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Towards an algorithmic city: Transformation in politics, regulation, governance, and service provision

Introduction

Since the mid-twentieth century, the nature of urban communities has changed profoundly due to technological developments, and the pace of change is likely to be as fast, if not faster, in the near future. The concept of the smart city has emerged as an umbrella concept to reflect such technological developments in the urban context. The smart city is a multi-dimensional phenomenon. Smartness can be increased in urban life by establishing cyber-physical systems in traffic, using the Internet of Things in collecting and processing health information, enhancing collective intelligence in urban planning through Web 2.0 applications, utilizing augmented reality in providing location-specific information and services to customers, utilizing large-scale multi-source data in analyzing and designing urban development, and so forth. Such “smartness” in a smart city is largely produced by autonomous service, learning, interactive, and control systems, which can be characterized as technologically enhanced disembedding and integration mechanisms. They enable us to create and utilize artificial intelligence, which relies on formal models, metrics, and algorithms. This brings us to the core topic of this chapter, the idea of an algorithmic city or “a-city,” which emanates from the increased importance of algorithms in practically all aspects of techno-savvy modern life, be it business, work life, politics, social networking, or service delivery.

Algorithms appeared in the global news in the 2010s, one of the catalysts being their anticipated revolutionary impact on business and work life. The increased importance of the platform economy and the rise of algorithmic business models started to attract attention due to their introduction in airline pricing, stock trading, e-commerce, and transportation. Gartner (2016), for example, assumes that algorithms are redefining the architecture of business. The new business model has its widely discussed forms and consequences, as depicted in *The Guardian* headline (May 15, 2016), “Rise of the billionaire robots: how algorithms have redefined hedge funds.” This leads us to another aspect of the emerging algorithmic economy, employment. The impact of technology on employment is a centuries-old issue. However, the contemporary discussion has gained new nuances since the news media started to trumpet, “Robots will steal your job” (*Business Insider*, Feb 15, 2016). The job losses in finance, law, and other professional services have been big news in particular, as the highly paid and well-educated experts, symbol analysts, and knowledge workers have become directly threatened by artificial intelligence and robotics.

Another major contemporary issue is the role of algorithms at the intersection of politics and media. Probably the most widely discussed event in this respect is the 2016 US presidential election. Newspaper and magazine headlines of that time are most telling: “How Facebook's algorithm could influence the US election result” (*New Statesman*, Sept 8, 2016), “How social media filter bubbles and algorithms influence the election” (*The Guardian*, May 22, 2017), and “If Google and Facebook rely on opaque algorithms, what does that mean for democracy?” (*ABC News*, 11 Aug 2017). In short, a completely new public debate erupted, with algorithms, artificial intelligence, and major platform companies on one side, and democracy, privacy, information rights, and the preconditions for good governance on the other.

A particular topic that reflects a paradigm shift in media concerns news recommender systems that facilitate the filtering of news and information. They are powerful tools for professionals and various audiences to cope with information overload and assist in decision-making processes based on user preferences. They form actually paradigmatic examples of the emerging algorithmic reality. The informatization and algorithmization of the media bring about new opportunities by offering a customized news experience and facilitating innovative journalistic practices, but they might also produce less positive consequences. Among the most critical is the fact that personalized news selection may result in a personalized information sphere known as a "filter bubble" (Pariser, 2011). This implies a shift from human gatekeepers to algorithmic gatekeepers employed by platform companies and media houses (Verdegem & Lievens, 2016).

Such developments have raised concerns about the influence of artificial intelligence and algorithms on democracy. One of the first local responses to this challenge came about in 2017, when the City of New York unanimously passed a bill to tackle algorithmic discrimination, the first measure of its kind in the country. The bill orders, among others things, the establishment of a task force to study how city agencies use algorithms to make decisions affecting residents' lives and whether any of the systems appear to discriminate against people based on age, race, religion, gender, sexual orientation, or citizenship status. This bill reflects the concerns that were raised by ProPublica's investigation into racially biased algorithms used to assess the criminal risk of defendants (Kirschner, 2017).

These snapshots of the public debate on algorithms tell much about the significance of this topic. We are dealing with a factor that affects vital aspects of our lives. How this multi-faceted trend materializes at the local level is difficult to conceive in its totality. The influence of algorithms on urban structures and processes is fairly superficially addressed, usually either from an overtly optimistic techno-centric perspective or from an extremely critical or pessimistic point of view. This chapter aims to contribute to this debate by offering conceptual clarification of this emerging phenomenon and assessing its main problems and potential in the public domain. To be more precise, this chapter seeks to answer to the following question: How does the increased impact of algorithms reshape cities? In order to keep the discussion manageable, the focus is primarily on the core aspects of local public affairs and the fundamental functions of city government, most notably electoral politics, regulation, governance, and service provision.

Methodologically, this chapter presents an exploratory conceptual analysis that utilizes empirical exemplifications or vignettes to provide evidence of early developments on the institutional side of algorithmic urbanism. The first task of such an endeavor is to reduce ambiguity by providing conceptual clarification. The next step is a second-order theoretical analysis in which the phenomenon is problematized, analyzed, and synthesized (see e.g. Shkedi, 2007). As we are dealing with an emerging phenomenon, the nature of the analysis is primarily descriptive, even though the explanatory aspect is involved in the form of the contextual explanation of the algorithmic revolution as theorized by John Zysman and colleagues (2011). The problematization of the core phenomenon and the theorization of its emergence are followed by a conceptual analysis of the key concept, the algorithm, and its manifestations in the urban context. The last phase of our theoretical analysis is the synthesis, which combines conceptual analysis with contextual specifications, and, on that basis, builds a conceptual scheme of the dimensions of the algorithmic city. This discussion is supported by the use of vignettes describing those aspects of the development of the real-life algorithmic city that are available in the media and academic literature. These data are gathered selectively from the results of searches of Google and EBSCOHost Research Databases and repositories of smart city cases, such as ICOS (http://icos.urenio.org/).

Regarding the structure of this chapter, the discussion starts with the algorithmic revolution. The following sections clarify the idea of the algorithmic city and discuss the management and regulation of algorithmic practices in local public affairs, the latter including exemplifications that both help to illustrate theoretical points and serve as weak signals of future development. Theoretical and empirical analyses make it possible to outline the fundamental features of the emerging "hyper-urban" formation referred to as the algorithmic city.

In the midst of the algorithmic revolution

What are algorithms?

An *algorithm* is an encoded procedure that includes a list of logically defined instructions for calculating a function. Usually, it refers to a set of steps for a computer program to accomplish a task. It processes the given input data in order to produce a desired output as a solution to a formalized problem.

Algorithms can be used to perform an endless range of functions, such as searching, sorting, compressing, encoding, pattern-matching, identifying, parsing, and so forth. These lead us to the utility of such procedures. The main functions of algorithms include prioritization (search engines, Q&A functions, etc.), classification (reputation systems and credit scoring), association (trend predictions), and filtering (spam filters, recommender systems, news aggregators) (Lepri et al., 2017). Algorithms can perform these functions in various ways depending on the strategy applied. The main strategies include iterative, divide-and-conquer, greedy, brute force, and back-tracking algorithms, each having their specific operations and paradigmatic application areas. Actually, there is no predetermined set of algorithms, but rather each algorithm is developed to be applied to a specific type of problem, and the latter ultimately determines the key features of each algorithm.

Classic examples of algorithms include software that is used to control technical devices. Route finding algorithms can be used to find the shortest or most convenient way from point A to point B. A minimax search algorithm has made it possible to create a checker-playing program that beats human opponents. In the computer world, algorithms perform a range of essential functions behind the scenes, such as audio and video compression. Concerning the natural environment, we can use algorithms to simulate weather patterns. The list goes on. Algorithms can benefit practically anything that can be expressed as a formalized problem statement. Algorithms work at the core of machine intelligence, which works essentially as a calculation written in software for data-driven decision-making (Lepri et al., 2017; cf. Agrawal et al., 2016).

While well-defined processes can be controlled and formalized problems solved using algorithms, it is challenging to think of such complex socio-economic entities as cities in terms of algorithms. We can use two fundamentally different metaphors for illustrating the nature of algorithmic urbanism, the city as a garden and the city as a laboratory, the former emphasizing the embeddedness of the code in the urban milieu with the power to shape a self-organizing urban community, and the latter seeing the city as a kind of aggregate of instances of the use of formal algorithms (cf. Poletto & Pasquero, 2012). In this chapter, our approach is closer to the latter.

The special relevance of urban algorithms comes from their ability to model the entire city, facilitate social interaction, and design responses to changing situations. In such an ideal cyber-physical-social system (CPSS), all services would be adjusted to the given situation and customized to a degree (Hindi, 2013). Such algorithmic urbanism is fairly similar to the concept of the conscious city, which promotes human–environment interaction and especially the responsiveness of the urban environment to city dwellers' needs by taking a cognitive science view of the utilization of artificial intelligence in urban design and management. Such a city is aware of the needs, moods, and activities of its inhabitants and responds to them using various ubiquitous and intelligent systems (Palti & Bar, 2015).

It is noteworthy that algorithms have started to look as if they represent a modern myth. While they can be seen as powerful entities that rule, sort, govern, shape, or otherwise control our lives, their alleged obscurity and inscrutability make it difficult to understand how they perform their functions and what exactly is at stake. This increases the difficulty of conceiving the action needed to govern and regulate algorithmic social reality (Ziewitz, 2015).

How algorithms are revolutionizing societies?

Algorithms were initially developed in mathematics and later became an important conceptual tool in computer science. Until recently, they had hardly any impact on the social sciences. However, the situation started to change gradually in the post-war decades and they finally broke through in the 2000s in the context of service transformation (Zysman, 2006) and the increased interest in the platform economy, artificial intelligence (AI), and a host of other technology trends (Brynjolfsson & McAfee, 2014; Hussain, 2017).

Brynjolfsson and McAfee (2014, 90) express the relevance of this new reality by referring to two critical events that have deeply affected human history: the emergence of genuinely useful AI and the global connectedness of people via the digital network. Separately, neither of these events would have been as powerful without their mutual reinforcement. They create new opportunities that are comparable to the Industrial Revolution. Zysman (2006, 48), who has emphasized in the same way the co-evolution of digitalization and network logic, has described the significance of this change thus: “The drama is that tools and technologies based on algorithmic decomposition of service processes may have the power to revolutionize business models the way manufacturing was revolutionized in the industrial revolution.” Zysman and colleagues (2011, 40-41) claim that just as work was transformed by the evolution of manufacturing, the consequences of the algorithmic revolution in services and the nature of work in both public and private sectors are profound. If these descriptions are accurate, taking into account the decisive role of algorithms in AI, speaking about the *algorithmic revolution* is not an exaggeration.

The idea of the algorithmic revolution appeared in the writings of John Zysman in the context of service transformation, which is particularly relevant for considering politics and public policy and governance. Zysman emphasizes that the key issue in the development of the service economy is not the size or growth in value of the activities labeled “services,” nor is it in any straightforward sense about digital technology. Rather, claims Zysman (2006), it is about how the application of rule-based information technology tools to service activities transforms the services component of the economy, altering how activities are conducted and value is created (Zysman et al., 2011, 40). This implies profound changes in the way organizations create value.

When activities are formalized and codified, they become computable. When functions and activities are translated into explicit rules for their execution, it further enhances the chances for unbundling them in a manner equivalent to decomposition in manufacturing. In short, “[p]rocesses with clearly defined rules for their execution can be unbundled, recombined, and automated” (Zysman et al., 2011, 40). In services, this allows the rapid replication, analysis, re-configuration, customization, and creation of new services. Increases in computational power and the rise of new technological tools imply a tremendous increase in the scope and volumes of activities that benefit from algorithms.

There are numerous examples of simple digitalization in public services that are gradually developing towards platform solutions based on algorithms or – more broadly – AI. The utilization of rule-based practices has been improved in the public sector through managerial efforts, which have their roots in Taylorism and the theory of bureaucracy, and more recent connections with New Public Management (NPM). E-government discourse brought a significant impetus to this discussion in the late 1990s by emphasizing a transformation that is rooted in the adoption of IT tools. Such changes reflect the overall transformation in the public sector, which has for some two decades developed from face-to-face customer services into interactive and transactional services over the Web, which Glushko (2010) describes as a development from *interaction* to *information*. Public-sector logic is slowly developing further towards platform-based intelligent service systems, which in Glusko’s scheme would be a third phase revolving around *intelligence*. This development points to the logic of the institutional side of algorithmic urbanism, which suggests that algorithms are key enablers in this last phase of the development of the mode of public service and governance.

The algorithmic city

Conceptual remarks

Concepts are our means for understanding, constructing, and communicating social reality. At times in discourses on dynamic and rapidly changing phenomena, the manufacturing of new concepts increases conceptual confusion. This has certainly happened in the area where technology meets urbanism. We only have to think of such concepts as the smart city, the intelligent city, the conscious city, the knowledge city, the ubiquitous city, the digital city, the e-city, the virtual city, city 2.0, the technocity, the informational city, the networked city, the innovative city, and so forth. So, why coin yet another term? To start with, most of these concepts carry the burden of their genealogies and have connotations that do not do justice to the emerging pervasive logic associated with artificial intelligence and its algorithmic core. The concept of the smart city is closest to what we are discussing here, but it is limited by its primary interest in: (a) cyber-physical systems to enable the efficient use of natural resources and assets; (b) the management of such areas as energy consumption, utilities, and traffic; and (c) the improvement of transportation systems, infrastructure services, and urban mobility. This is because the factual use of this concept is rooted in the idea that creating smart solutions and systems is essentially a technologically oriented endeavor (Neirotti et al., 2014; cf. Komninos, 2015; Anttiroiko et al., 2014). In addition, a loose – often self-congratulatory – smart city labeling by city governments, developers, and researchers (Hollands, 2008), together with the gradual broadening of the scope of this concept (Anthopoulos, 2017), has increased its ambiguity. Is there actually any city in the developed world that does not claim to be smart? In any case, by taking into account the current discourse at the intersection of urban and technological aspects of development, we may see the smart city as an umbrella concept and the algorithmic city as one of its instances.

Another reason for using a novel concept is its ability to mark a difference and to point to particular novel features. The difference concerns a new logic that cannot be reduced to our ability to provide services on the Web or to control devices or structures using ubiquitous technologies. For example, conventional Web services offer a Web presence and facilitate interaction and transactions, while the algorithms go deeper into the very functional logic of social life. The remote control associated with ubiquitous technologies and the functioning of cyber-physical systems are certainly important features of applied artificial intelligence, but the latter with its algorithmic core cannot be reduced to them.

Having said that, such a labelling is not without risks. To start with, the early use of the concept of the algorithmic city in magazines and academic articles shows surprising variations in its meaning. A chapter of its own in this respect is a way of seeing urban algorithms metaphorically as an embedded, context-sensitive coding logic of the self-organizing community (Poletto & Pasquero, 2012). An alternative way is to see the algorithmic city in terms of coding urban space, which creates connections with systems theory, complexity and chaos theories, and the new science of cities (Batty, 2013). By combining complex urban reality with technology, the algorithmic city becomes a framework for understanding urban space in terms of interaction (Hindi, 2013), underlying codes and systems (Innocent, 2017), and the provision of relevant geospatial information to inhabitants (Hamilton et al., 2014). This hints that the early conceptualizations of the algorithmic city revolved around the code and geospatial data, and the social outcomes of their use. This technological core is applied to an urban context, of which the major dimensions are physical space, local social interaction, and urban governance, as depicted in Figure 1.

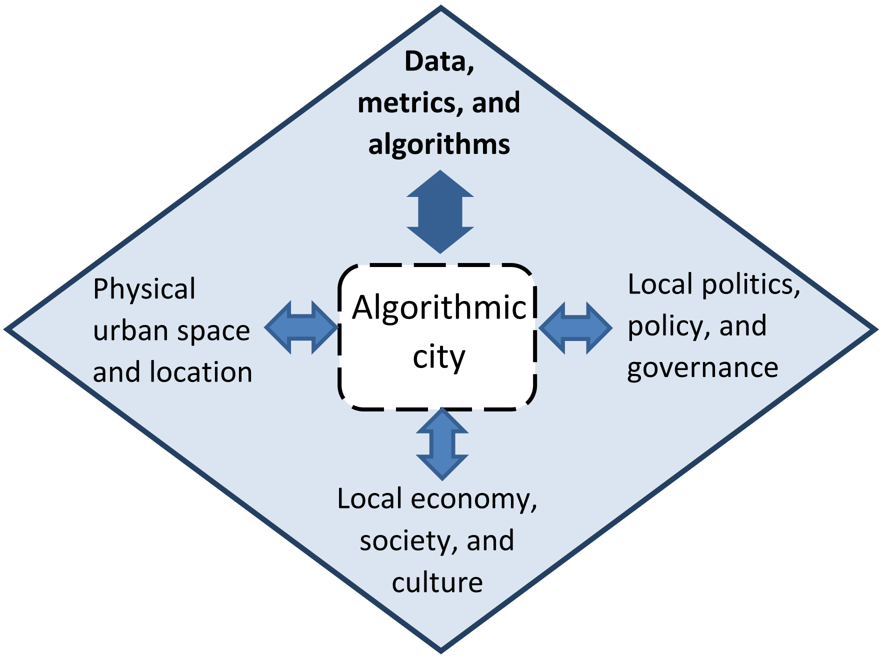

Figure 1. The four dimensions of the algorithmic city.

A particular deficiency in the early conceptualizations of the algorithmic city is the insufficient role given to the special features of the public domain. Many of the early conceptualizations actually imply a replacement of the political-administrative machinery by algorithms. There is, however, a need for a serious consideration of how realistic or meaningful such assumptions are. It must be acknowledged that the power of algorithms, together with the rising influence of social media and other decentralizing tendencies, will undermine the legitimacy of political institutions in some respects and diminish the role of the bureaucracy as a gatekeeper. However, local political institutions may still be needed for discussing the rules of the game as well as providing a framework for policy making and deciding about collective resource allocation – following the principles of direct, participatory, or representative democracy – as there is a need to secure the rule of law and guarantee a certain degree of democratic control over the algorithmic social reality.

Algorithmization and related technology trends

It has become evident that the urban future will be profoundly affected by a range of powerful technological trends. *Informatization* started decades ago. Its impact is becoming clearly seen in public policy, governance, and services in the form of the replacement of human interaction with computerized and automated information processes (cf. Glushko, 2010). Digitalization is the generic technological precondition for informatization. *Digitalization* itself describes a process in which practically all aspects of social life are integrated within a digital sphere or cyberspace, which is then used to control or recreate social reality. *Cyberspace* may sound a somewhat old-fashioned term, but is still widely used. It describes in essence the digital sphere that facilitates and mediates social and human–environment interaction. In general, metaphorical references to cyberspace, virtual worlds, and digital space are becoming outmoded since such systems are ubiquitously present and embedded in our socio-technical environment; they are part of our everyday digital experience (cf. Komninos, 2015).

In concrete terms, digitalization became a hot topic after the Internet explosion in the first half of the 1990s, of which the most fascinating service at that time was the World Wide Web, or simply, the Web. However, rather soon the first generation of the Web started to evolve, and new forms of social interaction emerged. The result was another powerful trend, referred to as *social media* or the slightly broader concept of *Web 2.0*, which rose in the late 1990s and proliferated around the mid-2000s (O'Reilly, 2005). It brought users and user-generated content to the center of the Web. The other side of the social dimension of the digital relates to the generic role of human and social actors in the functioning of cyber-social systems, i.e. not so much as content providers but as consumers or service users. *Cyber-social systems* use embedded digital structures and devices to facilitate, enhance, and scale human endeavors. Today one can advertise, sell, purchase, play, meet friends, share ideas, turn on appliances, and even steal in cyberspace. From a human-centered point of view, human actors and their interaction with digital systems are essential for the functioning of these systems, and they appear as critical factors that determine the outcome of such systemic processes (Perno & Probst, 2017). Smartness brought about by such social uses of the Web is called *collective intelligence* (CI), and the increased use of AI in CI is said to be leading to an "augmented collective intelligence." The latter improves CI by both bringing efficient data processing and automation through AI into collective processes and reducing transaction costs associated with CI (Verhulst, 2018; Anttiroiko, 2018; Komninos, 2015).

Technology is evidently redefining our relationship with the physical environment; it is manifest in a host of novel concepts, such as ubiquitous technologies (UbiTech), the Geospatial Web (GeoWeb), Location-Based Services (LBS), Augmented Reality (AR), the Internet of Things (IoT), Web 3.0, Web^2 (Web squared), and cyber-physical systems (CPS), which have brought the separation of bits and atoms to an end, so to speak (Mitchell, 2003; see also Komninos, 2015; Pitroda & Mihaile, 2017). In a paradigmatic form, they all connect geospatially or locationally referenced data with objects that can be utilized for controlling devices and physical objects, infrastructures, animate beings, or human behavior. There are various kinds of CPS, IoT, and other applications and systems; they all in the big picture build a precondition for global multi-modal connectivity, which is supported and distributed by the utilization of third-party clouds, service-oriented architecture (SOA) and software, and platforms and infrastructure as a service models (SPI model or Xaas for short).

A foundation of a parallel trend, *Big Data* or more generally datafication, was laid down a long time ago, even though the term itself was coined as late as in the latter half of the 1990s. It became a hot topic after the business community started to speculate about the opportunities of computer systems' improved capability to utilize data derived from multiple sources. In their book, *Urban Data*, Pagani and Chiesa (2016) describe how datafication introduces modalities that enable us to find effective ways of coping with the host of economic, social, and ecological challenges faced by contemporary cities. Even if Pagani and Chiesa discuss automated, parametric, and algorithmic practices and articulated models that allow us to challenge complexity, their discussion focuses primarily on datafication. Such an approach can be applied in very concrete ways to various urban processes, such as town planning and architectural design (Celani et al., 2015). This is the same aspect that Stimmel (2016) emphasizes in her book on smart cities. When this view is elaborated further, it leads to an abstract view of data flows at the heart of urbanism that can be called a real-time city (Kitchin, 2014). Data is an essential part of the input side of algorithmic procedures; many algorithms that support decision-making and resource optimization are designed to analyze massive amounts of human behavioral data from various sources, and even apply machine learning in the process to improve the output, which reflects the need to develop both the input and output side of the procedure in order to provide the best possible support for decision-making (Lepri et al., 2017).

The algorithmic revolution – or rapid and profound algorithmization – started to rise during the 2000s, reflecting the increased use of algorithms in the digital world and cyber-physical systems designed to perform various control and decision-making functions. An umbrella concept that covers this area is artificial intelligence (AI), often discussed together with robotics, which is more or less self-explanatory regarding its core meaning. What algorithmic reality and AI bring to the field of technology trends is intelligence applied to any given social activity – from governance to business to leisure – that utilizes various data sources when applying given models, metrics, or calculations for performing its task. This development is closely associated with such concepts as the intelligent Web, autonomous systems, machine intelligence, and machine learning (ML) (Shroff, 2013; Rajan & Saffiotti, 2017).

The idea of the algorithmic city obviously implies that we discuss the use of algorithms in an urban context. The urban dimension is conventionally associated with geospatial and locational data at the core of urban knowledge processes and dynamism. The novelty of the algorithmic city in this context must be sought from *intelligence* that is radically changing the approach to urban structures and processes. The AI revolution unfolds as a key catalyst nested in the broader digital revolution, which has, since the 1960s, gradually transformed urban knowledge processes and infrastructures. This relates to our discussion of the smart city, since it assumes that the "digital" can be harnessed to render urban systems more efficient. There is an important transition occurring in this respect, however. A few years ago, the hot topic was Big Data, emphasizing the ability of cities to collect, store, and process gigantic flows and stocks of data; now, the discourse is focused on AI, referring to the increased capability of cities to make sense of this data with the help of metrics, algorithms, and machine learning (Miailhe, 2017).

To summarize, what has been said above is close to how Pitroda and Mihaile (2017) describe the merging of technology trends: "Improvements and convergence in machine learning and neurosciences combined with the 'Big Data' and 'Internet of Things' revolutions, and powered by the ubiquity of high-performance scalable computing are now propelling us into a new age of Artificial Intelligence." What is essential in this picture is that it has been evolving at a quick pace by integrating various aspects of worldly reality, in which algorithms and artificial intelligence appear to have a key role as they process and enrich data and bring about smart solutions that go beyond the human capability of processing, analyzing, and synthesizing data. This conceptual field is illustrated in Figure 2.

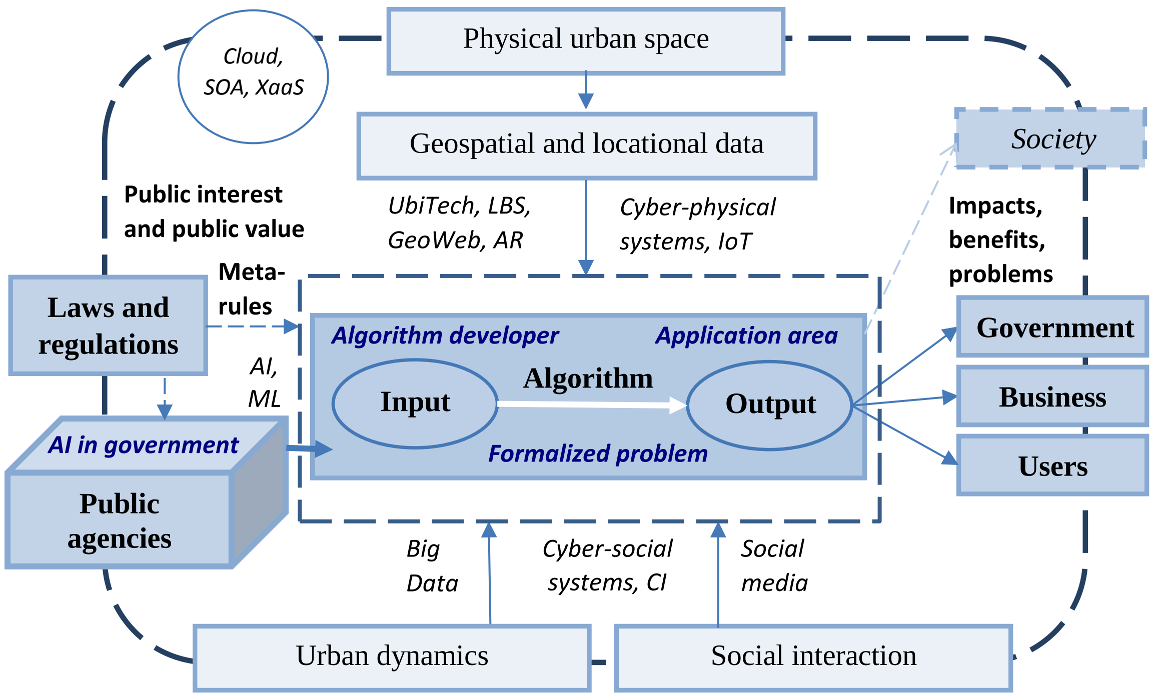

Figure 2. The main elements and technological trends associated with the field of algorithmic governance.

Managing and regulating algorithmic city

The city has been placed at the forefront of the debate on megatrends and the future of humanity. Both in academia and international governance, urbanization has attracted much attention, not least because in 2008 we passed a symbolically notable milestone: more than a half of the global population now live in urban areas. The figure is expected to be in the region of 70% by 2030. In fact, some scholars have glorified the city itself as a major social innovation that has helped humankind to achieve better living conditions in terms of material wealth, health, and sustainability (Glaeser, 2012). The metropolitan revolution and new localism are fairly recent outcomes of the same discursive turn, reflecting a dramatic shift in power politics and policy-making towards the emphasis on the role of cities, metropolitan areas, and regions in solving social and economic problems (Katz & Nowak, 2017; Katz & Bradley, 2013; Barber, 2013).

The pervasive impact of technological development in practically all aspects of human life, together with global urbanization or "glurbanization," has sparked discussion about the role of technological solutions developed for cities in promoting such goals as economic growth, social inclusion, and sustainable development. The most commonly used label for such a discourse is the *smart city*, which has gained a lot of attention as it reflects the conviction that technological solutions play a key role in solving urban problems. In most of the conceptualizations, smartness is seen as a multi-dimensional phenomenon associated with such factors as connectedness, social inclusion, and sustainability (Komninos, 2015; Stimmel, 2016). Algorithmic urbanism as a dynamic phenomenon and the algorithmic city as its institutional dimension play an essential part in this discourse. Zysman and colleagues (2011) assume that the algorithmic revolution affects the methods of service delivery and influences the gradual reshaping of public governance. Algorithms bring into the picture a novel element, a rule-based or automated form of governance that cannot be reduced to any conventional mode of public governance. Hence, there is the need for a new concept that depicts the novelty associated with the use of algorithms in public governance.

There is a tendency to view algorithmic governance as a mechanism that undermines the legitimacy and requirement for political institutions and administrative machinery. Such a radical view highlights the ability to model the city on the basis of a plethora of interactions, which will turn the city–people relationship upside down, i.e. cities will adapt to people and their changing habits (Hindi, 2013). This view is fundamentally about human–environment interaction and thus it provides a limited view of the role of algorithms in society. Such an approach presumes that as the algorithm is able to aggregate interests, facilitate decentralized decision processes, and perform decision, control and monitoring functions, we will not need politicians or bureaucracy. As appealing as this may sound, it appears to be an unrealistic vision – at least in the short term. However, it is plausible to say that new forms of algorithmic governance have the potential to redefine forms of governance and reorganize or replace many government functions. A particular issue will be whether key power holders, interest groups and the general public are able to agree both on the general principles of the use of algorithms in public service and governance and on how varying interests are molded into these algorithms.

As this chapter focuses on cities, the primary association of the use of algorithms is "urban," which creates an immanent connection with location and physical space. In such a field of application, algorithms can be used to gather relevant inputs – such as location, visit history, or construction updates – and provide outputs that help us to orient ourselves in our environment, for example, when choosing the best route or estimating travel time. In everyday life, we benefit from a range of geospatial Web applications and location-based services that facilitate urban interaction and dynamism, as in the case of ordering a taxi or checking traffic conditions. Even if we speak of a city or the "urban," we have to take into account global platforms and service ecosystems, as many of the services we use in a particular city are actually hybrid services that integrate resources and service components of both local and extra-local origin. For example, we use these digital tools and platforms in searching for information and shopping online, securing transactions, checking credit cards, choosing and buying books or plane tickets, dating, and networking on social media, and a large part of these services are being provided by extra-local platforms with algorithms at their functional core (see Hamilton et al., 2014). This is how algorithms as key components of digital platforms and wider service ecosystems pervade our everyday life.

Regarding public governance, there is the compelling question of how algorithmization affects citizen participation and democratic control. There is a true challenge to make the case for developing transparent algorithms by which computational processes organize and present geospatial, governance, and service-related information to inhabitants (Hamilton et al., 2014). Transparency is one of the most important issues here, because practically all processes in which algorithmic management methods are applied take place in the "background" of user experience; they become felt through their effects rather than as interactive processes *per se* (Hamilton et al., 2014). Angwin and colleagues (2016) remind us that "machines" help us not only with manual labor but also with intellectual tasks, such as curating the news we read, calculating the best driving directions, or providing buy-hold-sell recommendations to shareholders. But as such technological systems make more decisions for us, it becomes essential to understand the algorithms that produce such judgments or recommendations. All too often, these algorithms operate as black boxes, which implies that it is impossible for outsiders to know what the data sets or other inputs are, how they are processed, and, thus, how algorithms end up with their solutions.

Algorithmic politics

Local politics refers to processes of organized interest articulation and aggregation and related collective policy and decision-making within a community. One of the key processes in dealing with community affairs is electoral politics, which is a mechanism that determines who is eligible to represent the community in local decision-making bodies. The algorithmic revolution gradually entered electoral politics in the 2010s, the most famous cases being the electioneering in the US presidential elections and the referendum on EU membership in the UK (known as Brexit), both in 2016. Political campaigning and marketing has always touched upon the borders of legitimacy throughout the world for a number of reasons. However, it seems that the utilization of algorithms has brought a new factor into the picture, one characterized by a pervasive mediatization and an intensified manipulative use of big data and social media – and, as the flip side, the rise of populism.

An indication of the seriousness of the situation is that in 2017 the Information Commissioner's Office (ICO), an independent authority in the UK aiming to uphold information rights in the public interest, launched an investigation into how data is used by political parties in campaigning. The issue is, broadly speaking, whether the analytics and algorithms that allow for modern-day political campaigning to be precisely targeted (micro-targeting) require new data protection guidelines. This emerging form of political life is sometimes called *transactional politics*, which calls for greater clarity in terms of how data use, analytics, and algorithms are governed (Trendall, 2018).

Lastly, a vision of the city run by AI has found its expression in Japanese local elections. Michihito Matsuda, a candidate in mayoral elections held in April 2018 in Tama city in Tokyo Metropolitan Area, said that if elected, he would lead the city with the help of AI. His candidacy was partly financed by two men, one holding a high position in SoftBank, the global software provider, and the other being a former employee of Google Japan. Matsuda ultimately was not elected; he came third with some 4,000 votes. The idea behind the AI Mayor is that an AI robot would analyze petitions put forward to the council, break down the pros and cons, and assess their effects. The robot could also participate in dialogue before calculating how to implement residents' wishes and propose compromises to solve conflicts of interest. The candidate explained how AI would guarantee that decisions would follow a clear logic, mistakes would be eliminated, and corruption would be eradicated. The problem with this message is that at the moment AI is not able to deal with such a major challenge, not to mention the potential manipulation of the system by those who know how each algorithm works. Nevertheless, a particularly interesting idea raised by this candidacy is the suggestion that AI could enable pure, rational, and corruption-free politics and policies, which is definitively an appealing message in a time characterized by a growing distrust in politics (Withers, 2018). Even though this case was not successful and AI-based policy-making still leaves a great deal to be desired, similar ventures may appear in the technologically advanced democracies of the near future and – who knows – might gradually start making a difference.

Algorithmic regulation

Regulation is an intentional activity that sets a framework for action and is directed at achieving a pre-specified policy goal. Even if regulation works both within and outside of the government, its most essential feature is that it aims at securing public interest by regulating a particular domain of activities that involve private, non-governmental, and civic actors. This domain of regulated activity can include any socially relevant activity, such as customs procedures, traffic behavior, the private provision of health care, vehicle emissions systems, airline automatic pilot systems, credit card fraud detection systems, and Internet search engines.

Regulations are enacted by legislature or governing bodies, and they are supposed to be enforced effectively by the regulator or the broader law enforcement system. Algorithmic regulation is an alternative form of government regulation: unlike a conventional regulatory system, algorithmic regulation applies computer algorithms to regulations and law enforcement. An analogy with platform companies works well here, as they started algorithmic regulation much earlier than governments. In short, just as companies like Google, Microsoft, Apple, and Amazon built their own regulatory mechanisms to manage their platforms, governments at different institutional levels exist as kinds of platforms to ensure the success of communities, regions, and nations, and such public governance platforms need to be well regulated (O'Reilly, 2013).

Yeung (2017) defines *algorithmic regulation* as a decision-making system that regulates a domain of activity in order to manage risk or alter behavior through the continual computational generation of knowledge from data emitted and directly collected from numerous dynamic sources pertaining to the regulated environment. It is supposed to identify and, if necessary, automatically recommend action or refine the system's operations to attain a pre-specified goal. What is essential in algorithms when compared with other means of regulation is their machine-learning, data processing, and storage capacity, on the one hand, and the limited transparency of the codes and the users' or other stakeholders' complex relationship with the algorithmic regulation on the other (cf. Lodge & Mennicken, 2017). Algorithmic regulatory systems share four features (O'Reilly, 2013):

1. A deep understanding of the desired outcome,
2. Real-time measurement to determine if that outcome is being achieved,
3. A set of rules (algorithm) that make adjustments based on data,
4. Periodic, deeper analysis and assessment of whether the algorithms themselves are correct and perform as expected.

There are indicators showing that the mode of regulation may be developing towards a higher level of sophistication. Lawrence Lessig (1999) has pointed out how the "Code is Law," i.e. the code is ultimately the architecture of the Internet, and as such it is capable of constraining an individual's actions via technological means. Hassan and De Filippi (2017) have taken this idea further by stating that the digital environment opens the door to a new form of regulation, which imposes its own values by embedding them into a technological artefact. Thus, regulation by code is progressively establishing itself as a regulatory mechanism adopted not only by the private sector, but also by the public-sector organizations. Governments and public administrations increasingly rely on software algorithms and technological tools in order to define code-based rules, which are automatically executed or enforced by the underlying technology. This is the case, for example, in the use of computer algorithms to support judicial decision-making and determine jail sentences or parole (O'Neil, 2016). When "code" becomes "law," it simultaneously becomes a new form of regulation whereby technology is used to enforce existing rules. Especially since the advent of blockchain and Machine Learning (ML), we have witnessed a new trend, whereby rules become fully technologically embedded. Such new rules are enforced *ex-ante*, making it difficult for people to breach them. When the law is executed as a code, the given rules are highly formalized and leave little to no room for ambiguity (Hassan & De Filippi, 2017).

There are two technologies worthy of special mention here. First, blockchain technology as an emergent technology provides new opportunities to turn law into code. For example, with the advent of smart contracts (i.e. software deployed on a blockchain-based network and executed in a distributed manner by a distributed network of peers), blockchain technology has the potential to revolutionize the way in which people coordinate themselves and transpose legal or contractual provisions into a smart contract with a new set of code-based rules that serves as a guarantee of execution (Tapscott & Tapscott, 2016).

The other piece in the puzzle is ML, which allows software to acquire knowledge from external sources and to learn or do things that it was not explicitly programmed to do. The availability of growing amounts of data, along with the recent advances in neural networks and data mining techniques, has led to the widespread adoption of ML in several online platforms. What ML enables is the introduction of code-based rules that are inherently dynamic and adaptive, taking the "code is law" closer to traditional legal rules characterized by the flexibility and ambiguity of natural language. In principle, to the extent that regulatory systems can learn from the data they collect or receive, they can evolve constantly, refining their rules to better match the specific circumstances to which they are meant to apply (Hassan & De Filippi, 2017).

Algorithmic decision-making and social control

The most frequently cited cases of algorithmic policy and decision-making are the algorithms used in policing, law enforcement, social control, and the social benefit systems. As pointed out by Eubanks (2015), policy algorithms promise increased efficiency, consistent application of the rules, timely decisions, and improved communication. However, they also raise issues of equity and fairness, challenge existing due process rules, and can occasionally even violate people's basic rights and threaten their well-being.

Predictive policing relies on data built upon a foundation of historical racial inequities in law enforcement. A case in point is Chicago's Strategic Subject List (SSL) or "heat list" of the 420 people most likely to be involved in violent crime sometime in the future. The list is the result of a proprietary predictive policing algorithm that processes and analyzes data on parole statuses, arrests, social networks, and proximity to violent crime (Eubanks, 2015). These kinds of applications may make anyone look suspicious or reflect racial or other biases. However, data crunching and AI may also reveal sensitive truths about racial or identity issues, which may raise new tensions within the climate of political correctness and over-sensitive political culture, especially in multicultural countries like the USA. This is most obvious with the systems like Chicago's SSL. In essence, SSL calculates risks. It helps the police to determine not only those who drive gun violence in the city but also the people they need to target with warnings or offers of help. Like in most similar cases, Chicago Police Department has been unwilling to open the algorithm to the public. After a lengthy legal dispute, a local newspaper, the *Chicago Sun-Times*, obtained one version of SSL and was able to shed some light on it. This is a typical case of the current transitional phase of algorithmic governance, where institutions have a tendency to keep algorithms secret. Even though some parts of SSL were released, which is certainly a step forward, it is still unclear to outsiders how the algorithm itself works, how different factors are weighted, and whether the system is fair and effective, as many details are still kept secret by the police (Dumke & Main, 2017).

Another case is the use of algorithms in risk assessments designed to help battle implicit human racial bias. New Jersey, for example, implemented an algorithm called the Public Safety Assessment (PSA), which predicts the likelihood that an individual will commit a new crime if released before trial, and also the likelihood that they will fail to return for a future court hearing. In addition, it flags those defendants who present an elevated risk of committing a violent crime. The algorithm works by comparing risks and outcomes in a database of 1.5 million cases from 300 jurisdictions nationwide. It produces a score of one to six for the defendant as well as a recommendation for bail hearings based on the algorithm that processes this data (Vijayakumar, 2017). What is actually promising in the case of PSA is that after the application of the system, the state sets bail for far fewer people than it did before. It is not without controversies, though. Some see that the system allows criminals to roam free, while others believe that it is more equitable because bail often allows the wealthy to buy their freedom. As the PSA score acts only as a recommendation, judges do not need to follow it (Vijayakumar, 2017).

Remote eligibility systems form an important application area. Such systems usually run on the assumption that lacking some vital information or documents — in a process that often requires a lot of supporting material— is an affirmative refusal to cooperate with the welfare determination process. Eubanks (2018) tells an illuminating story to shed light on the functioning of such an algorithmic system. In the fall of 2008, Omega Young got a letter prompting her to recertify for Medicaid. However, she was unable to make the appointment because she was suffering from ovarian cancer. She called her local Indiana office to say she was in hospital. Her benefits were cut off, the reason being her "failure to cooperate." The tragedy of the case is that she won an appeal for wrongful termination and all of her benefits were restored: it was too late for her, however, as she died on March 1, 2009, one day before this corrective decision was made.

Interestingly, automated decision-making and recommendation systems, such as predictive policing and remote welfare benefits systems, no longer simply help humans in government agencies to apply procedural rules; rather they become the primary rule-oriented decision-makers. Algorithmic decision-making takes on a new level of significance when it moves into the realm of public policy. As put by Eubanks (2015), the algorithms that dominate policymaking —particularly in public services such as law enforcement, welfare benefits, and child protection— act less like data sifters and more like gatekeepers. They mediate access to public resources, assess risks, and sort groups of people into the "deserving" and "undeserving" or the "suspicious" and "non-suspicious." When things go wrong, policy algorithms may cause real damage that is difficult to remedy immediately under existing legal protections. If community members are unfairly stigmatized or if they have been denied access to services to which they were supposed to be eligible, not only is it difficult to correct the decision, but it may also be devastating on an individual level.

Algorithmic public service management

The most profound changes in algorithmic logic in services have already taken place in the platform business and sharing economy, as exemplified by cases like Amazon, Airbnb, Lyft, and Uber. Uber, for example, revolutionized passenger transportation services across the world with its algorithmic management system (Ries & Miailhe, 2017). It has expressed its role as a neutral intermediary that connects supply and demand with an automated mechanism for finding the right price, making their profit by licensing software. Such systems give companies an opportunity to manipulate algorithms in their favor and to steer their drivers' behavior. Software can also be used as a tool in competition, as in the alleged use of Uber's "Hell" software that was used to entice double-appers to drive exclusively for Uber. On the other side of the equation, Uber drivers may also work together to game the company's algorithms. Such side effects imply that algorithmically managed services are based on logic that cannot be observed at the level of overt or observable behavior relating to social interaction, and, accordingly, regulators need to take a closer look at the special features and underlying logic of algorithmic business and service models (Simonite, 2015; Rosenblat & Stark, 2017; Herrera Anchustegui & Nowag, 2017). Even if algorithm-based public services operate within a public domain and are supposed to produce public value, it does not mean that they are free from the manipulation or bias found in social media and algorithmic business models.

Algorithms have been for understandable reasons prevalent in recommending, sorting, and similar functions, as well as in performing social control. However, in typical interactive public services, such as health care, day care, and education, the direct use of algorithms is still rather rare, even in the developed world. This hints that algorithms have been easier to utilize in public administration and in performing managerial and governance functions than in interactive public services. Nevertheless, opportunities in this field are significant, for algorithms can potentially, for example, help in teaching students, provide knowledge support to interactive services, and assist in making diagnoses and giving recommendations for methods of care. Educational, medical, and social welfare algorithms may not replace all the teachers, doctors, and caretakers, but rather facilitate and support their work. The take-up of such new systems depends not only on the return on investment or expected efficiency gains, but also on legal and regulatory issues and, ultimately, social acceptance and legitimacy. We may even claim that our perception of algorithm-assisted public service is a reflection of our trust in government (Van de Walle & Bouckaert, 2003), and several conditions must be met in order to build this trust, the obvious critical factors including trust in technological tools applied, the reliability and validity of the data, and the outcomes and social consequences of the use of such systems (Bresnick, 2018; see also Watters, 2015).

We have discussed previously the political, governance, and policy aspects of algorithm use in the public domain. However, this is also a burning managerial issue, as just like in other domains, algorithms have a role to play in performing managerial functions. The issue is not only about managerial practices but also about management philosophy. Services are rooted in social rules, regulations, and local conventions, and algorithmic logic will require that many of such value premises are changed, either proactively or reactively (Zysman et al., 2011, 41). If we look at this issue from the point of view of public service organization, there is a need for change management that deals with obvious novel requirements in work processes and human resources. As a rule, the automation of basic activities may make some work obsolete, but it also requires that professionals start performing more advanced tasks: "the analytical tasks of managing information flows generated by ICT-enabled services often require a different set of skills than providing the service itself" (Zysman et al., 2011, 21).

Lastly, managerial algorithms designed to increase efficiency and improve an organization's performance and customer satisfaction must overcome some peculiar challenges. The case of Washington DC's teacher evaluation system is most telling. The motivation behind the construction of the system was a need to do something about underperforming schools in the metropolitan area. It was assumed that the ultimate reason behind the poor performance was the quality of teaching, or, to put it more bluntly, the teachers who were not doing a good job. The expected solution to the problem was to lay off poorly performing teachers. A teacher assessment tool called IMPACT was developed and, as a result, at the end of the 2009–2010 school year, the district fired all the teachers whose scores developed by the algorithm put them in the bottom two percent. Later, more teachers were laid off. However, the idea of evaluating educational progress and calculating how much of their advance or decline could be attributed to teachers was not as simple as the system designers assumed. This case shows how AI creates its artificial world, which is then used to justify the intervention in the real world. It neither uses feedback to learn nor triangulates its results or assesses them against the relevant context. Rather, it is self-perpetuating and can eventually become destructive if applied mechanically. So, in the case of Washington DC school district's performance evaluation system, teachers with low scores were failures and that was how they were treated. The scores did not inspire the search for truth, but embodied it.

In this particular case, the problem was that if some actors within the system manipulate it, some others may suffer as a result. This hints that manipulative and rent-seeking behavior is worth serious consideration in the design and use of such systems. It appeared that the scores of incoming pupils were higher than their factual performance level. For example, many of those students who were ranked at an advanced reading level struggled to read even simple sentences. Something was wrong in the social side of the cyber-social system that was not taken into account in the "model world," and this occasionally brought about irrational outcomes that affected the lives of many. High levels of erasures on the standardized tests were a widely practiced form of cheating. This was partly caused by the institutional system: the stick of the system was that if students stumbled on the test, the teachers' jobs were at risk, while on the carrot side, over-performing students meant bonuses for teachers and administrators. As difficult as it may be to believe, it is likely that some teachers had corrected their students' exams out of fear or greed. Then, when some teachers had to start teaching classes of students with artificially inflated scores, it looked as if the children had lost ground over the following year, and the teacher in question appeared to be an underperformer. This is how many teachers were punished by the system, some for good reason, some not.

To generalize, an algorithm processes large data sets from various sources and comes up with a probability that a certain person might be a bad hire, a risky borrower, a terrorist, or a miserable teacher. This probability is distilled into a score that can turn someone's life upside down. And when the person fights back, suggestive countervailing evidence is not necessarily enough. The human victims of the system as a rule have to provide an ironclad case, while the truthfulness of algorithm due to its "objective" calculative nature is taken for granted (O'Neil, 2017).

Towards citizen-centric and well-governed algorithmic city

There is a reason why Zysman (2006) and Brynjolfsson and McAfee (2014) emphasize the revolutionary nature of algorithmization. It has huge potential to transform almost anything in our world, assuming certain fundamental conditions are fulfilled. It has the potential to increase the efficiency, effectiveness, and smartness of public governance, policies, and services. This potential can be realized only if algorithms work properly, are validated, and gain political legitimation. That is why the issue is at the same time technological, social, and political. We will next address three particular issues that revolve around algorithmic power, identity, and policy: (a) the preconditions for a bottom-up approach to algorithmic governance; (b) the understanding and improvement of the rights of data subjects affected by algorithmic services and governance; and (c) the design of clear policies and governance principles concerning the transparency and governance of algorithm-based practices.

From power politics to bottom-up design. The discussion about the dark side of algorithmization has revolved around the violations of privacy, information asymmetry, the lack of transparency, discrimination, and social exclusion (Lepri et al., 2017). It would be too narrow a view to associate the dilemma of algorithms in the public sector with awareness, access to information, or transparency – it is much more than that. It is about accountability, democratic decision-making, and public-sector management, and unfortunately the signs of the future development are not particularly encouraging (see e.g. World Wide Web Foundation, 2017). In fact, in the social sciences – at least in terms of internationally distributed books – the year 2017 marked the rise of literature that warned us of the power of algorithms and similar emerging technologies and their pervasive – either potentially or factually harmful – impact on citizens' lives (O'Neil, 2017; Finn, 2017; Ferguson, 2017; Foer, 2017; Wachter-Boettcher, 2017; Cheney-Lippold, 2017).

O'Neil (2017) explains how algorithmic governance tends to work as a black box. Interestingly, such opacity and complexity is part of the power algorithms offer to those who introduce such systems. Furthermore, as such systems are built by humans, many of the models encode human prejudice and bias into the software. The reality shows that they tend to punish the poor and the oppressed in society. O'Neil (2017) calls these harmful models and tools as "weapons of math destruction" (WMD).

Nevertheless, the big picture may not be so gloomy. Along with general tendencies towards participatory governance, a new style of service management and governance may emerge, relying on human–computer interaction and machine learning techniques in which citizens are to be governed as co-creators of personalized services (Williamson, 2014). Hindi (2013) sees that there is a chance to make algorithmic reality a bottom-up process if people are willing and able to take the lead: "All we need is for people to convince city operators, utility companies and governments to open their data so that more predictive models can be built, and cities efficiently managed." Creating bottom-up processes in such a challenging field as algorithmic governance may not be that easy, however, as in the current representative system of governance the processes are controlled by the trinity of algorithm developers, techno-bureaucrats, and political representatives. Bottom-up processes require transparency, open discussion, and active civic participation facilitated by participatory platforms or consensus conferences in determining the rules and practices of algorithmic governance that have not seen the light of day so far. The little evidence we have is rather discouraging, in fact. Tenney and Sieber (2016), for example, have analyzed data-driven civic participation in Toronto, Canada. They argue that the use of large volumes of data that are handled through complex assemblages of computer software and algorithmic treatments are becoming modern approaches to citizen engagement in local public affairs. However, this tends to strengthen passive participation at the expense of active participation. They conclude that "[i]n the case of VGI [volunteered geographic information], large amounts of citizen-contributed data are algorithmically harvested and repurposed, which render citizen-government relationships into passive forms of indirect interaction (i.e., asynchronous, automatic, and repurposed content)." Such observations imply that the bottom-up style of development of the algorithmic city has critical obstacles to overcome.

From data subjects to mediatized life-worlds. Access to information and the protection of privacy are at the forefront of the policy debate over algorithmic governance. Such a discussion usually concentrates on individuals and their data rights. For example, the EU Directive on the protection of individuals with regard to the processing of personal data and on the free movement of such data (Directive 95/46/EC) requires that the member states of the EU guarantee every data subject the right to obtain from the controller confirmation of whether data relating to a person is being processed and, if so, for what purpose, as well as "knowledge of the logic involved in any automatic processing of data concerning him/her at least in the case of the automated decisions referred to in Article 15 (1)." Article 15 discusses the data subject's right to object to automated individual decisions. It states every person should be guaranteed the right not to be subject to a decision that produces legal effects concerning him/her or that significantly affects him/her, if the decision is based solely on the automated processing of data intended to evaluate him/her or his/her performance, creditworthiness, reliability, or other aspect of his/her life. Exceptions to this rule include the data subject's consent, sufficient measures to safeguard his/her legitimate interests (e.g. allowing him/her to express his/her view of the matter), and processes that are authorized by law, which is expected to lay down measures to safeguard the data subject's rights (EU Directive, 1995). The use of personal data and data protection is generally seen to concern individuals, not collective entities, which may actually suggest a false sense of agency and considerably increase the burden of individuals in these kinds of processes. In any case, it is challenging to enact laws that guarantee human rights in the algorithmic social reality. Most notably, it is difficult to regulate the digital and media world to minimize algorithmic manipulation and discrimination (Wagner, 2016).

Even if individuals' data rights are definitively among the most urgent policy issues in dealing with algorithmization and the overall digitalization and the development of cyber-social systems, there is a particular contextual issue to be addressed. Emerging algorithmic logic that is mediated by complex cyber-physical-social systems operates through media interfaces. *Mediatization* is an important co-evolving process, which is building a new dominant interface to urban life. It has a real impact on how we orient in our real and digital environments, and how we interpret our social reality. For example, in the early 2000s, Matei and colleagues (2001) asked residents of Los Angeles to highlight a map to indicate areas they thought were dangerous. They found that the differences among the shapes people drew could be predicted by which media outlets they watched. We may legitimately assume that the dramatic changes in the media landscape, such as the rise of the Internet, social media, and smart phones, have affected our spatial orientation and sense of community (Hamilton et al., 2014). To take this scheme further, we may even claim that the most sophisticated forms of cyber-physical-social systems (CPSS) are transforming these systems as an extension of humans, echoing Marshall McLuhan's (1964) idea of the role of media as an extension of man. At the same time, the mediatized sense of community creates a media-induced connection to one's living environment, which takes us close to the idea of an imagined community (cf. Hepp et al., 2018).

What is most striking is that mediatization implies individualization as an instance of partially augmented, trans-local hybrid urbanity. The immediate physical environment continues to be a complex setting for and condition of human existence, yet its connection with CPSS molds algorithmic urbanism into an environment for the "mediatized citizen," who is ubiquitously connected and possibly living under some kind of filter bubble, increasingly detached from genuine human interaction and diversity. It is worth emphasizing that no city is solely virtual, mediatized, augmented, automated, or algorithmic, and no city dweller is completely detached from his or her urban context. Nevertheless, the role of cyberspace and the technologically mediated dimensions of social life have increased along with the pervasive digitalization of our life-worlds. A potential direction of change in the public domain is paradoxically towards a kind of algorithmic individuation of regulation, public policy, and collective consumption in a pervasively mediatized environment. This is hardly a desirable future, for rather than individuals living in a filter bubble, there is need for a "sociodiversity" that fuels collective intelligence and innovation, compels us to reflect upon opposing viewpoints and positions, and improves the resilience of communities (Helbing et al., 2017).

Policy for algorithmic governance. The previously discussed challenges boil down to the issue of how to preserve fairness, due process, and equity in automated decision-making. We may, of course, use the principles of administrative law as the point of departure, for even if they are primarily concerned with human decisions involved in the exercise of state power and discretion, they offer an avenue for the regulation of algorithm-assisted decision making in the public sector (Oswald, 2918). Moreover, some laws and regulations already address the issues relating to the use of algorithms, as is the case with the European Union's General Data Protection Regulation (GDPR) 2016/679 (Goodman and Flaxman, 2017). However, regulation usually lags behind innovation, and the rapidly evolving algorithmic reality makes no exception. In order to make sense of this challenge, Eubanks (2015) provides a framework that highlights four categories that should be taken into account when considering the use of algorithms in the public sector, those of algorithms, their contexts, identified problems, and smart policy responses. We thus need to learn more about how policy algorithms work; consider the political context of algorithms; address how cumulative disadvantage sediments in algorithms; and respect constitutional principles, enforce legal rights, and strengthen due process procedures.

These questions are part of a wider agenda. If widespread and pervasive technologies are not compatible with the values of our society, they are likely to cause considerable damage. There is even a chance that computerized systems will take over the world and create an automated society with totalitarian features. To prevent such a development, we must decentralize the functions of information systems, support informational self-determination and participation, enable user-controlled information filters, support collective intelligence, and enhance digital literacy and enlightenment (Helbing et al., 2017). Policy for algorithmic governance is one of the most important elements of this agenda. What such a policy should look like in concrete terms has been developed by a British innovation foundation Nesta. It has identified principles or a code of standards that revolve around the transparency and governance of the AI-based decision-making in the public sector (Copeland, 2018):

> 1. Every algorithm used by a public sector organization should be accompanied with a description of its function, objectives and intended impact, and made available to those who use it.
> 2. Public sector organizations should publish details describing the data on which an algorithm is trained, and the assumptions used in its creation, together with a risk assessment for mitigating potential biases.
> 3. Algorithms should be categorized on an Algorithmic Risk Scale of 1-5 (5 referring to those whose impact on an individual could be very high, and 1 being very minor).
> 4. A list of all the inputs used by an algorithm to make a decision should be published.
> 5. Citizens must be informed when their treatment has been informed wholly or in part by an algorithm.
> 6. Every algorithm should have an identical sandbox version for auditors to test the impact of different input conditions.
> 7. When using third parties to create or run algorithms on their behalf, public sector organizations should only procure from organizations able to meet Principles 1-6 above.
> 8. A named member of senior staff should be held formally responsible for any actions taken as a result of an algorithmic decision.
> 9. Public sector organizations wishing to adopt algorithmic decision making in high risk areas should sign up to a dedicated insurance scheme that provides compensation to individuals negatively impacted by a mistaken decision made by an algorithm.
> 10. Public sector organizations should commit to evaluating the impact of the algorithms they use in decision making, and publishing the results.

By applying the above-mentioned principles, many of the problems we face today in algorithmic urbanism could be avoided. Good algorithmic governance would also contribute to a balanced development in our increasingly technologically mediated and mediatized world.

Conclusion

The discussion in this chapter has shed light on the institutional side of the emerging algorithmic urbanism. It paints a picture of a city as a densely populated settlement with its urban dynamism increasingly determined by algorithm-driven autonomous systems. Local governments are throughout the developed world becoming affected by the increased use of algorithms in political life, regulation, decision-making, public management, policy-making, and the provision of public services. Such new tools have the potential to enhance efficiency, effectiveness, impartiality, and predictability in performing the functions of government.

An algorithm is a rule-based procedure that collects relevant data, processes it according to the given rule, and produces an outcome that a responsible public organization can use in performing its functions. It is worth remembering that algorithms do not "think" when they approve credit cards, recommend news feeds, count votes, determine financial aid, or process other rule-based functions. As pointed out by Vijayakumar (2017), "we rarely realize how much blind trust we place into algorithmic decision-making."

Regarding the nature of algorithmic intelligence, it is essentially aggregative and calculative even if we are making progress with machine learning and creative algorithmic intelligence. Such an intelligence creates a risk of making us intellectually lazy (cf. Anttiroiko, 2018). There is also evidence that in many occasions it is difficult to correct machine-assisted rule-based decisions. When algorithms become woven into the fabric of society, it may, if poorly regulated and managed, take us towards an "automated city," which with its underlying rule-based logic mirrors the features of control society as people lose direct control over many aspects of their lives.

Eubanks (2015) goes further by staking that perhaps the most troubling aspects of algorithmic policy-making and governance are its lack of empathy and its potential for separating digital decision-makers from the embodied impact of their choices, thus feeding a peculiar form of systemic unresponsiveness. Algorithms belong to the family of policy tools that operate at a distance, which tends to downplay the role of social and emotional intelligence in collective processes. The inclusion of the human element in these processes increases transaction costs dramatically, which means that to be able to realize efficiency gains, such mediation should be based on sophisticated democratic meta-governance together with the use of collective intelligence to humanize AI (Verhulst, 2018).

So, how then should one conceive algorithms or "machines" in general as a part of politics, public policy, and governance? Matzner (2016) favors the view that we should not see the machine and human relationship as fully separated or opposite spheres. Rather, we should seek to answer the question of how this difference comes into being in the first place and affects our societies. He concludes:

> We have to drop the hope that transparency and accountability will make algorithmic systems the objective or neutral tools we always wanted them to be. We have to make explicit the inherent problems of such systems and either consciously accept and mitigate them ‑ or give up algorithmic decision-making for areas where the consequences are just too far-reaching. (Matzner 2016).

An initial step on this road is to demand the opening of algorithms, the success of which ultimately determines whether the algorithmic city will remind us of an open book or a black box (Hamilton et al., 2014; cf. Pasquale, 2016).

The algorithmic future does not come from outside; it emerges within a society and is thus affected by how we conceive and utilize it in an asymmetric governance field. As concluded by Kenney and Zysman (2016), even if the cloud, big data, algorithms, and platforms do not dictate our future, how we deploy and use these technologies will. In other words, the exact nature of that transformation will be determined by the choices we make in social, political, and business life. These choices are made in thousands of individual situations conditioned by the economic power, the technological capabilities, the institutional environment, and the social conditions that determine the future of the algorithmic city.

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