Critical Visualization

Rethinking the representation of data

Peter A. Hall
Patricio Dávila

BLOOMSBURY

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Acknowledgements

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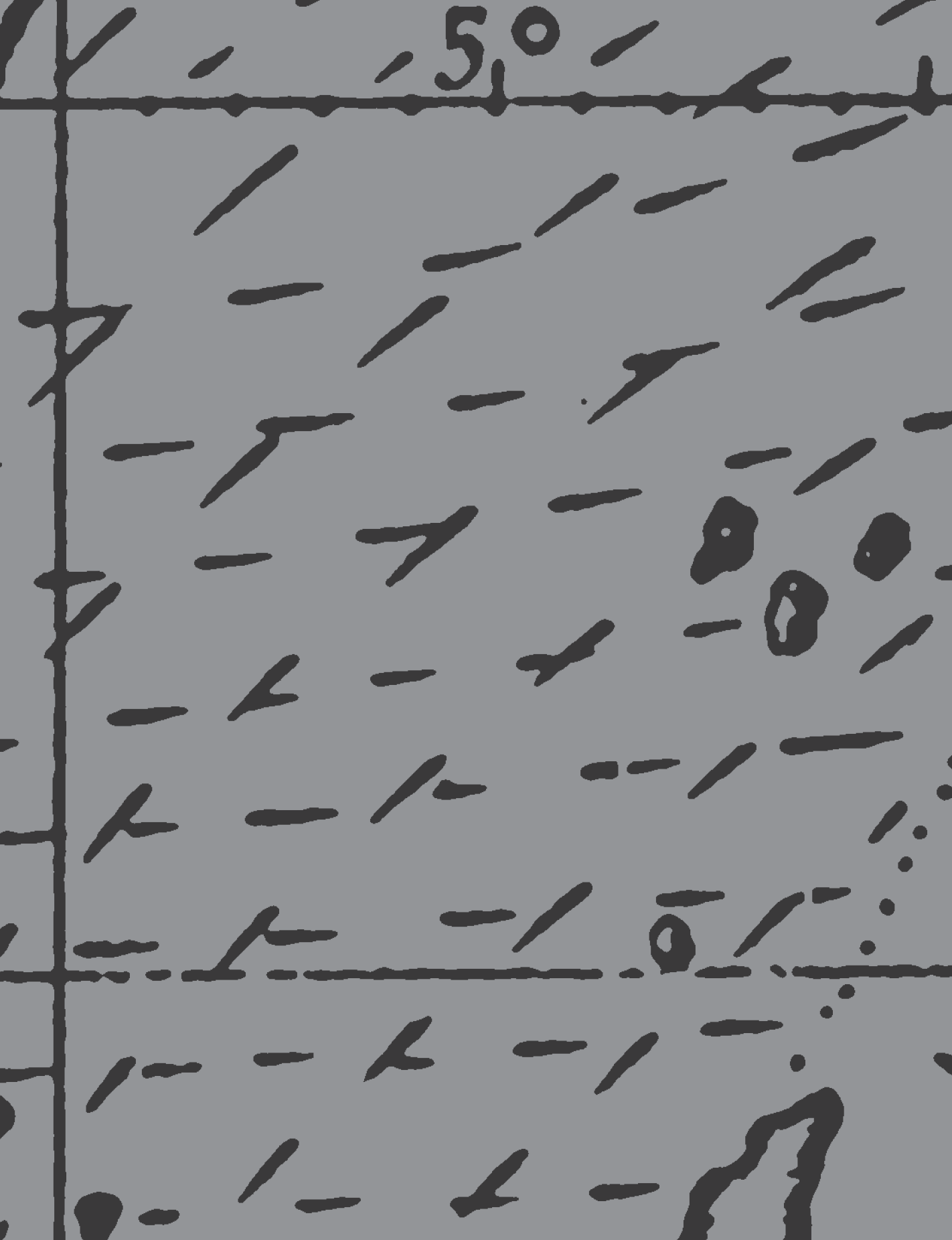
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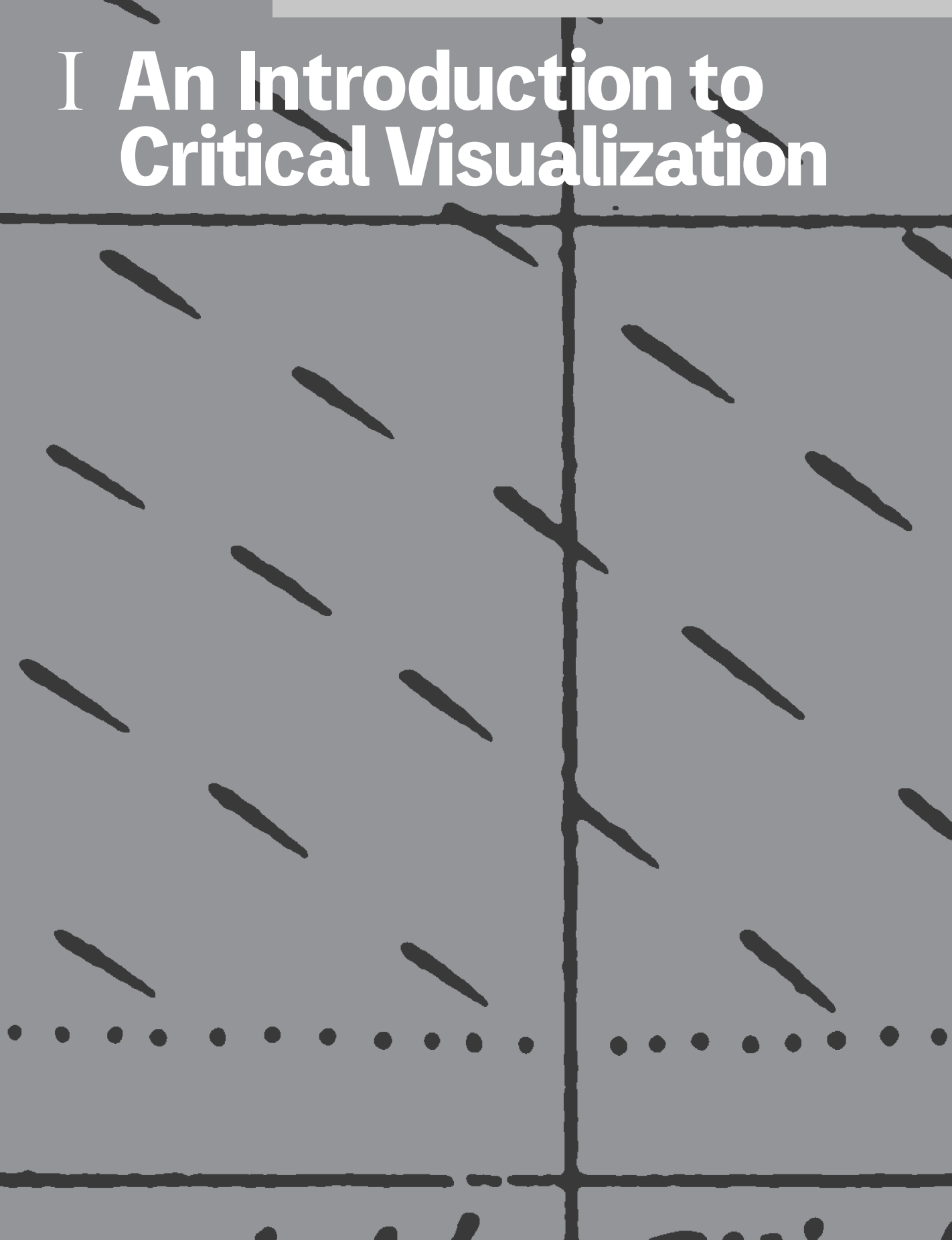
I An Introduction to Critical Visualization



In 2020, as the impact of the novel coronavirus pandemic began to make news, the phrase 'flattening the curve' became a familiar trope: data visualization as a shared cognitive image. For those fortunate enough not to contract the virus or witness its effects on a friend or family member, data was the face of COVID-19: as Bruno Latour wrote in *Le Monde* newspaper in March 2020, this was 'a virus whose trace is known only to scientists and whose effects can only be understood by collecting statistics' (Latour, 2020). Embedded in the phrase and the simple graph that accompanied the article—showing the number of cases since the outbreak (*y*-axis) against the number of days (*x*-axis)—was a statistical argument for mass behaviour change. A steep epidemic curve showed the unchecked spread of the virus; a flatter curve showed how the reproduction rate (R-rate) of the virus could be reduced, and the burden on healthcare systems lessened, with mitigation measures such as physical distancing, face masks, and lockdowns. But whether the 'flatten the curve' visualization contributed to the mass behaviour change it required is a more complicated question, as evidenced in the wildly differing cultural and demographic responses to quarantine, distancing and mask-wearing orders across the world.

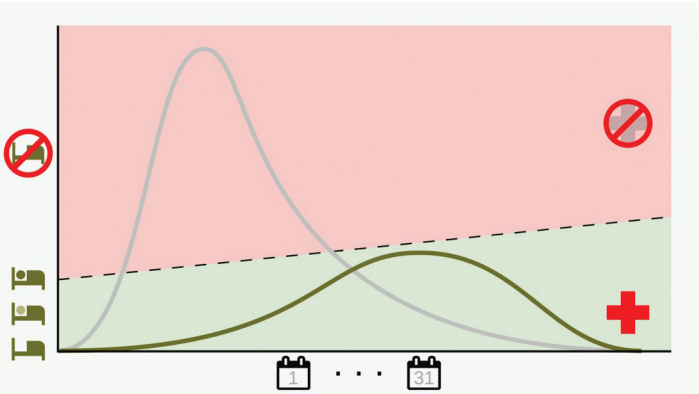


Figure 1.01 — **Graphic showing 'flattening the curve' (by slowing the spread of pandemics) and 'raising the line' (increasing healthcare capacity), so that healthcare demands hopefully stay within capacity.**
RCraig09, licensed with CC BY-SA 4.0.

The paradox of our data-heavy era is that mass data literacy (or numeracy) has not followed the masses of data. The kind of scepticism toward scientific evidence that Latour decried in a seminal 2004 essay critiquing critique has become part of an *infodemic*, fuelled by conspiracy theories and fake news, and disseminated through seemingly un-poppable filter bubbles. Our ability to collect data has far surpassed our ability to read data, construct and evaluate evidence and discern facts. Likewise, our ability to critique data visualizations, evaluating their integrity, their sources and the political-economic contexts of their production have not kept up with the pace of output. The veil of neutrality drawn over data visualizations becomes more opaque and impenetrable when the socio-technical infrastructure that produces them is obscured behind

so-called neutral technologies: human decisions sealed behind computational logic (i.e. algorithms). This is one reason why this book makes a case for a critical approach to visualization, to confront a familiar problem exacerbated by the filter bubble effect (Pariser, 2012). On the one hand, there is the blunt deployment of data visualization to support powerful agendas. On the other, there is a blind distrust of visualizations that do not conform to a given prejudice. To counter this effect, we advocate both the rigorous critique and unfolding of data visualization and the practice of creating visualizations that are counter to, or critical of, dominant narratives. To paraphrase the geographer Denis Cosgrove's remarks on maps: always make visualizations, always question visualizations (Ross, 2006).

This book is written for those whose interest, business or practice is the visualization of data, as well as for those who study data and its impact in fields such as human-computer interaction, science and technology studies, critical data studies and digital humanities. As authors, researchers, designers and educators in communication design and media practice, we are interested in how data and its collection, manipulation and presentation both *empowers* and *disempowers* the people and the interests that are represented (or misrepresented) by the data. Our premise is that data visualization has flourished in terms of technique and creativity, but that this has come at the cost of critique. As we shall discuss, the idea of what it means to be critical has itself been critiqued, but we remain convinced that a robust field of data visualization warrants a robust critical discourse.

In the field of communication design and graphic design, the deficit of robust critical discourse becomes particularly apparent when contrasted with related fields such as critical data studies and critical cartography (to which we frequently turn for cues on method). In graphic design circles, as in mainstream media, the burgeoning of data visualization across disciplines has brought with it a form of information fetish or aestheticizing of information that tends to stunt the growth of critical discourse. Entangled with this fetish is the position, influentially demonstrated by Edward Tufte, for example, that the 'efficient', 'clear' and 'excellent' visual display of quantitative information will reveal the truth and help us solve all manner of social and technical problems in a fair, unbiased way (Tufte, 2001, pp. 13–15). The achievements of dataviz proselyte Hans Rosling, for example, included showing how data visualization can counter popular misconceptions about global health, but did not emphasize critical thinking around the circumstances of its gathering, selecting and presenting.

Figure 1.02 — **Hans Rosling presents *The Joy of Stats*.** © BBC

A CRITICAL FRAMEWORK

To establish a framework for critical visualization, we might begin with a series of statements, which we explore in the subsequent chapters:

1. **Data visualizations are part of larger *data assemblages*** — complex socio-technical systems, composed of many apparatuses and elements that are thoroughly entwined, whose central concern is the production of data (Kitchin, 2014, p. 24). As we discuss in Chapter 3, a good example of a data assemblage is the census, a large amalgam of apparatuses and elements that shape how a census is formulated, administered, processed, communicated and how its findings are employed.
2. **Data assemblages enhance and maintain the exercise of power** within society, particularly where they assemble institutions, regulations, laws, administrative measures, scientific statements and moral propositions (paraphrasing Michel Foucault's notion of the *dispositif*). One way in which a data assemblage maintains power is in the deployment of categories to organize what, or who, gets counted and how. As discussed in Chapter 3, once a person or group of people is classified, for example, as autistic, affluent, bi-racial or healthy, the classification has an effect on that person or group, which philosopher Ian Hacking terms a 'looping effect'. In this way, data classifications 'make up people' (Hacking, 2006).
3. **Data visualization critique reveals the assemblage**, or *explicates* the assumptions, apparatuses and elements that are entwined in the form: critique does not simply pass judgement on a visualization's formal clarity or excellence (although this certainly helps us make better visualizations). Here we lean on Foucault's account of critique: 'A critique does not consist in saying things aren't good the way they are. It consists in seeing on what type of assumptions, of familiar notions, of established, unexamined ways of thinking the accepted practices are based' (Foucault, 1981/2002, p. 456). In revealing the assumptions and unexamined ways of thinking, critique also reveals what or whose interests are being excluded.

4. **Data visualizations need to be situated in time and space** to counter the visual rhetoric that connotes omniscience, or the 'god trick' (Haraway, 1988, p. 581), that suggests data has been gathered, and is being viewed, from nowhere—a position often confused with *objectivity*. One way to situate a visualization is to draw from the expertise of those familiar with the data site and processes of its generation. We can also borrow a framework developed in Actor-Network Theory to analyse how things take shape through identifying, enrolling and mobilizing other interests. For example, in Chapter 2, we explore how Florence Nightingale's famous polar area graphs developed as part of her process of accruing support from politicians, military chiefs and newspapers, making herself indispensable to the network.
5. **Critical visualization practice uses assemblages, explication and an analysis of power** to create counter-narratives or critical visualizations. This is vital because—as is evident from point 2 of the framework—data visualizations and data assemblages function to enact power and, as such, tend to serve the interest of the powerful. As Catherine D'Ignazio has eloquently argued, 'there is profound inequality between those who are benefitting from the storage, collection, and analysis of data and those who are not' (D'Ignazio, 2017, p. 6).

Three of the terms deployed here—assemblage, situated knowledge, Actor-Network Theory (ANT)—indicate the discourses we are adapting to the task of critical visualization.

The concept of an *assemblage* goes back to Gilles Deleuze's and Felix Guattari's (1983) account of the heterogeneous entities—humans, non-humans, organizations, laws, things—that come together to produce power or agency through their relations.

The *situated* data visualization refers to Donna Haraway's (1988) account of the 'situated knowledges' produced by subjects who acknowledge the contingency of their own position in the world, and, in doing so, produce greater objectivity than those who claim to be neutral.

Actor-Network Theory describes (confusingly) not a theory, but a set of 'material semiotic' tools and methods of analysis for explaining how heterogeneous relations between human and non-human actors are continuously forming and reforming to enact power (Law, 2007). The tools of ANT help us explore how a data visualization translates the disorder of the world into patches of orderliness—by imposing categories, defining, counting and sorting entities into those categories, and then deploying

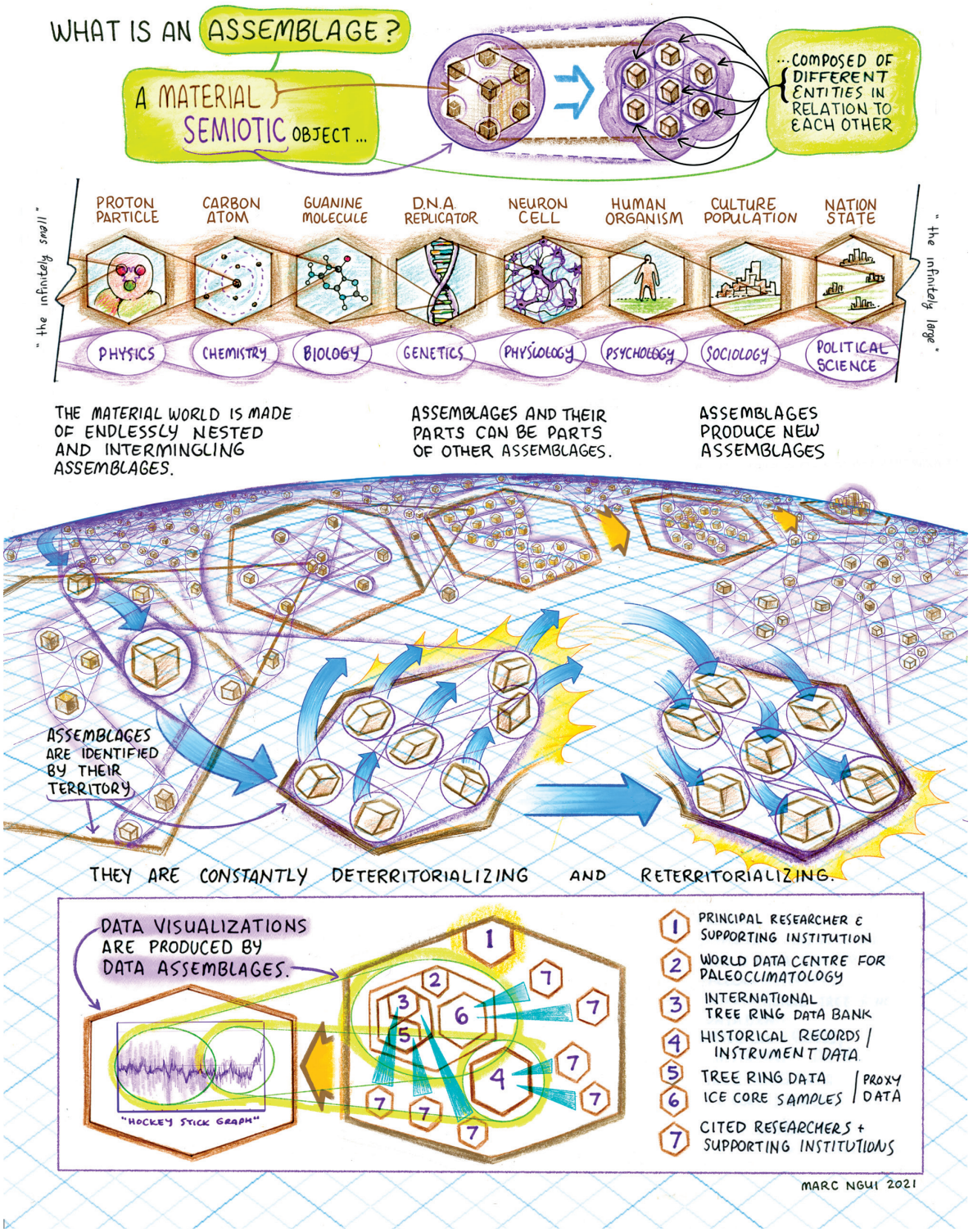


Figure 1.03 — **Assemblage.** Marc Ngui

that order to influence behaviour and shape policy. ANT emerged in the early 1980s and, unlike prevailing literary and linguistic approaches to meaning-making, focused on empirical case studies in science and technology to tease out how social and material things ('actors') — such as electric vehicles, door-closing mechanisms, scallops and Louis Pasteur's laboratory — enacted power by identifying, enrolling and mobilizing social-material relations (Callon, 1986; Latour, 1992; Law, 2007). Because it characterizes power as networks of associations, ANT does not tend to account for factors outside of those associations (e.g. a pervasive ethnocentric bias) that are nonetheless influential (Müller, 2015). Assemblage theory, however, accounts for such a bias, and helps explain how data visualization enacts power.

In short, we are applying to data visualization some of the ideas and methods from the last three decades of scholarship in science and technology studies (STS) and geography (Müller, 2015). Our aim is to show how visualization both *represents* and *enacts* interests, and how it *structures* and *imposes* power relations.

Rather than evaluating a visualization's stand-alone excellence, clarity or integrity, then, we can use the framework detailed earlier to situate and contextualize a visualization's claims to authority and to remind us that every visualization assembles an alliance — or ragtag army — of interests, each with their own history. Krause (2019) sets out a case for writing 'data biographies' with questions probing the authorship, purpose, method of collection, intended audience, impact and limitations of every data set. In a similar vein we can introduce a visualization to our framework with questions loosely derived from the basic investigative method taught to trainee journalists: the *who*, *what*, *when*, *why* and *how*? The sequence that follows leans rather more heavily on the *what*, because, as we shall see, unravelling the conditions of a visualization's development nudges us to consider the ANT-ian 'moments' of identifying, enrolling and mobilizing that accompanied its production and pre-production. So we arrive at *who*, *when*, *why*, *what*, *what*, *what* and *what*:

Who made the visualization and for whom?
When did they make it?
Why did they make it?
What social/cultural conditions was it made under?
What belief systems is it reinforcing or challenging?
What processes, or translations, preceded its production?
What has been excluded?

To apply the questions to an example, let's turn to a popular source for the aestheticizing of information as a form of cultural production: David McCandless' much-cited book *Information is Beautiful* (McCandless, 2012) and its cover image, the 'Colours and Culture' visualization.[1]

Who made it? David McCandless, a British data journalist.

When? In 2009, just as 'infosthetics' and dazzling graphics were gaining prominence, fuelled by widely available data mining, scraping and mapping technologies.

Why? The full title, 'Colours and Culture: The Meanings of Colours around the World' indicates that the intention was to demonstrate how colours mean different things in different cultures (e.g. red means good fortune in China, but debt in the West).

***In what social/cultural conditions*?** The reassuring idea that data visualization can help make sense of complex, bewildering, interconnected problems becomes more appealing when an expert guide offers his or her services. As a data journalist, McCandless has developed a practice of data interpretation using spreadsheets, and subsequently design tools, to 'tell stories' with data (McCandless, 2015). Any entrepreneur requires a level of showmanship, and we can speculate that the 'Colours and Culture' visualization was produced more for its form than its function, as we shall explain shortly.

What belief systems is it reinforcing/challenging? On close inspection, the visualization reveals its dependence on tertiary sources, namely Wikipedia and 'general web' (presumably Google). This might indicate the strangely skewed sense of world geography evident in the infographic: there are two continents represented (Africa, Asia), three subcontinents (America, South America and Eastern Europe) two religions (Hindu and Muslim), one Indigenous group (Native American) and two countries (Japan and China).

***What has been excluded*?** There is no Western European ring and the designation 'Asian' is unclear. In fact, the logic behind the categories in the key is unclear, if not entirely ad hoc. In the graphic, 'America' on the outer ring, has 53 entries. 'South America' on the innermost ring, has just five entries (red for danger and success, green for death, purple for mourning, blue for trouble).

1 For a viewable and zoom-able visualization, see p.7 of the book sampler: http://infobeautiful2.s3.amazonaws.com/IIB_Sampler_Dec2016.pdf (accessed 21 May 2021).

The troubling impact of a closer inspection of 'Colours and Culture' is that the visualization's claims to authority, objectivity and even credibility fall apart amid the ruins of its incoherent logic. At risk of lingering too long amid the rubble, we might, prior to departing, consider the apparatuses on which it depended for its appeal to authority: Wikipedia, specifically the world's largest online site of encyclopaedic knowledge production and — presuming that 'general web' means Google — the world's largest search engine. The national, corporate and gender biases inherent in Wikipedia's declared 'neutral point of view' (NPOV) approach to entry-writing have been the subject of extensive debate (e.g. Menking and Rosenberg, 2020). Similarly, the notion that search engines like Google provide a level playing field for 'all forms of ideas, identities and activities' is confronted by Safiya Noble, for example, who exposes the social problem of data discrimination and the oppressive effects of search algorithms (Noble, 2018). One fierce criticism of McCandless' *Information is Beautiful* platform is levelled by designer Neville Brody, who, in a debate on the BBC, argued that 'the idea of making beautiful information misses the point: trying to make information pretty can hide the core message. Information is political' (BBC, 2010). Brody's critique supports our premise that the collection, sorting, arrangement and presentation of data empowers some and disempowers others (point 2 of our framework) — to create a beautiful visualization that purports to show how colours mean different things to different cultures, but to populate it with data gleaned from one dominant region using apparatuses whose effect is to perpetuate a particular epistemology or particular worldview, is to effectively undermine the claim to pluralism.

In the McCandless example, the who-when-why-what questions served to poke behind the glossy facade of a visualization to reveal the larger *assemblage*, or *actor-network*, to which it relates. Law (2007) has argued that there is little difference between the assemblage and actor-network, but while the actor-network approach insists on *symmetry* in exploring the strategic, relational and productive character of heterogeneous entities, assemblage points to the *imbalance* of power that results.

The imbalance of power also provides a rationale and motive for making new, critical visualizations (framework point 5). Those equipped to deal in data generally have power and resources on their side. D'Ignazio identifies the imbalance between the data-haves and data-have-nots in her case for engendering a 'creative data literacy' that benefits the traditionally disempowered.

> Because it is state and corporate actors who possess the resources to collect, store and analyze data, individuals (e.g., citizens, community members, professionals) are more likely to be the subjects of data than to use data for civic purposes. There is a strong case to be made for cultivating data literacy for people in non-technical fields as one way of bridging this gap. (D'Ignazio, 2017, p. 6)

As we demonstrate in Chapter 3, one rhetorical function of a data visualization is to erase or obscure the decisions and machinations that accompanied its development. For the statistical display of quantitative information to be clear and 'excellent', it must eliminate all uncertainty, ambiguity and preparatory work including consultation and participation. Tufte's oeuvre demonstrates this effect, and the process of concealment in visualizing data is strikingly analogous to the way human input is often concealed in algorithmic decision-making. Cathy O'Neil's aptly named book *Weapons of Math Destruction* provides a series of case studies where data and algorithms were deployed, often blithely, to discriminate against their subjects, such as a Washington school district fifth-grade teacher who was fired because her performance was red-flagged by a new algorithm that failed to take into account key contextual information; the teacher went on to a successful career in a private school (O'Neil, 2017, p. 7). Our argument is not to make all data visualization messy and inconclusive, but to draw attention to the rhetorical effect of concealing decisions behind decisive graphical user interfaces.

This book, then, makes a case both for *critiquing* visualizations and for *making* critical visualizations. Both activities draw from the framework above, and in some cases subvert the rhetorical appeals to authority implicit in rules and guidelines on user-friendly or efficient visualization. In both aspects of critical visualization, we take cues from critical cartography, which, as we explore in Chapter 2, emerged in the post-Second-World-War years, out of a discipline that had followed a similar discursive framework as data visualization: a 'cartography of progress' (J. Crampton, 1994, p. 2) governed by internal technical interests and disengaged with ideological concerns (Kitchin and Dodge, 2007).

DEFINING THE FIELD

The field of data visualization is itself subject to different disciplinary perspectives and conceptions of its scope. Disciplines of relevance here are media studies, statistics, computer science, geographic information science and design — all of which have differences as well as commonalities in their approaches to visualization and its critical discourse. In his recent cultural history of data graphics in news media, Murray Dick uses the term 'infographic' interchangeably with 'data visualization', arguing (after Alberto Cairo) that the two concepts exist on a spectrum from

description to explanation. Outside of the news context, however, the term 'infographics' is quickly disparaged for its association with newspapers' tendency toward distorted graphics that exaggerate the recent rate of change (Dick, 2020). In statistical approaches to data visualization, the field is characterized by the pursuit of efficient methods for displaying quantitative data: Fienberg categorized graphical methods for illustrative, analytical, computational and decorative purposes (Fienberg, 1979, as cited in Dick, 2020) — the latter category sitting uncomfortably close to Tufte's disparagement of 'chartjunk'. In human-computer interaction (HCI) and geographic information science (GIS), the emphasis is on how the human brain best processes and analyzes information, supported by empirical measurement and user testing. Johanna Drucker's critique of this, the dominant approach to interaction design, is that it is 'reductively mechanistic':

> Its goal is to design an environment to maximize efficient accomplishment of tasks — whether these are instrumental, analytic, or research oriented — by individuals who are imagined as autonomous agents whose behaviours can be constrained in a mechanical feedback loop (Drucker, 2014, pp. 151–152).

In our own design-centred work, we have argued that dominant data visualization discourses neglect critical contexts. We have proposed new categories for contexts of use that elevate artistic visualization — that which reflects on cultural conditions, challenges dominant assumptions, and offers new modes of representation — alongside journalistic and scientific contexts of visualization (Hall, 2011). We have also argued for the use of the term 'diagrams of power' to capture the ways in which a diagram can be said to be both visual and non-visual, representing data and communicating ideas on the one hand, and arranging bodies and things on the other (Dávila, 2019). This sense in which design is ontological — enacting a way of being in the world — has been argued by Willis (2006) and Fry (2012), who have critiqued 'instrumentalist' tendencies that evaluate ideas, concepts and discourses in terms of their functional (and economic) success.

The dominance of instrumentalism, or what Murray Dick calls a 'functionalist-idealist' approach to data visualization, is exemplified in the central figure of Jacques Bertin, whose 'efficiency principle', introduced in the book *Semiology of Graphics* (Bertin, 1967/2011), has sustained a fifty-year influence on data visualization since its publication (Harvey, 2019). Bertin drew from his experience as a cartographer to establish a system using seven variables for the graphic organization of information: size, position, colour, orientation, shape, tone and texture. The reduction of complexity, the use of a grid for establishing scale and measurement of space, and the flattening of volumes (e.g. the spherical planet) are long-established premises of cartography, but Bertin's system facilitated the further abstraction of information into a typology and syntax with its own internal logic, anticipating the arrival of geovisualization. For Bertin, visual logic determines

the communication of signs and symbols; propositions can be created by the rigorous application of the signs in a system. But his system is 'monosemic' (meanings are singular), which leaves no room for symbolic or cultural contexts or audience (Dick, 2020).

Where cartography had tended to conceive of maps as tools for storing and communicating spatial information about the environment, Bertin's system focused on their role as methods for analysing and processing information (MacEachren, 2004). This laid the groundwork for the codification of graphic efficiency, simplicity, and consistency in Tufte's works on statistical graphics, and a computer science-based approach to data visualization, evident in, for example, Ben Shneiderman's (1996) golden rules of interface design, and Per Mollerup's (2015) guidelines on data design. A contrasting approach to Bertin's positivist semiotics would be a social semiotic perspective on how signs establish and change their meaning in different times and cultures (Hodge and Kress, 1988).

At the heart of cartographic principles, and underlying Bertin's approach, is the idea of orientation: that the person reading the map can locate themselves, and the person reading the visualization can effectively make comparisons and inferences without feeling that the rules of scale and consistency — or the data represented — are changing. But abstracted from the task of representing measurable space, Bertin's system and its successors in data visualization *imply* a point of view without actually *revealing* one. The authority of a standardized system for representing data, like the standardized cartographic approach of flattening the earth and overlaying a longitude and latitude grid, has the effect of making the subject disappear. When satellite imaging technology is combined with Bertin-ian systems of visual logic, as in Geographic Information Systems (GIS), where data (e.g. traffic or weather patterns, or census data) are overlaid with spatial information, the effect is compounded, since the visual syntax has no capacity to show the origins, location or authorship of the data being visualized, yet it delivers the view from nowhere with absolute authority. Laura Kurgan has argued that, 'For every image, we should be able to inquire about its technology, its location data, its ownership, its legibility, and its source. To facilitate that inquiry, an image and its associated data should remain closely linked' (Kurgan, 2013, p. 26).

The widespread public use of satellite imaging and the Global Positioning System (GPS) on mobile phones and in-car navigation has exacerbated the loss of a sense of scale. Whereas the scale of a printed map is fixed, on a screen it slides continuously with the simple zoom action of pinching one's finger and thumb. In her many projects that problematize the authority and singular gaze of the satellite view, Kurgan has highlighted the work involved in rendering the view from nowhere, which includes extensive post-production work, to ensure the satellite view is flattened, seamless

and lit uniformly. GPS itself embodies an 'unhinged' sense of stable and fixed location, since it comprises an orbiting network of 24 military satellites whose data must be reconciled with adjustments informed by Einstein's theories of relativity. As Kurgan puts it (citing Peter Galison), 'GPS and a whole new set of technologies linked to it have introduced, or hyperbolized, a profound decentering or disorientation (Kurgan, 2013, p. 16).

Defining the field, then, demands a trans-disciplinary line of inquiry that never loses sight of the socio-technical nature of data design conventions, their histories and interests. Crossing disciplines is easier when we trace genealogies. Geographer Jeremy Crampton points out that the origins of GIS lie in the thematic maps and statistics — the 'technologies of management' — that emerged in the nineteenth century (Crampton, 2010, p. 10). Tufte and cartographic historian Arthur Robinson both concur that the origins of thematic maps are tightly entwined with the history of cartography, extending back at least to Edmund Halley's map of trade winds (Tufte, 2001, p. 26; Robinson, 1982, p. 46). Denis Wood extensively tracks the post-Second-World-War *invention* of thematic mapping as an attempt to professionalize and securitize an academic interpretive mode of analysis distinct from the more instrumental 'base mapping' (D. Wood, 2010, pp. 121–126). As we have argued previously (Hall, 2008, p. 122), maps, thematic maps and visualizations are all projections of particular cultures at particular times and places, from Medieval *mappae mundi*, which divided the earth into three continents with the Holy Land at the centre (Robinson, 1982, pp. 9–11), to nineteenth-century disease and morbidity maps, which reflected concern with the social conditions of crowded cities — and speculated dubious correlations between geography and developmental disorders (e.g. Robinson, 1982, pp. 174–176). By the same token, network visualizations of the late twentieth century privilege a popular notion of the network as abstracted from physical space, fetishizing the spectacular complexity of technicoloured links and nodes in empty 3D space (Hall, 2008, pp. 120–124).

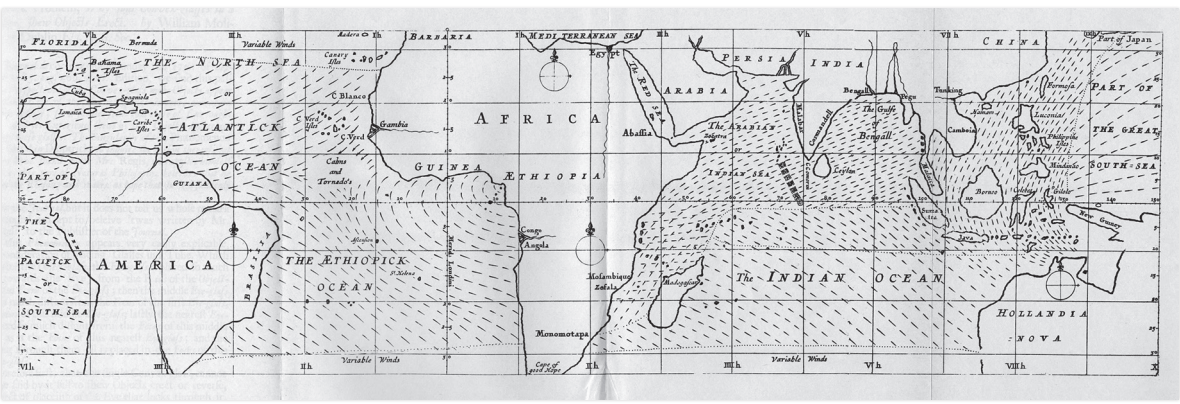


Figure 1.04 — **Edmund Halley's pioneering map of trade winds, 1686.** Edmond Halley

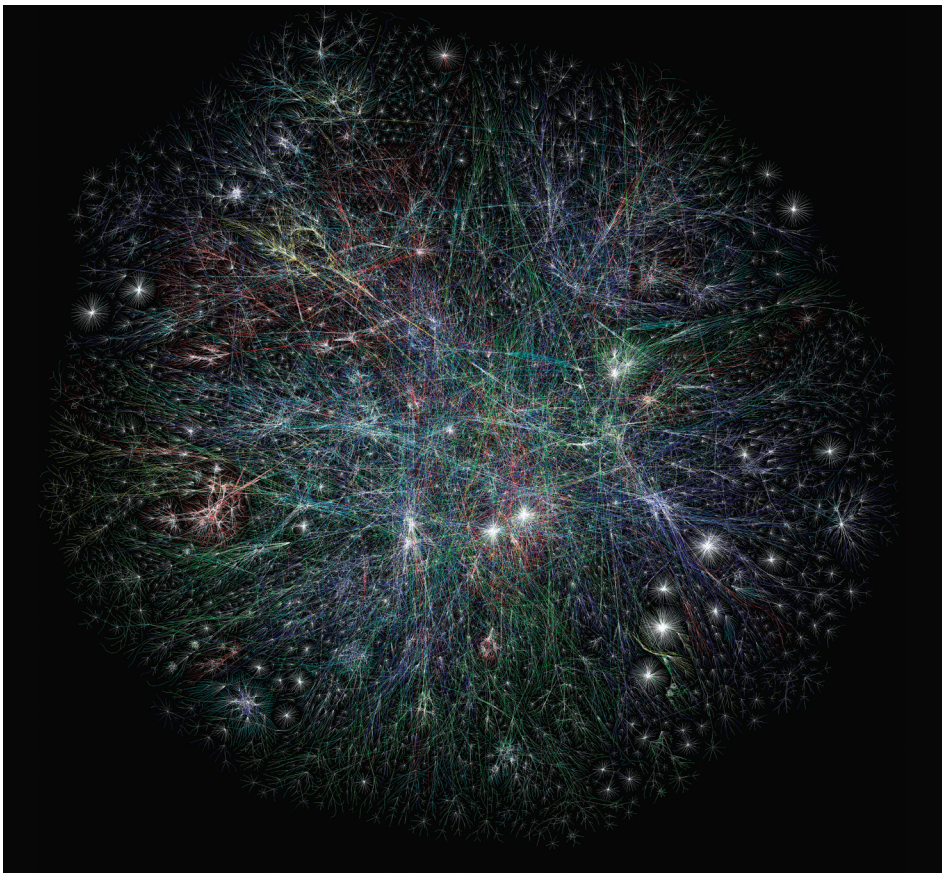


Figure 1.05 — **Barrett Lyon's Opte map of the internet, 2003.** The Opte Project

The terms 'data' and 'visualization' also warrant some unpacking. As Daniel Rosenberg writes, in recent histories of science, data are commonly characterized as incontrovertible facts, reflecting the etymology of the word, which we consider in Chapter 3. The earliest use of the term *data* is in a 1646 theological text, where the word refers to a list of theological propositions 'accepted as true for the sake of argument — that priests should be called to prayer, that liturgy should be rigorously followed, and so forth' (D. Rosenberg, 2013, p. 20). In seventeenth-century scientific tracts, the term *data* was used to identify facts that were, by agreement, 'beyond argument'. The legacy of this connotation is present in the rhetorical function of the word today: *data* means that which is arrived at through experiment and observation, but it is also the premise from which we start—'that which is given prior to argument' (D. Rosenberg, 2013, p. 36). This can be contrasted with the word *fact*, derived from the Latin *facere*, 'to do'. Hence, a fact is something that has been done, or exists. Facts exist, but data is given.

The basis for facts and data is evidence, a word that has a Latin root that suggests more active human witness, coming from the Latin verb *videre*, 'to see'. The connotations of the three words can thus be understood in terms of their contexts of contemporary use: facts exist, evidence is based on what we see (and know) and data, based on facts and evidence, are assembled to make a case or an argument. Or as Rosenberg puts it: 'facts are ontological, evidence is epistemological, data is rhetorical' (D. Rosenberg, 2013, p. 18).

We might like to believe that the visualization of *that which is given* is the less political practice of making data clear, accessible, and even beautiful, but the term 'visualization' comes with a baggage of its own. The term, again deriving from *videre*, emerged in the nineteenth century to denote mental images of things that could not be seen (D. Rosenberg, 2013). The contemporary meaning of the word, according to Orit Halpern's extensive study of the development of vision and reason,

> straddles the actual practices of depicting and modeling the world, the images that are used, and the forms of attention by which users are trained to use interfaces and engage with screens. (Halpern, 2014, p. 23)

Halpern argues that visualization has shaped thought by training our perception, defining reason, and—by extension—transforming notions of governmentality. Governmentality, a term conceived by Foucault to denote mechanisms for regulating populations, in the twentieth century became tied to data, calculation and neoliberal economics. At the same time, visualization came to describe the processes of bringing into sight that which is not already present:

> Visualization slowly mutated from the description of human psychological processes to the larger terrain of rendering practices by machines, scientific instrumentation, and numeric measures. (Halpern, 2014, p. 23)

In short, the visualization of data can be understood as a technique or technology for disciplining and managing populations and bodies, training them to see and understand the world through particular—economic, statistical, cognitive—lenses. One focus of this book is how visualization can also be used to reveal the world through different lenses, but typically, design's role in the data visualization assemblage tends to be one of complicity with power, sealing unexamined ways of thinking behind powerful visual performances. Halpern shows, for example, how visualization environments such as the IBM pavilion at the 1964 New York World's Fair played the role of influencing public acceptance of computing, and contemporary ideas about psychology, attention and space (Halpern, 2014, p. 143). IBM and designers Charles and Ray Eames, whose firm designed the twenty-two-channel installation 'Think', which projected a simultaneous flow of apparently disconnected film and animation clips,

sought to get viewers to make non-linear connections between images at the speed of thought, to 'think like a machine'. The effect and affect, argues Halpern (2014, p. 83), was to create what György Kepes called an 'experiential' form of vision.

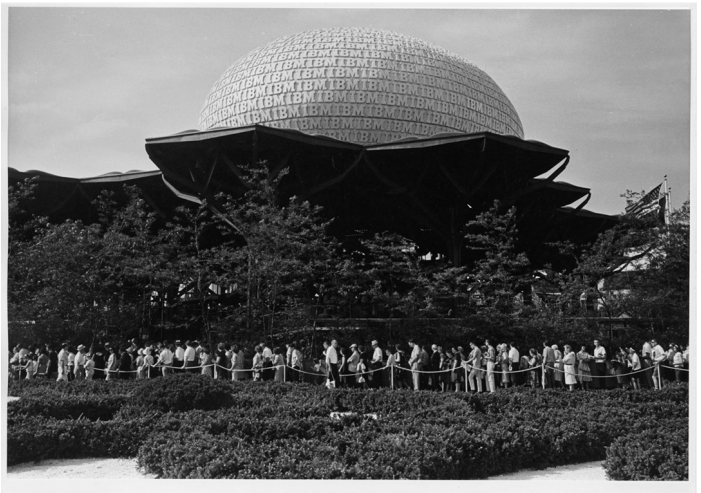


Figure 1.06 — **IBM Pavilion 1964 World's Fair.** Courtesy of International Business Machines Corporation, © International Business Machines Corporation

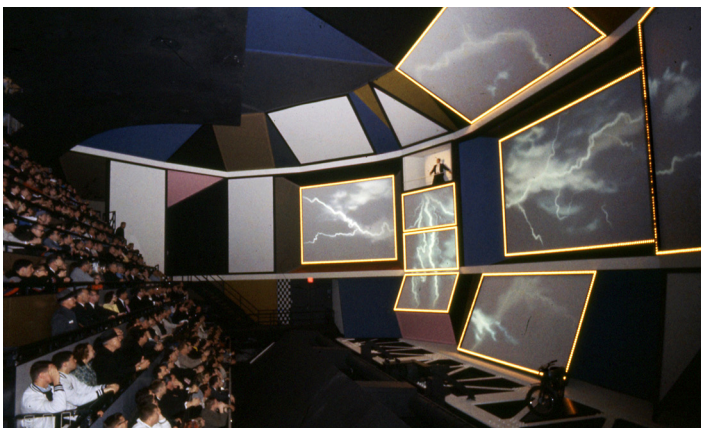


Figure 1.07 — **'Think' multi-screen film by Charles and Ray Eames at the IBM Pavilion, 1964 World's Fair.** Courtesy of International Business Machines Corporation, © International Business Machines Corporation

Data visualization, then, is much more than the technical pursuit of clarity through the excellent display of objective information. Visualization structures a world and ways of looking at it, disciplines forms of attention and, as we argue in Chapter 6, engages viewers to see the world differently. As we discuss in Chapter 3, data is neither objective or raw — Lisa Gitelman amply demonstrates this (Gitelman, 2013). Data is always situated. Data is always gathered at a certain time *in certain places*, *by certain organizations* with a certain purpose.

The mechanistic flavour of data visualization discourse is located as a primarily Western bias by Drucker, whose book *Graphesis* makes a well-substantiated case for more interpretive, humanistic approaches to visual forms of knowledge production. Drucker notes that visual forms of knowledge production (i.e. 'graphesis') have played a subordinate role to logocentric and numero-centric forms of knowledge in the West, and a methodological foundation for graphesis has to be 'cobbled together' from an array of contributing intellectual traditions, including: knowledge as vision; languages of form; universal principles of design; Gestalt principles of perception; the semiotics of graphics; techniques of framing and reading; issues of computation vision and the typology of graphic forms. (Drucker, 2014, p. 20).

LOOKING AT VISUALIZATION BEYOND WESTERN PARADIGMS

In his various writings on decoloniality, Walter Mignolo argues for 'delinking' from dominant Western paradigms of thought and practice, and 're-existing' through praxis, the idea that theory is doing and doing is thinking (Mignolo and Walsh, 2018, p. 7).

> Decolonial thinking and doing aim to delink from the epistemic assumptions common to all the areas of knowledge established in the Western world since the European Renaissance and through the European Enlightenment. Re-existence follows up on delinking: re-existence means the sustained effort to reorient our human communal praxis of living. (Mignolo and Walsh, 2018, p. 106)

To delink data visualization from its dominant Western paradigms requires a critical interrogation of the inherent assumptions: whose data? What interests are being furthered in this view, and what interests are being silenced? Here, critical visualization can learn from the work of geographer J.B. Harley, who introduced the concept of 'cartographic silences' — the knowledges buried by the territorial imperatives of the map-makers (John Brian Harley, 2002). Developing new approaches to visualization requires that silenced forms of knowledge are given an opportunity to 're-exist' in new data, in new ways of seeing old data and in new representations of that data.

An example of how a twofold approach to critically thinking about and critically making visualization works is provided by two contrasting projects that responded to the urgent problem of waste generation (according to the World Bank, in 2050, waste generation will reach 3.40 billion tons annually, outpacing population growth by more than double).

The Trash|Track project, launched in 2009 as part of Massachusetts Institute of Technology's (MIT) Senseable City Lab, posed the question 'Why do we know so much about the supply chain and so little about the