed that it has become the most prevalent discursive distinction in the social sciences. By extracting the noun phrases appearing in the 14,613 articles published between 2010 and 2015 in the journals categorized under “Sociology” by the Web of Science and plotting their co-occurrence, the authors obtained a network displaying a clear separation between a literature centered on “practices,” “case studies,” “discourses,” and “meaning” and another privileging “data,” “surveys,” “rates,” and “associations” (see figure 41).

In their respective spheres (namely local situations and society-level trends), both qualitative and quantitative methods are perfectly productive. They allow researchers to engage in depth with specific interactions without getting lost in the tangle of influences surrounding them; and to “look at the big picture” without bothering about single brushstrokes. Yet, convenient and established as it may be, the quali/quantitative divide only works as long as local situations are effectively shielded from the larger network of influences (such as when scientific activities are protected by the material and institutional walls of the laboratory) and when global structures are underpinned by a potent aggregation apparatus (such as when states guarantee electoral statistics).

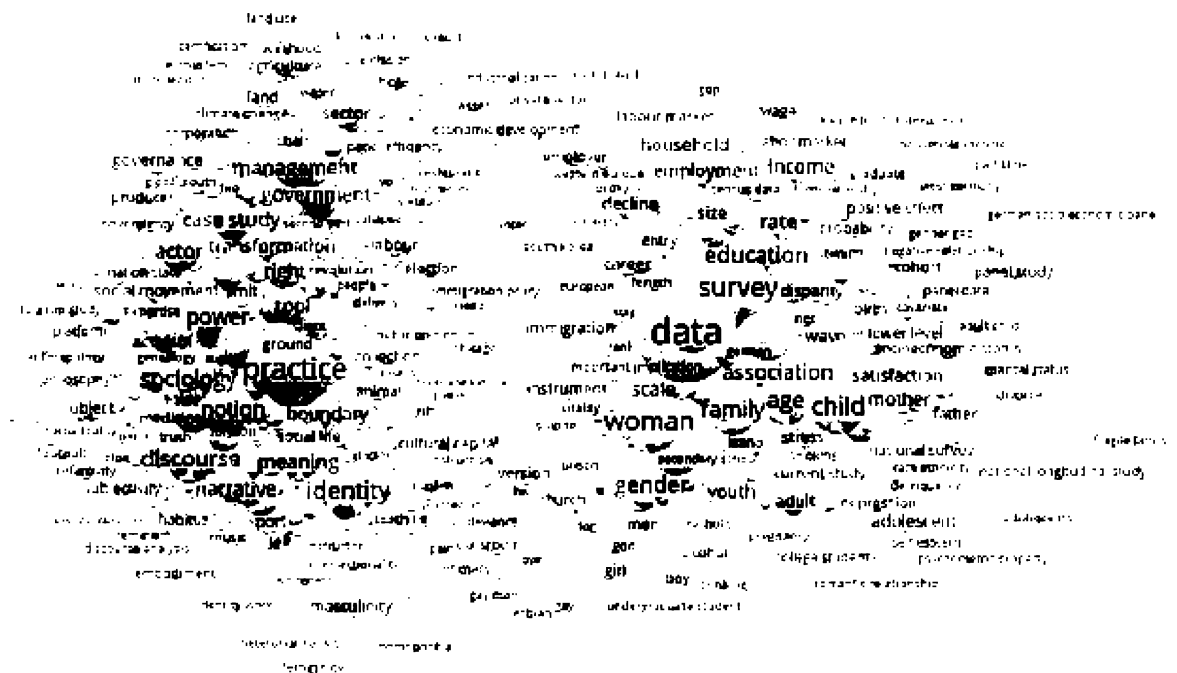


Figure 41 The divide between qualitative and quantitative methods as revealed by a visual network analysis of noun phrases co-occurring in sociological articles (Traag & Franssen, 2016). Qualitative methods on the left, quantitative methods on the right.

Controversies, alas, are precisely the moments when the separation between global and local phenomena is called most brutally into question. In controversies, nothing resembles a situated interaction because actors are constantly invoking or complaining about the external influences interfering with their local action; and nothing resembles a collective structure because no aggregation holds in the shifting game of alliances and oppositions. Where disputes rage, where actors cannot come to agreement, where social ties come undone or where change unfolds so quickly that old institutions dissolve before new ones are created, quantitative and qualitative methods reach their limits. Qualitative researchers will often observe that the actors in sociotechnical debates are desperate to be counted (or to be counted differently, Gray et al., 2016). Parents of children suffering a rare neurological disorder will fight to have their diagnoses construed as cases of a larger disease to which more funding is allocated. Proponents of vaccines will arrange it so that the side effects of the immunization are compared with the effects of the targeted disease, rather than being judged on their own. There is no way of simplifying a controversy by situation without ignoring how adversarial actions are entangled in aggregation practices of all sorts. Conversely, quantitative researchers will discover that their approach is frustrated by disagreements about which attributes are important and which are not. In a dispute over a wind farm, for example, focusing on real estate effects implies discounting other concerns for which figures may not be as readily available, such as the consequences on biodiversity. In controversies, quantification is problematic because existing datasets are themselves contested.

Controversies thus resist many of the strategies commonly used to deal with social complexity. They overflow both situation and aggregation and compel scholars to search for new research techniques. By an unfortunate choice of terms, such techniques have come to be called *quali-quantitative methods* (Venturini, 2012; Blok & Pedersen, 2014;

Munk, 2019). The name is misleading as it could be confused with “mixed methods” that combine qualitative and quantitative techniques (Johnson & Onwuegbuzie, 2004; Small, 2011). This is not the purpose of quali-quantitative methods, which are not meant to alternate between situation and aggregation, but to work out new ways of investigating action networks other than by these two classic strategies (Munk, 2019).

Lessons from scientometrics

Already in the 1980s, the founders of ANT were beginning to search for new quali-quantitative techniques that would make it possible to translate the inseparability of actor-networks into an actionable methodology. They did so initially by turning to the field of scientometrics.

Since the Scientific Revolution, academics have invested remarkable resources in the inscription of their work, for example through the standardization of authorship and institutional affiliations, the formalization of citations, keywords, and abstracts, etc. (Leydesdorff, 1998). And since the work of Eugene Garfield and the Institute for Scientific Information he founded in 1960 (Garfield, 1979; Cawkell & Garfield, 2001), such records have been conveniently collected and distributed as research data. Actor-network theorists could therefore begin experimenting with a vast array of scientometric data and techniques to follow scientific controversies (Callon et al., 1983). A first batch of these experiments is contained in the book *Mapping the Dynamics of Science and Technology* (Callon et al., 1986), which in many ways marks the birth of controversy mapping and its idea that sociotechnical debates could be studied through the inscriptions left by their protagonists:

Although we do not want to reduce scientific and technological activity to the transmission of literary inscription, we nonetheless consider inscription to be a central feature of sciences and technology. Scientists themselves attach particular importance to texts, treating them both as a goal (the publication of a scientific article) and as a means (a way to build a world and persuade others). Since they are also relatively explicit (for they have to stand on their own beyond the laboratory walls) our argument is therefore that though sciences cannot be reduced to texts, these nevertheless constitute a primary source of data for any study of the way in which worlds are created and transformed in the laboratory. *Instead of following the actors we may therefore follow the texts.* (p. 11, emphasis added)

Unfortunately, relying on a narrow definition of what counts as an author, a contribution, and a citation, scientometrics is constrained to the formal scientific literature. To extend their reach, ANT scholars therefore moved from scientometrics to text analysis (Callon et al., 1991; Teil & Latour, 1995; see also Demazière et al., 2006) and contributed to the development of several pieces of software (Leximappe, Candide, Calliope, Réseau-Lu, Prospéro) to analyze technical reports and press articles (Chateauraynaud, 2011a).

The breakthrough, however, came with the advent of the World Wide Web and the new landscape of opportunities it opened for the study of public debate. Here in the words of Bruno Latour:

Owen Gingerich, the great historian of astronomy, spent a lifetime retrieving all the annotations of all the copies of Copernicus's first edition. He could thus give a precise meaning to the rather empty notion of "Copernican revolution" and could show which parts of the book everyone had read and misinterpreted. Nowadays, any scientist can do the same for each portion of each article he or she has published so long as the local library has bought a good package of digital data banks ... But what is more extraordinary is that any journalist can do so as well for the latest Madonna video or the dirtiest rumour about Prince Harry's love affairs. In other words, the former distinction between the circulation of facts and the dissemination of opinions has been erased in such a way that they are both graduating to the same type of visibility – not a small advantage if we wish to disentangle the mixture of facts and opinions that has become our usual diet of information. (Latour, 2007)

The hypertextual organization of the Web meant that the techniques devised for the study of scientific citations could be applied to an increasingly large variety of texts and, as a consequence, that the quali-quantitative approach developed in scientometrics could be extended to the study of many more social situations. The idea of studying social phenomena through the records produced by digital media, however, has required *a double intellectual flip*: one to distinguish digital methods from virtual research and another to distinguish digital methods from big data and computational social science.

Digital methods beyond virtual research and computational social science

The *first flip* of digital methods consisted in treating digital media not just as objects of study but as a means of investigation. When the Web first saw the light of day, the reflex of the social sciences was to treat it as a new terrain for old methods. Notions such as "cyber-culture" (Negroponte, 1995), "virtual communities" (Rheingold, 1993), "online identities" (Turkle, 1995), and many others were introduced to conceptualize the new field within the established traditions of social research: to treat "the virtual" as a separate continent with its own geography and indigenous peoples. Surprisingly for a medium that was said to make barriers in time and space obsolete, the advent of cyberspace actually revived the conflation of place and culture long abandoned by social research (Gupta & Ferguson, 1992; Olwig & Hastrup, 1997). For a while, cyberspace seemed as exotic as the Pacific or the Amazon had once been (Munk, 2013).

The notion of cyberspace, however, was quickly overtaken by the speed at which digital technologies infiltrated everyday life. Electronic media became so pervasive that they could no longer be conceived as a separate domain (Rogers, 2009). Digital media clearly offered more than another field of application for old social theories: they offered a possibility for renewing social research methods.

The more electronic media plays a role in supporting our actions, the more our interactions become traceable (Lazer et al., 2009; Mitchell, 2009b; Giles, 2012) and these new traces have not only fed into the old methods of social research (in the way, for example, online surveys replace paper questionnaires) but also prompted the emergence of a novel generation of *natively digital methods* (Rogers, 2004, 2013a). The first encounter between ANT and these methods took place in 1998, during the first conference of the research program *Virtual Society?* (Woolgar, 2002). In his keynote, Bruno Latour (1998) suggested

that digital mediation might provide the inscription of collective actions that ANT had been looking for:

Once you can get information as bores, bytes, modem, sockets, cables and so on, you have actually a more material way of looking at what happens in Society. Virtual Society thus, is not a thing of the future, it's the materialisation, the traceability of Society. It renders visible because of the obsessive necessity of materialising information into cables, into data.

Yet, the *second flip* of digital methods consists in recognizing that digital records hold great promise, but also also great challenges for social research (Savage & Burrows, 2007, talk of a “coming crisis of empirical sociology”). It is tempting to think of digital traceability as a vast carbon paper, offering the social sciences more data than they had ever dreamt of. Yet, the carbon paper metaphor is misleading, for it portrays mediation as a neutral operation – as if the media could transport interactions without transforming them, as if inscription devices did not favor some types of actions and discourage others. Digital and social media have transformed our interactions not just recorded them.

Unlike the traces produced by a telescope or a microscope, digital records are (in general) not created *by* or *for* the academic community. Although the Internet and the Web were both invented by researchers, the digital media of today belong to the companies and institutions that have paid the huge costs necessary to set up their infrastructures (Frischmann, 2001). This is true at every level of digital networks: from the submarine cables (Boullier, 2013), to the social platforms allowing anyone to push and pull information from the Web (Helmond, 2015). Media are not ecosystems (Fuller, 2005) evolving spontaneously out of “chance and necessity” (Monod, 1970), but artificial “landscapes” (Rogers, 1999; Rogers & Marres, 2000) carefully cultivated by the actors that participate in their construction.

This is why *more digital records* does not translate directly into *more research data*. Digital records only become research data through a complicated process of extraction and refinement. Much of this work is hidden because it takes place somewhere in the infrastructures of surveillance, business, or administration, where digital inscriptions are made (Bowker et al., 2009). This does not mean that we should renounce exploiting these inscriptions in social research, but it means that they should always be used with caution and never without enquiry into the conditions of their production (Marres, 2012; Marres & Gerlitz, 2016). When issues spike on Twitter, we should ask to what extent their visibility is inflated by the platform's trending and recommendation algorithms, or by the action of bots and click farms. When Wikileaks releases thousands of diplomatic cables, we should ponder the moral implications of their use (Benkler, 2011). If Wikipedia opens an application programming interface (API) to download the edit history of all its pages, we should consider how these records are influenced by the bureaucratic management of the encyclopedia (Viegas et al., 2007; Niederer & Van Dijck, 2010). To be exploited as proxies of collective life, digital records need to be repurposed for our research interests and such repurposing work requires significant effort (Rogers, 2013a). The second flip performed by digital methods is in some respects a backflip. It requires us to step away from the big data hype to recognize that digital data (or digital *capta* as in Drucker, 2011) are never given and always doubly constructed: firstly, by the actors (web platforms, computer protocols, silicon companies, users, etc.) that inscribed them originally and, secondly, by the scholars that curate them for research purposes.

According to Dominique Boullier (2015, 2017), this double construction inaugurates the “third generation” of social sciences and the emergence of a new coalition of material inscriptions, research techniques, and interested social actors (see [figure 42](#)).

	1st generation	2nd generation	3rd generation
Concept of the social	Society/(ies)	Opinion(s)	Vibration(s)
Collection device	Censuses	Surveys/polls	Traces
Validation principle	Exhaustiveness	Representativeness	Traceability
Main players	States	Mass media	Brands
Operational actors	National institutes	Polling organisations	Web platforms
Founding authors	Durkheim	Gallup, Lazarsfeld	Callon, Latour, Law
Semiotic formats	Crosstabs and geo-maps	Statistical charts	Networks and timelines
Technical criteria for data quality	Relevance, accuracy, comparability, coherence	Confidence intervals Probabilities	Volume, Variety and Velocity (Big Data)
Social Science's, dominant modality	Explanation	Correlation	Prediction

Figure 42 The three generations of social sciences (adapted from Boullier, 2015, 2017).

The point of Boullier’s triadic model is to highlight that social research is always carried out hand in hand with the dominant sociotechnical infrastructures. Putting the founders of ANT in the same column as brands and web platforms reminds us that no matter how hard we may try to distance ourselves from these actors and their interests, the very fact that we exploit the same digital records forces us into some sort of business with them. Herein lies another form of complicity that controversy mapping cannot escape.

Still, with all their biases and more or less welcome companions, digital records still create a possibility for new ways of conceptualizing collective life that dispense with the conventional oppositions between qualitative and quantitative, situation and aggregation, micro and macro, individual and society, interaction and structure. The characteristic experience of digital environments is that of a flow of heterogeneous entities, which coalesce and dissolve without creating binary distinctions:

The best proof that those two levels do not correspond to any real ontological domains is that they begin to disappear, to be literally redistributed, every time one modifies or enhances the quality of access to the datasets, thereby allowing the observer to define any actor by its network and vice versa. (Latour et al., 2012)

Surfing from website to website, we encounter no barriers separating individual from collective, micro from macro. We just move following the fabric of the digital hypertext, which is denser in some directions and sparser in others, but never torn or discontinuous. This experience is even more forceful on social media, where persons and institutions, groups and products are all embodied in the same type of pages within the same interfaces. Some pages are longer, others are shorter, some have lots of connections, others have few, but they all look and feel the same. Social media can be investigated as networks of friendships, as networks of users, as networks of shared concerns, etc., without ever changing datasets or social dimensions.

Digital technologies provide us with inscriptions whose granularity, dispersion, and rhythm are often unprecedented in social science. The search query logs we discussed in the opening of the chapter, for instance, do not resemble either quantitative or qualitative data, but offer an unconventional combination of time series and linguistic co-occurrence. Similarly, records extracted through websites are characterized by a distinctive blend of multimedia contents and network connections. And social media add various metrics of visibility and engagement to this already singular mixture. The flourishing diversity of records forces but also helps social sciences to experiment with new forms of aggregation and situation, as well as with new research strategies that do not resemble either.

Digital media and the attention economy

As argued in the introduction to this book, the advent of digital media has transformed not only the study of controversies, but also controversies themselves. Media (digital as well as traditional) make a huge difference in public debates, notably by augmenting the number of people who are interested in them, and should therefore be counted among the actors in these debates. According to Noortje Marres (2015, but see also Marres, 2005b, 2007):

The investigation of how digital settings influence the public articulation of contested affairs must then become part of our empirical inquiry. Digital controversy analysts should ask not just substantive questions but also formal ones like how is doing issues through data leaks different from doing issues with press releases? If digital devices play a role in the organization of public controversy, then controversy may be constituted differently depending on what devices and formats are deployed in its enactment. (Marres, 2015, p. 671)

As they are taken up by media, disputes are amplified, altered and diffracted in a multitude of different ways that depend on the particular nature of each mediation they pass through (see Chateauraynaud, 2011b, on the “ballistics” of controversies). In the next pages, we focus in particular on online networks and social media platforms, which constitute some of the dominant fields in which digital methods operate and entail specific methodological and political biases.

On October 17, 2019, Mark Zuckerberg, the CEO of Facebook, gave a speech at Georgetown University. Presenting his platform as a champion of free speech, he argued that “democracy depends on the idea that we hold each others’ right to *express* ourselves and *be heard* above our own desire to always get the outcomes we want” (emphasis added). While compelling, such a slogan is only accurate if *both* “expressing” and “being heard” are considered. Democratic dialogue depends on the conditions of listening as much as on the possibility of speaking, and media effects can be assessed only by considering both ends of the communication process. This, unfortunately, does not seem to be the case

for Facebook and most other social media platforms, whose infrastructures have been instrumental in giving voice to an ever-growing number of actors, but have generally failed in caring about who ended up being heard and how. Symptomatically, Zuckerberg's speech contains more than 100 mentions of "speech," "expression," or "voice," but only seven of "hearing" or "listening."

Such a focus on the liberation of speech and such a neglect of the conditions necessary to listen to each other can be traced back to the early days of the Internet. While the idea of a distributed digital network derived from a need to protect military systems from nuclear attacks by ensuring, through the redundancy in the communications network, that the elimination of a central hub would not cause a communications breakdown (Baran, 1964), most Internet technologies have been developed by circles of fringe engineers inspired by academic meritocracy and American counterculture (Cardon, 2010). In these communities, the decentralized nature of the new telecommunication protocols became strongly associated with egalitarian utopias (Flichy, 2007). The Internet, indeed, offers something that no media has ever offered before, namely "many-to-many" communication. Before its advent, communication could either be bidirectional but limited to few people (as in face-to-face encounters, paper mail, and telephone calls) or open to many people but unidirectional (as in megaphones, books, radio, and television). Digital media made it technically possible for many people to hold bidirectional discussions with many others, which was promptly seized upon by voices as different as former US vice-president Al Gore and the technolibertarian John Perry Barlow:

The Global Information Infrastructure will be a metaphor for democracy itself ... it will in fact promote the functioning of democracy by greatly enhancing the participation of citizens in decision-making. And it will greatly promote the ability of nations to cooperate with each other. I see a new Athenian Age of democracy forged in the fora the Global Information Infrastructure will create. (Al Gore, "Speech to the International Telecom Union," Buenos Aires, 21 March 1994)

We are creating a world where anyone, anywhere may express his or her beliefs, no matter how singular, without fear of being coerced into silence or conformity. (John Perry Barlow, "A Declaration of the Independence of Cyberspace," Davos, 8 February 1996)

These democratic ambitions, however, had to reckon with the fact that, while Internet *protocols* (i.e., the rules allowing computers to communicate with each other; see Galloway, 2004) are indeed relatively egalitarian, Internet *infrastructures* (i.e., the server farms, cables, and satellites that support such a communication) are definitely not. First of all, the access to digital technologies differs widely by regions and social classes, with powerful groups dominating the most advanced technologies (van Dijk, 2006; Fuchs & Horak, 2008). Second, the ownership of Internet infrastructures is highly concentrated (Warf, 2011; Boullier, 2013), which allows states and private companies to disconnect entire countries within a matter of hours (as happened, for example, in Egypt during the so-called "Arab Spring;" Glanz & Markoff, 2011, but see Wagner, 2012, for an opposite case); to control and filter online contents on a massive scale (as in China and Russia; Xu et al., 2011; Soldatov, 2017); or to intercept the communications of virtually any citizen in the world (as the case of the US National Security Agency; cf. Lyon, 2014). Finally, the concentration of infrastructural power has been further aggravated by the rise of social media platforms (Plantin et al., 2018). As remarked by "critical social media" scholars (van Dijk, 2013; Fuchs, 2014), the bulk of the Internet traffic, which used to be dispersed in a

myriad of forums, blogs, and websites is now concentrated in a handful of platforms which impose their own proprietary protocols, claim ownership of user data, and profit from their exploitation (as captured in the notion of “surveillance capitalism”; Zuboff, 2015, 2019; Langley & Leyshon, 2017). This worrisome concentration is the reason why Zuckerberg is so keen to affirm Facebook’s commitment to the freedom of expression: “I understand the concerns about how tech platforms have centralized power, but I actually believe the much bigger story is how much these platforms have decentralized power by putting it directly into people’s hands.”

This particular conception of freedom of expression, however, is not without drawbacks. While it is true that digital media have allowed many more people to express their opinion publicly and therefore reduced the power of broadcast media (Taylor & Harris, 2008; Hardy, 2014) as information gatekeepers (Shoemaker & Vos, 2009) and agenda setters (McCombs, 2004), it is also true that this greater freedom of expression has come at a cost to our capacity to listen to each other.

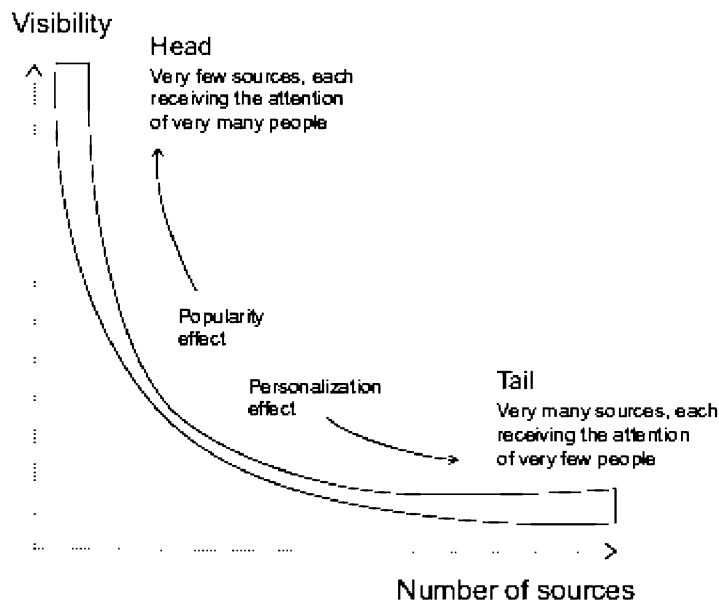


Figure 43 The power-law distribution of online attention and the popularity and personalization effects that skew it (created by the authors; released by the authors under CC BY-SA 4.0).

To appreciate how public attention has been transformed by the advent of digital media, one should start by considering how online visibility is allotted so that a tiny minority of sources captures the vast majority of attention. The discovery of this “power-law distribution” came from the study of the hyperlinks connecting different websites, which scholars use as proxies of online attention, in the absence of direct ways of measuring Internet audiences on a larger scale. Studying visibility through citation practices, scholars noticed that Web links are not allocated according to a “normal distribution” (in which most websites would receive a number of links close to the average), but according to a “power-law distribution” in which a tiny minority accrue the vast majority of links, while most websites receive little or no attention (see [figure 43](#)). This distribution of hyperlinks suggests that while many voices can speak on the Web, few of them are actually heard. Considering each end of this distribution, scholars expressed opposite critiques about online debate.

Scholars who study the “head” of the power-law (the few hundred websites that collect the most online attention) have suggested that public debate may be more concentrated online than in traditional broadcasting media. Considering the distribution of hyperlinks in the early days of the blogosphere, Matthew Hindman (2008, see also Hindman et al., 2003), for instance, concluded that the concentration of the audience for news and political debate was higher in websites and blogs than in newspapers or television. According to him and others, this extreme concentration comes from the “preferential attachment” of digital networks (Barabasi & Albert, 1999), i.e., the fact that online attention is largely driven by popularity in a self-sustaining loop that pushes the most visible websites to become even more dominant (cf. the next chapter).

On the other hand, considering the “tail” of the power-law (the billions of websites that receive only a very limited and often quite specialized attention), scholars have observed that the Web may in fact be a “narrow-cast medium” that increases the fragmentation of public discourse. The idea was first put forward in positive terms by Nicolas Negroponte (1995) with the image of the “Daily Me,” a one-copy newspaper automatically tailored to the interests of each of its unique readers. This idea was then developed into a more critical position by several scholars. Cass Sunstein, for instance, denounced how a “situation in which thousands or perhaps millions or even tens of millions of people are mainly listening to louder echoes of their own voices ... is likely to produce far worse than mere fragmentation” (2001, p. 16). Similarly, Eli Pariser called “filter bubble” the risk that, by reducing the diversity of information available to each Internet user, personalization can work as “centrifugal force, pulling us apart” (2011, p. 10). This idea is still dominant in academic literature and popular lore, although it has been severely challenged by studies showing that social media may actually increase exposure to diverse political content (Bruns, 2017, 2019; Bechmann & Nielbo, 2018).

Despite their contrasting perspectives, these scholars share the idea that the evolution of digital networks has distributed attention even more unevenly. According to these authors, Web communication can only be “few-to-few” or “few-to-many.” Between these two extremes, the forces of popularity and personalization skew the curve of online attention and erode its middle.

The amplification and acceleration of public debate

The considerations above address the topology of digital networks as if it was fixed, and neglect how these media dynamically redistribute attention. If the power-law distribution of online visibility is stable, its composition is definitely not. Although at any given moment few websites concentrate most of the attention, the identity of such websites changes rapidly (think of how, in just a few years, AltaVista or MySpace almost disappeared while Twitter and Instagram climbed to the top of the Web).

Likewise, online fragmentation is countered by the fact that conversations are not just clustered but *fractally* and *dynamically* clustered. If it is true that online discussions can reach levels of extreme specialization, it is also true that more specific topics are embedded in more general ones – so that, for instance, hyperspecialized conversations on fly-fishing are included in larger discussions on fishing, which are in turn part of debates on water quality and, more generally, environmental preservation, sports, and leisure. This conversational embedding facilitates the occasional uprising of content from the periphery to the spotlight of online debates, allowing previously ignored sources to reach substantial,

albeit transient, visibility (Jenkins et al., 2013). These dynamics explain, for instance, how an unknown Swedish teenager, who started a solitary school strike against the climate inaction of her country, ended up addressing the United Nations just three-and-a-half months later. This is not to say that Greta Thunberg reached recognition only thanks to digital networks, but the speed of her ascent owes much to her social media success (Tait, 2019).

Yochai Benkler (2006) describes this type of attention dynamics as a “a filtering and transmission backbone for universal intake and local filtering” (p. 248), “a peer-produced filter and transmission medium for a vastly larger number of speakers than was imaginable in the mass-media model” (p. 255). The dynamics of digital media may make sociotechnical debates more inclusive, allowing marginal viewpoints to be considered and sometimes promoted to the center of the conversation. Such an outcome, however, is not obvious and cannot be left to the *technological laissez-faire* preached by social media companies (Fenton, 2011). As demonstrated by the growth of online misinformation, online attention dynamics are not without downsides. The very same mechanisms that propelled climate activism and other progressive causes (Gerbaudo, 2012, 2017) have, since the very beginning of the Internet, also paved the way for misogynistic, racist, anti-democratic ideologies (Phillips, 2015; Nagle, 2017).

Our point is not that online media can be good or bad depending on who uses them (an argument that, as asserted by Umberto Eco, 1964, can be made for every medium), but that the dynamism of digital networks can be beneficial in reducing the asymmetry of communication, but also toxic in over-revving and thus overheating the engine of public debate. To be sure, the acceleration of attention cycles does not begin with digital media. Already in the 1960s, Marshall McLuhan observed that “the ‘message’ of any medium or technology is the change of scale or pace or pattern that it introduces into human affairs ... amplif[ying] or accelerate[ing] existing processes” (1964, p. 8; see also McLuhan & Fiore, 1967) and several other scholars have described the risks of such acceleration (Downs, 1972; Hilgartner & Bosk, 1988). Yet, in digital media, attention cycles have reached an even more untenable speed (Lorenz-Spreen et al., 2019) because of an unprecedented convergence of (1) economic incentives, (2) algorithmic technologies, and (3) social practices (Venturini, 2019a).

The first factor of acceleration is the development of a full-fledged market for online attention. This market surfaced in the early 2000s, when most Internet actors gave up the hope of selling their services and began seeking their revenues in advertising (Goldhaber, 1997; Lanham, 2006), like earlier electronic media (Smythe, 2006; Turow, 2005). To be commercialized, however, online attention needed to be “marketized” (Çalışkan & Callon, 2009, 2010), which had already proven difficult for radio and television (Bourdon & Méadel, 2014). The solution came with two innovations introduced by Google’s advertising network (Lee, 2011). The first is the repurposing of Google’s search algorithm, PageRank (Rieder, 2012; Cardon, 2013), as a tool for the fine-grained matching of audiences and advertisements. The second is a system of automatic auctions allowing advertising prices to be established with little human intervention (Mehta et al., 2007). This double automation allowed handling micro-transactions that were unprofitable for traditional agencies and to offer to each and every website the possibility of selling its traffic (O’Reilly, 2007). The model really came into its own with the advent of social media platforms and the way in which they have blurred the distinction between advertising and content. In the ensuing “like economy” (Gerlitz & Helmond, 2013),

catching the fleeting attention of users has become more important than cultivating sustained interest, thus making *clickbaiting* strategies omnipresent in online communication (Hamblin, 2014; Carlson, 2015).

The second factor of acceleration is a series of technologies for tracking the behaviors of Internet users and using the resulting data to segment online audiences and charge ad buyers (Hoffman & Novak, 2000). Most websites contain today multiple trackers, often from third-party data-brokers aggregating and reselling this information (Mayer & Mitchell, 2012; Anthes, 2015; Crain, 2018). Likewise, social media advertising platforms are increasingly popular among marketers for their micro-targeting capacities (Trottier, 2011; Barbu, 2014). While the efficacy of this kind of marketing may be overstated (Marotta et al., 2019), tracking is undoubtedly instrumental in generating more marketable attention. YouTube, for instance, measures the time spent watching videos in order to suggest other videos that will extend viewing time (Zhao et al., 2019) and Facebook measures scrolling to build pages that will induce more of it (Lorenz, 2017). To sustain this loop of tracking and engagement, media companies have massively invested in machine learning algorithms (Mackenzie, 2017), whose validation relies crucially on their capacity to produce further media consumption (Cardon, 2015; Ananny & Crawford, 2018; Cardon et al., 2018). Following the example of Twitter's trending algorithm, most of these recommendation technologies are calibrated to identify and push uprising conversations "emphasizing novelty and timeliness ... in terms of identifying unprecedented surges of activity" (Gillespie, 2016, p. 55). The algorithmic reward of trendiness encourages a constant reshuffling of online visibility, but it also facilitates the surge of attention bubbles that rise and fall without really contributing to advancement of public debate, as candidly admitted by YouTube engineers: "in addition to the first-order effect of simply recommending new videos that users want to watch, there is a critical secondary phenomenon of boot-strapping and propagating viral content" (Covington et al., 2016, p. 193).

The last factor of acceleration is the practice of social sharing as encouraged by online networks. One of the strategies used by online platforms to nudge user engagement is to design their interfaces in a way that emphasizes the number of likes, shares, upvotes, reads, etc. These "vanity metrics" (Rogers, 2018) promote a type of microcelebrity (Marwick & boyd, 2011; Hearn & Schoenhoff, 2016) that is ephemeral but not inconsequential. Pushing the idea that individual visibility can be gauged by the same metrics as commercial brands, social platforms encourage users to adopt strategies of "personal branding" (Khamis et al., 2017). Redistributing content with high trending potential, users act to increase their visibility and, at the same time, contribute to the acceleration of online media (Jenkins et al., 2013).

Together, the economic, technical, and social factors discussed above create a media environment whose main risk is neither concentration nor fragmentation, but a pace of discussion which makes issues ephemeral (Hassan, 2011) and engagement superficial (Dencik & Leistert, 2015). Controversies thrive in this hyper-competitive media system where they are extremely effective at capturing public attention thanks to their capacity to ignite high-activation emotions – a capacity that has not been lost on an increasing number of actors who have learned to exploit them as political and commercial attention bait. Keeping this in mind is important when turning to digital methods as tools for the study of sociotechnical debates. Online media make public disagreements more visible but also more ephemeral (Davies, 2020) and more radical (Marwick & Lewis, 2017). Digital

controversy mapping must reckon with this acceleration and amplification because the use of digital methods comes with an implicit prioritization of online platforms versus other arenas of debate and thus with the risk of exacerbating some of their effects (Venturini & Rogers, 2019). This is why extra care and critical reflection is essential when dealing with digital inscriptions of social life. You cannot seriously study anything with the Internet without studying the Internet at the same time.

6

Collecting and curating digital records

In this chapter, we learn the hard craft of compiling datasets from websites, search engines, and document archives.

As shown in [figure 44](#), the workflow of digital methods can be roughly grouped into four main operations (as distinguished, among others, by Flyverbom & Madsen, 2015): (1) collecting digital records; (2) curating them into a corpus of data which fits the purpose of the research; (3) analyzing the corpus; (4) making the research public. Such a sequence is, of course, highly idealized. More than an ordered sequence of operations, the practice of digital research resembles a game of snakes and ladders with constant overlapping and iteration. It is not uncommon to discover at the moment of finalizing a publication that some crucial piece of information is missing and that data collection should begin anew. For the sake of simplicity, however, we will present digital research as an orderly pipeline. In this chapter, we discuss some of the techniques connected to the first two operations, in [chapter 7](#), we will exemplify one technique for analysis of which we are particularly fond, and in [chapter 8](#) we will consider the question of making research public.

The debate on circumcision is a classic and long-lasting controversy. Should it be banned? In which form? And for what reasons? These questions come up regularly in different configurations, as events in different countries put circumcision back on the public agenda. To gain an overview of some of these issues, Wikipedia offers several good starting points, such as the pages about “circumcision,” “circumcision controversies,” and “ethics of circumcision.” A quick browse of these pages makes it clear that we are not dealing with a binary opposition, but with a range of debates within the debate. For example: Does circumcision reduce the risk of HIV/AIDS, HPV and cervical cancer, penile cancer, urinary tract infections, transfer of sexually transmitted diseases like syphilis or chlamydia? Is it a cost-effective way to reduce these risks? What are the pros and cons of different pain management techniques during the procedure? Does it affect the sensitivity of the penis and thus the ability to feel sexual pleasure? Does it affect the parental bond? Can parents make a decision for a child when the procedure is irreversible and not medically necessary? What weight should be given to arguments about religion and social acceptance?

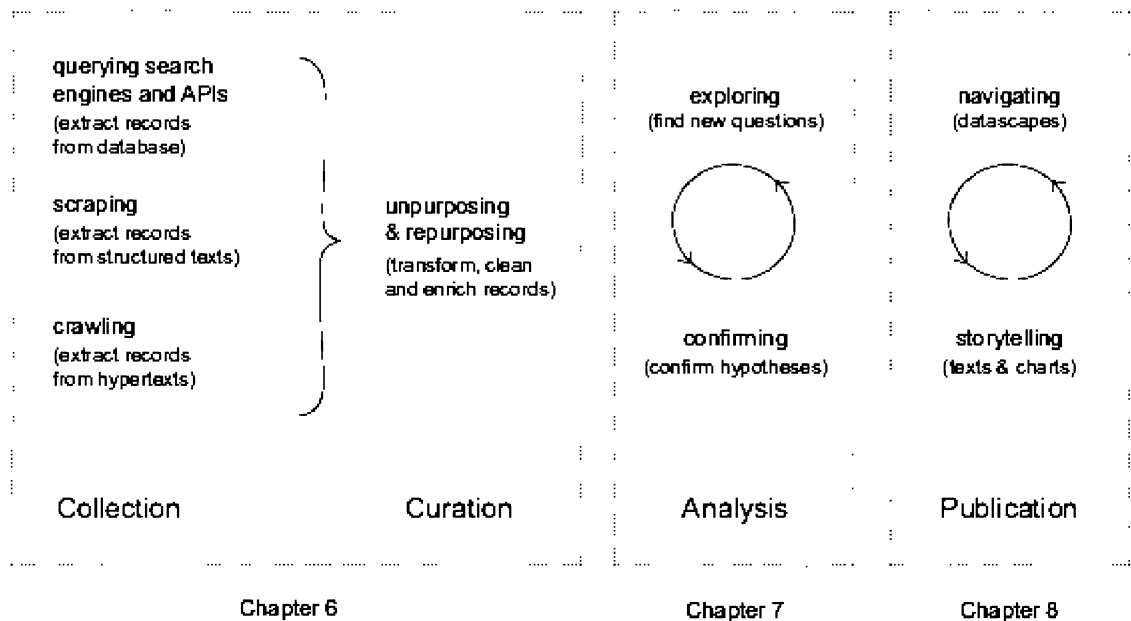


Figure 44 The research chain of digital methods and how it will be covered in the following chapters (created by the authors; released by the authors under CC BY-SA 4.0).

As is common practice in Wikipedia, when one of these subtopics grows to a certain size, editors will typically branch it off and create a dedicated page for it. For a mature topic like circumcision, this means that we have a large number of potentially relevant pages to consider. To discover them, we can use a *crawler*, a tool capable of identifying the hyperlinks starting from an initial set of web pages (commonly called “seeds”) and of following them to find new pages and new hyperlinks (for this example, we used a tool called Seealsology which focuses exclusively on the hyperlinks present in the “see also” section of each page; popular crawlers for controversy mapping include Issuecrawler, developed by the Digital Methods Initiative in Amsterdam, and Hyphe, developed by the médialab of Sciences Po Paris; cf. Girard et al., 2012; Jacomy et al., 2016). To generate the network in [figure 45](#), we used “circumcision controversies” as the seed page and set the crawling distance to 0 to identify the links contained in the seed page.

The crawl yields a number of interesting pages that we would not have found by simply searching for “circumcision” on Wikipedia (such as the ones on “reproductive rights,” “violence against men,” or “foreskin restoration”) and which we could have just as well used as seeds. We can explore them by changing the crawl distance to 3 in order to find all the pages that are three hyperlinks away from the seed page (see [figure 46](#)).

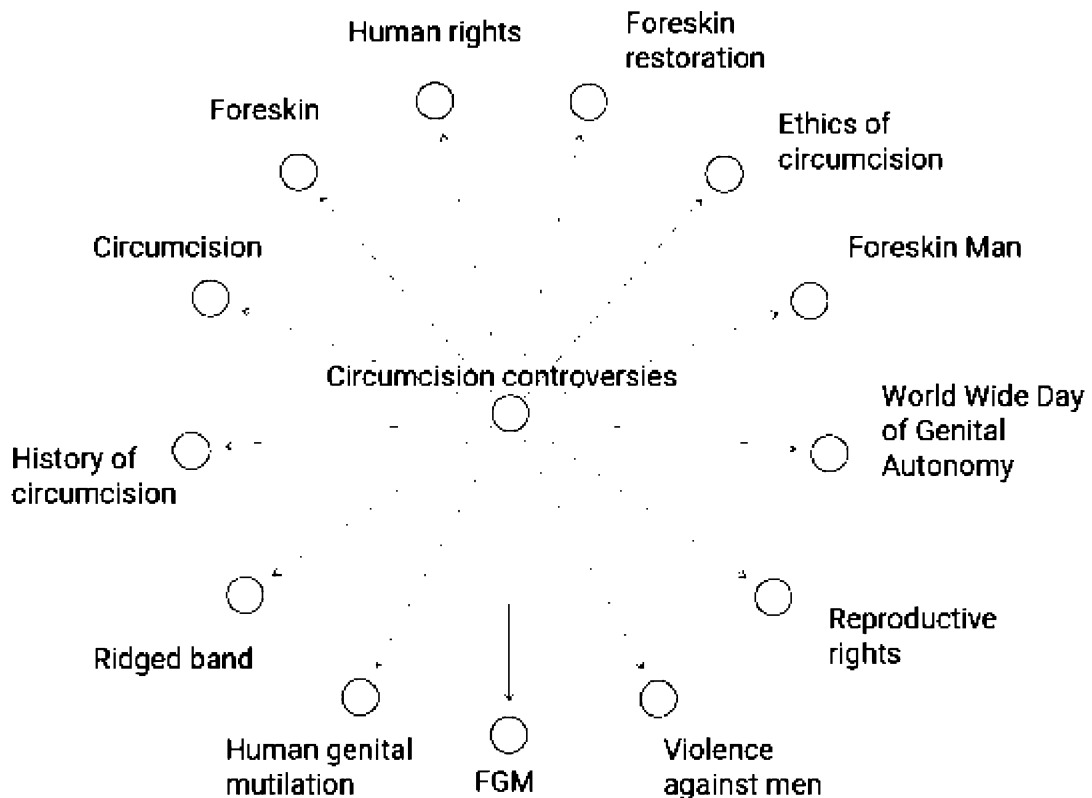


Figure 45 Thirteen pages discovered by crawling the “Circumcision controversies” page on Wikipedia at crawl distance 0 (created by the authors, released by the authors under CC BY-SA 4.0).

Expanding the crawl in this way yields more interesting leads, for example pages on “bodily integrity” (a legal principle from the field of human rights), “bioethics of neonatal circumcision,” “gishiri cutting” (a technique for female circumcision used in western Africa), or “labiaplasty” (a form of cosmetic genital surgery typically sought out voluntarily by women). It also yields pages that are quite unrelated to circumcision, such as the ones on “parental leave” or “human overpopulation.”

What we are not yet able to see, however, are the pages that link *to* these pages without being cited back by any of them. A crawler cannot follow hyperlinks backwards (the so-called backlinks), which means that pages that link to “circumcision controversies” but are not linked back, while potentially very relevant, will remain unseen. To deal with this problem, we have to query Wikipedia’s underlying database through its Application Programming Interface, or API, which offers an “endpoint” for backlinks. Most online platforms have APIs that allow programmers and programs to extract specific types of information defined by the API syntax. In this case, then, we are lucky that the Wikipedia developers have included backlinks in the list of possible requests. Through the backlinks, we discover actors like Douglas Gairdner, the British pediatrician who from the late 1940s onwards began mobilizing public opinion by claiming that a ban on circumcision could save lives, or Genital Autonomy America, an interest organization pursuing the same agenda (see [figure 47](#)).

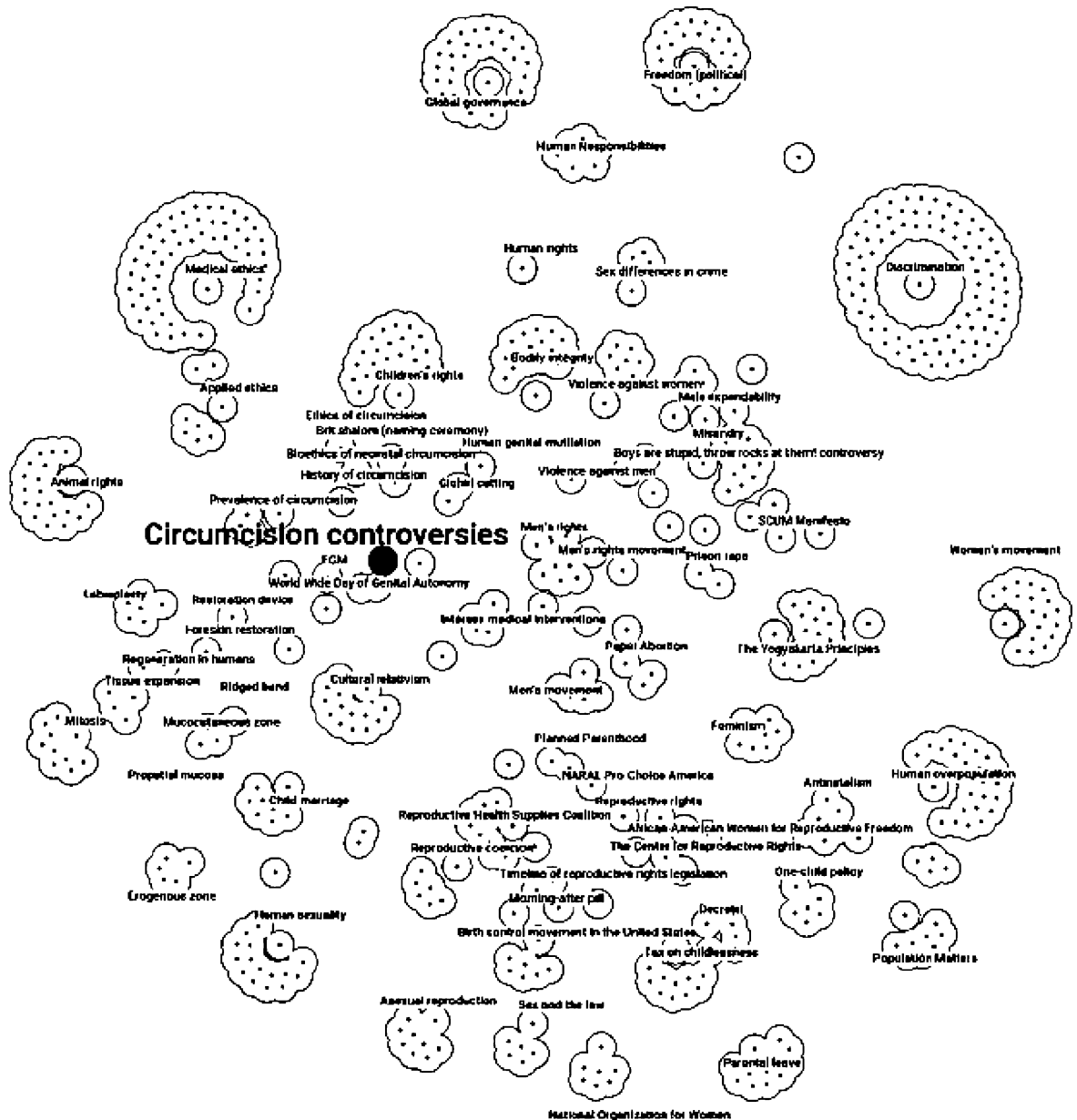


Figure 46 Network obtained by crawling the “Circumcision controversies” page on Wikipedia at crawl distance 3. The seed page is highlighted (solid black) and the pages found 1 and 2 hyperlinks away are labeled. Unlabeled nodes represent pages discovered but not visited by the crawler as they lie beyond the set distance from the seed (created by the authors; released by the authors under CC BY-SA 4.0).

Another option, if we move beyond the SeeAlsology tool, is to identify *all* the links between a set of seed pages, for example the pages in the circumcision category (en.wikipedia.org/wiki/Category:Circumcision). Inside the “Circumcision” category, we find a number of subcategories: “Circumcision debate,” for example, or “Female genital mutilation.” And if we open these categories, more subcategories will appear. These subcategories contain 173 circumcision-related pages in total, and the API allows us to ask for all hyperlinks between them. We show the result in [figure 48](#), where two distinct clusters are clearly visible. These two groups of related pages revolve around male and

female circumcision (a.k.a. female genital mutilation) respectively. Rather than being part of the same issue, the debates about male and female circumcision seem to be associated with different people, different problems, and different events.

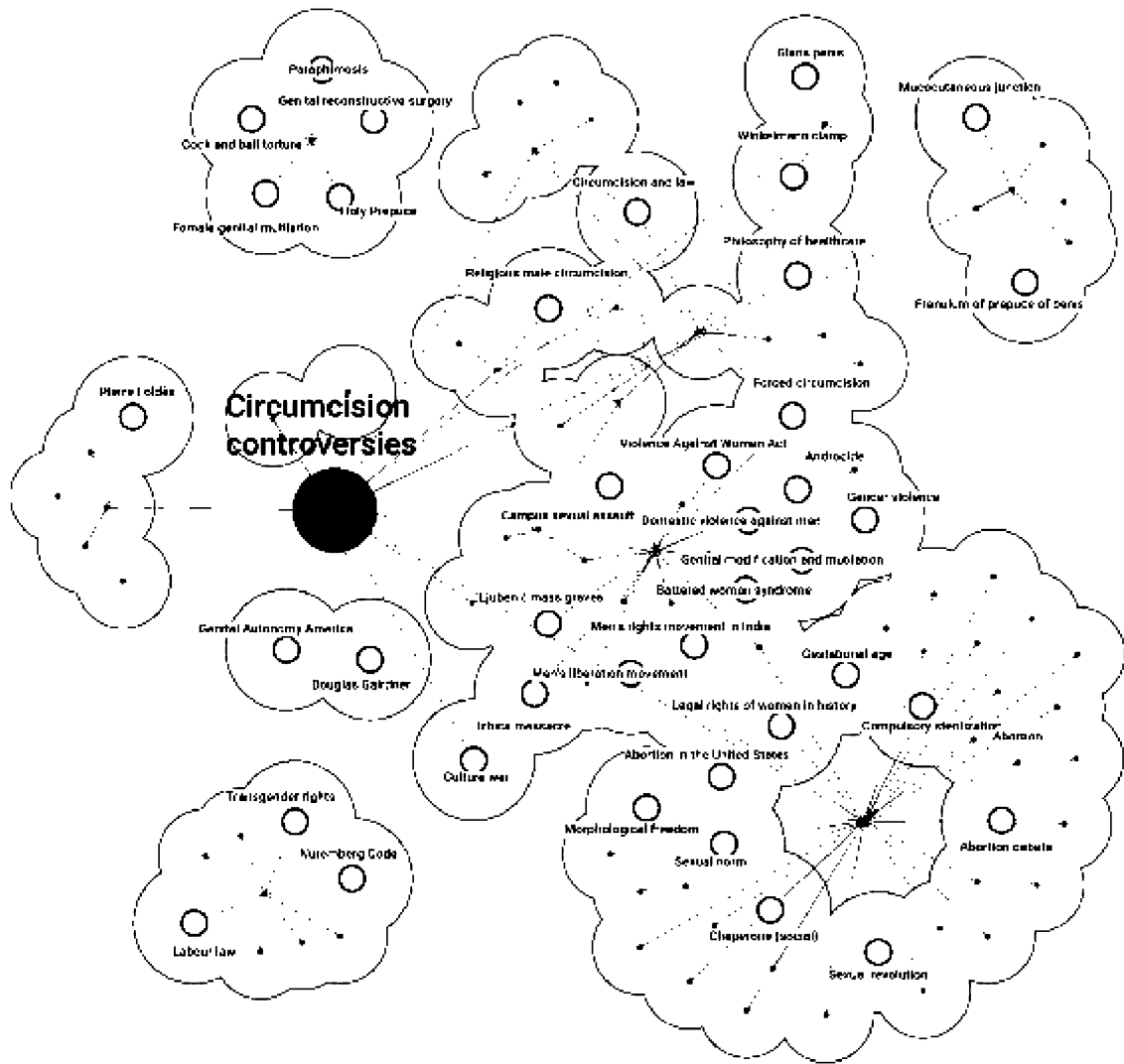
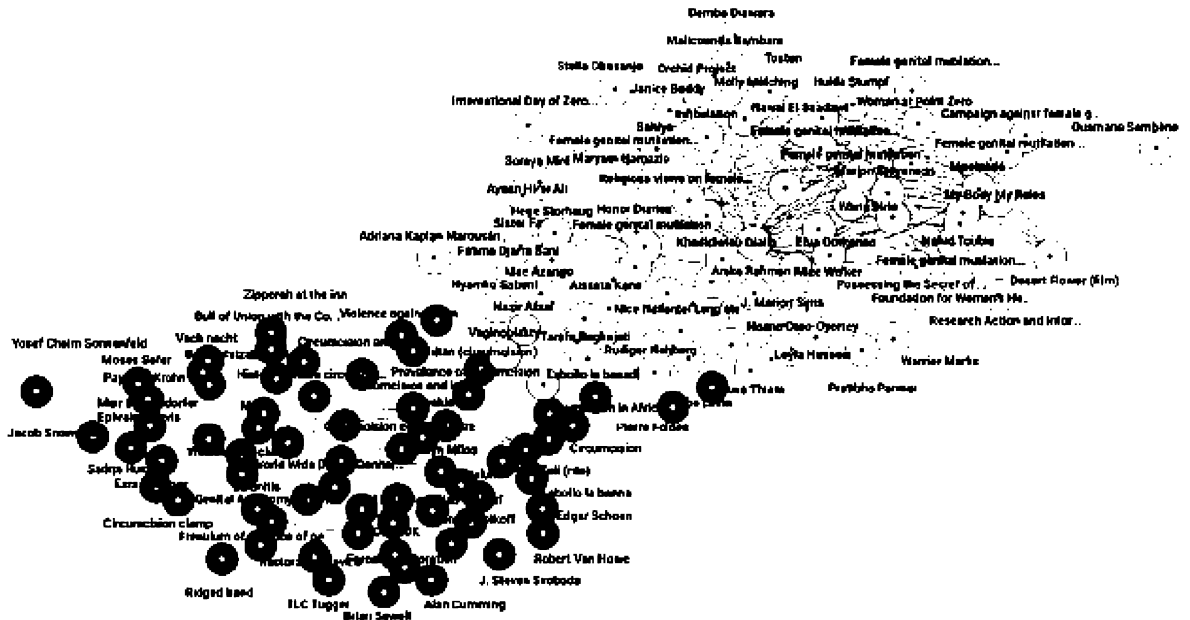


Figure 47 Network obtained by crawling the “Circumcision controversies” page on Wikipedia at crawl distance 1 while also calling Wikipedia’s API to find pages through backlinks. Pages that are only found through backlinks are labeled (created by the authors; released by the authors under CC BY-SA 4.0).

Looking at the network in [figure 48](#), we notice that the clustering on the right around female genital mutilation is particularly dense. This is due to the fact that the editors of Wikipedia included at the bottom of many of these pages the link template shown in [figure 49](#). Link templates are typically developed as part of Wikipedia projects where editors agree to work on substantiating a particular topic (in this case female genital mutilation). While the prevalence of the template and its effects on the network tells us something about the priority given by editors to a certain subset of the controversy, we may wonder whether it exaggerates the perception that Wikipedia pages on circumcision cluster “naturally” along a divide between male and female issues.



Male circumcision

Figure 48 Network of pages from the “Circumcision” category on Wikipedia connected by all hyperlinks between them. Pages about male circumcision group on the left (dark gray with white center), while pages about female circumcision (known here as female genital mutilation) group on the right (white with black center) (created by the authors; released by the authors under CC BY-SA 4.0).

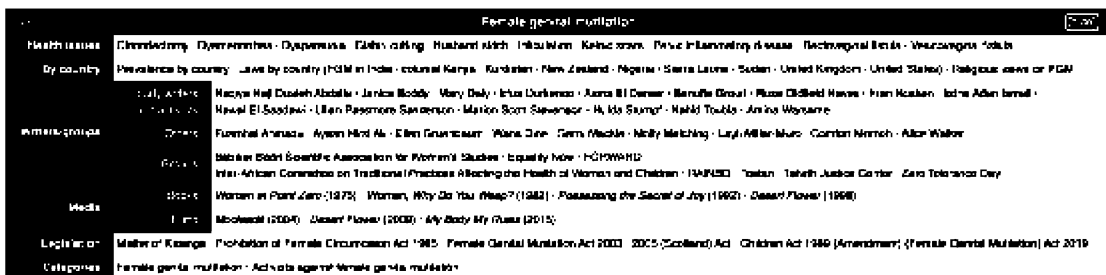


Figure 49 An example of a link template from Wikipedia. The “Female genital mutilation” link template.

If we want to avoid this templating effect, data collection becomes more complicated. While Wikipedia’s API has an endpoint that allows us to get all links on a page, there is no endpoint for getting just the links that are part of the main text and ignoring the templates. The solution to this problem is called *scraping*. Scrapers work off the structure of web pages, exploiting the fact that their HTML source contains instructions about how information should be displayed on the screen. If we want to get just the hyperlinks that appear in the actual text of the page, we can take advantage of the fact that, on Wikipedia pages (and most other standard web pages), all text paragraphs are marked up with the tag `<p>` at the beginning and `</p>` at the end. If a link is found inside those two tags, the

scraper can be sure that it is dealing with an in-text link. In [figure 50](#), we show the resulting network.

The dense clustering of pages around female circumcision on the right has now disappeared in favor of a structure that resembles that of the cluster around male circumcision on the left. The overall impression that pages cluster along a male/female divide remains intact, however, and this seems to confirm that this is indeed the dominant way of organizing circumcision content on Wikipedia.

To test this impression further, we can explore another type of connection, considering the external sources that pages reference in support of their claims. In accordance with Wikipedia’s editing guidelines, each page is equipped with a set of references as footnotes at the bottom of each page. We can exploit this feature by calling the API and building a network where the nodes are the pages in the circumcision category (same as the previous network) but the edges reflect the number of external references shared by two pages (an edge here does not represent a direct link from one page to another, but the percentage of external references that the two pages have in common) (see [figure 51](#)).

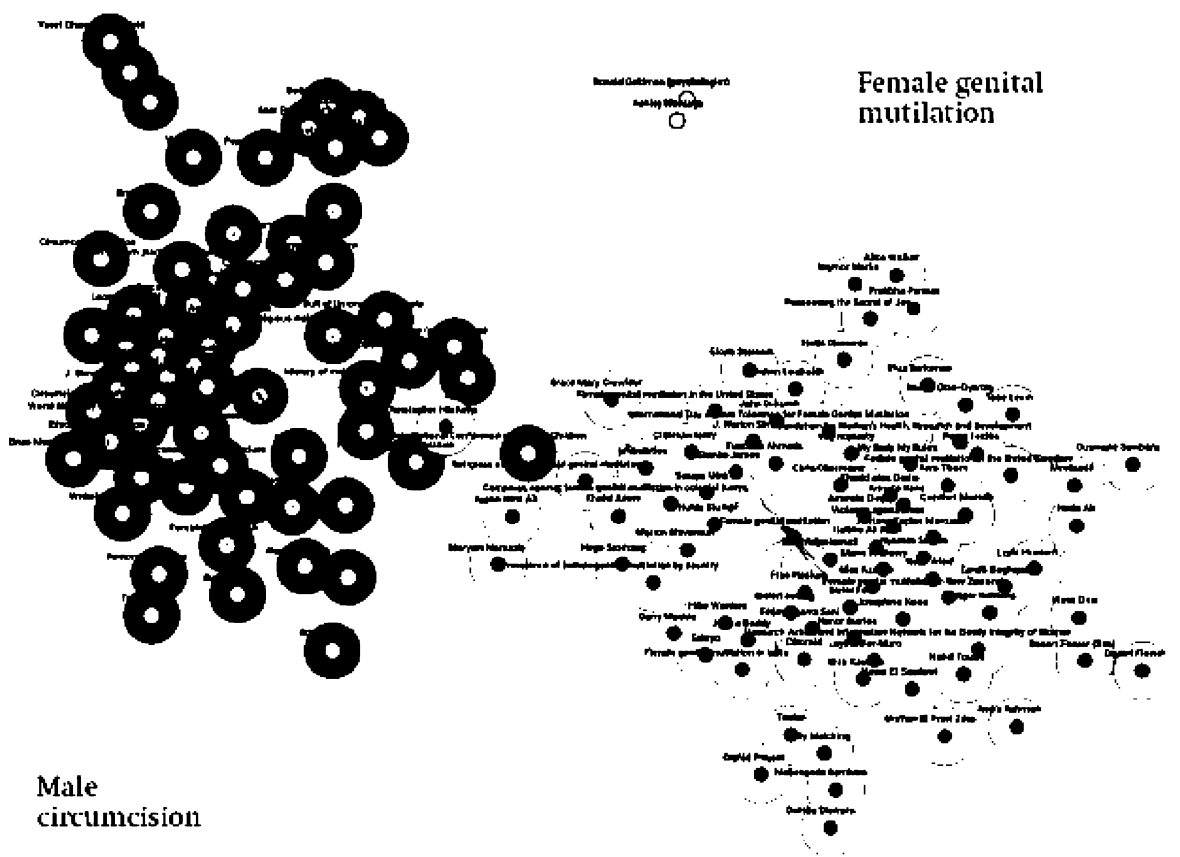


Figure 50 Network of pages from the “Circumcision” category on Wikipedia connected to each other by in-text links only. Pages about male circumcision group on the left (dark gray with white center), while pages about female circumcision (known here as female genital mutilation) group on the right (white with black center) (created by the authors; released by the authors under CC BY-SA 4.0).

Male circumcision

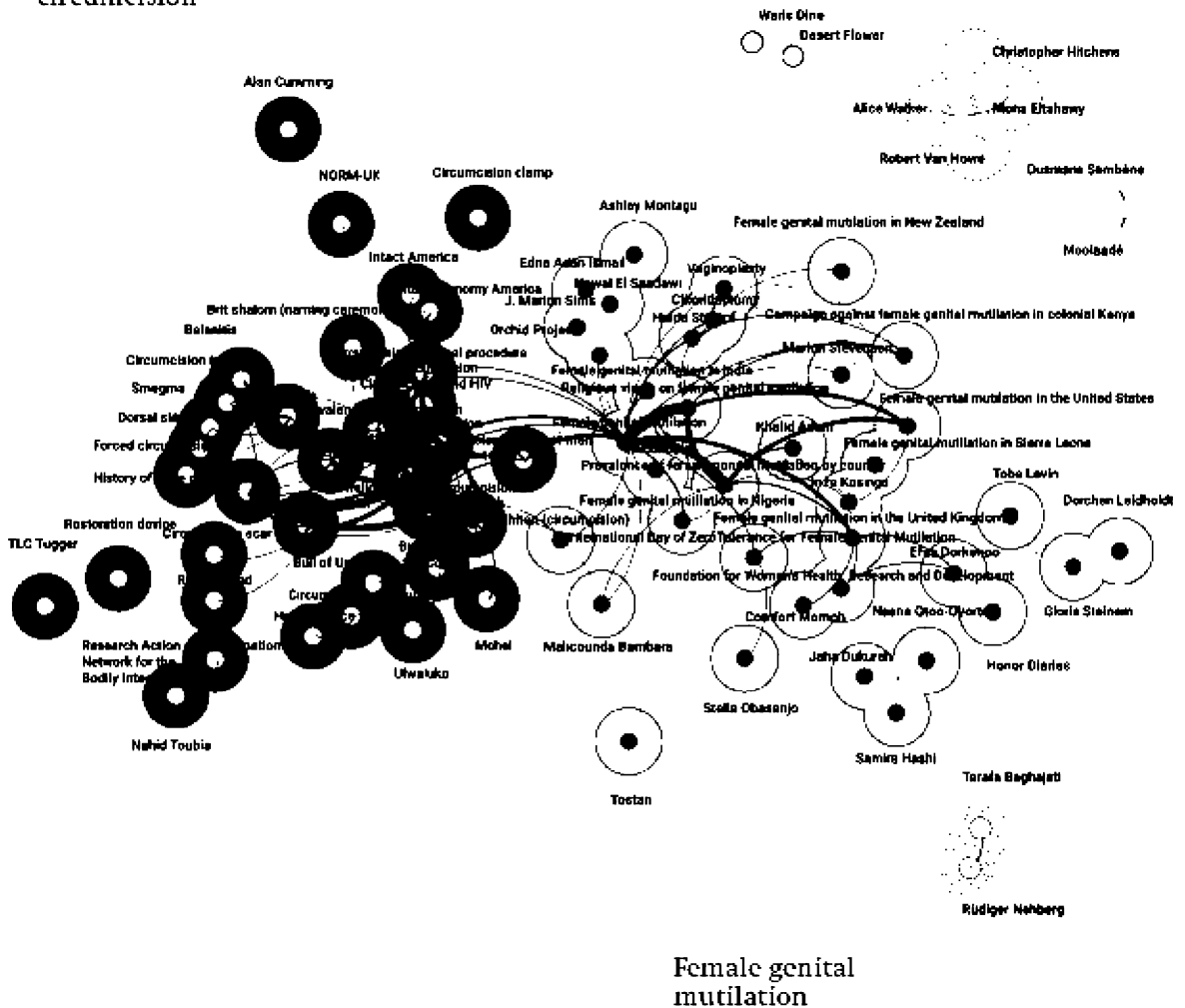


Figure 51 Network of pages from the “Circumcision” category on Wikipedia connected by the degree to which they reference the same external sources. Pages about male circumcision group on the left (dark gray with white center) while pages about female circumcision (known here as female genital mutilation) group on the right (white with black center) (created by the authors; released by the authors under CC BY-SA 4.0).

The first thing to notice is that the edges are now weighted (represented here by varying thickness). The fact that page pairs can have a different ratio of references in common, and thus be more or less strongly related, translates in the network as a different force of attraction of the edges connecting their nodes. By harvesting relationships differently, we enable a different view of the circumcision space on Wikipedia, but the overall pattern of two clusters centered on male and female circumcision is retained and strengthened by the observation that pages about male circumcision draw on a different literature than pages about female circumcision.

As we covered in the previous chapter, to be used for research, the information extracted from online platforms must be “repurposed,” that is transformed so that it fits the objectives of the investigation. As the examples above show, this repurposing draws on work already undertaken by the actors of the platform in question. It draws, for example, on the way in which Wikipedia has chosen to mark up the hypertext of its web pages,

designed the endpoints of its APIs, and how the editors of Wikipedia have organized content into categories. Some of these native ways of organizing and forming digital records are easier to repurpose than others, but the most straightforward solutions are not necessarily the best suited for your research question. Deciding how to collect digital records is therefore already in itself a curatorial step. It involves active reflection on the reappropriation of the formats of the medium.

Sometimes this means dropping information that is not relevant, as we did, for instance, when we discarded the template links or focused on the references only. Other times it means enriching a corpus with information that is not immediately featured as data points. There is, for example, no direct way of knowing how much each of our Wikipedia pages about circumcision talks about different religions, although this is a highly relevant topic in this context. The editors of Wikipedia do not group the 173 circumcision-related articles along religious lines. There are no sub-categories for circumcision content relating to Christianity, Judaism, or Islam. Neither does the API offer religious filtering as a feature on its endpoints. A solution is to count how many times words related to each religion occur in each of the pages as a proxy of the association between different religions and circumcision issues (see the results in [figure 52](#)).

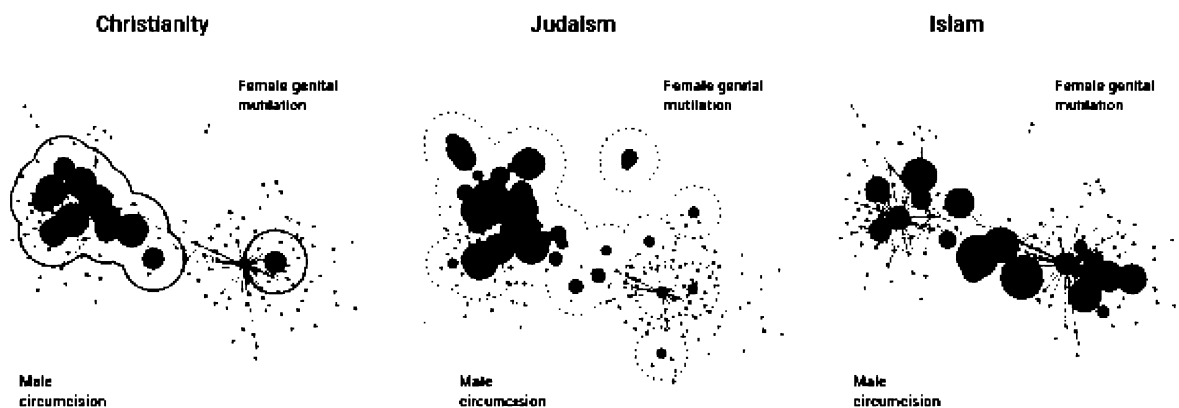


Figure 52 Three versions of the same network of pages from the “Circumcision” category on Wikipedia connected to each other by in-text links only. The pages are sized by the degree to which they mention Christianity, Judaism, and Islam, respectively (created by the authors; released by the authors under CC BY-SA 4.0).

Follow the medium!

Collecting traces is a key operation of digital research, and one that is far from trivial. As discussed in the previous chapter, digital scholars have little control over the inscription devices that provide them with their empirical material. Working with second-hand records obtained by piggybacking on or repurposing existing digital media, researchers need to be cautious. A few years ago, for example, we were working on the relation between wellbeing and economic trends and trying to correlate search patterns extracted from Google Trends with data from economic surveys. Reviewing the literature, we stumbled on a paper describing a correlation between the US unemployment rate and searches for the side effects of drugs and disease symptoms (Askitas & Zimmermann, 2011, 2015). The results were compelling: when the unemployment rate began to rise because of the financial crisis in 2008, so did queries for side effects and symptoms (see [figure 53a](#)). Trying to reproduce these findings we noticed that it was the expressions “side effects” and

“symptoms” that coincided with unemployment rather than the names of particular drugs or diseases. We then discovered that other ancillary words had the same curve (e.g., the word “template” also rose at the end of 2008), which raised a red flag (see [figure 53b](#)).

It occurred to us that in late 2008 Google enabled its “auto-complete” feature by default. This feature suggests common search expressions so that when you type “apple pie,” for example, Google will propose “apple pie *recipe*.” Similarly, when you type “motivational letter,” it will propose to append “template.” And when you type the name of a drug, it will propose “side effects.” Though this does not necessarily invalidate Askitas and Zimmermann’s conclusions (which are based on subtler arguments than the simple correlation), it does remind us of the importance of taking the action of the medium seriously. Indeed, the introduction of auto-complete is also one of the reasons why Google FluTrends, a famous project inaugurated by Google to monitor the spread of influenza through its search data, has become a much less reliable proxy (Lazer et al., 2014). This imbroglio of user and platform actions is typical of most online situations (Venturini et al., 2018).

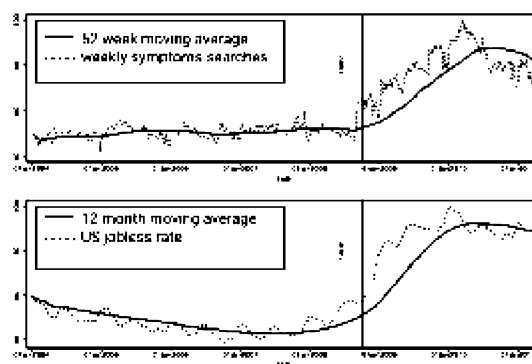


Figure 53a Apparent correlation between queries for “side effects” and the unemployment rate in the US (original figure from Askitas & Zimmermann, 2011; courtesy of Emerald/the International Journal of Manpower)

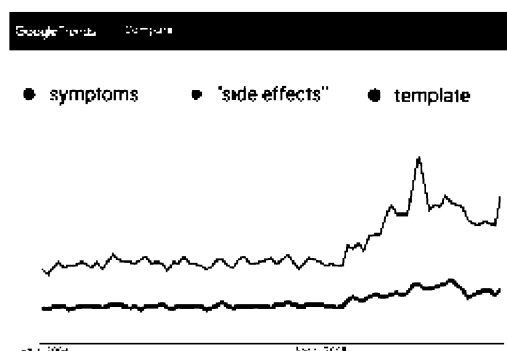


Figure 53b The similarity of trends in Google Trends for the queries “symptoms,” “side effects,” and “template” (data source: screenshot from Google Trends, <https://www.google.com/trends>).

Marres and Moats (2015) describe three approaches for observing the role played by digital media in controversies. The “precautionary approach” focuses on the biases that online platforms impose on the observation of public debate and tries to identify and discount such interferences (e.g., in the example above, by subtracting the impact of Google auto-suggest when studying search trends). The “affirmative approach” conceives the role of

media more positively, highlighting how, by channeling controversies through their specific technical formats, online platforms make disputes more observable. Finally, the “empiricist approach” takes a *symmetrical* stance and observes how online media shape social debates, but also how social debates influence online media.

A good place to start is to consider whether the digital records we study are the phenomenon under investigation or a proxy for it. Social media, for example, have become a gold mine of records for the study of social movements, as civic organizations increasingly rely on them to coordinate their actions (Gerbaudo, 2012). Yet, it is one thing to use records from social platforms to study street protests (Rogers & Marres, 2002) and another to use them to investigate online mobilization. In the first case the medium is a research tool, in the second it is also the object of research. We can thus distinguish between “weak” and “strong” ambitions in digital methods (Birkbak & Munk, 2017). In *weak digital methods*, researchers focus specifically on actions carried out on the medium that they observe. In *strong digital methods*, they use those actions to make larger claims about collective life, which is obviously trickier and demands more careful consideration.

When digital records are used as proxies for more-than-digital phenomena, it is crucial to consider what kind of operationalization they enable (Moretti, 2013a), i.e., how digital inscriptions can be related to the actions under investigation. There are, for instance, different ways to find traces of the relations between the actors of a controversy. One can look at the hyperlinks between their websites, consider the overlap of their Facebook friends, follow their mutual retweets, or explore their references on Wikipedia. Each of these operational definitions will highlight different aspects of the situation, a bias that the researcher should be able to account for and possibly to exploit. Debates on Twitter, for instance, are organized around hashtags, they are restricted to short statements, they evolve through retweets and replies, and so forth. A mapping based on Twitter data should then draw on these *affordances* (Weltevrede, 2016; Bucher & Helmond, 2017) rather than on traditional categories like age groups, social strata, or geographical locations, which are simply not the way in which Twitter “does” controversies (a situation that Rogers, 2013b, calls “post-demographics”).

One way to isolate media influences is to compare the same phenomena across different digital environments. Because they allow comparison, cross-platform projects can produce findings whose robustness carries beyond the limits of a single medium through a technique that Richard Rogers (2017) calls “online grounding.” For example, when observing the erratic rise and fall of issues on Facebook, it is difficult to know whether such a rhythm is an indication of the superficiality of those debates or a general effect of the platform which encourages shorter attention spans (Munk & Olesen, 2020). By comparing how the same topics evolve in the blogosphere, in newspapers, or in the scientific literature (Lorenz-Spreen et al., 2019), one can distinguish the underlying features of a collective phenomenon from the specific way in which it is enacted through a particular medium.

Accounting for the influence of the medium is not simply a question of avoiding bias. In digital methods, the classic prescription of ANT to “follow the actors” extends to digital media. Digital media clearly make a difference in the way controversies engage people, parties influence the debate, knowledge claims travel, evidence is mobilized, etc. As such, they must be considered as actors in the controversies we study, rather than as neutral repositories where information is stored for our convenience. As argued in the previous

chapter, digital traces are not a carbon copy of interactions that would have taken place in the same way regardless of digital mediations.

Querying

The first and foremost operation in digital methods is to isolate the information relevant to one's research from the much larger datasets from which it can be extracted. This operation is called "querying," a general label that covers the interaction with both search engines and APIs. While the particular style of querying depends on the syntax of the API or on the interface of the search engine, two elements must always be considered.

The first are the keywords used in the search and the operators connecting them (AND, OR, NOT, quotation marks, etc.). In most cases, effective queries are composed of unambiguous, subject-specific keywords connected by operators in highly structured expressions. Subject-specific keywords include proper nouns, scientific and technical terminology, and scientific references. Unstructured and ambiguous queries should be used only when the objective of the researcher is to expose such an ambiguity. Richard Rogers (2017) describes a project in which the term "rights" was queried in a variety of national Google domains in order to identify which types of human rights were more prominently ranked. Here a deliberately vague query is used to explore online debates about human rights in different countries, repurposing Google as a "socio-epistemological machine" (p. 87) through the comparison of its different national indexes.

Rogers' project highlights the importance of a second element of querying, namely the *query context*, which includes the choice of the API or search engine, but also the filters applied through the metadata available in the queried dataset, such as the type of record or the place or time where it was captured. When not explicitly defined by the user, the query context is typically inferred by search engines. For example, when you type "restaurant" in its search box, Google will take into consideration not only your location (suggesting restaurants that are nearby), but also the history of your earlier searches (trying to guess your favorite style of food). In digital research, this personalization should always be kept in mind and either countered (by installing a "research browser" which is kept as free of personalization as possible) or exploited (e.g., by triangulating results proposed in different locations or for different users).

Since the right combination of keywords and context is so crucial, formulating a research query often more resembles computer programming than everyday searching practices. This is evident when working with APIs, where querying requires writing a piece of code in a programming language and understanding the syntax of the available endpoints, but is no less true when working with search engines. While designing a set of maps about the scientific literature on human and social questions related to the use of artificial intelligence (cf. [chapter 8](#)), we harvested data from the ISI Web of Science search engine with the query shown in [figure 54](#).

Since there is no such thing as a one-fits-all search strategy, the best results come from testing and combining the results of different search engines and APIs, keywords, and search contexts. In fact, the comparison of results (in terms of composition and ranking) is in itself a research method. The easiest version of this technique consists in choosing queries that refer to different issues and contrasting their results to highlight the different discourses associated with them (Ben-David & Huurdeman, 2014). Advanced versions may involve comparing the results through time in order to detect the evolution of topics;

through different publishing platforms in order to detect how they resonate in different spheres (e.g. Factiva for news media, Amazon for popular literature, Scopus for scientific literature, etc.); or in different languages serving as geographical or cultural markers (see several of these techniques used to analyze the European debate on ageing in Rogers et al., 2015). Anders Koed Madsen (2012, 2015) calls this technique “web-vision analysis,” highlighting the way in which researchers can use different datasets and filtering parameters to compare different angles on the same phenomenon, providing the researchers “with an arsenal of variables that can be used to manipulate the construction of the web-visions in a quasi-experimental fashion” (2012, p. 62).

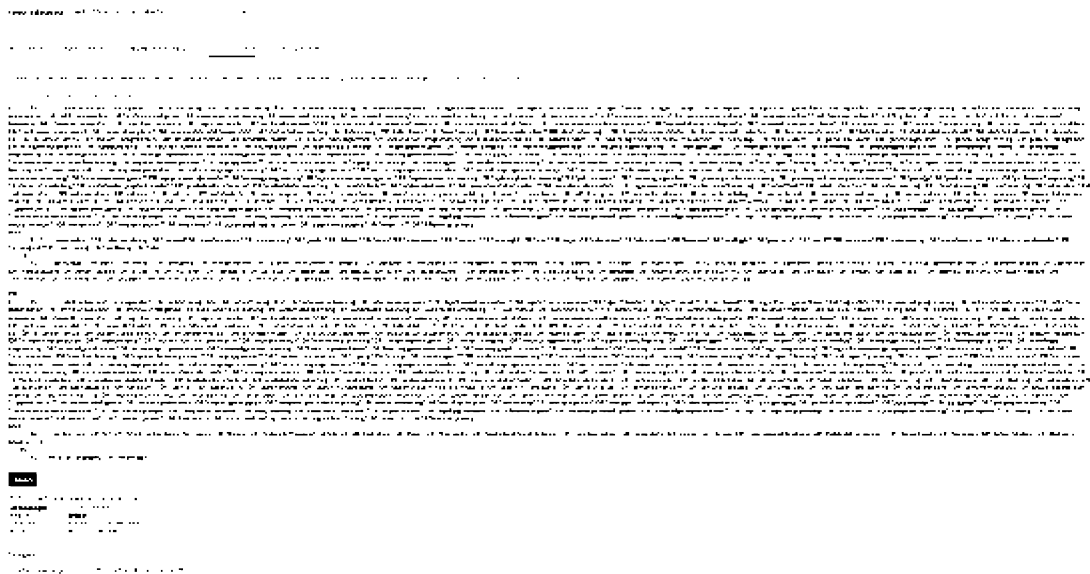


Figure 54 An example of a sophisticated search query in ISI Web of Science.

Scraping

Though search engines and APIs are handy sources of digital records (particularly for those who master the subtle art of querying), this does not mean that their results can always be directly used in research. Digital media have changed many things about the way in which information is stored and transmitted, but they have not yet changed the fact that inscriptions are in most cases packaged in the form of *documents*. We will not enter here into the complex discussions about the elusive notion of “document” (Briet, 1948) or the fact that digital documents can be anything from a 280-character tweet to a 1000-page report, while also including sound and static or moving images. Our point is just that records are seldom found at the level of granularity required for the purposes of research. Most of the time the information we look for is embedded in larger documents, bundled with off-topic or downright undesired information. “Semantic web” and “linked data” (Berners-Lee et al., 2001; Bizer et al., 2009) may one day succeed in marking up such documents and delivering only the relevant bits, but, for the moment, many digital records come in the form of HTML pages, PDFs, word-processed documents, images, video, etc.

Solutions have been developed to extract particular bits of information from these documents, *provided that* some regular correspondence exists between the target records and their formatting or position in the documents – for example, titles always come in the first line, or are always capitalized, or are always marked with a specific HTML tag. When

this condition is met, it becomes possible to “scrape” documents and extract structured information from them. Luckily, the increasing use of content management systems (CMSs) and the rigid separation they impose between content (stored in relational databases) and form (defined by HTML templates and Cascading Style Sheets) guarantees that elements of the same type will regularly be formatted in the same way. Such luck, however, comes at a price. When we reappropriate the regularities of the websites we scrape, we implicitly also accept *someone else’s* way of structuring information: “scraping does not just insert a strange technique into social research practices, it involves the importation of categories into social research that are strictly speaking external to it” (Marres & Weltevrede, 2013). This is not necessarily a bad thing. According to Noortje Marres and Esther Weltevrede, scraping encourages a productive dialogue between digital scholars and their objects, helping social research to produce results that are relevant for the actors it studies. However, the biases of scraping should not be forgotten: scraping does not sculpt new forms from completely amorphous materials, but rather selects and reorders pre-existing items. Consider time, for example: scraping Twitter puts you in a world of hours and minutes; scraping Factiva, in a world of days; scraping ISI Web of Science, a world of years.

Both the importance and difficulty of scraping is often underestimated. This is particularly true in the case of so-called “open data.” In the last few years more and more private and public organizations have published their archives on the Web, responding to an increasing demand for institutional transparency. The opening of such archives is certainly good news (Davies & Bawa, 2012). Yet, many of them contain documents rather than structured data, making it difficult to use the information they contain. If some of these open data archives have been translated into usable data, it is typically through the work of journalists, data-geeks, and sometimes citizens who scraped those documents to extract meaningful and structured information from them (Gurstein, 2011; Gray et al., 2016).

Crawling

Search engines and APIs have become so ubiquitous that we often forget that most digital inscriptions are not natively organized as *results lists*, *search indexes*, or neatly documented API *endpoints*. Rather, in line with the relational nature of the Web, digital records are most often organized as networks. Exploring these networks is relevant for controversy mapping because their organization tends to mirror the alliances and oppositions that structure sociotechnical debates. Figure 55, for example, shows the online landscape of the Palestinian political debate, as charted by Anat Ben-David in 2007 following the hyperlinks connecting it. The map allows us to observe the separation between Fatah and Hamas, the two main parties of the Palestinian Authority, as well as to notice which websites are most central and cited in both clusters.

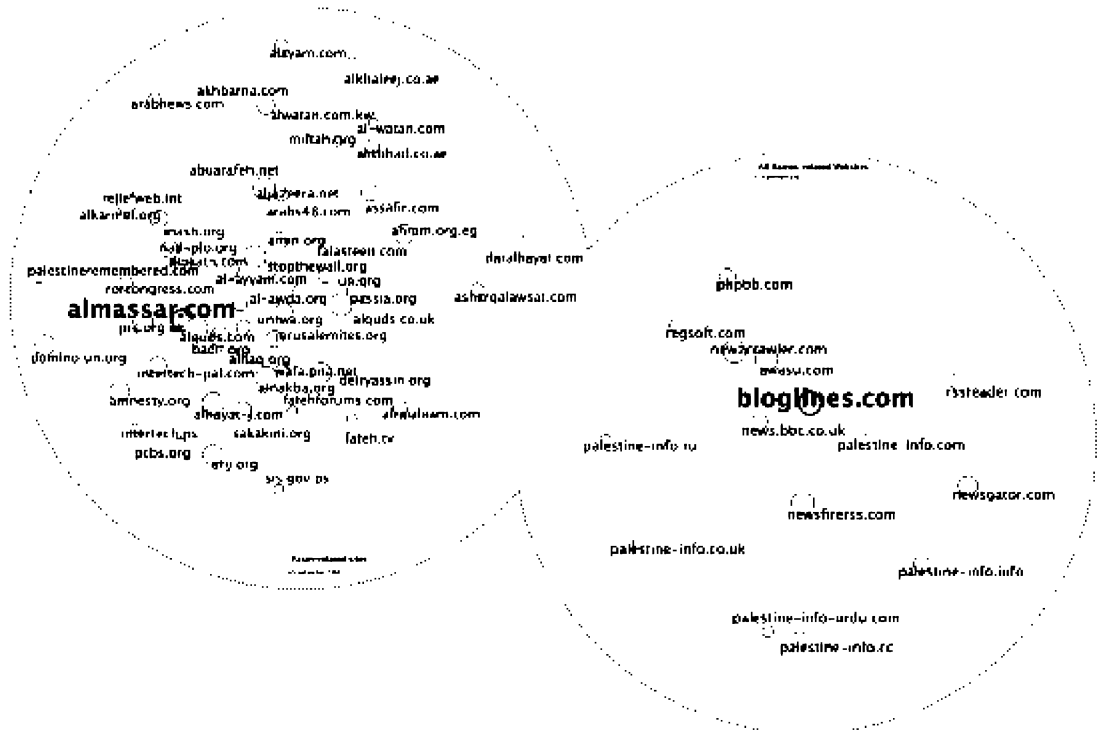


Figure 55 The Palestinian Blogosphere as crawled by Anat Ben-David in 2007. Websites are connected and drawn visually closer by the hyperlinks between them. Fatah-related sites cluster on the left and Hamas-related sites cluster on the right.

The network in [figure 55](#) has been created using a tool called the Issuecrawler and developed precisely to explore issue networks online (Bruns, 2007; Rogers, 2013b). As we saw in the introduction to this chapter, web crawlers are pieces of software capable of navigating through web pages by following the hyperlinks between them (Jacomy et al., 2016; Ooghe-tabanou et al., 2018). Riding a crawler, however, is often quite an adventure. As a medium-size website can contain hundreds of pages, each with dozens of hyperlinks, and large hubs can have millions of pages and neighbors, parsimony is paramount to successful crawling. Cartographers should therefore at least consider:

- the number and the nature of “seeds,” i.e., the start-pages from which the crawl is launched;
- the “crawl depth,” i.e., how far from the start-pages the crawler will be allowed to travel within each website;
- the “crawl distance,” i.e., how far the crawler will be allowed travel moving from the seed websites to their neighbors and neighbors’ neighbors.

A more sophisticated strategy, inspired by scientometric co-citation (Small, 1973), consists in asking the crawler to visit neighbors *only if* they are linked by at least two or three of the seeds. A standard crawl launched from a dozen seeds will likely return a few thousand neighbors. Co-citation will trim them down to a reasonable couple of hundred. Yet, if these neighbors become the seeds for a second crawl (and then a third and a fourth, etc.), the number of new neighbors will quickly grow unmanageable. Increasing the co-citation threshold (e.g., to four or more seeds) is inadvisable as this would risk excluding relevant

findings. To strike a fair balance between crawling too much and not crawling enough, there is no catch-all strategy. Instead, cartographers must manually steer their crawlers in accordance with the peculiar relational structures of digital networks that we can describe as a three-layered pyramid following a model developed by Mathieu Jacomy and Frank Ghitalla (see [figure 56](#)):

1. The *top layer* is occupied by a few websites that capture most hyperlinks and attention. Websites such as Wikipedia, Facebook, Twitter, etc., receive connections from all online communities and are known by most Internet users. They consistently show up in the first results of search engines and contain content relevant to almost any subject. These websites are highly connected both locally and globally. From a network perspective, they are “everywhere.” Though these websites are influential in setting an agenda, they are often too generic to be relevant to specific controversies.
2. The *middle layer* contains a large number of websites that animate discussions about particular topics. These websites are well connected within their community and known by specialists and amateurs of their subjects. They rank highly in search engine results, but only for specialized queries, and their contents are equally specialized. These sites are highly linked locally by similar sites, but scarcely linked globally. They are “somewhere” in the network (clearly located within a thematic cluster) and often constitute the most interesting finds for controversy mapping.
3. The *deep layer* comprises the majority of websites, most of which tend to be relevant almost exclusively to their own creators. They are scarcely connected and read only by a few people, they are rarely prominent in search results (indeed, often altogether absent), and scarcely linked both locally and globally, which situates them “nowhere” in the network. Most of these websites are not interesting for controversy mapping, but “golden nuggets” can be hidden among them.

While the particular websites occupying the different layers may change very quickly, the layered organization itself is robust and fractal. By fractal, we mean that you will encounter the same three layers no matter the level at which you position your research. For example, if you are interested in the news for the region where you live (let’s say the north of France), you will encounter a top layer occupied by the websites of national newspapers (such as *Le Monde*, *Liberation*, *Le Figaro*), then a middle layer of regional newspapers (*Paris-Normandie*, *Le Télégramme de Brest*, *La Voix du Nord*) and finally a myriad of periodicals dedicated to specific cities. If you move “up” from national news: you will find the top international newspapers (*The New York Times*, *Le Monde*, *The Guardian*, etc.), then the national ones and then the regional. If you move “down” to local news, you will encounter regional newspapers as the top layer, then the periodicals of your city and finally a deep layer of news circulars dedicated to specific neighborhoods. Likewise, a similar clustered pyramid can be found on the Web, but also within specific platforms such as Facebook or YouTube.

This relational structure has direct consequences for the practice of crawling. The clustered pyramid of online networks is characterized by an *inverse gravity* that leads crawlers upward toward the most visible websites and away from the specific debate clusters that the controversy mapper is interested in. To resist this upward gravity, researchers should build their Web corpus following a three-step crawling protocol:

1. You typically find your way into an online debate somewhere between the top and middle layer and are quickly drawn upward. The first task therefore consists in

excluding the websites that are too generic (websites such as Wikipedia, Facebook, or YouTube appear in all crawls and all controversies, so unless you can separate each of their pages, they are not very interesting). The websites or parts of websites that are specifically about the controversy should be kept as the beginning of the corpus.

2. Crawling against the reverse gravity of online connectivity, we can now expand the corpus with relevant websites from the middle layer, while excluding websites dedicated to adjacent but different debates.
3. As we gradually descend through the middle layer, we increasingly encounter websites in the deep layer and while excluding most of them, we might have a chance to find some interesting exceptions. The moment to stop the crawl is when most newly discovered sites are from the deep layer.

The three-layered pyramid and the three-step crawling protocol are ways to represent and deal with the elusive relational structures of online media. This elusiveness derives from the fact that online networks are shaped by two opposing dynamics of association that we may call *communal attachment* and *preferential attachment* (see also Easley & Kleinberg, 2010).

Communal attachment means that websites (or social media accounts) tend to connect to other websites with shared interests (Centola et al., 2007; Ackland & Shorish, 2014). Culinary sites are more inclined to cite other culinary sites (or indeed other culinary sites with similar interests, Munk & Ellern, 2015); blogs typically cite other blogs; right-wing pages pay more attention to conservative pages (Adamic & Glance, 2005); French-speakers prefer to associate with fellow Francophones. The specific type of resemblance is less important than the fact that these similarities are mutual and that websites that receive a link also tend to *link back*. This backlinking is not always direct and yet it typically remains in the same vicinity: not all blogs cited by your fly-fishing blog will reciprocate, but they will still link to similar websites, some of which will eventually cite your blog. It is because of this communal attachment that the fabric of the Web does not extend seamlessly, but is organized in clusters gathering websites with similar connections, “friends of friends” so to speak (cf. Gibson et al., 1998; Flake et al., 2002; Roth & Cointet, 2010).

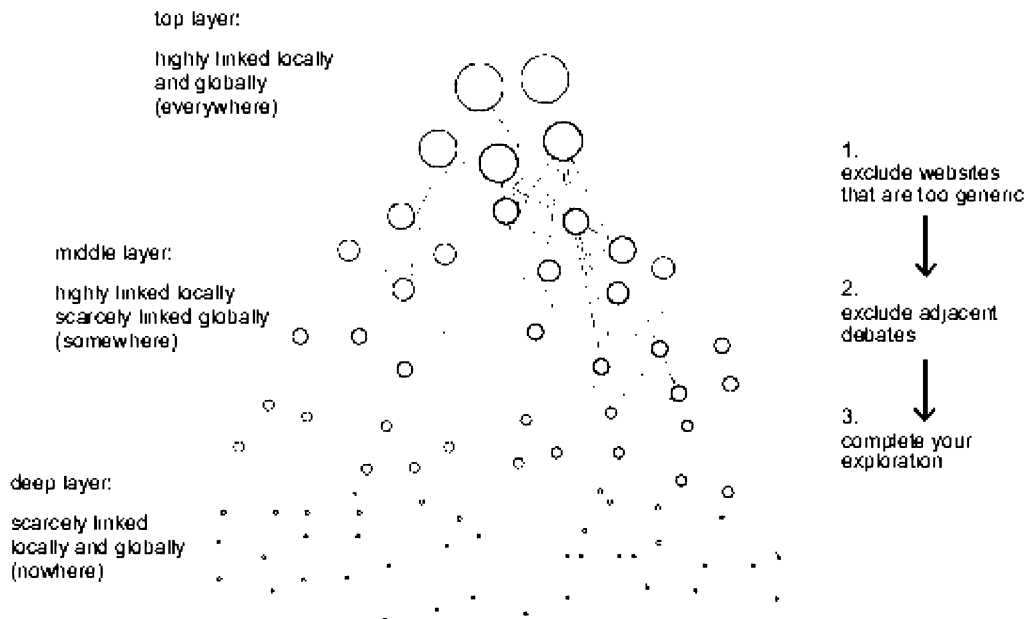


Figure 56 The three-layered model of online connectivity and the three-step crawling protocol developed by Mathieu Jacomy and Frank Ghitalla.

The second dynamic of online association, preferential attachment, means that websites that are already highly cited have a higher probability of attracting new hyperlinks. Preferential attachment is the reason why, despite its vast dimensions, the World Wide Web can be traversed in a few clicks (just 19 according to Albert et al., 1999). With one click from a Madonna retrospective of your favorite vintage music blog, you can be redirected to the Wikipedia page of the 1980s pop star and, a click later, find yourself contemplating the question of Christian symbolism. This experience of virtual teleportation is possible because, while most websites are associated with a small number of other websites within a restricted circle, some hyper-connected platforms and portals, such as Wikipedia, Facebook, or Reddit, have millions of contacts spanning from and to distant online spheres. It is because of these sites that the diameter of the Web is so surprisingly small and information can spread so fast across it (Barabási, 2002).

Preferential attachment is not limited to digital networks and was in fact first observed by social network analysts. In the late 1960s, the American psychologist Stanley Milgram organized an unusual experiment. Milgram asked random people from remote cities in the US to dispatch a letter to another random citizen. The subjects were instructed as follows: “if you do not know the target person on a personal basis, do not try to contact him directly. Instead, mail this folder ... to a personal acquaintance who is more likely than you to know the target person” (1967, p. 64). To Milgram’s surprise, most letters reached their destination in six or less steps (hence the popular idea of the “six degrees of separation” between any two persons in the world). Milgram explained this result through geometric progression: even if every individual knows only 100 persons, through six degrees of separation the message can potentially spread to billions of people (100^6 to be precise).

In reality, however, the overlap of social circles lowers the magnitude of Milgram’s progression significantly. While every person can have several acquaintances, each of which can have several acquaintances as well, for people in the same social circle most of these acquaintances will be the same. In highly clustered networks (where friends of my

friends tend to be my friends too), the progression of *new* connections is not geometric but much slower. Thirty years after Milgram’s experiment, Duncan Watts and Steven Strogatz (1998) demonstrated that small world structures emerge not because of geometric progression but because of network shortcuts. Even if the majority of connections remain in the vicinity of their source, the existence of a few heterogeneous associations can dramatically shorten the network diameter (see [figure 57](#)). It is not because people had many close friends that they could efficiently dispatch Milgram’s letters, but because they had a handful of distant acquaintances (in line with the importance of “weak ties” described by Mark Granovetter, 1973, 1983).

In statistics, a “normal distribution” (also called the Gaussian distribution or bell curve) is one where most values gather around the arithmetic mean, which therefore defines the characteristic scale of the phenomenon (see [figure 58](#), left). For example, the height of a human population is defined by its average because most individuals are close to that average, with only a few being much taller or shorter. While many natural and social variables follow this distribution, some are distinctively different. At the beginning of the twentieth century, the Italian economist Vilfredo Pareto noted, for example, that wealth does not distribute around the average. Instead, 20 percent of the population controls 80 percent of the resources while the majority is left with the remaining fifth. The same skewness was later observed for academic citations, where a few authors gather most of the attention (cf. de Solla Price, 1965).

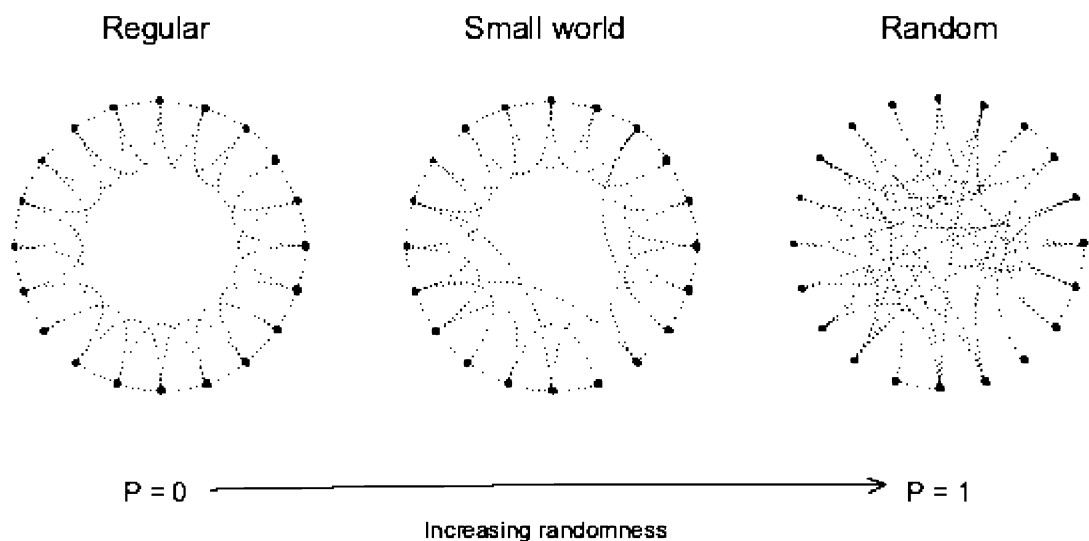


Figure 57 Network shortcuts (long edges across the middle of the network) and the formation of small worlds in clustered networks (Watts & Strogatz, 1998; courtesy of Nature Research).

Robert Merton (1968) attributed this distribution in academic citations to what he called the “Matthew effect,” from the Gospel of Matthew verse “for unto every one that hath shall be given, and he shall have abundance, but from him that hath not shall be taken away even that which he hath.” According to Albert-László Barabási and Réka Albert (1999), a similar mechanism is at work on the Web: as new websites are created online, they do not connect randomly to existing websites, but link *preferentially* to those that already have numerous connections and are therefore more visible. This “preferential attachment” produces a distribution even more skewed than the 20/80 observed by Pareto, with the greatest majority of web pages receiving few or no hyperlinks, and a tiny minority

attracting literally billions of connections (see [figure 58](#), right). The average number of hyperlinks therefore does not define the “typical scale” of the Web, making it a “*scale-free network*” (Barabási et al., 2000).

The two dynamics described above are equally important but also diametrically opposite (Newman, 2001; Aral et al., 2009; Leskovec et al., 2009b). While communal attachment encourages homophily and tends to generate thematic communities; preferential attachment encourages hierarchy and tends to create a pyramid of attention concentrated around a few hyper-visible actors. Keeping these dynamics in mind is crucial when crawling, as they lead crawlers in opposite directions. Communal attachment goes in circles (within the same community) and creates clustering; preferential attachment goes upward (toward the most visible) and creates ranking. Together these two forms of attachment shape the Web into the three-layered pyramid discussed above. They also justify the three-step protocol we recommended as a solution to resist the inverse gravity created by preferential attachment and highlight the alliance and opposition clusters created by communal attachment. A successful crawl should reveal the pecking order of digital arenas, while resisting the temptation to focus on the most visible websites only. It should also explore the clustered texture of online discussions, yet show that no debate is an island.

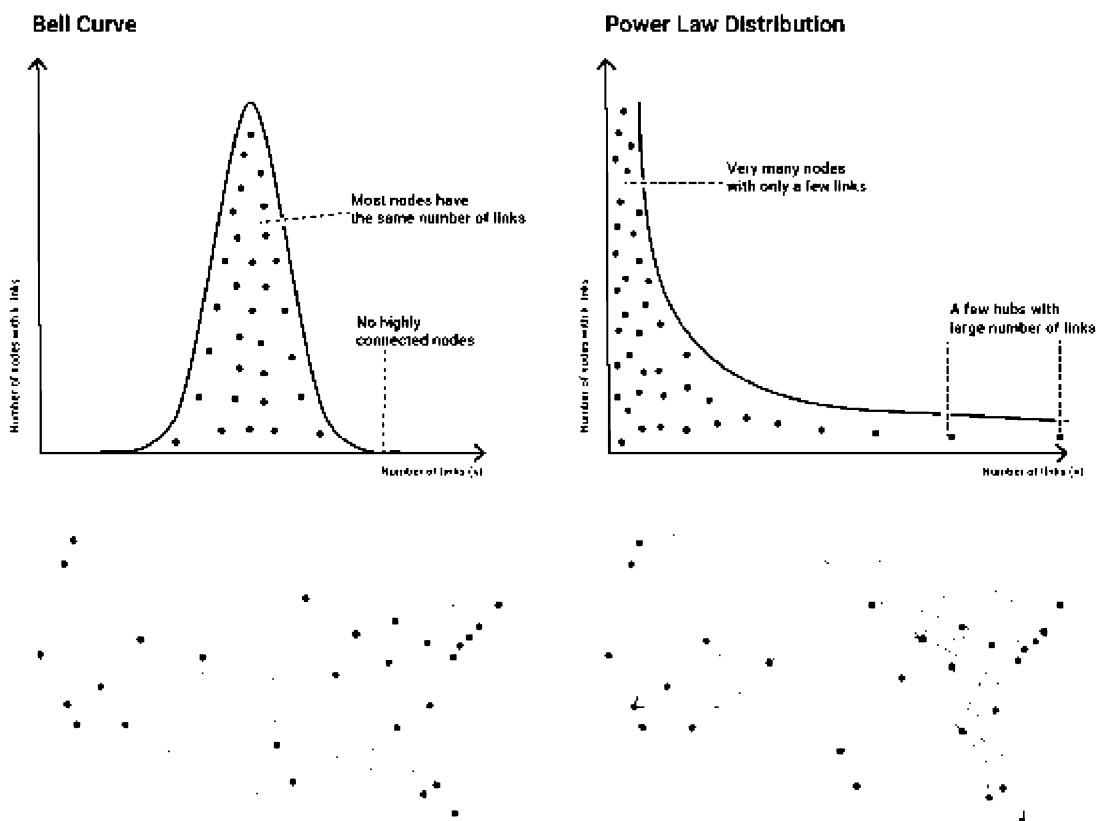


Figure 58 Left, normal distribution of connectivity in the US highway system; right, the power-law distribution of connectivity on the Internet (image source: Barabási, 2002, p. 71).

Curating

We cannot say it too many times: *digital records are not straightforwardly research data*. A bunch of records collected in bulk from one or more online platforms will never yield interesting results, as findings will be buried under an avalanche of duplicates, errors, and irrelevant information. As Lisa Gitelman reminds us, “raw data is an oxymoron” (2013): digital data, like any other kind of data, exists only insofar as they are extracted, cleaned, compiled, de-duplicated, indexed, and by such work transformed into a *corpus*. All data are born from an act of cleaning, the laborious separation of the relevant from the irrelevant information, i.e., from whatever comes to be seen as “noise” in relation to a specific research interest. This is particularly true for digital data, in part because, as we observed in the previous chapter, most are generated outside the vetted apparatus of social research methodologies and in part because of their sheer volume: more records inevitably means more cleaning. It may well be that “data is the new oil,” as preached by big data enthusiasts, but this oil certainly does not flow out of electronic networks as crude oil springs from a well. If anything, digital records resemble unconventional oil: bituminous sands that one has to collect, filter, and distill by the ton before fuel can be obtained.

A good example of the importance of selection comes from the “Cablegate” controversy: the leak of hundreds of thousands of classified cables sent to the US State Department by its foreign diplomatic missions. WikiLeaks, the platform that received the leaked cables in the fall of 2010, chose not to release them directly on its website, as it had done for previous leaks. Rather, Julian Assange, WikiLeaks’ editor-in-chief, decided to publish them through five international newspapers (*El País*, *Der Spiegel*, *Le Monde*, *The Guardian*, and *The New York Times*). Such a decision, surprising for a platform whose mission is to bypass the traditional information gatekeepers (according to Assange’s vision of “scientific journalism,” cf. Benkler, 2011; Lynch, 2012), was officially justified by the need to anonymize the names of persons who may have been endangered by the leak. The rationale for this choice, however, also includes the need to secure the challenging work of expert curation necessary to extract meaningful pieces of information from an ocean of generally boring diplomatic cables.

The work of curating digital datasets is often called “data mining” but this metaphor is misleading because it implies that researchers would know clearly and from the start which bits of information are relevant and which are not. However, while it is crucial to draw a line between noise and signal in the overloaded information environment of digital media, such a line can be drawn in different ways depending on the objectives of the research, it will likely move as the investigation unfolds, and it is often the very object of contestation between the actors of the situation.

A case in point comes from a study we recently carried out about the attention cycle of the most prominent French political channels on YouTube. After spending months collecting hour after hour the number of views for all the videos published by more than 1,000 channels, we discovered many of our data points did not make sense. For many videos, the *cumulative* count of views seemed to decrease at some point in their viewing history. These impossible “negative views” derive from the fact that YouTube monitors the viewing patterns of its videos and regularly corrects the views that it judges “not legitimate” as generated by bots, click-bait, or click farms. The problem is that this correction happens retrospectively and often after several days. If we wanted to study the rise and fall of different channels and topics, we had to recalibrate all the views recorded for each video. At the same time, we realized that, while these “fake views” needed to be removed from the data of our study on attention cycles, they could become the corpus for an equally

interesting study on YouTube visibility metrics. The distinction between legitimate and illegitimate views has major implications for the functioning of the recommendation algorithms and monetization of videos (van Es, 2020). Changes to the way YouTube defines and measures attention have major impacts on Youtubers' business models and may spark controversy. This happened, for instance, in 2012 when YouTube readjusted its recommendation algorithm to start maximizing the total watch time rather than number of views. In the ensuing debate, decisions about how to measure visibility and how to clean view records became an extremely interesting object of contention. The noise of one situation can be the signal of another.

This observation suggests that, while controversy mapping and STS have much to learn from data science (as this chapter has tried to show), the opposite is also true. The curation of a corpus is an excellent occasion to put to good use STS insights about the hard work necessary to build scientific facts out of messy empirical observations. In a paper titled "We are all social scientists now," Justin Grimmer notes that the analysis of big data "is not only a matter of solving computational problems," but also of "careful research design, and the creative deployment of statistical techniques" (Grimmer, 2015, p. 80). Similarly, Joseph Dumit and Dawn Nafus (2018) lament the fact that textbooks tend to concentrate on analysis and skim over cleaning operations, which they call "the other ninety per cent" of data science. The teaching and practice of computational methods, they argue, would benefit from recognizing "that there are actual fields where people are trained to think critically and expansively about interpretation, and to be rigorous about ambiguous situations rather than avoiding them ... [and] a whole discipline devoted to mapping stakeholders and understanding social implications and feedback effects" (p. 255).

Acknowledging the work necessary to distill usable sociological data from digital records is important to avoid two common misunderstandings about digital methods (Venturini et al., 2014a). The first is the naive hope that digital methods will make research easier and faster. For every manual task that digital and computational tools allow us to mechanize (and there are plenty!), new types of curation become necessary. Even when data collection is smooth (and this is the exception rather than the rule) and even when analysis relies on tried and tested computational tools (also the exception), the passage from collection to analysis always necessitates some form of active transformation and incorporation. Such work is often neglected in academic papers because it is admittedly tedious and hardly original (Denis, 2018), yet, in practice, it often consumes the largest share of time and resources, and produces most of the "data friction" (Edwards, 2010).

The second misunderstanding is that digital methods can liberate research from interpretative work, as in the prophecy of the "end of theory" proclaimed by *Wired* editor Chris Anderson:

"Correlation is enough." We can stop looking for models. We can analyze the data without hypotheses about what it might show. We can throw the numbers into the biggest computing clusters the world has ever seen and let statistical algorithms find patterns where science cannot. (Anderson, 2008)

The flaw of the argument is striking. Anderson refers to "numbers," "patterns," and "correlations" as if they were obvious and unproblematic. Yet, the actual experience of doing digital methods speaks to the exact opposite: that it is always painfully difficult to choose among the proliferation of questionable and contradictory numbers and patterns. Correlating everything with everything else, as Anderson suggests, makes no sense

because nothing correlates with anything unless noise is removed and records transformed into variables. This is where theory and interpretation creep back into the picture because, depending on how researchers decide to curate their data and choose to separate information from noise, different trends and patterns will emerge.

Digital methods, as we have seen, challenge some of the established ideas of social research (above all the separation between qualitative and quantitative approaches) and offer new techniques to do research on and with online media. Yet, realizing this potential requires caution and reflection at all steps, from the choice of the sources, over the querying, scraping, or crawling of records, to the curation of the corpus.

7

Visual network analysis

In this chapter, we learn about the affinities and differences between actor-networks and network visualizations, how to use the latter to explore relational data, and how to identify clusters, centers, bridges, and peripheries.

A strong sign of the elective affinity between ANT and digital methods is the fascination they share for networks. For ANT, collective situations are best described as networks of action and for digital methods those situations can be studied through online networks. It can therefore seem unsurprising that network analysis plays a central role in controversy mapping. Similarly, given the emphasis on cartography and information design, there can also be some self-evidence to the fact that controversy mappers commonly approach network analysis as a visual rather than mathematical practice. Yet, as we saw in [chapter 4](#), the diagrammatic visualizations of actor-networks typical of early ANT (e.g., [figures 28, 29, 31, or 32](#)) have very little to do with network layouts. Indeed, visual network analysis has its own complex history, which we will explore in this chapter, and is neither exclusive nor equivalent to Actor-Network Theory or digital methods (Jensen et al., 2014; Munk, 2018; Jacomy, 2020; Venturini et al., 2020).

There is a popular perception in Denmark that the controversy surrounding the human papillomavirus (HPV) vaccine was sparked by a TV documentary. The documentary was aired by a national broadcaster in March 2015 and told the personal stories of young girls suffering from a range of inexplicable symptoms. They were backed by a group of doctors who, against the official position of the Danish Medicines Agency and the general consensus among their peers, attributed these symptoms to side effects of the HPV vaccine. The documentary sparked a public outcry both among supporters of the vaccination program and its detractors. As shown in [figure 59](#), however, vaccination rates had already been declining for a couple of years prior to the documentary and both media coverage and Google searches related to the vaccine had risen and fallen before (Suppli et al., 2018). So why was the documentary perceived as a game changer?

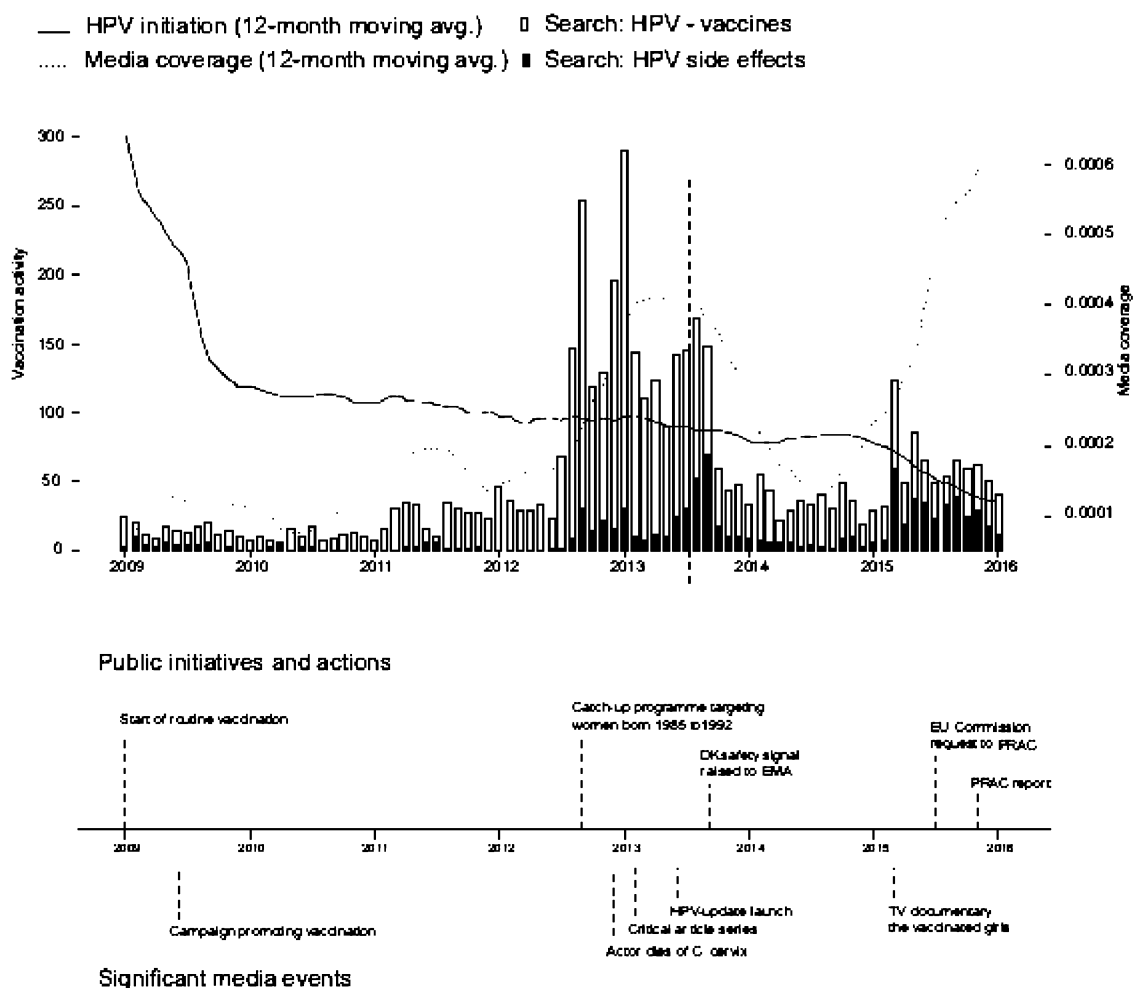


Figure 59 HPV vaccination activity in Denmark month by month from 2009 to 2016, Danish media coverage of the HPV vaccine, and Danish Google searches for “vaccines” and “side effects” in the same period. Below, timeline of the HPV controversy in Denmark (Suppli et al., 2018).

Timelines are of limited use here, because the answer ultimately has to do with a change in social topology rather than a simple shift in attitudes. The common reaction among vaccine supporters was to blame Facebook as the main vehicle through which the documentary had sparked what they perceived as an avalanche of public skepticism and resistance to the vaccine. From their perspective, the events were construed as a scandal where social media turned a spark into a wildfire. They reported being suddenly confronted by hordes of lay people who were mistaking personal stories and anecdotal evidence for science, flooding the platform with emotions and obscuring the basic facts about the vaccine and its benefits.

Interestingly, however, when mapping this controversy, we found no significant difference in the volume of Facebook talk about the HPV vaccines and its Year possible side effects before and after the documentary aired in 2015 (see figure 60). In a dataset of 25 million posts and 150 million comments from more than 70,000 Danish Facebook pages, we were able to find just below 500 posts and comments mentioning the vaccine and its side effects in 2013 and just above 500 posts and comments in 2015. In both 2014 and 2016 the volume dropped to about half of that. If we look at the content, the first spike in 2013 happens in response to a series of newspaper articles whereas the second spike in 2015

references the documentary, but both spikes talk about adverse side effects of the vaccine (Munk & Olesen, 2020). So, public skepticism definitely pre-existed the documentary and did so on Facebook as well.

Mentions of “bivirkning” in Danish HPV-related Facebook talk

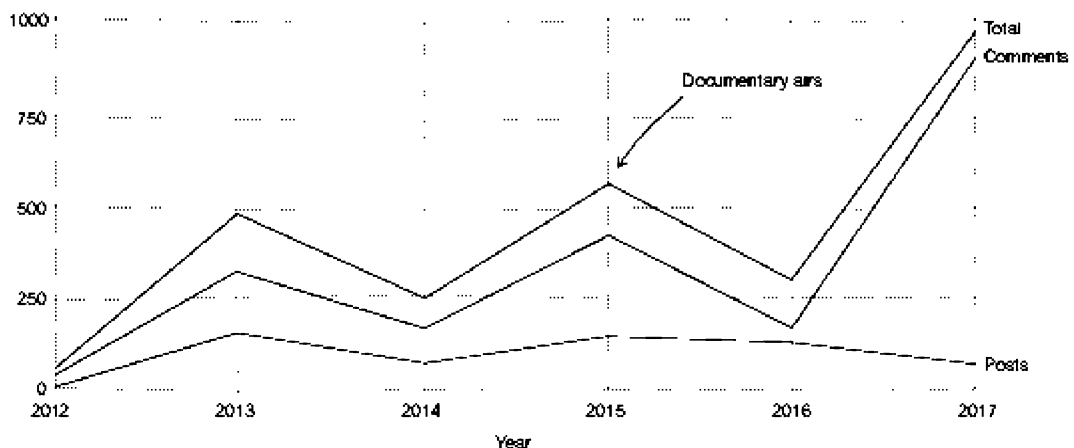


Figure 60 Mentions of “side effect” (in Danish “bivirkning”) in Danish Facebook conversations related to the HPV vaccine year by year 2012–2017. Note that annual fluctuations are driven by mentions in the comments rather than in the posts (Munk & Olesen, 2020).

How come, then, that supporters of the vaccine had the feeling of a major controversy breaking out on Facebook in 2015? A visual network analysis of user activity around the posts we collected provides a clue. In [figure 61](#), we have built a network of all the posts mentioning “HPV” and “side effects” from 2012 to 2017. Each node is a post and two posts are connected when the same user has liked or commented both of them. The more users engage with both posts, the stronger is their connection. Using a force-directed layout to place posts with strong user-similarity closer together, it is possible to identify a two-pole clustering (i.e. two groups of posts repeatedly engaged by the same users). Qualitative analysis reveals that most posts in the cluster on the left are skeptical about the vaccine while most posts in the cluster on the right support it.

This is, effectively, a map of social topology. It reveals that the debate about the HPV vaccine takes place in a landscape where your position matters. If you are commenting on a post on the far-left side of the network, you will likely run positive posts into users who have been active only on skeptical vaccine posts. Conversely, if you are commenting on posts on the far-right, you will likely meet other users who are positive about the vaccine. As the left half of [figure 61](#) shows, posts about HPV side effects from 2012 and 2013, although substantial in volume, are located in the two extreme ends of the network. This suggests that, before the documentary, the two clusters acted effectively as separate echo chambers. This means that people discussing negligible side effects and praising the vaccine rarely came into contact with people sharing stories about severe symptoms.

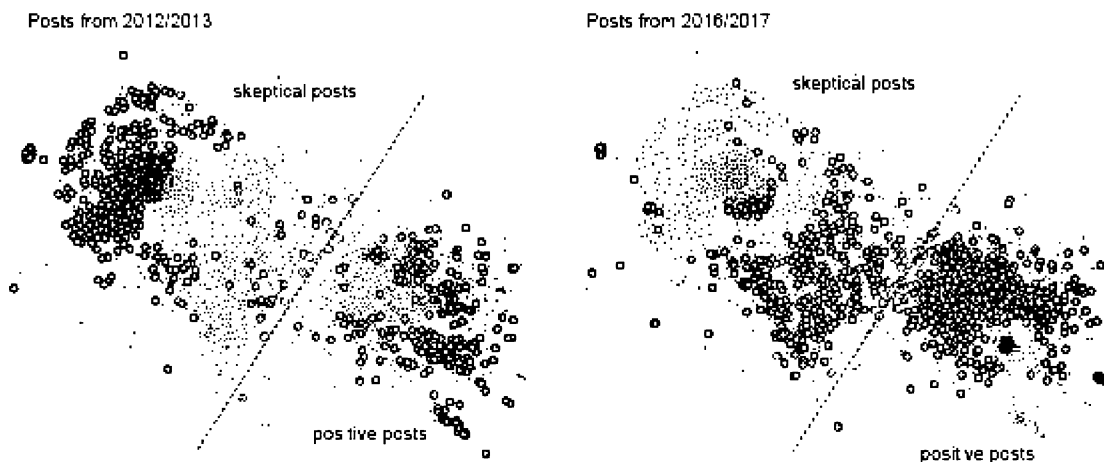


Figure 61 Network of Facebook posts mentioning both “HPV” and “side effects” from 2012 to 2017. Posts are connected if the same users have liked or commented on them. Posts that are skeptical of the vaccine tend to be engaged by the same group of users, while posts that are positive towards the vaccine tend to be engaged by a different group of users. In the version on the left, the posts published in 2012 and 2013 are highlighted. In the version on the right, posts published in 2016 and 2017 are highlighted (Munk & Olesen, 2020).

This situation changed with the 2015 documentary, which did not engender a new form of vaccine skepticism but brought the two hitherto separate groups of Facebook users into contact with each other. In the right half of [figure 61](#), the posts about HPV side effects from 2016 and 2017 are all grouped around the middle of the network, a consequence of this interconnectedness. The same users are active across these posts and it is likely that commenting on one of them would bring you into contact with both positive and skeptical views. What the vaccine supporters experienced following the documentary was this relational change which suddenly forced them to share the same debate space as the skeptics.

Visual network analysis in practice

In their mathematical definition, networks (or graphs) are sets of nodes (also called vertices or points) and edges (also called arcs) connecting them. They are “oriented” or “directed” if their edges point from one node to another, expressing a non-reciprocal relation (e.g., citing or liking someone), and they are “weighted” if their edges are of different strength, expressing a relation whose force can be measured (e.g., how many times two people have met or how many messages they exchanged).

Visual network analysis (or VNA) is a technique for analyzing networks by reading their visual features (see Venturini et al., 2020, as well as the blog by Mathieu Jacomy, reticular.hypotheses.org). VNA is different from standard network analysis because it is not meant to extract indicators of relational structures (as in Scott, 1991, or in Wasserman & Faust, 1994) or to model the underlying “forces” that shape networks (as in Robins et al., 2007). Instead, the objective is to transform the matrix of associations (the mathematical substance of any network) into an image that can be interpreted visually.

Before discussing the origin of VNA and its affinity and differences with ANT, we will provide some guidelines for how to practice it. Our case study is a simple network of

Wikipedia pages extracted through Seealsology, a tool that crawls the links contained in the “see also” section of Wikipedia articles, in order to explore the semantic field related to a page or a group of pages (as also introduced in the opening of [chapter 6](#)). In our example, we crawled the articles related to the “Green Revolution,” a term generally used to refer to a series of innovations, which, between the 1930s and 1970s, contributed to the modernization of food production all over the world and particularly in developing countries. The tool was set to start from the page en.wikipedia.org/wiki/Green_Revolution and to crawl at a distance of four hyperlinks from it. For the sake of legibility, the results were then filtered to keep only the pages with at least eight connections, thus obtaining a network of 210 nodes and 1,109 edges.

VNA employs three visual variables to graphically represent the features of a network: *position*, *size*, and *hue*. For reasons discussed in the next section, *position* is by far the most important – the one that most directly translates the mathematical characteristics of the graphs. The other two variables, size and hue, are less crucial and easier to understand. According to Jacques Bertin’s *Sémiologie Graphique* (1967), the main difference is that *size* is adapted to represent ordinal values (comparing two elements, it is possible to say which one is bigger and by how much), while *hue* is not. Accordingly, size is used in VNA to render quantitative differences between nodes or edges, while the hue is used to designate categories.

For the sake of clarity, we break down our exercise of visual network analysis in steps (roughly corresponding to the three variables just introduced), but the practice of VNA is always messier and requires iterative adjustments of variables and parameters to make networks legible. In many ways reading a network and making it readable is the same operation (Venturini et al., 2020).

Structural holes, clusters, and sub-clusters

To explore the relational organization of this Green Revolution network, we start by positioning the nodes in a two-dimensional space using the software Gephi and the layout algorithm ForceAtlas2 (Jacomy et al., 2014). This layout algorithm works by drawing nodes that are directly or indirectly connected closer together and thereby highlights regions where numerous nodes are tightly connected and regions that are empty or almost empty. Sometimes, network regions have clear boundaries, like the cliffs separating a plateau from a valley, but most of the time their borders are gradual, like the slopes of a mountain. The fuzziness of these regions does not prevent us from recognizing them: a mountain can be distinguished from a plain even if it is impossible to say exactly where one starts and the other ends. Also, most networks initially appear as shapeless hairballs of points and lines and it is only by testing different layout algorithms and parameters that differences in relational density can be perceived.

To highlight these differences, we can place our network on a background representing its density heatmap (see [figure 62](#), top). This helps us recognize the emptier zones of the graph, the so-called “structural holes” (Burt, 1995) – in the image their position is roughly indicated by two dotted lines. From the appreciation of structural holes, we can move to the identification of the denser zones of the network. In [figure 62](#), bottom, we have highlighted the main clusters (dotted gray) and the smaller sub-clusters (white with black borders). Clusters and subclusters have been manually labeled and about a half of the node labels have been removed to increase legibility.

The main divide of the network separates the pages dedicated to discussions about “agriculture” (on the left in both renderings in [figure 62](#)) from those dedicated to “genetics” (on the right). This divide corresponds to the two main controversies related to the Green Revolution: the effect of agricultural modernization on land management, food production, and the scientific improvement of plant biology. On both sides, we can then observe a secondary divide between the questions more directly connected to humans at the top (“C. Land rights” on the left and “D. Evolutionary genetics” on the right) and the questions more connected to the environment at the bottom (“A. Agricultural systems” on the left and “B. Genetic conservation” on the right).

The lower part of the graph is significantly more populated than the upper and its two clusters can be divided into several sub-clusters. The identification of the sub-clusters always involves some further interpretation. By definition, the sub-clusters are smaller and less clear-cut than the main clusters and only a qualitative appreciation of the network can define them. In our example, drawing on the density of connection and our knowledge of the topic, we can detect four clusters on the bottom-left (“A.1 Food Security”; “A.2 Extensive vs Intensive Agriculture”; “A.3 Ecological Engineering” and “A.4 Permaculturalists”) and three on the bottom-right (“B.1 Plant Genetics”; “B.2 Genetic Pollution”; and “B.3 Ecological Conservation”).

Besides identifying clusters and sub-clusters, a visual network analysis should also observe their volume and density. Making sense of these properties is necessary to understanding the balance of forces in the network. The volume of clusters is defined by the number of nodes they encompass. Density, on the other hand, measures the cohesion of clusters and distinguishes groups of nodes that are highly connected from groups that are more weakly associated. In our example, the cluster “A. Agricultural systems” is both the largest and the densest, suggesting that the questions related to agriculture dominate the way content around the Green Revolution is organized in Wikipedia.

Centers and bridges

Having surveyed the landscape of clusters and structural holes, we can use it as a basemap to analyze two notable positions in spatialized networks: centers and bridges.

Centrality can be global (referring to the whole network) or local (referring to one cluster). Nodes are *globally central* if they are evenly linked to all the regions of the network and *locally central* if they are predominantly linked to other nodes within their cluster. Central positions (local or global) can also be occupied by entire clusters or sub-clusters and not just single nodes.

Bridges, on the other hand, are nodes (or clusters) that are linked to some (two or more) but not all regions of the network. Bridges tend to be located between the regions they connect, if their connections are evenly distributed between them, or within one of the regions, if they are more connected to it than to the others.

In our example, the center of the network is relatively empty as a consequence of the clear divide between agriculture and genetics. The centers of the two main clusters, on the contrary, are clearly occupied by two sub-clusters: the subcluster on “A.2 Extensive vs Intensive Agriculture” at the heart of the discussion on agriculture and the B.2 sub-cluster on “genetic pollution” at the heart of the discussion on genetics. To showcase the nodes occupying central and bridging positions, we have enlarged them in [figure 63](#). As often happens, many of the central nodes share the same label as the sub-clusters in which they are located. This is not surprising as central nodes also tend to be the most representative nodes of their clusters. A notable exception is the node “Sustainable agriculture,” which, although at the center of the “A.3 Ecological Engineering” cluster, is also very connected to the cluster on “A.2 Extensive vs Intensive Agriculture.” This is an interesting example of a node that is both a cluster and a bridge.

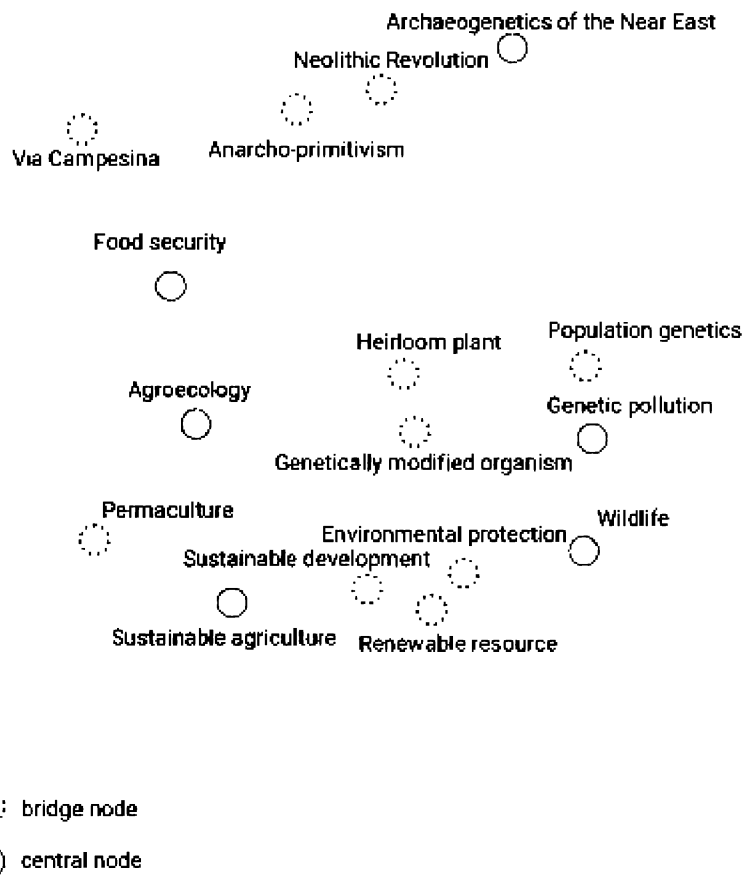


Figure 63 Central (continuous contour) and bridging (dotted line) nodes in the Green Revolution network (created by the authors; released by the authors under CC BY-SA 4.0).

Looking at the bridges, the most important is “Genetically modified organism” that connects the centers of the two main clusters and is thereby positioned near the center of the network. At least in Wikipedia, the question of GMOs (genetically modified organisms) seems to occupy a crucial position connecting the different discussions about the Green Revolution. At the bottom of the graph, three bridges (“Environmental protection”; “Sustainable development” and “Renewable resource”) unite the discussion on ecological engineering to the question of ecological conservation – suggesting a strong connection between these two debates in Wikipedia. Two more bridges, “Permaculture” and “Via Campesina,” deserve to be mentioned: without them, the clusters “C. Land rights movements” and “A.4 Permaculturalists,” respectively, would be separated from the rest of the graph.

Node ranking

The second variable of VNA, *size*, is generally used to rank the nodes in a network according to their importance. Not only is it easy to compare the area of the circles representing the nodes, but a larger dimension *literally* translates into a greater visibility. Because nodes are defined first and foremost by their connections, a typical way to rank nodes is by counting their edges (their “degree”). If the network is directed, as it is in our example, the nodes with many incoming edges (or high “in-degree”) are called “authorities,” while the nodes with many outbound edges (or high “out-degree”) are called

“hubs.” In a network of Wikipedia pages, then, authorities are highly cited pages, while hubs are pages that cite many other pages. Note, however, that when counting inbound and outbound links, we are only considering the pages of the Green Revolution network and not the whole of Wikipedia.

Looking at the authorities of our network in [figure 64](#), it is interesting to observe that they are all located in cluster A. “Agricultural Systems,” proving (once more) that this cluster dominates the discussion about the Green Revolution. Not surprisingly, most authorities are nodes that we already encountered as centers of the sub-clusters (e.g., “Sustainable agriculture”; “Agroecology”; and “Food security”) – it is precisely because they are highly cited by the other pages of their sub-clusters that these pages occupy their center. As sometimes happens, a bridge (“Permaculture”) is also one of the main authorities of the network, highlighting the importance of its connecting role. Finally, it is remarkable that all the authorities of the network concern critical aspects of the Green Revolution, such as its poor sustainability and inability to assure food security. The distribution of outbound links appears to be even more skewed than the distribution of inbound links, with one page, “Sustainable agriculture,” being by far the largest hub of the network.

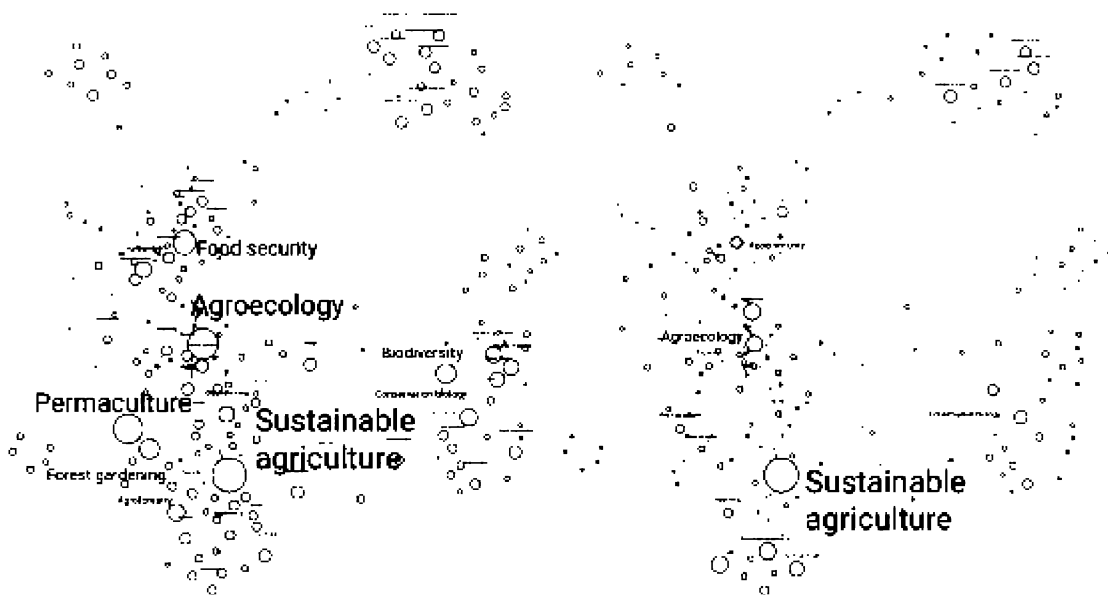


Figure 64 Authorities (left) and hubs (right) of the Green Revolution network (created by the authors; released by the authors under CC BY-SA 4.0).

Node typology

The last visual operation that can be performed on a network is to color its nodes according to some form of categorization. Each category is projected on the network as a layer of colors applied to the same base map. In our case, the nodes of the network had been manually categorized according to their thematic focus. Since hue is a “non-mixable” visual variable – a node can be red or blue, for example, but not both at the same time, nodes must be classed in mutually exclusive categories. A page, for example, can be classed in the category “ecology” or “genetics,” but not in both. In the (not uncommon) case of nodes resisting a unique classification, mappers can introduce a residual category such as “multiple” or “misc.”

Once the nodes are colored (as shown in [figure 65](#)), it is interesting to observe how the colors are distributed in the different regions of the network and, in particular, if nodes of the same color tend to be closer than nodes of different colors – thus creating a correspondence between typology and topology. When such correspondence is observed it can be used as a basis to explain differences in the density of the network.

Though the correlation between typology and topology is pretty strong in our network, it is far from perfect. The pages about genetics, for example, spread over two clusters covering both “B.1 Plant Genetics” and “D.1 Population Genetics,” which is of course to be expected. More interestingly, the pages we classified as ecology can be found both in the cluster “A.3 Ecological Engineering” and “B.3 Ecological Conservation,” thereby explaining the strong connections between the two groups of nodes at the bottom of the graph. In a symmetrical way, the cluster “A.1 Food Security,” despite the tight connection of its nodes, also contains pages that we had classified under the “agro-economics” category.

Finally, it is interesting to look at exceptions, for instance the page “Terra preta” (a type of dark, fertile anthropogenic soil found in the Amazon). Though this page describes an ancient agronomic technique, it is found in the ecology engineering cluster (and is surrounded by ecology-related pages) because it is often cited as an example of how a wise human intervention may improve the ecological balance of the soil. The page “surplus product” clearly refers to an economic notion, but it is close to the pages on prehistoric society because the agricultural revolution of the Neolithic is generally recognized at the first moment of creation of such surplus. These examples illustrate how VNA can also be used to locate possible tensions and find interesting cases to follow with other techniques.

In fact, when graph theory was introduced in the eighteenth century, it was precisely replacing a geographical representation by a mathematical one. The city of Königsberg in Prussia is built around two islands in the river Pregel. In the eighteenth century, Königsberg had seven bridges connecting the islands to each other as well as to the banks on each side. While it was possible to demonstrate by enumeration on a map that you could not visit all quarters of the city without crossing the same bridge twice, it had become somewhat of an obsession for mathematicians to *prove* this impossibility. In 1736, Leonard Euler thus turned the map of the city into a matrix of associations, laying the foundation of graph mathematics and making it possible to calculate, rather than visualize, that a complete tour of Königsberg would necessarily have to cross its own path (see [figure 66](#)). Since Euler's feat, large swaths of network science have disregarded visualization and focused instead on the mathematical appreciation of graph structures.

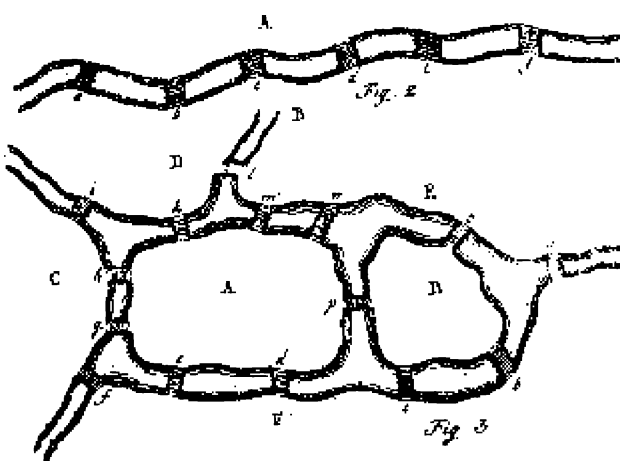
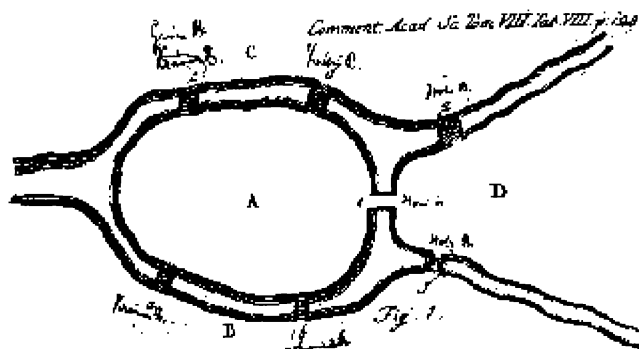
The idea of drawing networks came into its own when graph theory was applied to social phenomena by Jacob Moreno in the early twentieth century. As the founder of social network analysis (SNA), he was very explicit about the importance of visualization:

That is how the Greeks accounted for the forces of attraction and repulsion among men. It is the most beautiful Greek poetry that when love begins an arrow flies to the chosen ... Instead of searching with a torch the labyrinth of love and hatred, they had a mythical formula. We have tried to analyze this network. The forms taken by the interrelation of individuals is a structure and the complete pattern of these structures within a group is its organization. *The expression of an individual position can be better visualized through a sociogram than through a sociometric equation.* (Moreno, 1934, p. 103, emphasis added)

Visual metaphors are recurring in Moreno's writings, which seemed less interested in making social networks quantifiable than in making them observable.

Interviewed by *The New York Times*, he affirmed:

If we ever get to the point of *charting* a whole city or a whole nation, we would have an intricate maze of psychological reactions which would present a *picture* of a vast solar system of intangible structures powerfully influencing conduct, as gravitation does bodies in space. Such an *invisible* structure underlies society and has an influence in determining the conduct of society as a whole ... Until we have at least determined the nature of these fundamental structures which form the networks, we are working *blindly* in a hit-or-miss effort to solve problems which are caused by group attraction, repulsion and indifference. (*The New York Times*, 1933, emphasis added)



		16
A*	8	4
B*	4	2
C*	4	2
D	3	2
E	5	3
F*	6	3
		16

Figure 66 Turning the city of Königsberg and its bridges into a matrix of associations (original figures from Euler's 1736 paper).

For Moreno and his early followers, identifying visual patterns became the equivalent of looking for social dynamics: *graphs became graphic once again* (Freeman, 2000). This emphasis on visualization, however, gradually disappeared from the SNA tradition as the advances of graph mathematics absorbed most of the attention of social network analysts. As an indicator, a search performed in January 2020 on the index of the journal *Social Networks* for articles containing "visual*" in their titles returned only a few dozen results (about 1 percent of the 5,600 papers published by the journal in the 40 years of life of the journal). Yet, the interest in network visualization did not die out and recently surfaced again in academic and popular culture. With the inclusion of visualization modules in software for network analysis, images of networks have started sprouting up everywhere. They decorate buildings and objects; they are printed on t-shirts and posters; they colonize the desktop of our computers and the walls of our airports. Networks have become the emblem of late modernity, the very form of its imagination. This success, we believe, is connected to the *figurative power* of networks.

EMOTIONS MAPPED BY NEW GEOGRAPHY

Charts Seek to Portray the
Psychological Currents of
Human Relationships.

FIRST STUDIES EXHIBITED

Colored Lines Show Likes and
Dislikes of Individuals
and of Groups.

MANY MISFITS REVEALED

Dr. J. L. Moreno Calculates There
Are 10 to 15 Million Isolated
Individuals in Nation.

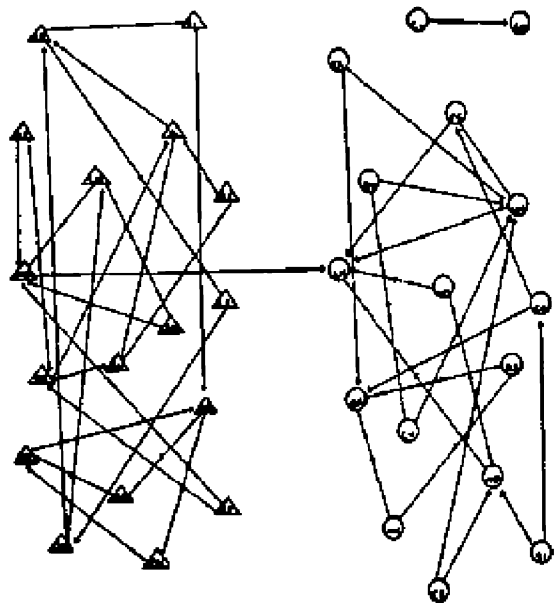


Figure 67 Left, headline, subhead and lead of Moreno's 1933 *New York Times* interview. Right, Jacob Moreno's sociogram of friendship in a class of 4th grade school students (Moreno, 1934)

The title of Moreno's interview in *The New York Times* "Emotions mapped by new geography" hints at such power, suggesting that network diagrams may have visual affordances comparable to those of geographical maps. Representing the friendship relations of a fourth-grade class through a network of triangles, for boys, and circles, for girls (Moreno, 1934, p. 38), Moreno gives us an immediate perception of the friendship patterns: the fleetest look at [figure 67](#) reveals the difficulty of cross-gender relationships (or at least the difficulty of admitting them).

Looking at Moreno's sociogram, however, we can also recognize how network visualizations are different from geographical maps. Conventional cartography (and all other Cartesian visualizations) depends on a system of coordinates independent from the items projected on it. The space of networks, on the contrary, is defined by the relations among nodes that it contains. Relational patterns are manifest only because nodes are artfully positioned in the space. It is because Moreno's nodes are placed according to their connections (rather than, for instance, to the way pupils sat in the classroom), that we can easily spot that there is only one cross-gender friendship.

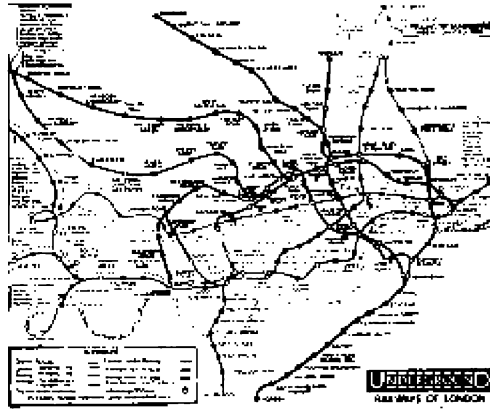


Figure 68a The London Underground map before Harry Beck's redesign (Fred H. Stingemore, 1931).

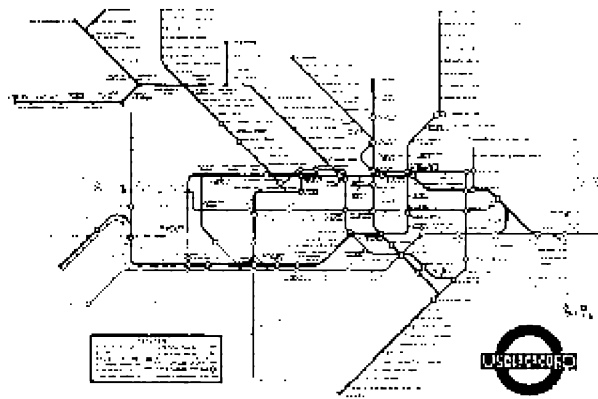


Figure 68b The London Underground map after Harry Beck's redesign (Harry Beck, 1933).

An illustration of the difference between maps and networks is offered by the diagram of the London Underground and the way Harry Beck redesigned it in 1933. Before Beck, the map was a geographical chart (the stations being located according to their geographical coordinates, see [figure 68a](#)). After the redesign, the map became a network of connections with stations positioned according to their connections (see [figure 68b](#)). The gain in legibility is such that Beck's approach not only still shapes the London Underground map, but is nowadays used by most city transportation systems.

The visual trick performed by Moreno and Beck is the same and consists in drawing closer the connected nodes and drawing apart the disconnected ones. Starting in the 1980s, this approach has been developed into a family of algorithms for network spatialization called "force-directed" or "spring-based" layouts (Fruchterman & Reingold, 1991). In these layouts, nodes are charged with a repulsive force that drives them apart, while edges act as springs binding the nodes that they connect closer together. Thus, following a physical analogy, the algorithm changes the disposition of the nodes until reaching an equilibrium of the forces of repulsion and attraction.

While this approach was originally introduced to reduce line-crossing and thereby increase graph legibility, its most interesting by-product is its ability to *give meaning* to the disposition of the nodes. In a force-directed layout, visual proximity between nodes

follows from the fact of their direct or indirect connection. More precisely, as demonstrated by Andreas Noack (2009), the visual clustering observed in force-directed layouts is fundamentally equivalent to the mathematical detection of relational communities by cutting the network in a way that makes it more “modular” (Brandes et al., 2006; Newman, 2006). This equivalence is crucial to our argument because it proves the differences in the variations of density observed in spatialized networks roughly correspond to the differences of associations in the mathematical structure of graphs. With a crucial difference: while mathematical clustering imposes a clear-cut dissection of the network, visual clustering maintains a fuzziness that matches the ambiguity of collective phenomena.

This is the source of the figurative power of networks, the deepest bond between Actor-Network Theory and network analysis and the basis of visual network analysis. Thanks to force-directed layouts, the focus on associational density demanded by ANT can be operationalized through a series of techniques to explore networks visually. This allows us to *see*, quite literally, the separations within a controversy without presupposing them.

Exploratory data analysis and visual methods

With its capacity to translate complex network structures into observable graphical patterns, VNA comes in handy for the exploration of large relational datasets. Introduced by John Wilder Tukey (1977), exploratory data analysis (EDA) is an approach that aims at discovering new questions through a descriptive inquiry into the data, rather than validating existing hypotheses as in classic confirmatory data analysis. EDA is less interested in finding evidence than in developing “a sense of intimacy with the nuances of the data, ... against the routine use of statistical procedures ... [which] obscures the individual nature of the data, removes the analyst from the details of the world held in the data, and impedes the development of intimacy” (Behrens & Chong-Ho, 2003, p. 35).

EDA employs a variety of computational techniques to extract condensed indicators about the composition of data but is also particularly keen in its use of visual diagrams. More than numbers, images arouse intuitions and raise questions. VNA can be counted among these exploratory techniques because of its visual focus but, more importantly, because of the ambiguous nature of its observations, which forces us to remain attentive to the specificities of the phenomena that we explore.

Because of this “blurriness,” VNA differs from most other visual techniques whose goal is to present data in the clearest and most visually parsimonious way (cf. Cleveland, 1985, 1993; Tufte, 1990, 1997). Edward Tufte (1983) famously affirmed that designers should maximize the data/ink ratio, focusing as precisely as possible on the message they want to convey (see also Wainer, 1984). While this principle of communicative economy remains valid, VNA aims less at conveying messages than at offering ways to delve into relational datasets. It leaves space for interpretation and this is precisely what makes it suited for the kind of exploratory data analysis we introduced above. Citing Tukey again (1962):

“[it is] far better an approximate answer to the *right* question, which is often vague, than an *exact* answer to the wrong question, which can always be made precise.” Data analysis must progress by approximate answers, at best, since its knowledge of what the problem really is will at best be approximate. (p. 14, original emphasis)

Maintaining margins of ambiguity is essential in controversy mapping whose objective is not to validate a set of hypotheses derived from a pre-existing theoretical framework but to explore the richness of sociotechnical debates. It is also generally appreciated in interpretative social sciences and humanities. As observed by Johanna Drucker (2011), because of the fuzziness of their subjects, much socio-cultural research cannot bear the degree of exactitude implied by conventional statistics:

The most striking feature distinguishing humanistic, interpretative, and constructivist graphical expressions from realist statistical graphics is that the curves, bars, columns, percentage values would not always be represented as discrete bounded entities, but as conditional expressions of interpretative parameters – a kind of visual fuzzy logic or graphical complexity. Thus their edges might be permeable, lines dotted and broken, dots and points vary in size and scale or degree of ambiguity of placement, and so on. These graphical strategies express interpreted knowledge, situated and partial. (Drucker, 2011, p. 5)

The strength of VNA thus comes from its capacity to conserve some of the ambiguity of the phenomena it represents. Where are the frontiers of a group? Which nodes occupy the center of a community? Which edges bridge separated social regions? None of these questions has exact answers in social research and none is imposed by network visualizations. Where most community algorithms generate clear-cut and non-overlapping partitions, force-directed layouts reveal zones of different relational density but with unclear borders. Network mathematics is great to test relational hypotheses, but network maps can be more useful when the problem is to explore controversial phenomena. Network maps are productive not despite their ambiguity, but because of it: they help researchers problematize their observations.

The magmatic nature of relational phenomena

The use of networks for the study of sociotechnical debates began with the book we already indicated as the foundation of controversy mapping. In *Mapping the Dynamics of Science and Technology* (Callon et al., 1986), the editors justify the study of scientometric records with reference to their relational nature:

The force of such texts also resides in the fact that they contain links with other texts (references to the literature), work and institutions. These are built into the world presented in the text and may thus be transmitted between contexts. In sum, *texts make possible the construction of linkages between existing entities and the formation of novel entities*. (pp. 10 and 11, emphasis added)

But the alliance between network analysis and ANT really gained momentum when digital traces entered the picture. In one of the first papers on digital methods, Noortje Marres and Richard Rogers (2005) set out to trace the “fate of issues and their publics on the Web” (as the title of the paper reads) and found that online controversies tend to be organized as “issue-networks”:

We took to the Web to study public debates on science and technology, but we found “issue-networks” instead ... Following hyperlinks among pages dealing with a given issue, we found that these links provided a means to demarcate the network that could be said to be staging the controversy in the new medium. (Marres & Rogers, 2005, p. 922)

Every time we receive a LinkedIn invitation, our professional field becomes more like a social network. When it is articulated through Instagram likes, popularity literally becomes a matter of connection. And when we shop online, we increasingly expect to see “Customers Who Bought This Item Also Bought” displayed next to each product. The more it passes through the relational technologies of the Internet, the more collective life can be captured as network data, read through the theory of networks, and made available for analysis through network visualization.

But there is a second reason why networks are interesting for controversy mapping and it relates to the way in which their analysis makes us sensible to the differences in the density of association. Saying that digital sociality is characterized by a heterogeneity that overflows traditional sociological divides does not mean to say that no distinctions can be drawn. On the contrary, as soon as the classic micro/macro opposition is abandoned, many other differences become visible (cf. the example we provided in [chapter 4](#) on actors and television series or university professors and professional affiliations). These differences are *manifold* (multiple rather than binary), *situated* (relevant to some situations, but not to others) and, above all, *dynamic* (constantly changing at different paces). Zygmunt Bauman (2000) has called this organization of collective life “liquid” to highlight the way in which traditional categories and boundaries are constantly redefined:

We are presently moving from the era of pre-allocated “reference groups” into the epoch of “universal comparison,” in which the destination of individual self-constructing labours is endemically and incurably underdetermined ... These days patterns and configurations are no longer “given,” let alone “self-evident”; there are just too many of them, clashing with one another and contradicting one another’s commandments. (p. 7)

We prefer the term “magmatic” (Venturini, 2010) as it also includes the possibility of the gradual or sudden crystallization of the social flow and the emergence of relatively stable arrangements that embank collective action until the break of the next controversy. In magma, solid and liquid states exist in a ceaseless mutual transformation: while, at the margins of the flow, the lava cools down and crystallizes, some solid rock touched by the flow melts and becomes part of the stream. The same fluctuation between different states of solidity can be observed in controversies. Through this dynamic the social is unremittingly constructed, deconstructed, and reconstructed.

Networks display the same magmatic nature. They are *liquid* in the sense that their global equilibrium can at any moment be transformed by changes in the connectivity of important nodes, but they are also *solid* in the sense that local clusters can be extremely resistant to external pressures because of the high density of association between their nodes. Network analysis resonates well with Actor-Network Theory because both have roots in the same “relational thinking” (Emirbayer, 1997) – the idea that individuals and institutions, nodes and structures are the consequence, *not* the causes, of the flow of associations and dissociations. In the words of Sophie Mutzel:

Both of these approaches reject a priori reifications such as “the social” or “society”; instead, these notions are constructions out of social enmeshing and become only observable ex-post. Both resist reference to the representational or the symbolic; instead, they focus their empirical analyses on material reality and the meanings actors themselves ascribe to it in struggles and controversies. Both of these approaches consider the production of meaning as an activity of connecting/disconnecting and analyse how actors come to be created through collaborations of other actors in different contexts. The stories actors tell make the links between them explicit. For both approaches, the ties precede the nodes. (Mutzel, 2009, p. 878)

In network analysis as in ANT, the crucial information does not concern the essence of entities – their identity or properties – but the associations (and dissociations) among them (White, 2008). More precisely, what counts are the differences in the density of connections. The fabric of networks and of actor-networks is continuous but not uniform. It alternates regions that are denser in nodes and edges and regions that are sparser. This variation in the density of associations fits both the theory of actor-networks and the experience of digital sociality. And this is why the association of these two types of network analysis became an emblematic tool of controversy mapping.

Networks are not actor-networks

While advocating for the operationalization of ANT through network analysis, we must also highlight three crucial differences between the two approaches: (1) the heterogeneity of nodes and edges; (2) the reversibility of actor-networks; (3) the dynamics of relational change (see also Munk, 2018; Venturini et al., 2019).

The heterogeneity of nodes and edges

The first difference between networks and actor-networks is pointed out by Michel Callon in the very paper that introduced the notion of the actor-network:

[an actor-network] is distinguished from a simple network because its elements are both heterogeneous and are mutually defined in the course of their association. (1986, p. 32)

We discussed in [chapter 3](#) how important it is for ANT to extend the notion of *actors*, to include not only individuals, but also collective and non-human entities. At first glance, this openness is well attuned to the agnosticism of graphs, which have been used to represent almost anything from websites to neurons and from proteins to citations. Yet, while actor-networks allow and even prescribe the assemblage of items of different nature, networks tend to flatten qualitative differences. To be sure, it is possible to build networks whose nodes represent entities of different types (see, for instance, Cambrosio et al., 2004), but such differences generally do not affect the way in which nodes associate.

As for the edges of networks, the difficulty of handling heterogeneity is even greater. Take a network from Facebook: as long as the edges are limited to one type of connection (say friendship links), graph analysis is straightforward (cf. Rieder, 2013), but trying to combine different relations immediately raises the problem of weighting: how many “likes” should count as equivalent to a comment? Is sharing a text a stronger or weaker connection than sharing an image?

Negative relations are especially complicated. Collective phenomena are characterized by oppositions as much as by alliances (and actors are defined by their enemies as much as by their friends; think of the notion of anti-programs introduced in [figure 29](#)), but conventional network analysis offers no convincing way to handle negatively charged edges. The only form of opposition recognized by graphs is the lack of association. In citation analysis, for instance, it is commonly accepted that “there is no such thing as negative publicity.” Garfield, one of the fathers of scientometrics, makes it very clear: “If scientists tend to ignore inferior work that is of little importance, then the work that they do go to the trouble of formally criticizing must be of some substance. Why, then, should negative citations be considered a sign of discredit?” (1979, pp. 361, 362). While this argument makes sense when studying academic celebrity or visibility in general, giving up the distinction between positive and negative connection is highly problematic in sociotechnical debates because it makes us blind to the difference between alliances and oppositions which, of course, is the defining feature of a controversy. This is particularly dangerous in digital media, where the incapacity of most platforms to distinguish between positive and negative attention has allowed rogue political actors to turn Internet trolling into a highly effective electoral strategy (the most infamous example being the 45th President of the United States; Merrin, 2019). Still, no straightforward solution exists for this problem. While studying controversies in Wikipedia, for instance, we could easily trace “reverts” (the action of discarding a whole block of edits by changing a page back to a previous version), but we had no way to represent these agonistic edits in a force-directed layout (in which, as explained above, edges always express an attractive force). Instead, we were obliged to turn them into positive relations according to the principle of “my enemy’s enemy is my friend.” Rather than showing that editor A and B were both opposed to editor C, we inferred that A and B were allied (Borra et al., 2014).

The reversibility of actor-networks

In [chapter 4](#), we explained how the hyphen in “actor-network” should be read as an equal, not as a plus, and that “ANT is not a theory of actors *and* networks, but a theory of actors *as* networks”:

To follow an actor-network is a bit like defining a wave-corpuscle in the 1930s: any entity can be seized either as an actor (a corpuscle) or as a network (a wave). It is in this complete reversibility – an actor is nothing but a network, except that a network is nothing but actors – that resides the main originality of this theory. (Latour, 2010a, p. 5)

This reversibility is absent from graph mathematics, where nodes and networks are described by different properties and measured by different metrics. In network analysis a substantial difference separates nodes (indivisible and impenetrable) and networks (global and composite) in line with the classic sociological divides (micro/macro, interactions/structures) rejected by ANT. When network analysis nonetheless remains relevant for the study of actor-networks, it is because the conceptual separation between nodes and networks is less significant in the actual technique of visual network exploration. All the key properties of nodes depend more or less directly on the overall topology of the network and, conversely, all the key properties of the network depend on the local arrangement of nodes and edges. The importance of a node, for instance, depends not only on its number of connections, but also on the global configuration of the graph. A scarcely connected node can still be highly influential if its neighbors and neighbors of

neighbors are well-connected (a property that is famously captured by the Google PageRank algorithm; Page et al., 1998; Rieder, 2012). Likewise, as discussed in the previous chapter, the global diameter of a network can be drastically reduced by a few hyper-connected individuals.

The dynamics of relational change

Another divergence between Actor-Network Theory and network analysis concerns time. Whereas ANT is primarily a theory of change (focusing not on the structure of associations but on their dynamics), network analysis is deeply associated with a static approach. In the words of Mustafa Emirbayer:

Paradoxically (for a mode of study so intently focused upon processuality), relational sociology has the greatest difficulty in analyzing, not the structural features of static networks, whether these be cultural, social structural, or social psychological, but rather, the dynamic processes that transform those matrices of transactions in some fashion. Even studies of “processes-in-relations,” in other words, too often privilege spatiality (or topological location) over temporality and narrative unfolding. (Emirbayer, 1997, p. 305)

The difficulty of dealing with complex dynamics through graphs is probably one of the reasons why *none* of the diagrams appearing in the founding texts of ANT are networks, but rather sketches of translation stages (Callon, 1986), programs and anti-programs (Latour et al., 1992), or merges and separations (Law & Callon, 1992). To be sure, it is not that graph mathematics is not interested in dynamics. After all, classic applications of network theory include the routing of trains and communication lines, but movement in graph theory is mainly movement *through* networks, rather than movement *of* networks. Rooted deep in graph mathematics is the separation between what flows (ideas, goods, signals, etc.) and what stays (the infrastructures constraining the flow). This separation is problematic for ANT, which has always assumed that flows define structures and not the other way around: as trails left by children running through uncut grass rather than trains bound by the routes of their tracks. This is another reason why many actor-network theorists have been uncomfortable with graph topology and why John Law and Annemarie Mol proposed replacing the metaphor of networks with the constant transformation of “fluid spaces” and the constant overflowing of “fire spaces” (Mol & Law, 1994; Law & Mol, 2001).

This problem of a lack of dynamics in network analysis is particularly acute in the case of sociotechnical debates (Munk, 2018). Controversies are interesting precisely because they upset the way the social fabric is woven, changing the formation of groups and identities, fostering new alliances and breaking old ones. Controversies are tectonic forces that break and transform the shape of social territories. They make and remake space (Massey, 2005). As a consequence, social cartographers can never simply project the trace of a new debate on a standard map of the collective space, but are forced to rebuild their “base map” at each case study.

Part Three

Politics of mapmaking

8

Representing controversies

In this chapter, we learn some lessons from the history of cartography about the social and political implications of mapmaking, the notion of objectivity, and the narrative and exploratory potentials of atlases.

The technique of visual network analysis introduced in the previous chapter exemplifies the ambition to not only investigate the complexity of sociotechnical debates, but make it visible by putting the multiple and heterogeneous components of a controversy on the same plane. This is why controversy mapping is indeed a form of cartography. It bears similarities with geographical mapping and especially with the surveying of new land. As discussed in the previous chapter, the goal is to chart each controversy *as* a space (i.e., a *terra incognita* surveyed for the first time), rather than *onto* a space (i.e., pinning entities to an existing map of a well-known territory).

In October 2019, we were invited to make a cartographic intervention at the Global Forum on Artificial Intelligence for Humanity (GFAIH). Convening more than 400 experts from industry and research at the Académie des Sciences in Paris, the forum was meant to encourage discussion about the human and social consequences of artificial intelligence (AI). In this context, we decided that our intervention should aim at diversifying the forum's conversations and avoiding them centering too narrowly on engineering and computer science. To do so, we developed a series of maps exploring the different issues, disciplines, and institutions mobilized by the scientific literature on "AI for humanity."

Querying ISI Web of Science (see [figure 54](#) in [chapter 6](#)), we collected a corpus of 23,000 bibliographic records for articles and conference papers published on societal questions connected to advanced computation technologies. We extracted all the references present in three or more records and built a network in which two references were connected if they co-appeared in the same bibliographies, according to the technique of bibliometric coupling (Thelwall & Wilkinson, 2004). We spatialized this co-citation network with a force-directed layout and fixed the position of the nodes. We used the resulting diagram as a *base map* on which we projected the keywords, disciplines, and institutions present in each record, sizing them according to their frequency (see [figure 69](#)). Printed as four large posters, the maps were displayed on a table around which the participants of the forum were invited to gather and discuss interpretations. In this intervention, we furthered the technique of VNA in two interesting ways.

Our first innovation was to remove the two most common elements of network diagrams, namely nodes and edges. We replaced the edges of the base map with a *density heatmap*, in which regions with higher concentrations of nodes were filled with darker color. We also removed the points representing the nodes and left only their labels, to obtain a diagram that looked like a combination between a contour map and a word cloud.

Second, by projecting different types of information (keywords, disciplines, and institutions) on the same reference base map, we encouraged the participants of the forum to engage with our diagrams. To make sense of the atlas, they had, at the very least, to shift their gaze from one map to the other and learn to distinguish the unvarying element (the density map) and the varying one (the labels projected onto it). This nudged the people who engaged with our maps to consider them not just as illustrations, but as navigational devices, an active posture which was reinforced by the setup of the intervention. The maps did not hang on the wall but were spread horizontally on a large table where participants could move them around and mark them with pens and highlighters (e.g., noting down their position in the landscape or circling in their allies and the issues that concerned them). Their interaction with the maps was live broadcast on a widescreen at the entrance of the forum, so that most participants saw other individuals interacting with the maps before seeing the maps themselves (see [figure 70](#)).

Regrettably, however, our atlas may have failed to highlight some of the controversies that are hidden behind an event like the GFAIH that, sitting between the scientific conference and the technological fair, was by construction consensual. Our atlas encouraged the comparison between different issues, disciplines, and institutions, but not the appreciation of the tensions opposing them. This is often the problem with networks, which are great to show association and clustering but lack the visual and mathematical tools to reveal diverging viewpoints. Consider the two images in [figure 71](#). The one on the left displays our network with a classic points-and-lines representation. The problem with this type of diagram is that it represents the graph from a perspective that no one will ever be able to take: a sort of god's eye view from where all entities and their connections are perfectly visible. This is not the view we had of our ISI Web of Sciences corpus, which would have been better rendered by the image on the right in which clusters of literature appear as hazy masses and in which only the most visible keywords are identifiable.

But we could do better than that. Instead of just making the image blurrier, in an attempt to render the myopic view of an external observer, we could have tried to present a view from somewhere in the landscape. In [figure 72](#), we visualize the same network as seen from the viewpoint of the two most cited references in our corpus, situated in two different regions of the network, roughly corresponding to the social sciences and computer sciences.

relational phenomena include the viewpoint from which they are observed – the closer the things are that we observe, the more distinct they will appear; the further the more blurred and subsumed by large categories. Seen from these particular vantage points, AI appears for what it is: a multiple and situated object – a classic lesson of controversy mapping.

Maps as descriptions

While controversy *analysis* can be traced back at least to the work of Dorothy Nelkin in the early 1970s, controversy *mapping* was introduced in the 1980s, by Bruno Latour, Michel Callon and their colleagues at the Centre de Sociologie de l’Innovation to teach STS to the students of the École de Mines, a time-honored engineering school in Paris. Instead of imposing a theoretical instruction in STS and ANT, they asked their students to draw up the inventory of a controversy of their choice (see also our conversation with Bruno Latour in the postscript), thereby giving them a hands-on experience of the complexities of technoscience in society. Who are the actors? What are the main points of contestation? What are the sites where the controversy occurs? And what are the main events through which it unfolds? Answering such questions was not only the starter for a more sophisticated analysis but also a reliable eye-opener for STS newcomers, who were frequently surprised by how sprawling the answers could be. Seeking open-minded answers to seemingly simple questions about who, what, when, or where turned out to be a major analytical task and an effective way to train students in the anti-theoretical stance of ANT.



Figure 71 The same network of scientific literature related to “AI for humanity” as seen (left) from a non-expert observer perspective and (right) from a god-like perspective (created by the authors; released by the authors under CC BY-SA 4.0).



Figure 72 The same network of scientific literature related to “AI for humanity” as seen from the perspective of the most cited reference (left) in the social sciences (danah boyd & Kate Crawford, 2012, “Critical questions for Big Data, information” in *Communication b Society*, 15:5), and (right) in computer sciences (Leo Breiman, 2001, “Random forests, in *Machine Learning* 45:1) (figures created by the authors; released by the authors under CC BY-SA 4.0).

This is the first sense in which controversy mapping is indeed a form of mapping – a descriptive practice that records and inscribes relations (e.g., Callon et al., 1986; Bingham & Thrift, 2000). This is slow and laborious ant work, as Bruno Latour pointed out:

I was ready to drop this label for more elaborate ones like “sociology of translation,” “actant-rhizome ontology,” “sociology of innovation,” and so on, until someone pointed out to me that the acronym A.N.T. was perfectly fit for a blind, myopic, workaholic, trail-sniffing, and collective traveler. An ant writing for other ants. (Latour, 2005b, p. 9)

The notion of mapping stresses here the importance of producing a thorough description *before* adding interpretative or conceptual layers. Refraining from deciding in advance what qualifies as an actor, which issues are pertinent, or how they align with each other and instead following the associations woven and unwoven by the protagonists of our controversies. In a previous paper, we called this posture “just observe”:

If Latour glued “just” to “observe,” it was to prevent students from reducing investigation to a single theory or methodology. In the cartography of controversies, all concepts and all protocols deserve consideration, especially if they come from actors themselves. All shortcuts declined, observation is compelled to be as rich and complex as its subjects. (Venturini, 2010, p. 268)

Mapping as describing is thus a basic observational technique that ANT analysts must deploy, regardless of how they choose to use its results at a later stage. It encourages

cartographers to open black boxes and stay relational, but it does not insist on the representational meaning of “maps” or “mapmaking.” It is a form of mapping, if you will, that does not require visualization.

This preference for description over prescription, to be sure, is not limited to ANT and, interestingly, the cartographic metaphor seems to be used in similar ways in other schools. For example, Ottmar Edenhofer (co-chair of the Working Group 3 for the IPCC 5th Assessment Report) uses the notion of mapping to describe the mission of the IPCC to be “policy relevant but not policy prescriptive”:

Researchers, along with stakeholders, act as the “cartographers” of different, viable policy pathways and their practical consequences by acting as the “mapmakers” of the political solution space. They provide a guidebook with alternative options for policymakers (i.e., the “navigators”) and the public. Such maps cannot replace travelling (i.e., decision-making), nor can they resolve all environmental policy conflicts, yet they can provide an important orientation in otherwise uncharted territory. (Edenhofer & Kowarsch, 2015, p. 63)

This use of “mapping” as a metaphor for scoping new situations has a radically empirical flavor in both ANT and controversy mapping, which entails that research should never move too far from what is observed in the field or traced in digital records. In the words of Bruno Latour: “No trace left, thus no description, then no talk. Don’t fill it in. It’s like a map of a country in the sixteenth century: no one went there, nor did anyone come back – so leave it blank! Terra incognita” (Latour, 2004a, p. 70).

Maps as spaces for commensuration

Dissuading us from using theoretical assumptions to simplify our objects of study, ANT also condemns us to dealing with a multitude of entities and arguments that are *heterogeneous* and *freely associated* (following Callon, 1984). The source of trouble here is not so much the number of these items, but their irreducible diversity: how can we arrange public institutions, individual whistleblowers, ecological equilibria, chemical molecules, moral principles, legal provisions, and who knows what else in the same associational space? How can we make the different actions and actors of a controversy comparable and commensurable, that is measurable according to the same relational scales? The problem of heterogeneity encourages the controversy analyst to consider a second more literal interpretation of “mapping”:

Issue mapping takes as its object of study current affairs and offers a series of techniques to describe, deploy, and visualize the actors, objects, and substance of a social issue ... Ultimately, the aim is to produce mappings that will aid in identifying and tracing the associations between actors involved with an issue, and to render them both in narrative and in visual form so that they are meaningful to one’s fellow issue analysts and their audiences. (Rogers et al., 2015, pp. 9–10)

Mapping here is not just a metaphor for rigorous description, but an ambition to produce *visual* representations that will help actors to make sense of the issues they are dealing with. These maps do not have to be geographical but are intended as spatial representations. As such, they fit the wide definition of maps introduced by Harley and Woodward in their *History of Cartography* (1987): “maps are graphic representations that facilitate a spatial understanding of things, concepts, conditions, processes, or events in the

human world” (p. xvi). In this sense, mapmaking is the representation of heterogeneous elements in visual space that facilitates their comparison and the investigation of their associations.

In his book on the history of cartographic thinking, David Turnbull (2000) suggests an affinity between the development of mapmaking techniques and the emergence of modern science (see also Robinson & Petchenik, 1976). In both cases, the objective was to create an abstract plane where different entities could be located and measured against each other. Turnbull makes his argument by citing Marshall McLuhan:

Maps are a prime vehicle for repositioning, reframing, rethinking science because theories are maps, maps are science instantiated, without maps science would not have been possible. The art of making pictorial statements in a precise and repeatable form is one that we have long taken for granted in the west. But it is usually forgotten that without prints and blueprints, without maps and geometry, the world of modern science would hardly exist. (McLuhan, 1964, p. 157)

Both mapmaking and scientific research do more than just reproduce the natural configuration of the world, they create a new dimension in which distant things are made *commensurable*. And in both cases, the comparability demands considerable methodological and organizational efforts. Noting the 121 years it took to draw the *Carte de Cassini* (the first national map based on a unified triangulation grid), Turnbull observes:

Ultimately the national map could only be achieved by bringing into line not only the King, but also the satellites of Jupiter, pendulum clocks, telescopes, surveying chains, trigonometry, quadrants, new printing techniques, all the provinces of France and the earth itself. In aligning all these places, practices, people and instruments a new space was created, a space that we now take for granted, but one which did not come into existence naturally or even easily, requiring as it did the physical and social labour of tying France together with surveying chains. (Turnbull, 2000, p. 120)

If maps today provide a standardized space for locating heterogeneous phenomena, it is only thanks to the work of generations of geographers, astronomers, explorers, navigators, *and their powerful sponsors* (Jacob, 1992). From the beginning of the sixteenth century (when the Spanish monarchs tried to standardize the map of the New World) to 1787 (when the meridians of Paris and Greenwich were triangulated on the same longitudinal system), huge difficulties had to be surmounted to patch a multitude of local practices of orientation into a standardized plane of reference. The construction of a coherent geographical space would not have succeeded without the support of powerful allies, in particular the nascent modern states (Buisseret, 1992).

As it happens, however, it is not necessarily in such standard topographical space that the differences most relevant to controversies are usually found. Scientific groups and expert communities are not typically delimited on a geographical basis; neither are protest movements or institutions. A controversy could upset the way social groups relate to each other, bringing them closer or driving them apart, with no change in their geographic locations. Controversy mapping needs spatial planes to make its heterogeneous entities commensurable, but these planes are closer to the tentative diagrams of early cartography than to the standard grid of current geography.

First of all, controversy mapping needs a *non-standardized* notion of space, one in which proximity and distance can be adapted to the nature of the dispute at hand. Contrary to

modern geographical maps, controversy representations cannot presuppose the existence of a standardized space. In this sense, they are akin to the portolan charts used by sailors before the introduction of the Mercator projection. Though debate still rages over whether or not these charts employ some geodesic projection (Tobler, 1966; Boutoura, 2006), historians generally agree on the fact that portolans do not offer a fully-fledged spatial grid but just an ensemble of distance and direction. Portolan charts are maps of relative locations, lists of directions between notable points, and controversy maps provide a similar orientation. They cannot offer a fixed space where entities can be projected on the basis of their coordinates, but they provide some representation of the position that actors occupy *relative to each other*.

As discussed in the previous chapter, this is why controversy mapping has adopted network visualizations to represent its associational spaces. Networks are useful visual objects, as they are both relational (their structure is defined by the associations among their nodes), and spatial (embodying notions like proximity, regions, bridges, path, etc.). As Latour has suggested, they offer an alternative way of defining the space of associations: “the notion of network helps us to lift the tyranny of geographers in defining space and offers us a notion which is neither social nor ‘real’ space, but associations” (Latour, 1996b, p. 371).

The graph in [figure 73](#) is an example of a non-geographical map, what we might call a “self-grounding” chart: a representation that creates its own space instead of exploiting a pre-existing one. It visualizes 20 years of international negotiations on climate change as a network of interrelated topics. The terrain, so to speak, consists of the negotiations of the UN Framework Convention on Climate Change (UNFCCC) as covered by the reports of the *Earth Negotiations Bulletin*. In the network, the expressions that often co-appear in the same paragraphs of the bulletin are connected and clustered together in 12 groups corresponding to the main issues discussed in the negotiations.

Eight clusters are related to the question of “mitigation” (the efforts to reduce the impact of climate change by reducing the emissions of CO₂) and are outlined with dashed lines. Three are related to the question of “adaptation” (the efforts to cope with the impacts that we will not be able to mitigate) and are outlined with dotted lines. Looking at the position of these issue-clusters, one can observe the difference between mitigation and adaptation (the two main pillars of climate negotiations). While the clusters related to mitigation are scattered across the graph, the clusters related to adaptation are tightly grouped at the center of the map. This reflects their different status in the UNFCCC negotiations: where mitigation is the primary objective of the conference, and is thus omnipresent but also dispersed, the discussion on adaptation is more specialized, but also more central.

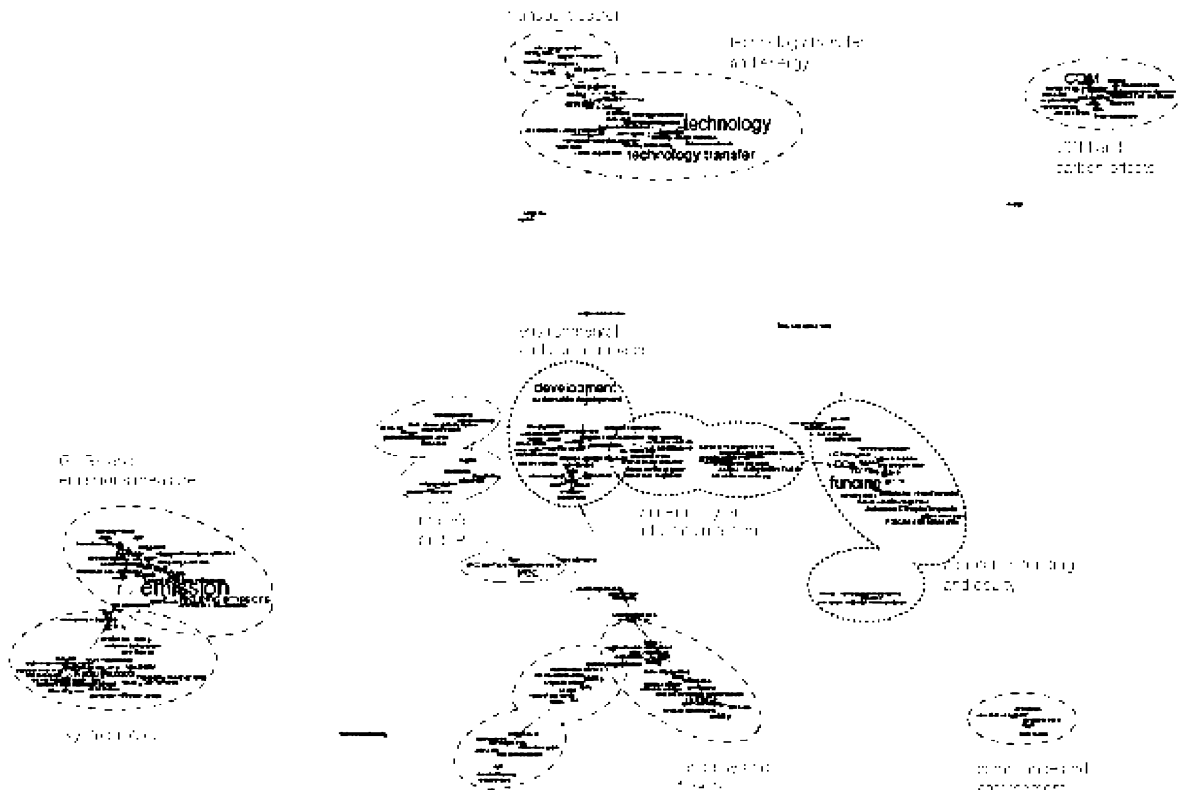


Figure 73 Negotiations in the United Nations Framework Convention on Climate Change (1995–2013) mapped as a network of co-occurring noun phrases. Figure adapted from the EMAPS project, climaps.eu (Venturini et al., 2014; licensed under CC BY-SA 4.0).

Note that the interpretation of the map can refer only to the *relative* position of the clusters. It does not matter, for instance, that the fuel and transport discussion is in the upper part of the graph, or that land use and forests is in the lower part. What counts is that these two issues find themselves at *opposite* ends of the network, indicating that they are seldom discussed together. This is what we mean when we say that relational maps resemble portolan charts rather than Mercator projections.

A second aspect in which controversy mapping differs from modern cartography is its poorer visual sophistication. Debate maps, even the best ones, are never as clear as geographical maps. On the one hand, this could simply be a matter of evolution. Whereas geographical cartography originated two millennia ago (if one takes the works of Eratosthenes and Ptolemy as foundational), the cartography of controversies is still in its infancy. To overcome hard problems like longitude and projection, geographical mapmaking solicited help from neighboring disciplines like astronomy, geodesy, chronometry, and mathematics. Controversy mapping is in a similar interdisciplinary predicament, but still a far cry from achieving the legibility of geographical maps (cf. Dodge et al., 2011, pp. 193–296). This, however, is not always a disadvantage. What controversy maps lack in visual purity, they might gain in their capacity to display the messiness of collective phenomena. As John Brian Harley pointed out in his essay on “Deconstructing the map” (1989), the smoothness of geographical maps derives in part from the way in which they silence some aspects of reality to make others more salient: “where, on the page, is the variety of nature, where is the history of the landscape, and where is the space-time of human experience in such anonymized maps?” (p. 13). Every

map, be it a controversy or a geographical one, must choose which entities to privilege and which to hide. In this sense, every map is a lie, and the more visually refined it is, the easier it is to be deceived by it. Mark Monmonier, who wrote an entire book on *How to Lie with Maps* (1991), makes it clear: “There’s no escape from the cartographic paradox: to present a useful and truthful picture, an accurate map must tell white lies” (p. 1). The legibility of geographical maps comes in part from the artistry of their designers, but also from the simplification and standardization that have been imposed on the spaces they depict. Such simplicity is denied to controversy maps which are, by definition, maps of contested territories, whose frontiers are shifting, and whose features are under constant transformation. This is why some roughness and imperfection should be preserved in controversy maps: their very objective is to reveal the struggle between different ways of simplifying collective situations.

Maps as instruments of power

The acknowledgement that every map privileges some aspects of its territory and conceals others reminds us that while looking at a map one should always consider its particular affordances. In other words, what is it good for? Not unlike geographical maps, controversy maps are often designed in response to *navigational* needs. Not in the sense of sailing the sea but in the sense in which, according to Lucy Suchman, “map-based navigation” has become the modern archetype of intentional action: “the European navigator exemplifies the prevailing cognitive science model of purposeful action ... the view, that purposeful action is determined by plans, is deeply rooted in the Western human sciences as the correct model of the rational actor” (1987, pp. 25, 27).

As an example of this navigational function, we transformed the network introduced above to serve a specific navigational purpose, namely to negotiate the twists and turns of climate diplomacy. To do so, we relied on the issue-clusters and used them as thematic dictionaries to identify topics in the negotiations. In the streamgraph in [figure 74](#), each topic is represented by a flow whose size varies from year to year proportionally to the visibility of its topic – measured by the number of paragraphs of the *Earth Negotiation Bulletin* that contain at least two terms of the corresponding dictionary. The flows are also sorted so that, for each Conference of Parties (COPs), the highest flow corresponds to the most visible theme in that COP, while the lowest corresponds to the least visible. For example, “Adaptation funding & equity” is the most visible issue in the first COP and “Post-Kyoto and Redd” is the most visible in the last.

The issues related to the adaptation to climate change are highlighted in [figure 74](#), revealing how in the earliest COPs, adaptation was considered almost exclusively from the angle of its *financing* (an issue strongly pushed by developing countries). In the second phase of the negotiations, however, with most parties failing to achieve their mitigation objectives, an “adaptation turn” can be recognized in the rise of the question of vulnerability (from COP10 to COP14) and in the more recent ascent of the question of the climate impacts (from COP16 on). This second map therefore not only shows the relative position of diplomatic issues, but also tries to reveal how climate diplomacy navigated through different topics from COP to COP.

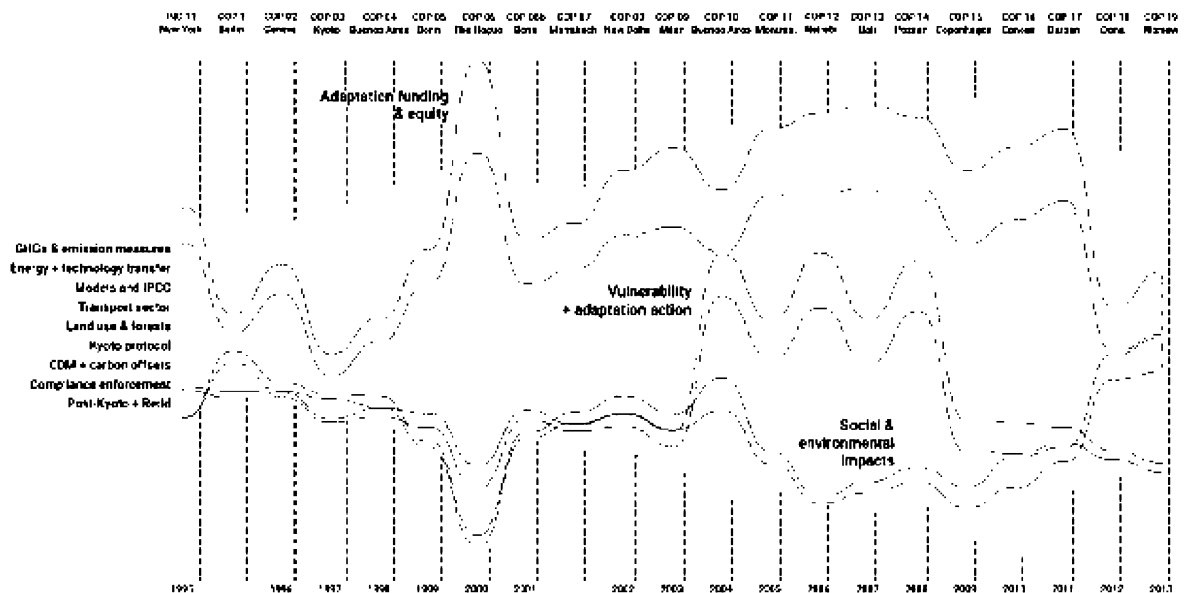


Figure 74 Rise and fall in the visibility of issues in the international climate negotiations (the streams directly related to the question of climate change adaptation are highlighted). The visualization shows the temporal evolution of the semantic clusters in figure 73 (adapted from the EMAPS project, climaps.eu, Venturini et al., 2014b; licensed under CC BY-SA 4.0).

Important as it is, however, navigation has never been the only objective of cartography. While maps are certainly helpful when we have to find our way, they are also effective instruments for transforming the spaces we are trying to navigate. Ancient Romans, for example, deployed their cartographic skills not only to travel through their dominions, but also, and more importantly, to rule them. More than tracing the routes of the existing roads, their maps served to build new ones:

Romans had little interest in theoretical consideration of form and in methods of laying down geographical data on a sheet of paper; ... they did not consider it worthwhile to argue about the relative merits of projection or systems of coordinates. They were interested in practical questions. They measured the distances between various places, not in order to establish their latitude or longitude, but for the practical purpose of making as accurate a record as possible of military and trade routes. (Bagrow, 2010 p. 38, cf. also Nicolet, 1991)

Geography has always been a tool for warfare, as we are reminded by Yves Lacoste's book (1976), *La Géographie, ça Sert, d'abord, à Faire La Guerre* (geography is first and foremost meant to wage war). Too often this military origin of mapmaking is neglected in favor of its more respectable maritime ancestry. We cited above how one of the IPCC's co-chairs mobilized cartography to explain how scientists should act as "map-makers" and "provide a guidebook with alternative options for policymakers (i.e., the 'navigators')" (Edenhofer & Kowarsch, 2015, p. 63). How different would this metaphor sound, if we were to acknowledge that policymakers are not only navigators, but also commanders in the current environmental conflicts! We would, for example, recognize that the role of the IPCC and other expert assessments is not just to provide neutral descriptions, but also to draw the maps that will be used in diplomatic skirmishes (Hulme, 2009; Beck, 2011).

Similarly, we should acknowledge that controversy maps also afford certain power moves both to the cartographers and to the actors who use their maps.

Besides the military use of maps to move armies, select targets, or plan attacks (or, in controversy mapping, to identify key allies and opponents), there are at least three different ways in which mapmaking can be employed to assert power.

The first use is connected to administration. Since the sixteenth century, modern states have invested heavily in geographic cartography to stabilize their power. Cartography accompanied the birth of the “nation state,” facilitating the conflation of a political institution (the state), a cultural group (the nation), and a spatial entity (the territory). According to Denis Wood (2010), the success of this operation is best demonstrated precisely by the fact that geographical maps now appear perfectly natural to all of us:

Since scholars are unanimous that maps helped to bring the state into being – that maps helped construct the state – it certainly can’t be the map’s putative ability to “represent a part of the earth’s surface.” ... But then, thinking about the map as a representation had always been a mask, a cloak, a way of making the creative aspects of mapmaking ... disappear. From their inception it had been essential that states appear as facts of nature, as real enduring things, things like mountains; and at all costs to obscure their recent origins in violence and their tenuous hold on tomorrow. And maps were able to grant this precisely because maps too had been constructed as facts of nature. (Wood, 2010, p. 33)

What used to be a rough control over unsure boundaries, little by little became a scientific domination of every inch of the social fabric (at least in the Western world). This cartographic expansion is illustrated by the diversification of objects that could be represented on maps, from the natural and transportation features (rivers and roads) to the distribution of a growing variety of entities (populations, wealth, education, dialects, agricultural predispositions, cultural practices, and many others). Combined with the parallel rise of statistics (Desrosières, 1991, 1993), cartography provided national administrations with tools to track every aspect of collective life, thus facilitating the emergence of the centralized management typical of modern states (Scott, 1998).

To be sure, the expansion of cartographic control did not come without controversies. Communities all over the world have countless times opposed the official mapping of their territories as a form of resistance to state authority. An interesting example is provided by Benjamin Orlove (1991) who studied a conflict between the Peruvian government and the peasants around Lake Titicaca. The quarrel concerned the transformation of the lake reeds in an ecological reserve and the consequent regulation of their harvest. Analyzing a set of maps produced during the dispute, Orlove shows how the programs and anti-programs of the two parties are translated into opposite visual designs. While the peasants’ maps divide the space into a series of equivalent and contiguous portions each centered around a village – thereby suggesting that each community controls a territory and that together they control the region – the government’s maps focus on towns and roads to present the area as urbanized and linked to other regions. Even more interesting, the government’s maps can be read as a narrative presenting the administration’s plan of action: the first map separates the natural reserve from the rest of the country; the second map partitions the reserve in different zones; and the third assigns zones to exploitation contracts. Similar cases are discussed by Peluso (1995) on Indonesian forests and by Sparke (1998) on native territories in Canada.

In controversy mapping, we could imagine different actors lobbying the cartographers to represent the debate in ways that are to their advantage. For example, some years back we were involved in mapping the public debate around a new school reform. One of the maps we created showed how issues co-occurred in Facebook discussions. While concerns about curricula, student wellbeing, or the physical design of classrooms were central to the debate, in the sense that many users were discussing them in many contexts, concerns about teachers' preparation time were specific to teachers and appeared as a separate cluster on the periphery of the map. This was quickly seized upon by some municipal administrators as an argument that teachers should not be the only actors heard on school reforms (Madsen & Munk, 2019). It is easy to see a controversy map that enacts the multiplicity of positions around a matter of public concern as a way to counteract established institutions of power and their efforts to establish some form of hegemony over the narrative. In this case, however, multiplicity became a power tactic for the municipal administration, which was locked in a political battle with the teachers' union. Even mapmaking efforts that strive to represent a multiplicity of voices and perspectives can thus be reappropriated as tools of administrative power.

The second way in which mapmaking can be employed to assert power is connected to the rhetorical force of visualization. As argued by John Pickles in an essay on propaganda maps (2011), "the map is a text, like any other in this regard, whose meaning and impact may go far beyond the limits of technique" (p. 402). Maps can be used to tell stories, convey messages, push arguments. As an example of the rhetoric of maps, Denis Wood dedicates an entire chapter of his book on the *Power of Maps* (1992) to the Official Highway Map of North Carolina. According to Wood, such a map "screams" the vision of the state that produced it and, at the same time, effectively naturalized it. North Carolina is presented as a modern state through the choice of elements that the map exhibits (e.g., highways instead of public transportation) and through its system of signs and codes (which privilege cities, roads, and tourist attractions).

Part of the power of maps comes from their capability to deliver an ideological discourse in ways that are more difficult to detect than, say, in a text. By the force of their visual conventions, maps represent their objects as if they were natural features rather than deliberate statements and thus favor those who control the production of the maps. This is true for traditional maps, but also for the more recent and more interactive geographic information systems. As argued by Jason Farman (2010):

As Google Earth zooms in to the earth from a distance, the "disembodied master subject" as Donna Haraway theorised is "seeing everything from nowhere." These representations are believed to be objective; they are simply images of reality and outside the realm of cultural interpretation. The problem with positioning GIS as software that simply gathers empirical data and presents it as fact is that such "scientific objectivity" is typically situated and privileges those in power. (Farman, 2010, pp. 877, 878; but see also Dunn, 2007)

In controversy mapping, neglecting the obligations to state the cartographer's position and open the inquiry to others (as per the cartographer's creed in the introduction) could result in maps that naturalize, rather than problematize, the landscape of debate.

Finally, the third form of cartographic power consists in using maps not to travel, administer, or narrate a territory, but to transform it. In the introduction to this section, we cited the way in which Romans used their cartography to build a network of roads that

facilitated the military occupation of their empire, but cartographic interventions can be even more direct. Modern conflicts provide several examples of “ecological warfare” – the use of explosive or chemical weapons with the purpose of transforming orographic or hydrologic equilibria; triggering processes of erosion; disrupting agriculture or natural vegetation; changing the distribution of populations.

A well-known example is the US bombing of dikes along the Red River during the Vietnam War. In a paper that is a great example of critical geography and of controversy mapping, Yves Lacoste (1973) provides a detailed analysis of the attacks. The analysis reveals that the bombing concentrated in the areas where the river is higher and the plains flattest (to maximize the flooding); that it hit the most populated and agriculturally important areas of the country; that it targeted the places where the dikes were most subjected to water pressure; that bombs were not dropped directly on the dikes but on their side, where they produced the hardest fractures to repair. Lacoste concludes that this military operation could not have been carried out without the support of expert cartographers who scientifically identified the points where the bombing had the greatest likelihood of changing the territory.

Focusing on epistemic disagreements and power struggles, controversy mapping cannot afford a naive conception of mapmaking. Mappers must consider not only how debate actors produce maps to advance their interests, but also how their own visualizations may influence the way in which the controversy unfolds. In this sense, controversy mapping is a form of “critical cartography” (Crampton & Krygier, 2005; Crampton, 2010) and shares the four defining principles of this approach:

1. The first principle of critical mapping is that maps are incredibly useful ways of organizing and producing knowledge about the world, but that these orders of knowledge also incorporate unexamined assumptions which act as limits which deserve to be challenged.
2. One way to challenge these orders of knowledge is by putting them into historical perspective. This historicization of knowledge not only shows that other times did things differently, but by providing an intellectual history it allows us to see the edges of our own limits, and to conceive of other knowledges that might be useful. Critical mapping also emphasizes that the way maps and spatial knowledges have been deployed has varied tremendously between cultures and places. This can be described as a spatialization of knowledge.
3. Critical mapping also holds that geographic knowledge is shaped by a whole array of social, economic, and historical forces, so that knowledge does not exist except in relation to power. When we speak of maps as political, it is this relationship between knowledge and power that is at stake.
4. The critical mapping project is also one which has an activist, emancipatory flavor to it. Sometimes this approach is concerned with overthrowing the influence of official knowledges (such as those of the government or the state) by showing their historical and spatial contingency ... At other times this approach seeks to dismantle more specific forms of knowledge. (Crampton, 2010, p. 17)

As an illustration, the matrix in [figure 75](#) draws on the analysis carried out through the previous figures to show the level of intervention of the 21 most active countries on the main issues in the negotiations.

We leave the interpretation of the map to the reader, but our intention in designing it was to reveal how some states purposely shy away from some of the negotiated topics (have a look at China on “land use” and the US on “carbon offsets,” and compare, for example, with Timothy Mitchell’s work on “carbon democracy”; Mitchell, 2009a).

Second-degree objectivity

Since representing something is never a neutral or inconsequential operation, and since actors in controversies constantly represent issues to their advantage, controversy mapping cannot rely on the conventional definition of “objectivity” and “impartiality,” as something that cannot be ascribed to a singular perspective. Nor can it – like a dictionary or an encyclopedia – stick to the consensual parts of a situation and ignore the issues that remain disputed. In controversies, by definition, this kind of first-degree objectivity is not available, which puts us in an awkward situation: how can cartographers be objective and impartial when no one else is? The standard sociological answer would be: by abstracting themselves from the disputes and observing them from the outside. According to such an answer, while actors would inevitably be biased, sociologists could and should have no stake in the debate. Objectivity, in other words, would come from avoiding to take a position in the controversy or, more precisely, from taking a position *above it*. This “solution” is clearly at odds with the basic tenets of ANT, which holds that in collective existence, there is no “above” (and if there was, it would certainly not be populated by sociologists). What is mistaken for objectivity is mere distance from phenomena. Not being part of controversies does not provide researchers with a higher or better point of view. If anything, it gives them an alienated and thereby worse perspective on collective dynamics. Actors, on the contrary, have an intimate experience of their controversies, they know their issues by heart, and are familiar with the positions of their allies and enemies.

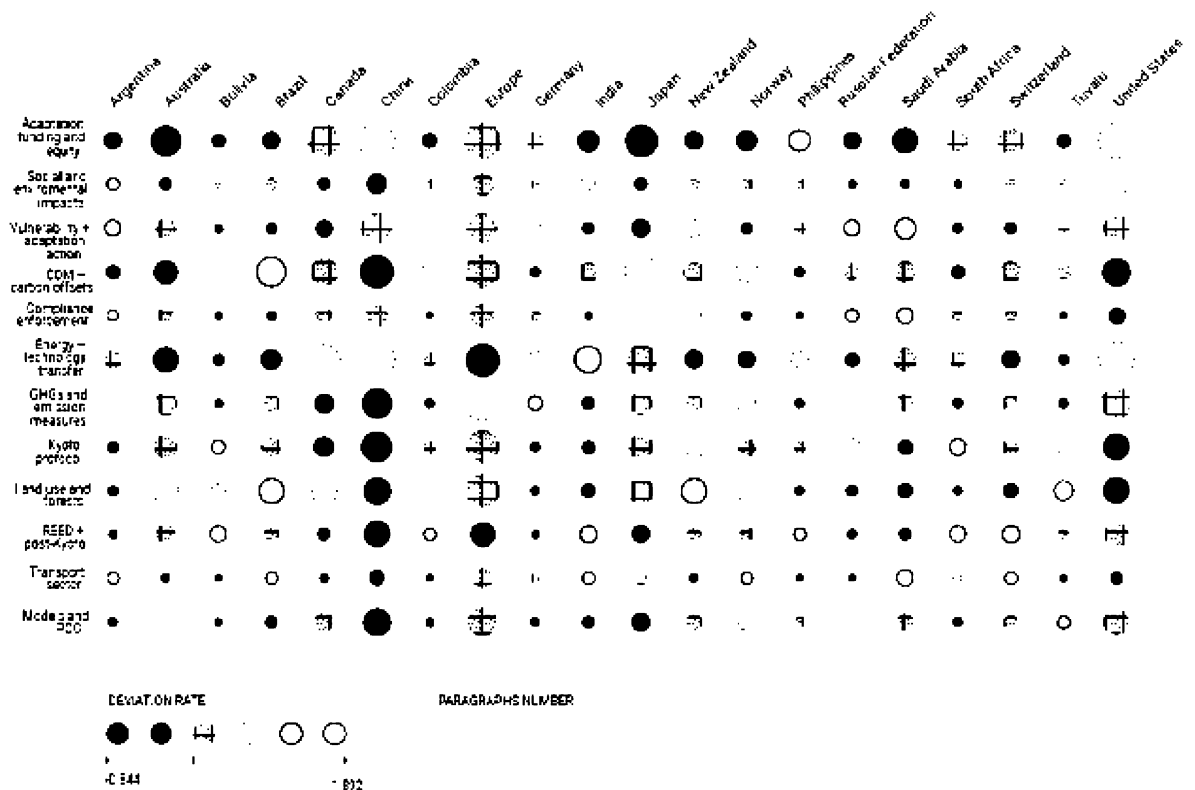


Figure 75 The level of intervention of the 21 most active countries (columns) in the UNFCCC negotiations across the 12 most prevalent issues (rows). Bubble size reflects the number of paragraphs in the *Earth Negotiation Bulletin* where the country in question is engaging the issue in question. Coloring reflects the degree to which the level of intervention deviates positively (darker gray) or negatively (lighter gray) from what is statistically expected (figure adapted from the EMAPS project, climaps. eu (Venturini et al., 2014b and licensed under CC BY-SA 4.0).

If controversies seem less messy when seen from outside, it is only because they are out of focus. This does not exempt mappers from being objective and impartial, but it encourages them to find a new definition of such values. We will call this second-degree objectivity. Such objectivity resembles the “mobile perspective” invented by Cubism – the simultaneous representation of the same subject from a variety of angles (see an interesting controversy about this idea in Richardson, 1995, and Stalnaker, 1996). Unlike first-degree objectivity, which is produced by reducing all perspectives to a single viewpoint, second-degree objectivity is obtained by the multiplication of different viewpoints. It is a kind of objectivity that comes from diversity rather than from uniformity; it is a kind of impartiality that comes from exploring a multitude of biases, rather than abstracting from them. *But what exactly is second-degree objectivity and how can it be obtained?* There are, in this respect, three common but unsatisfying solutions.

Objectivity by abstention

The first solution is to not combine the different viewpoints at all. According to this approach, mapping means reporting all the accounts provided by the actors, resisting the temptation to weave them into a unified narrative. In such an approach, controversies appear as provisional intersections where trajectories meet without merging. A famous

illustration of this approach can be found in Akira Kurosawa's movie, *Rashomon*. The film tells the story of the same murder four times, each time taking the point of view of another of its four protagonists. As the narrations unfold one after another, the viewers witness the contradictions among the different versions, but they receive no indications as to which is the correct one.

This first approach is faithful to the complexity of controversies and can help the public to see things from the "viewpoint of the natives" (Galison, 2014). It has, however, two disadvantages. First, while it can be useful in helping readers situate themselves in different positions of the controversy, it does not help them navigate between them. The map is likely to be as chaotic as the territory and, as such, not very useful for orientation. By displaying the unreduced complexity of a controversy, cartographers typically fail in making it legible for a larger public.

The second disadvantage is that it allows cartographers to remain in hiding and avoid taking a position. Presenting themselves as neutral relays of the actors' points of view, cartographers adopt an *objectivity by abstention*, as if impartiality could be achieved by renouncing one's subjectivity. This approach is often flaunted by our controversy mapping students. When asked about their opinion, they swear that they just reported the ideas of actors and abstained from having their own. Of course, this is just a posture: when investigating a dispute in the detail demanded by controversy mapping, it is impossible not to form an opinion about it. Also, there is nothing wrong with it: cartographers are allowed and even encouraged to express their own ideas, as long as they are faithful to the ideas of the others. It is more honest to avow one's standpoint than pretending not to have one.

Landscape objectivity

Opposite to objectivity by abstention is what we could call *landscape objectivity*. It relies on the assumption that, although it is impossible to decide who is right and who is wrong in a controversy, it is still possible to provide a unified description of the debate space. In this approach, controversies are territories with a well-defined topography, with peaks and valleys, outposts to be conquered and sinkholes to be avoided. Different views derive from different viewpoints and, by knowing where actors stand, it is possible to infer what they will see and how they will move.

This second solution, of course, has its own disadvantages. First, it pretends to grant cartographers a vision from above that quite resembles first-degree objectivity, presenting the maps as bird's-eye views of a territory. When controversies are visualized as networks in particular, it is important to resist the impression of looking down on nodes and edges as if from some higher vantage point. Networks do not reveal objective social structures and their focus on the density of associations often hides other interesting features that the cartographer should observe and describe through other techniques.

The second disadvantage of landscape objectivity is that it separates actions from their context. The premise is that the actors' inclinations can be inferred from (and thus grounded in) their position in a debate landscape. "This is what an anti-vaxxer would typically say," "what else would you expect from people on the no-global left?" or "only rumors come from social media" are all statements informed by this logic. Resting on the idea of a stable social order, they are untenable when exploring social change and particularly controversies, where actions constantly overflow and reshape their established banks in a relentless process of "social landscaping."

Talk-show objectivity

Caught between the shortcomings of objectivity by abstention and landscape objectivity, cartographers are often tempted by what they mistakenly believe to be an intermediary solution: the talk-show. The principle is well known from television debates and consists in giving all viewpoints an equal opportunity to express themselves. Cartographers who pursue this strategy abstain from taking decisions on what is important and what is not, and thus end up with a completely uniform landscape. For instance, confronted with the evolutionism-creationism debate, they give both sides the same treatment – and thereby misconstrue both. If this particular controversy is engaging, it is because it mobilizes two viewpoints with radically different statuses. On the one hand, more than two centuries of paleontology and evolutionary biology; thousands of scientific books and papers; countless pieces of evidence coming from fossils, DNA, and ice cores. On the other hand, an even longer tradition of bible studies and countless commentaries on how each word of the bible should be interpreted. Putting the theory of evolution and the doctrine of creation on the same level (as demanded by some creationist groups), is the surest way to misunderstand both.

In [chapter 1](#), we discussed the hacking of the East Anglia Climate Research Unit and the ensuing “Climategate” controversy. In the wake of the quarrel, journalists were criticized for falling into the trap of climate change deniers and giving too much importance to a fabricated scandal. Since then, several news venues acknowledged the risk that a naive conception of impartiality may grant excessive visibility to fringe opinions. In the words of the BBC Executive Trust: “When there is a consensus of opinion on scientific matters, providing an opposite view without consideration of ‘due weight’ can lead to ‘false balance’, meaning that viewers might perceive an issue to be more controversial than it actually is.”

Relational objectivity

Talk-show impartiality, to be sure, has nothing to do with second-degree objectivity, which is *not* obtained by giving equal importance to everyone and everything. Quite the contrary, second-degree objectivity comes from attributing to all actors a representation proportional to their agency (what Whatmore & Landstrom, 2011, call their “political capability”). This operation is reminiscent of the editorial policies of Wikipedia. Because of its collaborative nature, the online encyclopedia has been forced to shift from “a traditional positivist approach of encyclopedia construction, which assumes that there is always one truth and a certain predictable level of quality, to a constructivist, ‘grounded’ approach, which assumes that there are always multiple truths and quality, and they change over time” (Stvilia et al., 2005, p. 109). The solution found by Wikipedia to handle second-degree objectivity is encapsulated in its “neutral point of view” policy according to which: “neutrality requires that each article or other page in the mainspace fairly represent all significant viewpoints that have been published by reliable sources, *in proportion to the prominence of each viewpoint*” (emphasis added). The comparison with Wikipedia highlights that the proportionality upholding second-degree objectivity is far from trivial:

While Wikipedia projects an external image of “objective” and “neutral” knowledge, the very meaning of neutrality and objectivity in its core policy is constantly disputed. Neutrality is profoundly altered to refer to ambiguous, precarious, and ever-shifting definitions, moving with the social processes that produce them. (Matei & Dobrescu, 2011)

In controversy mapping, a similar ambiguity can be observed, as being *proportional* means giving different visibility to different viewpoints according to (1) their representativeness, (2) their influence, and (3) their interest.

1. The *representativeness* of a viewpoint depends on how many actors subscribe to it. An argument shared by many actors deserves more visibility than one that is relatively marginal. For example, in describing climate controversies, it would be misleading to give the same weight to the IPCC and to climate skeptics. To be proportional means conveying the fact that scientists believing in anthropogenic global warming are much more numerous and better organized than their opponents (Oreskes, 2004; Cook et al., 2013). This does not mean, of course, that skeptics or deniers should be neglected. Not only because the goal of controversy mapping is to present opposing viewpoints, but also because representativeness is a matter of weighting more than of counting.
2. The number of supporters or allies a viewpoint can mobilize directly is not the only criterion for its relevance. When presenting ANT’s theory of action in [chapter 4](#), we discussed how the actors that succeed in establishing themselves as “obligatory passage points” can derive influence from such a position. Controversies are not free of asymmetries, not all positions are equal and actors fight to build and occupy the most influential of them. Actors occupying dominant positions deserve special attention because they will have a better chance of shaping the controversies and forcing others to align behind their interests (the very definition of power in controversy mapping).
3. For example, climate change deniers may constitute a small minority in the scientific debate and, to some extent, in the political debate, yet they played a crucial role in delaying the regulation of greenhouse gas emissions and succeeded in electing one of them as the 45th President of the United States (De Pryck & Gemenne, 2017). Another, more encouraging, example is the Alliance of Small Island States (AOSIS), a negotiating group gathering several dozens of low-lying coastal and small island countries. From the onset of the UN climate negotiations, the AOSIS has been extremely active in setting the agenda of climate diplomacy. Despite their small population and their marginal geopolitical role, AOSIS countries managed to build a solid coordinated action and to capitalize on the symbolic influence derived from the threat of sea-level rise (Betzold et al., 2012). Neglecting this actor on account of its limited size would prevent us from understanding important dynamics of the negotiations.
4. If influential viewpoints should have a central place in controversy mapping, they should not fill up the space of representation. Controversy mapping cannot content itself with *majority reports*, as the very existence of disputes depends on the presence of *disagreeing minorities*. It is often these minorities who bring controversies into existence by refusing to settle with the mainstream and instead reopening the black boxes of science and technology. No matter how marginal, diverging viewpoints can

be interesting when they express productive ways to question what is taken for granted.

Second-degree objectivity thus comes from the capacity to display a controversy from its different viewpoints, giving each of them a visibility proportional to the actors they represent, the influence they are able to exert, and the interest they have in the eyes of the cartographer. How much importance should be given to each of these three criteria is left purposely unspecified. Cartographers can privilege one or the other depending on their interests and the particular nature of their controversy and, when possible, they should discuss such weighting with the actors of the controversy themselves.

Controversy atlases

In [chapter 1](#), we said that controversy mapping must make controversies easily legible for a “lippmannian public” (a public which is characterized by limited attention and interest) and just above we argued that this goal must be reached through the mirror maze of second-degree objectivity. Throughout the whole book, we have oscillated between two goals: respecting the complexity of sociotechnical debates and providing readable descriptions for a distracted public. Alas, there is no way to avoid this contradiction, no way around the tension between richness and legibility. In order to contribute to sociotechnical democracy, controversy mapping needs to deploy the intricacy of technoscientific imbroglios, *but also* to make them readable; to explore their full complexity, *but also* to facilitate their understanding; to help the public in opening the black boxes of technoscientific debate, *but also* in closing them down.

Simplify too much and the richness of the controversy is lost. Simplify too little and the map will be as complex as the territory and therefore useless (see [figure 76](#)). This is the contradiction famously illustrated by Luis Borges and, before him, by Lewis Carroll:

- “What do you consider the largest map that would be really useful?”
- “About six inches to the mile.”
- “Only six inches!” exclaimed Mein Herr. “We very soon got to six yards to the mile. Then we tried a hundred yards to the mile. And then came the grandest idea of all! We actually made a map of the country, on the scale of a mile to the mile!”
- “Have you used it much?” I enquired.
- “It has never been spread out, yet,” said Mein Herr: “the farmers objected: they said it would cover the whole country, and shut out the sunlight! So we now use the country itself, as its own map, and I assure you it does nearly as well.”

Lewis Carroll, *Sylvie and Bruno Concluded*, 1893

The Cartographers Guilds struck a Map of the Empire whose size was that of the Empire, and which coincided point for point with it. The following Generations, who were not so fond of the Study of Cartography as their Forebears had been, saw that that vast Map was Useless, and not without some Pitilessness was it, that they delivered it up to the Inclemencies of Sun and Winters.

George Luis Borges, *Of the Exactitude in Science*, 1946

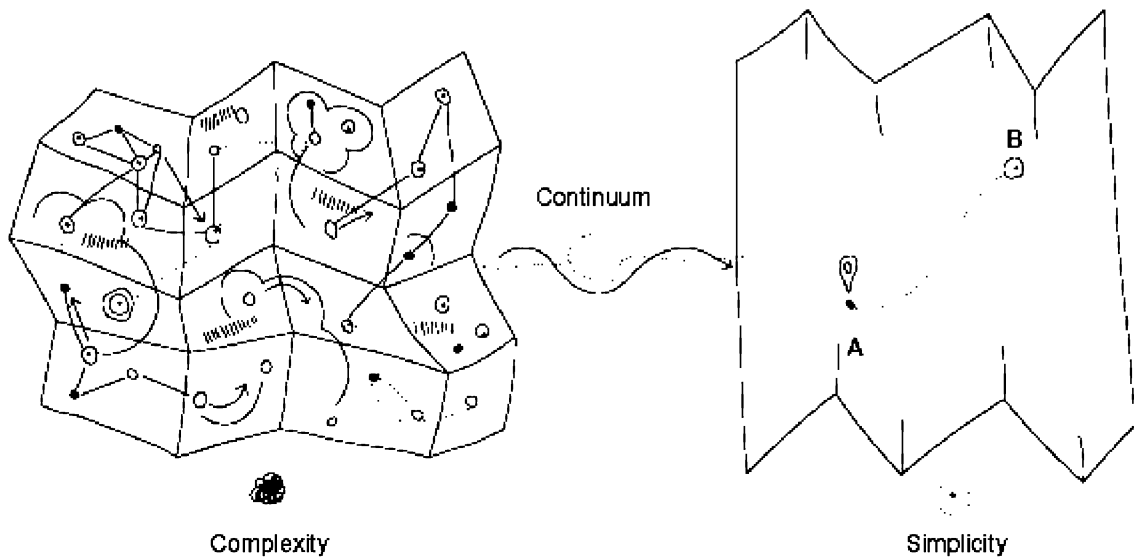


Figure 76 Two unsatisfactory maps. Too complex (left) and too simplified (right) (adapted from Venturini et al., 2015c).

The trade-off between richness and legibility, however, can give impetus to the cartographic effort if, instead of asking where to *stand* on the legibility/complexity spectrum, we ask how to *move through it*. Framed as a question of process, the contradiction can be “unpacked” and dealt with through two separate “moves.” The first multiplies the representation of the controversies and replaces maps with atlases. The second allows the reader to shift between narration and exploration in a movement of datascape navigation.

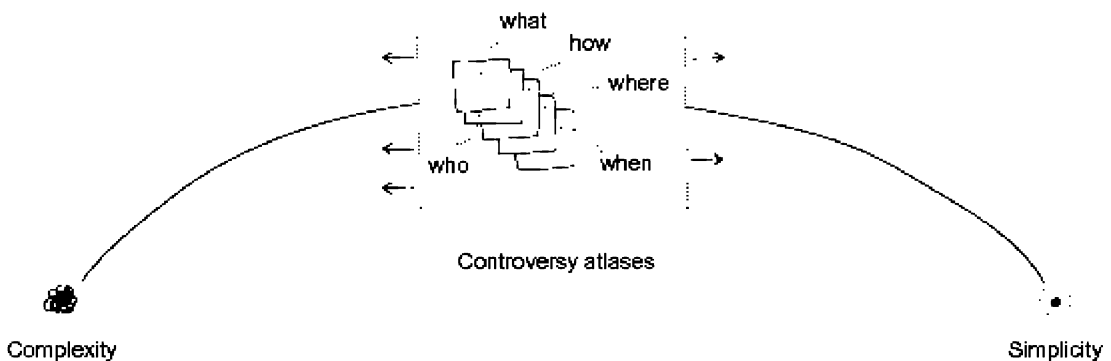


Figure 77 The controversy atlas as a way to manage the trade-off between the richness that comes with complexity and the legibility that comes with simplification (adapted from Venturini et al., 2015c).

In [chapter 3](#), we said with Donna Haraway that there is no such thing as a view from nowhere, no location from which to gaze at everything at once. Such a panoptical map would have to be *many times* the size of its territory and would be folded onto itself in all sorts of ways. Controversies are ontologically multiple: they exist in a pluriverse that, by definition, cannot be mapped at once. What is needed, therefore, is not an impossibly exhaustive map but a multitude of partial maps. Not a controversy map, but a *controversy atlas* (see [figure 77](#)).

What sort of maps should be collected in a controversy atlas depends largely on the dispute under investigation. In some cases, the most important aspect is the evolution of the debate and a chronological sequence should therefore be central. In other cases, the balance of forces is key and a representation of the opposing alliance is more relevant. The only way to respect the specificity of each controversy is to match it with a series of *ad hoc* representations. The best we can do is to list a few types of maps we have encountered in our practice. In fact, you have encountered them too, as we used them in the introduction to describe the controversy about the elephants of the Amboseli National Park.

The first type of map is meant to show that statements are never isolated but emerge in arguments between actors. It is therefore crucial to be able to show how different discourses question and respond to each other. Among the many ways to do so, a classic solution is the Porphyrian tree. Showing how questions and answers branch and connect, the “tree of disagreements” makes it evident that controversies are much richer than binary oppositions.

A branching diagram such as the one in [figure 78](#) does a fair job in conveying the multiplicity of the controversy. It shows how every question asked in the debate is met with different answers and produces a cascade of additional interrogations, whose answers confirm, but also complicates the main opposition between the beyond-park and the outside-park approach. The diagram makes it clear how different issues are connected in a vast network of mutual interferences so that a decision taken on a specific matter has repercussions on other questions (many other examples of this type of diagram can be found in *The Book of Trees* by Manuel Lima, 2014).

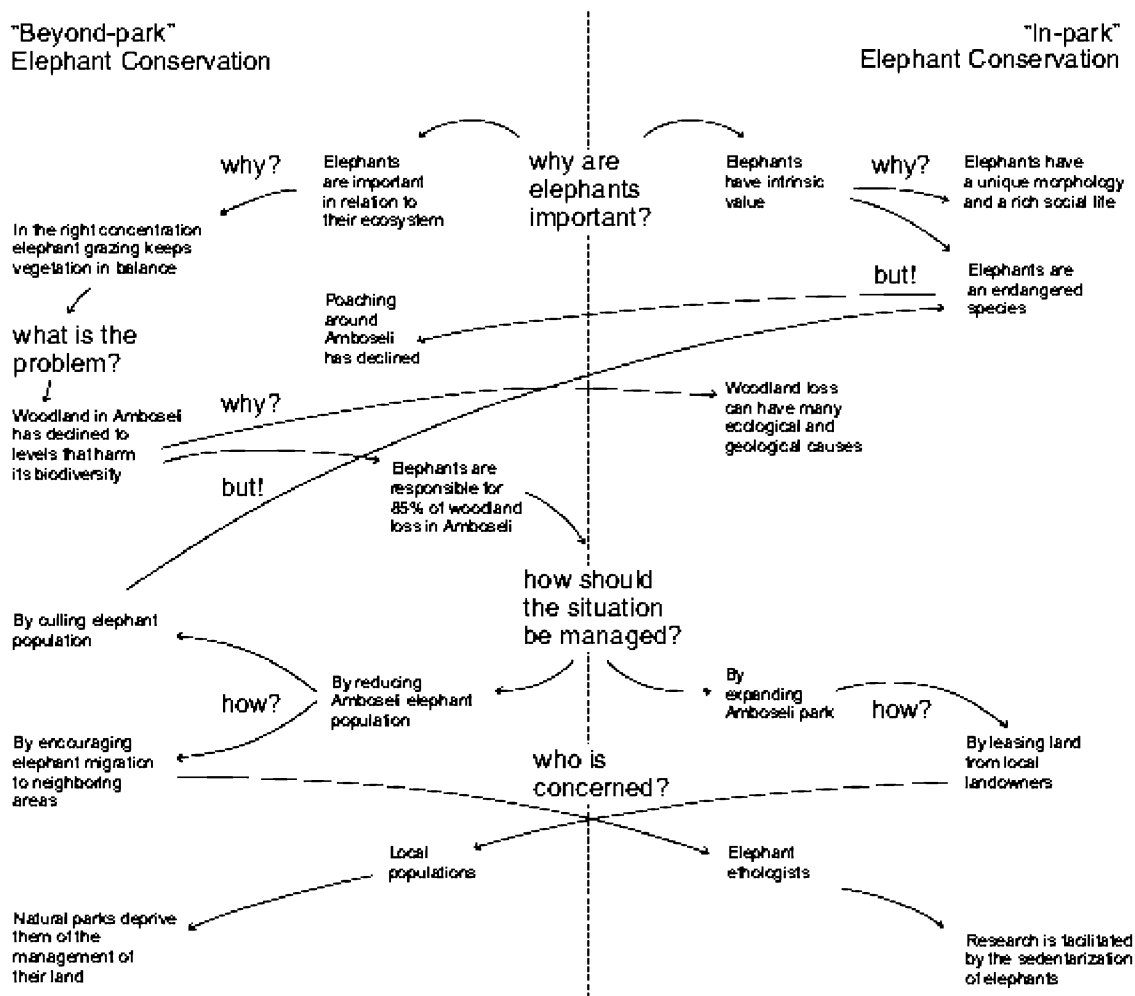


Figure 78 An example of a tree of disagreements (reproduced from figure 1) around the conservation of Amboseli elephants. Western’s position and its associated knowledge claims and prescribed actions on the left, Moss’s position on the right. Main battle line in the middle (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

A second type of map aims at connecting statements to their authors. Proposing, supporting, elaborating, or refuting an argument is never just an intellectual exercise. In sociotechnical debates, every statement is a “speech act” (Austin, 1962; Searle, 1969) that forges alliances and entrenches oppositions between actors. It is worth recalling here that controversy mapping inherits from ANT a broad definition of actors: scientists and engineers, of course, but also lay experts, activists, decision makers, and not only individuals but also collective actors (research institutions, enterprises, lobbies, etc.) and non-human actors (instruments, theories, laws, natural elements, etc.). Showing who shares which arguments, the “table of actors and issues” is therefore the very basis of controversy mapping.

A simple double entry table such as the one presented in figure 79 is often a convenient solution to show the position taken by different actors on different issues of a controversy. The table can be read by its columns to focus on the position of an actor on different issues, or by its rows to compare the position of different actors on the same issue. In figure 79 we

used the text of the cells to convey the exact argument employed by each actor in relation to a specific matter of concern, and a background to reveal the argumentative likenesses between the actors (dots for the beyond-park approach and stripes for the outside-park approach). To make the table more readable we ordered the columns arranging the actors in a sort of continuum between the two approaches.

A third type of map shows the associations between entities in the controversy, such as actors or issues, which are always enmeshed in intricate webs of alliances and oppositions. Many proxies of these relations can be found in digital records (hyperlinks, scientific citations, language sharing, mentions in social media, etc.) and mappers can produce parallel maps to explore and compare several types of relations. They can also, as in the example in [figure 80](#), manually draw the connections between the actors based on their qualitative appreciation of the controversy.

A fourth type of representation is meant to show how controversial subjects are always and simultaneously part of larger meta-controversies and made up of smaller sub-controversies. Cartographers are free to choose their level of investigation, but they must be able to situate their case study in the different “scales of dispute” to which it belongs. In particular, it is important to show that, though controversies are often fought on the battlefield of technical details, they also tend to oppose conflicting worldviews. No matter how specific controversies may look from the outside, from the viewpoint of their actors they are a war of worlds. Conversely, no matter how abstract the principles at stake are, controversies are always decided through specific and concrete arrangements.

As illustrated in [figure 81](#), controversies are often impossible to fit into one scale only, as different actors have different views about what is more general and more specific. This is why overlapping and even opposed worldview scales are sometimes necessary. As Bruno Latour reminds us, “levels of reality do not nestle one within the other like Russian dolls. It cannot be said that the small or the short lie within the large or the long, in the sense that the largest or the longest contain them but with just ‘fewer details’” (2017c, p. 93). While it is certainly acceptable to break the complexity of controversies into different scales to facilitate the comparison along commensurable issues, atlases should not fail to show the connections across scales.

Actors Issues	David Western	Maasai communities	Kenyan government	Local press	Tour operators	International donors	Cynthia Moss
Nature	the overall diversity and balance of ecosystems	an inseparable element of collective existence	a national resource to be strategically managed	a topic of interest for public opinion	a touristic attraction	a world heritage	specific species with outstanding zoological value
Elephants	a keystone species crucial to keep the ecosystem in balance	allies/competitors in the use of land & natural resources	an African landmark species	an African landmark species	a touristic attraction	a species with an exceptional morphology and social life	a community of animals with individual names and life stories
Conservation	the duration of the processes that support biodiversity	the traditional ways of living in balance with one's land	one of the components of national land use planning	a potential source of political controversies	allies/competitors in the exploitation of natural resources	a responsibility of the international community	the preservation of wildlife
Local communities	traditional experts and potential allies in biodiversity management	the rightful owners and custodians of the region	one of the many stakeholders to be taken into consideration	a potential readership	allies/competitors in the exploitation of natural resources	a potential threat to wildlife	a potential threat to wildlife
Natural parks	a solution that risks creating a harmful inside/outside asymmetry	a threat to traditional land use and a source of economic resources	a solution to manage natural resources and attract international funds	a potential source of political controversies	an institutional context for commercial activities	national institutions funded and monitored by the international community	an established solution to shield wildlife from humans
Scientific expertise	an activity that should be made accessible to local stakeholders	a type of knowledge that should interact with traditional culture	a guide and a justification for national policies	a source of information to understand human and natural developments	allies/competitors in the exploitation of natural resources	a guide and a justification for international policies	a specialized activity restricted to experts and their peers

Figure 79 An example of an actor/issue table of the Amboseli controversy (reproduced from figure 2). Actors in the columns and their positions on different issues in the rows. Shading indicates the level of commitment to “beyond-park” or “in-park” solutions (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

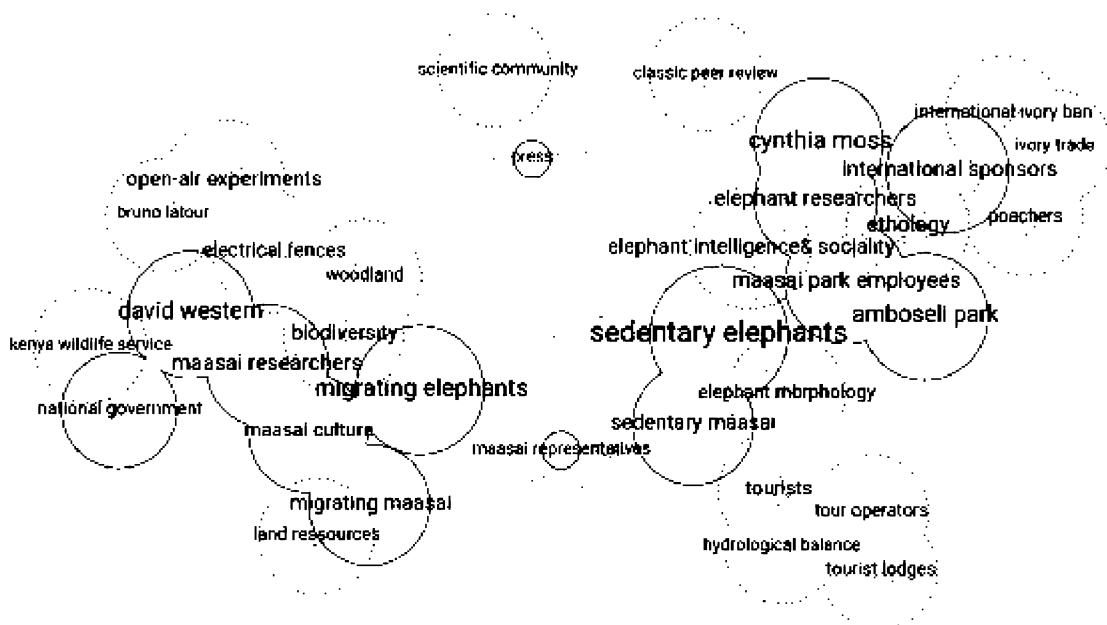


Figure 80 An example of a network diagram (reproduced from figure 3). Network of actors in the Amboseli controversy. The alliance of actors supporting the “beyond-park” solution on the left, the alliance supporting the “in-park” solution on the right. Neutral actors are circled with dotted lines. Hesitant actors are marked with a gray halo (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

Finally, besides presenting what controversies are about, who fights them, and how they join forces, cartographers must also visualize how they evolve through time. Controversies cannot be statically described, because their actors are constantly busy fighting for the reproduction or the transformation of the status quo. Temporality – be it trends in the debate’s evolution or the sequence of the events through which the conflict unfolds – is therefore crucial. One option is to let the atlas contain multiple time-sliced versions of the types of visualizations discussed above. Another is to create a timeline of the debate dynamics (Aigner et al., 2011; Rosenberg & Grafton, 2013). As an example, [figure 82](#) tracks the shifting balance of forces between the beyond-park and the outside-park approach across the main events of the Amboseli controversy.

A simpler solution is to present the development of a controversy with a diagram (inspired by Vonnegut, 2005) that has the evolution of its complexity (loosely defined as the variety of actors and issues that are mobilized in the debate and their degree of mobilization) on the y-axis and time on the x-axis. Based on this representation, we can propose different controversy profiles (see [figure 83](#)).

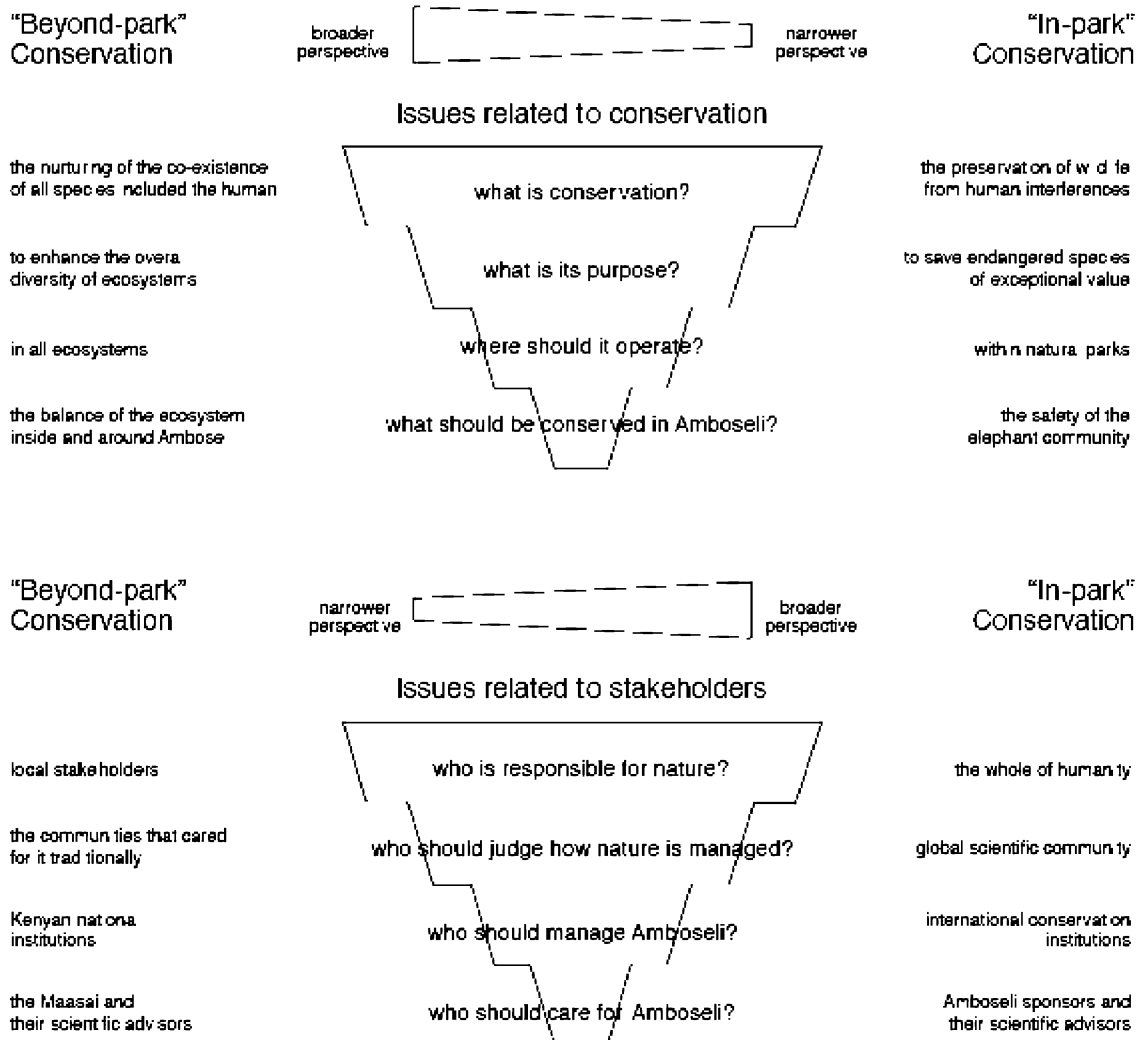


Figure 81 An example of debate scales in the Amboseli controversy (reproduced from figure 4). On the left, the positions of actors in favor of “beyond-park” conservation; on the right, those of actors in favor of “in-park” conservation. The upper half of the diagram focuses on questions related to nature conservation, where “beyond-park conservation” advocates for a broader perspective on most issues; the lower half on questions about the role of stakeholders, where “in-park” conservation advocates for a broader perspective. In both cases, questions become more specific from the top to the bottom of the inverted pyramid (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

1. *The adventure*: controversies that grow to be burning hot but are finally resolved by the victory of one of the factions or the achievement of a compromise.
2. *The complexity explosion*: controversies whose complexity continues to grow indefinitely without any of the actors managing to reduce it.
3. *The whistleblower*: controversies that are announced by some early actors who remain isolated for a long time before succeeding in getting the debate started.
4. *The singularity*: controversies that are suddenly propelled into existence by some particular (and often unexpected) event.

5. *The closure*: controversies that are slowly but steadily solved by a progressive convergence of actor positions.
6. *The rebound*: controversies that seem to be on their way to a resolution, but suddenly warm up again.
7. *The last Japanese*: controversies that are considered closed by most of their actors, except for a few that keep fighting to keep them open (similar to Japanese soldiers who continued to defend remote Pacific islands long after WW2 was over).
8. *The rollercoaster*: controversies occupying the public space in a significant but intermittent way, being recurrently discussed but never actually solved.
9. *The minority report*: controversies in which a small minority refuses to accept the general consensus but fails to mobilize other actors behind their cause.
10. *The stable complexity*: controversies that are characterized by a high number of actors and issues during their whole existence.

**"Beyond-park"
Elephant Conservation**

**"In-park"
Elephant Conservation**

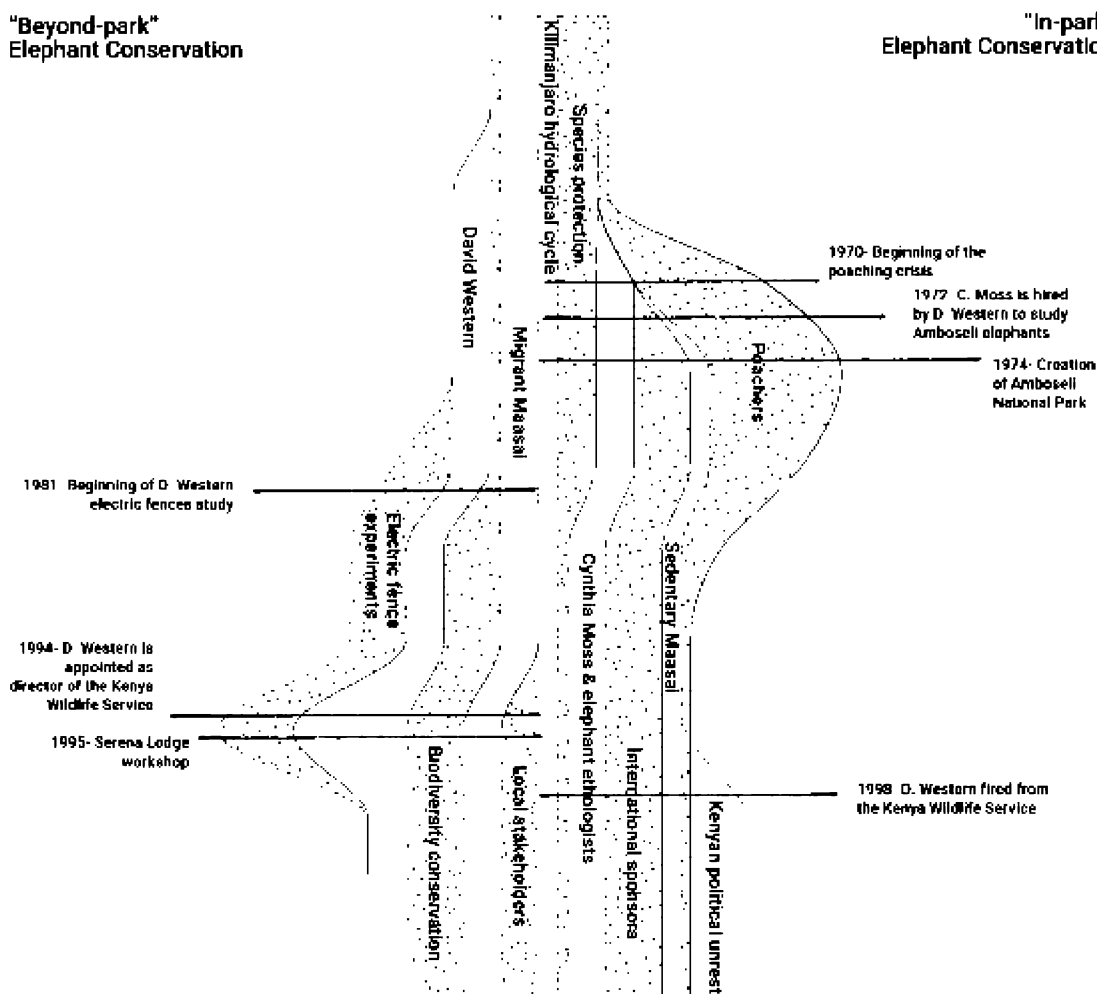


Figure 82 An example of debate dynamics (reproduced from figure 5). Stream diagram of the temporal evolution of the Amboseli controversy. Time flows from the top to the bottom of the diagram with each stream representing an actor. The size of each stream indicates the level of engagement of that particular actor at a particular moment in time according to a qualitative estimation (created by the authors based on the account provided by Thompson, 2002; released by the authors under CC BY-SA 4.0).

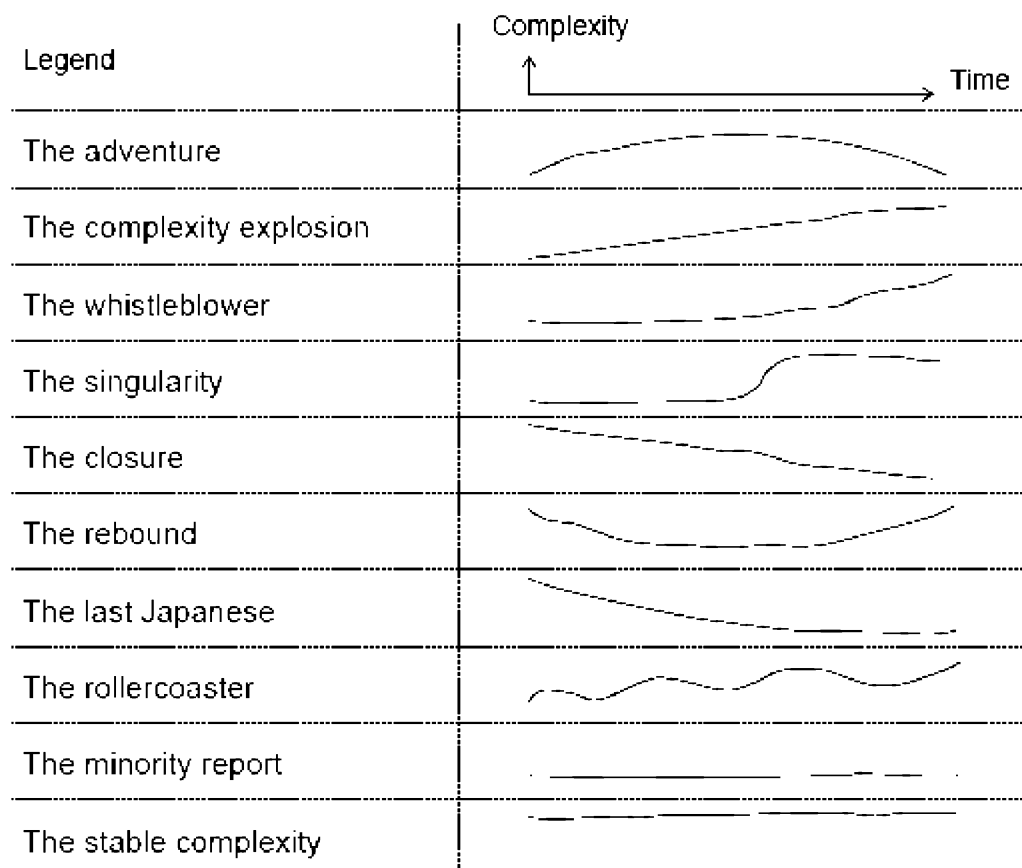


Figure 83 Ten types of evolution in the complexity of a controversy over time (created by the authors; released by the authors under CC BY-SA 4.0).

Narration and exploration

A good atlas does more than juxtapose a bunch of maps; it adds order to them. From history to politics, from arts to medicine, from astrology to psychology, atlases are *systematic* collections of representations. As the mythological figure from which they borrow their name, atlases bear on their shoulders not just a bundle of entities but an entire world. In the words of Marco Quaggiotto, the concept of atlas “doesn’t depict as much a list of maps, but rather a system of representations of space, a communication device aimed at representing complex contexts through the use of many partial overlapping narrations: a network of maps, diagrams, texts and paratexts, combined together to describe the space of research in its multifaceted aspects” (2010). By organizing the maps they comprise, good atlases allow their readers to browse through them (Ricci, 2010) in two opposite modes that we shall call *narration* and *exploration*.

Good atlases derive their legibility from their capacity to *tell a story*, to focus not on *mimesis* (i.e. the close reproduction of their object), but on *diegesis*, the careful selection and arrangement of information (Genette, 1972, 1983; see also Segel & Heer, 2010). The ordering force of narration is a crucial counterbalance to the methodological and visual heterogeneity of controversy mapping. A good storyline provides readers of controversy atlases with a thread to follow through the mirror maze of second-degree objectivity, and its disorienting multiplication of viewpoints. In Greek mythology, Ariadne of Crete guides

Theseus out of the Minotaur's labyrinth by using a spool of thread. One of the interpretations of this myth associates Ariadne's ruse with narration and its power to lead listeners through intricate situations (cf. Miller, 1992). The same power must be invoked in controversy atlases whose legibility depends greatly on a good storyline, a *fil rouge* capable of stitching together their different maps and the different methods through which they have been produced.

In the previous chapters, we have provided several classic examples of controversy storylines. You may tell how some actors fought to see their voice acknowledged, as Epstein (1996) did in the case of AIDS. You may tell the story of institutions failing to consider alternative expertise, as Wynne (1989) did for the controversy over the Cumbrian sheep. You may report the adventures of an ingenious actor pushing its program through a series of inventions and partnerships, as Hughes (1983) did for Edison and its electricity. Or illustrate how a project is ripped apart by the disagreements of its own sponsors, as in the case of the TSR2 plane studied by Law and Callon (1992). You may present the story of a successful alliance, such as the one between Thomas Hunt Morgan and the *Drosophila melanogaster* (as in Kohler, 1999), or the epic struggle between opposed program and anti-programs, such as the ones of Pasteur and Pouchet in Latour's account (1984).

A good storyline has five characteristics:

1. It is *unified* (though it may contain twists and turns, it arranges them linearly).
2. It is *clear* (it should be possible to pitch it in one or two paragraphs).
3. It is *specific* (it remains close to the nuts and bolts of the controversy).
4. It is *instructive* (it is potentially generalizable to other collective phenomena).
5. It is *politically honest* (it declares the intervention that it hopes to produce).

A good storyline simplifies and streamlines the controversy that it narrates and therefore, inevitably, sacrifices some of the details and intricacies that make its mapping interesting and justified. It is crucial that these details are not lost but provided to the reader "on demand" (Shneiderman, 1996). In [chapter 4](#), we introduced the idea of a "chain of reference." Drawing on Latour (1995a) and his description of a soil science project in the Boa Vista forest, we argued that research protocols can be described as sequences of transformations. You go out to observe an event; pin down your observations as notes and sketches; prepare questions for your informants and record their answers; organize your notes in a coherent field report; then in a coherent text; and, finally, publish your story as a research paper. Or you put your hands on some administrative records; re-format and recode them; turn them into figures and tables from which you calculate indicators and regressions; and, finally, publish your story as a research paper. Or you find digital traces in the logs or APIs of some information system; struggle to fit them in a format that your laptop can read; clean out the 95 percent irrelevant for your research; push what remains through some analysis tool; refine the results with some textual or visual software; and, finally, publish your story as a research paper.

In all these cases, you start from a messy empirical phenomenon and *progressively* move toward an orderly scientific fact. The adverb "progressively" is crucial because, in order to be scientifically valid, the shift from phenomena to facts must be realized through a sequence of transformations aligned in such a way that their effects can be traced and, if necessary, *reversed*. This reversibility (the possibility to check every step back from the

final results to the initial observations) constitutes the “chain of reference” and the hallmark of what makes a claim “scientific.” Disclosing portions of the chain of reference is the very function of the oversized *paratextual apparatus* (Genette, 1997) that accompanies most scientific texts. Footnotes, endnotes, bibliographies, tables, figures, captions, table of contents, annexes, citations, bibliographic references, etc., have all been introduced in academic style precisely to allow readers to reverse the flow of the scientific evidence (Hartley, 2008). Scientific papers are a peculiar form of literature (Gusfield, 1976). Like all forms of narration, they reduce the complexity they address. Yet, unlike other genres, they are always ready to rewind such simplification: you don’t trust the results? Here is the analysis! You don’t trust the analysis? Here is the data! You don’t trust the data? Here is the protocol that produced them!

If the possibility to access a richer and cruder presentation of observations is important in all scientific endeavors, it is crucial in controversy mapping. Relying on a simple storyline helps making controversy atlases more legible but unavoidably betrays some of the complexity. A betrayal that should be compensated for by making sure that a less simplified version of their stories is available for the interested readers.

Datascape navigation

In recent years, both the construction of the chain of scientific reference and its textual and paratextual presentation have been affected by digitization (Desrochers & Apollon, 2014). Before the advent of personal computers, the journey from initial records to published results tended to pass through a series of incongruent supports, such as notepads, audio and video recorders, questionnaires, data tables, typewritten reports, calculators, printed texts. The necessity to move through these different supports made the retracing of a study almost as costly as the original research. For instance, retracing a statistical chart meant moving from the chart to a calculator; from the calculator to the data table; from the table to the survey sheets; from the sheets to the sampled population; from the sample to the actual phenomenon. Digital media do not spare us from the effort of transforming records, but they can displace the costs of reversibility from the reader to the medium (Venturini, 2012). Through digital media, large segments of the chain of reference (from the raw data to the algorithms employed to treat them; from the background materials to the software used for analysis or visualization) can be published with the main text of the article (cf. Willinsky, 2006; Ince et al., 2012).

By making scientific results more transparent and replicable, digital media transform the way in which research is read and written. Enabling a smooth circulation between narration and exploration, they transform the relationship between the researchers and their publics in a direction that is coherent with the participative stance of controversy mapping. For instance, discussing the practice of accompanying publications with a “companion website,” Bernhard Rieder and Theo Rohle observe that

such a website could further document methodological choices, provide in-depth information on technical aspects, and, if possible, source code. It could also, as part of a data-sharing plan, provide access to the “raw” data that went into the project, allowing other researchers to experiment with different approaches and arrive at different results. Also, a companion website seems like an ideal vehicle to present results more dynamically and interactively. Instead of providing the research results as a closed, finished product, Web-based interfaces could allow audiences to explore them both inductively and deductively, involving them in the process of knowledge production. (Rieder & Rohle, 2012, p. 81)

Digital media, therefore, come in handy for a second time: not only for tracing social phenomena (as we explained in [chapter 4](#)), but also for *re-tracing* the cartographic process. Exploiting the multi-modality and hyper-textuality of digital publication, it becomes possible (albeit not easy) to make controversies readable while respecting some of their complexity. Combining the two movements of narration and exploration in a circle, *datascape navigation* provides the reader with a simple narrative path through the debate, but also with the possibility of stepping off that path to explore the complexity of controversies (see [figure 84](#)).

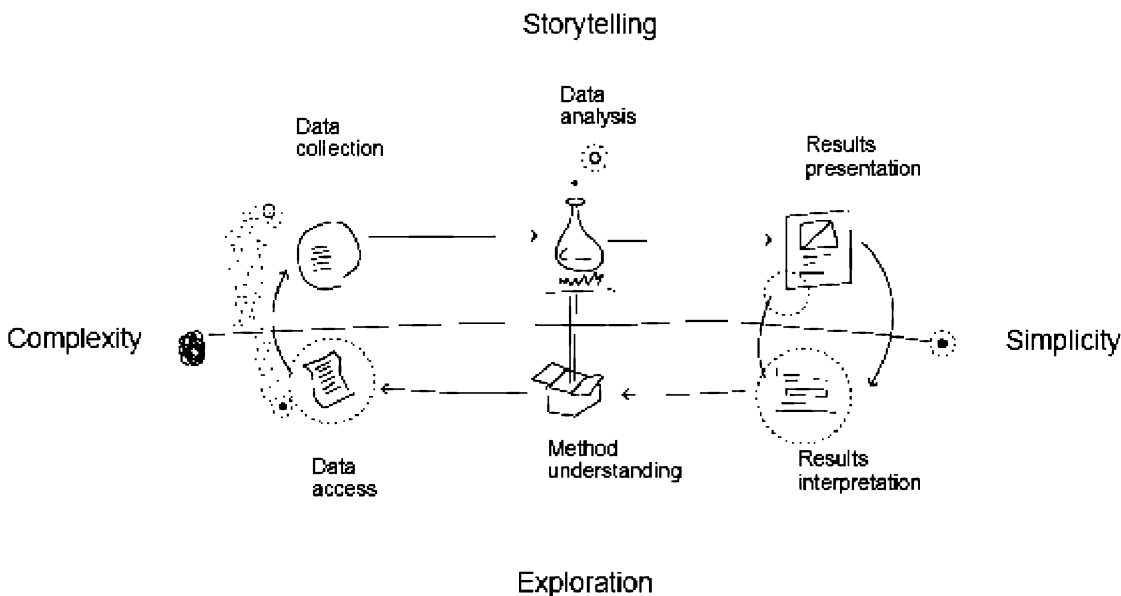


Figure 84 The narration-exploration circle of controversy mapping. Two circles are visible: a bigger one that encompasses all the steps of the digital methods research process and a smaller one that displays the iteration between presentation and interpretation of results in a datascape (adapted from Venturini et al., 2015c).

This was never clearer to us than in an investigation of the French parliamentary system. In a project titled *La Fabrique de la Loi – The Law Factory* (Venturini, 2019b), we collaborated with the French NGO Regard Citoyens to assess how much national laws are transformed by parliamentary debates (a very particular form of public controversy). Setting up the research, we were confronted with the classic trade-off between complexity and legibility. We could dissect the parliamentary trail of a few bills, but how to ensure that we had selected a representative sample and that an overall sense could be extracted from such exploration? Or we could compute statistical measures of transformation for all French laws, but how to know whether those metrics were not too simplistic?

Eventually, our NGO friends avoided both approaches and created instead an online platform allowing citizens to explore in detail all the 300 laws discussed between 2008 and 2014, but also to have a broad overview of parliamentary activities. The website lafabriquedelaloi.fr allows comparing how long different laws were discussed in different parts of the parliament and how many words were changed through these discussions (see [figure 85a](#)); identifying how much each article of each law was modified at each passage (see [figure 85b](#)); considering the amendments proposed by different political groups (see [figure 85c](#)); and reading the transcription of each word spoken by each parliament member on each specific article at each stage of the discussion (see [figure 85d](#)).

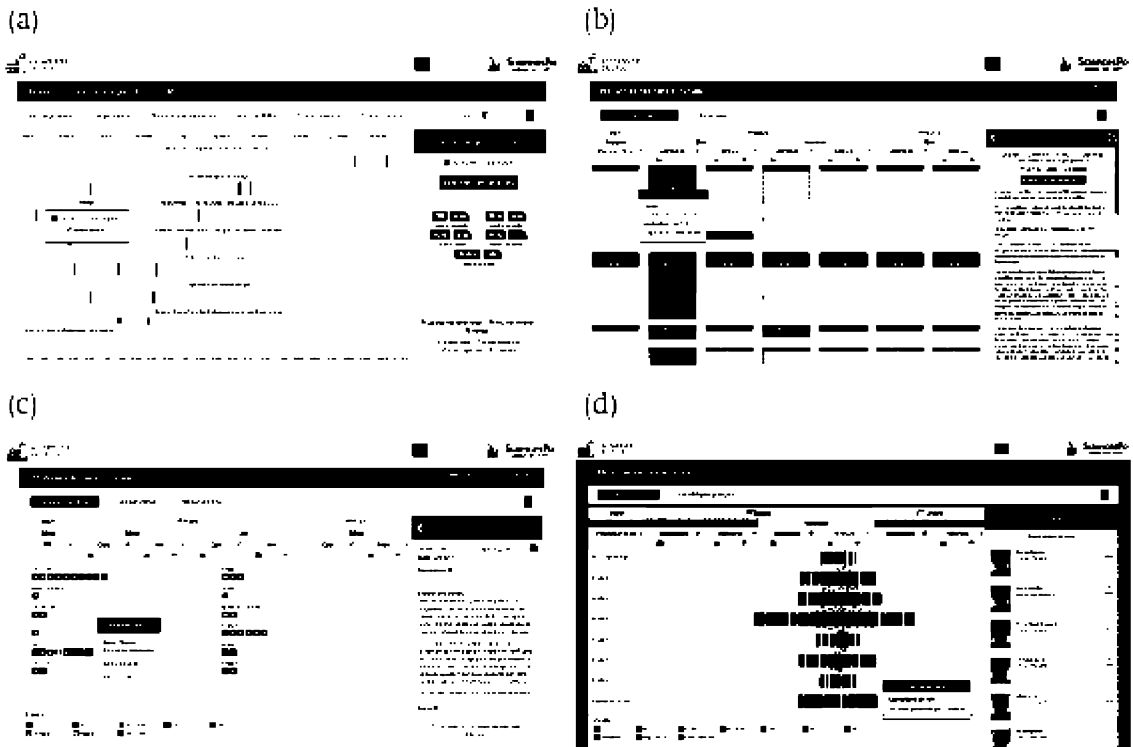


Figure 85 Datascape navigation on lafabriquedelaloi.fr. Together, the four interfaces allow the user to navigate between aggregate overviews and the qualitative minutes of specific debates; licensed under CC BY-SA).

Allowing users to navigate from aggregated overviews to the minutes of a debate (and back), *La Fabrique de la Loi* provides another example of how digital media help overcome the divide between qualitative and quantitative methods, but also demonstrates that narration and exploration can happily coexist as functions of the same digital platform. Datascape navigation reconciles the respect due the complexity of debate and the need to make this complexity legible – not by striking an impossible compromise between them, but by facilitating the movement between one and the other.

9

Mapmaking as a form of intervention

In this chapter, we learn how it can be necessary and democratically desirable to involve actors in the mapmaking process and how to organize data sprints to facilitate that involvement.

In the previous chapter, we discussed critical geography and its call to consider the political consequences of mapmaking. This call is very much in line with the work that has been done in STS to re-politicize science and expertise (e.g., Mol, 1999; Barry, 2001; Mitchell, 2002; Latour, 2004c; Bijker, 2005; Braun & Whatmore, 2010) and it applies *reflexively* to controversy mapping. We cannot claim that controversies are interesting (and democratically productive) because they crack open the silos of “science,” “technology,” “ethics,” “law,” “politics,” or “the social,” but refuse to commit our own practices to the same scrutiny. Controversy mapping cannot pretend to stand above the messiness of the territories that it charts and, instead, should accept to be, as Donna Haraway has put it, always and already “in the belly of the monster” (1991).

A few years ago, when the debate on fake news was raging in the wake of the 2016 US elections, we engaged in the writing of a *Field Guide to Fake News and Other Information Disorders* (Bounegru et al., 2018) to help journalists and media professionals trace misinformation online. While we were producing the guide, however, the very notion of “fake news” became itself the object of intense contestation, moving from a primarily academic use as a designator of misinformation, to a political weapon in the hands of the newly elected president of the United States. As noted by Claire Wardle, director of the fact-checking network First Draft that was sponsoring the production of the field guide, “the term ‘fake news’ has also begun to be appropriated by politicians around the world to describe news organizations whose coverage they find disagreeable ... becoming a mechanism by which the powerful can clamp down upon, restrict, undermine and circumvent the free press” (Wardle & Derakhshan, 2017, p. 16). This new controversy forced us to juggle two quite opposite demands. On the one hand, the desire of our sponsors to highlight the difficulty and political danger of simplistically categorizing news as either true or fake. On the other hand, the original request of our journalistic partners that we trace online misinformation, which would of course require us to decide on a particular interpretation of misinformation and thus to take sides in the meta-debate about fakeness.

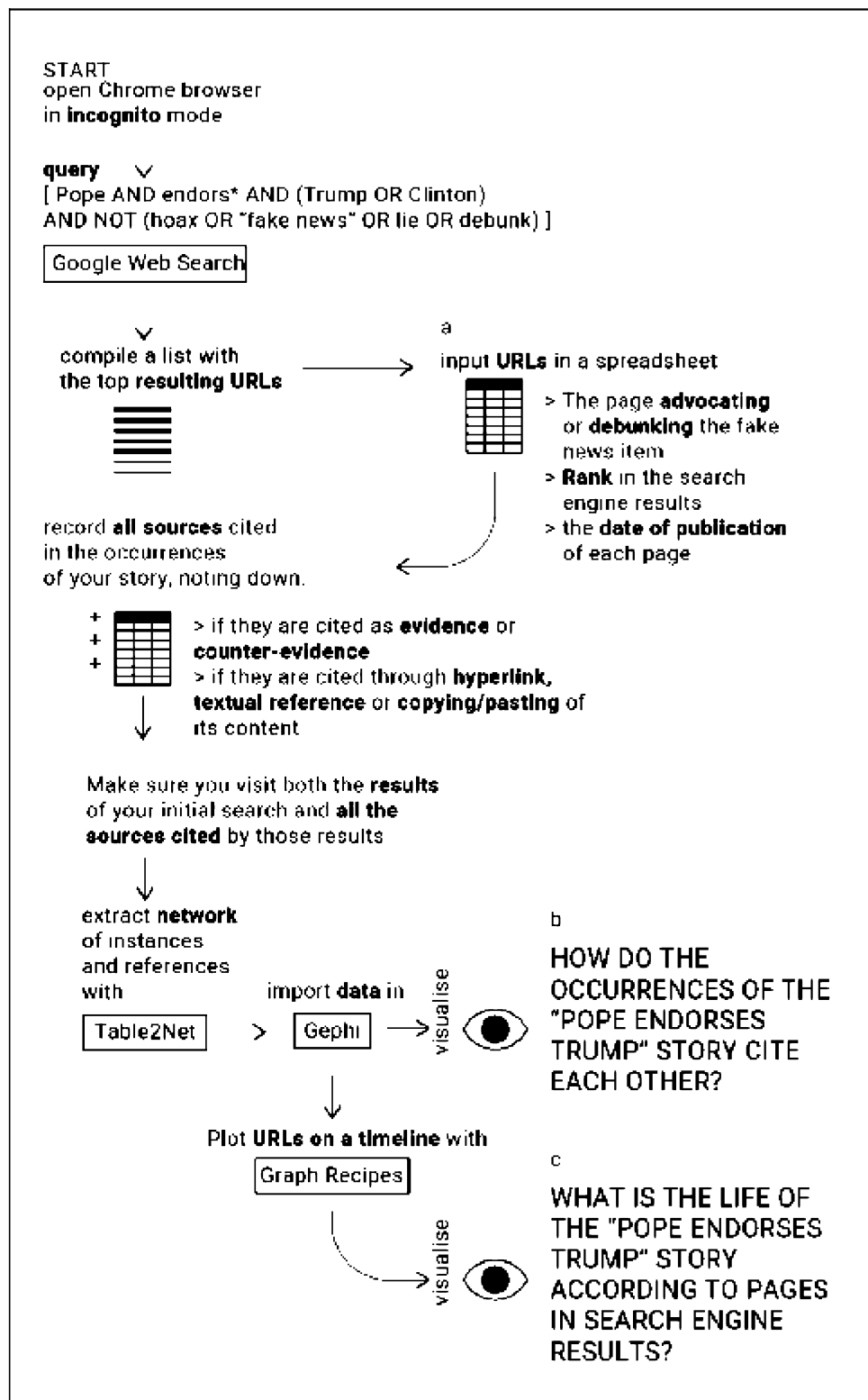
In the end, we tried to reconcile the two requests by redefining our intervention. Rather than providing maps, we invited journalists and fact-checkers to join us in a series of workshops to co-design a set of mapmaking recipes that would help the user inquire into issues of digital misinformation. By this shift we tried to satisfy the need of our partners to actually identify fake news, while simultaneously facilitating a deeper reflection on the

nature of online communication. An example of one such mapmaking recipe is provided in [figure 86](#). Taking the case of a fake news story from the 2016 US presidential election, namely that the Pope endorsed the Republican candidate, the recipe demonstrates how to repurpose a simple Google search to build a diagram of the trajectory of a piece of misinformation and to ask questions such as: Who shares it? In what form? By debunking it, promoting, or satirizing it? And who are they citing when they do so?

By asking the user to map the diffusion of the story not only through the websites advocating it but also through those debunking it, the recipe adds a crucial twist to a rather classic fact-checking technique. This exercise in symmetry, typical of controversy mapping, made it tangible to us and our partners in the newsroom that the popularity of many fake stories depends less on their capacity to deceive their readers than on their capacity to outrage them (Phillips, 2016; Venturini, 2018). In [figures 86a](#) and [86b](#), this is illustrated by the fact that the story we followed was spread more intensely and more durably by factchecking initiatives than by fake news websites. The story, it turned out, thrived less as a fabricated fact than as pure clickbait. As danah boyd puts it:

I can't help but laugh at the irony of folks screaming up and down about fake news and pointing to the story about how the Pope backs Trump. The reason so many progressives know this story is because it was spread wildly among liberal circles who were citing it as appalling and fake. From what I can gather, it seems as though liberals were far more likely to spread this story than conservatives. What more could you want if you ran a fake news site whose goal was to make money by getting people to spread misinformation? Getting doubters to click on clickbait is far more profitable than getting believers because they're far more likely to spread the content in an effort to dispel the content. Win! (boyd, 2017)

Acknowledging rather than denying our hesitation about how to deal with fake news and using it as an occasion for co-design with the actors in the field (Bach et al., 2018), we discovered that our most interesting contribution could be to shift the debate from the risk of fabricated facts to that of memes (Shifman, 2013), clickbait, trolling and other forms of ephemeral distractions that prevent online audiences from committing to actual democratic inquiry (Castaldo et al., 2021).



Figures 86a and 86b Recipe for tracing the fate of a fake news story online (Bounegru et al., 2018). Licensed under CC BY 4.0 (data source: fakenews.publicdatalab.org).

Figure 86a The digital methods protocol.

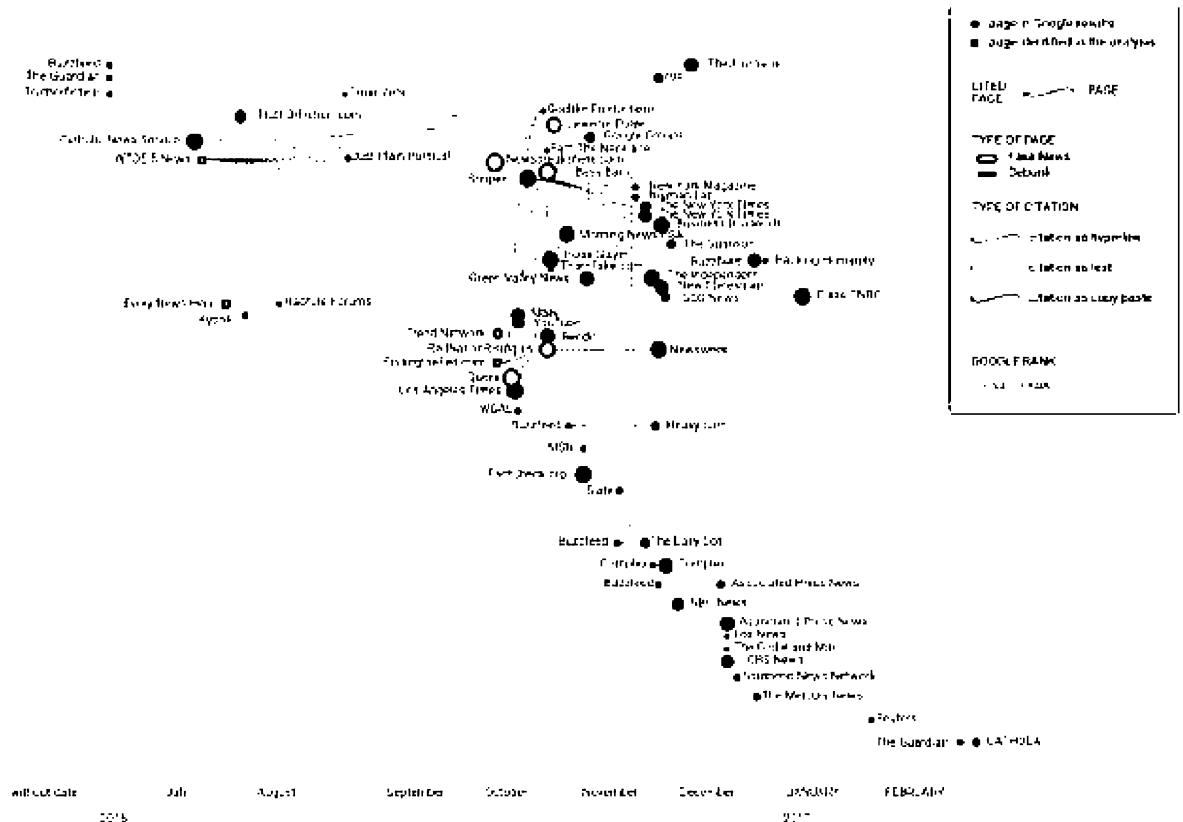


Figure 86b The resulting visualization (output “b” from the protocol) showing how the original “Pope endorses Trump” story is circulated by other sources, with what purpose (debunking or fake news) and with what kind of citation (hyperlink or not).

Hybrid forums and parliaments of things

In [chapters 4](#) and [5](#), we criticized the conceptual and methodological shortcomings of the so-called micro/macro divide. Its political implications are equally problematic. Introducing a separation between individual behaviors and societal structures, the micro/macro divide discounts, and thus discourages, the kind of organized collective action that is the foundation of civic participation. This discouraging effect is evident for the theories that present structures as *sui generis* social facts that can only be influenced by other social facts, but is also true (though in a subtler way) for those who present structures as global effects emerging unintentionally from a multiplicity of local interactions (an idea first introduced by Lewes, 1875).

There is a false appeasement in the notion of “social emergence,” the spontaneous dawn of global order from a multitude of local exchanges. The idea of macro-structures emerging from micro-interactions de-politicizes the state of collective systems. If structures (institutions, norms, markets, cultures) evolve spontaneously, then none can be held responsible for them. They derive from the actions of a multitude of individuals, but do not correspond to the intentions of any of them. There is no better illustration of this false appeasement than the famous model of urban segregation proposed by Thomas Schelling (1971, 1978) to account for the racial segregation of American cities. In a classic example of social modeling, later rewarded with the Nobel Prize for Economics, Schelling

suggested that urban segregation may emerge unintentionally at the macro level despite opposite individual preferences: “surprisingly, the results generated by this analysis do not depend upon each color’s having a preference for living separately. They do not even depend on a preference for being in the majority!” (Schelling, 1971, p. 180). As noted by Wendy Chun, however, through such a charitable interpretation “the long history and legacy of race-based slavery within the United States is completely erased as well as ... the history of redlining and other government sanctioned programs that made it almost impossible for black citizens to buy homes in certain neighborhoods” (Chun, 2018, pp. 82, 83). The micro/macro divide is not only methodologically inaccurate and theoretically questionable but also politically dishonest (Venturini et al., 2015b; Jensen, 2018). Instead of favoring accountability and engagement, it hides the action that produces collective asymmetries and the inaction that puts up with them.

The social fabric is not woven by the wisdom of crowds and when it is torn, it is seldom by accident. Collective existence is shaped by the intervention of actors whose specific responsibilities can and should be traced. Rejecting the micro/macro divide is rejecting the naturalization of social life and affirming that social inequalities derive from the political stakes of specific actors – not only individuals, of course, but also corporations, institutions, markets, technologies, and so forth. Overcoming the micro/macro divide therefore highlights the responsibility of social research. If collective phenomena emerged spontaneously, their investigation could be defined as pure naturalistic observation. But when collective effects follow the efforts of specific actors (often against those of many others), then their description becomes a political act in itself. Investigating some debates (instead of others), deploying some chains of actions (instead of others), following some actors (instead of others) entails political choices and produces political effects:

Choosing to make visible, to connect, to show some links, and this on behalf of some actors, means subtracting some of the leeway of other actors, contributing to the creation of asymmetries and the rendering of some configurations as impossible. This is, therefore, a political intervention. (Callon, 1999b, p. 76 our translation)

To intervene in public discussions and oppose collective inequalities, controversy mapping must therefore make visible how the playing field is not level and who is responsible for these asymmetries. Our duty as controversy mappers is to help clarify who has a stake in the debate and deserves to be heard, not only taking the “viewpoint of the subjugated” (as claimed in [chapter 3](#)), but also working with them to make their stance more visible.

Controversy mapping therefore has an inherently subversive flavor. Not in the sense that it intends to overthrow established institutions, but in the sense that it inevitably exposes them to public scrutiny and opens them to public discussion. According to Michel Callon, Pierre Lascoumes and Yannick Barthe, a key role of controversies and their mapping is to provide “hybrid forums” (see also Callon & Rip 1991) where the tensions between individual actors and institutional representatives can be discussed:

Actors involved in socio-technical controversies are not mistaken. When they establish a new hybrid form, they lay their cards on the table: “We do not accept the monopoly of experts! We want to be directly involved in the political debate on questions that our representatives either ignore or deal with without speaking with us!” Every hybrid forum is a new work site. It is a site for testing out forms of organization and procedure intended to facilitate cooperation between specialists and laypersons, but also for giving visibility and audibility to emergent groups that lack official spokespersons. The task of the actors is all the more difficult as it comes up against two monopolies: that of the production of scientific knowledge and technology and that of political representation. (Callon et al., 2001, pp. 35–6)

If the continuity between individual and collective action compels controversy mapping to seek those whose voices are less audible but more deserving to be heard, the entanglement of human and non-human actors makes this engagement even broader. As we claimed in [chapter 3](#), the power relations established by science and technology are not limited to human beings. Think of the channeling of waters (Bijker, 2005); the domestication of vegetables (Pollan, 2001); the bending of metals (Derry & Williams, 1960, pp. 114–56); the exploitation of fossil fuels (Gras, 2007); the control of germs and bacteria (Latour, 1988); and the harnessing of molecules and atoms (Welsh, 2003). By enrolling nonhuman actors, technoscience has mobilized their political agency and made them part of society. They have become, as Bruce Braun and Sarah Whatmore put it, the “stuff” of politics (2010). In antiquity, we could ignore the existence of magnetic forces. In the Middle Ages, we lived happily without clocks. In the Renaissance, we could consider copper an ornamental metal. But imagine how space would change if magnetization was to disappear from our compasses; how time would be transformed if clocks suddenly refused to work (Koyré, 1957); how life would change if copper wires stopped transporting electric signals (Hughes, 1983).

Not only are more and more human beings connected across continents and cultures, but our existence is increasingly entangled with that of billions of nonhuman beings. Through the centuries, farmers and breeders have tamed the behavior of species and modified their genetic code, what is generally referred to as the “domestication syndrome” (Nabhan, 1989). Domestication is a “syndrome” because it makes plants and animals less fit for survival and increasingly dependent on human beings. Because of domestication, a growing number of non-humans only exist because we created them and only survive because we enable them (Weisman, 2007). *But the opposite is also true.* While we were domesticating them, dogs were domesticating us in return (Lorenz, 1954; Nagasawa et al., 2015). When, in the nineteenth century, the potato crops failed in Ireland because of a blight epidemic, hundreds of thousands of people died. When, in the 1930s, the soil of the US Great Plains turned into dust (from the combined effect of deep plowing and drought), half a million Americans had to emigrate. Without our non-human companions, we would not endure for long (which makes it particularly worrying to note that humans are passing from being one of the main sources of biodiversity to being the main threat against it; Cardinale et al., 2012).

We live not only in a multicultural but also in a *multi-natural* and *multi-species* world. There is little hope of “saving humanity” without “saving non-humanity” as well. As remarked by Pope Francis in one of his encyclical letters, the crisis of modernity is political and environmental at once: “The human environment and the natural environment deteriorate together; we cannot adequately combat environmental degradation unless we

attend to causes related to human and social degradation” (Pope Francis I, 2015, p. 33, para. 48). More recently, the United Nations Human Rights Council released a report expressing in similar terms the way in which fighting climate change is a necessary condition to protect human rights (Knox, 2019; see also Humphreys & Robinson, 2010).

The mindset required to consider the political rights of humans and nonhumans *together* can be expressed as an extended version of Immanuel Kant’s moral theory as summed up in his moral imperative: always treat humans as an *end* and never as a *means* (*Grounding for the Metaphysics of Morals*, 1785). All one has to do is to replace “human” with “actors” to obtain a compact version of ANT’s theory of action and of the politics of controversy mapping. Latour expresses this idea through the distinction between “intermediaries” and “mediators”:

An intermediary, in my vocabulary, is what transports meaning or force without transformation: defining its inputs is enough to define its outputs ... Mediators, on the other hand ... their input is never a good predictor of their output; their specificity has to be taken into account every time. Mediators transform, translate, distort, and modify the meaning or the elements they are supposed to carry. (Latour, 2005b, p. 39)

The problem of modernity is that most of the actors that used to be defined as docile intermediaries turn out to be recalcitrant mediators. This is true for human beings (migrants, indigenous people, social minorities) as well as for non-human ones (endangered species, polluted aquifers, climatic systems, zoonotic viruses). New equilibria can only come from renewed negotiations, which can only succeed if all the stakeholders are invited to the table, humans and non-humans alike – which takes the idea of hybrid forums a step further:

Let one of the representatives talk, for instance, about the ozone hole, another represent the Monsanto chemical industry, a third the workers of the same chemical industry, another the voters of New Hampshire, a fifth the meteorology of the polar regions, let still another speak in the name of the State; what does it matters, so long as they are all talking about the same thing ... the object-discourse-nature-society whose properties astound us all and whose network extends from my refrigerator to the Antarctic by way of chemistry, law, the State, the economy, and satellites. The imbroglis and networks ... they are the ones that have to be represented; it is around them that the *Parliament of things* gathers henceforth. (Latour, 1993, p. 144, our emphasis)

It is not easy to describe the precise form of these “parliaments of things,” because each of them should be specifically organized to fit the characteristics of its matter of concern. We can, however, discuss the case of what we believe to be the largest and most institutionalized instance of such a parliament, though rarely recognized as such, namely the Intergovernmental Panel on Climate Change (www.ipcc.ch).

Established in 1998 under the auspices of the UN Environment Programme and of the World Meteorological Organization (Agrawala, 1998), the IPCC assesses and summarizes the research on climate change with the aim of informing the international negotiations of the UNFCCC. The IPCC Assessment Reports (ARs) and their “summaries for policy makers” (SPMs) result from the work of hundreds of scientists (more than 1,800 for the fifth report) and diplomats (most countries of the world have a delegation in the Panel). Such double representation is meant to ensure that the interests of both the socio-ecological

systems and the sovereign states are considered and composed (Siebenhüner, 2003; De Pryck, 2015).

Since its foundation, the panel has been attacked by climate skeptics who have accused the IPCC of being polluted by politics (Beck, 2012). And yet it is precisely because the IPCC is open (sometimes against the desire of its scientific experts) to heterogeneous interferences that it can mediate between different actors and interests. If the IPCC were to become a purely scientific institution, much of its value would be lost. It is precisely from its impurity (Barthe & Gilbert, 2005) that the IPCC derives its strength and arguably why it was awarded the Nobel Prize for Peace in 2007 (“for its efforts to build up and disseminate greater knowledge about man-made climate change, and to lay the foundations for the measures that are needed to counteract such change”) and inspired several similar initiatives (De Pryck & Wanneau, 2017).

However, abiding by a realist idea of the relationship between science and politics – summarized in IPCC’s mantra: “Policy-relevant, yet policy-neutral, never policy-prescriptive” – the organization often seems wary of acknowledging its hybrid nature, particularly in its public communication (Beck, 2011). Because of this, the most interesting innovations of the IPCC risk being lost and its protagonists falling back on a conventional distinction between science and politics. The IPCC is a fascinating institution, tasked with the impossible mission of accommodating, in the handful of pages of its famous Summaries for Policy Makers, the interests of hundreds of nations but also of thousands of social and natural systems. Yet instead of taking pride in such work and praising the collaboration of its participants, the institution hides behind an untenable divide, separating authors, who pretend to care exclusively about scientific facts, and delegates, who pretend not to influence the contents of the reports. Luckily, neither of these postures corresponds to the actual practices of the IPCC, which are instead based on a complex architecture of procedures for negotiating the boundaries between the world of scientists and that of policymakers (Latour, 2012; De Pryck, 2021).

Controversy mapping as an open-air experiment

In suggesting that sociotechnical dispute should be debated in dedicated hybrid forums or parliaments of things, controversy mapping encourages us “to avoid equating democratic politics with the institutions of representative government and the machinery of policymaking, and to be more attentive to the multiple and emergent constitution of publics and their political capabilities” (Whatmore, 2009, p. 592). This call for renewing the institutions of political debate takes inspiration from the “antagonistic pluralism” imagined by Chantal Mouffe (1999, 2005, 2013). According to Mouffe, modern democratic institutions struggle to deal with controversies because they pursue the unachievable ideal of “deliberative democracy” and deny the fundamentally antagonistic nature of collective life. Misled by the dream of rational debate imagined by Enlightenment thinkers (such as Montesquieu and Sieyès), the supporters of “deliberative democracy” such as Habermas (1967, 1989) or Rawls (1971, 1993) believe that social harmony could be reached by removing all barriers to Egalitarian and rational discussion. By aiming at a universal “us,” deliberative democracy denies the fundamental us/them distinction on which all political action is based (Swyngedouw, 2010, makes this point on the climate change debate). Mouffe cites Wittgenstein (1958) and his observation that the ideal of rational communication may end up making political debate impossible: “we have got on the

slippery ice where there is no friction and so in a certain sense the conditions are ideal, but also, just because of that, we are unable to walk: so we need friction. Back to the rough ground.”

Instead of the “ideal speech situation” imagined by Habermas (Estlund, 2006), we are left with controversies and their asymmetries, frictions and imperfections. This has led STS to adopt a more interventionist stance (Jespersen et al., 2012; Martin, 2016), focusing on rebuilding sociotechnical arrangements in collaboration with specific actor groups (Yearley et al., 2003; Whatmore & Landström, 2011; Downey & Zuiderent-Jerak, 2017). While debates over technoscience have existed at least since the late nineteenth century (Fressoz, 2012) and probably before (Jarrige, 2016), from the 1980s on, administrations and scientific institutions have tried to channel these debates in a series of more institutionalized arenas according to an approach often called “public engagement with science and technology” (cf. Petersen, 1984; Jasanoff, 2003b; Bucchi & Neresini, 2007; Saurugger, 2010; Pestre, 2011; Chilvers & Kearnes, 2015). This has produced a variety of experiments under a variety of names (cf. Rowe & Frewer, 2005): for example, participatory modeling (Yearley et al., 2003); consensus conferences (Einsiedel et al., 2001); deliberative mapping (Burgess et al., 2007); living labs (Björgvinsson et al., 2010); competency groups (Whatmore, 2009); participatory technology assessment (Durant, 1999); and science shops (Leydesdorff & Ward, 2005). While the intentions behind these initiatives are often praiseworthy, the risk remains of staging weak forms of participation instead of eliciting the more diverse and interventionist engagement required by hybrid forums:

It seems unclear if these institutional arrangements have restored public trust in science as their promoter had hoped for, perhaps because they still implicitly envisioned the public through the “deficit model”: the public lacks knowledge and expertise and is waiting to be enlightened. One more troubling concern perhaps, is that these institutions could be considered less as a tool for helping the public participate in the governance of science, than as a tool for governing the public’s anxieties about science, while leaving the general course of scientific research unaltered. (Strasser et al., 2019)

According to Michel Callon (1999a), public engagement with technoscience comes in three basic varieties. The “public *education* model” is premised on the idea of a public deficit of knowledge and assigns to the scientists the task of facilitating the transmission of information. The “public *debate* model” acknowledges the stakes of the public in the production of knowledge and accepts a need to keep scientific claims open to commentary from those affected by their consequences. Finally, the “*co-production* of knowledge model” assumes that scientific activities should be pursued in a constant and genuine dialogue with their publics. Controversy mapping falls in the last category and, in line with its intellectual origins, it proposes as sort of *open-air* experiment shared between the observer and the observed. From STS, controversy mapping derives the idea that researchers should facilitate public involvement in technoscientific projects (Jensen, 2012) and raise questions about trust (Wynne, 2006), the role of experts (Nowotny, 2003), the democratization of knowledge (Stengers, 1997, 2000), and the viability of technological fixes (Woolgar, 1990; Brandt, 2006; Hyysalo, 2006; Ehn, 2008; Petersen & Munk, 2013). From ethnomethodology and ANT, it inherits the commitment to describe collective situations throughout the methods developed by their protagonists and to co-build its inquiry with anyone or anything that participates in the situation or feels concerned by its

consequences (Dewey, 1938, 1946). Ultimately, however, the stronger push to openness comes from the fact that controversies themselves cannot be contained in institutional spaces because they are precisely the moments when sociotechnical black boxes are prised open and existing framings overflowed by the appearance of new actors or new alliances.

The radical openness of controversies means that their mapping invariably begins with a blurred appreciation of their features and an unsure definition of their actors. This is why the political engagement proposed by controversy mapping is always shaped like a spiral (see [figure 87](#)). It starts from reaching out for a *non*-representative sample of actors, asking them wrong questions, and obtaining disappointing answers. It continues, mistake after mistake, by improving the number and the quality of informants, enhancing relations with them, and producing better and better maps. It ends by co-designing a number of diagrams with a heterogeneous group of coinvestigators.

Figure 87 The spiral of public participation (adapted from Venturini et al., 2015c).

Linus Torvalds's style of development – release early and often, delegate everything you can, be open to the point of promiscuity – came as a surprise. No quiet, reverent cathedral-building here – rather, the Linux community seemed to resemble a great babbling bazaar of differing agendas and approaches (aptly symbolized by the Linux archive sites, who'd take submissions from *anyone*) out of which a coherent and stable system could seemingly emerge only by a succession of miracles. (Raymond, 1999, pp. 21–2)

Faced with radical uncertainties about how their projects will develop and who will join them (a condition which closely resembles that of controversy mappers), open-source programmers came up with an interesting collaboration format often called “barcamps” or “hackathons,” short self-organized events in which a group of developers convene to work intensively on a digital project. Three features of hackathons and barcamps are particularly appealing for controversy mapping:

1. *The heterogeneity of the actors involved.* Hackathons are generally open to different types of actors. The need to achieve deliverable results by the end of the event requires the gathering of competences from the entire programming range: from setting up server infrastructures, to designing wireframes, from scraping data to implementing front-ends. The push for heterogeneity also derives from the necessity to exchange with potential end-users, who should be at hand and ready to express their needs.
2. *The effort to convene participants physically.* The unity of time and place that characterizes hackathons is an appropriate counterbalance to the dispersion of open-source teams and of controversy mapping projects. One of the problems of controversy mapping's inherent multidisciplinary nature is that the experts from one field may have a blurred appreciation of the inputs needed by experts from other fields. Issue specialists can formulate research questions in ways that are impossible to formalize for analysts; analysts can elaborate data in ways that are difficult to visualize by designers; and designers can deliver visualizations that are irrelevant for issue specialists. Techniques of distant cooperative work can ease some of these difficulties, but nothing speeds up collaboration more than face-to-face discussion.
3. *The “quick and dirty” (or “design to cost”) approach.* The short and intensive nature of hackathons shields these events from the dream of exhaustivity often associated with “big data.” Participants know that they will only be able to treat limited amounts of digital inscriptions and that they will only achieve imperfect results, but they accept such constraints more as a challenge than as a flaw. Making the most out of light infrastructures, simple logistics, and agile organizations, participants are aware that their work should reuse code and data gathered in earlier projects and that their outcomes should become the bases for further ventures. Hackathons and barcamps are not only iterative within their meetings, but also explicitly conceived as intermediary steps of larger developing cycles.

Drawing on these three features, we developed our own research format called the “data sprint.” Data sprints differ from their ancestors because of the efforts invested in “contextualization” before, during, and after the event. Unlike hackathons and barcamps, data sprints are always preceded by extensive preparation. When participants meet up, most of the research infrastructures should be ready. Time-consuming operations such as the cleansing of data or the engagement of issue experts should be accomplished in

advance, so that the days of the sprint can be dedicated entirely to the operations that require a direct collaboration. Also, participation in data sprints is not open: sprinting lineup and team formation are taken care of in advance to make sure that the working groups contain all the competencies needed to achieve results. Data sprints are also generally longer and more structured than their antecedents. While hackathons and barcamps are usually organized over two or three days, sprints work better when they extend over a full working week. The main reason for this is to give the participants time and occasion to realign their goals and expectations based on what they learn through the process of mapmaking. In data sprints (as in the classroom), the learning potentials of controversy mapping come from the process of mapmaking rather than from the maps as end results. This, however, adds significantly to the time and resources needed to get the most from a mapping project. Indeed, it can be hard to explain to participants the paradoxical process of trying to provide solutions while also constantly redefining the terms of the problem (Munk et al., 2019). Finally, data sprints require a greater follow-up than hackathons and barcamps. The “quick and dirty” approach that characterizes the days of a data sprint should be complemented by an extensive work of refinement and documentation, in order to endow the results with the precision and robustness demanded by scientific research.

Data sprints are therefore built as transdisciplinary collectives assembling over several days to explore and visualize a set of research questions. When a sprint involves a relatively large number of people (say more than a dozen), participants should be distributed into small teams dedicated to independent (but related) research projects. The exact composition of these groups will vary depending on the controversy they address, but the following competencies are always necessary.

Issue experts: Regardless of the specific objective of the sprint, the first order of business is always the formulation of research questions. This is done with the help of people that have stakes in the inquiry, because they are affected by it, produce knowledge about it, intervene politically in it, represent its constituencies, etc., and thus not only the official or academic experts, but also the kind of lay experts discussed in [chapter 3](#). These people are at once the issue experts who are able to unfold the matters of concern for the rest of the participants, and the alpha users who will be able to provide feedback and commentary on the intermediary results. The selection of these issue experts/alpha users does not presume to be representative (as, for example, in citizen conferences) but is driven by the need to acquire stakes in the controversy.

Media scholars and data scientists: Data sprints, as their name indicates, tend to revolve around the investigation of digital records, which need to be detached from the context of their production, prepared for the objectives of the sprint, filtered, sorted, ordered. To carry out these operations of “data wrangling,” it is crucial to have people that know how records have been created and that are able to repurpose them.

Developers: Sprints are supposed to be agile. They must be able to adapt not only to what the issue experts bring to the table, but to what the research collective makes of these contributions. The one asset that more than anything ensures this agility when working with digital methods is the talent and responsiveness of developers. The idea that development can be fully anticipated is anathema to successful sprints. The job of the developers is to adapt tools and scripts for particular analysis needs, harvest missing data, and help the designers build applications for exploring the datasets.

Designers: Competences in data design and information visualization are needed throughout the whole sprint process. Visualizations are essential to facilitate the iterative exploratory data analysis on which sprinting is based. They are also crucial for making sure that the results of the sprint are delivered in a form that makes them available to specific issue publics.

Project managers: Research questions must be asked in such a way that they are both feasible with the available methods and relevant for the issue publics in question. This requires a translational competence. Project managers must be sufficiently knowledgeable of the controversy to understand the questions posed by the issue experts and sufficiently adept with digital methods to see the potentials and constraints flagged by designers and developers. The project managers become, in a sense, the stewards of the alpha users, helping them to express their needs and to make sense of the results produced.

Sprint organizers: Not all the participants, however, should be embedded in a team. A few persons (depending on the size of the sprint) should be devoted to logistics support, facilitating the exchange of data, methods and ideas among groups. Besides making the necessary practical arrangements for the sprint to take place (booking rooms and accommodation, organizing food, distributing programs and practical information, etc.), the organizers play a key role in the preparatory phase leading up to the sprint, most obviously by deciding on the overall sprint theme. Although sprints should be agile enough to accommodate evolving research questions, some framing is necessary for an effective mobilization of experts. Thematic framing is also necessary for pre-collecting datasets. Likewise, although sprints should be agile enough to accommodate the harvesting of new datasets, the organizers should do what they can to anticipate relevant data sources.

For the sake of clarity, it is also possible to single out different sprint activities that, though mingled in practice, correspond to different organization concerns.

Posing research questions: The invited issue experts generally suggest research questions at the very beginning of the sprint. On the first day, experts are given the occasion to unfold the controversy from their viewpoint (through short keynote speeches) and to answer questions from the other participants (most of whom have little previous knowledge of the issue at stake). Written briefs can also be prepared and circulated before the meeting.

Considering the relevance and implications of research questions: Besides suggesting research questions, issue experts are also invited to help the other participants to get a grip on the controversy. This can be done through Q&A sessions or panel discussions, but it also happens through informal consultations as part of the running feedback on data visualizations. It is a matter of making sure that the projects never diverge from the interests of their potential users, but also, quite importantly, a matter of issue experts questioning each others' positions. Effectively, this means that no mapping project is the monopoly of one issue expert alone.

Operationalizing research questions into feasible projects: This process begins even before the sprint as the organizers try to anticipate what types of projects the sprint might lead to. We found that an excellent way of doing this initial vetting is to ask issue experts to consider interesting datasets. This provides a chance for the experts to attune to what a digital methods project can and cannot achieve. The actual operationalization, however, happens during the sprint and is generally led by the project managers.

Procuring and preparing datasets: As mentioned above, while it is desirable to have datasets available in advance, this is sometimes at odds with the agility of the sprint. Time and resources should therefore be put aside during the sprint to complete the data collection in line with the questions raised by the issue experts.

Writing and adapting code: Sprints are issue-specific and their aim is less to develop generic tools than to adapt existing code to the research questions raised by the issue experts. This does not mean, however, that effort shouldn't be invested in making datasets, scripts, and visualizations re-usable beyond their original projects. Sprints should remain faithful to their open-source roots and ensure that all the data, code and contents produced are freely available through open licenses.

Designing data visualizations and interfaces: One of the driving forces of data sprints is that they deliver tangible outcomes. These outcomes may have different forms, but they always share the characteristic of being usable by the actors of the controversy. Often, this results in the issue experts leaving the sprints with tangible results that they immediately mobilize in the debates. More generally, this means that specific efforts should be invested to design the outcomes of the sprint so that they are relevant not only for the researchers, but also for their potential users.

Eliciting engagement and co-production of knowledge: This last mode of engagement is necessary to create a space for researchers and actors to experiment with new collective arrangements – or hybrid forums as we called them above. The six activities described above should all be arranged so that this type of engagement might be achieved. If sprints fail in creating a common space for the co-production of knowledge between social scientists and social actors, they fail in all other respects as well.

Critical proximity

As explained in [chapter 2](#), a great deal of the success of controversy analysis in the 1970s and 1980s came from the force of direct observation of scientific practices. By applying ethnographic techniques to the study of laboratories, STS obtained more situated accounts of how scientists and engineers work. This approach, however, has the drawback of constraining the inquiry to a few local situations, in most cases scientific or industrial laboratories. While these places clearly deserve special attention, being among the “control centers” of modern societies (Latour, 1988), their power derives from their webs of connections. To follow these connections, actor-network theorists moved on to consider the inscriptions that make such a distant control possible but also observable for the researchers – not least those created by digital technology.

The focus on inscriptions and more recently *digital* inscriptions, however, risks distancing us from the situations that we investigate. Digital records put a screen (literally a computer screen) between us and the controversies that we analyze. Instead of traveling the territory that we are supposed to map, we sit comfortably behind our desk, assessing and combining records that others have produced.

Combining digital methods with data sprints provides a guardrail against this distancing as it facilitates the direct exposure of the cartographers to the controversies they study. This is why a data sprint needs to include at least some of the actors of the controversy. Their presence ensures that sprints are not just simulations (Wheeler, 2006), but *transpositions* of societal debates in situations where they can be newly addressed. In this sense, the ethos of

data sprints resembles more that of participatory cartography (Chambers, 2006) than that of the simulations employed by the UN and other institutions to engage students and citizens (Fuss Kirkwood-Tucker, 2004). Even more, perhaps, data sprints bear similarity to the “temporary autonomous zones” imagined by the anarchist poet Hakim Bey (1985): situations where the ordinary rules of the political game are suspended, opening the space for testing new forms of organization – exactly what hybrid forums and data sprints are supposed to achieve.

An example of how replicating controversies is less important than experimenting comes from an unusual diplomatic simulation in which we participated in 2015. A few months before the meeting of the Paris Climate Conference (COP21), Sciences Po Paris hosted a week-long simulation of the diplomatic debate. The event was jointly organized by CliMates (an association of students inspired by Laurence Tubiana, one of the chief French negotiators for the COP21) and the Ecole d’Arts Politiques (SPEAP) of Bruno Latour. During the preparation, tensions arose between the two groups over the format of the debates. CliMates insisted that the simulation should remain as close as possible to the actual setup of the international negotiations, while SPEAP students pushed to introduce debate innovations (admitting, for example, delegations representing non-human actors such as “forests,” “oceans,” “un-extracted fossil fuels”). Their discussions were fascinating because they showed how difficult it is to build alternative spaces of discussion while staying true to the original stakes of collective controversies.

This difficulty is encountered in the organization of all data sprints, since the move to a controlled setting is always at risk of “neutralizing” the phenomena we would like to experience. The temptation is strong to defuse the violence inherent in controversies and to organize sprints as friendly meetings where people sit around the table using data as an occasion to line up their disagreements cordially (cf. Pestre, 2007). This is not what a sprint should look like.

Controversies are infectious. They get you hooked, outraged, passionate, and confused, all at the same time. They can instill in you a sense of injustice and the desire to take a stand and make a difference. They will make you a militant and a subversive, or a defender of due process and expert rule. In sum: they will engage you. Far from being an exercise in critical distance, cartography mapping is an “interested method” (Asdal, 2018) and a form of “critical proximity” (Latour, 2005a; Birkbak et al., 2015). Its goal is always to intervene in the debates it addresses and yet its intervention is always oblique, for controversy mapping pursues its own political program by describing the programs of everyone else (Vikkelsø, 2007). Unlike most other forms of political intervention, controversy mapping wishes to intervene in the debate not by pushing one side of the story but by deploying *all sides*. It is, in that sense, what Isabelle Stengers would call a “cosmopolitical” program (Stengers, 2005), an effort to slow down the reasoning of those who too hastily claim that all positions can be encompassed in the same common world and instead induce some hesitation (see also Munk & Abrahamsson, 2012).

A personal recollection will illustrate this idea. It dates to a time when we were investigating a series of controversies about biopiracy – the fight of traditional farming communities against the legal and technical appropriation of biological resources by agribusiness corporations (Venturini, 2007b, 2008). Our case study was the so-called “terminator seeds” or Genetic Use Restriction Technologies (GURTs). This type of biotechnology consists in adding to the DNA of a plant a gene that induces the production a toxin that prevents the germination of its seeds. Through this system, seed companies can

commercialize plants that develop normally but whose seeds are incapable of germinating – thus stopping farmers from replanting their yield and forcing them to buy new seeds every year (cf. Eaton & van Tongeren, 2002). Since its patenting, various civil associations have put up a major fight against this technology, presenting these seeds as *unnatural* because contrary to the very essence of seeds (the reproduction of life) and *immoral* as a capitalist attack on the food security of farming communities. Through these arguments, GURTs' opponents have been able to mobilize public opinion and to stop the implementation of this technology. In 2000, the United Nations Convention on Biological Diversity recommended a moratorium on terminator seeds "until transparent scientific assessments of its impacts are made and its socio-economic impacts validated" (CBD decision V/5, section III, para. 23). To us there was little doubt about who to side with in this controversy. GURTs, we believe, are one of the most absurd and dangerous technologies ever invented and should be opposed without hesitation. And yet, the arguments used by terminators' opponents were, in our opinion, too simplistic.

Human intervention in the genetic heritage of plants is as old as agriculture and farmers have always promoted some biological features (e.g., seed gigantism) and suppressed others (e.g., various types of toxicity). A more recent example (but still a century older than GURTs) are the so-called "hybrid varieties" derived from a modification of the isolation method (Crow, 1998). Isolation consists in sowing only the seeds from some plants of a crop in order to generate, after a few generations, a line characterized by a uniform genetic heritage. These "pure lines" are interesting for modern agriculture because they produce plants that grow and come to maturity at the same time and in a similar way, thereby facilitating the mechanization of agriculture and the standardization of pesticides and fertilizers. Pure lines, however, have a major default. When applied to varieties that replicate by sexual reproduction (corn, for example), pure lines exhibit "inbreeding depression": the crossing of genetically similar parents generates a loss of vigor and productivity. Hybrid seeds provide an ingenious way to get around this problem by the cross-fertilization of two different pure lines. Hybrid varieties have a normal vigor (because they are generated from parents with different DNA) but remain highly uniform (because all plants are offspring of the same parents and thus have similar genetic heritage). In addition to circumventing inbreeding depression, the hybrid technique produces a notable side effect. Because of their genetic uniformity, these crops are burdened by a "second generation inbreeding depression," since fertilization occurs between sister plants. For several decades, hybrid varieties have been the standard of modern agriculture, and *exactly like GURTs*, they force farmers to buy new seeds every year.

Hence our political dilemma: as much as we wanted to support the opponents of GURTs, we could not avoid revealing the fallacies of their arguments. Controversy mapping entails exposing simplistic claims even when they come from the party that we would like to support. According to Dominique Pestre, "controversy analysis is a formidable war machine against the evidence created by any discursive form – and can therefore risk undermine the discourse of victims from within" (Pestre, 2007, pp. 39–40, our translation). In our cartographic intervention, we are therefore forced to take the high road of sociotechnical complexities. In our example, this required providing a detailed explanation of terminator seeds and their resemblance to classic agricultural techniques and then proposing more complex but more robust reasons to refuse them. These reasons have to do with the way in which GURTs constitute the latest step in a long process of agricultural standardization that has deleterious effects on social and biological diversity.

Taking the detour through complexity demanded time and effort, but revealed how the simplistic arguments against GURTs (even if upheld by valid moral and political intentions) were exposed to the risk of being sidestepped by a further technological fix. In the case of terminator seeds, this fix is the development of the so-called “trait GURTs” (or T-GURTs), a technology to control the reproduction not of the entire seed but of specific genes only. This solution provides a technical solution to the problem of sterility (T-GURTs are not sterile) while providing agribusiness companies with an even more sophisticated dominion over plants and their growers. Instead of the coarse strategy of controlling the germination of seed, these technologies allow the companies to switch on and off particular characteristics within the plant, in general the improvements obtained by transgenesis.

T-GURTs bypass the simplistic arguments employed against GURTs, but that does not mean that they should not or cannot be opposed. They cannot be denounced for the manifest violation of some universal natural or social law, but they can be denounced for the way in which they promote the interests of agricultural corporations against those of farming communities and ecosystems and for the way in which they reduce social and biological diversity. The agricultural activist Vandana Shiva expresses this idea with words that apply both to terminator seeds and to controversy mapping in general.

The main threat to living with diversity comes from the habit of thinking in terms of monocultures; from what I have called “Monoculture of the Mind.” Monocultures of the mind make diversity disappear from perception, and consequently from the world ... Alternatives exist, but are excluded. Their inclusion requires a context of diversity. Shifting to diversity as a mode of thought, a context of action, allows multiple choices to emerge. (Shiva, 1993, p. 5)

Controversy mapping in the shadow of Gaia

In 1957, an earth-born object made by man [the Sputnik satellite] was launched into the universe, where for some weeks it circled the earth according to the same laws of gravitation that swing and keep in motion the celestial bodies – the sun, the moon, and the stars ... The immediate reaction, expressed on the spur of the moment, was relief about the first “step toward escape from men’s imprisonment to the earth.”

... The banality of the statement should not make us overlook how extraordinary in fact it was; for although Christians have spoken of the earth as a vale of tears and philosophers have looked upon their body as a prison of mind or soul, nobody in the history of mankind has ever conceived of the earth as a prison for men’s bodies or shown such eagerness to go literally from here to the moon. Should the emancipation and secularization of the modern age, which began with a turning-away, not necessarily from God, but from a god who was the Father of men in heaven, end with an even more fateful repudiation of an Earth who was the Mother of all living creatures under the sky?

... There is no reason to doubt our abilities to accomplish such an exchange, just as there is no reason to doubt our present ability to destroy all organic life on earth. The question is only whether we wish to use our new scientific and technical knowledge in this direction, and this question cannot be decided by scientific means; it is a political question of the first order and therefore can hardly be left to the decision of professional scientists or professional politicians.

(Arendt, 1958, prologue to *The Human Condition*)

Hannah Arendt’s prophecy encapsulates the rationale of this field guide. It describes modernity as the condition of living in a world that has become too small for contemporary technoscience. As Marshall McLuhan observed, “the extreme form of this implosion or contraction is the image of the astronaut locked into his wee bit of wraparound space. Far from enlarging our world, he is announcing its contraction to village size” (1964, p. 295). Arendt’s quote also contends that taking care of such an environmental crisis is a political rather than a scientific problem. Controversy mapping has in a certain sense been developed to deal with this problem or, more precisely, with the multiplicity of issues deriving from the impossibility of modern society dumping the unwanted consequences of its actions (and the conflicts that they produce) in an external environment where they can be forgotten about. Each of the controversies discussed in this book is unique but they all have their root in the same planetary *Zeitgeist*.

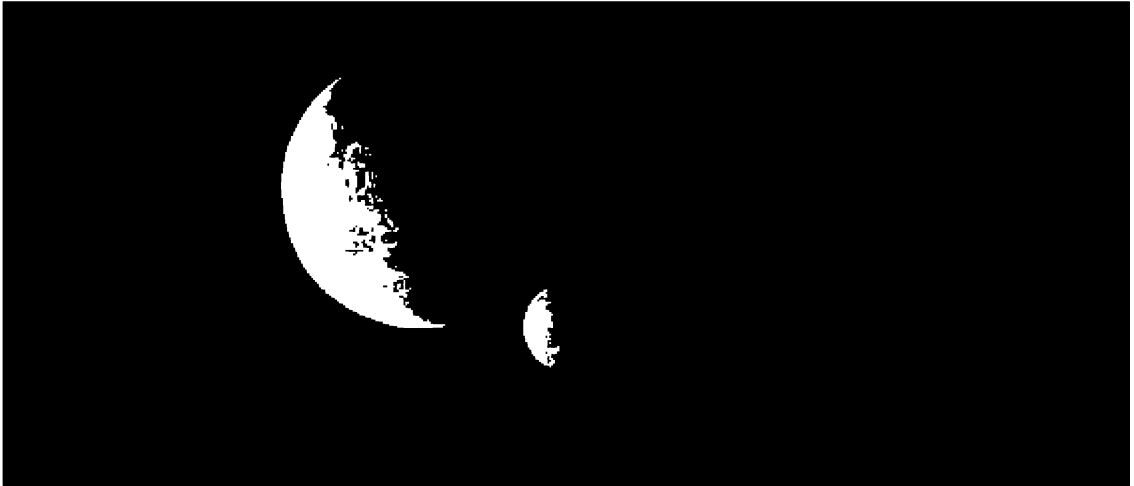


Figure 88 The planet Melancholia crashing into the Earth in the 2011 movie by Lars von Trier (photo: Alamy).

In the opening sequence of *Melancholia* (the 2011 movie by Lars von Trier), the Earth is hit and annihilated by a giant extraterrestrial planet (figure 88). The catastrophe is met with an unsettling sense of paralysis. Eyes turned to the planet *Melancholia* filling the sky, the characters move in slow motion, terrified yet incapable of acting (while, of course, continuing to disagree on whether the planet will or will not hit the Earth). A perfect metaphor for the twenty-first-century predicament. After decades in which they thought they had finally mastered their world, humans find themselves helpless in the shadow of a planetary catastrophe. While this is not the first ecological collapse faced by humanity (see Diamond, 2004, for quite a few others), it is unprecedented in the way in which it reveals the deadlock of modernity. Like the characters in *Melancholia*, we observe the hazard facing us but remain incapable of acting on it. This paralysis represents a deep rationale for controversy mapping. To understand it, we need to go back to the way in which modernity has always framed the relationship between society and its environment.

Arguably, the modern way to deal with natural hazards saw the light of day in 1755, in the wake of the great Lisbon earthquake. After what is often referred to as the first modern disaster, the philosopher Jean-Jacques Rousseau contested the framing of what happened as a fact of nature or an act of God. Had the houses been built differently, had the population been spread more evenly, had there been a proper evacuation rather than a chaotic escape to the harbor where the subsequent tsunami wreaked havoc, topped off by a devastating fire, much of the loss could have been avoided, he argued. What emerged in the aftermath of the Lisbon quake was the idea that humans, through their skill and ingenuity, can anticipate and manage natural hazards.

In the following two centuries, a combination of scientific achievements and rational decision-making helped us fight one disease after another, enabled food and energy security, and mitigated a score of other natural hazards. Yet, as progress was made, mounting evidence also suggested that dangers were not disappearing but rather shifting from the exterior to the interior of collective life. Gradually, it became clear that the unintended consequences of the struggle to protect humans from natural hazards could be as dangerous as the hazards themselves (Giddens, 1991; Beck, 1992, 2009). The sinking of the unsinkable Titanic, the proliferation of weapons of mass destruction, oil spills,

thalidomide babies, prion diseases, financial crises, and pandemic outbreaks are all signs that progress might be less linear than supposed. As Zygmunt Bauman (2006) puts it:

At the end of a long journey of (unintended) discovery undertaken in the hope that it would place humanity at a safe distance from cruel, since unfeeling and callous, nature, humanity found itself facing human-made evils every bit as cruel, unfeeling, callous, random and impossible to anticipate (let alone to nip in the bud) as were the Lisbon earthquake, fire and high tide. (p. 63)

What Bauman pronounces is a malaise that has become deeply rooted in public discourse and the social imaginary. This malaise is generated by the kind of second-order problems that constitute the most common source of sociotechnical debates and thus the central object of controversy mapping. This distinctively modern class of issues has been dubbed *wicked problems* (Rittel & Webber, 1973) because its “proposed ‘solutions’ often turn out to be worse than the symptoms” (Churchman, 1967; see also Crowley & Head, 2017). The more we struggle to distance ourselves from nature and its risks, the more our actions, especially those mediated by science and technology, generate hazardous collateral effects, some of which become planetary threats in their own right. *Melancholia* is not an alien menace, but the mirror of our own world or, to use its mythological name, *Gaia*.

In Greek mythology, Gaia is the mother of all beings, the primal Goddess who gave birth to the Universe, the Titans, the Giants, and all the Gods. But Gaia is also a modern myth, formulated in the 1970s by James Lovelock and Lynn Margulis (Lovelock, 1972; Lovelock & Margulis, 1974). According to the “Gaia hypothesis,” our planet features a queer imbalance of temperature, acidity/alkalinity, and atmospheric composition whose persistence over thousands of years can only be explained by the presence of living beings (Kirchner, 1989, 2002; Schneider et al., 1990; Ruse, 2013). The geophysical properties of the biosphere, in other words, are not the condition of life but its consequence (and in particular of the invention of photosynthesis by prokaryotic organisms some 2.4 billion years ago): Earth and its atmosphere became breathable because it was breathed by living beings.

While the discovery that Earth is capable of regulating its own geophysical imbalances can be credited to the chemist James Lovelock, it was the microbiologist Lynn Margulis who came to explain how such an imbalance has been built through the symbiotic evolution of “trillions of jostling, feeding, mating, exuding beings” (Margulis, 1999, p. 149). Margulis’s unique contribution was to highlight the interactions that connect the global state of our planet to the actions of its inhabitants and in particular to the smallest of them, the microbes; see [figure 89](#) (Margulis et al., 1995). The theory of Gaia as a symbiotic system encourages us to think of the environment not as the setting where life takes place, but as the network of life itself.

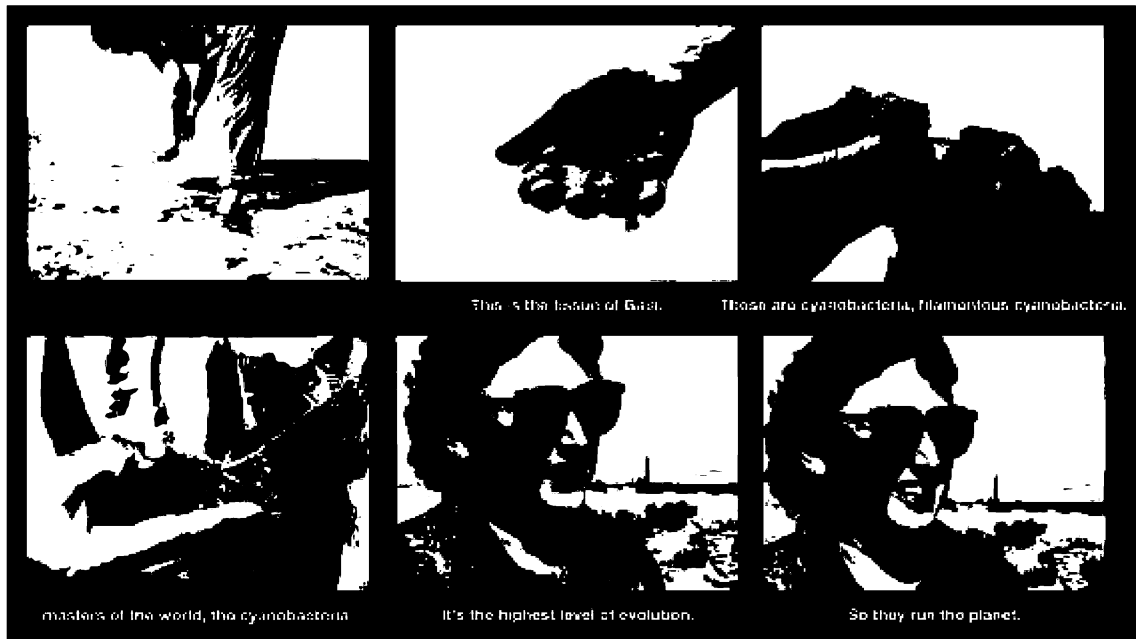


Figure 89 Lynn Margulis carving a sample from the cyanobacteria tissue responsible for the Great Oxidation Event, which enabled the development of multicellular life (from the documentary “Symbiotic Earth,” 2017; courtesy of Hummingbird Films).

This idea resonates deeply with Actor-Network Theory and controversy mapping. Dealing with sociotechnical debates, we are constantly reminded that non-human actors (natural beings or technological objects) are not inert props on the stage of human actions, but fully-fledged characters themselves. This is particularly manifest in the global crises surrounding climate change, environmental migration, biodiversity loss, economic crises, and so forth. These crises are “environmental” not only because they are related to the depletion of ecological resources, but more importantly because they pronounce the end of the idea that humans can manage nature and its hazards. In the words of Margulis (1999):

The human move to take responsibility for the living Earth is laughable – the rhetoric of the powerless. The planet takes care of us, not we of it. Our self-inflated moral imperative to guide a wayward Earth or heal our sick planet is evidence of our immense capacity for self-delusions. (p. 144)

We need to be freed from our species-specific arrogance. No evidence exists that we are the “chosen,” the unique species for which all the others were made. Nor are we the most important because we are so numerous, powerful, and dangerous. Our tenacious illusion of a special dispensation belies our true status as upright mammalian weeds. (p. 150)

The end of Nature

According to Margulis, the Gaia hypothesis owes its origin to the same event that in Arendt’s opening quote marked the doom of modernity: the “success of the international space program that began with the launch of Sputnik ... the penetration of space brought forth Gaia theory” (Margulis, 1990, pp. 7, 8). Indeed, the formulation of the Gaia hypothesis followed a series of famous photographs of the Earth taken by NASA’s astronauts in the 1970s (see [figure 90](#)), which deeply influenced the development of the environmental movement (Poole, 2010; Lazier, 2011). Seen from space, our planet looks

surprisingly small and isolated, a “blue marble” surrounded by darkness. The shift in perspective couldn’t have been more dramatic: Earth, which used to be a vast *terra incognita* boundlessly extending around the human enclaves, suddenly appeared as a tiny island in an ocean of emptiness.

Since the 1970s scientists have reinforced the recognition that Earth is a confined environment with strict boundaries that cannot be crossed with impunity. In 1972, Donella and Dennis Meadows, together with other scholars of the Club of Rome, published an influential report on *The Limits to Growth* (Meadows et al., 1972). Using a computer simulation, the report suggested that the unrestrained exploitation of natural resources could lead to a systemic collapse (and according to Turner, 2008, 2012, 2014, we are well on track for that “business-as-usual” scenario). Along the same line, in 2009, 28 scientists identified nine global environmental systems at risk of irreversible disruption (Rockström et al., 2009). In 2015, according to the same scientists, four of these “planetary boundaries” had been transgressed – climate change, loss of biosphere integrity, land system change, and biogeochemical cycles (Steffen et al., 2015) – with ominous consequences that are becoming increasingly manifest.

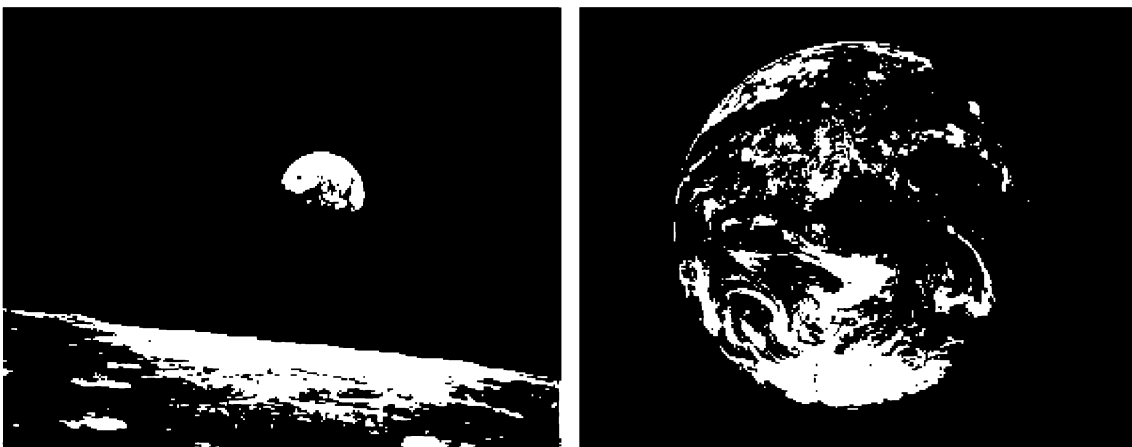


Figure 90 Two of the first and most famous pictures of the Earth seen from space, Earthrise (left) and The Blue Marble (right) (Wikimedia Commons/NASA, 1968 & 1972).

Though the exact determination of the “limits to growth” and of the “planetary boundary” remain controversial, it is difficult to deny that the expansion of modern societies has made our planet much smaller. Quite literally: landfills have been crammed to a point where it is increasingly difficult to dispose of our waste (Strasser, 1999; O’Neill, 2019); garbage patches float as mini-continents in the oceans (Marks & Howden, 2008; Hoshaw, 2009); gas emissions have turned the atmosphere into a giant greenhouse (Lashof & Ahuja, 1990); poverty and conflicts create growing migratory pressures in a world with no new territories to settle (Tir & Diehl, 1998; DeFries et al., 2010).

Earth used to be big. So big, in fact, that it could take whatever we threw at it, serving as a stable *homeostatic system* into which we could discharge the unwanted consequences of our actions. Not anymore. The impact of human activities, which used to be negligible to the great cycles of the planet, has grown so large that the Geological Society is considering the possibility of declaring a new geological era, the *Anthropocene* – the age of humans or, to be more precise, the era in which humans have become the prime force in the evolution of the planet (Monastersky, 2015; Waters et al., 2016; Zalasiewicz et al., 2016). While this label may exaggerate our importance (after all, as Margulis famously remarked, Gaia is “a

tough bitch”, more than capable of outliving “a lively ape with a yearning for a relatively hairless mate,” 1999, p. 149), it does have the advantage of reminding us that to live in the shadow of Gaia is not just to live in an *interconnected* world, it is also to live in a *confined* world.

Perhaps ominously, the name Gaia was suggested to Lovelock by William Golding, Nobel laureate in Literature and author of *Lord of the Flies* (1954). Golding’s novel follows a group of young boys stranded on an uninhabited island and provides a dystopian metaphor of collective life. Despite the innocence of the children and their best intentions, their cohabitation soon regresses into a state of profound brutality. The isolation is a crucial element of Golding’s plot. Cramped in a confined island, the children are constantly faced with their mutual interdependencies and this turns out to be a recipe for disaster. It is thus tempting to read Golding’s dystopia as a metaphor of life in the shadow of Gaia, a premonition of the conflicts engendered by the fact of having colonized all the external spaces where the unwanted consequences of our collective existence could be dumped. In the words of Bruno Latour:

Ecological crises are translated most often by the disappearance of everything external to the human world, every reserve for human action, every discharge by means of which one could, up to now, in the delicious euphemism invented by the economists, externalize actions. This paradox has been noted often: the concern for the environment begins at the moment when there is no more environment, no zone of reality in which we could casually rid ourselves of the consequences of human political, industrial, and economic life. (Latour, 2004b, p. 58)

The crisis we are experiencing is thus “environmental” but also “endogenous.” It derives not from an external threat, but from the growing impossibility of *externalization*. “Externalization” is a word employed by economists to describe the capacity of industrial systems to benefit from values that they have not created (positive externalities) and to discard the collateral effects that they do not want to deal with (negative externalities). The capacity to handle both types of externalities is a crucial feature of all economic systems (Buchanan & Stubblebine, 1962; Dahlman, 1979), but it is particularly crucial for the modern economy whose obsession with growth has been fueled (quite literally) by the way in which we have been able to drain resources from our environment and dispose freely of the waste products back into that very same environment (e.g., Gras, 2007; Mitchell, 2009a).

It goes without saying that the trick of externalization becomes increasingly difficult in the absence of an *external* environment. This is another way to argue that controversies do not arise because technoscience is led astray by external factors but derive from the internal frictions produced by the way in which sociotechnical development squeezes into the same space of consequences a growing number of actions and actors that used to be independent. Recycling is a classic example. In principle, the answer to the shortage of landfill sites is to recycle our waste products. In practice, before it can be used as raw materials, garbage requires careful sorting on a level that has made recycling economically unfeasible in Western countries. Since the 1970s, the solution has been to export garbage to Asian countries, whose booming industries and poorly regulated labor markets absorbed the work and health externalities of recycling (while transportation costs were externalized by “backhauling” container vessels sailing back to Asia after shipping goods to Western markets). Starting from the 2010s, however, the market for global waste began to clog as China introduced stricter regulations on waste importing (the “Green Fence” in 2013, the

“National Sword” and several other bans in 2017 and 2018), soon followed by several other Asian countries (Brooks et al., 2018). The closure of this externalization sink has already generated all sorts of controversies, from internal tensions due to the sudden surge in the cost of waste disposal; to environmental strains linked to the increase in landfills and incineration; to retaliation in international commerce and foreign policies.

Never before has our cohabitation on the planet been so complicated. Never before have we been so many and so mutually dependent. The extension of technical infrastructures, the interconnectivity of markets, the standardization of communication channels, everything seems to bring us closer and bind us tighter. Technoscientific progress has bound us to the smallest amino acids in our blood stream and the highest layers of the atmosphere, the krill floating in the Antarctic sea and the oil trapped in the deepest geological strata. If the ancient Gaia was a motherly goddess, modern sociotechnical systems are Medusas so intricate that we are petrified at the very sight of their daunting complexity. Reaching the limits of the planet, we have also reached the limits of globalization (Yearley, 1996; Sassen, 1998; Beck, 2002; Osterhammel & Peterson, 2003). Modernity, it turns out, relied essentially on the possibility of externalizing the unwanted consequences of our actions and now that the trick has become impossible, the tension rises in a planet transformed into a pressure cooker. The crisis we face, it seems, is the backlash of our vain attempt to “escape from men’s imprisonment to the earth” denounced by Hannah Arendt’s opening quote.

Learning from Penelope

The complexity of collective existence is not a good reason to stall, however. Controversies can be productive when their complexity becomes a matter of democratic debate and, rather than a denunciation of modern errors, this book hopes to be an encouragement to deal with them. Acknowledging that collective action is subject to a variety of interferences does not exempt us from trying to unravel their imbroglios. Quite the contrary, the growing diversity of actors urges us to identify specific responsibilities. This begins with making clear that the “we” employed in this conclusion is inclusive of consequences, but not of responsibilities. When we say that “we” are all connected in one worldwide tangle, we refer to all beings whose life is touched by technoscientific globalization. Yet, by saying that this interconnection has been produced by “our” technoscience, we refer to a much smaller number of actors, namely those responsible for its development and use – specific corporations, governments, institutions, and sometimes even specific individuals, that controversy mapping is supposed to help identify and make accountable. Sociotechnical networks may have spread across the planet, but they have not spread evenly (Diamond, 1997; Anderson, 2002). In modern collective life, advantages and liabilities are distributed asymmetrically, with some actors harvesting most of the benefit and others paying most of the costs. But how to line up the teams when the players are constantly changing? How to distribute responsibilities, when the cast of actors includes not only the usual suspects (greedy industrialists, corrupted politicians, shady lobbyists, etc.) but also all sorts of less expected human and non-human actors?

To follow these networks of liabilities and interests, whose configuration is specific to each controversy and constantly evolving, we sought help in digital records and digital methods. Digital technologies, no doubt about it, partake in the problem we just described: not only do they add to the ecological crisis by contributing to the consumption of large amounts of

energy and chemicals (Plepyš, 2002; Berkhout & Hertin, 2004; Robinson, 2009), but they also dramatically extend the distance and speed of our interdependence. More specifically, as public debate is concerned, digital media allow more voices to join the discussion, but also open the gate for rumors (Rojecki & Meraz, 2016), misinformation (Kata, 2010), conspiracy theories (Del Vicario et al., 2016), propaganda (King et al., 2017), junk news (Venturini, 2019a), and information bubbles (Hendricks & Hansen, 2014).

Still, if digital media have not made collective life any simpler, they have at least made it more traceable. Not that controversies were impenetrable before the Internet, but their fastidious tendency to connect vast societal consequences to tiny technical details, their way of extending far in time and space but through narrow chains of actions impossible to generalize, their propensity to mix local and global, made them impervious both to qualitative and quantitative techniques. Sociotechnical debates have a reticular nature that defies classic distinctions between micro and macro, human and nature, individual and collective, objective and subjective, etc., but that is well attuned to the webs of online media. Unlike the infrastructures of early modernity, digital infrastructures have developed to adapt to a context of fluxes rather than of boundaries, to facilitate and take advantage of the reconfiguration of connections rather than the stabilization of categories (Peter, 2015). This is why records extracted from digital networks and analyzed by repurposing the methods of digital media offer a suitable operationalization for the actor-networks of sociotechnical controversies.

Digital methods, however, do not make our inquiry into controversies any easier. They do not reduce the cost of tracing social interactions but merely displace it from the academy to the companies and institutions that build and maintain digital infrastructures. Relying on digital inscriptions thus means adding all sorts of biases to the tangle of interferences that controversy mapping must patiently unfold. In particular, it means taking into consideration the way in which digital media accelerate collective conversations to a pace that sometimes makes critical reflection impossible. Repurposing the inscriptions and methods of online networks and platforms therefore demands caution and sometimes even firm resistance to their way of hastening public debate.

Controversy mapping is a daughter of its time, a method which has come into its own at the intersection of the digital revolution and the environmental crisis. It begins with the recognition that living in the shadow of Gaia is to be faced with a complexity that, unable to vent to the outside, escalates inwards – not branching as a tree, but twisting and turning like the roots of a potted plant. Confronted with this thickening complexity, modernist strategies reach their limits. Relying on economic growth or technoscientific progress to push against the boundaries of the planet will only tighten the nooses that already bound our actions.

Hence the paralysis that seems to have seized our societies and the growing fortune of populist discourses all over the world. As the globalization facilitated by modern technoscience (and pushed by the economic and political elites that profit from it) proves increasingly unsustainable and unjust, the urge grows to cut the connections that expose us to the rest of the world and entrench each nation, each group, each family behind solid walls (Latour, 2018). As the ecological crisis deepens the cracks in our social fabric, public opinion is beguiled by the temptation to match the extreme challenges facing our collective life with extreme political solutions (Žižek, 2008).

Yet, cutting the knots that bind us to the rest of the world in a single stroke is not an option. The infrastructures of globalization have become the blood vessels of our collective existence and slashing them is like escaping one's body but slitting one's wrists. Because they derive from the very success of technoscience, modern sociotechnical controversies allow no quick or technological fix (Rosner, 2004). Our social and environmental problems are "super wicked" (Levin et al., 2012) because all attempts to tackle them inevitably generate new troubles. This does not mean that they cannot be attended to, but it means, as suggested by Kelly Levin and her colleagues, that they need to be unfolded progressively, patiently creating one positive path-dependency after the other. The intricacy of these problems should neither paralyze us nor encourage a laissez-faire mentality, but it should make our political actions more cautious and caring (Tronto, 1993; Mol, 2008; Larrabee, 2016). Hakim Bey, the anarchist poet whose "autonomous zone" provided inspiration for the data sprint, calls this situation "the closure of the map" and suggests that solution can only be found *from within*:

The last bit of Earth unclaimed by any nation-state was eaten up in 1899. Ours is the first century without *terra incognita*, without a frontier ... Not one square inch of Earth goes unpoliced ... until for most of us the map *becomes* the territory ... And yet because the map is an abstraction it cannot cover Earth with 1:1 accuracy. Within the fractal complexities of actual geography the map can see only dimensional grids. Hidden enfolded immensities escape the measuring rod. The map is not accurate; the map *cannot* be accurate ... The map is closed, but the autonomous zone is open. Metaphorically it unfolds within the fractal dimensions invisible to the cartography of Control. (Bey, 1985, pp. 101, 102)

This exploration that turns from outside to inside, from acceleration to deceleration, from unexpected consequences to welcomed interferences, is a fitting note on which to end this field guide. In a time marked by a global pandemic, the looming prospect of a climate disaster, and growing social and political instability, controversy mapping has no easy solution to offer, but it can provide tools to chip away at the enormity of what must be done in the years ahead. Tools to open the black box of technoscientific infrastructures, unfold their networks of attachments, expose their externalities, but also to deal with the acceleration and amplification of media debates and with the consequences of digitization. None of this is easy, but all is necessary and urgent. Controversy mapping can help but proposes no shortcuts; it will not ease the work of democratic inquiry, but make it slower and more painstaking; it does not celebrate complexity, but will not try to bypass it either. This is not the time to be as bold as Ulysses sailing beyond the Pillars of Hercules, but to be as determined as Penelope who, patiently and as the night falls, unravels her web.

A conversation with Bruno Latour

“A mix or maybe a mess of ideas”

Bruno Latour (BL): The adventure of controversy mapping started about 30 years ago. At the time, we had a very specific problem: to teach science studies to the engineering students of the École des Mines without triggering all sorts of odd reactions. I was inspired by the tradition of controversy studies that colleagues such as Steven Shapin and Harry Collins had developed in England and I was trying to do the same thing in teaching. I did not want to complicate the lives of the engineering students too much and yet have them absorb the strange notion that society is important in science and technology. It seemed to me that a good idea was to let the students choose a topic that was not already settled and then have them do a little bit of inquiry. I had learned that from Harry Collins, Andrew Pickering, and Wiebe Bijker, who was teaching in Twente and working along the same lines.

The digital aspect arrived a few years later, when a student had the idea to use a website for what we had been doing on paper boards or by staging simulated debates. It was just the beginning of the Web, really, but the idea stabilized quickly: in a year or so, everybody was doing websites.

Finally, the notion of cartography came from the work that Michel Callon was doing on co-word analysis and scientometrics at the Centre de Sociologie de l'Innovation (CSI) at the École des Mines. In fact, the actors of the early Web were themselves experimenting with this type of analysis (the old AltaVista system). So, we just grabbed all those cartographic metaphors. I'm not sure it was the best idea, but it did stick.

Tommaso Venturini (TV): Yet, mapping is not the only metaphor that one could use for digital research. Nowadays, most scholars prefer computational metaphors like counting, computing, or calculating. Why did you go for mapping instead?

BL: I don't think it came from a great theoretical insight at the time. We had cword analysis, which was called maps, and I had directed a thesis by Genevieve Teil on what would now be called artificial intelligence, using co-word analysis. It was a time of enthusiasm. The other connection was my work on Gabriel Tarde and his idea that quantification could be pushed one degree further into even simpler bits and units. At the time, we naively believed that the flood of data from the Web would render the research that Callon and the others had done on co-word analysis almost easy and legible. We thought that mapping as an orientation could be combined with code and algorithms. It was a mix or maybe a mess of ideas. The nice thing was that the students were very enthusiastic about it, and that solved my problem of teaching sociology of science to engineers. It was sufficiently technically complex for them to be fun and it did approximately what I wanted, namely encourage them to engage with technical issues, realize interviews, and read all sorts of documents. As a pedagogical tool, it worked so well!

When I moved to Sciences Po, I kept using this tool but for the exact opposite purpose, namely, to teach science and technology to students who were more versed in social and political science. Tommaso knows the rest. After I met him in Trento, he started working with me to establish this new course in the ecosystem of Sciences Po. We realized that

mapping really meant developing websites with interviews, documents, diagrams, and a little bit of web-based cartography, which, however, has always been just one element in the atlas. So, the word cartography was in one sense a name for the whole Web-based atlas and in another it referred to the part of that atlas which used digital methods to illustrate points that could not be clarified by other means.

“Every philosophy of science concept is in fact a simplification of a data structure”

TV: What was the role of design and visualization in this mapping effort?

BL: One of the things which is very important in your book and was crucial for me as well was finding ways to show the multiplicity of positions on an issue without separating immediately the part which is technical from the part which is social. In fact, “don’t make this separation” was the only instruction of the course. The solutions invented by the students (some very naive but some very clever) gave us the idea that in addition to the metaphorical aspect of maps, information design could actually provide the opportunity to approximate what was a map in the old days of longitude and latitude. From day one, all we did was to follow the students. From them we learned that it was possible to visualize not only digital data but the whole ecosystem of a dispute.

Anders Munk (AM): Looking back at controversy visualizations, one can see a shift in the early 2000s from conceptual diagrams of actor-networks to actual data visualizations. Something quite significant seems to have happened around the time you met Richard Rogers and his group.

BL: Oh yes, of course. It happened during Noortje Marres’ PhD (Marres, 2005b), which I was following as an external advisor. She immediately pointed to the double aspect that you mentioned: not only the diagrammatic side (basically the illustration of concepts from philosophy of science) but also the hardcore data crunching. I remember that we were very impressed by the fact that Google PageRank itself was based on methods derived from the Science Citation Index (the same index I had known as a huge book, flipping through its pages when I was writing *Laboratory Life*). To me and Noortje, this connection suggested that philosophy of science could be quantified – that the acceptance or rejection of a position could be materialized, if only we had enough data. Our idea was that every philosophy of science concept is in fact a simplification of a data structure and I still maintain that idea, and your book does it as well. But, as you know, I’ve never understood very much about the data crunching part, so I was following Tommaso and Donato Ricci in design. I was following those who were following Richard Rogers.

“The word controversy has always been controversial”

AM: You organized the “Making Things Public” exhibition (see Latour & Weibel, 2005), which represents the moment in which controversy mapping also became a democratic instrument, a piece of equipment for the public.

BL: Yes, that was my idea. In 2005, in that exhibition, we already had a whole section of examples of visualizing controversies through digital tools – the equivalent of what is now done by Jennifer Gabrys and her school of visualization. I still believe in the brave idea we

had in 2005 that this might be the democratic solution to the chaos produced by scientific controversies.

In the beginning, we were accused of relativism. This was the critique we had to fight. For example, when we developed the FORCCAST project, we had to reassure the French government that we were not using public money to encourage relativism. Our argument was that the more we knew about the complexity and difficulty of producing science, the more we would gain confidence in scientific procedures. Thirty years later, in the middle of a fake news world, I'm not sure if we have succeeded. The problem is no longer to debunk the excessive authority of science, but the exact opposite. At the beginning, scientists were saying: "Why do you keep talking about controversies, there is no controversy in science. Science is about facts." And now people say: "Why do you add more chaos to an already chaotic situation."

But your book maintains a very straight and clear line. In both cases, the solution is to increase the awareness of the complexity of scientific constructions. Before it was a way to avoid placing too much confidence in science, and nowadays it is a way to regain confidence in science. Now, who else believes this apart from us? I don't know.

TV: Indeed, we used to have this belief that opening up technoscientific controversies to democratic scrutiny and debate could solve some of the problems of science and technology, but now we discover that, particularly in its digital instantiation, democratic debate might itself have a lot of problems. Some scholars even go as far as saying that we should just ignore a lot of these controversies, because by studying them we end up giving too much visibility to actors that do not deserve it.

BL: As you know, the word controversy has always been controversial. This was the experience of every single student in our class: as soon as we mentioned the word controversy, we were rebutted by our interviewees that "there is no controversy, it is just idiotic people who believe things which are not true."

For me the turn was in 2002, when writing the paper on "Why has critique run out of steam" (Latour, 2004c). This is when I encountered the false controversy. The excess of controversy coming from climate change deniers, and before them from the tobacco industry, became the canonic example of what was coming and is now massively developed. If we had to start the class again, we should probably say that most controversies should be ignored. But remember Tommaso: we did spend a lot of time in the first classes, when students were choosing their subjects, providing rules of thumb on controversies to avoid. Now there are probably ways to use digital tools to sort out the disputes which are "noise" so to speak – noise made by conspiracists who use the language of empiricism and quibble on details. The excess of empiricism, which started with negotiationism, has become a sort of a generalized language because of the Web. Our task now is making the distinction between this excess of empiricism and the right dose of empiricism that is necessary in order to do inquiry.

AM: On the other hand, this is still something we encounter both with our students and our informants: it is such an easy move (too easy) to write off a dispute as a false controversy, right?

BL: I agree. Do we have digital tools for that? Is there enough signal to recognize the "wrong" controversies so to speak – the ones coming from "wrong" sources?

TV: My hunch would be that discussions that do not last long enough, are rarely productive because they only traverse the public debate and do not stay long enough to produce actual deliberation. There's a very nice article by Noortje about "public facts." She talks about the "Brexit bus" and makes the argument that even if the claim plastered on the bus was as much junk news as you can get, it actually sparked interesting discussions in the UK about austerity and public health funding, precisely because it stayed long enough in the public debate. So maybe more than true or false, we should measure the consequences of a controversy on the public debate.

"We believed we would have Tarde, and we got fake news"

AM: The analogy with geographical maps might be useful here. It is well known from the history of cartography that maps can easily fall into the wrong hands. You have mapped a territory and now it's being conquered or taxed in ways that you did not intend. This is also something we know from ANT: when you are descriptive in your research practice, you leave yourself open to being appropriated by agendas that you do not necessarily agree with.

BL: Yes, we had this objection many times. Myself, I am no longer teaching controversy mapping. I teach self-description of territories in small villages and cities in France. We face the same difficulty, but we don't use digital tools anymore. One of the dangers we realized during these years is that it is difficult to resist the weight and power of digital platforms. So, everything we do now in the self-description of territories is just papers and boards and theater. It is a completely different project, of course, but it is related to what you are saying, Anders, because it is a way to counteract the fake objectivity that could get into cartography. So self-description of lived territory would be an alternative.

TV: You mentioned Gabriel Tarde and ANT very briefly. What do you think is the relation between Tarde's sociology, Actor-Network Theory, and controversy mapping?

BL: Tarde, as you know, is the invented ancestor of Actor-Network Theory, after the fact. ANT does not descend from Tarde, but I chose him as its ancestor for philosophical as well as algorithmic reasons. Tarde's great idea was that if we had chunks – very small chunks – of data, every quality (conversation, images, etc.) can be quantified. Since this was written a good century before we actually had those data, I think the word precursor is fitting for Tarde. Even though the statistical work he was doing at the time was amazingly primitive, he had the idea that an increase in the quality of the data could transform statistics from a rough overview into a way to quantify qualitative phenomena. This is why, for me, Tarde, Actor-Network Theory, algorithms, and of course the notion of monad is really the same bag.

In the early 2000s, we were embracing masses of microdata produced by GAFA-before-they-became-GAFA [Google, Apple, Facebook, and Amazon]. Only later (and it was actually very naive of me to believe otherwise), we realized that GAFA were actually invading everywhere and making a lot of money out of this. But when all this came about, I believed naively that they were realizing Tarde's dream. We believed we would have Tarde, and we got fake news.

AM: What is the role of controversies in this? In *Reassembling the Social* (Latour, 2005b) you make the argument that if you want to pursue a Tardian sociology, you also need to

pursue controversies because that is where the monads become observable. Shouldn't we front-stage controversies even more in order to make the social observable?

BL: Yes, except that your book appears in a world where the closure of controversies is more important than it was 30 years ago. When we started, the question for the class was really "can we avoid closing controversies too quickly?" We believed that the power and authority of scientists and engineers and economists was weighing too much on us. Now, 30 years later, it is exactly the opposite: we would like to close up some controversies and arrive at something like an agreement, on climate change, for example, and on many other things. The same tools, I think, should now be used also in the opposite direction: show that it is very possible to close controversies and to lock them in. But it is the same tool because, after all, and as we always said, facts end up being produced. It takes time, but we can produce them.

It is very interesting to observe how the disputes around Covid-19 force everyone to do science studies and, each day, learn new things about how scientists disagree. And we would love to have some stabilization. For example, I had the Covid and I would like to know if I'm immunized for more than a few weeks or months. It's not the same time as when I started. Back then, we had the idea that the power of medicine was too strong and that we needed to break down this hegemony. Now we would love to have some stabilization – not hegemony, but at least some stabilization. The tools that you develop in the book are the same, but the emphasis has changed.

"The temporal aspect of fact making"

AM: Isn't there a conflict, though, between the democratic need to have more closure and the pure Tardian ambition that if we want to make the social traceable, we need more controversy? In other words, if our only interest is sociology, then controversy is great because it produces traceability?

BL: Well, can we have traceability with closure? Could we ask closure to produce traces as well? From the beginning we were interested in the temporal aspect of fact making. We were accused of being relativist because we were interested in the moments of uncertainty. Yet we always knew that, in the end, facts are stabilized. Sometimes, as the saying goes, because people lose interest, and sometimes because they are proven. It has always been the temporal movement which interested me, since the days of *Laboratory Life* (Latour & Woolgar, 1979). Now, in terms of democratic interest, the tools that you develop in the book are more directed to regaining confidence in the ways science is produced. I think it's a question of where the stress is put. The general idea is always the same: that facts cannot be studied if they don't have a temporality – if they are not studied in their lineage, in their whole movement. Yet the stress, even in teaching, is different: before we wanted to destabilize students, now maybe we want to stabilize them a little bit. But tell me if I'm wrong.

AM: I have been quite surprised about how willing my students can be to denounce any disagreement on the science of Covid-19 as being purely conspiratorial and fake. I sometimes feel the need to reinvigorate their curiosity and suggest that there could be an actual controversy there. Maybe the authority of science is still weighing a little bit too heavy on them.

BL: It's an endless fight. Now there are people in France who want to reinstate the old-fashioned authority of science. They want to vet journalists when they say something about science, so that "real scientists" decide what should be said. Unfortunately, we science studies people have to fight all the fights simultaneously. We still have to fight against the old reactionary idea that we could go back to good old-fashioned facts which are not made by anybody. But we also have to fight to prove that, in spite of all the conspiracy theories, scientists can stabilize facts. It takes time to get science inside society. I thought it would go much further and faster, but the answer is still: "no, it takes a lot of time."

"Here is a new task for controversy mapping"

TV: Beside the changes to the media and public debate that we mentioned, would you say that this shift in the accent of controversy mapping is also related to the ecological crisis? From the fact that we are no longer just facing science, but also Gaia and the Anthropocene?

BL: When we were doing controversy mapping happily, so to speak, we thought that there was no danger in developing the notion of controversy because there was an agreement on the fact that we were living in the same world. Now, I use the notion of "planets" to describe the completely different situation in which we do not share a common world at all. People live on different planets and that is the source of online misinformation and the shift away from the traditional democratic ideal that we can agree to disagree as long as we share the same world. This argument is disrupted on both sides. On the one side, some people believe that everything coming from institutions is just lies and conspiracies. On the other side, the rational side, people say that we should be able to agree and that it is very cognitively abnormal that people disagree so much.

In science studies, we have always known that you need societies, administrations, and institutions in good order to agree about scientific facts. With the new climatic regime, we realize that you also need a common world to build these institutions. This is what climate change has shown us: if you have no common world, no matter how your society is organized, it is not possible to stabilize the facts. This is why the situation is much more grave, much more tragic than it was. I recently discussed my book on *Politics of Nature* (Latour, 2004b) with someone and I realized that it was immensely optimistic about the possibility of agreeing to disagree. All of those procedures which I invented were useful, but they supposed a common world. We do not live on the same planet anymore. People are now saying "whatever you say is wrong, there is no climate change, there is no Covid, it is a Chinese invention." Conspiracism for me is not a cognitive defect but the complete irrelevance of the notion of a common world.

So here is a new task for controversy mapping: redraw the lines that allowed us to build a common world. That is what I am doing now with what I call "selfdescription of territories." Then, if we have a common world, we can begin to imagine the institutions of society and, only then, begin to agree on facts. So, we were a bit naive as to the extent to which disputes could break the social order. Before climate change, we could not anticipate that people would also disagree about where we live.

AM: Is it pushing it too far to say that controversy mapping only makes sense when a common world has been established? I am asking because there has been a debate inside STS and ANT, with John Law, for example, arguing that we should be satisfied with interfering and multiplying, that anytime we try to draw boundaries or define rules for what

counts as a common world, we are taking sides and becoming proceduralists. Maybe this reflects a disagreement on what we are supposed to do with STS: are we militantly pulling the rug under all forms of hegemony or are we trying to build something?

BL: I don't think we imagined, at the time we began doing controversy mapping, that we might be in a situation where some of our students would be QAnon devotees. There is a point when the notion of "agreeing on disagreeing" falls apart. When we realize that we live on different planets, we also realize that we lack the diplomatic work necessary to begin to build something like a controversy mapping. There is an extra work of restitching connections (a work of diplomacy, in Stengers' sense), which must be carried out before we can assemble the tools for controversy mapping.

Don't forget that controversy mapping was born inside the slightly protected space of the classroom – a space where we can do the work of inquiry without immediately being sent to different planets. But, and this is my vignette of Greta Thunberg meeting Donald Trump at the United Nations, what do you do in that case? Controversy mapping is a way of assembling disputes and ruptures, but now it has to face huge gaps in the way the world itself is being produced. If controversy mapping is going to serve the public outside the classroom, then it needs to include the preliminary diplomatic tools that make that sort of discussion possible.

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