1. Engines of Order

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Part I
1. Engines of Order

Abstract

The chapter discusses central terms like ‘information’ and ‘order’, and it proposes the concept of ‘engine’ to point toward the infrastructural embeddings that have allowed techniques initially conceived for document retrieval to become pervasive mediators in online environments. While this book constitutes a humanistic exploration of technical substances rather than their practical application, the chapter pays tribute to the fact that the techniques under scrutiny have become prevalent in a specific situation, in this world and not another. To this end, the chapter discusses three critical trends: computerization, information overload, and social diversification.

Keywords: information ordering, computerization, information overload, social diversification, digital infrastructures

Although the various practices described as ‘information ordering’ have become ubiquitous parts of online experiences, the two notions making up the term are far from self-evident. Instead of providing strict definitions, however, I take ‘information’ and ‘order’ as starting points for an investigation into a domain of techniques that intervene in deeply cultural territory in ways that come with their specific framings and epistemological perspectives. Instead of asking what information and order are, I am interested in the operational answers enacted by algorithmic techniques. This means remaining at a certain distance from common uses of the vocabulary and concepts that characterize the fields associated with information ordering, itself already a somewhat uncommon term. Information scientists and readers familiar with volumes such as Svenonius’s authoritative The Intellectual Foundation of Information Ordering (2000) or Glushko’s recent The Discipline of Organizing (2013) will notice that my interpretative lens can differ substantially, despite the shared subject matter. This begins to manifest in seemingly small gestures, for example,
when glossing over paradigmatic distinctions between classification and categorization or between data, information, and knowledge. Instead of committing to particular definitions of these and other terms, I am interested in understanding how they inform and coagulate around specific ‘problematizations’ (Foucault, 1990, p. 10f.) of the domains they refer to and how they are strategically deployed in the construction and justification of techniques that produce epistemologically distinctive outputs. So far, I have used the term ‘information ordering’ very broadly, connecting it to tasks such as searching, filtering, classifying, or recommending items in online systems. The following section discusses information and order in sequence to address – rather than resolve – their vagueness.

**Information Ordering**

The techniques and practices discussed in this book hinge to a great extent on the term ‘information’ and the key role it plays in and around computing. My concern, however, is not the ontological question of what information is, but rather its practical role in different discourses and ‘its apparent ability to unify questions about mind, language, culture, and technology’ (Peters, 1988, p. 21). In the already somewhat restrained domain I will be investigating, the term has become a central instrument in the endeavor to bridge the gap between human practice and the workings of computing machinery. Here, the fact that information has no shared definition,¹ both in and across different epistemological sites, that it remains ‘a polymorphic phenomenon and a polysemantic concept’ (Floridi, 2015, n.p.), should not be seen as a failure or deficit but, on the contrary, as a strategic benefit when it comes to smoothening conceptual differences and bringing entire domains into the fold of computing.

As AI-researcher-turned-social-theorist Philip Agre has shown in great detail in his critique of artificial intelligence, polysemy – or, rather, the strategic arrangement of precision and vagueness – plays a productive role in technical work because it helps in binding human affairs to the technical

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¹ ‘Information is not just one thing. It means different things to those who expound its characteristics, properties, elements, techniques, functions, dimensions, and connections. Evidently, there should be something that all the things called information have in common, but it surely is not easy to find out whether it is much more than the name’ (Machlup and Mansfield, 1983, p. 4f.).
world and the other way around. The following paragraph summarizes his pivotal argument:

It is frequently said that technical practice employs an especially precise and well-defined form of language, but this is misleading. In fact, terms like ‘knowledge,’ ‘planning,’ and ‘reasoning’ are simultaneously precise and vague. Considered as computational structures and processes, these terms are as precise as mathematics itself. Considered as descriptions of human life, however, they are profoundly imprecise. AI continually tries to assimilate the whole of human life to a small vocabulary. (Agre, 1997a, p. 48)

Agre’s analysis details how artificial intelligence reduces the complex and ambiguous phenomenon of human ‘action’ to the much more contained notion of ‘execution of plans’, thereby opening up concrete pathways toward implementation in a working system, a fundamental requirement of the discipline (Agre, 1997a, p. 12). This involves conceptual work: plans are defined as mental structures that consist of subplans, going down a compositional hierarchy to a set of basic operations. The decomposition into small steps prepares a proclamation of equivalence between plans and computer programs (Agre, 1997a, p. 5f.). What is essential, here, is that this reductive, operational understanding of planning is used in such a way that it keeps the initial starting point, the rich world of human action, as a referent. If plans are programs and action the execution of plans, one can now – by definition – simulate human action. The gesture is supported by the idea that ‘the proof is in the programming’ (Agre, 1997b, p. 140), which leads to a form of tautological reasoning: a technical idea is true if one can build it, and if one cannot build it, it is not a technical idea and therefore has no merit in the field.

We can find comparable semantic operations in many areas of computer science, and the term ‘information’ often plays a pivotal role in connecting the worlds of humans and machines in similar ways. A well-known example can be found in Warren Weaver’s introduction to Claude Shannon’s *A Mathematical Theory of Communication*, published as a joint book in 1948 (Shannon and Weaver, 1964). Here, Weaver distinguishes ‘three levels of communication problems’, beginning with the technical problem (A), which is concerned with the fidelity of symbol transmission and thus the level where Shannon’s mathematical definition and measure of information are situated. But Weaver then also postulates a semantic problem (B) that refers to the transmission of meaning and an effectiveness problem (C) that asks
how conduct is affected by meaning. While he is somewhat prudent in this regard, he clearly wishes to extend Shannon's model from level A to levels B and C, which should only require ‘minor additions, and no real revision’ (p. 26). The statistical framing of information on level A finds its equivalence in ‘statistical semantic characteristics’ on level B, and the ‘engineering noise’ that troubles Shannon's technical transmissions becomes ‘semantic noise’ (p. 26). The communication of meaning is framed in similar terms as an encoding/decoding type operation. The engineering communication theory ‘has so penetratively cleared the air that one is now, perhaps for the first time, ready for a real theory of meaning’ (p. 27). If meaning ‘behaves’ like information, it is to be investigated and conceptualized in similar terms, which, very concretely, suggests and requires ‘a study of the statistical structure of language’ (p. 27). What we end up with resembles the transformation Agre describes: a definition of meaning that does not fully reduce it to Shannon's notion of information but postulates a somewhat vague equivalence that enables and authorizes the transposition of the conceptual and analytical apparatus from one to the other. And, as an additional benefit, since that apparatus is mathematical in nature, there is now a clear path toward building a running system, for example, for the practical task of machine translation. The field of information retrieval broadly follows this program from the 1950s onward.

However, an important nuance has to be introduced at this point. The movement of ‘absorption’ or ‘incorporation’ of various aspects of human life into the space of computation is often discussed as formalization and critiqued as a reduction of an overflowing richness into the cold language of mathematical logic. Golumbia (2009), for instance, takes Chomsky’s attempts to model the fundamental rules of language as a finite set of algorithms as his main example to show how ‘computationalism’ installs formal logic as both an analytical tool and a model for the workings of the mind itself. While Chomsky's work does not seek to build working systems for machine translation but to understand the fundamental principles of cognition (Katz, 2012), such explicit instances of ‘high rationalism’ have indeed radiated throughout the field of computing. But in many domains, for instance in information retrieval, the conceptual apparatus driving formalization can be surprisingly unambitious, subscribing to the pragmatic mindset of statistics rather than the rationalistic purity of logic. In the paper that first laid out what is now known as a Bayes classifier (Chapter 6), M. E. Maron (1961) programmatically states ‘that statistics on kind, frequency, location, order, etc., of selected words are adequate to make reasonably good predictions about the subject matter of documents containing those words’
(p. 405), and this is basically all he has to say about the nature of language in that text. Although a logician himself, he considers the modeling of human language in mathematical logic to be an impasse and instead promotes Weaver's probabilistic perspective.²

Information retrieval shares AI's practical goal 'to make computers do humanlike things' (Swanson, 1988, p. 97), but it takes a different route to achieving it. The key referent on the 'human side' in tasks like document search is clearly something having to do with meaning and knowledge, but there is an almost comical desire to not develop any serious theory of these concepts and to stick to commonsense uses instead. Lancaster's (1968) classic definition of information retrieval creates even more distance by arguing that an 'information retrieval system does not inform (i.e. change the knowledge of) the user on the subject of his inquiry [but merely] on the existence (or non-existence) and whereabouts of documents relating to his request' (p. 1). Rather than commit to a theory of knowledge, information retrieval sits comfortably in a space where the relationship between knowledge and information is implied, but remains vague.³ In the end, information's designated role is to be 'the essential ingredient in decision making' (Becker and Hayes, 1963, p. v) and this results-oriented epistemic 'attitude⁴ runs through the field to this day. For example, the famous Text REtrieval Conference (TREC) series, which has been organizing competitions in retrieval performance since 1992, is based on comparing participants' systems to known 'right answers', that is, to classifications or rankings that were manually compiled by experts. The primary goal is to attain or exceed human performance in situ rather than furthering deeper understanding of cognitive processes. Chomsky indeed argues that 'Bayesian this and that' may have arrived at some degree of practical proficiency, but 'you learn nothing about the language' (Katz, 2012, n.p.). His deep disdain for the statistical approach to machine translation is an indicator that the field of computing is characterized by real epistemological variation and disagreement. As Cramer argues, '[c]omputation and its imaginary are rich with contradictions, and loaded with metaphysical and ontological speculation' (Cramer, 2005, p. 125).

² 'Thus the goal of processing ordinary language by translating it (first) into a logical language brings with it more problems than prospects, and raises more questions than it answers' (Maron, 1963, p. 139).
³ 'To impose a fixed boundary line between the study of information and the study of knowledge is an unreasonable restriction on the progress of both' (Machlup and Mansfield, 1983, p. 11).
⁴ I take this term from Desrosières (2001).
When it comes to the concept of ‘order’, we could again pursue formal definitions, pitting it against notions like entropy, but keeping a loose understanding means remaining open to the practical propositions made in the field. The OED broadly suggests that order is ‘the arrangement or disposition of people or things in relation to each other according to a particular sequence, pattern, or method’. Order, in this definition, does not have the connotations of Cartesian regularity, uniformity, or immutability. And, indeed, the types of ‘ordering’ the techniques discussed in this book perform can be fuzzy, fragmented, and dynamic. They generally subscribe to probabilistic frameworks but also draw on other mathematical fields to deal with complexity and variation. Indeed, computing has been instrumental in shifting the problem of ‘arrangement and disposition’ from static conceptions of order to dynamic processes of ordering.

One way to think about such changing conceptions leads through Michel Foucault’s *The Order of Things* (2005) and Deleuze’s reading of that text merits particular attention. Here, the central term to delineate historical formations, each carrying its own specific understanding of order, is that of *épistémè*. Deleuze (1988) reads the classic *épistémè*, situated roughly in the seventeenth and eighteenth centuries, through the notion of ‘unfolding’ and couples it with what he refers to as the ‘forces that raise things to infinity’ (p. 128). Epitomized by Linnaeus’s *Systema Naturae* (published in twelve editions between 1735 and 1767), divided in the kingdoms of animals, plants, and minerals, this *épistémè* is organized around categorization into a timeless system. Following the logic of representation, there is an incessant production of two-dimensional tables that establish the bounds of the order of things; concrete entities do not define this space, they are merely positioned on it through the attribution of identity and difference with other entities, in infinite variation.

Around 1800, the modern *épistémè* first appears as a perturbation of the classic order. There are irreducible and contingent forces – life, work, language – that break through the preset representational grids ordering the entities these forces are entangled with. In Darwin’s work, for example, there is no predefined *regnum animale* (‘animal kingdom’) that covers all animals and their infinite variations. On the contrary, the tree of life starts with a single organism and the way it evolves is contingent and dependent on interactions between individuals and their specific environments. There is no eternal plan or order: life sprawls and disperses in different directions through successions of abundant yet finite variations. According to Deleuze (1988, p. 126f.), the modern *épistémè* is marked by an empiricism organized around the continuous ‘folding’ of the forces of life, work, and
language. History is not simply variation on a constant theme, but a process of becoming. The order of things is the result of that process and no longer the unfolding of an eternal blueprint.

Rather than stopping at this point, Deleuze attempts to address a question Foucault famously evokes at the end of *The Order of Things*, asking what comes beyond the modern épistémè. It makes sense to quote the central passage of Deleuze’s argument in full:

> Biology had to take a leap into molecular biology, or dispersed life regroup in the genetic code. Dispersed work had to regroup in machines of the third kind that are cybernetic and informatic. What would be the forces in play, with which the forces within man would then enter into a relation? It would no longer involve raising to infinity or finitude but a fini-unlimited, thereby evoking every situation of force in which a finite number of components yields a practically unlimited diversity of combinations. (Deleuze, 1988, p. 131, translation amended)

This notion of the ‘finité-infinite’ provides a compelling way to address the question of order – ‘the arrangement or disposition of people or things in relation to each other’ (OED) – and how it connects to the algorithmic techniques under scrutiny here. Foucault’s épistémès are not only connected to particular visual forms of arranging, such as the table or the tree, but they contain specific ideas about the nature of order itself. In the classic period, order is thought to be pregiven, a ‘God-form’ (Deleuze, 1988, p. 125) that runs through the things themselves, constantly unfolding according to eternal, unchanging principles. The scholar observes, designates, and takes inventory; and although words and things are considered to be distinct, a well-built analytical language or taxonomy keeps them from falling apart by producing a correct account of a world ‘offered to representation without interruption’ (Foucault, 2005, p. 224). In the modern period, however, order is an ‘outcome’, something that is produced by the processes of life, work, and language.

How does the notion of the fini-unlimited incubate a third understanding of order? The crucial element, here, is the idea that a limited number of elements can yield an (almost) unlimited number of combinations or arrangements. As shown throughout the second part of this book, permutative

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5 While the common translation of ‘finité-infinite’ as ‘unlimited finity’ may be more elegant than ‘finité-unlimited’, this amounts to a rather drastic change in emphasis. For a discussion of the topic from a different angle, see Galloway (2012).
proclivity is indeed a central characteristic of algorithmic information ordering: for any sufficiently complex dataset, the idea that ‘the data speak for themselves’ is implausible; developers and analysts select from a wide variety of mathematical and visual methods to make the data speak, to filter, arrange, and summarize them from different angles, following questions that orient how they look at them. Rather than ideas of a natural order, there are guiding interests that drive how data are made meaningful.

This argument is indeed central to two popular books by David Weinberger, *Everything Is Miscellaneous* (2008) and *Too Big to Know* (2012), which are almost manifestos for a fini-unlimited épistémè. Even if Weinberger’s epistemic attitude and historical trajectory differ substantially from my own, we share the fundamental diagnosis that information ordering increasingly revolves around gestures of disassembly and reassembly that follow specific interests and desires: ‘How we choose to slice it up depends of why we’re slicing it up’ (Weinberger, 2008, p. 82).

Indeed, it has become widely accepted that computers, whether we think of them as computing machinery or as digital media, encourage ‘disaggregation and disassembly, but also reaggregation and reassembly’ (Chadwick, 2013, p. 41). The central idea informing the relational model for database management, for example, is to cut data into the smallest parts possible to allow for dynamic recombination at retrieval time with the help of a powerful query language that makes it possible to make selections, calculations, or ‘views’ on the data. Outputs are selected and ordered based on the ‘question’ asked. The machine learning techniques discussed in Chapter 6, to give another example, provide the means to create information sieves inductively. By ‘showing’ a spam filter which emails are considered undesirable, the classifier ‘learns’ to treat each word or feature as an indicator for ‘spamminess’. But no two users’ classifier profiles will be exactly the same, not only because they receive different emails but also because they will have different definitions of what constitutes an unwanted message. This book traces such instances of a fini-unlimited in a manner that remains attentive to commonality yet refrains from singularizing a space of variation into a totalizing assessment.

My purpose, however, is not to postulate a new épistémè, a new understanding of order that would have emerged sometime after WWII, and then to show how this new formation has ‘found its expression’ in a range of algorithmic techniques. In line with the cultural techniques tradition, and in particular with Bernhard Siegert’s (2013) radical formulation, I consider that order, as a concept, does not exist independently from ordering techniques and that any broad shift would have to be considered, first and foremost,
as a consolidation in the network of ontic operations established by the techniques themselves. From a methodological perspective, this means that the concrete gestures of ordering and the technical, functional, and epistemological substance they carry are the necessary starting points.

**Engines Ordering *This* World**

While one can look at algorithmic information ordering techniques as a series of technical ideas, their role as ‘epistemological operators’ (Young, 2017, p. 45) acting on the world in significant ways cannot be understood without consideration for their embedding in ever-expanding infrastructures that play fundamental roles in mediating and constituting lived reality (Burrows, 2009, p. 451). As Peters argues, ‘[m]edia are not only devices of information; they are also agencies of order’ (Peters, 2015, p. 1) in the sense that they support and organize social, political, and economic systems in specific ways. The functional substance of ordering techniques cannot be separated from their application to the bits and pieces of the ‘real’ world. They have become part of ‘the connective tissues and the circulatory systems of modernity’ (Edwards, 2003, p. 185) and their integration into larger ‘operative chains’ (Siegert, 2013, p. 11) binds their broad technical potential into more specific roles. My emphasis on technicity is therefore not in opposition to the perspective Peters (2015) calls ‘infrastructuralism’ (p. 33) but approaches the large systems that define and support modern life from the perspective of their smaller components.

The term ‘engine’ indeed serves to link the work done in particular locations or instances to its broader infrastructural embeddings. Donald MacKenzie’s *An Engine, Not a Camera: How Financial Models Shape Markets* (2006) studies financial markets in these terms, connecting fine-grained attention for the substance or content of calculation with an appreciation of its role and performativity in larger systems. Financial theory, understood as a series of conceptual and mathematical models, is analyzed as ‘an active force transforming its environment, not a camera passively recording it’ (MacKenzie, 2006, p. 12). How investment markets are framed conceptually and methodologically has concrete consequences for individual (e.g., investment decisions) and collective (e.g., regulation, market design) choices and behavior. The performative dimension of a financial model, method, or theory is strengthened further when it becomes reified in software that defines operative modes directly (MacKenzie, 2010). Both the ‘cognitive’ and the ‘mechanical’ understanding of performativity can be fruitfully applied
to information ordering, but the latter calls increased attention to forms of operation and automation that are particularly relevant.

Following Adrian Mackenzie’s (2017a) take on machine learning, one could emphasize information ordering as a field of academic inquiry and an epistemic practice that is organized around mostly well-delineated steps, where a deliberately selected technique is applied to a contained dataset at a specific moment in time to generate a classificatory output. While this is certainly a common setup, the infrastructural perspective emphasizes a scenario where large-scale platforms capture, support, and channel human practice continuously and information ordering becomes a pervasive arbiter of real-life possibilities. Indeed, the degree to which calculative processes have penetrated into the fabric of contemporary societies is striking, although historiographical work (Beniger, 1986; Yates, 1989; Gardey, 2008) has clearly shown that data collection and analysis techniques have a long history, becoming steadily more central to organization, coordination, and control in business and government over the course of several centuries. Even modern-sounding approaches such as graph algorithms or machine learning have been around since at least the 1960s but were only widely taken up over the last two decades. The question why this has not happened earlier and why this is happening now on such a large scale can serve as an entry point into a deeper appreciation of the context algorithmic information ordering operates in. In the remainder of this chapter, I will thus establish a broader picture, beginning with an assessment of what has been called ‘computerization’ and followed by a discussion of ‘information overload’, the problem most often put forward by early information retrieval specialists. Taking a more sociological angle, I will then single out social diversification as a contextual factor that cannot be ignored.

**Computerization**

One of the reasons for the somewhat delayed adoption of algorithmic information ordering could be that computers were simply not powerful enough before the turn of the century, making the exponential growth in speed and capacity the principal driver. In his acceptance speech delivered on receiving the Turing Award in 1972, Dijkstra (1972) noted that ‘as the power of available machines grew by a factor of more than a thousand, society’s ambition to apply these machines grew in proportion’ (p. 862)
and his argument cannot be easily dismissed: processing brawn is indeed a prerequisite for making certain applications of information ordering a feasible option. Another technical explanation could call attention to the growing availability of algorithmic techniques beyond university labs and specialized documentation centers. But instead of singling out individual ‘causes’, it makes sense to think about these elements as parts of a larger, self-reinforcing process of ‘computerization’.

While the term has fallen out of fashion after its heyday in the 1970s and 1980s, speaking of computerization reminds us that digital media are not just sleek graphical interfaces for making and accessing various kinds of ‘content’ or ‘data’ or, but also machines that vary in shape and ability, offering a variable computational basis for the implementation of all kinds of forms, functions, and autonomous operation. The capacity to connect ever-expanding capabilities for storage, transmission, and processing to rich and sophisticated input and output interfaces connected to the world in myriad ways has allowed the computer to infiltrate and to constitute a large number of practices. This can be understood as a process of progressive mediatization, a ‘deepening of technology-based interdependence’ (Couldry and Hepp, 2016, p. 53) that is not limited to consumer devices and includes countless activities in business or government. While the term ‘infrastructure’ is not reserved for technical systems, it is clear that fewer and fewer practices are not channeled through computing in one way or another.

The web still constitutes the prime example for a pervasive, general-purpose infrastructure that affords access to media content and social interaction as well as myriad services that rely on its technical malleability to organize activities through end-user interfaces and backend coordination. The rapidly expanding entanglement of practices related to communication, coordination, consumption, and socialization with computing is realized through the design and adoption of ‘activity systems that are thoroughly integrated with distributed computational processes’ (Agre, 1994, p. 105). Facebook, for example, can be understood as a highly complex amalgamation of various layers and instances of hardware and software that, together, form a global infrastructure for ‘socializing online’ (Bucher, 2013). Agre (1994) argues that an activity is ‘captured’ in the technical and conceptual vocabularies computing provides when it is enabled and structured by software-defined and computer-supported ‘grammars of action’. Since the way this happens is clearly not a mere transposition of previous forms of ‘socializing’ into a new environment, computerization must be seen as an ‘intervention in and reorganization of [human] activities’ (Agre, 1994, p. 107). Facebook is not a neutral or transparent means to make, maintain,
and enact social relationships, but, ‘by organizing heterogeneous relations in a specific way, constitutes a productive force’ (Bucher, 2013, p. 481) that operates and mediates through an arrangement of deliberately designed forms and functions. Information ordering techniques become engines of social order when they operate and intervene in such environments, where ‘[t]hey may change social relations, but […] also stabilize, naturalize, depoliticize, and translate these into other media’ (Akrich, 1992, p. 222).

To consider the evolution of computing hardware from the mainframe to personal computers and further to mobile, networked, and integrated devices would be one way to analyze the deep incursions into the frameworks of human life computers have made. Notions like computerization and grammatization, however, seek to address the many different ways broad technical possibilities have been connected to a large variety of practices. If we follow Turing (1948) and Manovich (2013c) in framing computers both as universal machines capable of simulating all other machines and as ‘metamedia’ uniting various media forms in a single screen, software stands out as the principal means to create the fine-grained structures capable of capturing the components of highly complex activities such as online gaming or project management.

More recently, scholars have used the term ‘datafication’ to call attention to the process of ‘taking information about all things under the sun – including ones we never used to think of as information at all, such as a person’s location, the vibrations of an engine, or the stress on a bridge – and transforming it into a data format to make it quantified’ (Mayer-Schönberger and Cukier, 2013, p. 15). This is clearly an important aspect to consider. The result of datafication has been the rapidly increasing production and availability of very large datasets that often comprise transactions (logged events or behavior) or other forms of nontraditional data such as traces of movement in navigational or physical spaces, social interactions, indications of cultural tastes, or sensor readings. This, in turn, stimulates demand for analytical capabilities. The accumulation of complicated yet highly expressive unstructured data in the form of textual communication, for example, has fueled interest in techniques like topic modeling or sentiment analysis that seek to make them intelligible and ‘actionable’, that is, applicable to decision-making.

However, speaking of computerization rather than datafication emphasizes that data accumulation enables forms of ‘immediate’ management that operate through interface modulation. The direct application of algorithmic ordering is made possible by the emergence of digital infrastructures and environments that allow for both data collection and output generation,
in the sense that the structure and content of what appears on a screen or some other interface can be compiled in real time on the basis of data that may have been collected over extended periods of time. Differential pricing on the web provides an elucidating example: a user’s location, software environment, browsing history, and many other elements can be situated against a horizon of millions of other users and their shopping behavior; this knowledge can then be used to estimate an ‘optimal’ sales price. The result of this calculation, made in the fraction of a second, can be directly integrated in the interface served to that user, showing an individualized price for an item. Content recommendation, targeted advertising, or automated credit assessment are variations of the same logic.

This instant applicability of data analysis is a crucial step beyond traditional uses of calculation or ‘mechanical reasoning’ because it integrates and automates the sequence of collecting data, making decisions, and applying results. Human discretion is relegated to the design and control stages and expressed in technical form. Instead of merely detecting or describing some pattern, the results of algorithmic information ordering are pushed back into the software-grammatized spaces the input data were initially taken from, creating new and particularly powerful forms of ‘an environmental type of intervention’ (Foucault, 2008, p. 260). Algorithms become engines of order that intervene in the processes they analyze, creating feedback loops that direct behavior to realize specific goals. Whether we consider that the various trajectories of computerization, datafication, or ‘platformization’ (Helmond, 2015) converge into an ‘accidental megastructure’, an encroaching ‘planetary-scale computing system’ (Bratton, 2015, p. xviii) or not, it is clear that algorithmic information ordering can now rely on infrastructural conditions that constitute a favorable habitat.

Information Overload

Even today, however, algorithmic information ordering is most often not presented as a means to automate decision-making in integrated digital environments, but more modestly as a solution to the problem generally referred to as ‘information overload’. The idea holds that computer-based, networked infrastructures consistently confront users with too much

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7 A recent report by the White House summarizes: ‘Broadly speaking, big data seems likely to produce a shift from third-degree price discrimination based on broad demographic categories towards personalized pricing and individually targeted marketing campaigns’ (Executive Office of the President of the United States, 2015, p. 19).
information – too many documents, too many contents, products, or people, too much ‘stuff’ than could possibly be handled by any individual. These are the circumstances where algorithmic information ordering becomes the preferred solution. As Andrejevic argues, ‘[d]ata mining [...] comes to serve as a kind of “post-comprehension” strategy of information use that addresses the challenges posed by information overload’ (Andrejevic, 2013, p. 41). Of course, neither the assessment that too much information is hampering understanding, nor the call for technical solutions are recent phenomena.

In 1945, when Vannevar Bush described his Memex, an imaginary personal information machine (Buckland, 1992), he famously argued that ‘a growing mountain of research’ was ‘bogging down’ scientists (Bush, 1945, p. 112). The idea that the production of printed material had outpaced human capacities indeed became the foundational assessment and problem space for information retrieval. Popular historian James Gleick’s book Information does not mention the field by name but gives a concise description of what had become a universally accepted diagnosis around the middle of the twentieth century:

Deluge became a common metaphor for people describing information surfeit. There is a sensation of drowning: information as a rising, churning flood. Or it calls to mind bombardment, data impinging in a series of blows, from all sides, too fast. (Gleick, 2011, p. 402)

The cognitive capacities of individuals, the assessment holds, are simply insufficient to deal with the masses of items the ‘information society’8 is confronting them with. While early lamentations concerned the proliferation of printed material, computer systems quickly became the main object of speculation. When Herbert Simon (1971) declares in the early 1970s that ‘[f]iltering by intelligent programs is the main part of the answer’ (p. 72) to the information overload problem, he can already look back at two decades of research and experimentation in that direction.

With the advent of networked computing and the web in particular, the question of information abundance and overload is posed with renewed vigor and often in terms that register the widening of applications beyond document search and information retrieval. Chris Anderson’s notion of ‘infinite shelf space’ (Anderson, 2006, p. 16), to name one take on the issue, initially refers to Amazon’s seemingly bottomless catalogue, but is quickly extended to other domains covered by the web. In the domain of social

8 The popularization of the term is generally attributed to Machlup (1962).
interaction, for example, the end of the ‘tyranny of locality’ (Anderson, 2006, p. 16) has allowed burgeoning online communities and dating sites to overcome the limitations of physical distance, resulting in much larger pools of possible interlocutors. Here, as elsewhere, we find larger ‘marketplaces’ for all kinds of ‘goods’, not only larger archives of (text) documents. These developments indeed inform the remarkable expansion of the domain covered by information ordering. Although Beer (2016) rightfully argues that phenomena like ‘big data’ need to be seen ‘as part of the long series of developments in the measurement of people and populations’ (p. 9), many of the techniques involved have actually been adapted from technical lineages initially concerned with ordering text documents and not people. The crucial moment is the realization that any kind of entity or item can be handled in similar ways when fit into certain data representations. Once grammatized into an information system, ‘a human being is merely a document like any other’ (Ertzscheid, 2009, p. 33).

Contemporary Internet platforms certainly extend this logic significantly. Referring to online platforms as marketplaces emphasizes that there are units of exchange being made available in a way that each participant could, in theory, access every single one of them. The web makes documents available. Amazon makes consumer goods available. Spotify and Netflix, respectively, make music and audiovisual contents available. Uber makes units of transportation available, AirBnB of housing. Facebook, OkCupid, Meetup, and Monster all make people available, even if they do so quite differently. Since these services often dominate their specific niche and are generally much less limited in geographical and logistical terms than their offline equivalents, they can host large numbers of units and participants. The threshold for participating in online marketplaces is generally low: writing a message on Twitter, which could potentially reach millions of people, is almost effortless.

Building on Coase’s (1937) theorization of transaction cost, authors like Ciborra (1985) and Agre (1994) have convincingly argued that information technology makes it easier to organize (economic) activities through markets rather than firms, since it affects all three of the main difficulties transactions have to overcome:

The costs of organizing, i.e. costs of coordination and control, are decreased by information technology which can streamline all or part of the information processing required in carrying out an exchange: information to search for partners, to develop a contract, to control the behavior of the parties during contract execution and so on. (Ciborra, 1985, p. 63)
This reduction of transaction cost, which has also been recognized by popular authors like Clay Shirky (2008), has facilitated the emergence of the very large marketplaces for information, goods, and people we take increasingly for granted. And the prominent place the transaction cost approach gives to search clearly highlights the mediating role Simon’s ‘intelligent programs’ are set to play in areas that have little to do with text documents. Large online platforms indeed rely heavily on data collection and algorithmic information ordering to filter, recommend, or personalize, that is, to connect users with the units on offer. By modulating the distance between specific participants and specific items, techniques perform ‘navigational functions’ (Peters, 2015, p. 7) or forms of ‘programmed coordination’ (Bratton, 2015, p. 41) in otherwise flat networks or markets. Spam filtering is an interesting example in this context: while unwanted mail is certainly not a new phenomenon, the extraordinarily low cost of sending huge quantities of electronic mail has multiplied the practice by orders of magnitude. The ‘renaissance’ of the Bayes classifier (Chapter 6) as a means to fight spam can be seen as an attempt to solve the problem without locking down the open, marketlike structure of the email system. Filtering is one way to manage connectivity and mass interaction.

Unsurprisingly, information retrieval has developed in close relationship with statistics, the principal field concerned with applying ‘mechanical reasoning’ to matters where too many individual units hamper understanding. Statistical mechanics, for example, materialized when it became clear that a description of the empirical behavior of gases based on the measurement of individual molecules would be utterly impossible. Even if the behavior of every molecule in a gas were to be considered as fully deterministic – which quantum mechanics denies – it would be practically impossible to determine the position, direction, and velocity of all individual molecules and to calculate the myriad micro-interactions between them. Mechanical statistics proposed means to manage this disconnection and to conceive the emergent behavior of the whole in terms of statistical ensembles rather than individuals. Similarly, as Foucault (2009, p. 104) points out, the study of epidemics and economic dynamics in the nineteenth century undermined the dominance of the family as model for understanding and governing society. Instead, the ‘population’ – the term now used in statistics for sets of items of any kind – emerged as a proper conceptual entity seen as giving rise to phenomena and dynamics that could not be reduced to its constituent parts. Both molecules and people could no longer be described in deterministic terms when encountered as ‘living multiples’ (Mackenzie and McNally, 2013) too great in number to describe individual behavior and interaction. In both cases, statistics would resolve the supposed contradiction
between uncertainty and control by providing the concepts and techniques to reason with and about such multiples. Statistics both challenges secure descriptions of the world by ‘eroding determinism’ and furnishes a new language and methodology to ‘tame’ the resulting uncertainty (Hacking, 1990). Notions such as regularity and variation, distribution and tendency, or dependence and correlation are means to move beyond cognitive overload by addressing ‘the many’ as statistical ensembles rather than individuals.

Information ordering turns statistical descriptions into engines that intervene in the processes they observe. Peters indeed reminds us that the history of statistics – etymologically the ‘science of the state’ – is not one of ‘pure’ mathematics but indeed always tied to practical applications and the realization of pragmatic goals:

[R]ulers don’t want to rule over an imaginary state: they need to make policy, control populations, tax incomes, raise armies. They need facts. And so, statistics arose as the study of something too large to be perceptible – states and their climates, their rates of birth, marriage, death, crime, their economies, and so on – and secondly, as a set of techniques for making those processes visible and interpretable. (Peters, 1988, p. 14)

Algorithmic information ordering relies heavily on statistical techniques to tame information abundance and largely subscribes to a pragmatic epistemology and ethos that seeks to make large quantities of information not only visible and interpretable, but also navigable, actionable, and (economically) exploitable. This line of reasoning leads us further down the rabbit hole into properly sociological territory.

Social Diversification

The enormous production of all kinds of information and the reduction of transaction cost that fuels the ‘transition to market-based relationships’ (Agre, 1994, p. 120) sit in the midst of social transformations that further exacerbate the perception that ours is a time of complexity, chaos, and disorientation, which makes information ordering – as a mechanism for both description and management – particularly attractive. The schematic assessment that follows remains superficial but adds a layer of explanation that points to deeper transformations than the ‘information overload’ and ‘transaction cost’ narratives can capture.

In Ulrich Beck’s formulation, modernity, and the period since WWII in particular, is characterized by ‘processes for the “diversification” and
individualization of lifestyles and ways of life’ (Beck, 1992, p. 91). The emergence of consumer capitalism has shifted the focus from production to consumption and brings forth an ever more fine-grained variety of commodities and experiences in virtually all areas of human life, from food to cultural goods and vacations. Societies adopting liberal democracy have seen many traditional social segmentations and taboos erode, continuously extending individuals’ capacities to live lives that differ substantially from those lived by both previous generations and next-door neighbors. According to Giddens (1994), ours are decentered, nontraditional societies ‘where social bonds have effectively to be made, rather than inherited from the past’ (p. 107) and ‘choice has become obligatory’ (p. 76). One may rightfully wonder whether there is any ‘real’ difference between the many breakfast cereals available in supermarkets, but my objective is not to adjudicate whether these variations in patterns of consumption, in socioeconomic status, in geographical anchoring, in political and social values, in sexual preferences, in cultural identities and tastes, and so forth are meaningful or not. The argument I want to put forward is threefold: first, we live, at least on the surface, in societies characterized by high degrees of diversity in terms of lived lives; second, these lives increasingly unfold through infrastructures that log and survey them in various ways, generating large amounts of data that reflect (some of) that diversity; third, these lived lives are patterned and not random. The last point requires particular attention.

The social sciences have spent the last 200 years trying to understand how individuals and society relate, how variation and commonality entwine to produce complex and dynamic arrangements that stabilize, form institutions, and so forth. The most common term used to address stability in society is that of structure, whether it is understood descriptively to denote nonrandomness or analytically to refer to actual social forces. The notion of social structure is at least partially tied to group membership, either externally attributed or used by actors to demarcate themselves. Categories along the lines of estate, class, caste, profession, and so forth are the result of historically produced (socioeconomic) classification and stratification that resulted in more or less consistent groups that shared characteristics and social standing, which, in turn, differentiated them from other groups. These segmentations have – at least in part – lost their ‘binding force’ (Giddens, 1994, p. 63) and structuring capacity, as well as their utility as descriptive concepts.9 Established arrangements have been disrupted and new ones

9 In his introduction to the sociology of stratification, Saunders writes: ‘Compared with the nineteenth century, when Marx developed his theory, the class system has become highly complex and differentiated’ (1990, p. 85).
are more complex, dynamic, and opaque, beginning with the organization of labor, ‘which has exploded into a multiplicity of activities and statuses, expressing subjectivities and expectations which cannot be reduced to the traditional concept of class’ (Lazzarato, 2006, p. 187).

One may wonder in how far attempts to think social structure from the bottom up as multiplicities are reactions to these transformations. Simmel's (1908) ‘social geometry’ can already be seen as a way of conceptualizing Vergesellschaftung (‘societification’) from the individual, who, due to increasing social differentiation, enters into complex relationships with various others and is less and less confined to a primary group. The recent interest in Tarde’s monadological understanding of society (Latour et al., 2012), as well as the continued popularity of other ‘inductive’ currents – including social exchange theory and social network analysis – can be seen as mere methodological trends or, more fundamentally, as attempts to grapple, conceptually and methodologically, with decentered societies that are grouping in more flexible, transient, and diverse ways. Rodgers indeed calls the recent decades an ‘age of fracture’, where the ‘emergence of the market as the dominant social metaphor of the age’ (Rodgers, 2011, p. 44) reinforces a trend toward forms of social organization that revolve around mass interactions between atomized individuals. As I will show in Chapter 7, graph analytical algorithms like PageRank draw heavily on such atomistic conceptualizations of society, but information ordering on the whole thrives on gestures of disassembly and dynamic reassembly.

In a situation characterized by social differentiation on the one side and ambivalent forms of global and local integration on the other, data collection and analysis promise to make the social legible and actionable, to reinstall mastery over societies that continuously create differentiations that no longer conform to traditional groupings and categorizations. This is, at least in part, where the demand for computational data analysis and algorithmic information ordering comes from. As complexity and opacity grow, the epistemic and commercial value of techniques that promise to produce viable descriptions and effective decisions grows as well. This promise, however, still hinges on the ‘structuredness’ of society in the sense that elements are arranged in increasingly complicated ways without devolving into randomness. Forms of coherence, commonality, and stability continue to exist even if they can no longer be reduced to conceptual pivots such as class. The emergence of what Couldry and Hepp (2016) call ‘media-based’ or ‘mediatized collectivities’ (p. 175) – which may well be assembled and ordered algorithmically – represents one vector of coagulation even as ‘the spectrum of possible collectivities has increased fundamentally’ (p. 175).
The ‘fragmentation of audiences’ (Andrejevic, 2013, p. 12) resulting from the proliferation of channels and outlets becomes an opportunity for those capable of reassembling fragments into addressable groupings.

Most importantly, if it has become difficult to speak of a ‘working class’ today, it is not because (economic) exploitation has disappeared, but because forms of exploitation have become too intricate and varied to summarize them easily into clear-cut sociological concepts. The transformations Wagner (2016) describes as a ‘dismantling of organized modernity’ (p. 109), where globalization and individualization have dissolved the binding forces of space and time (p. 120ff.), yield a situation where ‘formal domination’ in terms of legal rights has given way to new kinds of domination that are often based on past formal privilege (p. 146ff.), but also increasingly individualized. As Giddens (1994) remarks, individuals’ capacity to make choices in virtually every sphere of life does not guarantee egalitarian pluralism since decision-making ‘is also a medium of power and of stratification’ (p. 76). And Bourdieu’s (1984) assessment that different forms of capital – economic, social, and cultural – are connected means that, for example, years of education, level of income, and cultural tastes correlate. Forms of analysis that make it possible to describe and act upon such multivariate relationships spanning different domains of life ‘tame’ social complexity. A much-discussed study in attribute prediction based on Facebook Likes makes a clear case in point:

Facebook Likes can be used to automatically and accurately predict a range of highly sensitive personal attributes including: sexual orientation, ethnicity, religious and political views, personality traits, intelligence, happiness, use of addictive substances, parental separation, age, and gender. (Kosinski et al., 2013, p. 5802)

One may rightfully interject that the researchers used contestable concepts, for example, concerning gender. But this critique risks missing what makes these techniques so attractive in operational settings: when the task is to make distinctions in a seemingly amorphous mass of customers or other entities, the epistemic objective is not disinterested, conceptually rich knowledge and not even getting classificatory predictions right every time; it is to make (quick) decisions that are more accurate than a coin toss,¹⁰ speculative inferences that produce advantageous outcomes.

¹⁰ There are, of course, many areas where higher precision is required, but this (slight) exaggeration should serve to highlight differences between epistemic requirements.
more often than not. And statistical techniques combined with rich data generally perform much better than that. The above-mentioned study was able to predict gender with an accuracy of 0.93 and sexual orientation with 0.88. In many commercial domains, a level of 0.51 would already be satisfactory. The targeting of advertisement, for example, does not have to be perfect to make it economically viable, merely better than purely random placement. There are many powerful techniques for producing such better-than-coin-toss performance at very little cost and these techniques have the additional benefit of providing an empiricist narrative that includes moments of testability and verifiability when effects, for example on click-through rates, can be directly observed. The integrated digital infrastructures or marketplaces discussed above reward economic actors capable of making even slightly better predictions than their competition.

For all intents and purposes, the technical environments we inhabit have become our ‘real’, and the data these environments generate so effortlessly reflect part of human reality. There would be many caveats to add at this point, but I still propose that we consider the possibility that the masses of collected data are not hallucinatory fever dreams, but somewhat spotty and skewed windows on complex societies that are increasingly grammatized and captured by the very technical structures that produce these data in the first place. Since Facebook is a dominant means for social interaction and organization, the data generated by the platform reveal our societies, at least particular aspects from particular vantage points. But Facebook's capacity to modify user behavior through interface design and algorithmic processing reminds us that integrated infrastructures are more akin to social experiments, controlled environments that can be modified at will, than to settings where sociality is merely observed. In digital spaces, the difference between representation and intervention collapses into a continuous feedback loop. This is why Zuboff (2019) describes ‘surveillance capitalism’, which seeks to derive monetary surplus from the datafication of human experience, as ‘a market form that is unimaginable outside the digital milieu’ (p. 15).

Information ordering techniques acting as engines of order that actively modulate relationships between users and circulating units of various kind operate on existing patterns and fault lines in diversified yet unequal societies. They arrange atomized individuals into ad hoc groups, to the point where ‘the processes of social segmentation become flexible’ (Lazzarato, 2006, p. 182) and follow the operational goals of the moment rather than a desire for stable, disinterested description. Large and small variations
between (datafied) individuals can be read from vantage points tied to specific performance targets, such as longer time on site, higher click-through rates, lower loan default ratios, more productive employees, and so forth, but also integrated into broader activities, such as market research, product development, or strategic planning. Zuboff’s (2019) extraction of ‘behavioral surplus’ is clearly not the only way algorithmic techniques can inform processes of value production, but the combination of infrastructural capture, data collection, and information processing indeed provides distinctive means to know and to act on complex societies on the basis of an empiricism that is epistemically biased in a way that the opposition between ‘objective’ and ‘subjective’ does not apprehend. Algorithmic techniques, just like other forms of mechanical reasoning, provide seemingly impartial ways to pursue deeply partial objectives.

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