Urban AI: understanding the emerging role of artificial intelligence in smart cities

Aale Luusua · Johanna Ylipulli · Marcus Foth · Alessandro Aurigi

1 Introduction

The development of artificial intelligence (AI) continues to boom, and as a result, there is a major push towards integrating these technologies into cities. This phenomenon, which we can refer to as urban AI (Luusua and Ylipulli 2020b), is being built on the foundation of previous technological developments in cities. Different types of autonomous and self-learning systems are now being integrated into contemporary computing systems; and as computing systems in general are now part of urban lives and urban places and spaces, we argue that these existing urban technologies act as a gateway for the introduction of AI technologies, especially in cities (Luusua and Ylipulli 2020b). These developments are also connected with the smart city agenda, which specifically aims to integrate more and more digital technology into urban environments (e.g., Hollands 2008; Willis and Aurigi 2020; Aurigi and De Cindio 2008).

The parallel phenomena of urbanization and digitalization have enabled the rapid expansion of urban AI into everyday spaces, places, and lives. Thus, they may be found everywhere: in mobile, personal, or infrastructural computing. Importantly, they have already made their way into commercial end-user applications, such as personal assistant applications, supporting various degrees of autonomy in vehicles (e.g., partial autopilot systems, adaptive cruise control, parking-assistant systems), and increasingly into everyday homes (home assistant systems and smart speakers). Contemporary travel practices are fundamentally informed by AI. Without adaptive and autonomous algorithms, we would not take the routes we now often take via car, air, rail or even by foot and bicycle; we would not use the accommodation services we use when we get there; and, we might not even visit the places that we do visit without digital recommendations (Luusua and Ylipulli 2020b; Foth 2016). In short, urban AI molds our experiences of the environment in a manner never seen before. It also rearranges our society in more subtle ways, through AI-led meta-analysis of previously separate datasets sourced from urban mobility systems, geographical information systems (GIS), and urban closed circuit television (CCTV) systems equipped with face-recognition (Graham 2002; Gray 2002), which gives rise to ever more sophisticated ‘digital twins’ of cities (Batty 2018; Cureton and Dunn 2021).

Thus, we can define urban AI as the study of the relationship between artificial intelligence systems and urban contexts, including the built environment, infrastructure, places, people, and their practices. As seen from this description, the phenomenon transcends existing disciplines, which warrants an interdisciplinary approach. Applications of urban AI can now arguably be said to orchestrate cities and regions to an increasing extent. Utilizing the terminology of Ray Oldenburg (1989), we can see that AI has permeated all types of urban places: first, second and third places; i.e., homes, workplaces, and public urban places, respectively. We can add a fourth place, travel, or nomadic spaces, to this list (Foth et al. 2020). Urban technologies in general turn these localities into hybrid places (de Souza e Silva 2006), where urban experiences and governance are digitally augmented and mediated (Aurigi and De Cindio 2008). Furthermore, we can understand these hybrid cities also as landscapes...
for producing and harvesting big data (Luusua and Ylipulli 2020a; Ylipulli and Luusua 2019; Zuboff 2020), serving as a part of business-driven smart city planning agendas (Cardullo and Kitchin 2019).

It is important to note that through the integration of human-like capabilities relating to decision-making and learning, much is being added to the agency of urban technology systems through AI. AI is deeply intertwined materially, economically, and experientially with these existing technological trajectories. The development of urban AI and the rise of the associated field of urban science are also raising many ethical issues (Crawford 2021; Cugurullo 2021; Kitchin 2016; Rittenbruch et al. 2021), and as AI applications are developed further, these prompt questions of city-making ethics, namely who has the right to design and live in cities (Cardullo et al. 2019; Foth et al. 2016; Lefebvre et al. 1996) and what is lost when cities are being reduced to visions of digital data streams (Mattern 2021). As urbanization and digitalization propel each other forward, these phenomena become deeply entangled and thus in urgent need of being empirically studied, scrutinized through different theoretical lenses, problematized, and critiqued.

These emerging phenomena raise many questions regarding AI as part of urban environments, including how these systems will affect both our lived experience of cities and city-making itself. To rise up to this challenge, there is an urgent need for a concerted effort to investigate urban AI as an interdisciplinary research theme (Kukka et al. 2015); that is, to scrutinize the intersections of AI, the physicality of spaces, people’s lives, and the ethical and political dimensions of urban AI around the world. Arguably, urban AI can be expected to affect the dynamism between urban, rural and suburban areas as well as regions, and the governance of and global competition between cities and states. Finally, it is important to bring forth applicable theories, methods, and connected research themes from various fields to grasp these phenomena fully.

Recognizing the importance of these phenomena, we hosted a workshop (Urban AI: Formulating an Agenda for the Interdisciplinary Research of Artificial Intelligence in Cities) in conjunction with the ACM Conference on Designing Interactive Systems (DIS’20) in July 2020. This workshop formed and gathered an interdisciplinary community of researchers around the topic of urban AI to discuss issues at the intersection of AI technologies and cities—i.e., urban life, spaces, places, and infrastructures—from an interdisciplinary, critical, scholarly, and design-oriented perspective. We called on researchers from various disciplines to reflect with us on the question of how to formulate relevant, thoughtful, critical, participatory, and democratic approaches to researching and developing urban AI. Built on a careful initial reflection of personal and disciplinary backgrounds and viewpoints, our workshop produced a preliminary research agenda of issues relating to researching AI in cities. Among these, ethical issues, critical analyses and designs, and various global and cultural perspectives were especially salient.

Even though the COVID-19 pandemic prevented us from coming together in a physical location, the remotely held event brought together a sizable group of researchers from various disciplines across design, the humanities, social sciences, technology, and engineering. Having received a selection of enthusiastic contributions for the Urban AI workshop, and to capture and build upon the discussions fostered by the event, we decided to edit a special issue on the topic. Thus, in this special issue of the journal AI and Society, we begin to sketch the outlines of urban AI as an interdisciplinary research area to examine the phenomena of AI systems across urban spaces, places, and lives. This special issue presents 12 original research articles, which approach the topic from theoretical, empirical, and interdisciplinary points of view. The special issue is further complemented by Curmudgeon Corner opinion pieces and book reviews and concluding remarks by Michael Batty.

The article contributed by Kars Alfrink and colleagues questions the imperative to make AI more transparent no matter what. While transparency and even notions such as ‘explainable AI’ have gained significant interest from academia and industry, the push for more transparency is often taken for granted. So it is timely for this paper to ask what transparency will look like in practice and what will it achieve? Alfrink and team led a design research study examining utilization of an AI-powered smart electric vehicle charge point and found that transparency cannot be reduced to a product feature. If transparent AI is conceptualized in the same simplistic ways as the usually compliance-driven provision of lengthy terms and conditions written in legalese, then users may risk having an experience that is time-consuming, burdensome, and irrelevant to their immediate needs. Alfrink et al. suggest that transparency as a design goal needs to be coupled with agency, control, and an ability to understand and challenge automated decision-making when required.

Continuing with these themes from a theory-led perspective, Yu-Shan Tseng offers a fresh perspective on studying algorithmic technologies, including urban AI systems. The text draws mainly from urban studies and critical algorithmic studies, arguing that the dominant approach to studying algorithmic technologies within these fields has focused on advocating transparency and human accountability when deploying algorithmic systems. This can refer to opening up algorithmic source codes and/or operative logics. In other words, to render the algorithmic technologies accountable, urban scholars should aim for opening up the black boxes of these systems. According to Tseng, some scholars have recently argued that transparency-based remedies may not
be the best way forward; rather, algorithmic systems should be studied by focusing on power relationships embedded in them and by paying attention to wider social contexts in which they operate. Tseng presents urban assemblage as an alternative way to explore these systems, and specifically the urban AI phenomenon.

Criminologist and surveillance studies scholar Lena Podoletz’s research is situated at the most fascinating yet scary intersection of emotional AI and smart cities. Her paper opens the reader’s eyes to the entire utopian–dystopian spectrum of possible scenarios—noting that someone’s utopia is often someone else’s dystopia. Urban AI increasingly feeds off human physiological data gathered from our smart homes, cars, workplaces and public spaces, including eye tracking, facial expressions, body movements, speech and vocal tone, heart rate, galvanic skin responses, and even brain waves via EEG (electroencephalography). The public health response to the COVID-19 pandemic has been used to excuse the mass analysis of health data such as body temperature and justify associated curtailments of civil rights and liberties. However, using examples where emotional AI is deployed for policing and security, Podoletz warns of the risks and implications when measures thought of to be temporary become permanent. Discussing issues of accuracy, bias, accountability and privacy, she argues that societies grounded in values of human rights and liberal democracy are incompatible with the intrusiveness and totalitarian nature of using emotional AI for urban surveillance and policing.

This special issue also contains three papers that take on the issue of mobility technologies in the era of urban AI. Mobility technologies touch on almost all aspects of cities—including their materiality, functionality, and the practices of urban inhabitants. Thus, their relationship to the urban context must necessarily be a major research area in urban AI. Giulio Mecacci and colleagues define a theoretical framework to understand and promote a responsible transition to traffic automation in urban environments. The authors posit that their Meaningful Human Control theory provides useful conceptual tools to reduce potential unwanted consequences of traffic automation. The notion of “designing for meaningful human control” is promoted as a design strategy. The aim is to keep human actors in control while minimizing the operational activities of drivers. To understand urban AI as a phenomenon, theory building is essential; however, there is a dearth of common conceptual tools to build interdisciplinary understanding. The paper offers an important contribution to the emerging area of urban AI theory and concepts.

Grounded in an overall theoretical lens of the right to the (digital) city, Nitin Sawhney offers a tour de force journey across a plethora of contested issues when urban AI meets transport and mobility. He first unpacks key challenges such as discriminatory access, safety, participatory planning, privacy, and surveillance. This is followed by an examination of possible policy responses, specifically the European Commission’s proposed regulation of AI systems and its possible implications for urban AI platforms, illustrated by the example of Amsterdam’s automated parking control system. Structured in a conceptual framework of rights, risks and responsibilities, Sawhney concludes with a thought-provoking speculation into Indigenous protocols that introduce new criteria into the urban AI debate, such as notions of place, relationality, reciprocity, respect, and sovereignty. Sawhney argues that learning from such protocols can open up new ways to ethically guide the design and deployment of urban AI.

Focusing on the theme of city-scale automation, and more specifically, autonomous vehicles, Fabio Iapaolo offers a fundamentally material and spatial viewpoint into urban AI. The author discusses the role of AI as a catalyst for transformation in cities and the interplay between AI and the fabric and form of the city. Too often, the prevailing discourse on AI in urban environments revolves only around the notion that AI will fundamentally alter cities and urban landscapes. But, we would be amiss to not ask the reverse. This question is fundamentally important if technologists are to design effective and ethical systems for urban environments. It can also help maintain a sense of balance to the relationship between technologies and their environments. Context truly matters, not only for users of technology, but for the technologies themselves as well. In his article, Iapaolo presents an important challenge to this common assumption by choosing to also investigate how cities—their materiality and the humans, nonhumans, and technologies therein—affect AI systems.

In her article framed as a speculative essay, Stephanie Sherman follows traces left by the famous concept of Panopticon, often used to describe the logics of digital intelligence. The idea of the Panopticon was created by philosopher Jeremy Bentham in the eighteenth century and popularized later by Michel Foucault (1975). It depicts an architecture of centralized and omnipresent control which has been later mapped on smart cities by urban scholars. In The Polyopticon: A Diagram for Urban Artificial Intelligences Sherman investigates the conceptual origins of Polyopticon and highlights how it has been used to critique institutional surveillance and control; further, the essay explores how Urban AI phenomena could be viewed through the lens offered by the concept of Polyopticon. The Polyopticon refers to an alternative framework describing “a distributed, poly-perspectival, polyvalent, and polyphonic network of Urban AIs”. Sherman’s notions resonate in many ways with the ideas expressed by Yu-Shan Tseng; both authors challenge the simplified views of power asymmetries in smart cities and seek alternative ways to understand and capture the logics of Urban AI as a societal phenomenon.
Continuing with our theory-led investigations into urban AI, Anthony Vanky and Ri Le provide a critical discussion of some existing uses and shortcomings of AI, namely computer vision, as parts of urban contexts. As more and more urban AI systems are implemented in various contexts, the more we need critical readings of such technologies to both evaluate them and to build a theoretical basis for the interdisciplinary study of urban AI. Using Clifford Geertz’s notion of ‘thick description’, the authors build a framework to evaluate the varied uses of computer vision technologies that weigh meaning. By scrutinizing cases of implemented examples of urban computer vision, Vanky and Le make a contribution by drafting a framework for evaluating the thickness of an algorithm’s conclusions against the computational method’s complexity required to produce that outcome.

Among the empirical works in this special issue, Tan Yigitçanlar’s and colleagues scrutinize the relationship between the urban public sector and AI. More specifically, the authors examine local city governance through a series of semi-structured interviews with city managers from Australia and the USA. This contribution is as important as it is timely. As stated in the beginning of this Introduction, AI systems are a part of a long continuum of various technologies being integrated into the urban landscape. Furthermore, cities also often engage in public–private partnerships to make their cities more technology rich. The city managers, then, are crucial in this process. It is urgent to research the views, visions, challenges, and competence of city officials to gain a full picture of the hopes and challenges that lie ahead as the phenomena of digitalization and urbanization continue to advance and intertwine.

Complementing this expert-focused research from a human-centered AI (HCAI) point of view, Anu Lehtio and colleagues provide a citizen-focused study. The design and implementation of AI systems has thus far been an opaque process for non-technologists. When introduced into urban living environments, issues of democracy and participation become ever more timely and important. In their paper, Lehtio and colleagues make a contribution to this knowledge gap by examining citizen perceptions within a smart city context through surveys and scenario-based interviews in Finland, recognizing five central themes in their participants’ attitudes concerning AI and smart cities. This type of thematic work with city inhabitants is necessarily highly context driven; thus, further research performing similar human-centered studies must be a central part of the study of urban AI.

Continuing in the Nordic context, Jouko Makkonen and colleagues study how intelligent technologies could support the use of common areas in ‘Nordic superblocks’, a planning and living concept in which residents of an urban block share their gardens, common spaces, and utilities. On the basis of layperson participant interviews as well as expert workshops, the authors identify potential for AI systems to support space sharing and social interaction, adopting a possibility-oriented outlook on the technological augmentation. Often, technology research considers urban environments to be somewhat static—a permanent background for technologies and their users and non-users. Urban AI research must bridge the gap between urban planning and technology research, considering both areas of design from a non-deterministic point of view as malleable and subject to change. This paper addresses this gap through a fitting participatory and democratic approach.

AI in urban settings may not only be the subject of scrutiny, but also a tool for the evidence-based study of cities. Utilizing AI and laser imaging techniques to collect an urban data set, Pooyan Doozanadeh and colleagues compare street quality in wealthier and poorer neighborhoods in Los Angeles, CA. Their counterintuitive results indicate no betterment due to affluence in areas in the city—in fact, according to the authors, their results indicated an inverse relationship. Among the 98 zip codes they analyzed, poorer neighborhoods had a better street condition in Los Angeles. In addition to discussing these results, the authors also reflect on how AI and automatic data collection enable researchers to collect data for the purposes of urban planning and management. This points to an important area of urban research that AI enables, and where much work needs to be done, critically but constructively, to apply these technologies to further understand cities.

Additional viewpoints to these research articles are provided by our invited Curmudgeon Corner authors. Toby Walsh has dedicated his paper to the question of whether AI will end privacy, and how to avoid an Orwellian future? The answer might surprise you, and comes in two parts. Walsh first sensitizes the reader to the diverse range of tensions between utopian and dystopian scenarios of AI and privacy use cases, which are no longer future music but here and now. He rightly argues that, “With our digital selves, we can lie. […] But it is much harder to lie about your analog self.” With AI-driven applications increasingly feeding off our most intimate personal (and physiological) data sources, will it be possible to have our cake and eat it, too? Walsh is optimistic suggesting that AI can in fact offer help in preserving privacy by for example, quarantining AI computation on personal devices themselves to prevent sensitive data from entering the cloud, as well as using AI-driven privacy assistants to secure and police such restrictions.

If AI and its applications have advanced to the status of hype and mainstream cult, then critiquing them might somewhat entail a form of counterculture. Perhaps offering a ‘post-counterculture,’ the Curmudgeon Corner contribution by Jean Burgess takes these arguments head on and offers a critique of the ‘Big Critique’ genre of AI. Drawing on
thoughts and ideas from her 2022 book “Everyday Data Cultures” (Burgess 2022), Burgess argues that the often polemical, heroic and antagonistic nature of these critiques risks a polarization of ‘Big Tech’ versus ‘Big Critique’ that omits and forgets about the mundane lives of everyday people. She posits that it is these vernacular, everyday meaning-making practices that are the most likely inspiration for “more inclusive, creative, and ethical AI futures.”

These perspectives are complemented by Minna Ruckenstein’s Curmudgeon commentary where she argues for re-humanizing algorithmic systems. The goal of this project is not limited to highlighting human involvement in technological processes but the aim is also to scrutinize how humans are involved and therefore implicated in such processes. Ruckenstein refers to an interesting concept of “algorithmic drama” by Malte Ziewitz (2016) that occupies the central stage in much of the research focusing on AI and algorithms: Technology becomes seen either as the hero or the villain, creating unforeseen wealth and wellbeing for humanity or threatening our very existence. Instead of centering the agency of the technology, we need to re-focus on human agency and investigate on grassroot level people behind technology.

Approaching these themes from a deeply urban point of view, special issue co-editor Alessandro Aurigi cautions against designing urban AI without a deep understanding of and dialog with the urban context it is implemented in. To avoid harmful developments, Aurigi argues that urban AI should be part of a wider city strategy. In this view, AI is seen as a constituent of the urban fabric and the multi-layered structure of contemporary and future cities. This view also expands the traditional purview and responsibility of strategy makers, urban planners and civil engineers further into the novel realm of digital augmentation (Aurigi and DeCindio 2008). In the spirit of a Curmudgeon corner piece, this article runs counter to the public discourse which often frames AI as an almost inevitably disruptive technology. Instead, Aurigi’s thoughtful piece asks designers, developers, researchers, planners, and politicians to ask, how can we holistically integrate urban AI as a part of contemporary and future cities?

Fabio Duerte and Barbro Fröding reflect on the role of big data and related methods in relation to social phenomena, which are central to understanding, planning for and living in cities. They present us with two challenges: the first of which is the well-known quandary regarding privacy in relation to data; this challenge becomes doubly interesting when it is applied to cities. Since the birth of modernity, cities have been seen as places where anonymity reigns supreme, for good or ill. What, then, will happen when that anonymity and the privacy it engendered are eroded by cities becoming landscapes of big data harvesting through the use of urban AI (Luusua and Ylipulli 2021)? This brings us to the second challenge the authors present, which relates to the first one. Duerte and Fröding argue that the paradigm of big data has in itself become a methodological bias. This bias, they argue, may lead to a notion that creating and applying more complex and multilayered neural networks inevitably leads to improved results. However, as the authors point out, this may not be true of all phenomena, especially social phenomena. This is crucial to understand in the context of cities, which are not only backgrounds for social action, but irrevocably a part of it in everyday urban life.

Finally, Michael Batty provides his view on this abundant collection of urban AI-themed articles in the Guest Editorial. Batty reminds us that the applications of AI that we are seeing thus far—including in this special issue—are still applications of weak or narrow AI (Kurzweil 2005), that is to say, they do not have or are intended to have human-level abilities. These types of applications are a world away from those imagined by the pioneers of AI (e.g., McCarthy et al. 1955) to be right around the corner. Yet, even narrow AI has much potential to alter the built environment and to exacerbate existing urban issues, as demonstrated by the articles in this special issue. AI, when applied in the urban context, arguably becomes entangled with every classic urban issue, from mobility to inequality. Thus, the current collection cannot be seen as being definitive of urban AI research; rather, it represents a beginning of the work.

While the collection presented in this special issue is extensive and diverse, we can only scratch the surface of the urban AI phenomenon here. To complement these, we have also included three book reviews: Shannon Mattern’s “A City is not a Computer: Other urban intelligences” by Hira Sheik; Federico Cugurullo’s “Frankenstein Urbanism” (2021), reviewed by Johanna Ylipulli; and Katherine Crawford’s “Atlas of AI: Power, Politics and the Planetary Costs of Artificial Intelligence” reviewed by Aale Luusua.

Urban AI as a phenomenon is here to stay, evolving over time into unknown directions. Thus, the work must also be continual, evolving along to meet the challenges posed by AI systems in urban environments, and vice versa. The papers introduced here present both theoretical and empirical investigations that critique both the nascent technological systems as well as the very concept of AI, employing theories and methods from various disciplines. This is arguably extremely important, as the making of AI, as well as the planning and design of urban environments, are inherently multidisciplinary endeavors. AI research here can borrow much from urban studies scholarship, and the way it conceptualizes cities and urban life. Whatever has been a focal point of research on cities must be reinvestigated in the age of AI. Within urban AI, then, these two trajectories meet and are entangled. The research and design of AI in and for cities will require both looking back as well as looking forward. We call for researchers, designers, experts, policy-makers
and citizens to join us in this interdisciplinary and multi-stakeholder effort.

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