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ORIGINAL RESEARCH

Algorithms and Organizing

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Algorithms are a ubiquitous part of organizations as they enable, guide, and restrict organizing at the level of everyday interactions. This essay focuses on algorithms and organizing by reviewing the literature on algorithms in organizations, examining the viewpoint of relationality and relational agency on algorithms and organizing, exploring the properties of algorithms, and concluding what these mean from an organizational communication viewpoint. Algorithms need data to be collected. The data are always biased, and algorithms exclude everything that is not in their code. They define what is seen as important. Their operating principles are opaque, and they are political due to human interference. Algorithms are not just used. Rather, they are co-actors in organizing. We argue that algorithms demand rethinking communication in the communicative constitution of organizations and call for more empirical research emphasizing the properties of algorithms, the relationality of algorithms, and the temporality of the materialization of algorithms.

Keywords: Agency, Algorithms, Artificial Intelligence, Communicative Constitution of Organization, Organizational Communication, Materiality, Organizing, Relational Agency, Sociomaterialism

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We live in a technology-imbued world. The rapid development of the use of big data and smart algorithms makes the questions related to technologies increasingly important at all levels of society, from political decision-making to startup businesses. Different kinds of digital platforms utilizing algorithms play a fundamental role in organizing in the 21st century. These algorithms enable, guide, and restrict organizing from the beginning as well as at the level of everyday interactions from both inside and outside of an organization. They can blur the borders of formal organizations, affect working methods, or even define the existence of a company. Algorithms have impacts on several organizational aspects. For example, they affect decision-making at the strategic and managerial level, but they also affect workers' everyday routines, such as how an Uber driver selects their routes, how a

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salesperson meets their customer, how newsbites are formulated and published on the web, or who a translator asks for help in a problematic situation.

The effects these new technologies have on organizations depend on the technology itself but also on the ways people respond to, perform with, and adapt to that technology in a certain context (Leonardi, 2012). In popular discourse concerning algorithms, artificial intelligence (AI), human discussions with AI, automatization, and robots have all captured the attention of journalists, scholars, and individuals concerned with whether there will be jobs for humans in the future. Furthermore, legal and ethical issues have been under scrutiny. The effects of algorithms on the level of organizations and everyday work have yet to be discussed as intensively. This is also true in the case of organizational communication processes as a whole—especially with the relational aspects of communication—which algorithms are in some way a part of; some of these processes are not fully understood or even recognized.

We argue that there are specific reasons why organizational communication scholars should be interested in algorithms and the properties of algorithms by examining the effects of these on organizing. Our viewpoint is one of relational agency, and our premise is that everyone and everything mediates something in relation to someone or something (e.g., Kuhn et al., 2017; Cooren, 2020). Thus, algorithms communicate to us, through us, and for us. However, we argue that recognizing this is only one side of the coin. It is important to gain an understanding about what algorithms are in fact capable of mediating in the first place, and this must be answered before one can ask about how they perform this mediating.

From our viewpoint, grasping the operating logics of algorithms is useful for organizational communication scholars who truly want to understand algorithms in their studies regardless of whether they study communicative processes at the micro, meso, or macro level. This is because these operating logics affect communication itself at all these levels. We claim that to comprehensively understand the part algorithms play in organizing, they should be studied as part of *all* communications that constitute organization. In other words, focusing only on algorithm use or algorithms in explicit action downplays crucial parts of their effects on organizing. It is the mere existence of algorithms that makes a difference in organizing in current organizations; "software was formerly embedded in things, but now things—services as well as physical objects—are woven into software-based network fabrics" (Kenney & Zysman, 2016, p. 64). This is why scholars should be interested in algorithms.

In this essay, we will define algorithms and argue for focusing on the concept of an algorithm, review the literature and theories on algorithms in organizations, take a stance for relational agency, and conclude by presenting a research agenda for studying algorithms and organizing. To sum up, the aim of this essay is to argue for the overall importance of the study of algorithms in organizing and to provide a theoretical viewpoint for studying algorithms as part of *all* communications that

constitute organization by focusing on relational agency and on certain properties of algorithms.

Concepts of AI and Algorithms

AI embodies a wide variety of applications, tools, and techniques (Jarrahi, 2018), and thus defining it as a concept can also have different kinds of emphasis, from a human-centered to a rationality-centered focus where empirics and mathematics and engineering are involved in different ways (Russell & Norvig, 1995). Often, a distinction between weak/narrow and strong AI is mentioned especially in AI research. Weak, or narrow, AI refers to a computer or program that follows a program or action based on input and that uses algorithms and programmatic responses to simulate intelligence (al-Rifaie & Bishop, 2015). Strong AI refers to systems that try to mimic the human brain: The higher-level thinking capacity and, for example, decision-making (al-Rifaie & Bishop, 2015). Despite the variation between practical and theoretical AI implications, it is made up of algorithms. Furthermore, currently, strong AI is quite rare in organizing; this is even though smart and learning algorithms in the form of weak AI have become ubiquitous in organizations (Glaser et al., 2021). Therefore, we use and focus on the term algorithm in this essay.

How an algorithm is defined depends on the perspective, and the definition can serve different epistemic purposes (Ferrario & Loi, 2021). According to the Cambridge Dictionary, an algorithm is a "set of mathematical instructions or rules that, especially if given to a computer, will help to calculate an answer to a problem." Algorithms are mathematics and code functioning as problem-solving tools for many purposes, such as giving recommendations, selecting the best candidate, predicting sports results or weather, and so on (O'Neil, 2016). This view aligns with organizational purpose; the common benefit organizations see in algorithms is that they are often used as mathematic rules, or *precise recipes*, enhancing or facilitating problem-solving and decision-making.

In research, algorithms are defined as autonomous computational tools used to enhance organizational capabilities and efficiency that may also result in negative consequences (Glaser et al., 2021). The definition can become more analytics-based when algorithms are defined as "computer-programmed procedures that transform input data into desired out-puts in ways that tend to be more encompassing, instantaneous, interactive, and opaque than previous technological systems" (Gillespie, 2014, p. 167). Although the significance of algorithms to organizations and organizational studies has been noted, their conceptualization is still at least partly limited in the algorithmic process itself and does not enable a full understanding and theorizing of the complex and often invisible influence algorithms have on organizations and organizing (Glaser et al., 2021). However, emphasizing the algorithmic process as a precise recipe is important when studying algorithms in organizations. We

argue that it is important to understand the algorithmic process, the relationality of algorithms, and many roles/meanings algorithms have in organizing.

Algorithms in Organizations

Theoretical Perspectives on Algorithms in Organizations

The biggest umbrella theory over the research on algorithms in organizations is the general view of sociomaterialism. From a sociomaterialistic viewpoint, organizing is an interplay between the social and the material, and these two should not be separated from one another (Orlikowski, 2007). Thus, humans and algorithms are seen as intertwined parts of the same reality, and they should be analyzed as hybrid forms of existence. There are different approaches to analyzing the sociomaterial reality of organizations. One of the most common ways is to categorize these approaches into relational ontologies or agential realism (strong sociomateriality) and substantialist ontologies or critical realism (weak sociomateriality) (for an overview, see Cecez-Kecmanovic et al., 2014; Cooren, 2020; Putnam, 2015). Relational ontologies assume that different entities exist or materialize only in relations, and, thus, the social and the material are fundamentally inseparable, whereas substantialist ontologies assume the social and the material to exist as separate entities that interact with each other (Cecez-Kecmanovic et al., 2014). For example, the relational viewpoint of Orlikowski and Scott (2015), built on Barad's (e.g., 2003) agential realism, focuses on the mutual entanglement of discourse and the material, meaning their existence is conjoined; practices and performativity are the most important focus in studying this relationship (Putnam, 2015). Furthermore, the substantialist viewpoint of Leonardi (e.g., 2011) focuses on the imbrication of human and nonhuman agencies together comprising organizations. Leonardi's viewpoint is one of affordances, and it also focuses on the restrictions of technological agencies. However, empirical studies on affordances have focused more on the affordance part of technologies instead of their non-affordances (e.g., Jarrahi & Nelson, 2018).

Recently, following relational thinking, Cooren (2018a, 2020) has criticized earlier sociomaterial studies from a communicative viewpoint. According to Cooren, previous theorizing concerning the social and the material has not been able to reach the main premise of sociomaterialism; that is, the social and the material should not be separated from one another. According to Cooren, terms such as entanglement (Barad, 2007) and assemblage (Orlikowski, 2007) substantiate the dualism they try to disprove. In this essay, we stem our argumentation from Cooren's (2018a, 2020) theorizing. More generally, our theoretical stance is the Montreal School of Communicative Constitution of Organizations (CCO). From the CCO perspective, communication constitutes—creates, generates, and sustains—organizations and organizing. This constitutive perspective opposes the so-called container metaphor, which sees communication as something that takes place *within* organizations either as a tool or as distinct processes (see Brummans et al., 2014).

Often, CCO is divided into three different schools or approaches: the Montreal School, the Four Flows School, and the Luhmannian Social Systems School (Brummans et al., 2014). Our theoretical approach is that of the Montreal School, so we only elaborate it here, from the viewpoint of relationality and agency, following the argumentation of Cooren (2018a, 2018b, 2020).

Cooren's (2020) relational approach starts from the premise that sociality and materiality are *properties* of all that exists. The focus should then be on the processes of materialization, which means "ways by which various beings come to appear and make themselves present throughout space and time" (Cooren, 2020, p. 1). Cooren puts equal weight on the transmissive and constitutive dimensions of communication because they, respectively, contain the relational dimension of organizing/organization and highlight how through these relations organizations materialize and organizing takes place. This means there must always be a channel, or a mediator, in communication. Thus, beings are experienced *through* something or someone that make them present (Cooren, 2020). In current organizations, algorithms are important mediators for many actions, messages, and meanings. Cooren (2020) concludes his theorizing with three stances. Firstly, everything and everyone existing are material. Secondly, this existence or materiality is a matter of degree. This means that the existence of a being is dynamic depending on contextual factors (e.g., the number of other beings participating in its materialization). Thirdly, everything and everyone existing are social, meaning made of relations. Thus, algorithms are at the same time social and material and they matter differently in different points in time. Algorithms materialize only in relations (i.e., they are made of relations, they matter in relations). To build our argument further, we focus next on the concept of *agency*.

Sociomaterial theorizing in general has focused on the concept of agency from the beginning (Orlikowski, 2007). From the Montreal School of CCO perspective, the agents involved in organizing are not only represented in communication but are also constructed in communication (Castor & Cooren, 2006). Thus, an algorithm can be talked into being or materialized even without its immediate presence. Additionally, acting happens in relation to someone or something and involves the capacities of other humans or things (Cooren, 2018b). This is an important notion regarding algorithms; as mathematics and precise recipes, they have certain capacities, or properties, that make them materialize and affect their role in organizing, as we will demonstrate later. According to Cooren (2018b), acting is always "acting for, with, and through [someone or something]" (p. 142). Thus, humans can act for, with, and through an algorithm and vice versa. Furthermore, Kuhn et al. (2017) presented the viewpoint of practices and the ways in which agency is sited in neither humans nor technologies: "meanings constituting a practice are contingent combinations of (non)human—hybrid agencies reducible to neither human or nonhuman—participants" (p. 158). Thus, any algorithm is a co-actor in the process of its utilization. This relational viewpoint on agency underscores that algorithms are not simply used. Rather, they are co-actors in organizing. As everything and everyone in

organizations are made of and in relations (Cooren, 2020), the agency of algorithms should be investigated through this notion; algorithms materialize in relations.

Studies on Algorithms in Organizations

As stated above, algorithms are both mundane and crucial in current organizations; there are many kinds of algorithms affecting organizations that start from ubiquitous platforms such as operating systems (e.g., iOS, Windows), globally used applications (e.g., Slack, Tripadvisor), and algorithms focusing on specific tasks in particular organizations, such as HRM systems and a wide scope of communication technologies. Furthermore, algorithms are widely in use in areas such as human resource management (see Cheng & Hackett, 2021) and healthcare organizations (e.g., Challen et al., 2019). In the field of organizational studies, algorithm-related research has focused on the possibilities they offer as tools or according to their qualities; algorithm use could have consequences (either amplifying or unintentionally harming) for organizational efficacy and performance (Glaser et al., 2021).

Decision-making is one of the main algorithmic functions argued in research. Using big data makes algorithmic decision-making an information-centric process (MacCrory et al., 2014); algorithms are increasingly autonomous decision-makers in heterogeneous and complex contexts (Davenport & Kirby, 2016). Decision-making is done either with the aid of an algorithm or by the algorithm independently (Kroll et al., 2017). However, despite the capabilities algorithms have—such as computational power and the ability to organize and to analyze complex and vast amounts of data—algorithms need humans for holistic, creative, intuitive, and equivocal decision-making (Jarrahi, 2018). This makes these processes highly relational. Algorithm-related decision-making process is of a certain kind, and it has a lot to do with the properties of algorithms as data-related mathematical rules, as we elaborate later in this essay.

Another direction that research on algorithms has taken is critical and concerns managerial control, discrimination, and other ethical and legal issues (De Stefano, 2019; Kellogg et al., 2020). For example, workers are monitored with different software and wearable devices, and they are evaluated—and even made to resign—by algorithmic processes (De Stefano, 2019). The algorithmic control is often seen as owned and utilized by employers (Kellogg et al., 2020). Despite this, the research does not typically focus on management (Glaser et al., 2021). In actuality, the opaque nature of algorithmic control enables employers to get information about the action of workers while simultaneously restricting the workers' possibilities to understand—let alone criticize—employers' strategies behind their decisions (De Stefano, 2019). These themes, too, originate from the properties of algorithms.

There are criticisms of algorithms as managers that compare data and algorithm-based management to Taylor's (1911) scientific management. Where the original Tayloristic scientific management was based on the power of managers—in defining, deciding, and controlling practically everything—the algorithm-based management

gives new but rather similar authority to technology. The concepts suggested to describe this power shift from managers to algorithms and data, and this change in the focus of control (from human practices to analyzing and controlling data) are scientific management 2.0 (Schildt, 2017) and digital Taylorism (Taska, 2017). Besides this authority shift, algorithms in organizing might also take us back in time by regressing perceptions of communication to overemphasizing communication as the transmission of information from managers/algorithms to workers.

Furthermore, there have been for quite some time studies focusing on human–robot interaction in the fields of human–computer communication and human–machine communication. For example, Edwards et al. (2016) found that humans are more suspicious toward robots as communication partners than toward other humans. In this essay, we are not focusing on the interactions humans have with algorithms per se. Thus, the wide body of literature directed toward human–computer/machine communication is not reviewed here. Another line of research we do not focus here is the one of human–AI collaboration (e.g., Sowa et al., 2021) because it is close to the approach of *using* technologies and it focuses especially on AI, while we discuss algorithms more generally.

In the field of organizational communication studies, the affordances perspective has been particularly popular in the understanding of the (positive) possibilities and implications algorithms could offer to organizations as well as the aspect of combining human agency and the materiality of digital technologies (e.g., Hauge, 2018; Hutchby, 2001; Krancher et al., 2018). In research, affordances usually describe the dyadic relationship between a technology and its user (Hauge, 2018). Even though Hutchby (2001) initially underscored the relational aspects of affordances, the typical affordance lens seems to disregard the presence and impact of other artifacts, people, and temporally contingent practices or, in other words, contexts (Hauge, 2018). Affordances can offer a valuable perspective in understanding what kinds of affordances emerge, and there are even efforts to explain how, why, and when they arise (Krancher et al., 2018). However, the affordance viewpoint focuses mainly on the *use* of technologies, which makes it very much human/individual-centered. For this reason, we claim it is an inadequate approach to analyzing the organizing properties current algorithms can carry because use/human-centeredness can disregard the relationality of the situation and leave out the dynamic and temporal agency of algorithms. Furthermore, organizational communication scholars have focused mainly on the affordances of communication technologies (e.g., Treem et al., 2015; Rice et al., 2017) and not so much on other technologies (i.e., algorithms) participating in the current organizational life. In the majority of studies, the main focus of the affordance viewpoint is on what technologies afford. With algorithms, it is equally as important to take into account what algorithms *do not afford* due to their characteristics (Vergne, 2020). The affordance viewpoint has been offered to narrow the gap between technological determinism and strict voluntarism, but if non-affordances are also taken into the equation, it makes the affordance viewpoint somewhat deterministic (Neff et al., 2012).

In earlier studies, agency has already been under scrutiny from an algorithmic, or technological, perspective. Ananny and Crawford (2018) showed how digital platforms and algorithms can be seen as hybrids of human and computational elements and as networks of human and nonhuman agents. Furthermore, Fleischmann (2009) argued that networks can carry collective agency in organizations, including both human and nonhuman agencies. Contractor et al. (2011) applied social network analysis with nonhuman technological elements as both nodes and connections, and they included the nonhuman technology as an inherent part of the organization. In a micro-level study, Steensen (2018) highlighted how software-based nonhuman agencies play an important role in occupational learning processes. Interaction between human and nonhuman (algorithmic) agencies is acknowledged in organizational studies (e.g., Gibbs et al., 2021; Sundar, 2020). Altogether, agency and technologies are closely tied in earlier studies, but the capabilities of algorithms, or what kind of agents algorithms are as precise recipes, have stayed in the background. Furthermore, as Cooren (2020) points out, acting is not only about the actor acting but also about what is represented (i.e., made present) in this act; this viewpoint has been neglected with algorithms. Moreover, we argue that current relational viewpoints have not sufficiently taken into consideration the different capabilities of different kinds of agencies; it is not the same to co-act with a door as with a complicated algorithm.

Despite the great influence of algorithms in organizations and the great interest in research around algorithmic functions (e.g., decision-making), there is still a lack of theorizing around algorithms per se specifically in the field of organizational communication. There are few profound studies in organizational research suggesting some theoretical grounds, for example, for managerial control as the contested terrain of algorithmic control (Kellogg et al., 2020 in honor of Edwards, 1979) and how algorithms should be seen in a performative, evolving, and biographic way to ensure a better understanding of their influence on organizational decision-making and new routines (Glaser et al., 2021). We need an understanding that covers algorithms in organizations from more than one perspective (e.g., qualities, use, benefits) and that takes account the wholesome role of algorithms in organizing. This is important because current organizations are heavily dependent on algorithms from their foundation (Kenney & Zysman, 2016). Furthermore, we argue, the current understanding does not reach the relational, agential, and communicational aspects of algorithms even though they are traditionally seen as important perspectives in understanding organizational communication (e.g., Brummans, 2018). For example, the work on community perspective and communicative processes such as commitment, trust, building relationships, or belonging is still indeterminate. Next, we will (a) pinpoint our view on algorithms in organizations and argue why the Montreal school of CCO approach as presented here is a valid starting point for studying algorithms and organizing, and 2) argue our basis for directions for future research.

Our Take on Algorithms in Organizations

As we present above, previous research has focused mainly on the algorithmic processes themselves or the use of different kinds of technologies (in organizational communication, mainly communication technologies). We argue that there are many kinds of algorithms in organizations participating in organizing, which communicate to us and through us throughout time and space and also outside the moments when we actually use these technologies; their mattering is dynamic and related to contexts (Cooren, 2020). The way for studying algorithms and organizing is focusing on the materialization processes of algorithms and acknowledging the backgrounds of the algorithms because their existence precedes the actual code in the form of an idea, for example (see Cooren, 2020). The analytical way to approach the materialization processes of algorithms is via the concept of relational agency and to grasp what algorithms cannot do, the properties and operating principles of algorithms must be understood because algorithms materialize *through* their properties. In other words, due to the essence of algorithms as mathematical recipes, they have certain kinds of capabilities as agents.

As stated earlier in this essay, there are many possible ways and theoretical approaches for focusing on algorithms and organizing. However, we see the Montreal School of CCO approach as presented here particularly appropriate for several reasons. First, the notion that algorithms are both material and social is central because most algorithms in organizations are planned to communicate, or to be social, in one way or another. Through this notion algorithms do not materialize only in relation to humans, but through the relations leading to their existence, including their properties. Second, the notion that the mattering of algorithms is dynamic and tied to contexts opens the possibility to widen the study of algorithms outside the moments they are in use because algorithms are then recognized to matter also when they are talked or acted into being. One criticism of affordance research has been its indifference to contexts (Hauge, 2018). Third, the notion of relational agency serves the purpose to explore algorithms as beings that communicate (i.e., relate) and act to humans, with humans, through humans, and for humans, maybe also in humans. Furthermore, as the materialization of algorithms happens throughout space and time, and every cause is already a consequence (Cooren, 2020), the communication of algorithms is already mediating someone's or something's ideas, properties, and capacities. For example, organizations communicate through algorithms (i.e., algorithm acts for the organization). Therefore, algorithms can be seen communicating their relations and through our viewpoint, we can focus on who or what communicates through algorithms. When algorithms are studied from this relational agency point of view, the wider context becomes visible, and the viewpoint is not limited to the *use* of these technologies. To sum up, we argue that these CCO viewpoints of relationality on organizing and agency match the technologically emphasized realities of contemporary organizations (see also Kuhn et al., 2019). Based on these views, the research on algorithms in

organizations, and the Montreal School of CCO theorizing about relationality and agency, we have formed three issues we think should be taken into account in future studies and theory development on algorithms and organizing.

The *first issue* we propose is that in relational materializing processes, the qualities of different participants matter and make a difference. Leaning on the definitions of algorithms, we have pointed out instances where algorithms matter as precise recipes. Because agency is relational and always involves the capabilities of other beings (Cooren, 2018b), and because algorithms are ubiquitous in today's organizations, it is important to acknowledge the properties of algorithms to gain an understanding of the manifold roles they play in organizing. Furthermore, acknowledging the properties of algorithms enables focusing on what algorithms do not do, and therefore, deepens our understanding of their qualities as agents, a viewpoint currently neglected in studies focusing on affordances of technologies (Jarrahi & Nelson, 2018). To sum up, we argue that distinct qualities of algorithms affect organizing practices because algorithms materialize through these qualities.

The *second issue* is that the impact of algorithmic agency does not have to involve the use or even direct functioning of these algorithms; rather, algorithms relate in a systemic organization. Algorithms go hand-in-hand with organizing from the beginning, and through the relational lens, we propose that algorithms are part of the organizing context even when not in use. Therefore, they are an inseparable part of the communicative constitution of organization, whether in the role of operating system, a customer relationship management (CRM) program, or a communication technology, for instance. Thus, interactions concerning algorithms (or any part of the algorithmic process from data collection to the assessment of algorithmic outputs) should be scrutinized. Studying how agency is given to algorithms in human interactions, or how algorithms materialize in human interactions, would help us to build understanding on how algorithms participate in organizing even when they are not used or explicitly in action in a given situation. It would also assist in understanding what kind of agency is usually attributed to technologies and how this agency is perceived (i.e., how algorithms materialize in action). Furthermore, there are many algorithms in many locations participating in organizing simultaneously, so a more systemic view of algorithms and organizing is needed for deeper understanding. A systemic view also means that it should be recognized that algorithms have backgrounds, they are consequences of many relations, they communicate or act on behalf of someone or something. To sum up, the existence and presence of algorithms in organizations should not be limited in the use of an algorithm, and a more systemic view is needed.

The *third issue* arises from the previous two issues; time is a crucial factor in understanding algorithms and organizing. We propose that the agency of organizing with algorithms and humans, and the materializing processes including algorithms, is a dynamic process in time and space (Cooren, 2020); the emergence of action/agency/organizing comes to life differently in different situations. Only a temporal viewpoint can describe the overall importance of algorithms in organizing. For

example, in her ethnomethodological study, Krummheuer (2015) demonstrated how technical agency transforms during action. The temporal observation of the reconfigurative properties of nonhuman algorithmic agencies is important; this is because many things remain as they are, but few changes critically over time (Rutz, 2016). In particular, data collection as part of organizing algorithms is important from the viewpoint of time: when data are collected, it is for the future use for algorithm(s). When these algorithms are acting in the present, they rely on data from the past as they are organizing for the future. To sum up, the concept of time should be present in studies focusing on algorithms and organizing.

Even though, we argue, these three issues are worth studying as part of organizing themselves, next, we bring our take on algorithms in organizations to a more concrete level by focusing on a few (overlapping and interrelating) properties of algorithms we think are important for studying organizing and by providing directions for future research on algorithms and organizing.

The Properties of Algorithms as a Base for Research Agendas

Regardless of the conceptualization, algorithms share properties that can be considered when studying organizing. Flanagin (2020) argues that focusing research on a certain technology (e.g., Twitter) is not beneficial due to vastly changing platforms. Consequently, the focus should be on phenomena, and the technology should primarily be a site for study. We concur and continue this notion by stating that a certain technology alone is often an insufficient site for a study, whereas the idea of an algorithm provides a solid foundation for analysis. Flanagin (2020) focuses on communication technologies and recognizes that communicative and social processes arise from such technologies. He suggests that decomposing technologies into their components enables studying phenomena across different technologies and, thus, supports our argument for focusing on algorithms. However, Flanagin talks about the *use* of communication technologies; the author fails to go into detail or take the actual properties of technologies into consideration before he directs attention to the capabilities of technologies. We argue that before focusing on capabilities, one should understand where these capabilities come from, their relationality. Thus, we have outlined some properties of algorithms that are common throughout different digital technologies that currently take part in organizing. These properties, we argue, affect the capabilities of algorithms as actors. Thus, the first issue we proposed above is used as the main premise for focusing on the properties of algorithms. Next, we review some properties of algorithms that we consider important from the viewpoint of organizing. We will also ponder some directions for future research.

Data Collection

Most of the algorithms in organizations rely on data, and this has many effects on organizing; data need to be collected. Data collection is relatively effortless but

making use of it requires humans to write a code (or a model or theory, see Glaser et al. 2021) for the algorithm to utilize the data as desired. Data collection is part of the materialization process of an algorithm even when the algorithm has not even been coded at the time of data collection. The data are collected for a reason implemented by the management of a company, for instance, and this reason relates to the data but also to the algorithm the data are for. The time dimension (our third issue) becomes apparent when data collection is under scrutiny. It is important to acknowledge whether the data are collected for a future algorithm under development or for fuel for an algorithm already at work.

Data for algorithms can be collected either from the target organization or from a wider scope (big data). If the source for the data is the organization itself, data collection affects everyday actions in organizations as the members of the organization take part in data collection. There are automatized methods, non-automatized methods, and a mixture of both for data collection. For example, an employee in a call center takes customer service calls by using a software that automatically records some basic information: Period of wait time before the employee answered the call, length of the discussion, how many calls the employee takes in an hour, and so on. After every call, the employee gives the software information concerning the reason for the call and whether or not the issue was solved. This is one example of how organizing practices are affected by data collection and how the (algorithmic) data collection procedure materializes through workers, or how this relational agency emerges as the algorithm materializes.

At times, organizations may collect data even before they know what it will be used for, and this is because data are money in the age of algorithms and the key to algorithms working well. Eventually, there will be potentially enough data for making predictions by algorithms and describing the most efficient practices. It can be said that the tenet of the present is to invest in data. This is an idea transferred directly from the big data industry of the internet to organizational practices and one example of how algorithms in organizations are embedded in the larger concept of platform economy (on platform economy, see Kenney & Zysman, 2016; Poutanen et al., 2020). Data collection has yet to be scrutinized in research as a part of algorithmic organizing. This is potentially due to the fact that data collection is not thought of as part of algorithmic practices as it often precedes the actual algorithm in action. In their recent work, Glaser et al. (2021) theorized algorithms in organizations from a temporal viewpoint and introduced a biographical perspective on algorithms; the authors, however, failed to include data collection within their theory.

Future research could focus on the actual data collection practices in organizations, how they are executed, how much time they take, to what extent they are automatized, and so forth. How does data collection alter work? It would be also worthwhile to study the ethics of data collection, how much workers know about what kinds of data are collected and how these data are being or will be used. How open are data collection procedures in organizations? Who decides what data are collected? Is there manipulation in manual data collection, for example, if only

positive achievements are recorded? Founding its functions on manipulated data would make a huge difference in the workings of the algorithm. Overall, the research focusing on the effects of data collection in organizations at management or worker levels is still scarce. Considering the enormous role data have in the current world, data collection in organizations should be studied, we argue, as a part of the materializing process of algorithms, from a temporal viewpoint.

Biased Data and Code

The data collected are always biased regardless of the data collection method (human or computer) (for an overview, see Silva & Kenney, 2018). Biased data cause algorithms to operate in a biased way. The notion of bias highlights how the algorithm does not exist in a void but materializes through relations; in this case, the relation is with the data. Thus, it must be stated that the data bias materializes through the algorithm. There are many famous big data-related examples of the effects of biased data on the outcomes of learning algorithms (e.g., Neff & Nagy, 2016). Furthermore, the bias of algorithms is not only a data issue. The design of an algorithmic model itself can contribute to creating and magnifying bias (see Hooker, 2021). In organizations, for example, racial or sexist issues in recruiting are not bypassed with algorithms even though being nonbiased has been one of these technologies' big promises (Silva & Kenney, 2018). In general, biased algorithms supporting decision-making can understandably result in biased decisions. Although algorithms are inevitably biased—because they reflect the biased world we live in—it is a problem if an algorithm magnifies bias. However, the problem arises if the biased property of the algorithm is not recognized or if it is denied and the algorithm is sold and/or perceived as an unbiased solution to a certain problem. This is exactly what many algorithms claim to do (e.g., O'Neil, 2016).

Future research should not disregard the relations between data and algorithms. The quality of the data connects with data collection processes and is, thus, a temporal issue. The question of bias is particularly interesting when studying decision-making algorithms in organizations. Biased data-based management is biased management when algorithms relate with humans, and it needs more attention in the research literature, from an equality viewpoint, of course, but also from a decision-making viewpoint in general. When considering bias in organizations, the focus is not only on humans but in other being as options (i.e., solutions, spaces, decisions, stakeholders, etc.), too.

Exclusive Algorithms

Some distinct features of algorithms—particularly interesting from an organizing point of view—can be drawn from shared characteristics of their code. Algorithms are always coded in a way that focuses on certain issues, leaving other issues out; they therefore simplify the reality for efficiency (O'Neil, 2016). Accordingly, algorithms are oblivious to the goings-on outside of their specific focus. For example,

Google's AlphaGO was programmed to play GO, and so it cannot learn to play any other game regardless of how simple it may be. Thus, algorithms mediate something specific, and this specific only, and so this starting point should be considered when studying the materialization of algorithms, or algorithms as co-acting agents in organizations. It should be stated that in the case of strong AI, the exclusiveness is not as categorical as it is with most algorithms. However, strong AI is still rarely in use in organizations.

From an organizing point of view, it is important to note that no algorithm can see the "big picture" and that their outputs should be evaluated with this knowledge. In the end, the exclusiveness of algorithms means they always draw a simplistic picture of complex phenomena and do not understand organizing outside their specific focus. In the case of an evaluative algorithm, if thing A is something that is, for instance, fun and good for team spirit but hard to measure for the algorithmic purpose, and therefore left out of the evaluation, the failure of the algorithm to see the big picture can lead to unexpected negative consequences.

Furthermore, this exclusiveness of the code is tied to the standard aim of efficient processes; algorithms give rise to an accentuated role of procedures (Beverungen et al., 2019). This leads to data- and algorithm-based management that resembles scientific management (or Taylorism). When information-centric and procedure-emphasizing algorithms fragment the work into micro tasks, this also alters the communication in organizations, and the relational aspects can be truncated. This can be fruitful for capitalism and effective for certain kinds of platforms or tasks, but it is certainly alarming if deeply human needs, possibilities, and fulfillments are overlooked or precluded. Thus, for example, interpersonal communication processes, such as manager–worker relationships, worker–worker relationships, group and team processes, and work communities, should be explored against the exclusiveness of algorithms when appropriate.

Simultaneously with the rise of algorithmic management, in the public discourse, communication skills, empathy, and listening are receiving increasing recognition as expectations and qualities of a good leader or manager. Therefore, the monitoring, controlling, and non-interactive tendencies of algorithmic management and the strongly humanistic communicative expectations of leaders create an intriguing tension in organizational communication between management by algorithms and by humans. It would be worthwhile to examine how the tension between human and algorithm-based nonhuman agencies is constructed, maintained, controlled, or exploited within the relational processes of the materialization of algorithms and in the processes of organizing.

Moreover, in future research, questions of power should be examined in environments of algorithmic management; when algorithms are the ones making decisions, they are also the ones using power. An interesting question is as follows: How is this power talked into being and by whom? The way algorithmic power materializes in human interactions is an important phenomenon for future research. Furthermore, how authority is given to algorithms in organizations and in

organizing is an intriguing question (see Cooren, 2010). What are the processes or relations that lead some things to matters of authority, why do they end up authoring or controlling—guiding, orienting, and disciplining—members' actions in organizations, and what do the members do when they invoke authority to algorithms that speak and act in and for the organization (see Vasquez et al., 2018)? How is authority given to algorithms, and do workers have the same ability to give agency to algorithms as do managers? Additionally, as decision-makers, algorithms are precise recipes and mathematics, considering only what is in their code.

Algorithms as Spotlights

The actual code-related decisions in the materializing process of algorithms have consequences in organizing processes. Following the feature of exclusiveness, the data "given" to algorithms or the mechanism of highlighting certain issues and undermining others can alter the issues that are seen as important in organizations. This is a process that comes to matter in time. Algorithms can restrict certain information and thus allow only certain kinds of action while blocking others; this may potentially cause workers to feel alienated (Kellogg et al., 2020). Particularly, all kinds of evaluative algorithms have a property in their code such that they do not take notice of thing A but emphasize thing B. For good evaluation scores, it would be wise to focus resources for thing B. As a result, thing A can wither away. Thus, thing A has no effect on the algorithm, but the algorithm has a significant effect on thing A: their relation is purely a one-way mirror. Furthermore, the structures of algorithmic online ratings affect the organizing practices of, for example, hoteliers by causing them to focus on the issues that the algorithm weighs as important (Orlikowski & Scott, 2015). O'Neil (2016) used the example of university rankings and highlighted how the issues weighed in the evaluative algorithms have changed the ways universities prioritize their functions and investments. Thus, algorithms have a say in the process of deciding what is seen as important in organizations and where to put resources, and they therefore affect organizing. As seen in these examples, these algorithms can work inside an organization or more globally; in both cases, the spotlighting property of algorithms is a question of authorizing, power, and control materializing in relations in a temporal way.

For future research, the question of leading or managing algorithms is interesting. Who is the one interpreting the algorithm (or algorithms) and able to see algorithmic impacts temporally in an organization? How is algorithmic control developing temporally in organizations? What kind of trust is built with algorithms? Are they taken as granted, natural laws? This is interesting because there is always someone or something acting through algorithms. Furthermore, negotiating and tracing responsibility in work life in decision-making, problem-solving, or conflict management situations will often include an algorithm as a participant. The responsibility and accountability of algorithms have been studied from juridical viewpoints, but these would be interesting from a communication point of view as well.

For instance, Castor and Cooren (2006) highlighted how problems are defined by selecting the agent(s) with key responsibility. In contemporary organizations, the agent with key responsibility is often a digital platform or a certain algorithmic function, both for bigger strategic issues and in everyday practices. This is one of the management challenges of the future.

Opaque Algorithms

Algorithms are often covered in secrecy because their processes are opaque. Their logics are hard to understand for someone who is not familiar with coding. Furthermore, algorithms are often concealed as business secrets (i.e., services or IT products), which means that the management and the workers in an organization are the only parties who know the inputs and outputs; despite this, they have no idea what the (algorithmic) process is between the inputs and outputs (e.g., Pasquale, 2015). For example, workers can be evaluated through an algorithm. These algorithms come in the form of a computer software where both workers and their managers provide agreed-upon information, such as sales, sick leave, customer feedback, and so on. Then, the algorithm gives a score for each employee but usually does not disclose the weightings that the different variables have in the process of evaluation. O'Neil (2016) gave an example of the evaluation of schoolteachers in the United States; a teacher lost her job but was unable to retrieve details about the information that the decision to fire her was based on. In addition, an algorithm can cover itself in secrecy, applying deep learning and altering its own code autonomously due to the logics behind the new code; this can remain unclear for the people working with the algorithm (Griffin, 2017). In fact, an algorithm usually cannot explain how it came up with its solution to a given problem (Brynjolfsson & Mitchell, 2017). Alternatively, there is often reasoning behind the opaqueness; keeping the algorithmic process secret ensures people cannot game the algorithm.

This characteristic of opaqueness is examined in explainable AI research as the "black box problem" in order to shed light on the logics behind algorithms for the sake of practical, theoretical, and even legal concerns (see Zednik, 2021). For example, not knowing why and how an algorithm works impacts on workers' trust in algorithmic decision-making (Burrell 2016). Some of this research has tried to develop techniques to improve the understanding of the algorithmic system for those whose behavior is being explained (Zednik 2021), but at the same time, it has been stated that it can never be fully opened. Currently, the organizational realities operate mainly with opaque algorithms.

In future research, it is important to examine the ways algorithms are part of organizing from managerial and work community perspectives. When algorithms become understood more and more as independent agents taking part in organizing in everyday work, one must also build trust in them and with them (see also Liu, 2021). The question of trust is important regarding opaque algorithms; how can one trust something unknowable? What are those communicative processes like

where trust and commitment are created? Who are the participants taking part in the trust building processes, how is trust developed over time, how and by whom it is maintained, and what kind of phenomenon is the trust between human and non-human agencies? These questions should all be considered. In addition, other relational communication processes, such as commitment, relationship formation, negotiation, learning, well-being, and persuasion, would be worthwhile to examine in the context of algorithms and organizing. It goes without saying that these research viewpoints are interesting in relation to the other properties of algorithms presented here, too.

Political Algorithms

Algorithms are always political in the sense that they cannot be separated from humans; algorithms are invented, ordered, and (at least initially) coded by people. Again, this illustrates how algorithms are media for something or someone of the relational nature of the materialization of algorithms. Furthermore, people are included in algorithmic processes in many ways as platform workers perform microwork that prepares, verifies, corrects, and even impersonates algorithms (Tubaro et al., 2020). In the organizational world, the goals of algorithms are not neutral. Rather, they aim for something specific, and this is more often than not the aspect of efficacy. Companies and coders developing codes are rarely organization scholars, and algorithms are designed to be *deterministic* (Neff et al., 2012); in a sense, algorithms aim at modifying organizing practices. They are neither neutral parts of organizing processes nor natural laws in any sense even though they are often conceptualized as mathematics and have a scientific aura around them.

Future research should put weight on the fact that algorithms are not neutral nor existent in themselves. The existence of algorithms is always relational, and, consequently, algorithms are always acting as mediators of something. How and by whom algorithms are given authority? Who or what communicates through algorithms? Algorithms are not purely causes themselves; they are consequences from their beginning. This calls for attention to the temporality of the materialization of algorithms. In many cases in organizations, algorithms are business, which means, for instance, that if a part of an IT system does not work in the anticipated way, the system provider will not fix it until they have enough customers complaining about the same problem (because it is business). Thus, meanwhile, the client organization has to find ways to co-act with insufficient algorithmic processes. This would be an interesting topic for study and demonstrates again how algorithms mediate the ideas of others. Altogether, malfunctioning algorithms would be something to dive into.

Here, we have introduced six properties of algorithms we think are important from the viewpoint of organizing. These properties are heavily interrelated, and they are separated from one another just for analytical reasons. We are sure there are other ways to categorize or classify algorithmic properties; our main point is that these properties matter in organizing with and through algorithms (our first

issue). Furthermore, we emphasize that algorithms in organizations and as part of organizing processes should be viewed as relational, systemic (our second issue) and throughout time and space (our third issue). There is organizational communication through algorithms, within algorithms, and about algorithms. All these levels should be explored in the flow of time. Looking into the authentic interactions in organizations concerning the materialization of algorithms from the viewpoint of agency is important in future research. Altogether, the ongoing development of smart and deep learning algorithms will bring forth new questions concerning algorithmic agency. Algorithm perceived as a team member may not be a reality just yet, but it is only a matter of time until an algorithm will be intelligent enough to be considered as an equally intuitive actor with humans. Thus, we need theorizing and empirical research on algorithms and organizing.

Rethinking Organizational Communication

From an organizational communication viewpoint, we highlighted the properties of algorithms that effect organizing, and we argued that algorithms are not simply used but rather are versatile co-actors in organizing. Nevertheless, the question of what this all means for communication as a concept remains. Is there a need for rethinking communication when studying organizing in the era of AI? We postulate that the properties of algorithms and their increasing role in organizing raise interesting questions concerning communication in organizational contexts.

How, then, do algorithms affect our conception of communication as constitutive of organizations? We start from the most fundamental concepts, information sharing and shared meanings. From the point of view of communication, algorithms as mathematical recipes do not negotiate or create shared understandings; they send and receive messages (information). This is an important issue concerning algorithmic organizing: Algorithm-based communication within [sic] organizations is declined back in time to the transmission model by Shannon and Weaver (1949), meaning algorithms emphasize the information-centered view of communication, which, in organizational communication studies, has been conjoined with the container metaphor. From an imaginative viewpoint of an algorithm, it communicates in a container by transmitting information. One could argue that each decision made by an algorithm is a meaning, but those meanings are not negotiable with the algorithm. They are already in the code of the algorithm in the form of either 1 or 0. Furthermore, the feedback from algorithms to humans can be opaque because the algorithmic process itself is opaque. If we conceptualize organizations as communicative constitutions (e.g., Brummans et al., 2014), algorithms are a significant actor in organizing; for them, communication is the transmission of a strictly limited (by their code) type of information. Algorithms act, communicate, and make a difference, but all meanings are human-made. Then, what kind of communication is constituting organizations, and what is the role of shared meanings in this process?

If we see an algorithm as a participant in interaction, we have to recognize it is fundamentally different from human participants. An algorithm is based on data from the past; it can process only information it recognizes as part of its scope; the process behind its decisions can be opaque, and it is coded for a particular aim. Both Castor and Cooren (2006) and Suchman (2007) argue that agents involved in interactions are constituted in communication. Suchman (2007) continues that humans and nonhumans do not constitute each other similarly. At the same time, there are two different participants in interaction: one shares information and constructs meanings and the other only focuses on information and makes decisions based on the information retrieved. These interactions are not equal, and the operational logics of the participants differ greatly. By the current tools used supporting management actions (e.g., De Stefano, 2019; Libert & Beck, 2019), management can fire the least effective workers according to the data provided by an algorithm without knowing who they actually are; they can fire them without any construction of shared meanings or knowledge of the contexts in which the workers operate. For example, pregnancy can affect a worker's efficiency, but this means nothing to an algorithm unless the algorithm processes this kind of personal data. Another difference between humans and algorithms is interpretation: algorithms try to interpret according to their code and nothing else, whereas humans tend to interpret human-like properties in algorithms (Edwards et al., 2019).

For Cooren (2020), communication is both transmissive (relational) and constitutive (materializing). However, traditional inclusive/interactional conceptualizations of communication (e.g., Frey et al., 2000, p. 27) see communication as information transmission and as the construction of shared meanings. From a conceptualization viewpoint, we ponder whether there is congruence between *existence* (as a result of materialization) and *meaning* (as a result of negotiation). There must be existence before meaning. Thus, meaning is something more or beyond mere existence; a being must exist first to have a meaning. With other concepts, if communication is reduced to something that connects discourse and matter (Putnam, 2015), we claim that we lose important parts of the communicative constitution of organization in a form of construction of shared meanings. Even though meanings are not formed by algorithms per se, and the centricity of meanings has been questioned (Kuhn et al., 2017), meaning through symbols is something that seems very human. Meanings matter in relationships, in motivation, in a sense of belonging, in quality of work, and in efficacy, and they matter, in the end, under the bottom line.

Let us end this section with some practical issues where the need for rethinking communication emerges in the current communicative constitution of organizations. Take, for example, the case of Uber. Where, how, and by whom is the organizing taking place? In this case (and in the cases of Airbnb and gig workers), all communication is platform-based and run by algorithms except if the driver and the customer end up having a discussion. These organizations are communicatively constituted, but that communication is of a certain kind (i.e., transmission of information). From a management or leadership communication point of view, it is the

algorithm (platform) that is led and managed. We argue that one of the future skills of leaders in all organizations will be recognizing when they are leading humans and when they are actually leading a platform, algorithm, or information system. Furthermore, leaders themselves are led or managed by algorithms. This means leaders must know how to work *with* algorithms and *through* algorithms and realize that when they are "constructing a shared reality" with an agent (algorithm), it is not actually creating any meanings but merely processing information. Additionally, the properties of algorithms we introduced mean that algorithms as managers and participants in communication are biased, completely blind to everything not in their code, and shadowy concerning their operating principles.

Conclusion

The smarter the algorithms participating in organizing get, the more scholars need to understand their operating principles. The more intelligent an algorithm seems, the more its actions are taken as a given, and the more the algorithm is authoritative. We argue that it would be problematic to ignore the issues presented in this essay around the properties of algorithms. Algorithms are not only *used*, but their existence is apparent in many relations in organizing. Organizational communication is about other algorithmic technologies too, not only about communication technologies. Furthermore, algorithms are in many ways active *agents* in the communicative processes of organizing. Algorithms aim at being deterministic, but other actors (human and nonhuman) have their say in the process as well. Even though algorithms are sometimes theoretically seen as actors in current research, the focus is still on their use (especially communication technologies) and on human-computer communication. The focus should be on a more diverse group of algorithms and on how these algorithms communicate or act through humans or nonhumans in organizations. At the same time, it should be noted that there are beings such as ideas, economical goals, big data, and managers communicating and acting through algorithms, too.

We argue that the biggest need at the moment is for empirical research. Organizational communication scholars should study algorithms participating in organizing as this could provide valuable information not only to scholars but to those coding and working with these algorithms. Currently, the situation is at times backwards. Industry spokespeople and journalists get a fair share of attention in many theoretical papers. The danger in this is that scholars build theories according to what algorithms *are said to be* and not according to what *they actually are and do*. Thus, we call for empirical studies; we should observe, interview, and survey the developers, buyers, users, and co-workers of algorithms. The findings of such research can, for example, illuminate the most efficient ways of technology use or the most enabling types of digital platforms or highlight the technological issues that constrain human agents.

Also, for further theory development, more original empirical research is necessary. Thus, we join Guzman and Lewis (2020) and Kuhn et al. (2019) in calling on organizational communication scholars to think about and test our theoretical assumptions in the world of digital platforms. One could argue that all communication theories should be tested in these new environments. What an organization is and how one can define it, what hybrid leadership communication or hybrid management communication is, or what kinds of communication phenomena take place repeatedly in such a manner that there would be point in trying to understand and conceptualize them as a theory or a model of some kind should all be considered. We must study algorithms as they are developing since the theoretical base in our field must stay with the pace of the new ways of organizing. Furthermore, we need to understand the role algorithms play in our lives. In the end, one of the key questions in organizing will remain: are technologies supporting the organizing processes humans prefer, or are technologies changing the ways humans organize to be suitable for algorithms? In this essay, we have hopefully given the readers viewpoints to consider when doing research in environments and contexts where algorithms are materialized.

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