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Organizations Decentered: Data Objects, Technology and Knowledge

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Abstract. Data are no longer simply a component of administrative and managerial work but a pervasive resource and medium through which organizations come to know and act upon the contingencies they confront. We theorize how the ongoing technological developments reinforce the traditional functions of data as instruments of management and control but also reframe and extend their role. By rendering data as technical entities, digital technologies transform the process of knowing and the knowledge functions data fulfil in socioeconomic life. These functions are most of the times mediated by putting together disperse and steadily updatable data in more stable entities we refer to as data objects. Users, customers, products, and physical machines rendered as data objects become the technical and cognitive means through which organizational knowledge, patterns, and practices develop. Such conditions loosen the dependence of data from domain knowledge, reorder the relative significance of internal versus external references in organizations, and contribute to a paradigmatic contemporary development that we identify with the decentering of organizations of which digital platforms are an important specimen.

History: This paper has been accepted for the Special Issue on Emerging Technologies and Organizing.

Keywords: digital technology • organizational form • organization and management theory • organizational processes • practice • information technology and systems • organization communication and information systems • digital transformation

Introduction

In this paper, we theorize the relationship between data, knowledge, and organizations. The subject is broad and elusive but also relevant and timely. The urge to confront these matters is driven by the technological advances that characterize our time, neatly outlined in the call for papers of this special issue. The diffusion of digital technologies expands the reach of data and multiplies the occasions by which they are involved in organizations. These developments move data to the centerstage of socio-economic life and make them a widely diffused component of the dealings of social and economic actors. Increasingly, organizational operations across a variety of fields are intermeshed with data derived from the broader internet ecosystem, social media, internet of things-based solutions, commercial and industrial platforms, and the like.[1]

It would seem reasonable against this background to ask what kind of organizational changes do these developments bring about? How do the ubiquity of data and the technologies by which they are managed impinge upon organizations and their environments, diffuse novel objects of knowing and establish new organizational patterns and management practices? The rapidly growing scholarship on these matters is indicative of a widespread sentiment of economic and organizational change of significant proportions (e.g., Bailey et al. 2012, Leonardi 2014, Orlikowski and Scott 2014, Barley 2015, Von Krogh 2018, Faulkner and Runde 2019, Monteiro and Parmiggiani 2019, Zuboff 2019, Østerlie and Monteiro 2020, Alaimo and Kallinikos 2021, Pachidi et al. 2021). In contexts as diverse as manufacturing, police, healthcare, retailing, oil extraction, education, banking or insurance, data are not just important assets but the centerstage of a good deal of organizational processes and the principal material by which critical actions, commitments, and services are made. As data increasingly mediate key organizational concerns (Waardenburg et al. 2018, Kellogg et al. 2020, Leonardi 2021), organizations become immersed in the management of data and by data. Still, we know very little of the organizational patterns, knowledge processes, and

practices with which the production, managerial uses, and commercialization of data are associated.

Data are semiotic artifacts, instruments of knowing (Buckland 1991, Tuomi 1999) used to capture or represent, know, and act upon the world (Bailey et al. 2012, Jones 2019, Østerlie and Monteiro 2020). A history-informed understanding of management practices (Yates 1989) shows data as widely diffused management tools that have over time assumed important functions in office work and administration ahead of the current data "revolution" (e.g., Chandler 1977, Cline-Cohen 1982, Beniger 1986, Miller and O'Leary 1987). As we illustrate in some detail over the next section, data have in the form of various, predominantly paper-based, records served as tools of organizational memory but also as widespread means for controlling and rationalizing clerical and expert work (Zuboff 1988). In this latter quality, they have played a critical role in navigating the uncertainties of the future (March 2006) through their considerable involvement in the making of budgets, plans, or forecasts (Chandler 1977, Yates 1989, Kaplan and Norton 1996).

The diffusion of digital data and advances in the technologies by which they are handled reinforce the traditional functions of data as administrative support tools and means of organizational rationalization. These same developments also qualitatively transform the role of data by virtue of redefining the conditions under which they are produced and shared, used, and managed (Orlikowski and Scott 2014; Alaimo and Kallinikos 2017, 2021; Swanson 2020, 2021). In a wide range of instances, data are no longer a secondary component of administrative support but a pervasive *resource* and *medium* through which organizations come to know and act upon the contingencies they confront (Alaimo et al. 2020b). Examples are furnished by such diverse practices as learning analytics in education, personalized medicine, banking and stock trading, robotics, performance-based contracting in industry 4.0, traffic management systems, reviews and rating systems in online services, reputation and attention metrics in media and advertising industry, recommendation and personalization technologies in digital platforms and social media. Data and the ways they are produced, aggregated, and made to matter pervade most of these fields while their significance keeps on growing continuously.

The relevance of these developments is manifested in the increasing attention which algorithms and AI-based learning systems more generally have received in recent organizational scholarship (e.g., Orlikowski and Scott 2014, Faraj et al. 2018, Von Krogh 2018, Monteiro and Parmiggiani 2019, Kellogg et al. 2020). From a certain point of view, the focus on algorithms is another entry to some of the questions we seek to highlight in this paper. Data and algorithms can certainly be viewed as flipsides of the same coin. It is nonetheless important to remind that algorithms maintain the connection with their surroundings through the data that they are fed. Data are, as it were, the "sensing arms" of algorithms, the means through which algorithms transcend their operational closure as procedures of calculation and link to reality. It is through data that algorithms communicate with their environments, get to "know" and "learn" from what is going on around them. Algorithms without data are no more than mathematical exercises (Gillespie 2014). Although it may ultimately be pointless to contrast data with algorithms, it is worthwhile to stress the patterns by which they presuppose and reinforce one another. The impact of algorithms on organizations, societies, and markets is heavily shaped by the events or stimuli data mediate and thus by the scope, size, and quality of these mediations upon which algorithms operate (Dourish 2016, 2017; Alaimo and Kallinikos 2017, 2021).

Cast in this light, the focus on data offers distinct dividends to the understanding of the technological and organizational developments that mark our time. Such a focus should not, however, be seen as anything else than an analytic strategy. Technology, data, AI, and algorithms are inseparable components of the technological developments that mark our time. Still, meaningfully integrating such a focus on data into the analysis of organizations unravels critical social, technical, and knowledge predilections under which data are produced and used (Zuboff 1988, Bowker and Star 1999). Data, even the most straightforward of them, derive from encoding facts (or what passes for facts, see e.g., Poovey 1998) in ways that reflect specific points of view, functions and technical constraints, systems of knowledge, and objectives (Zuboff 1988, Borgmann 2010, Knorr-Cetina 1999, Tuomi 1999). We conceive of data as *cultural records* to indicate their socially derived nature and, at the same time, signal their objectification to various systems of notation and marking. Data, it should be made clear, exist only as records (Yates 1989, Buckland 1991) and, in this regard, are different from knowledge and information but also other types of signs, oral or natural (Borgmann 2010, Bailey et al. 2012). By cultural records we do not mean records of culture. Rather, we use the term to indicate the social origin of data, dispel a widespread misconception of data as neutral or hard marks (data points) and stress the fact that they are engineered in ways that encode a series of social, technical, and knowledge predilections. Conceiving data as cultural records allows for crossing the divide between the social interests that data encode and the technical functions they perform in and across organizations.

The focus on data furthermore carries the promise of redirecting the analysis to less obtrusive and far

more diffused operations than algorithmic computation that shape the contemporary workplace and organizations more widely (Bailey et al. 2012). Assessing the functions that data fulfil in many contemporary organizational settings requires recognizing that data seldom matter in singular. In a variety of contexts, individual data items are carefully pieced together to larger knowledge entities that we refer to as objects of data or, shortly, *data objects*. Viewed as clusters of individual data items, data objects furnish a layer of meaningful entities upon which further and often elaborate operations are built. Work with data considerably coincides with the making of data objects to a critical medium for representing and acting upon reality. Once established and diffused throughout organizations, data objects become the basis upon which a range of operations are performed (e.g., clustering and analytics) that enable comparison and assessment of individuals and groups over time, and the inference of patterns and behaviors taking place at a larger scale and across contexts. Recommendation and personalization systems, for instance, in online retail platforms and social media operate by aggregating diverse data such as clicks, likes, or ratings into objects such as *users* or *items* that serve as the basic entities for computing similarities and other scores and advance real-time personalized recommendations. What has been called the "algorithmic management" of Uber's drivers is not dissimilar. Such management is essentially enabled by datafied representations of drivers, that is, objects made of data such as rapid acceleration, harsh braking, speed, location, and so on, which in turn allow the constant control and monitoring, indexing, and nudging performed via several connected technologies and applications (Rosenblat 2018, Möhlmann et al. 2021). In these and many other instances, the construction of data objects furnishes the basic reference points around which a good deal of novel processes of knowing and organizational patterns unfold.

These observations should indicate that our paper is predominantly concerned with wider changes that extend beyond particular settings and organizations. There is, undeniably, considerable diversity in the ways these developments are manifested but also recurring attributes that stand out across situations. This paper is about tracing the broader transformations with which such recurring attributes are associated. It shows how data, data objects, and technologies are refashioning the process of knowing in organizations, redefining key tasks and organizational operations and, ultimately, the status of organizations as socio-economic entities.

Over the next section, we undertake a brief historical review of data and the various functions they have assumed over time in the management and rationalization of organizational work. The review helps cast the role of data in a larger time perspective and, the same time, sets the stage for distinguishing the newness of digital data. We subsequently articulate our understanding of digital data and how they change traditional ways of encoding stimuli and representing events. Building on this, we elaborate on the role of digital data objects and show how they become central reference points of organizational knowledge making and action. These ideas converge to a discussion section in which we advance our interpretation of the wider organizational effects of the data revolution. As data objects diffuse throughout the socioeconomic fabric, they loosen the tight grip of domain knowledge over the production and use of data, reorder the relative significance of internal versus external references, and contribute to a widespread contemporary development that we identify with the *decentering* of organizations. The term captures broader and hugely important transformations that challenge our understanding of organizations as relatively bounded socioeconomic entities, marked off from others and from their environments (Santos and Eisenhardt 2005). In the concluding section, we briefly position our contribution within the broader context of organizational research to which we feel it belongs and outline a few suggestions for further research.

Knowledge, Objects, and Data in Organizations

The history of organizations is closely associated with the history of data as records and the various systems of representing, tracking, and controlling organizational operations. Bookkeeping and budgeting, systems of classifying, indexing, filing, and archiving have always been central organizational operations. The production of systematic, mostly paper-based, records has been a vital requirement for rendering organizational operations inspectable and comparable over time and across contexts and deciding about future courses of actions (e.g., forecasting and budgeting). At the same time, organizations have themselves heavily influenced the establishment and development of conventions, techniques, and systems of notation, and the types of data and content such systems have been able to produce (Chandler 1977, Hopwood 1987, Miller and O'Leary 1987).

Viewed in this light, the history and development of information processing systems, knowledge, and organizing are bound up with each other. Writing itself emerged as elementary accounting and record keeping system rather than, as previously believed, a transcription of oral communication (Ong 1982, Goody 1986). Commercial objectives more than social life motivated and established writing conventions and the ways these have been deployed to track and control transactions and exchanges (Beniger 1986). Several important

contributions have highlighted how the development of practices of formal communication and information processing systems within organizations have been heavily depended on data and knowledge objects of various sorts such as documents, order reports, memoranda, memos, and so on (see, e.g., Yates 1989; Cortada 2011, 2019; Ceruzzi 2012; Gitelman 2014). Business historians have provided evidence concerning the rise of modern management and how it has been tied up with the shift in data making practices and related knowledge objects that sought to chart and document processes that occurred within organizations, including the movements of goods and people and the coordination of core production operations which, for first time, took place across organizational units (Chandler and Cortada 2000). The newly constituted class of managers and business administrators created and used internal data as the main language of business and "instruments of management" (Chandler 1977, p. 104).

The need to produce a different kind of data were driven by the industrial revolution and its shifting requirements of control, which in turn helped establish a new breed of management practices and tools (Beniger 1986). Internally generated data and more complex accounting tools developed in tandem with newly established types of organizations such as modern corporations that used these tools to monitor, control, and coordinate workers and the production and distribution of goods. By establishing specific ways of gathering, handling, analyzing, and transmitting data and, over time, providing for further specializations of administrative roles and tools, modern corporations instituted themselves and modern management as well (Chandler 1977, Yates 1989). From this perspective, data records emerge as important preconditions for effective and efficient business administration and, at the same time, as a key medium by which a good deal of management decisions are coordinated and made (Beniger 1986). As Yates aptly puts it "administration without records is like music without notes" (Yates 1989, p. 13).

These ideas suggest that data are cognitive and communicative media that encode stimuli or events in the form of records (Buckland 1991, Borgmann 2010). As records, data are always embedded in specific formats (i.e., alphanumeric characters) and physical bearers (i.e., paper) and used to mark, represent, store, and exchange information or knowledge. Data and the knowledge objects they help construct are essential to organizations. Being intangible, knowing practices require some formalization and physical support to be reproduced, maintained, stored, or communicated. Data have a material embodiment or support, but also a specific format that makes them a unit of expression (syntactic unit) within a broader cultural (semantic) system. The function data and knowledge objects perform is always conditioned by the relationship between their material and conceptual dimension. There is no data, data-making, or data practice without physical embodiment and cognitive and communicative standards, which in turn always stand in a dynamic relationship with existing systems of knowledge (Eco 1976), social contexts, and histories (Borgmann 2010). Knowledge, in one form or another, pre-exists and predetermines the making of data (see also Tuomi 1999; Kallinikos 2007, pp. 52–57; Jones 2019). It is only because there exist certain infrastructural and institutional conditions of knowing that something such as a sample of water can effectively become the sign of rising pollution level or a mark of four letters on paper the symbol of fire (Borgmann 2010, Edwards 2010).

Organizations can therefore deal with intangible entities such as ideas, concepts, or memories only when these are expressed, described, or represented as data or in some other physical way (Buckland 1991). In turn, these *things* become effectively informative because they are backed by a complex infrastructure of knowledge with its institutions, technologies, tools, systems, professions, and interpretative practices (Searle 1995). For much of the history of modern corporations, data as records have been tightly coupled with specific formats, documents, tools and, over time, with the development and systematic application of domain knowledge to a large variety of occasions. In this sense, data records have historically been important tools for the making of knowledge objects and critical for the implementation and use of formal systems of knowing in organizations and society (see e.g., Chandler 1977, Yates 1989, Gitelman 2014).

The fashioning of new knowledge objects out of data started early in the history of modern corporations. Already by late 1850s, for instance, data about profit and loss were deemed not enough to monitor business performance and had to be coupled with newly created objects such as operating ratios, which remain among the basic standards with which managers judge the performance of business enterprises (Chandler 1977, p. 110). Along with documents and graphs, operating ratios belong to the class of objects that have been conceived and studied as knowledge objects (Gitelman 2014). Other examples of widely diffused knowledge objects are furnished by scores, rankings, or ratings in educational and financial settings (Power 1997; Espeland and Stevens 1998, 2008; Espeland and Sauder 2007; Poon 2009), engineering drawings and sketches (Henderson 1991; Carlile 2002; Bechky 2003a, b; Ewenstein and Whyte 2009), project management or strategy tools such as timelines or Gantt charts, Porter's Five Forces, strategic group

maps or the BCG growth-share matrix (see i.e., Sapsed and Salter 2004). Knowledge objects of this sort have always been relevant for the establishment and diffusion of specific social and organizational practices. They have been commonly perceived as social artifacts across a wide and cross-disciplinary literature and variously linked to the making of knowing patterns, organizational configurations, and professional identities (e.g., Appadurai 1988; Barley 1986; Bowker and Star 1999; Knorr-Cetina 1999, 2001).

With the adoption and diffusion of digital technologies in organizations and digitization of records and operations across different domains, the links between data, knowledge objects, and organizational knowing have been refigured. Before the advent and diffusion of digital technologies, knowledge domains, such as accounting or auditing, and the tools or techniques, data and social practices that underlay them had remained tightly coupled. Knowledge practices have been linked to knowledge objects characterized by an integral makeup and relatively long lifespan. As we show in some detail below, the changes introduced by data and digital technologies unbundled knowledge objects and refigured organizational knowing. Some of these transformations have been traced already by Zuboff (1988) who connected data and the advent of the *electronic text* to a paradigmatic shift in the modes and patterns of working, knowing, learning, and acting within organizations. Bailey et al. (2012) have analyzed the nature of data-based representations and unveiled the role of simulations in the remaking of knowledge practices and work relations while Kallinikos et al. (2013b) studied the effects of digitization upon cultural memory institutions such as libraries, archives, and museums. Barley (2015) highlighted the importance that representations, visualizations of data outputs and results, have in conspicuously changing work practices across knowledge boundaries. More recently, Monteiro and Parmiggiani (2019) studied, in the context of marine environmental monitoring, how the digitization of the mapping of physical entities (i.e., marine biomass) and related organizational changes brought about a new way of knowing they call synthetic. Also, Pachidi et al. (2021) documented how the introduction of data analytics in a telecommunication organization brought a dramatic change in what they called the regime of knowing, triggering struggles, and several copying strategies between different types of expertise (see also, e.g., Faraj et al. 2011; Kaplan 2011; Leonardi 2012, 2021; Leonardi and Treem 2012, 2020; Faraj et al. 2016; Sergeeva et al. 2020). Each of these contributions has investigated how social and organizational operations converge on specific knowledge objects, their digitality and materiality, manipulability, and use. In this regard, they provide good antecedents for considering how data and digital technologies support the making of a new breed of knowledge objects, whose materiality and knowledge functions impact upon existing organizational patterns and the process of knowledge making.

Digital Data and Knowledge

Digital data continue the traditions of data as records yet signal a break with traditional record-keeping and knowledge making. Digital data codify real-life stimuli or digitize traditional tokens such as numbers, texts, or pictures in the form of strings of 0 and 1 able to be processed by computers and encoded on electronic signals or magnetic fields, which constitute their physical carriers or material bearers. It may initially be hard to see how these technological and formal attributes of digital data impinge upon existing knowledge objects and management traditions. It is in fact common to consider digital data as innocent transcriptions of cultural records and established modes of representing and signifying. However, the closer examination of digital technology suggests that its *material* and *logical* layers interfere with existing knowledge as they transform the conditions under which knowledge objects are constituted, shared, and acted upon (e.g., scores, rankings and ratings, operating ratios, patient, or customer records) (Faulkner and Runde 2013, 2019; Kallinikos et al. 2013a).

Data are cultural records, human-made artifacts whose main purpose is to store and transmit intangibles such as information and knowledge. However, when transformed into digital bits, cultural records become heavily mediated by and variously entangled with the language and materiality of machines. These last confer data several distinct attributes and establish new conditions for producing, sharing, and making sense of them. Such conditions are, among other things, dictated by the fact that it is possible to produce, access, manipulate, and interpret digital data only via digital artifacts such as application programs and software more generally. The evolving characteristics of digital artifacts together with the configurations of interconnected devices, online network dynamics, and algorithmic learning are only some of the elements of a shifting data production and data management landscape that makes up a complex and novel infrastructure within which knowledge develops (see, e.g., Yoo et al. 2010; Leonardi et al. 2012; Dourish 2017; Faulkner and Runde 2019; Aaltonen et al. 2021).

Being cultural records, digital data are never found or extracted in the way of physical resources but produced by a vast infrastructure of knowing. Yet, in the digital world, the technological infrastructures supporting data making are largely indifferent or agnostic to the content of what is recorded. Indeed, one of the

principles of computer science is to reduce the notion of information to something agnostic, a quantifiable resource (Shannon and Weaver 1944) whose transmission error could be expressed into probabilistic terms and whose production, storage, and potential value could always be optimized via increased computation and technological (or channel) capabilities (Buckland 2017). The content-agnostic approach of machines and computation does not imply neutrality in the modality by which data are made, transmitted, or used (Winner 1986; Dreyfus 2001) or, as the recent literature on critical big data or algorithms has pointed out, in the conditions and consequences of their production (Iliadis and Russo 2016, O'Neil 2016, Eubanks 2018, Noble 2018). Being agnostic and being neutral are not the same thing. Being agnostic means to be indifferent or disregard the content and the context of what is recorded. This is what machines do, even if they can never remain neutral as the engineering and social conditions by which they achieve this encode several predilections.

Nonneutrality in data production can arise from any component in the vast material and symbolic infrastructure of knowledge production. Predilections can be embodied in device design decisions, the path dependencies of existing technologies, established field beliefs, organizational aims, or physical constraints, which severely limit the options of what can be displayed as a digital record and further elaborated as knowledge. As data production becomes ubiquitous and sensor technologies more distributed, embedded in multiple devices and interconnected, the balance between material and symbolic constraints is likely to shift. The constraining conditions that technologies impose on modalities of data production grow often more stringent with time and the path dependencies that accumulate (Bowker and Star 1999, Hanseth 2000). These technological conditions of data and content management contain strong elements of a dynamic that is often at a remove from domain knowledge and the contexts in which specific forms of expertise are exercised. Domain experts such as scientists, doctors, or engineers are often extraneous to the complex and distributed devices and mechanics of data production and called to intervene only at later stages of data processing (see e.g., Bowker and Star 1999, Barrett et al. 2012, Passi and Jackson 2018, Leonelli 2019, Pachidi et al. 2021).

These observations should indicate that the agnostic character of data production, the inbuilt technological constraints, and the formal logic dominating the language of machines unleash the bonds of digital records with the specificities of content and therefore with domain knowledge. Loosely linked to expert categories and guidelines, validation procedures and checks, and supported by an ever-expanding technological apparatus, the language of machines and the conventions of online communication interfere with the contexts of working and living, which have hitherto remained at a remove from these developments (Alaimo and Kallinikos 2017, 2019, 2021). Doctors and medical researchers, for instance, have come to confront data produced by patients through online personal diaries, patient communities, or social media (Kallinikos and Tempini 2014). Prosecutors and police officers nowadays deal regularly with evidence produced for infotainment and information hunting via crowdsourcing platforms (Gray and Benning 2019). Social media data are routinely used to make investment decisions in finance or to compute credit scores for insurance companies (O'Neil 2016). The ways such data are produced represent a break with the traditions, principles, rules, and methodologies of generating medical, financial, or criminal records and remain either black-boxed or at a remove from experts, yet they are routinely embedded into knowledge, decision making, and action (see i.e., Levy 2015, Eubanks 2018, Noble 2018, Waardenburg et al. 2018, Kellogg et al. 2020, Smith 2020).

An important characteristic of digital data are their homogenizing capacity. The increasing datafication (Faraj et al. 2018), that is, the translation of the diversity of cultural codes and conventions (e.g., image, sound, text, etc.) and different information processing systems (e.g., sales, accounting, bookkeeping, archiving, etc.) into the language of machines promotes the homogenization of knowledge and knowledge making (Yoo et al. 2010). When diverse things are rendered as digital data, they are bound to lose part of their distinct make up. They can be stored, transmitted, processed, and made sense of, using largely the same methods and devices. Digital methodologies and modalities of knowing traverse domains and contexts and make data portable, less context specific, and domain dependent. Two effects are worth stating clearly. First, the agnostic character of data production and the formal language of machines contribute to loosening the links between procedures of data making and domain knowledge. Second, these same processes shrink the distance across different, sometimes remote, knowledge and practice domains. Datafication operates under entirely new premises, which are partly derived from the convergence of several technological functions and new technological possibilities and partly from the commensuration of contexts that were previously held at arm's length from one another (Espeland and Sauder 2007). These characteristics of digital data making are briefly summarized in Table 1.

The processes we link to datafication still inherit some of the cultural and social functions of knowledge making, even when data are automatically and

Table 1. Characteristic of Digital Data Production

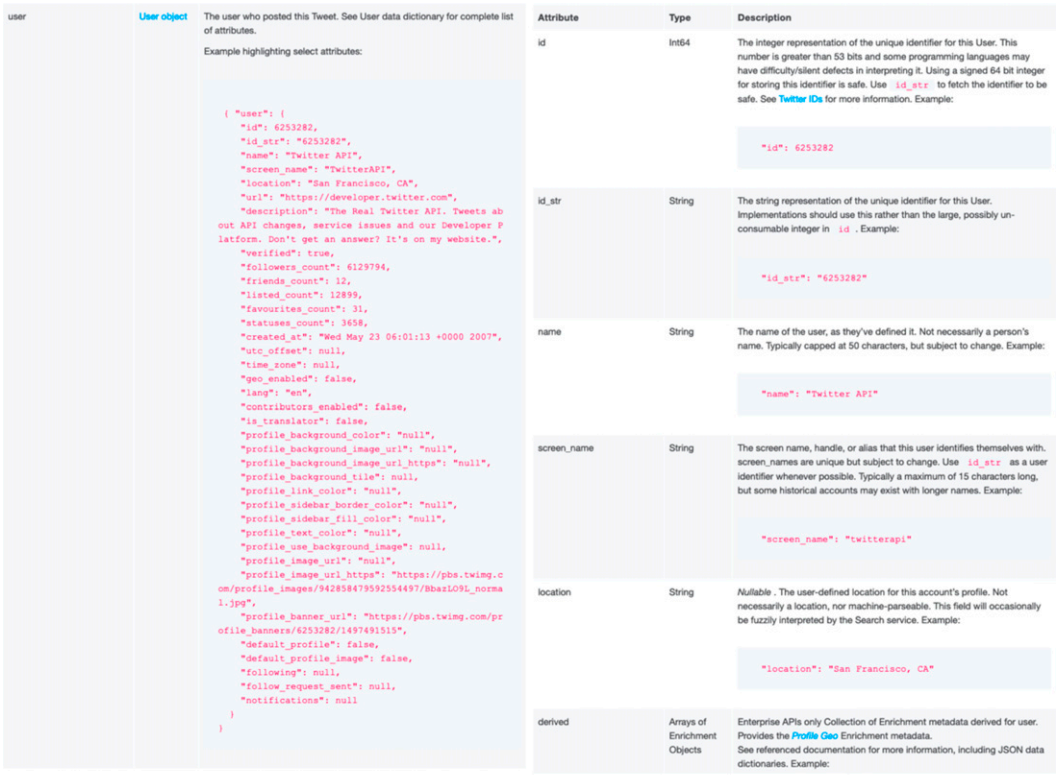
Characteristic	Definition	Implications
Content-agnostic	The machinery of data production is indifferent or disregards the content and the context of what is recorded.	Content-agnostic data production occurs without close reference to domain knowledge such as specific categories and rules, validation procedures, checks, methods, etc., as well as work profiles and experts.
Nonneutral	The engineering and social conditions of recording always entail predilections that are embodied in device design decisions and closely linked to the path dependence of technologies, beliefs, organizational aims, or physical constrains.	Nonneutrality occurs as path dependent technologies, organizational aims, and field knowledge impose their predilections upon the design of devices, practices, standards, and rules of data production severely limiting what can be encoded as data and elaborated as knowledge.
Homogenizing	The translation of cultural conventions (e.g., image making, sound making, video making) and different information processing systems (e.g., sales, accounting, bookkeeping, archiving, etc.) into the language of machines. When everything is digital data, then everything can be stored, transmitted, processed, and made sense of, using the same methods and devices.	Homogenizing shrinks the distance across different, sometimes remote, knowledge and industry domains. A great deal of different types of data can be in principle related, exchanged, and clustered together.

agnostically generated by machine systems (i.e., sensors). For instance, an automatically recorded click needs to be first defined, classified, and labeled as an online transaction and often as a transaction of a particular kind (i.e., a purchase, a click-through on a link, a like, etc.). Classifying an event or stimuli as a record of transactions is a cultural designation that the machine is instructed to do either in advance or on the fly, as the outcome of contingencies whose interpretation is embodied in operations of data processing such as the learning of algorithms. With loose links to context and knowledge domain, the agnostic, nonneutral and massive production of new data can sustain knowledge production and reproduction because it is supported by two interrelated and strongly ingrained expectations. The expectation of constant technological progress—in this case intended as the refinement of technological processing capacity (including machine learning algorithms and AI applications)—and its intrinsic promise that any problem or limitation arising from loss of reference and loss of contextual or domain knowledge at the moment of data production can always be addressed at later stages. Differently from paper-based records that remain fixed in their support, digital data are editable, constantly updatable, portable, and refigurable (Ekbia 2009; Faulkner and Runde 2013, 2019; Kallinikos et al. 2013a; Monteiro and Parmiggiani 2019). The possibilities and promise of constant manipulability of the digital medium change the conditions under which data are produced and processed into new objects of knowledge. They thus contribute to restructuring the knowing process and establishing an emergent knowledge paradigm whereby novel insights and possibilities of action can arise from the continuous manipulations of data rather than from whatever reality purchase and context relevance these data may have.

Digital Data Objects as Instruments of Knowing

The modalities and different conditions that underpin the constant data manipulation, aggregation, and processing we outline above give rise to a whole new breed of entities that were not there before, at least not in their current shape. In their simplest form, these entities are only aggregations of the multiple instances of the same data; for instance, all the clicks of an individual user on a given web page or all the recorded instances of a given sensor embedded in a wearable device. In more complex forms, these objects are configured by putting together different data types under a given structure or shape. We call these entities, as already indicated, (digital) data objects.[2] "Data" because, differently from the wider class of digital (software) objects to which they belong (see, e.g., Kallinikos et al. 2013a, Faulkner and Runde 2019), they are mostly made of digital data and metadata and "objects" because they have a duration, a relative stability, and a structure (Desrosières 1998, Hui 2016, Faulkner and Runde 2019).

Figure 1. (Color online) Example of User Object on Twitter

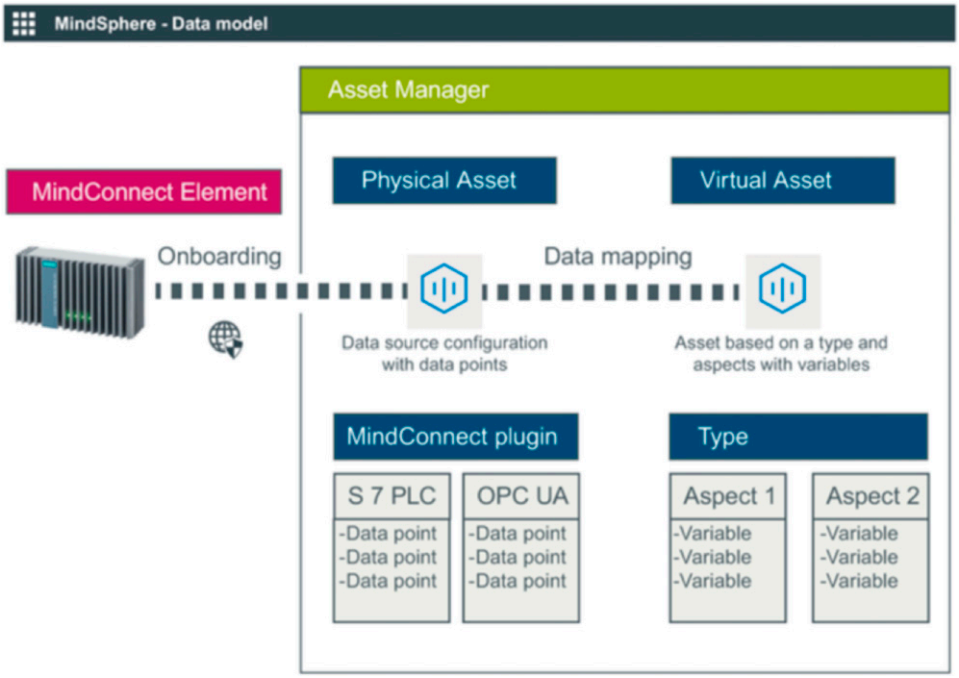


Notes. On the left is the example of a user object with selected and unspecified attributes, on the right the description of attributes (data) composing the objects (partial selection). Available online at https://developer.twitter.com/en/docs/twitter-api/v1/data-dictionary/object-model/tweet and https://developer.twitter.com/en/docs/twitter-api/v1/data-dictionary/object-model/user.

Data objects should be distinguished from software objects (Hui 2016). Data objects are technologically and structurally simpler than software objects. They are brought to being by a structure or schema whereby different data items are put together in a pattern or form. Such data structuring schemas differ from software programs and the painstaking instructions the latter embody. A typical example of a data object is a customer profile, made of several attributes that are themselves clusters of data (i.e., transactions, login data, etc.) structured under a given format. In this sense, data objects differ from software objects and the functionalities underpinning such objects. In the homogenizing world of digital technologies described in the preceding section in which everything is ultimately bits and bytes (that is, data), the difference is admittedly not always clear-cut. Even the simplest arrangement of data requires some sort of instructions as to how to identify, select, and assign tokens to it.

Rather than capturing an underlying essence, the conception of data objects we put forward stems from the function they fulfill in the process of knowledge making in which one or more organizations participate. Data objects and software objects fulfil different functions in the emerging infrastructure of knowledge that is linked to the making and processing of digital records. Although basically technical entities, data objects remain at the same time semantic artifacts, cognitive or cultural constructs, recurring arrangements of data ordered according to certain logics, criteria or schemata that serve cognition and knowledge aims. Data objects are the basic cognitive units, the elemental reality cuts—in the sense Eleanor Rosch and her colleagues attributed to basic objects (see, e.g., Alaimo and Kallinikos 2021)—of a complex infrastructure of knowing, without which other more inclusive perceptions and knowledge management operations would be virtually impossible. Credit scores, user profiles (Figure 1), ad impressions, click-through rates, viewability metrics, lookalike audiences, bid request and response objects in online auction infrastructures, customer profiles, worker profiles assembled from several data logs, assets (virtualized physical machinery), and their aspects (datafied attributes) in industry 4.0 are some conspicuous examples. They are all entities built by data aggregated on the basis of some schema or structure that makes the world legible and actionable in new ways, enabling new work practices within and across organizations.

Figure 2. (Color online) Example of Data Object Created by the Virtualization of Physical Assets (Machines, Engines, etc.) in Smart Manufacturing



Notes. The example is taken by Siemens' MindSphere platform, which has open specifications. Available at https://siemens.mindsphere.io/en/docs/tutorials/asset-manager.

Although data objects inherit many of the knowledge functions of knowledge objects, their digital makeup alters several of these functions. The attributes of data objects, for instance, are heavily mediated by the operative demands of the digital systems and technologies in which they are embedded (Bowker and Star 1999; Hanseth and Ciborra 2007). Their accessibility, both in terms of knowability and operability, is considerably shaped by digital interfaces, computational tools, and interconnected and layered devices. Differently from other instances of knowledge objects, the functions data objects fulfill are heavily overlaid by the technical prerequisites that stem from the fact that they operate as technical components in a larger technological data management infrastructure. Data objects, for instance, are always put together in some standard ways to be machine readable and (inter)operable across systems and devices.

Consider the example of virtualized machinery or "assets" in the context of smart manufacturing (Figure 2). These digital representations of physical machinery (e.g., a pump, an engine) are data objects made of several lower-level data objects that encode facets or operations of a machine, such as for instance energy consumption. Every aspect or attribute is, in turn, composed of several even lower-order data objects (e.g., power, voltage, etc.), which are the aggregates of the numerous and continuous instances of the same data point (the bits recorded as power signals). The making of these objects in manufacturing allows a good enough virtual representation, a digital double, as it were, of the operations of physical machines and furnishes a vital cognitive step toward new knowledge and organizational processes that develop around the monitoring of the performance of these machines. An instructive example of such processes is predictive maintenance—which is not just the effective prediction of when the maintenance should be made but also a profound transformation of the process of maintenance itself.

The capacity of anticipating impending equipment dysfunctions or failures that marks predictive maintenance derives from the possibility of aggregating and combining equipment performance data with data from various systems held within and, crucially, outside the organization hosting the "physical asset." These include, for instance, historic records, enterprise resource planning systems (ERP), manufacturing execution systems (MES), supervisory control and data acquisition systems (SCADA), and distributed control systems (DCS). Data objects are key in allowing a new breed of data-based knowing practices and data management techniques as they structure data in more flexible and scalable ways, overcoming existing data storing techniques (e.g., relational, nonrelational, etc.), specific use (e.g., analytics, predictive maintenance,

etc.) or systems. The introduction of data objects and related technologies (e.g., sensors, IoT platforms, data lakes, APIs, etc.) radically transforms how organizational operations and resources are known and acted upon and changes the role of the actors involved in the process. Differently from traditional maintenance, predictive maintenance is rarely the output of an individual team or even of an individual organization but is rather the result of collaborations and exchanges happening in emerging complex ecosystems. Two aspects of this illustrative example are worth restating: 1) data objects are placeholders of data that make visible and accessible organizational resources in novel ways fostering several novel knowledge and organizational processes, and 2) the consequent changes in organizations dealing with data objects instead of physical assets and novel knowing practices that transcend the confines of existing domains of work and expertise and established organizational boundaries.

In a great deal of contexts, objects of data constitute a firm point of reference, the means through which organizational knowledge and practice develop. They define units of knowledge, provide focus and orientation for action, and circumscribe the ground upon which other organizational and industry operations develop. To provide another illustration, the advertising industry has historically developed around the making of audiences (i.e., access, measurement, and report of viewing, listening, or readership habits, etc.). Advertising audiences today are compiled out of the aggregation of several types of data such as clicks and browse-overs, likes, transactions, and so on. Rendered as data objects, audiences become ubiquitous in the current digital world and one of the most telling examples of the new universe data and data objects bring about. For example, an audience is an entity that has little tangible reality apart from the data that are gathered (often repurposed) and assembled to provide (indirect) evidence of it (Aaltonen et al. 2021). There is no entity such as an audience, without the clustered data (clicks) that make the data object-audience in the first place. At the same time, advertising audiences constitute the reference point on which the activities of marketers, publishers, social media platforms, and other media companies that usually assemble, model, and trade them converge, together with the range of other industry actors concerned with the relevance, facticity, and commercial value of these entities. Data objects not only become the main knowledge object of the industry (i.e., repository of data on audience) but also widely diffused operational units able to execute the main exchanges in the advertising industry. For instance, buying and selling advertising online nowadays coincides with the automated auctions of data objects in real-time. In what is called programmatic advertising, data objects are both the goods being exchanged and the enablers of the practice of exchange, as they embed rules for the automated and real time bidding happening among thousands of disperse actors (Alaimo 2021). Data objects carry all the information needed to complete a deal. What has previously been constituted as a complex process with several objects (i.e., creatives, contracts, audience metrics, and reports, etc.) and several passages between marketers and publishers (and other actors) is increasingly carried out by automated bidding requests and bidding response objects supported by hyper-technological infrastructure of APIs, algorithms, protocols, and platforms. Such developments have radically reframed a good deal of the operations in which advertising is embedded and given rise to new actors, organizational and industry practices that are all mediated by learning and acting with and through data objects (Aaltonen et al. 2021, Alaimo 2021).

These observations attest to the pervasive functions data objects perform and make obvious that the making of data and data objects are closely associated with one another. Yet, they also signal an important difference between, on the one hand, data objects and, on the other hand, the conditions and modalities of data making. In contrast to data procurement or generation that may remain agnostic to their final use, data objects do maintain, in a great deal of cases, various links to domain knowledge and field practices via their attributes (fields or metadata). For instance, as seen in the example above, bid request objects contain several attributes (i.e., audience metrics, prices, modalities of ads delivery, and formats of creatives) through which data objects dynamically interact with their data environment (i.e., acquiring data related to the attribute, responding to other objects' attributes). This makes the function these objects perform particularly relevant. Data objects operate as mediating cognitive devices between the agnosticism of data production analyzed earlier and the broader context within which these data are required to work. By structuring the (often) unstructured, dispersed, fragmented, and continuous data flows of several data types, data objects re-establish a connection between data records and the novel infrastructure of knowing they help construct. The utility and instrumental involvement of data objects are centrally linked to their capacity to monitor things and activity patterns in real time, summarize and respond to the perpetually shifting contingencies that are characteristic of the current world. Data objects thus help address the cognitive hurdle arising from constant change (objects made of data aggregates are never the same) and the continuity needed to coordinate action (a schema of an object made of data has some *durability*). In this

Table 2. Data Objects

Definition	Digital form	Knowledge functions	Examples	Knowledge and organizational processes
Structured entities with a lifespan (duration) composed by aggregated data, which are organized according to a logic or schema	Belong to the broader class of digital objects as they are based on digital technologies and composed of digital data. Present the same characteristics of digital objects such as malleability, openness, editability, generativity, etc. (as in Kallinikos et al. 2013a, Faulkner and Runde 2019). They structure and standardize data to make them machine readable. Differ from digital (software) objects as they are made mostly of data and metadata (rather than programming functions) and because they serve different functions.	Belong to the broader class of knowledge objects, sharing the characteristics of being abstract, question generating and incomplete or expandable (as in Knorr Cetina 1999, Miettinen and Virkkunen 2005). Function as basic objects, the intermediate cognitive entities that link singular events (i.e., data) with more complex categories (i.e., data outputs such as predictions). Constitute central elements around which knowledge practices and organizational and industry operation develop (i.e., credit scores or advertising audiences). Work as mediating cognitive devices between the agnosticism of data production and domain or contextual knowledge. Constitute mediating devices between ideas or schemas and their realization or instantiations. Work as boundary objects mediating between different knowledge communities or expertise. Differ from epistemic objects as their digital materiality considerably alters their knowledge function and the role they play in the whole architecture of knowledge.	"Assets" of virtual machinery in smart manufacturing (digital twins or digital doubles). Profiles (users, customers, workers, such as "drivers" in Uber, clients, patients in online medical communities, stores, etc.). Products or exchange entities in various settings such as "tweets" in social media, "ad impressions" in advertising, audiences in advertising, "artist names" or "tracks" or "playlists" in social music platforms. Composite objects (made by data and metrics) such as credit scores, popularity indexes, click-through rates, viewability metrics, etc.	In all these cases, data objects are not the final output but an intermediate step on to which other more complex organizational processes develop. Some of these processes are, for instance, prediction, forecasting, monitoring, nudging, exchange.

sense, they operate very much like basic objects in categorization schemes, which are middle range constructs that reduce the variability of the world yet deliver entities concrete enough to aid perception, knowledge sharing, and action (Rosch 1975; Rosch et al. 1976). Data objects work as the building blocks of more abstract categories (Hui 2016). These ideas are summarized in Table 2.

In the online settings of music streaming platforms, to give yet another illustration, data objects such as artist names composed of aggregations of user play track data operate both as basic objects from which

more complex categories such as similar artists or popular artists are derived and as boundary objects allowing massive collaboration through the platform and its community of developers, partners, and users (Alaimo and Kallinikos 2021). Artist names are also the central entities in the recommender systems used to personalize music discovery, that is, advance individualized suggestions. The making of such data objects shape music knowledge genres and categories together with the possibilities of browsing and playing music. Users online can see and listen to artists only if they have been correctly *datafied* into objects by the system. Yet, on music streaming platforms, this happens by converting user listening behavior into data, pointing to a self-reinforcing cycle of knowledge production about music that appears to be substantially different from the socialized and culturally embedded traditional process of music listening. These shifting knowing processes have conspicuous and ramified economic and organizational consequences. Music producers, for instance, are adjusting the length specification of music tracks to better fit online requirements. Data objects become the entities through which different actors and communities work together and collaborate in a newly defined space of collective action. Knowledge objects have been variously studied in their functioning as boundary objects allowing collaboration between different experts and communities (see i.e., Star and Griesemer 1989, Ewenstein and Whyte 2009, Star 2010, Barley et al. 2012, Barley 2015). Yet, data objects express this boundary function differently as the formal nature and standardization of digital technologies alter considerably the knowledge processes they enable, the actors they participate in these processes, as well as the patterns of their collaboration (see, e.g., Passi and Jackson 2018, Monteiro and Parmiggiani 2019, Aaltonen et al. 2021, Alaimo and Kallinikos 2021, Pachidi et al. 2021).

Discussion: The Decentering of Organizations

The ideas put forward so far suggest that the ongoing entanglement of digital technologies with data marks a decisive turn in the ways knowledge is produced and put in use within and across organizations. Widely disseminated, aggregated, and embodied in digital data objects, digital data increasingly infiltrate the process of knowing and redefine core operations in organizations. In this section, we synthesize and further develop these ideas. We begin by outlining the *unbundling* of the strong ties that the production and use of data have traditionally maintained with domain knowledge, and the role data objects are called upon to play in this process as instruments of data structuring and, ultimately, knowledge management. We subsequently move on to linking this unbundling with an epochal development that we identify with the *decentering of organizations*, whereby the managerial predominance and constitutive role of internal and, largely, well-defined data sources (Chandler 1977, Zuboff 1988) are challenged and modified. As claimed in the introduction, we approach these matters with the objective of identifying a few essential attributes of the restructuring of the process of knowing and its organizational implications that stand out across contexts and situations and bespeak organizational changes of larger proportions.

The Anatomy of the Knowing Process

We have earlier maintained that the creation and use of knowledge objects have been bound up with the specific knowledge domains to which such objects usually belong (see, e.g., Henderson 1991, Bowker and Star 1999, Knorr-Cetina 1999, Carlile 2002, Ewenstein and Whyte 2009, Monteiro and Parmiggiani 2019). Operating ratios pertain to accounting, credit scores to finance, patient records to medical practice and healthcare, to mention a few obvious and widespread specimen of knowledge objects. Thus viewed, knowledge objects are the epistemic tools by which areas of the various types of domain knowledge that infuse organizations are concretized and instrumented, and consistently applied across a range of situations (Nelson and Winter 1982, Winter and Szulanski 2001, March 2006).

Knowledge objects trigger their own information needs. Under the circumstances in which the process of knowing is mediated by knowledge objects, the production of data must be resonant and broadly compatible with the operational specifications of the models and techniques that knowledge objects embody. Operating ratios call for accounting data of certain type, credit scores data about repayment histories and other personal and occupational details, patient records data of patient histories and examination results. In other words, the type of data required to accommodate the demands of the expert areas in which they are used have been bound up with the knowledge objects they serve and, by implication, the institutional entities (e.g., corporations, public agencies, professions) and sectors in which these objects are usually embedded. In this sense, data and knowledge objects have been closely linked with one another and centrally implicated in the construction of organizations. As explained earlier in this article, modern corporations arose when "internally generated data became instruments of management" (Chandler 1977, p. 104).

The developments we pinpoint in this paper are symptomatic of wider changes in the epistemic significance that knowledge objects have assumed in the process of knowing and the functions they have

performed in organizations. The diffusion of digital data and the structuring involvement of digital data objects unbundle the tight compound in which *domain knowledge*, *knowledge objects*, and *data* have traditionally been embedded (March 2006) and reinscribe the use of internally generated sources of information in a context marked by the ubiquity of external and miscellaneous data types (Weinberger 2007, Alaimo and Kallinikos 2021). Data collection, procurement, or acquisition are often conducted on premises that are disjointed from and rather loosely connected to prescriptive specifications derived in advance from knowledge objects, existing knowledge domains, and clearly defined organizational objectives. There are, of course, differences between industries, practice fields, and organizations as regards the intensity and depth of the disjunction between data, knowledge objects, and domain knowledge. At the same time, it is hard to deny the shifting conditions under which data are currently generated, repurposed, and exchanged, and the concomitant knowledge role that the structuring and use of data in the form of data objects assume across a variety of settings (O'Neil 2016, Bechmann and Bowker 2019, Smith 2020, Alaimo and Kallinikos 2021). As already indicated, in a great deal of situations characteristic of the current world, data and information reach social actors and organizations from sources and via routes with which they have little involvement, insight, or control. Data produced by sensors and IoT-based solutions across a large variety of occasions, internet site clicks and browse-overs, records of orchestrated transactions in retail platforms, stylized forms of user interaction on social media (e.g., reviews and ratings, tweets, likes), or equipment utilization and performance records in industrial platforms are increasingly laid upon internally generated data sources in organizations and used for a variety of purposes. As they gain momentum, these developments relax the tight grip that established types of domain knowledge (e.g., accounting, marketing, human recourses, engineering, and operations management) and its objects have traditionally maintained over internally generated data in organizations and redefine the process of knowing (Bowker and Star 1999, Kallinikos and Tempini 2014, Monteiro and Parmiggiani 2019, Pachidi et al. 2021).

It is against the background of these conditions that digital data objects emerge as tools of knowledge management that afford bridging the gap between the massive, agnostic, and standardized nature of digital data and the knowledge purposes such data can be made to serve in and across organizational settings. As repeatedly noted over the last two sections, data objects inherit important functional, social, and knowing attributes of knowledge objects. After all, data objects are social and cognitive entities used to bracket smaller or larger areas of reality in ways that enable consistent attention, monitoring, control, comparison, and intervention. At the same time, the technological nature and formal attributes of data objects transcend the embedment of knowledge objects within established knowledge domains and carry much of the granular, agnostic, homogenizing, and standardized attributes of digital data at the heart of the knowing process in expert settings and organizations.

In this regard, data objects are critical to the unbundling of data from knowledge objects and domain knowledge, and a driving force that lends that unbundling its functional importance. The specifications on the basis of which data objects operate are generic enough to allow the structuring of data along lines that enable a large variety of posterior uses (Yoo et al. 2010, Aaltonen et al. 2021). Data objects are functionally and epistemically under-determined. Rather than dictating in advance the type of data they need to draw upon, as it happens with traditional knowledge objects, the schemas of data objects are generic enough and are called upon to perform only an elemental ordering of the prevailing variety of data. Such ordering is a vital requirement for a variety of posterior purposes that such objects serve through further, and predominantly, machine-driven data operations of aggregation and calculation. In this regard, data objects work as intermediate entities that address the unbundling of data from knowledge objects and domain knowledge and a force that drives that unbundling.

Structural Implications

An inevitable outcome of the shifting process of knowing described above is the considerable augmentation of stimuli that derive from sources external to organizations or from circumstances beyond their immediate control. The disjunction of the process of data generation from knowledge objects along with the making of data objects to key instruments of data aggregation and management expand the range of potentially relevant stimuli and push the centerstage of organizationally relevant events from internal to external contingencies. A good deal of the references (selected stimuli) through which organizations decide about themselves and their environments, and conduct their operations, are no longer generated internally (Chandler 1977, Mintzberg 1979, March 2006) nor do they predominantly stem from internal considerations or constituencies (Luhmann 1990, 2002; Von Krogh et al. 1994; Roos and Von Krogh 1995; Kallinikos 2005). Across a variety of circumstances, such references are increasingly other-made than self-made, deriving from data generated in a much broader, dispersed, and fractured institutional and social space.

The novelty of these conditions stems from the fact that such a space can hardly be understood in terms of surrounding circumstances that occur in the neighborhood of a well-defined unit, as it has often been the case in the past (see e.g., Thompson 1967, Aldrich and Pfeffer 1976, Nelson and Winter 1982, March 1994). The developments we refer to do not make up an environing or enveloping area. They do not constitute a contiguous, as it were, field that extends beyond a relatively well bounded and concentrated set of operations that are supposed to make up an organization. The declining role of traditional knowledge objects, the profusion of digital data and the widespread availability of digital data objects as technologies of knowledge and control jointly drive organizations far beyond their proximate environments and familiar range of activities. The most characteristic illustration of such a state of affairs is the frequent migration of organizations across fields and industries previously separated from large knowledge gaps, different technological conditions and distinct managerial capabilities. Organizations such as Apple, Google, Facebook, or Amazon, to name a few prominent examples, have in their relatively short lifespan crossed several times the boundaries of far distant industries and activities. Such shifts are more frequent than it may originally seem and reflect the relatively smooth crossing of the knowledge, technological and institutional boundaries that have normally separated industries, fields, and organizations that current technologies enable (Henderson and Clark 1990, Kallinikos 2007, Yoo et al. 2010, Adner 2017). Changes of this sort are indicative of the unbundling of knowledge we described above and pervasive, bringing about what we conceive as the *decentering* of organizations. We deploy this concept to refer to the scattered and fractured constitution of economic, social, and technological space in which an increasing number of organizations operate and whose shifting contingencies they need to address.

The developments we associate with the decentering of organizations converge to a change of paradigmatic import that has so far been observed and studied in conjunction with commercial, often multisided, platforms (McIntyre et al. 2020). It has predominantly been approached from the horizon of economics and framed in terms of the transition from the internal conditions of the *supply economies of scale* characteristic of many organizations of the industrial and early information age to the external conditions of *demand economies of scale* of the mature information economy, marked by the value-reinforcing dynamics of network effects and increasing returns to scale (Arthur 1994, Shapiro and Varian 1998, Parker et al. 2016a). Parker et al. (2016b), in particular, have gone at some length to showing how these developments turn firms upside down, invert or reorder the relevance and significance of internal (supply) versus external (demand) stimuli. On their account, commercial platforms are inverted forms of traditional firms (markets qua firms), geared to accommodate the dispersion of demand and several, frequently shifting stakeholders that use the platform to pursue their own interests. These economically derived arguments are, no doubt, insightful and indicative of the developments we associate with the decentering of organizations and the radical inversion of the significance of internally versus externally generated sources of reference, knowledge, and capability building. At the same time, the economic developments Parker et al. (2016a, b) pinpoint are only specific instances of wider and deep-going transformations, whereby organizations, beyond the private service firms on which they focus, are constituted and managed.

Such transformations, we suggest, can hardly be captured apart from the qualities of digital data and the making of digital data objects to pervasive instruments of knowledge, action, and control analyzed throughout this paper. The rendition of real-life events to digital data liquifies and transcends their intrinsic constitution (Monteiro and Parmiggiani 2019) while the use of digital data objects as the technology through which data are arranged and managed further amplifies this process. This is how such diverse things such as equipment dysfunctions, health status, cultural taste or reputation can all be read from data comparisons that data objects afford. Although such readings often derive from data taken from different regions of the real, the data methods by which they are arrived at and managed are largely similar across these regions. Viewed in this light, data and data objects are vehicles of difference crossing, instruments through which the intrinsic constitution of material and institutional worlds can be transcended. The demand economies of scale that Parker et al. (2016a) suggest invert the firm are just instances of this *isotropic*, as it were, space in which the differences between unlike kinds of things and distances between remote and proximate events are cancelled out or rendered traversable (Borgmann 2010).[3] There are, of course, limitations to that process stemming from the variety of data formats and standards, lack of interoperability but also entrenched interest and cultural inertia (Hanseth et al. 1996, Bowker and Star 1999). History and experience nonetheless suggest that these limitations are possible to lift or, at least, moderate and deal with (Bowker and Star 1999). Like money and quantification that traverse the intrinsic value of things (Porter 1995), data and data objects are instruments of worldmaking (Goodman 1978) that bring about the collapse of institutional distances, the restructuring of interests and the redefinition of cultural habits. In this regard, they contribute to the making of a

commensurable space in which radically different instances (activities and goods) become *potentially relatable* and possible to be brought to bear upon one another (e.g., Espeland and Sauder 2007, Kallinikos 2007). These are the essential foundations of the process of decentering of which commercial platforms are just specific instances.

These predominantly macro-organizational concerns carry important implications for what has commonly been understood as the process of organizing (Weick 1979). Linked with the shifting anatomy of knowing we described above, the decentering of organizations is after all tied to their behavioral and institutional foundations and the ways work is carried out and managed in what can still be perceived as an internal space of authority relations, learning and decision making, interaction and role playing, skill and capability nurturing, and team and community building (Kallinikos and Hasselbladh 2009, Bailey et al. 2010). Our analysis of digital data and the illustrations provided in the preceding section suggest that datafication and what it entails contribute to essentially transforming the production process to a token-based knowing process (Zuboff 1988, Knorr-Cetina 1999, Alaimo and Kallinikos 2021) while intertwining internal and external events in novel ways that are still poorly understood (Von Krogh 2018, Faraj and Pachidi 2021). We have in this discussion section and, as a matter of fact, in the entire paper sought to outline the routes along which this happens. The exact articulation of how internal and external events bear upon one another raises tricky empirical questions that require protracted involvement in particular settings. Yet such a task can hardly be fruitfully pursued, we suggest, without due attention to the anatomy of the knowing process, the attributes of digital data and the conception of organizations as collections of a rather limited number of digital data objects that bracket facets of reality and constitute essential entities and relations of current organizing (Bailey et al. 2010). Our own empirical work (Alaimo and Kallinikos 2017, 2019, 2021; Alaimo et al. 2020a; Alaimo 2021) suggests that much of organizing unfolds around the modicum of stability provided by several (a few dozen or so) data objects and the ways they help glue together the many and separate pieces that define a knowing process in which the generation and use of data are not any longer a subchapter of domain knowledge and its objects.

Concluding Remarks and Open Questions

Data have so far been little theorized in organization studies, despite a broad awareness of the historical significance they have assumed in the constitution of organizations (Beniger 1986, Yates 1989, Chandler 1977) and a recent and quickly mounting interest concerning their impact on sciences, society, and economy (e.g., Leonelli 2014, 2019; Zuboff 2019). In this paper, we have sought to reintroduce the relevance of data into the analysis of organizations and show how the complexity and multidimensionality of data as cultural, epistemic, and technical artifacts are currently involved in important and far-reaching organizational transformations. We have associated the profusion of data along with the technologies and technology-based methods by which they are assembled and managed to the rendition of the process of production as a token-based knowing process. In turn, such a rendition, we have claimed, carries paradigmatic implications that we subsumed under the rubric of the decentering of organizations, whereby externally generated data sources and the huge variety of stimuli they encode infiltrate and restructure an increasing number of organizational operations.

Despite the painstaking analytic argumentation we have pursued, we are sharply aware that we have provided no more than a portrait of current organizational changes in brush strokes. The fuller exploration of these epochal changes can hardly be the product of a single article nor the achievement of two people alone. We do believe, however, that the analysis we have pursued responds to a timely need to give technology-linked organizational changes in general and data in particular the attention they deserve. As we keep concluding this paper, it may be worthy reminding that our focus on data differs from and in certain ways challenges current research on algorithms and other AI-based systems that have so far reclaimed much of the interest on these matters but also provides a much-needed complement to this research. The focus on data and data objects as critical components of the knowing process discloses an impressive gamut of operations that pervade technologically driven change in organizations and which otherwise risk being black-boxed and overlooked. Data in the form of data objects shape the outputs of algorithms and other AI-based systems and are implicated in their learning from "experience" by providing the epistemic or cognitive lenses, which these technologies use to "optimize" and "reshape" themselves. The link between data objects and algorithms and other AI-based systems in organizations needs of course further investigation and, crucially, empirical research that can trace and unravel the multiple ties they maintain with one another. This fertile area of research has to some degree been obscured by the lively interest on algorithms and machine learning technologies, and the phenomenal plausibility these last obtain as likely and discrete sources of social and organizational change. In this regard, research on data and data objects contributes to restoring a missing balance. It

also provides the opportunity for avoiding the looming reification of these technologies and focusing on, rather than circumventing, the detailed fabric of operations their involvement in organizations brings about.

The focus on data and the knowing process as technological accomplishment furthermore reopens the toolkit of organization theory positing more than one challenge to longstanding conceptions of knowledge, collaboration, learning and action in organizations (Von Krogh et al. 1994, Zammuto, et al. 2007, Leonardi and Barley 2010, Bailey et al. 2012, Faraj et al. 2018, Von Krogh 2018). How do organizations learn? Who learns and who adapts? Which are the units of meaningful action when technologies and technological operations reclaim extensive areas of human expertise and social interaction? As the tight compound of formal knowledge is unbundled and increasingly distributed and dispersed, the architectures of control shift from within to across organizations and institutional fields, raising several critical questions. How are organizational boundaries maintained in the face of these changes and organizations collaborate in the isotropic space of a commensurable reality that annuls established industry, operational and institutional distinctions? How are the persistence and identity of organizations guaranteed under the disperse and shifting conditions we have associated with the decentering of organizations? All these issues, we admit, need be addressed by considering the entire gamut of emerging organizational transformations, practices and knowledge processes that are linked to the composite constitution of data as technical, epistemic, and cultural artifacts and their unprecedent diffusion across most walks of personal and institutional living.

Endnotes

[1] It should be obvious from these remarks that our focus is predominantly on digital data. Like most ongoing discourses on digital data, we use the term "data" rather than "digital data" throughout this article. There are however a variety of occasions in which our use of the term extends back to the historical conditions that have antedated the advent and diffusion of digital technologies and digital data, and times in which we use the term to refer to data as a generic label that includes both digital and nondigital tokens. The difference is most of the times evident from the context in which we discuss the role of data and their importance for organizations. When this is not straightforwardly evident, we use the qualifier "digital" to forestall misunderstanding. This may not be an optimal solution, but there would not seem to be a silver bullet, so to speak.

[2] To avoid a rather awkward repetition, from this point onwards in this section we use the simpler composite term "data objects" instead of digital data objects. See also the preceding footnote.

[3] It may be worth pointing out that the value-reinforcing dynamics of network effects is an information and communication-based process (see, Shapiro and Varian 1998). Network effects emerge as things or events cross the specific regions to which they belong and become relevant or meaningful for large crowds.

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