Conclusions: The Present of Urban AI and the Future of Cities

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Abstract

The era of urban artificial intelligences has begun. It is already difficult to imagine urban futures without artificial intelligence (AI). In this final chapter, we draw on the volume's empirical findings to explore the repercussions of urban AI and give evidence of how the emergence of AI in cities is reshaping urban society, urban infrastructure, urban governance, urban planning and urban sustainability. Subsequently, we demonstrate how the city is influencing the evolution of AI, by molding its physical manifestations in actually existing spaces and determining its very intelligence. The second half of the chapter is dedicated to unpacking similarities between this collection's case studies of AI urbanism and well-known practices of smart urbanism. Here we highlight connections with past and present smart-city initiatives, as well as points of departure that suggest the formation of a novel AI urbanism. We conclude the volume by discussing the implications of the emergence of urban AI for urban theory and the future of cities.

Introduction: urban AI across spaces and scales

The era of urban artificial intelligences has begun. It is already difficult to imagine urban futures without artificial intelligence (AI). As the previous chapters have empirically shown, AI is being strongly integrated into the nature, character and functioning of urban spaces. Cities, in particular, are increasingly absorbing large volumes of AI technology into their transport, government and economic portfolios, triggering urban transformations of rare impetus. The technology in question is new, but the type of techno-urban symbiosis that we are now witnessing runs deep in the history of the city. For example, the reverberations of the introduction of combustion engines into the urban environment at the end of the nineteenth century are still echoing (Hall, 2014). Likewise, when the digital revolution of the 1970s transformed society's fundamental dynamics, the changes wrought on urban systems continued this momentum of sociotechnical change (Castell, 2011; Graham and Marvin, 2002). In essence, urban history tells us that significant technological innovations carry substantial and long-standing urban changes with them. Today, in the belief that 'AI is the new electricity', entrepreneurs and politicians from all over the world position AI as a great technological innovation (see Lee, 2018: 25). As urbanists, we expect such positioning to drive ongoing changes in the fabric of cities for many years to come.

This volume has clarified the urbanity of AI, revealing the urban as a space where multiple AIs become prominently visible, materially situated in the physical landscape and imbricated in everyday life. The contributors have identified several key reasons for the growth of AI in urban spaces, thereby shedding light on the drivers of the *urban AI phenomenon* which in recent years has emerged in the urban studies, design and planning literatures (Cugurullo, 2020; Luusua et al., 2022; Sanchez et al., 2022; Ye et al., 2023; Yigitcanlar et al., 2022). In Chapter 2, for instance, Dowling, McGuirk and Sisson illustrate how AI is emplaced through urban experiments, particularly in cities as the loci of pressing socio-environmental challenges. Their focus on autonomous vehicles (AVs) links this specific type of urban AI experimentation to the challenges of urban transportation. Similarly, in Chapter 9, Valdez, Cook and Potter find a connection between tackling some of the biggest challenges in transportation, such as car-dependency and traffic congestion, and experiments in urban robotics. Seen in these terms, the connection between AI and the urban is consolidated because cities present numerous development challenges and are sites of potential solutions.

This problem/solution interconnection and narrative at the basis of the diffusion of urban AI goes beyond transportation and is also observable in relation to pandemics (Chapter 19), the capacity to cope with climate change and environmental disasters (Chapter 21) and the issue of energy provision (Chapter 14). If, as Angelo and Wachsmuth (2020: 2201) remark, 'everyone thinks cities can save the planet', now an increasingly common belief seems to be that AI can save cities and thus the planet.

There are also potent economic drivers at play in the urbanization of AI. Cities provide demand and thus a market for AI-supported mobility innovations: hence the proliferation of AV experiments in the city (see Chapters 2 and 3). In addition, as While notes in Chapter 7, city managers do not simply see an opportunity in AI to improve the management of complex and often unsustainable urban systems. They also recognize the economic power of being at the cutting-edge of urban innovation. In this sense, AI becomes entrained in boosting a city's reputation internationally, elevating it as a global pioneer in technology and sustainability (see also Chapter 9). Last but not least, there is the pragmatic issue of infrastructure. AI is inevitably sutured to the urban as the site of concentration of technologically advanced infrastructures. This is the case, for instance, with mega hospitals in Chinese cities which are characterized by state-of-the-art infrastructure (necessary for the functioning of delicate AI systems), as well as by high-population densities which generate enough demand for expensive AI technologies and guarantee sufficient return on investment (Chapter 19).

As the case studies examined in this volume show, the emergence of urban AI becomes visible at multiple urban scales. The work of Jackman (Chapter 8) and Sweeney (Chapter 18) reveals that urban AI is entering intimate domestic spaces, thereby affecting the everyday life of individuals and families. Urban AI is also animating single buildings (Chapter 21) and urban precincts such as airports (Chapter 11), in a way that affects both their metabolism and experience. Overall, as many chapters illustrate, urban AI operates most consequentially in the city at the scale of large urban systems. Multiple urban AIs are reshaping cities' transport systems and supply chains (Chapters 2, 3, 4, 5, 6, 9 and 13), the mechanisms through which public security is maintained in the city (Chapters 7 and 15), the provision of housing (Chapters 17 and 20), the delivery of health services in urban areas (Chapter 19), and the generation and distribution of energy across urban spaces (Chapter 14).

There are of course importance exceptions to consider. These include urban AIs whose agency and spatial impact exceed the scale of the city, overflowing into international geopolitical networks (Chapter 16) and global supply chains (Chapter 5). In this sense, our urbanistic perspective on AI is in line with the work of scholars such as Dauvergne (2020), Crawford (2021), and Van Wynsberghe (2021) who have fleshed out the international character of AI as a technology whose production, distribution, consumption and ultimately (un)sustainability transcend geographical boundaries. In addition, we need to remember that there are AIs that are not strictly urban and operate in rural areas (Guo and Li, 2018), under the sea (Blanchard and Flint, 2017) and in outer space (Campa et al., 2019), in realms that are beyond the analytical scope of this volume, but that may converge with urban AIs in the near future due to the pull of planetary urbanization and the increasing interdependence of the planet's socio-economic, environmental and digital systems (Brenner, 2014; Jain and Korzhenevych, 2022).

When it comes to the spaces of urban AIs, this volume's contributions also show how the blurring between *physical* and *digital* spaces is accelerating. The seeds of these processes were evident in early smart-city experiments from decades ago (Angelidou, 2014; Couclelis, 2004; Willis and Aurigi, 2017). However, urban AI both increases and changes the dynamics whereby physical and digital spaces collide, to the point of becoming almost inseparable from one another. In Chapter 5, for example, Cugurullo and Kassens-Noor stress that AI-driven vehicles are part of digital platforms without which they would not function. More specifically, Waymo's autonomous cars are part of the Alphabet platform (i.e. Google) while Zoox's vehicles are a component of Amazon's platform. Through such digital platforms, AVs both share and receive urban data that the AI behind the wheel needs in order to understand and navigate urban spaces. Similarly, Chapter 9 highlights the hybrid location of urban robots' intelligence which partly resides in servers and clouds where much of the computation takes place and where data is stored. In this sense, urban AI becomes a medium that incorporates physical and digital spaces into a seemingly homogeneous whole where what is material and what is aethereal coexist under the aegis of a single non-biological intelligence. This is particularly the case of city brains which, as Chen's study indicates in Chapter 14, are an assemblage of material and digital infrastructures including tangible utility pipelines through

which essential resources such as water and electricity flow, and intangible digital twins mirroring and monitoring the physical reality of cities.

In the next section, we turn from the multiple spaces and scales of urban AI to its impacts on the city, and the ways in which the emergence of AI in cities is reshaping urban society, urban infrastructure, urban governance, urban planning and urban sustainability. Subsequently, we demonstrate how the city is influencing the evolution of AI, by molding its physical manifestations in actually existing spaces and determining its very intelligence. The second half of the chapter is dedicated to unpacking the similarities that exist between this collection's case studies and well-known practices of smart urbanism. Here we highlight connections with past and present smart-city initiatives, as well as points of departure indicating the formation of a novel AI urbanism. We conclude the volume by discussing the implications that the emergence of urban AI has for urban theory and the future of cities. Ours is a warning about the impending risks posed by multiple urban AIs and the obscure black boxes driving their operations, but also an invitation to politically engage as citizens with increasingly autonomous cities that might forever escape our understanding and thus our control.

How AI changes the city

AI is changing the city in multiple ways and through heterogenous impacts because, as we stress in Chapter 1, we are not addressing a single universal technology. An urbanistic perspective on AI means recognizing the existence of diverse urban artificial intelligences, acknowledging that these entail different urban repercussions. For example, tangible urban AIs such as AVs and urban robots have a physical volume, size and weight and therefore influence the shape of cities which need to adapt to their material presence. Autonomous cars and trucks, in particular, represent a bulky type of urban AI whose circulation in the city requires space in the shape of roads and traffic lanes. Chapter 5 delves into the production of urban space that the diffusion of AVs implies, emphasizing that the adoption of Shared Autonomous Vehicles (SAVs) would mitigate the pressure for *ex novo* road infrastructure. As Vitale Brovarone and Staricco remark in Chapter 6, the spatial impact of AVs does not depend simply on the technology per se, but also on how the technology in question is being employed. Both chapters make the case for SAVs as a more sustainable urban AI than

privately owned AVs which are expected to decrease travel disutility, prompt people to commute long distances, and lead to greater suburbanization (see also Cugurullo et al., 2021; Hawkins and Nurul Habib, 2019; Larson and Zhao, 2020; Silva et al., 2022). It follows that the spatial impact of urban AI is not predetermined nor is its sustainability.

Yet this collection makes clear that urban AIs will unavoidably influence urban sustainability. Hopkins points out in Chapter 4 that autonomous trucks are reshaping the very supply chains that sustain cities' metabolism. Similarly, While observes in Chapter 7 that urban robots are producing new mobilities, in a way that is not neutral for the social sustainability of the city. The presence of service robots operating on public streets, for example, implies a reformulation of pedestrian rights of way, and the diffusion of drones across cities is connected to the creation of new flight paths and corridors (see also Lockhart et al., 2021; Umlauf and Burchardt, 2022). These new spaces might not be evenly distributed and accessible, particularly when, for instance, private delivery companies like Amazon compete for exclusive access to urban drone corridors in the attempt to establish a 'flying warehouse' above the city (Jeong et al., 2022: 1). From this perspective, the production of space triggered by urban AIs is intrinsically connected to the distribution of power in the city.

This volume exposes the depth of the changes driven by urban AI and the need to understand them before they become irreversible. Some of the most poignant examples include domestic drones which, as shown in Chapter 8, are contributing to the formation of an intimate state of surveillance in a way that, particularly in the West, is firmly fixed on well-known dynamics of *surveillance capitalism* (see Zuboff, 2019). Similarly, Chapters 7, 9 and 11 focus on how robots are changing urban ecosystems by adding a *more-than-human* element to them, which is agential in nature and thus has the capacity to alter fundamental urban dynamics. The impacts of robots are ambiguous, ranging from support of humans in times of crisis such as delivering food during COVID-19 restrictions when human-to-human contact was prohibited (Chapter 9), to the application of police tracking and subsequent use of weaponized robots to intervene at a distance (Chapter 7). More subtly, as Lin and Yeo note in Chapter 11, the deployment of robots is resulting in work precarity as this type of urban AI provides urban managers with a cheaper and more compliant workforce. They also consider how urban robots are establishing new standards of urban living particularly with regards to cleanness

and health, as well as a comprehensive system of surveillance that lurks behind the smiling face of a robot.

At first glance, the repercussions of urban AIs tend to become less visible when the focus shifts to AI-enabled digital platforms, city brains, urban software agents and algorithms. However, the implementation of these immaterial urban AIs actually entails profound urban changes and consequences which are explored in the second half of the volume. In Chapter 15, Shapiro focuses on AI-controlled platforms employed to foresee the spaces and times of criminal activities and identify those individuals who are likely to be offenders and victims (see also Lally, 2021). His chapter highlights how the predictive solutions of urban AIs lack precision and tend to reproduce injustice by discriminating against racial minorities and chronically deprived urban residents (Richardson et al., 2019). Similarly, in Chapters 14 and 16, the authors observe a potent logic of predictability in the use of city brains in the governance of urban transport, security and energy. Chen's research in particular reveals how city managers utilize a city brain as a *mirror world* (Gelernter, 1993). City brains produce digital twins of existing cities through which human policymakers can zoom in on specific urban systems and foresee their evolution, but there is a problematic discrepancy between the real city and its digital representation (Chapter 14).

The logic of predictability that the contributors identify in city brains and digital platforms is also revealed in urban software agents and algorithms. In Chapter 20, Rosen and Garboden note how screening algorithms are widely used in the housing market to identify "good" and "bad" tenants and to predict their future behavior (see also Fields, 2022). However, as the authors remark, the way this type of urban AI operates is undermined by biases and stereotypes. It tends to exacerbate pre-existing biases and power-relations between landlords and tenants, resulting in discrimination against racial minorities, low-income people and women. Of course, there are also positive consequences to acknowledge, particularly in situations where urban AI is not set loose but rather controlled by human actors as a tool to improve well-established practices. For instance, Pisu and Carta's study shows how AI is aiding architects and urban designers in the design of buildings, districts and cities (Chapter 21). Similarly, Chapter 19 emphasizes the helpful role of urban software agents in the acceleration of epidemiological investigations.

Nonetheless, other chapters highlight how such aid comes at the expense of privacy. Guo and Cugurullo's research stresses that in the course of an epidemiological investigation, urban software agents obtain a lot of personal information on people's health, mobility and contacts, which serves as the foundation for a comprehensive system of surveillance (Chapter 19). These observations resonate with Sweeney's study of the *modus operandi* of AI digital assistants in domestic spaces (Chapter 18). With a focus on Amazon's Alexa, she examines the central role that this type of urban AI plays in housekeeping and caretaking, assisting in delicate and sensitive household tasks such as teaching children and reading to them at bedtime. In so doing, urban AI enters our home and monitors our most intimate activities while extracting large volumes of personal data. In this sense, urban AIs can be seen as unlimited *extractive technologies* that use private information as raw material (Zuboff, 2019).

In addition to specific urban changes connected to the implementation of particular urban AIs, this volume identifies broader urban repercussions that transcend single case studies. These urban trends are driven by the integration of AI into the city and are symptomatic of the transformative force of AI as a new technology which has entered urban spaces and systems only in recent times. The novel nature of AI means that there is not a simple process of assimilation into the urban fabric. Rather most cities go through delicate processes of experimentation whereby different urban AIs are trialed. In these terms, as is emphasized particularly in Chapters 2 and 3, the emergence of urban AIs are connected to the development of urban experiments (see also Beukers and Bertolini, 2021; Cugurullo, 2018; Evans et al., 2016; While et al., 2021). Such urban AI experiments de facto alter the material and digital infrastructures of cities, in order to create spaces where urban AIs can be tested. They also influence governance by forging new partnerships between the private and public sectors to carry out urban experiments (Dowling and McGuirk, 2022; McCarroll and Cugurullo, 2022). Problematically, as Stilgoe and O'Donovan stress in Chapter 3, the governance of urban AI experiments can be undemocratic when they are driven by public-private consortiums that do not involve citizens.

Especially in relation to urban governance, this collection shows how large-scale urban AIs are changing the status quo by establishing unprecedented levels of connectivity across multiple urban domains. AI-driven digital platforms and city brains, in particular, have agency over a plethora of urban sectors ranging from energy provision to policing. Furthermore, as

Greenfield (2018) reminds us, AIs "speak to each other", in the sense that they can be interconnected, thereby sharing information and functioning together as part of a larger technological assemblage. In other words, small-scale urban AIs such as AVs and robots do not operate in isolation but are instead connected to digital platforms. Urban governance is undergoing a process of homogenisation whereby a single AI platform controls multiple urban systems as well as smaller urban AIs (Cugurullo, 2021a). The process is so pervasive that in some cases, as Smart, Zhao and Curran argue in Chapter 16, individuals cannot opt out and have no choice but to live in cities and urban regions managed by city brains which, particularly in China, have become a pervasive tool of national governance.

The aforementioned AI-driven homogenization of urban governance in which multiple urban AIs coalesce into a single AI platform also has significant data implications. Several chapters shed light on the increasing dangers of *function creep*: 'the tendency of data initially collected for one purpose to be used for another often unintended or unanticipated purpose' (Brayne, 2017: 980; Koops, 2021). An emblematic case is that of public health data that Chinese urban software agents collect as part of epidemiological investigations (Chapter 19), which then feeds into the same governmental platforms that are employed to identify potential political dissidents and profile citizens in the age of the Social Credit System (Roberts et al., 2021). Indeed, as Barns observes in Chapter 12, urban AIs are frequently installed in public urban spaces where they can access large amounts of information that go well beyond their original purpose. In this sense, a potent repercussion of urban AI is an acute disturbance and transformation of what Kitchin and Moore-Cherry (2021) term *urban data ecosystems*.

How the city changes AI

Cities are far from inert recipients of new technologies. While AI is reconstituting the city, the city is actively constituting AI. This collection illuminates this mutual constitution and provides evidence of how the urban is reframing AI. First and foremost, several chapters highlight how urban AI experiments are shaped by their contexts. In Chapter 2, for example, Dowling, McGuirk and Sisson argue that in places where existing technology companies do not challenge car dependency, AV experiments evolve in a way that reinforces the dominance of the car. Such place-based AI experimentation reaffirms pre-existing logics, cultures and politico-economic interests (Acheampong and Cugurullo, 2019; Aoyama and Leon, 2021;

Escandon-Barbosa et al., 2021), rarely being transformative and instead tending to crystallize the status quo.

In addition, the city dictates how certain urban AIs will be employed. Vitale Brovarone and Staricco argue in Chapter 6 that urban governance is key to the development of AVs, as it can make the difference between the implementation of AV services and the diffusion of private autonomous cars. They also reflect on the importance of democratic urban governance, since urban AI is a technology that, if left unchecked in the hands of private companies, is likely to generate negative socio-environmental effects by reproducing established patterns of private ownership and consumption. Similarly, Moore and Bissell consider in Chapter 13 how the role and purpose of urban AI is determined by its context. Their study examines local dynamics whereby a community comes to utilize and control an AI platform in a cooperative manner, as an alternative to private ownership and management. They reveal how the community debates and doubts about the digital platform and the underpinning AI, ultimately shaping its function and evolution. Urban AIs are thus not static entities but rather evolve in a relational manner as they engage with urban residents.

Urban communities and urban authorities may indeed seek to hinder the diffusion of AIs across the city. This is the case in San Francisco where, as While points out in Chapter 7, the municipal government banned street robots in 2017 in light of public concerns about surveillance and mobility. San Francisco's story resonates with Lefebvre's idea of *the right to the city* (see Attoh, 2011; Harvey, 2008). In this instance, the right in question was that of pedestrians in a city supposed to be walkable without robots' interference on public spaces. This is also a story of fears and concerns which are powerful determinants in the acceptance of novel AIs (Cugurullo and Acheampong, 2023; Kelly et al., 2022; Li and Huang, 2020). In 2022, San Francisco's Board of Supervisors authorized the weaponization of police robots and gave them the right to kill criminal suspects. Citizens responded by protesting against killer robots and convinced the local authorities to remove that right in less than a month (Blanchard, 2023). Ultimately, the emergence of AI can be held in check or pushed forward depending on whether a city's culture is rooted in a tradition of public resistance or faith in innovation. San Francisco belongs to the former category, while Chinese cities where privacy issues and new technologies are perceived differently, often fall in the latter category (cf. Chapter 19). Urban geography matters. Place and its culture plays a key role in the acceptance

and fruition of urban AIs, exactly like it did in relation to early smart-city technologies (Karvonen et al., 2019; Miller et al., 2021).

The influence of place extends beyond matters of acceptance and modes of employment. Cities affect the very nature of urban AIs. As Sumartojo notes in Chapter 10, when an AI is set loose in an urban space, its actions and capabilities usually transcend what its creators had in mind. Her study on urban robots shows that urban AIs are not complete until they enter the real world. This is because urban AIs make mistakes and adapt to their surrounding urban environment and, is so doing, they change. In this sense, the urban experience defines what urban AIs are and what they do. Similarly, Valdez, Cook and Potter observe in Chapter 9 that the capabilities and actions of urban AIs are significantly influenced by the built environment and its inhabitants. Their research on delivery robots illustrates how urban AI can serve its function only if the interaction with urban residents works well. Human-AI relations in urban context are thus central to the existence of urban AI. These relations can be facilitated through the design of the city, as in the case of Milton Keynes, a new town where robots have abundant space to circulate without impeding the mobility of other road users (Chapter 9). By the same token, urban design can hinder the relations between urban AIs and humans in contexts in which space is restricted and artificial and human intelligences have to compete for it (Gaio and Cugurullo, 2022).

Furthermore, the city has an influence on the intelligence of urban AI, in terms of how the quality of being intelligent is understood and perceived. Stilgoe and O'Donovan point out in Chapter 3 that urban consortia composed of private and public transport players make urban AIs such as AVs intelligent, at least superficially. They do so by conducting urban experiments to prove that AVs are indeed intelligent, designing and controlling these experiments so that they do not fail. Upon observing AV trials, the public's perception is that of intelligent machines capable of navigating complex urban spaces but, as the authors remark, this is precisely what the urban experiment has been predetermined to achieve. In these terms, the appearance of urban AI as an intelligent entity becomes a matter of public persuasion and, in turn, the city becomes the stage where the spectacle of artificial intelligence is performed.

Finally, the actual intelligence of urban AI, intended as the capacity to develop knowledge and use it to act spatially, is shaped by the urban context where it is present. Lynch and Del Casino in Chapter 17 find a strong connection between the logic followed by urban software agents

and the logic underpinning the context in which these AIs operate. More specifically, they recognize in the operations of real-estate algorithms the capitalist logic of deregulated housing that is commonplace in many American cities, urging us to remember that the same logic is biased by 'racialized conceptualizations of space' (Fluri et al., 2020: 1). These findings resonate with Chapter 11 in which Lin and Yeo's work demonstrates that some urban cultures have negative effects on the manifestation of urban AI's intelligence, such as in the case of Singapore's airport where robots have been characterized in racist and sexist ways, mirroring the stereotypical image of low-wage workers. Overall, the collection highlights the agency of urban spaces and urban residents and its constitutive effect on the agency of urban AI. In this sense, Rosen and Garboden's findings from Chapter 20 are emblematic: landlords tune tenant-screening algorithms according to their interests and use them to reinforce their idiosyncrasies and find protection against lawsuits. In the city, AI becomes both a shield and a weapon, in the hands of urban stakeholders, that can protect some interests while undermining others.

The legacy of smart urbanism

The emergence of urban AIs should not only be examined from a spatial perspective. It should also be situated temporally to see where this urban phenomenon is coming from and leading to. AI is, in relative terms, a novel technology. Some urban AIs such as city brains are very new technologies and are being invented and rolled out proximate to the time of this writing (Zhang et al., 2019). However, as we note in Chapter 1, urban AI has not emerged out of the blue, but rather it represents the most recent link in a long chain of techno-urban development, and its ancestry can be traced to smart urbanism (Cugurullo, 2021b). This link is particularly evident in Chapter 11 where Lin and Yeo describe how new urban AIs are being rolled out in Singapore as part of a long-standing smart-city programme, *Smart Singapore*, that was initiated in 2014. Most importantly, we need to critically examine the legacy of smart urbanism to shed light on how recurring urban issues and unsustainable dynamics of high-tech urban development and governance are being reproduced in the age of urban AI. It is of crucial importance to realize that the advent of AI is not a tabula rasa that eliminates all the problems that have been caused by smart cities, providing planners, policymakers and citizens with a fresh start. Quite the opposite: in the contemporary city, AI exacerbates past

and present urban issues that, unless are fully comprehended and addressed, will come back with a vengeance and characterize the city of the future too.

A recurring problem that the contributors to this volume expose is the preponderant intrusion of private tech companies in the governance of cities. In Chapter 3, Stilgoe and O'Donovan emphasise the massive influence of technology companies in the governance of AVs, since they are the specialists supposed to enable the autonomy and intelligence of this type of urban AI. Similarly, Barns remarks in Chapter 12 that the owners of AI-mediated digital platforms also own the data that these AIs are collecting and often refuse to share it with city managers, thereby de facto governing a large portion of cities' data ecosystems singlehandedly. The delineation between private and public is increasingly blurred as governmental services and public infrastructures are outsourced to AI companies, as described by Sweeney in Chapter 18. In the not so distant past, the same issues were stressed by geographers and urbanists when major tech firms such as IBM and Cisco began to intervene in urban governance as part of early smart-city initiatives (Barns et al., 2017; McNeill, 2015; Vanolo, 2014). One crucial implication of such governance is that its mechanics remain opaque and impenetrable to city authorities. It reinforces power asymmetries by creating a condition in which AI companies know more about a city and its inhabitants than the government and the public do. In her chapter, Barns laments AirBnB's refusal to make its data available to city managers, despite the serious urban issues this digital platform leaves in its wake, including rental property shortages and gentrification-fueled residential evictions (Ferreri and Sanyal, 2018; Wachsmuth and Weisler, 2018).

These very mechanics are opaque to citizens. This volume provides evidence of the marginal role that citizens play in the implementation of urban AIs. Urban residents are largely removed from urban AI experiments, and when they do participate their role is often that of mere spectators (Chapters 3 and 14). Many people traverse urban environments ignoring that public urban spaces are permeated by AIs sensing their presence and analyzing their actions (Chapters 10 and 12). Most of the time, when individuals do engage with urban AIs, it is through uneven and obscure relations because the artificial intelligence is capturing and processing private information in ways that are beyond the comprehension of human intelligence (Chapters 8, 11, 13, 16, 18, 19 and 21). These uneven and undemocratic dynamics resonate with one of the most long standing and extensively discussed critiques of smart

urbanism: that of the marginalized role of citizens in the smart city. For Gabrys (2014), people living in a smart city are simply data points, producing information that governments use to control them and private companies leverage to generate profits. Citizens are not involved in the governance of smart cities, apart from tokenistic forms of participations such as hackathons and citizen-science projects (Perng et al., 2018). Instead, they are governed in a paternalistic manner by authorities that profess to have a better understanding of a city's problems and priorities (Cardullo and Kitchin, 2019; Shelton and Lodato, 2019). As Cardullo, Di Feliciantonio, and Kitchin (2019) stress, the citizens' right to the smart city is largely missing, and this collection shows that this is still the case in the post-smart city mediated by AIs. The problem seems to be even more acute today, as one of the assumptions underpinning urban governance in the age of AI is that *artificial* rather than *human* intelligences know better.

Furthermore, this volume finds a recurring syncretism between discourses about urban AI and *sustainability* discourses. In Chapter 4, for example, Hopkin's study indicates that the idea of sustainability is being instrumentalized to push for the implementation and diffusion of urban AI. Her research reveals that AVs in particular are being hailed as a sustainable transport technology on the grounds that they should be able to reduce car accidents and human fatalities. Similarly, in Chapters 14 and 15, Chen and Shapiro highlight that urban AI systems are wrapped in a logic of efficiency, as their promoters claim that the application of AI can improve a city's metabolic processes from environmental, social and economic points of view. These are the same discourses that smart-city researchers have repeatedly identified and critiqued. In the mid-2010s, there was a turn in smart-city discourses when *smart* started to be associated with *sustainable* (Bibri and Krogstie, 2017; Martin et al., 2018; Yigitcanlar et al., 2019). Today, *AI* is emerging as the new *sustainable*.

However, critical scholars noted that being *smart* does not necessarily mean being *sustainable* and today, we see a similar tension between AI and sustainability. In Chapter 2, Dowling, McGuirk and Sisson's findings suggest that the scientific mission of urban AI experiments, supposed to benefit cities' sustainability, can conceal more pressing economic agendas. As their contribution shows, established companies such as Volvo, General Motors and Volkswagen run AV experiments to preserve their economic power in a rapidly changing market, while new companies like NuTomony fight to become the new leaders with AI experiments as their weapon of choice. In this sense, the emergence of urban AI continues to

be connected to the dynamics of *neoliberalism urbanism* that smart-city scholars have exposed for over a decade (Chakrabarty, 2019; Grossi and Pianezzi, 2017).

As previous studies on smart urbanism have reported, private tech companies usually enter the field of urban governance to increase their market and accomplish their economic agendas, often to the detriment of non-monetizable goals including social justice, environmental preservation and citizen wellbeing (Cugurullo, 2018; Macke et al., 2018; Mackinnon et al., 2022). This collection reveals how private tech companies (Amazon and Google, in particular) reinforce their influence in city governance to craft the city as the ideal market for their new AI products. However, we are hesitant to suggest that this is a neoliberal urbanism redux (Peck et al., 2013). This volume illustrates the cosmopolitan geography of urban AI compared to smart urbanism's largely Western-centric dynamics. In Asia, for example, hybrid tech giants such as Alibaba, Tencent, Huawei and Baidu combine elements of both private and public companies and their operations, so markedly prominent in the emergence of urban AI (Chapters 14, 16, 19), cannot be simply ascribed to Western neoliberalism.

In terms of the actual sustainability of urban AI, more empirical research is needed. However, this collection has already shown that the socio-environmental problems typical of smart cities continue to be present in the age of urban AI. A common denominator between smart technologies and AI technologies is that their production requires the extraction of critical raw materials (Crawford, 2021; Zhou et al., 2021). From an environmental sustainability perspective then, technology lingers as a double-edged sword. For example, AI technology can lower the carbon emissions of the city where it is applied in the shape of autonomous energy systems predicting and managing citizens' demand in an efficient manner, but it can also wreak ecological havoc in the places where it is produced and disposed of (Van Wynsberghe, 2021; Yigitcanlar and Cugurullo, 2020). Above all, what *efficiency* actually means in practice remains vague (Chapter 15). This is particularly evident with urban metabolic processes and experiences that cannot be easily measured and quantified. How AI can improve the efficiency of cities is highly debatable (Broussard, 2018). Even in relation to tangible urban issues such as ecosystem preservation and the provision of renewable energy, initial urban AI experiments are not maintaining their lofty environmental promises (Chapter

14). This is a worrying echo of the many broken environmental promises of smart-city experiments (Colding and Barthel, 2017; Cugurullo, 2021b; Koh et al., 2022; Rosol et al., 2017).

Finally, it is important to recognise that similar to smart technologies, urban AIs are prone to glitches, malfunctions and cyberattacks (Leszczynski and Elwood, 2022; Kitchin and Dodge, 2019). As Maalsen (2022: 456) reminds us, the digitalization of urban governance via smart urbanism has made cities 'programmable' but also 'ultimately hackable.' In the era of urban AI, cities continue to be susceptible to intentional and unintentional disruptions. The glitchy nature of urban AIs has been noted in this volume (Chapter 13). AI is a delicate technology requiring constant maintenance, monitoring and updates. Most problematically, it is a technology that is developing and growing exponentially. In the recent past, city managers and urban policymakers have struggled to keep up with the fast pace of smart urbanism's technological innovation, due to unwieldy planning and policy processes (Angelidou, 2017). As Vitale Brovarone and Staricco note in Chapter 6, today some city authorities are not even willing to fully commit to the transition to urban AI because they will not be around long enough to steer it through to completion. The emergence and repercussions of urban AI cover a temporal scale that is much larger than the timeframe of urban administrative offices. This was a huge challenge in smart-city initiatives and one which will undoubtably plague any city that is in the process of embracing urban AI.

The future of AI urbanism

In the age of urban AI, cities are undergoing intense transformations that are changing their shape, metabolism and governance. There are connections with well-known practices of smart urbanism, but also departures with end points that are unpredictable. As we argued in Chapter 1, the proliferation of multiple urban AIs in the life, governance and planning of cities is producing a novel urbanism that we have termed *AI urbanism*. In this section, we draw upon the case studies examined in Parts 1, 2, 3 and 4 to look at the distinctiveness of novel AI logics and manifestations in the urban context and inquire into the emergence of post-smart cities. We do so by operationalizing the three main axes of urban changes identified in the beginning of the volume, namely *function*, *presence* and *agency*.

First, several chapters showed that what urban AIs actually do diverges from the function of traditional smart-city technologies. In Chapter 8, Jackman's study indicates that home-

surveillance drones do not simply quantify urban phenomena by generating heatmaps that calculate and locate heat in a given urban space. They also give meaning to them by determining, for instance, whether the source of heat is coming from a potentially dangerous person who is not supposed to be there. Their functions therefore include a value judgement (in this case, the determination of someone's malevolence or goodness) that was absent in smart urbanism. Similarly, in Chapter 19, Guo and Cugurullo illustrate the actions of urban software agents that calculate as well as interpret, providing an account of the health of both entire cities and individual citizens. This distinction between *counting* and *accounting* is particularly evident in Chapter 20 where Rosen and Garboden point out that screening algorithms not only count people but also qualitatively evaluate them to distinguish between good and bad tenants. Likewise, in Chapter 21 Pisu and Carta reveal how, in the field of urban design, algorithms do not simply quantify urban spaces but also evaluate them and propose design solutions underpinned by assumptions of what constitutes good design. This distinction cuts across multiple urban domains and operations.

Second, this collection provides numerous empirical examples of the presence of urban AI as an overt sociotechnical phenomenon. Tangible cars driven by AI are trialed on public roads or in urban testbeds where the built environment is designed specifically to test AVs in a sheltered environment separated from everyday urban mobility (Chapters 2 and 3). Urban robots have a highly visible presence: we can see them and also be seen by them (Chapter 7). This type of urban AI needs space just like humans. When robots occupy urban spaces, they can hinder our movements, for example, as pedestrians unless the urban environment is spacious enough to enable both human and non-human mobilities (Chapter 9). As Sumartojo stresses in Chapter 10, their spatiality is embedded in the real world and this diverges from smart technologies, such as sensors and underground smart grids, that tend to be hidden from everyday life. Some urban AIs are a constant part of our daily life. Digital assistants animated by AI are present in our homes. They connect with a plethora of smart devices already present in domestic spaces, including smart speakers, smart TVs, cameras, thermostats and vacuum cleaners, making them their appendages whereby AI infiltrates our households and interact with us (Chapter 18). This constant AI presence is something that we cannot ignore, particularly when urban software agents talk to us, inquiring about what we do, with whom and where (Chapter 19).

Third, this volume sheds light on the agency of urban AIs, examining their autonomy across several real-world examples. The question of autonomy is arguably one of the most complex aspects of urban AI and understanding its variegated nature requires nuance and a twofold perspective. On the one hand, the urban AIs discussed in this collection are *autonomous* rather than *automated*, in the sense that they do not follow prescribed routes or courses of action, acting instead in a non-repetitive manner and constantly changing their behavior in space with little or no human supervision. AVs, for example, operate autonomously because a human driver is unnecessary and the machine is constantly adapting its route on a case-by-case basis (Chapters 3 and 5). Similarly, delivery robots are material artefacts that navigate complex urban spaces without guidance from a human supervisor (Chapter 9). Once in the field, police robots do not need to be instructed or prompted to act, potentially supplanting the role of public officers and urban managers (Chapter 7). Likewise, the inputs of urban planners, architects and urban designers are redirected and, at times, decreasing as some algorithms are capable of developing design solutions by themselves (Chapter 21).

On the other hand, the agency of urban AIs depends upon the actions of a number of people. During an urban experiment, for instance, marshals notify vulnerable road users that an AV is approaching (Chapter 3). On public roads, while there may be no human driver steering the wheel, for an AV to function autonomously a lot of *ghost work* is required, as Cugurullo and Kassens-Noor illustrate in Chapter 5. This work is usually carried out by underpaid workers whose main task is to clean and classify the data that AIs need to comprehend and navigate complex urban spaces (Gray and Suri, 2019). Furthermore, part of the computation that is necessary for an urban AI to make sense of the surrounding environment takes place elsewhere, such as in the case of urban robots whose computational capabilities rely on servers, clouds and digital platforms (Chapter 9). The autonomy of urban AIs has thus complex geographies that transcend the physical spaces where they are materially present.

It is also important to note that space constitutes a limitation on the autonomy of urban AIs, particularly in relation to their prediction capabilities. Urban AIs operate in real-life urban environments that are always *emerging*: they are constantly changing and far from being finite and finished spaces (Chapter 10). This spatial condition, characterized by an immanent indeterminacy, clashes with the logic of predictability underpinning AI which, de facto, is incapable of managing the uncertainty of urban futures, particularly over extended time

periods (Luque-Ayala and Marvin, 2020). For this reason, urban AIs often operate together with human agents who employ their intuition (a quality that urban AI does not possess yet) to deal with uncertain scenarios (Chapter 19). Thus, urban AIs are only autonomous up to a point, and their sphere of influence is limited to what can be calculated, since AI cannot predict what it cannot first calculate. When the urban future becomes incalculable and nebulous, it is necessary for humans to step in and exercise their autonomy together with that of machines in a relational manner.

However, this operational limitation does not necessarily mean that the impact of urban AIs is limited. In fact, most of the contributors portray urban situations in which the agency of urban AIs can have substantial consequences. Autonomous cars and trucks traverse chaotic urban spaces adjacent to other road users (Chapters 2, 3, 4 and 5). As Stilgoe's (2020) work demonstrates, in this complex context rich in uncertainty, an inaccurate sensor reading can be lethal for a pedestrian. Furthermore, even in the best-case scenario, accidents will not be completely eliminated and AVs will find themselves in the position of having to distribute inevitable harm (Awad et al., 2018). Comparatively, surveillance-drones and police robots will not distribute inevitable harm: they will cause harm to individuals that they perceive to be dangerous (Chapters 7 and 8). Similarly, urban software agents and algorithms will decide who is not a good tenant and does not have the right to occupy a place, and who is a suspicious citizen that deserves scrutiny by the police (Chapters 15 and 20). These are all ethical decisions freighted with life-changing repercussions that urban AI is catalyzing in post-smart cities where critical value judgments are no longer the exclusive domain of human stakeholders.

Urban AI and urban theory

The rise of urban AI is generating new dynamics in the governance, planning and everyday experience of cities. This collection provides empirical evidence of the presence of autonomous technologies that are populating the built environment and interacting with its inhabitants across multiple scales. These dynamics, characterized by urban AI's novel capacity to produce accounts of urban phenomena and shape their evolution without human supervision (in limited but nonetheless significant spheres of influence), are indicative of an urbanism that goes beyond the impacts of smart cities. We are witnessing the formation of

post smart cities in which an emerging AI urbanism is producing novel urban experiences, designs and forms of governance, and potentially new urban spatialities that require new theorizations. In this section, we draw upon insights from this volume to develop a core set of theories and concepts that can help urban researchers and stakeholders make sense of the variegated relations between AI and the city.

First is the need to conceptualize the spatial dimensions of urban AIs. In Chapter 8, Jackman introduces the concept of *ambient AI* to illuminate the ubiquitous and yet seemingly invisible presence of urban AIs. Notwithstanding their often tangible materiality, the concept of ambience is helpful to highlight how some urban AIs, such as domestic robots and digital AI assistants, can disappear into the background of our lives, instead of imposing their presence upon us (Augusto and McCullagh, 2007; Payne and Macdonald, 2004). We often forget that urban AI is all around us, constantly observing and influencing what we do. On a related note, Sumartojo reflects in Chapter 10 on the notion and importance of *atmosphere*, paying attention to how urban AIs are perceived and felt in specific places and, in turn, how this perception changes the way a given place is experienced (Sumartojo and Pink, 2018). This is an important conceptual perspective that extends current AI studies, particularly in computer science, focusing on how AIs perceive space but not on how places perceive AIs (see, for example, Ke et al., 2020).

Second is the related question of how we should approach the ubiquity of urban AI as a pervasive ambient technology. For Barns, urban AIs should be understood as a form of *ambient commons* (Chapter 12). Drawing upon McCullough's (2013) theories, she proposes a commons-based approach to the regulation and application of urban AIs. The conceptual premise is to see public spaces and infrastructures as urban commons. In this sense, most urban AIs such as AVs, urban robots, city brains and AI digital platforms, should be seen as urban commons too, given that they are embedded in public spaces and infrastructures. This perspective provides a stepping-stone to argue for the integration of hitherto missing principles of public and civil values in the deployment of urban AIs and for citizens to play an active role in AI urbanism. Furthermore, it complements contemporary AI studies in relation to the thorny issue of *alignment* (Dafoe, 2021; Gabriel, 2020; McDonald, 2022). Since urban AIs have become de facto materially *public*—surrounding and affecting urban residents—they should be aligned with the interests and needs of the public. Therefore, citizens should be

regularly consulted on matters of urban AI and, as Moore and Bissell posit in Chapter 13, they also deserve the right to question it by exercising what Amoore (2019, 2020) refers to as an *ethics of doubt*.

Third is the question of how to effectively unpack the imaginaries and the trajectories of urban AI. Drawing upon Science and Technology Studies (STS) literature, Chen proposes in Chapter 14 the concept of *sociotechnical imaginaries* as a useful framework to understand the lock-in pathways that make cities and societies dependent on new technologies (see Jasanoff and Kim, 2015). These imaginaries depict an idealized social and environmental order that AIs are supposed to enable (Sartori and Bocca, 2022). She considers how AI imaginaries embody a trajectory of urban development that some cities follow almost blindly without paying attention to what is behind these imaginaries and the lived conditions that they produce. These reflections are important because these imaginaries are shaped by local political contexts and, in the case of China for instance, they mirror the objectives of the Communist Party (Chapters 14, 16 and 19). On the ground, there are profound discrepancies between imagination and reality. For example, there is little or no evidence that urban AIs are supporting urban sustainability goals (Chapter 14). Thus, as urbanists and critical social scientists, we need to devise alternative signifiers to describe what urban AI represents and is actually doing on the ground. Some suggestions are provided in Chapter 5 in which urban AIs such as AVs are alternatively portrayed as *mobile data collectors*, *space-shapers* and *environmental drainers*, rather than idealized modes of sustainable transportation.

Fourth is the meaning of the concept of *intelligence* in urban AIs. In Chapter 17, Lynch and Del Casino use a relational perspective to study the intelligence of urban AIs and focus on the relations between a given urban AI and its urban context. They refer to the philosophy of Byung-Chul Han according to whom any intelligence depends on the system in which it functions (Han, 2017). From an urban perspective then, we can think of urban AIs as autonomous technologies that are incapable of exercising their intelligence outside of the urban context in which they are designed to operate. An AV, for example, can be intelligent only while it is traversing a flat public road. Similarly, a service robot designed to serve food can exercise its intelligence solely within specific contexts such as restaurants and cafes. Their sphere of influence is limited to their designated urban spaces. Moreover, as Guo and Cugurullo note in Chapter 19, there is an important conceptual distinction between *narrow*

and *general* (urban) AIs, as most of the technologies discussed in this collection manifest intelligence exclusively in relation to single tasks, and the prospect of Artificial General Intelligence (AGI) seems to be far away from the contemporary urban landscape (Hirsch-Kreinsen, 2023).

Fifth, even if AGI is not around the corner, the presence of multiple urban AIs should make us reflect on our role as humans living in cities increasingly populated by non-biological intelligences. In Chapter 21, Pisu and Carta propose the figure of the *digital demiurge* intended as a human designer fully in charge of the production and design of urban spaces, who employs AI as a tool to craft the built environment. They stress the epistemological problems that arise when urban designers delegate their agency to an AI system whose mechanics are almost impossible to understand: the design would enter a *black box* thereby changing through processes lacking transparency. The black-box conundrum of AI can be already seen in several domains (Carabantes, 2020). In addition to urban design, planning and architecture, we should carefully consider the black-box problem in relation to policy and governance. We need to question what happens when urban policies are developed by obscure AI systems and what the role of human policymakers should be in the age of large-scale urban AIs, such as city brains, that are currently applied to govern cities.

As Valdez, Cook and Potter suggest in Chapter 9, it is possible that a clear-cut conceptual distinction between human and artificial intelligences in the urban experience and governance of cities is too simplistic and thus unnecessary in the first place. They evoke the notion of the *cyborg city* to emphasise how contemporary organic (humans) and mechanical (robots) entities are converging as part of the same urban processes in a fluid manner (Gandy, 2005). Ultimately, what is clear in this collection is that with the emergence of multiple urban AIs, the composition of the population of cities is changing and so are their power-relations and governance. In this emerging urban order, characterized by a hybrid of humans and AIs, it is important to recognize that human stakeholders are no longer the sole intelligence influencing urban development. We propose *posthumanism* as a useful theoretical framework to interpret the decentering of human agents in the governance and life of cities, and capture the complexity of nonhierarchical networks of human and artificial intelligences (Hughes, 2018; Wolfe, 2010). Particularly the rise of large-scale urban AIs, such as city brains and AI-driven urban platforms, indicates the formation of a *posthuman urban governance*

which goes beyond the human in the sense that human agency constitutes only a portion of it: most actions and powers of governing come from intricate human-AI relations that are yet to be explored.

Conclusion: warnings and invitations

In the age of AI, the formation of a posthuman urban governance is a problematic prospect. However, by *problematic* we do not necessarily mean *catastrophic* or *apocalyptic*. On the one hand, this is a warning in the sense that hybrid urban experiences, power-relations and governance networks characterized by human stakeholders and urban AIs will be undoubtably difficult to manage and regulate. On the other hand, this is an invitation to examine what is actually happening on the ground and avoid what Floridi (2020, 2022) refers to as *sci-fi distractions* involving AGI and futuristic superintelligences that do exist. These distractions have the tendency to shift our attention away from the real-world problems and opportunities generated by real-world AIs. In this spirit, a core aim and contribution of this collection has been to expose and interrogate, both empirically and theoretically, what happens in reality when existing AIs come into play in existing cities.

The findings of this volume clarify the complex processes of co-constitution and co-determination through which AI and the city co-evolve. They also have broader implications for AI studies and pertain to diverse disciplines such as computer science, philosophy, engineering, sociology and political science, which are collectively attempting to shed light on long-standing questions about the nature of non-biological intelligences and their regulation. This collection illuminates one of the most debated aspects of AI: its presumed capacity to think. Urban AIs do not think in the same way as humans and, therefore, it would be inappropriate to describe them as conscious entities. None of the urban AIs examined in this volume are capable of reflection and feeling emotions in a humanistic sense. Nonetheless, the same urban AIs are all capable of generating logics, rationalities and rule-sets that drive their actions and influence urban processes. Thus, it is important to acknowledge the fundamental difference between *thought* and *rationality*. Urban AI cannot think and, for example, reflect upon an ideal form of urban development, but it can produce a logical explanation that would make a certain form of urban development seem consistent with or based upon reason.

This volume's case studies provide multiple examples. Home-surveillance drones do not have the capacity to reflect on the nature of good and evil, but they can conclude that an intruder represents a dangerous individual (Chapter 8). Urban software agents cannot reflect on the social and economic implications of a pandemic lockdown, but they can reach the conclusion that a growing number of infected citizens justifies a limit to their mobility, in order to avoid a disease outbreak (Chapter 19). These findings are in line with recent debates about the intelligence of emerging generative AIs such as ChatGPT and Dall-E which can act and perform complex tasks in a rational manner, including the creation of new content, without actually grasping the implication and meaning of their actions (Floridi, 2023).

In addition, we draw on Flyvbjerg (1998) to stress that, especially in urban planning and governance, rationality is often shaped by power and discourses. In the context of this study, therefore, urban AI could seem intelligent, as in capable of rational thought and driven by reason, while in reality this capacity might be simply a label imposed by powerful human stakeholders. During a trial, an autonomous car might appear to be intelligent because of the way it navigates a complex urban space, but this could be a performance scripted by a consortium of private and public actors (Chapter 3). Real-estate algorithms might give the impression of thinking, but it is more likely that they are simply reproducing preexisting power-relations in the housing market (Chapter 17). As Natale (2021) warns us, many AIs are purposely deceptive: they are built to appear intelligent and their alleged intelligence becomes a veil hiding speculations and inequalities. This is an important warning that resonates with past urban experiments in which labels such as *eco*, *smart*, *resilient* and *low-carbon* were hiding unecological urban spaces (Avery and Moser, 2023; Cugurullo, 2021b; De Jong et al., 2015; Xie et al., 2019). This is also an invitation to critically examine potential discrepancies between the labels attached to urban AIs and their actual performance.

Several case studies also show that the level of intelligence of urban AIs is decoupled from their capacity to draw conclusions and make decisions. While it would be ambiguous to say that urban AIs can think and incorrect to state that AVs, urban robots, city brains and urban software agents can reason like humans, this volume provides evidence of the decision-making capabilities of these technologies. Without following the same cognitive process of human road users, an AV can decide in a split second what route to take in a way that surpasses human speed (Chapter 4). Similarly, city brains can quickly reconfigure a city's flow

of energy and vehicles by simultaneously making complex decisions about urban transport and energy systems (Chapters 14 and 16). However, even if their decision-making skill is faster than that of humans and tends to embrace more than one matter at the same time, it lacks ethical considerations precisely because of urban AI's inability to reason like a human stakeholder. Furthermore, the decisions made by urban AIs often lack nuance. For example, if a screening algorithm is assessing your profile, either you qualify as a tenant and you get the opportunity to rent a property, or you do not even if you are only missing a dollar (Chapter 20). This is of course problematic because real-life urban experiences and systems are characterized by shades of grey, rendering the binary logics by which urban AIs reach their conclusions too simplistic.

More problematically, the decisions that urban AIs make are at times not just simplistic but are also incorrect and biased. There is an epistemological discrepancy between how several urban AIs digitally represent reality and the actually existing cities. For instance, there are distortions between a digital twin created by a city brain and its material counterpart (Chapter 14). The decisions of urban AIs are frequently divorced from reality, as in the case of real-estate estimate algorithms that significantly overprice properties (Chapter 17). As Shapiro remarks in Chapter 15, such distortions can be exacerbated by the use of *dirty data* defined as 'data that is derived from or influenced by corrupt, biased, and unlawful practices, including data that has been intentionally manipulated' (Richardson et al., 2019: 18; see also Liang et al., 2022).

There is a need to be cautious about the decisions of urban AIs, not simply in relation to their impact on contemporary cities, but also to their influence on urban futures. This collection exposes the future-oriented nature of urban AIs' logics and actions. Urban AI can be both *predictive* and *prescriptive* (Chapter 15). In addition to predicting likely urban scenarios, it gives directives on what should be done to enable certain urban futures while preempting others. This is an invitation to carefully regulate urban AIs from an urbanistic perspective, with a double focus on present and future repercussions on urban living, governance and sustainability. Such regulatory efforts should go beyond current legislation and ethical frameworks about AI that, as Munn (2022) laments, are too abstract and general (also see Mökander et al., 2022; Roberts et al., 2022). This volume clearly shows that a single, universal AI does not exist. When AI become materially situated in the city, multiple heterogenous

urban AIs emerge, ranging from autonomous cars to weaponized police robots and from home-surveillance drones to city brains. Their urban impact and role in cities must be highly regulated on a case-by-case basis. A task like this will not be easy because of how deregulated many cities are in the first place (particularly in environments where urban and digital spaces mesh) but, given the plethora of problems discussed so far, the need to regulate urban AIs is necessary and urgent (Boeing et al., 2021; Ferreri and Sanyal, 2018).

We stand at a critical juncture in the history of the city. Through this collection we see how what Cugurullo (2020) terms the passage from *automation* to *autonomy* in urbanism is occurring across spaces and scales, with its effects already visible in numerous urban AI experiments. There are evident similarities with common smart-city initiatives, but also significant points of departure and challenges. In post-smart cities, traces of smart urbanism will remain and continue to influence urban processes. Looking back at its history, smart urbanism started as a niche in the late 1990s to quickly emerge as a global urban phenomenon that generated an explosion of smart-city projects (Joss et al., 2019). A similar escalation in AI urbanism has the potential to substantially shape the future of new and existing cities. What this volume has illustrated is likely only to be the beginning.

In many existing cities, urban AIs are becoming popular because they fill a void created by anemic and underfunded public services. Citizens, for example, are lacking public child- and elder-care services and thus rely on Amazon's AI home assistants (Chapter 18). Similarly, dysfunctional public transport systems result in excruciating commutes, leading commuters to contemplate the idea of autonomous cars as an idealized alternative where they can sleep or work while traversing the city in a self-driving vehicle (Chapters 5 and 6). In some cases, these dreams culminate in fully *autonomous cities*, such as The Line in Saudi Arabia, where key urban services and operations are expected to be 'run not by *human* but by *artificial* intelligences' (Cugurullo, 2021b: 14; also see Allam and Takun, 2022). Rather than dreaming of autonomous urban futures enabled by AIs, we may be better served by focusing on addressing the deficiencies in urban services and experiences that fuel such dreams.

The risks embodied in autonomous cities are not those of sci-fi apocalyptic scenarios that pit humans against artificial superintelligences (Bostrom, 2017). Instead, they involve the amplification of the real-world problems discussed in this volume, such as the formation of comprehensive states of surveillance, issues of alignment, injustice and epistemological

distortions between how AI sees the city and the actual urban experience. These risks created by technological innovations cannot be addressed by simply banning AI. Indeed, it is difficult to imagine an urban future in which AI will not be present in one form or another. Instead, they must be addressed by thinking carefully about the ways that we design and use urban AIs. At the end of the day, as this volume clarifies, many of the problems, risks and challenges of urban AIs are not intrinsic to the technologies per se but are an end result of how different urban AIs are employed. This makes them social, political and, above all, urbanistic problems that we can fix or, at the very least mitigate, by improving the urban planning and governance processes whereby AI gets materially situated in our cities.

Conceptually, one way forward could be to reverse the fourth axis identified in Chapter 1 and rephrase the *discourse* that surrounds the passage from smart to AI urbanism, with a focus on the crucial issue of control. This is about abandoning the idea of fully autonomous urban AIs and autonomous cities where control over the course of urban development and living has been delegated to non-biological intelligences. This would follow the example of a city like San Francisco where the citizens fought politically for their own vision of the city of the future, resisting some forms of autonomous urban AI (Chapter 7). This also means striving to provide citizens with access to the obscure black boxes that animate the numerous urban AIs populating our urban public spaces, and demand regular reality checks to verify the actual sustainability impact of urban AI imaginaries across time and space. These are all examples of urban political acts that urbanists have been advocating for a long time (Baviskar, 2020; Leitheiser et al., 2022; Swyngedouw, 2018). We have shown that AI changes the nature of cities as much as the city changes the nature of AI, and we need to remind ourselves that we are the city.

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