The Future of Urban AI

Global Dialogues on Urban Artificial Intelligence

Season 2 Summary

September 2024

URBAN AI

CORNELL TECH | HOME OF THE JACOBS TECHNION-CORNELL INSTITUTE

Contents

Acknowledgments

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Introduction

Urban Artificial Intelligence: From Real-world Observations to a Paradigm-Shifting Concept

Hubert Beroche, Founder at Urban AI

Cities are facing unprecedented challenges. The figures are well known: while occupying only 2% of the earth's surface, urban settlements host more than 50% of the global population and are responsible for 70% of greenhouse emissions. While concentrating most capital and human wealth, they are also places of systemic inequalities (Nelson, 2023), exacerbating and materializing social imbalances. In the meantime, cities have fewer and fewer resources to face those tensions. Increasing environmental constraints, combined with shrinking public budgets, are putting pressure on cities' capacities. More than ever, urban stakeholders have to do more with less.

In this context, Artificial Intelligence has usually been seen as a much-welcomed technology. This technology can be defined as machines' ability to perform cognitive functions, mainly through learning algorithms since 2012. First embedded in heavy top-down Smart City projects, AI applications in cities have gradually proliferated under the impetus of various stakeholders. Today's cities are home to numerous AIs, owned and used by multiple stakeholders to serve different, sometimes divergent, interests.

I first apprehended this diversity of AIs through a Smart City world tour during which I explored 12 cities and met over 130 stakeholders, in 2019 (Beroche, 2020). During this project, I met worldwide scientists and practitioners who are using AI for very different purposes: real-time earthquake detection in Tokyo, urban biodiversity monitoring in London, infrastructure maintenance in Montreal. Not only did they use AI differently, but they also developed, governed, and implemented it differently depending on local cultures, policies, and capacities. Singapore-based H3 Dynamics startup is using drones to create self-repairing cities (see Episode 11 below) while CANN Forecast developed a sensorless data-driven solution for urban maintenance (see episode 13 below), echoing political and capitalistic differences between the Asian city-state and Quebec's capital.

This series is an exploration of this diversification and aims to highlight practitioners and scholars who are inventing the future(s) of urban AI. While multiple urban AI futures are cohabiting, we can still conceptualized this emerging field under three features well illustrated in The Future of Urban AI series:

Urban AIs are hybrid

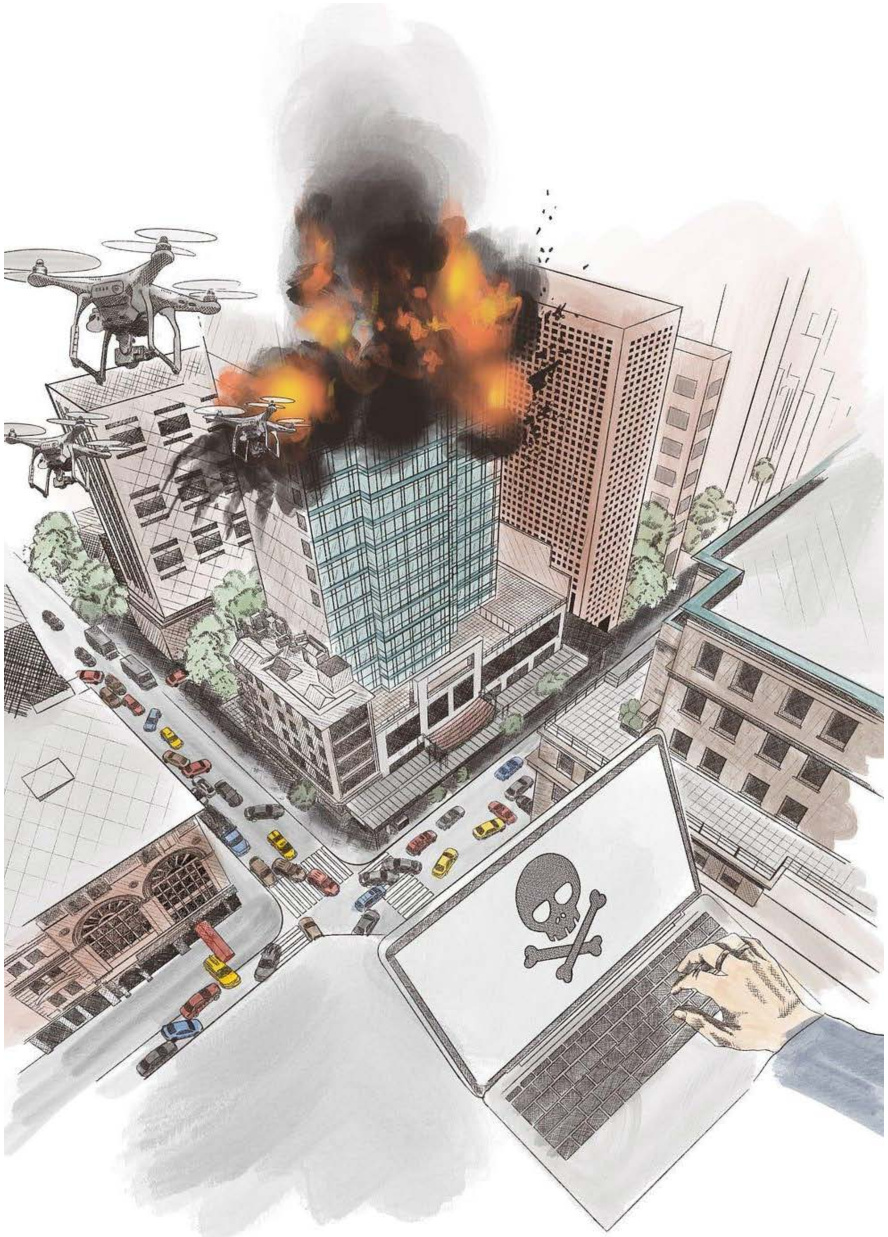
In other words, their mode of existence involves materiality, a presence in the physical world that sets them apart from various other forms of AI. This materiality is not only infrastructural but also, and more importantly, infra-ordinary. It reveals itself and unfolds in the banality of everyday life. Whereas the materiality of Facebook or YouTube recommendation algorithms is imperceptible — resting on a network of invisible infrastructures such as data centers, undersea cables, etc. — that of an autonomous boat, a drone or a Lidar sensor used for mapping a territory is apparent to us. This co-presence in the banality of everyday life has several very concrete implications. Among them is the fact that these AIs are critical as they have the potential to transform the lives of city dwellers. An error in the calculation of an AI embedded in a navigation software — let's say Waze, for example — can quickly create traffic jams or even accidents. More broadly, the hybrid nature of urban AIs should prompt increased attention to their design. One example is the interface of urban AIs, which often is limited to the surface of our smartphone screens. However, this mode of interaction is not only anti-urban but also dangerous. The smartphone literally blinds and obscures us to signals from the urban environment, potentially leading to road accidents, among other things. Hence a need to invent other materialities — poetic, virtuous, frugal, empowering — for these urban AIs.

Urban AIs are political and politicized.

Firstly, because they unfold in the city, which itself is subject to a web of regulations. In this sense, urban AIs must comply with local regulations of Municipalities and Local Governments. This is expressed by researcher Stefaan Verhulst through the concept of "AI Localism",

> "the hybrid nature of urban AIs should prompt increased attention to their design."

which "refers to the actions taken by local decision-makers to address the use of AI within a city or community". In other words, the governance modalities of an urban AI vary from one city to another depending on multiple local components, including political ones. This is evident, for example, with the emergence of AI registries in Helsinki, Amsterdam, and soon Barcelona as well as with the creation of an Algorithms Management and Policy Officer by the Municipality of New York. More radically, the recent ban on shared e-scooters in Paris, the prohibition of drone flights in dense urban areas in several countries where it is allowed in other regions of the world such as China, or the ban on facial recognition in many cities, reflects the localization of urban AIs. These examples demonstrate the rise of differentiated urban AI uses and developments, driven by local policies in complement to national, sometimes regional, regulations. This trend is so powerful that some scholars use the concept of "urban decoupling" (Ekman, 2020) to describe "the development of diverging types of cities and urban governance models in the future", letting envision an urban AI fragmentation.



Source: "Geopolitics of Smart Cities: Expression of Soft Power and New Order", by Urban AI and AdalanAI.

> "Being aware of the political dimension of urban AIs is crucial for anyone wishing to implement those technologies."

At the same time, urban AIs are also being politicized. As we've shown in the Geopolitics of Smart Cities report, which was presented by Ana Chubinidze in the 6th episode of this series (see below). By doing so, they can materialize and reinforce existing social norms, political powers, and economic systems. At the international level, this can lead to turning urban AIs into instruments of soft power. More radically, urban AIs can also be weaponized to attack or take control of urban vehicles (connected cars, drones), infrastructures (hospitals, airports), and dwellers (through targeted misinformation).

Being aware of the political dimension of urban AIs is crucial for anyone wishing to implement those technologies. It's the first step towards governing this technology and not being instrumentalized by it. It also allows us to understand that instead of being a constraint or a threat, this political dimension can be leveraged to empower communities and amplify cities' speech (Sassen, 2013). As all urban technologies should do.

Urban AIs are evolving in complex environments.

The city is a complex system (Batty, 2009). Urban order results from the interaction of a considerable number of independent yet interconnected agents. This order is inherently fragile, mutable, and dynamic. The latter element is particularly important as it justifies the existence of urban AIs. These algorithmic systems are relevant because they can enable us to better understand the evolution of this complex system that is the city. When used judiciously, urban AIs can enlighten individual choices and facilitate the understanding of urban dynamics. Having such knowledge, experts, and people can make better decisions for the city and their own lives. There are plenty of examples illustrated in The Future of Urban AI series: Ariel Noyman (MIT Media Lab) using AI and tangible interfaces as a tool of augmented and collective urban planning (see episode 4 below), Julia Zimmermann (Berlin CityLab), and Kris Vanherle (Telraam) using AI to help people better know and take care of their city, respectively in Berlin with participatory tree management (see episode 7 below) and Belgium with crowdsourced mobility data (see episode 2 below).

Furthermore, the complexity of the city itself is a factor that alters the fundamental nature of urban AIs. Take the example of an autonomous vehicle. While it travels on a highway, one can easily imagine that its automated navigation is activated. However, as soon as it enters the city, it becomes technically impossible to maintain this mode of operation . Unable to analyze and calculate the urban complexity in real-time (pedestrian crossings, traffic lights, construction works, etc.), the autonomous vehicle requires a switch to manual mode to avoid the risk of causing an accident as Ron Brachman explained during the initial episode this series (see episode 1 below).. Another example is the dazzling of laser recognition systems in Hong Kong during political protests in June 2019. Here, population density coupled with human ingenuity jeopardized the functioning of AIs — except, in this case, it was a deliberate sabotage.

A first conclusion drawn from these failures could be to simplify the city, to reinforce AI systems by creating "Autonomous Car car-centric cities" or surveillance cities. Many places are moving in this direction. However, we already know from past failures where this trajectory leads: towards inhospitable cities.

Urbanizing Artificial Intelligence

Another possibility is, as practitioners and scholars showcased in this series are doing, to start from this complexity to imagine, design, and implement urban AIs. To develop AI systems that are situated, open,

"Each time we talk about "urban AI" we are not only mentioning a tool or a concept but we are also expressing this collective vision."

frictional, decentralized, meaningful, and ecological. AIs that embrace urban complexity, empower multiple intelligences — not only an algorithmic one — and make possible diverse futures.

Drawing inspiration from Saskia Sassen's work, we name this process "urbanizing artificial intelligence". Urbanizing AI means making those technologies fit into cities' ancestral, multiple, and complex lives.

Each time we talk about "urban AI" we are not only mentioning a tool or a concept but we are also expressing this collective vision. A future where cities' speech thrive and, "poetically, humans dwell upon the earth" (Hölderlin). A future where AI tools serve flourishing and meaningful lives. People's lives.

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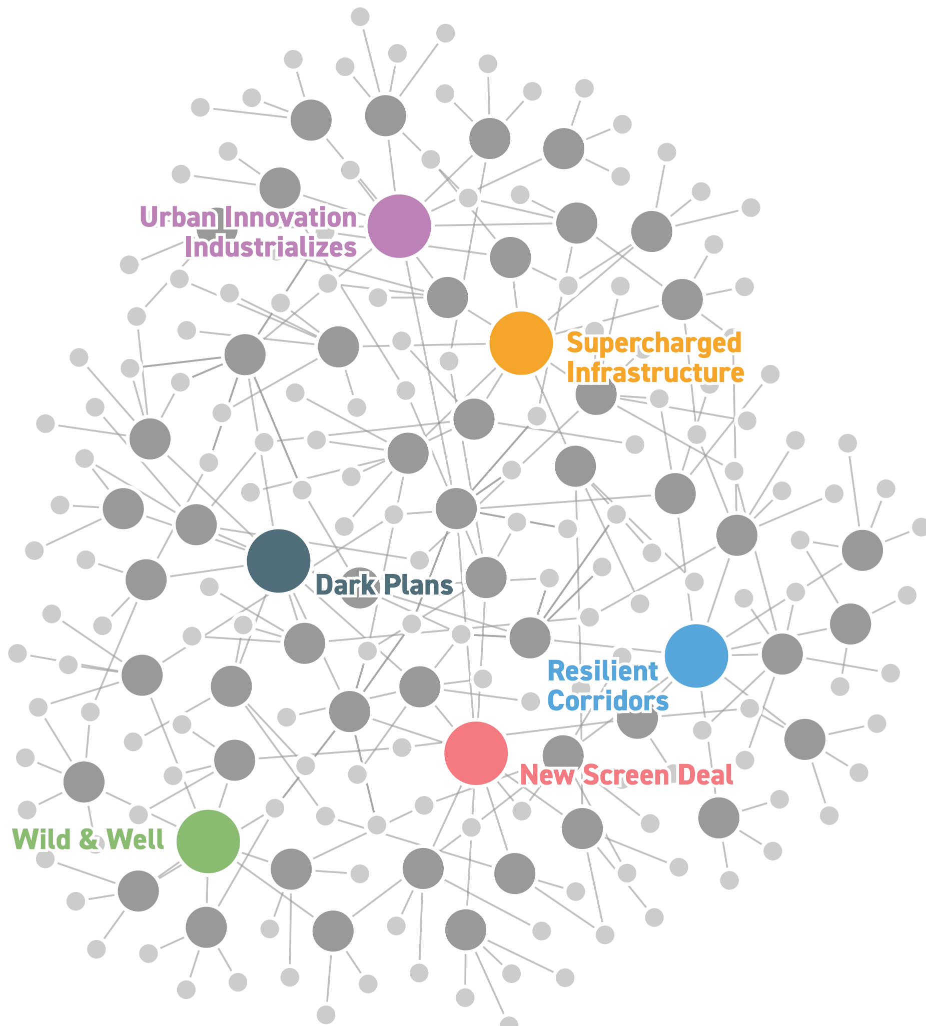
About



View The Future of Urban Tech

To deepen our understanding of how deep learning and other AI technologies are being used to address pressing urban challenges, UrbanAI and the Jacobs Urban Tech Hub at Cornell Tech partnered in autumn 2022 and again in autumn 2023 to produce a program of webinars.

Road Map: The Future of Urban Tech Horizon Scan

Our road map for this journey was The Future of Urban Tech, a ten-year horizon scan anticipating big scientific breakthroughs and engineering innovations in the field. Drawing on thousands of published sources—journals, news sites, and blogs—this study synthesized this raw data into 217 unique perspectives charting anticipated discoveries and inventions in urban tech over the decade ahead.

This complex set of possibilities is summarized in the horizon scan's six topline forecasts. Think of these as the front page stories you might read on a news site in 2032. They describe the big directions of change that will shape the journey ahead for everyone.

Three forecasts describe the transformation of "hard" urban systems. Supercharged Infrastructure will rewire the city into a deep, actionable web. Wild + Well cities will tap advanced biotechnologies to take livability to new heights. And Resilient Corridors will amplify our efforts to halt climate change and prepare communities for the inevitable shocks to come.

Three more forecasts unpack deep conflicts in "soft" urban systems. Dark Plans designed and enforced by software will shape cities in strange new ways. This will trigger a backlash, giving rise to a New Screen Deal that redistributes the risks and rewards of urban tech. Meanwhile, a planetary scale supply chain for city-making technologies will take shape as Urban Innovation Industrializes.

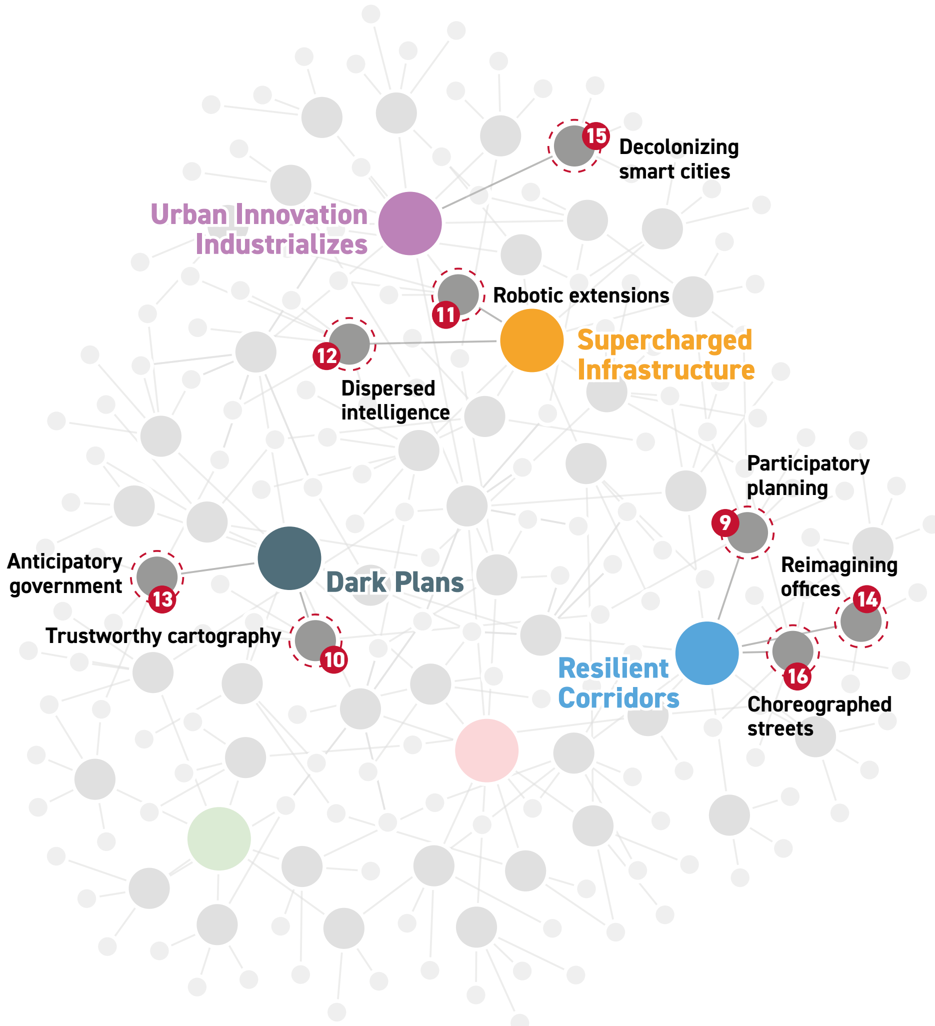
Ambassadors from the Future

AI is at work throughout each of these forecasts, creating new capabilities and raising new risks. To explore these in detail, we organized eight new sessions where thinkers and practitioners working at the forefront of urban AI could share their knowledge, insights, open questions and concerns about the future. These sessions continued a tour through the horizon scan that began in the 2022 series, as these "ambassadors from the future" provided a sneak peek at the opportunities and challenges we will all face in the coming years.

This notebook contains detailed summaries of each of these eight conversations. As the work of these brilliant scholars and practitioners highlights, we must be humble forecasters. For every hypothesis we might formulate, countercurrents aren't hard to find. Different futures can coexist in different world regions, and even within the same city. Our urban (AI) future is not a straight line but a branching network, a living thing that generates many ideas and inventions. Most we'll find curious. But there will also be extremes—remarkable innovations that fascinate us, and horrifying failures that shock us.

For cities, the challenge will be anticipating the extreme opportunities and risks of AI and putting structures in place to manage them. A handful, such as Amsterdam, Helsinki, New York, and Singapore have begun that process of studying and setting guidelines for the arrival of urban AI. But there is much more work to be done. UrbanAI and Cornell Tech are delighted to be your guides as we continue the conversation in the years to come.

The Future of Urban AI Series



9 Towards Participatory Planning

Synthesis of the Episode with
Damiano Cerrone, Co-Founder of UrbanistAI

View this Trend

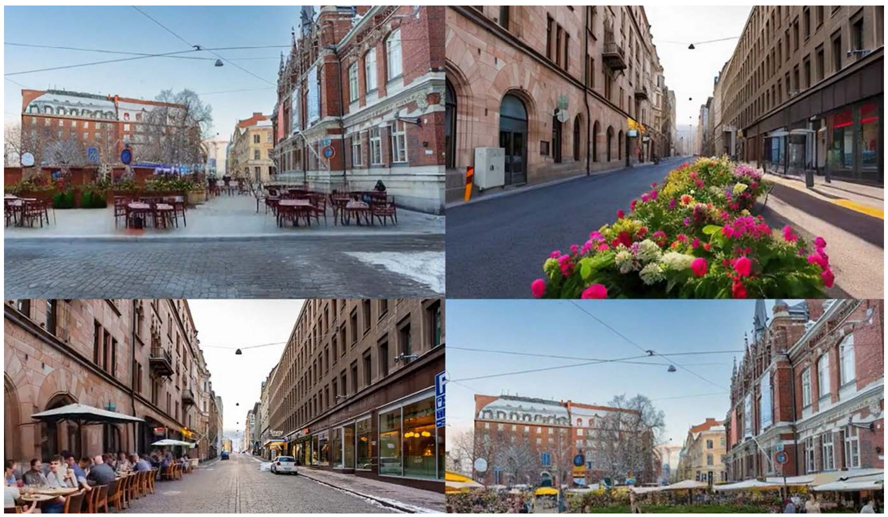
Watch the Session

Following the success of last year's "The Future of Urban AI" speaker series, Urban AI and The Jacobs Technion-Cornell Institute have launched a second season. This year's series continues to delve into the artificial intelligence (AI)-related elements of the "Future of Urban Tech" horizon scan, envisioning the impacts that advances in AI will have on people, policy, and place within cities in the years to come. Each week, experts at the forefront of urban AI will draw on their own work to imagine how AI will continue to shape our urban spaces, engaging with the challenges and opportunities that face the field. For the first episode of Season 2, Damiano Cerrone, co-founder of UrbanistAI, discusses the role of generative AI on participatory urban planning.

Traditional methods of public engagement in urban design processes involve distributing surveys to solicit stakeholder feedback. The format of such questionnaires (text on a screen) does not lend itself to inspiring respondents about the possibilities of the project, nor does it leave much room for expression on the part of community members. Then, given the technical nature of architecture and urban design drafting and decision-making, citizens are often excluded from the actual ideation processes. UrbanistAI seeks to utilize artificial intelligence tools to shift this paradigm, involving the community in urban design itself, effectively harnessing "the power of collective intelligence."

As Cerrone describes, the UrbanistAI platform helps transform public engagement in three main ways. First, it seeks to democratize and joyfully negotiate urban change — providing greater access for the public to design their spaces, and to do so in an engaging way. Second, it seeks to shift stakeholders from commentators to placemakers — allowing community members to have a meaningful and material role in design processes, rather than simply reacting to designs proposed by experts. Finally, it seeks to create a symbiotic relationship between technology and human habitat — harnessing the power of innovative tools to create more livable cities. To those ends, UrbanistAI develops and utilizes generative AI models (which can modify images of urban scenes on-the-fly, based on participant input) with the aim of reducing the technical barriers to urban design.

Any given urban resident might find it easy to answer the question "how do you want to change your city?" in abstract terms: more walkable, greener, more inclusive, etc. But translating those concepts into actionable design has traditionally required knowledge and skill beyond innate ability. With the use of UrbanistAI's generative AI models, members of the public can collaboratively imagine urban interventions by prompting the model to propose urban modifications based on citizen ideation sessions. The rapid reactiveness of generative AI allows a robust iterative design process, prompted by participant reactions to each AI-generated image, to occur within a short timespan. Further, the universal language of images allows more people of differing backgrounds to engage (even primary school-aged children).



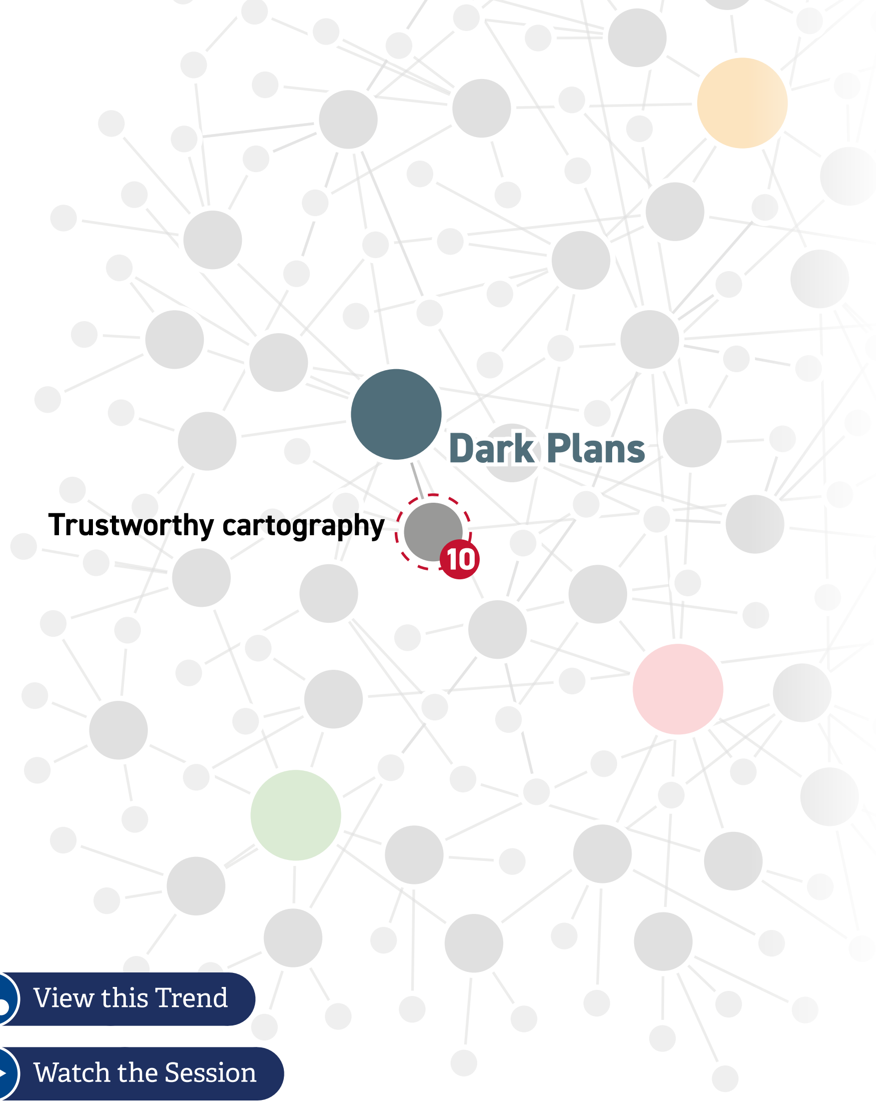
Source: UrbanistAI

UrbanistAI has used its technology and methodology to influence public engagement workshops around the world, including in Berlin, Germany; Cleveland, United States; Pristina, Kosovo; and Helsinki, Finland. In each case, it provides methodology and technology to workshop hosts, who then adapt the tools to fit the specific geographic and social contexts of their cities. The images co-produced in workshops generally result in moodboards, which urban designers can then use to inform their technical designs.

Given the rapid pace of technological development, particularly in the field of generative AI recently, UrbanistAI continually researches new methods and builds upon its models. It currently has a partnership with the Mohammed Bin Rashid Centre for Government Innovation in Dubai, to develop a generative AI model with the ability to modify a three-dimensional representation of the city, with the ability to take planning laws into account in its generations. Through this project, Dubai is on track to become the first city to train a Generative AI model. However, it took years for governments to feel comfortable adopting AI technologies for this purpose (1). In fact, UrbanistAI began developing its models in 2018, and has been working to inspire confidence among stakeholders since then. While generative AI tools still have a ways to go with regard to limiting bias, safeguarding against irresponsible use, protecting intellectual property, and ensuring data privacy, they show great promise to aid in the transformation of our livable spaces in imaginative and innovative ways.

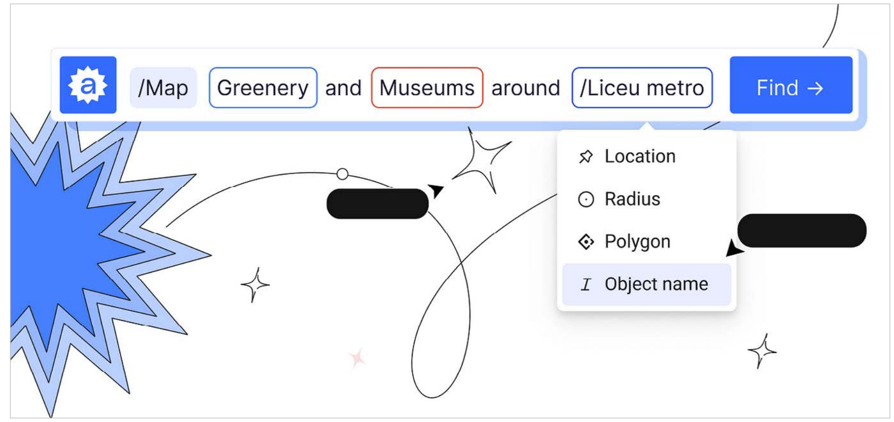
10 Trustworthy Cartography

Synthesis of the Episode with
Alexander Kamenev, CEO of Aino



View this Trend

Watch the Session



Caption:

In the last 3–5 years, the rapid development of artificial intelligence has unveiled radically new possibilities across many industries, including urban planning and architecture. With the recent emergence of large generative models like MidJourney and ChatGPT, architects and spatial designers have enthusiastically adopted them in their daily work. However, these AI tools are currently primarily used for creating visualizations (still far from perfect, by the way) and drafting explanatory notes. Yet, the true potential of generative AI in urban design still needs to be explored.

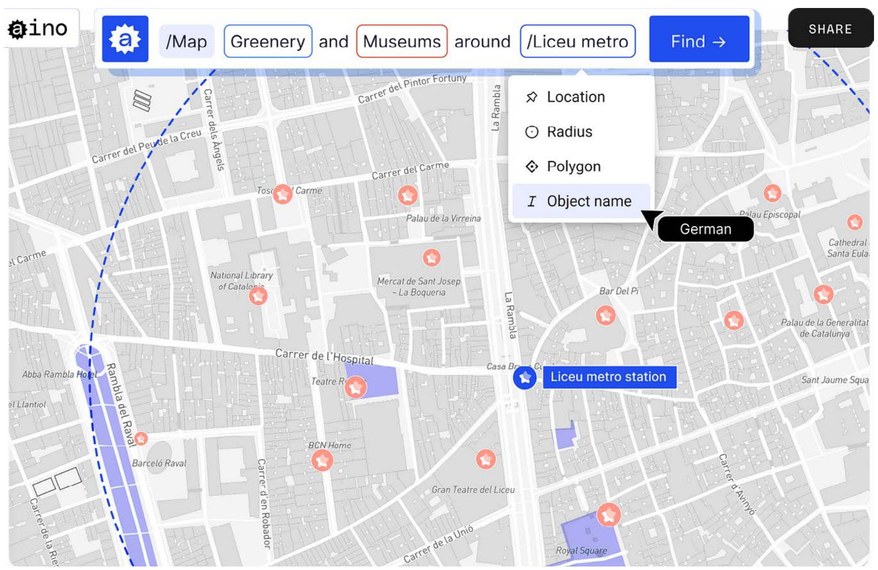
AI's tangible and quantifiable benefit lies in data processing during the pre-project analysis phase of urban planning. Before creating a concept, architects must evaluate usage patterns of a territory, existing and potential issues and social infrastructure in the area. This fundamental analysis includes demographic studies, the density of various functions, pedestrian and transportation accessibility, traffic congestion at critical points, and examining the terrain and landscape.

Architectural studios, urban consultancies, project bureaus, municipal administrations, and specialized universities all face roughly the same challenges in spatial data analysis and interpretation:

1. Many cities lack fully digitized or even collected data for the necessary parameters. That makes Data Gathering and Verification extremely challenging. Datasets often need to be procured (at best)

or scraped (at worst), followed by rigorous checks for accuracy and completeness. It requires, at least, significant time and financial investments and, at most, advanced data engineering skills.

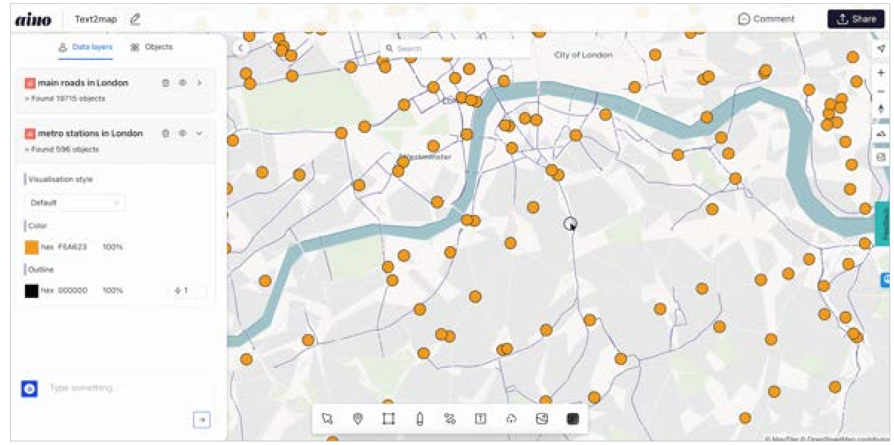
2. Architects creating urban development concepts must understand what they will be working with visually. This is where analytical maps come to the rescue. Building these maps also requires programming and visualization skills and typically involves software like ArcGIS (complex and expensive), QGIS (complex and less stable), and similar tools.



Source: Aino.world

At Aino, we thought: What if we could relieve architects of this headache and empower them to independently gather and process the necessary data without the need for GIS experts and costly software?

Text2Map



Source: Aino.world

This is how the concept of Text2Map was born. The model uses combinations of Large Language Models (LLM) and an algorithmic approach to visualize data from third-party APIs and our own databases right on the map.

This innovation allows users to easily search for georeferenced objects by simply inputting natural language queries without the need to write code or select keywords. The data is collected from open sources and third-party providers or uploaded directly by users. The results are then displayed straight on the map.

Here is the step-by-step process of the Text2Map engine turning questions in natural language, such as "How many bus stations are around Bryant Park in a 5-minute walk?" into API or database queries:

- **Tokenization:** The natural language input is tokenized, being split into individual words, or tokens. These tokens are then analyzed to understand the structure of the sentence and its constituent parts (e.g., subjects, predicates, circumstances, etc.).

- **Entity Extraction:** The system identifies and classifies words or phrases in the query that correspond to specific geo-entities, such as cities or districts.

- **JSON Generation:** After identifying entities and conditions, the system constructs JSON objects with the necessary metadata about the subject. This generated JSON is used for an API request.

- **Output:** The system visualizes the result on a map in user-friendly formats, ranging from points and arcs to hexagons and heatmaps.

The next stage of the Text2Map technology development involves implementing the functionality of limiting the search within or around precise locations or polygons. These objects can be uploaded by users, retrieved by the AI assistant, or previously placed on the map. This functionality will enable users to interact with relevant data slices without being distracted by visual clutter.

Conclusion

Generative AI has firmly established itself in the production of images and texts. However, the journey for spatial data is just beginning. With the rapid development of the GIS industry and the emergence of vast spatial datasets covering the entire planet (https://www.cnbc.com/2023/07/26/meta-microsoft-amazon-join-overture-maps-to-vie-with-apple-google.html), we can now train and adapt AI for real-world data. In this scenario, AI won't replace architects but will empower them, providing a foundational basis for every urban planning project. Furthermore, this evolution will pave the way for a new specialty in the GIS field: GeoAI specialists, responsible for ensuring algorithmic quality and applicability for spatial challenges.

By Alexander Kamenev and Anna Rakhman. Alexander Kamenev is an Urban AI Member and the CEO of Aino. Anna Rkhman is COO and Co-Founder at Aino, an AI-powered tool for urban consultants and data analysts to create, design, and publish interactive maps.

11 Self-Repairing Cities: How AI is Streamlining Maintenance Operations at Scale

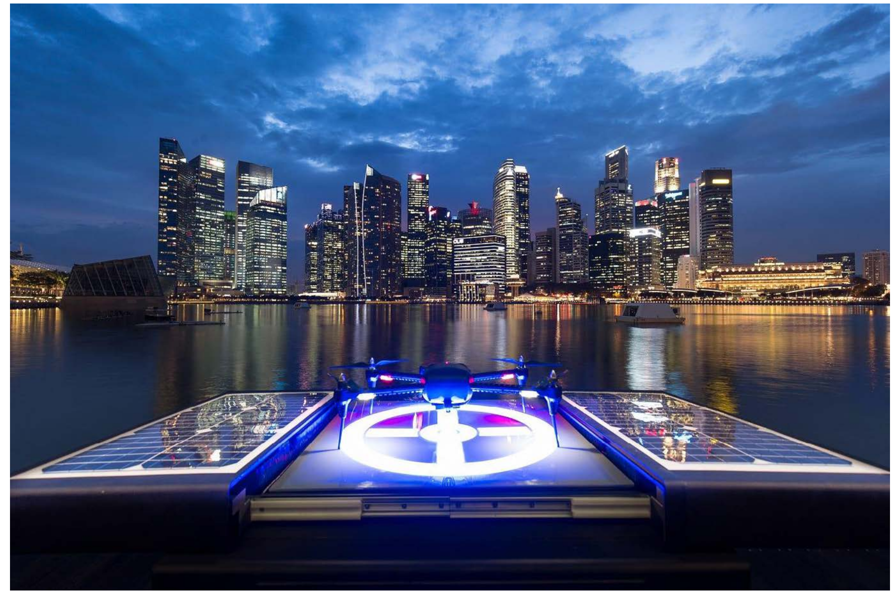
Synthesis of the episode with
Taras Wankewycs, CEO of H3 Dynamics

11 Robotic extensions

Supercharged Infrastructure

View this Trend

Watch the Session



Source: H3 Dynamics

Headquartered in Singapore, H3 Dynamics' customers span the public and private sector, facilities management firms, site operators, safety inspection and certification organizations, urban planners and architects, and regulators involved in legislating safety mandates.

What H3 Dynamics' customers have in common are tall buildings and many of them — skyscrapers at scale in Asian megacities — where the majority of humanity now lives and works.

Singapore alone is home to 40,000 buildings higher than 25 floors, and the majority of its population lives in HDBs (Housing Development Board flats). Managing the state of this built environment at this kind of scale has now become a struggle.

Starting in 2016, H3 Dynamics worked closely with the leading agency in Singapore in charge of Smart Nation implementation — and launched H3 Zoom in 2019, a cloud-based platform that digitizes maintenance operation workflows — from professional inspections to repair monitoring as a continuous cycle. The H3 Zoom platform allows companies and governments to automate visual building inspections for greater accuracy and safety, but also manage repair work across the entire lifecycle of the structure, and the now digitized process is becoming more and more autonomous.

At first, the company focused on inspections — and developed a robust AI solution to support precise defect identification and geolocation, across large outdoor surfaces, namely building facades. But this first application evolved and went deep into the client operational processes.

Source: H3 Dynamics

Over the years, the solution evolved towards remediation management, gathering the existing community of repair contractors, certified professional engineers, and inspection companies onto one single platform which clients can monitor seamlessly.

The solution's technology also evolved from external surface condition management on facades, to indoor unit inspection, safety monitoring, and energy loss detection.

The solution is giving access to several new layers of information on structures and buildings across cities. As such, organizations can track the physical condition of urban and remote facilities with a level of safety, efficiency, and accuracy not possible before.

Speed, productivity, and scale

Traditional inspection methods for high-rise buildings typically take several weeks or months, require expensive equipment rentals, and pose higher safety risks to people. Repair processes can take many months or even a couple of years — and this cycle is never ending. On inspection processes alone, H3 Dynamics customers have sped up building inspection processes by 80%, and increased productivity by up to 70 percent.

Drones and ground robots, as well as people, can capture information from buildings with video and other camera images, bringing this data into the H3 Zoom platform. The system uses technologies including AI and 3D modeling to create an interactive map that displays defects on the scanned structure surfaces, classifying potential risks, whether aesthetic anomalies or unsafe areas that require repair. Civil engineers or other recognized industry experts review and validate the automated findings, the system then generates a detailed interactive report that details safety risks, remediation advice, cost assessments for repair works, reach out to repair contractors, keep track of the quality of repair work and the contractors, and essentially keep track of the life of a building or thousands of buildings — an entire city — from one single pane.

By Taras Wankewycs, CEO of H3 Dynamics

Source: H3 Dynamics

Moving towards full automation and "self-repairing" cities

Ground robots are already in the buildings — cleaning floors and monitoring safety. Last year H3 Dynamics joined forces with Softbank Robotics, one of the world leaders in robotics applied to facilities management. Scanning activity using on-board cameras is a low-cost add on activity, with data reaching H3 Zoom's cloud over Wifi or 5G networks as frequently as needed.

The cloud is agnostic to data acquisition methods. H3 Dynamics has recently partnered with Australian company Voltin which has launched its "Autobat" solution, a "drone on a rope" capable of avoiding drone use in tight urban spaces or highly regulated airspace environments.

Managing tens of thousands of buildings will require more automation in the coming years. As the demand for physical world data continues to grow beyond capacity to acquire it using current "human in the loop" methods, H3 Dynamics is also planning for a fully autonomous drone to cloud to ERP solution — using drone vertiports placed on building rooftops — capable of managing entire building clusters or districts. These vertiport networks will be able to connect to H3 Zoom to transmit the necessary scans for processing when needed — while giving drones other roles, such as package delivery and first response during road accidents for example. The company has already started installing such vertiport infrastructure in less urbanised environments, such as industrial sites.

Cloud powers global plans

H3 Dynamics has envisioned unlimited expansion opportunities beyond his current customer base in Singapore and South East Asia to the broader APAC and Middle East Region, Latin America, Europe, and the United States.

"We are envisioning how industries and cities can evolve in 10 to 20 years, which we are translating into H3 Dynamics' autonomous service offering, and as a cloud-based company, we have no geographical boundaries."

12 Software-Defined Sensing

Synthesis of the episode with
Charlie Catlett, Senior Computer Scientist,
Argonne National Laboratory

View this Trend

Watch the Session

Software-Defined Sensing (SDS) refers to a flexible and remotely programmable approach to sensor networks, where the functionalities and capabilities of the sensor devices are largely determined by software rather than just hardware. In this conversation of our series The Future of Urban AI , we discuss how embedding Artificial Intelligence (AI) and Machine Learning (ML) into the sensor network in cities allow urban challenges to be better diagnosed and measured, focusing on use cases in Chicago, Illinois, and New York, NY. The speaker of this conversation, Charlie Catlett, is a Senior Computer Scientist at Argonne National Laboratory and a Senior Fellow at the University of Chicago's Monsueto Institute for Urban Innovation. Catlett has been a pioneer in network computing for nearly 40 years and co-founded the Chicago Array of Things (AoT) project at the University of Chicago's Urban Center for Computation in 2012.

In the conversation, Catlett introduces us to the evolution of **Argonne-led Urban Sensing Initiatives**. Since around 2011, Catlett and their team have been deeply engaged in embedding artificial intelligence (AI) into urban devices across Chicago. The initial significant project was the **Array of Things (AoT)**, which aimed to create a robust, reliable network of sensors and computing devices installed on city poles. The AoT project sought to test whether a resilient computer system could operate autonomously in challenging environments, like city poles, where physical access is limited. This initiative involved deploying approximately 150 devices throughout Chicago, designed collaboratively with scientific communities and city leaders. The 2020 paper "Measuring Cities with Software-Defined Sensors", published in the Journal of Social Computing (Catlett et al., n.d.), and the 2022 paper "Hands-On Computer Science: The Array of Things Experimental Urban Instrument" describe the AoT Experimental Instrument in greater detail.

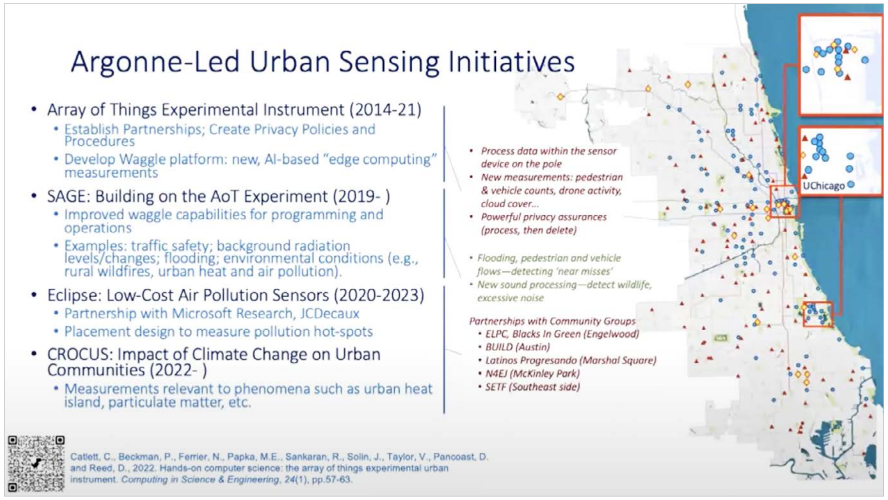


Figure 1: Argonne-Led Urban Sensing Initiatives

Building on the AoT, subsequent efforts have focused on enhancing the devices' capabilities. New projects **SAGE, Eclipse**, and **CROCUS** include advanced flood detection and collision avoidance systems. Notably, a recent collaboration with Microsoft Research and JCDecaux focused on air pollution sensing with low-cost air pollution sensors. This project Eclipse utilized the extensive sensor network to provide a comprehensive view of air quality across the city, with particular emphasis on communities disproportionately affected by pollution. It also highlighted challenges, such as the unequal distribution of bus shelters across neighborhoods, which impacted the project's equity goals. More recently, Catlett's team received a major grant from the Department of Energy to study climate change impacts on vulnerable urban communities. This project named CROCUS involves detailed modeling and measurement in six specific areas of Chicago, addressing issues such as the declining tree canopy and its effects on urban heat. Figure 1 shows the timeline of these different urban sensing initiatives.

Throughout the conversation, Catlett discusses some key challenges of embedded AI. First is **Device Design and Public Perception**. Initially, Catlett shares that the Array of Things (AoT) devices were designed to be aesthetically pleasing to encourage public curiosity and positive engagement. Over time, practicality took precedence, as seen with the more utilitarian SAGE nodes, as shown in Figure 2 on the top right. This shift revealed that device appearance and transparency about their functions are crucial for public trust. Visible surveillance components on devices led to significant community concerns, highlighting the need for ongoing dialogue about privacy and design impact.

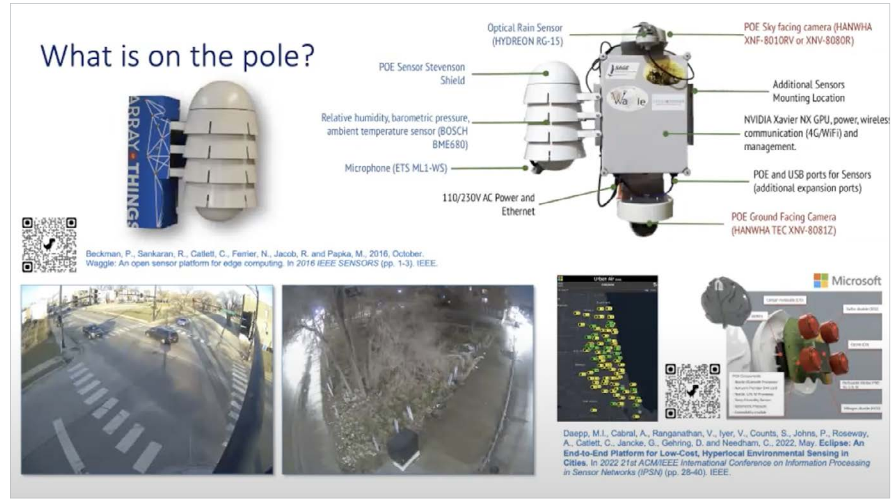


Figure 2: What is on the pole? Diagram of sensors for edge-computing

Catlett presents positive use cases and future vision for edge-computing (refer to Appendix 1) and SDS. While the earlier project focused on urban settings, project SAGE represents a significant evolution, integrating various software-defined sensors to enhance data collection and analysis capabilities. Software-defined sensing is akin to the concept of software-defined radio, a technology that allows radios to be reconfigured through software. Unlike traditional radios, which are fixed to specific frequencies and functions, software-defined radios can be programmed to tune into different frequencies and formats, adapting to a range of tasks from AM radio to cell phone communication. Similarly, software-defined sensors, like cameras and microphones, can be dynamically adjusted through software. This means that a single camera, for example, can be programmed to perform multiple tasks, such as vehicle classification or cloud observation, depending on the current needs.

This adaptability from programmability is exemplified by the project's infrastructure, which includes a diverse range of applications, an "app store" of sorts, developed by various teams. In practice, this means users can select and customize software for specific needs, such as monitoring pedestrian flow or detecting flood conditions. Currently, SAGE has developed about 60 apps.

However, there are limitations based on legal and practical constraints. In Illinois, stringent wiretapping laws restrict the use of microphones, which affects the scope of audio-based data collection. In contrast, in locations like New York City, microphones are employed to classify environmental sounds, such as bird calls and traffic events. This data helps in analyzing urban noise and can be used to improve city planning and public safety.

Privacy and community engagement should be central to any project's approach. In the AoT and SAGE projects, the selection of sensor locations follows a **three-pronged approach**: ensuring community interest aligns with the project's goals, engaging scientists who can provide meaningful insights from the data, and involving local policymakers who can act on the findings. This approach has guided the deployment of sensors in various locations, addressing issues like traffic safety and pedestrian pathways. Additionally, the project has incorporated public engagement tools, such as QR codes on bus shelters, to make data accessible and understandable to residents, as shown in Figure 3. Despite these efforts, community engagement has proven challenging, highlighting the difficulty in achieving meaningful interaction and feedback from diverse populations.

Figure 3: Data Legibility and Visibility- Empowering Participation

Catlett emphasizes the importance of a strategic and principled **privacy policy** that anticipates future technological advancements. The policy framework avoids being tied to the current limitations of technology, ensuring that it remains relevant as AI capabilities evolve. This foresight is crucial for maintaining privacy standards in the face of rapidly advancing technologies.

Lastly, Catlett reflects on the broader implications of AI in urban environments. The rapid advancement of AI technologies poses both opportunities and challenges for smart cities. The key to leveraging AI effectively lies in understanding and addressing the risks at the city level, rather than relying solely on broader legislative measures. As cities increasingly integrate AI and sensor technologies, it is essential to strike a balance between innovation and privacy, ensuring that technological advancements benefit urban communities without compromising their rights and safety.

Appendix 1: What is AI at the Edge?

Integrating AI into edge devices, or **AI at the Edge**, means that data is analyzed locally on the devices themselves, rather than sending it to a central server or cloud for processing. This reduces latency and dependency on network connectivity, enabling real-time analysis and decision-making. Table 1 outlines three advantages of adopting AI at the edge, offering roadmaps to effective and transparent urban sensor management policies.

Table 1: Why AI at the Edge?

Three Advantages of AI at the Edge		
1. Support for High-Data Rate Devices with Low Bandwidth Connectivity	**2. Low Latency**	**3. More Privacy and Security Through Short-Lived Data**
AI at the edge allows devices to process data locally, reducing the need for high bandwidth and frequent data transmission. This is crucial for handling high-data rate devices, such as those using cameras or sensors, in environments with limited network connectivity.	Processing data on-site minimizes the delay associated with sending data to and from the cloud. This enables real-time decision-making and immediate responses, essential for applications like traffic management and flood detection.	Edge AI systems can analyze data locally and retain only necessary information, while deleting raw data promptly. This approach enhances privacy and security by reducing the risk of sensitive data being stored or exposed.

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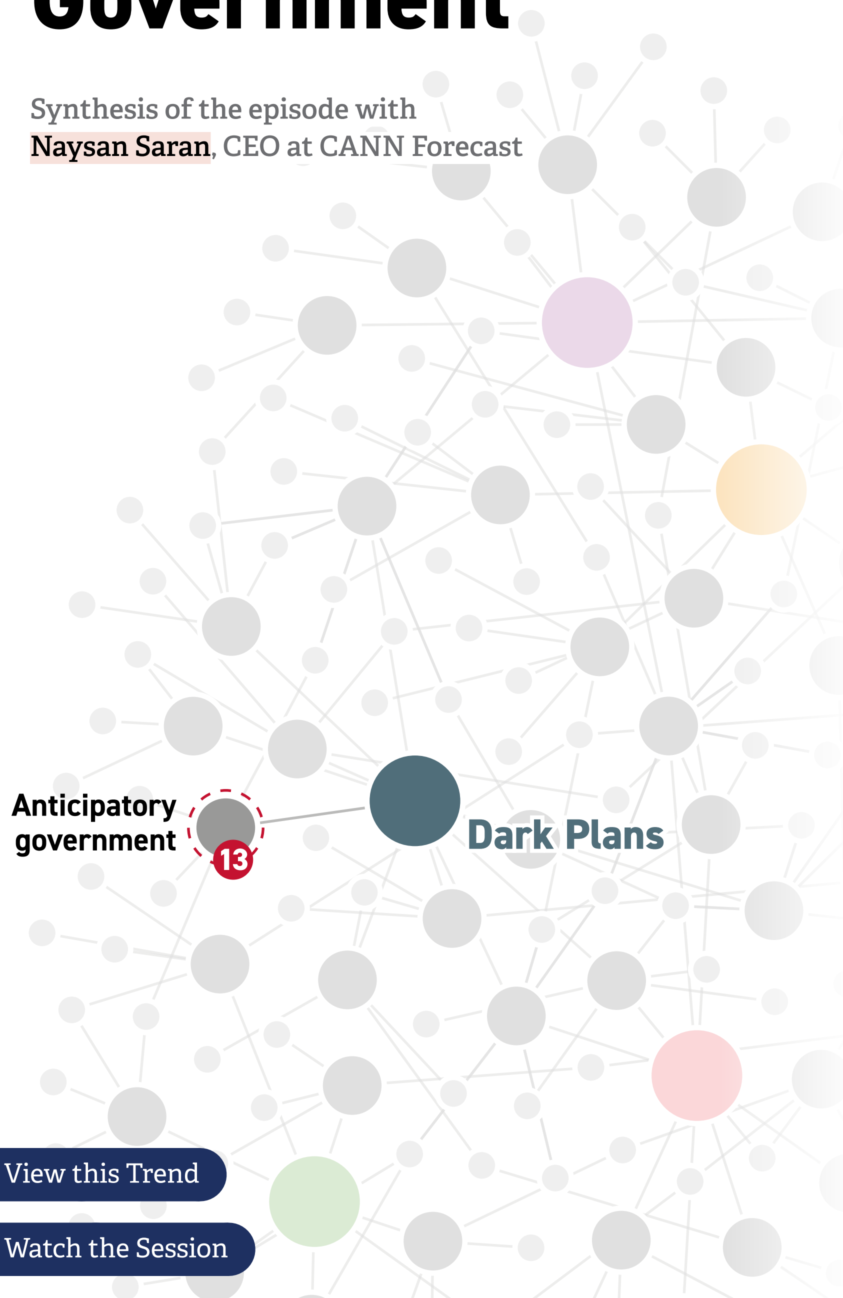
13 Anticipatory Government

Synthesis of the episode with
Naysan Saran, CEO at CANN Forecast



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In this conversation of our series The Future of Urban AI , we delve into the concept of anticipatory government for urban AI, focusing on use cases in Canadian municipalities. Naysan Saran, co-founder and CEO of CANN Forecast, emphasizes the critical importance of urban infrastructure, especially given the projected increase in urban populations by 2050. With two out of three people expected to live in urban areas, the need for efficient and effective urban infrastructure is paramount.

A significant challenge highlighted is the aging infrastructure in North America, with Canada's infrastructure deficit estimated at $122 billion (Saran, 2023). Years of neglect have led to water main breaks, sewer overflows, and road collapses, underscoring the urgency for municipalities to address these challenges efficiently within limited budgets.

CANN Forecast, applies artificial intelligence to the water management industry. The company has collaborated with over 35 municipalities in North America and France. Their work with public governments has led to solutions tailored to specific infrastructure challenges and research publications in Pipelines, AGU Water Resources Research, OECD, and Solar Impulse Foundation. By co-developing solutions with municipalities, CANN Forecast aims to bring innovation forward for the benefit of communities.

Figure 1: CANN Forecast specializes in innovation in the water and wastewater sector (Urban AI, 2023)

Two key use cases of urban AI presented include predicting leaks in the water network with the municipality of Halifax in Eastern Canada and conducting a 360-degree consequence of failure assessment with the city of Sudbury. These cases demonstrate how AI can detect anomalies in infrastructure systems and assess the likelihood and consequences of asset failures. By leveraging AI technologies, municipalities can proactively address infrastructure issues and optimize asset management strategies.

Halifax is one of the largest municipalities in Eastern Canada, located in Nova Scotia. It has a significant economy centered around its ports. Halifax Water, the organization responsible for the city's water infrastructure, tasked CANN Forecast with finding a methodology to identify leaks in two of their pressure zones, also known as district metered areas (DMAs). These DMAs have valves to control water pressure, and flow meters to monitor water in and out of the area.

The team's goal was to use this data to detect leaks as they occur. They employed a statistical time series forecasting methodology called Bayesian Dynamic Linear Models (BDLM). This approach uses historical flow data to calibrate a model that forecasts expected water flow. The key is not just to forecast but to detect significant deviations from the forecast that might indicate a leak.

The process works by comparing real-time flow data against the model's predictions. If the actual flow significantly deviates from the forecasted flow, it triggers an alarm based on the Bayes factor, indicating a potential leak. In the specific case they studied, the Bayes factor dropped below a threshold, signaling a break, as shown in the B graph in Figure 2.

This method allows CANN Forecast to identify anomalies within the water distribution network in real-time, providing timely alerts to drinking water operations. This proactive approach helps ensure the integrity of the water infrastructure and minimizes the impact of leaks.

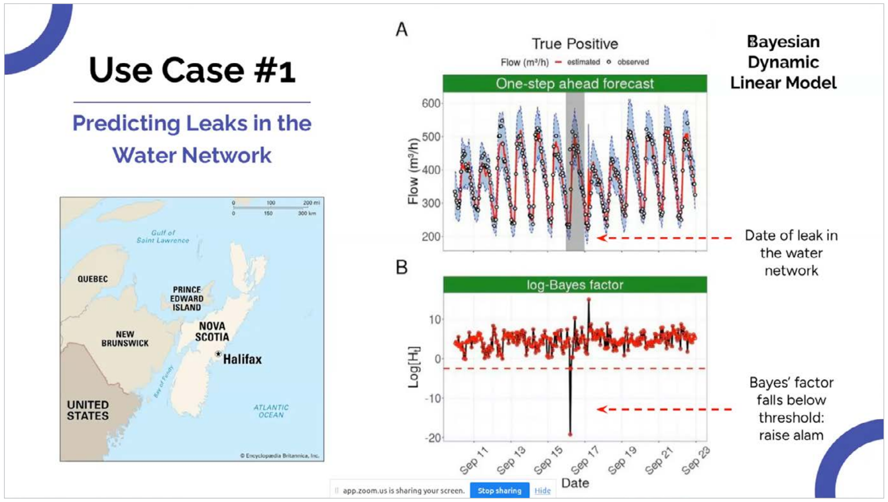

Figure 2: Use Case #1 Predicting Leaks in the Water Network with the Bayesian Dynamic Linear Model (Urban AI, 2023)

The second case focuses on asset management, particularly assessing the likelihood and holistic consequences of infrastructure failures. This approach is critical for municipalities like Sudbury, a mining hub in Northern Canada. A comprehensive risk assessment helps prioritize maintenance and investment decisions.

CANN Forecast measured key performance indicators (KPIs) such as the cost of repair, replacement, and rehabilitation. Repair costs cover immediate fixes, replacement costs involve installing new pipes, and rehabilitation extends the useful life of existing pipes. Their model aggregates cost data from various municipalities, providing accurate estimates even if a city lacks specific data. In addition to these costs, the model also considers the cost of lost water, property damage from flooding, and impacts on nearby places of interest by factoring in population density and traffic disruption using the Google Traffic API.

Public image is a unique feature in the model. Frequent infrastructure work can lead to public frustration, especially if it disrupts daily life repeatedly. They calculate this by analyzing the history of municipal work in an area over the past three years. The more recent work done, the less desirable additional projects become in the short term to avoid public discontent and media scrutiny.

By integrating these factors as shown in Figure 3, municipalities can make informed decisions on resource allocation, ensuring efficient and effective infrastructure management. This holistic approach helps identify high-risk assets and prioritize actions that minimize both immediate and long-term impacts.

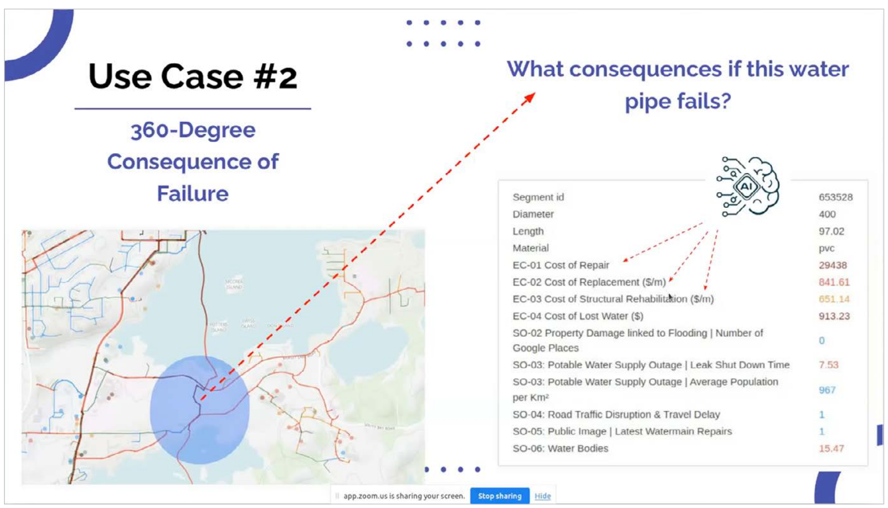

Figure 3: Use Case #2 360-Degree Consequence of Failure (Urban AI, 2023)

However, Saran also touches on challenges in implementing urban AI, such as change management, organizational silos, and data collection and preparation. These challenges highlight the complexity of integrating AI into existing infrastructure systems and the importance of addressing governance and data sharing issues.

Tailoring solutions for diverse municipalities is crucial due to varying technological maturity. Larger cities like New York, Montreal, and Toronto have the resources for advanced technologies, while smaller communities may be in early digital transformation stages. Not relying solely on sensors reflects a strategic approach to inclusivity. Developing models that work with existing data and infrastructure bridges the technological readiness gap, ensuring smaller communities aren't left behind and allowing scalability toward advanced technologies.

Lastly, Saran emphasizes considering social and environmental consequences when implementing AI solutions in urban areas. AI can reduce inequality by identifying and replacing lead pipes in underserved communities. However, Saran also stresses that prioritizing and implementing solutions that benefit marginalized communities is ultimately a social and political decision.

In conclusion, the conversation underscores the opportunities and challenges of anticipatory government for urban AI. By harnessing AI technologies, municipalities can enhance the sustainability, efficiency, and resilience of urban infrastructure.

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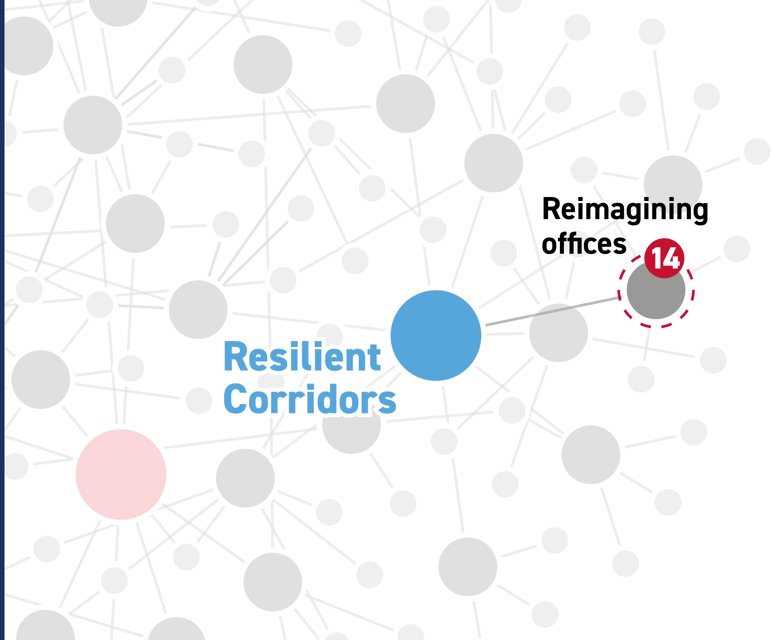
14 Self-Learning Buildings: From Static Containers into Adaptive Systems

Synthesis of the episode with
Davide Schaumann, Director of Intelligent Place Laboratory



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Static buildings Vs. Dynamic human needs

Built environments are designed to optimally serve the needs of their inhabitants. However, human needs continuously change. As new needs arise, even the best-designed facilities no longer function optimally. This may result in underperforming buildings, inefficient operations, dissatisfied users, and excessive consumption of natural resources.

For example:

- The widespread adoption of hybrid workstyles can cause significant fluctuations in daily workplace occupancy, leading to highly inefficient space utilization.
- Health crises and the ever-growing demand for healthcare services can strain hospital resources, which are often already constrained.
- Extreme weather events induced by climate change can cause substantial operational disruptions in airports and other transportation hubs.

How can buildings and cities be made more resilient to ever-changing human needs?

Buildings as adaptive systems

A common strategy to enhance buildings' adaptability relies on 'evidence-based' solutions, derived from past experiences that have helped the facility address previous challenges. However, if the context changes, solutions that may have worked well for past situations may not be adequate for new circumstances. Therefore, exploring novel approaches that look into the *future* rather than the *past* becomes essential to address emerging needs.

At the Intelligent Place Lab (IPL) we employ Artificial Intelligence (AI) and Multi-Agent Simulation (MAS) to predict and analyze the implications of adaptability strategies on the behavior of building occupants. This approach not only assists in designing new buildings but also enables the dynamic management of operations in existing facilities. It therefore ensures optimal resource allocation to meet continuously evolving operational demands.

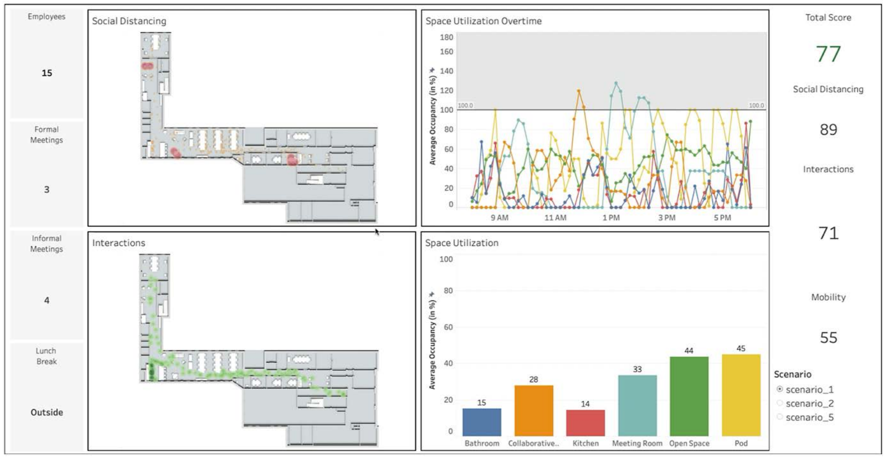


Figure 1. Example of a dashboard to analyze simulation outcomes for a Post-Covid workplace reactivation project

Simulating human behavior in built environments

The simulation process involves the following key components:

1. **Building Model.** Encompasses the structure's geometry, space functions, supported activities in each space, and any static or dynamic equipment present.

2. **Occupant Model.** Details the roles and profiles of the occupants, their relationships with others, and the tasks they're assigned.

3. **Activity Model.** Defines individual and collaborative tasks, their specific requirements, and any task interdependencies.

4. **Simulation Engine.** Computes the dynamic behavior of occupants, accounting for both scheduled and unscheduled activities that could potentially disrupt building operations.

5. **Analytics Module.** Analyzes the simulation output, providing a multi-criteria evaluation of spatial, social, and operational outcomes.

6. **Optimization Engine.** Systematical tests alternative scenarios to learn the most efficient strategies for addressing emerging needs.

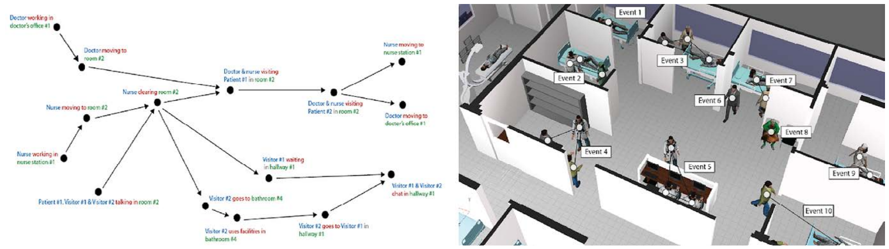


Figure 2. Simulating human behavior narratives in built environments (link to paper)

From smart humans to smart buildings

AI-powered optimization assists the decision-making process of architects, planners, and engineers in designing buildings. Post-construction, this system can be coupled with sensors and Internet of Things (IoT) infrastructure, aiding operations management in existing facilities. This approach effectively transforms buildings from static containers into adaptive systems. Learning from forward-looking simulations, buildings can offer recommendations for optimal resource allocation strategies.

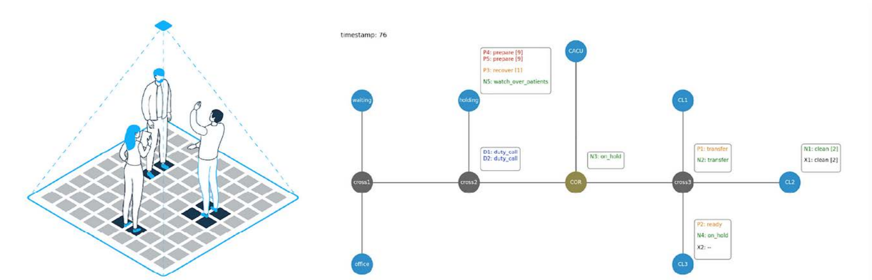


Figure 3. Embedding simulation capabilities in built environments for resource allocation management (link to paper)

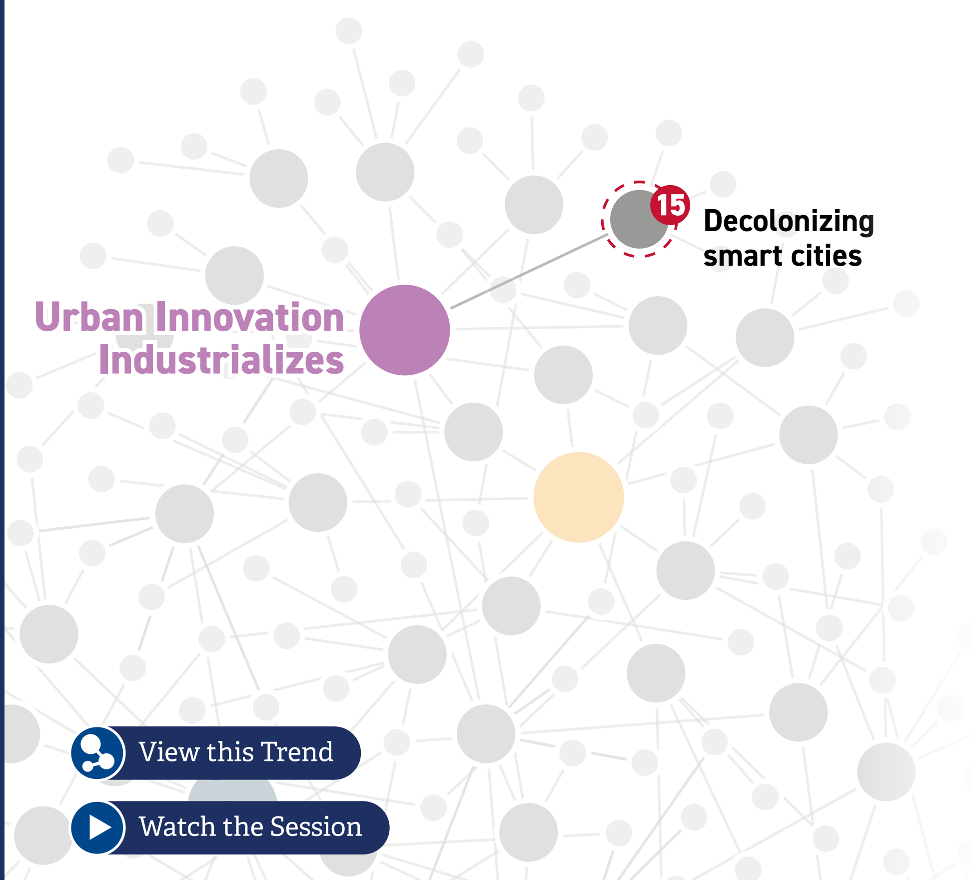
Towards holistic sustainability

Optimizing building design and operations leads to comprehensive enhancements within building ecosystems. This includes improved space utilization, enhancing occupants' experience, health, and well-being, as well as bolstering the operational efficiency of organizations that occupy buildings. Integrating these advantages is key to achieving combined social, operational, and environmental sustainability that meets the needs of individuals, organizations, and the planet at large.

By Davide Schaumann, Director of Intelligent Place Laboratory

15 Localizing Urban AI: Developments in Latin America

Synthesis of the episode with
Soledad Guilera, Universidad Torcuato Di Tella, Buenos Aires, Argentina



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Latin America is packed with natural wonders, ancient lost cities, and lively Latin cultures. The continent is one of the most urbanized areas in the world and it exemplifies the changes that urbanization can bring about. With over 82% of its population residing in urban environments — an increase from just 41% in 1950 — the urban areas have become central to the continent's development. This trend towards urban living is expected to encompass 90% of Latin Americans by 2050. Major cities such as São Paulo and Mexico City each have populations surpassing 20 million, with Buenos Aires, Bogotá, and Rio de Janeiro not far behind, hosting around 15 million people. Yet, the rapid and at times unplanned urban expansion has led to pressing challenges that demand immediate attention, and Artificial Intelligence has emerged as a crucial tool to tackle urban challenges.

Latin American cities pulse with a vibrant, colorful, and dynamic energy that is as diverse as the region itself. The character of these cities is a unique blend of tradition and modernity, where historic architecture melts with modern skyscrapers, and where cultural traditions are celebrated alongside the bustling metropolitan life. The streets are often filled with the sounds of music, from salsa to samba to reggaeton, creating a soundtrack that captures the essence of daily life. These urban spaces are also arenas of profound creativity and innovation, where art, fashion, and gastronomy reflect a melting pot of indigenous, African, European, and Asian influences. Social interaction is at the heart of (delete of the vine) Latin American cities with public squares and parks as popular gathering places.

However, there's also a palpable sense of resilience in these cities. Economic disparities and political challenges are part of the urban tapestry, leading to a stark contrast between affluent neighborhoods and informal settlements. The region's cities, while bustling hubs of culture and economy, face public service deficiencies, rising crime rates, and escalating housing costs. Approximately 160 million urban dwellers in Latin America live in informal settlements. These patterns of informal development demonstrate the dysfunctional way in which land markets are working in the region, highlighting an insufficient supply of serviced land at affordable prices. Moreover, the cause is often traced back to infrastructural gaps. Investment lags in key areas

— housing, clean water, sustainable energy, and telecommunications — are symptomatic of the recent economic stagnation and widespread corruption scandals, like the Lava Jato case. According to the World Economic Forum, a staggering annual increase in spending, up to $180 billion or 5% of GDP, is needed to bridge these infrastructural gaps.

The urban challenges are not limited to infrastructure alone. Living in cities is becoming too expensive for many, as costs outpace income growth. There is also a big divide in city life quality, with some areas having plenty of resources while others have very few. In addition, cities need to adapt and strengthen against the growing threats posed by climate change. Developing efficient and sustainable transit systems is still a pending matter and is critical for urban areas to support their residents. Increasing urban safety is essential to protect residents against crime and accidents. Effective city management and inclusive political processes are increasingly required to meet the diverse needs of urban populations. All in all, issues of affordability, equity, climate resilience, transportation, safety, and governance call for urgent attention and innovative solutions.

It is here, within this complex landscape of urban challenges, that Artificial Intelligence (AI) can play a key role in boosting urban development. Urban AI can pave the way for smarter and more equitable cities throughout Latin America. Through advanced mapping tools, it can transform satellite imagery into detailed maps that can range from informal settlements to open dumps. These tools can help city managers design and implement re-urbanization policies and lean towards more effective waste management and recycling programs. Through smarter surveillance systems AI can enhance public safety and foster cooperative efforts with legal authorities to tackle urban crime. Using AI's 3D modeling capabilities, city planners can simulate potential policy impacts in urban design leading to more data-driven and transparent urban management. Finally, AI-enabled chatbots offer 24/7 information and services to citizens and may contribute to more responsive and inclusive city management processes.

> "Approximately 160 million urban dwellers in Latin America live in informal settlements."

Recent developments in Latin America illustrate the implementation of AI in urban management. In Colombia, Barranquilla has employed AI for high-precision mapping of informal settlements. In Mendoza, Argentina, drones equipped with GPS technology have plotted the geography of open dumps, and machine learning models identified their content in terms of plastic, wood, and glass facilitating efficient waste management. Curitiba in Brazil implemented an AI-integrated surveillance system that helps analyze images and compare them to the police database for possible irregularities. Additionally, Buenos Aires, Argentina, has pioneered a 3D city planning platform to support neighborhood development and simplify the understanding of local regulations. The city has also implemented BOTI, the first city-developed chatbot for WhatsApp in the world, that offers round-the-clock citizen services and played a crucial role in improving the city's response during the pandemic, ensuring effective communication with residents during emergency situations.

Despite the potential that AI holds for transforming Latin American cities, the path to its full integration can face multiple obstacles. One of the most significant barriers is connectivity. In an era where AI systems depend on the seamless flow of data, inconsistent internet access and limited bandwidth can hinder the functionality of AI applications. The digital divide means that while some urban areas may enjoy high-speed internet, others are left in the connectivity shadows, unable to support AI-driven solutions. Further government actions will be needed to fix the digital divide and digital access gap.

Data privacy and security are additional concerns that come with the territory of AI. As AI systems process vast amounts of personal data, there is a growing unease over how this information is handled, stored, and protected. In Latin America, where regulations on data privacy are still being developed and sometimes are inadequately enforced or data privacy authorities do not have enough resources, there is a risk that the deployment of AI could lead to breaches of privacy if not managed with the utmost care.

Developing a workforce skilled in AI is another hurdle. The region needs more professionals who are not only trained in AI technology but also understand how to apply it within the unique context of Latin America's urban centers. This requires further investment in education and training programs to meet the demand for AI expertise.

Despite the opportunities AI presents, Latin America grapples with several barriers to its widespread adoption in urban environments. Challenges of urban infrastructure but also connectivity, concerns about data privacy and security, and developing an AI-skilled workforce in the region describe some of the barriers that cities face. The region's journey toward urban AI broad development and adoption will demand robust government initiatives, increased private sector engagement, and crucial academic contributions.

To overcome these barriers, a concerted effort from multiple sectors is necessary. Government initiatives are critical — they can provide the regulatory frameworks, infrastructure investment, and educational programs necessary to foster AI development. The private sector must also play a role, by driving innovation and investing in the technology and infrastructure that AI requires. Finally, academic institutions must contribute by conducting research and offering programs that can equip the next generation of urban planners and technologists with the skills needed to harness AI effectively.

As Latin America continues to urbanize at a breathtaking pace, AI offers the potential for optimism in urban development — a tool that, if leveraged correctly, could ensure that the cities of this vibrant continent are not only engines of growth but exemplars of innovation, safety, and inclusivity.

By Soledad Guilera, Universidad Torcuato Di Tella, Buenos Aires, Argentina

16 Choreographed Streets

Synthesis of the episode with
Mariela Alfonzo, CEO of State of Place

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> "Tech is a means to an end and not the end. And therein lies the real power of AI and tech within the urban space."

In the 16th episode of The Future of Urban AI, hosted by Anthony Townsend, Dr. Mariela Alfonzo, the founder and CEO of State of Place, argues that technology-enabled, evidence-based, and community-led city-making is key to creating more just, thriving, and resilient places. This episode is the last component of the Future of Urban Tech Horizon Scan, created jointly by the international Think Tank Urban AI and Cornell Tech.

State of Place employs visual machine learning models to analyze street-level images from sources like Google Street View and OpenStreetMap (OSM). These models extract detailed information about urban design elements (over 125 community-scale infrastructure assets), which are then processed into the State of Place (SoP) Index—a score from 0 to 100 that assesses the quality of the built environment across ten urban design dimensions. The software then visualizes this data graphically to showcase an area's assets and needs block by block, spatially helping city makers target and prioritize divested areas of opportunity.

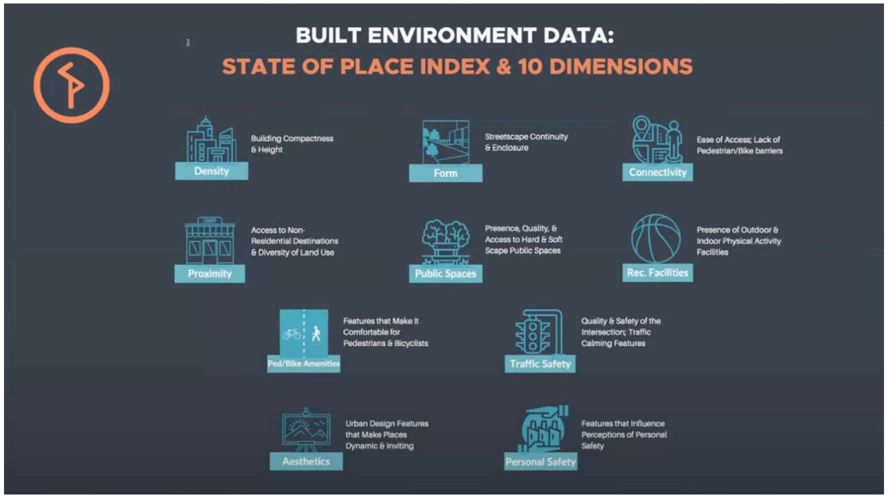

Figure 1: State of Place Index and 10 Dimensions.

Figure 2: Image showing how street level infrastructure assets, like sidewalks, benches, crosswalk, trees, lighting, different building uses, are analyzed algorithmically to process the State of Place score between 0 and 100.

AI for Spatial Justice

Spatial justice links social justice to space, rooted in the critical geography tradition from the 1970s and notably written by geographers David Harvey and Edward W. Soja. In "The city and spatial justice", Soja begins to define spatial justice as "the fair and equitable distribution in space of socially valued resources and opportunities to use them" (Soja 2009). Emphasizing *spatial* as a unique adjective is important because it allows us to address how space can perpetuate social inequalities and seeks to rectify these through inclusive and participatory planning processes.

"The post-2020 world has made it excruciatingly clear that *where* we live predetermines how *well* we live from who suffers from diabetes, to who can safely access the park, to who is impacted the most by floods, to who can access a good job," Alfonza says.

Poorly designed spaces can lead to higher rates of chronic diseases, increased crime, and diminished economic prospects. Conversely, well-designed spaces can foster healthier, safer, and more prosperous communities, as juxtaposed in Figure 3. Spatial justice means creating environments where all individuals have equal access to amenities and opportunities, thereby fostering overall community well-being.

Figure 3: (left) A good urban design example that comes with safer environments for kids to ride bikes, healthy lifestyles, and vibrant social lives; (right) A bad urban design example that correlates with higher biking accidents, higher child asthma rates, higher crime rates, and flooding events.

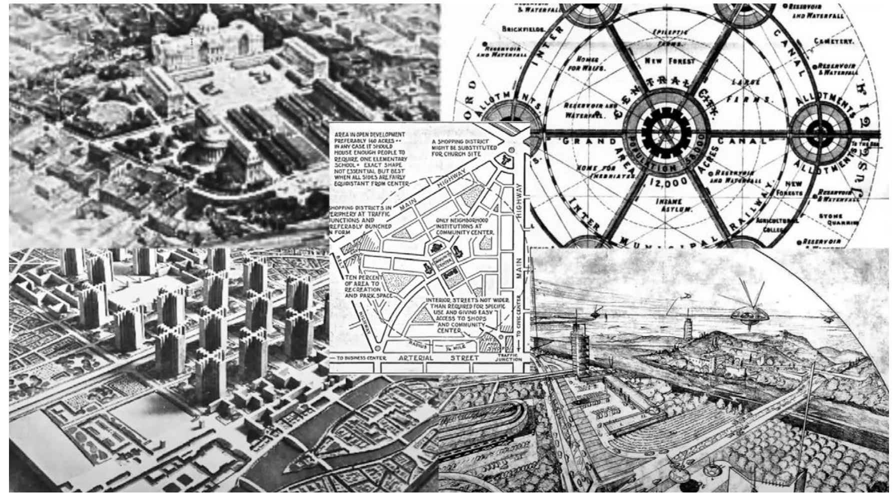

Figure 4: Collage of utopian city planning visions.

Alfonzo posits that city planning has often been reactionary, with grand visions like City Beautiful, Garden Cities, Radiant Cities, Broadacre Cities, and the Neighborhood Unit proposed as solutions for happier, healthier lives. However, these plans often failed because their implementations were watered-down versions of the original ideas, and fundamentally, utopias don't exist. Alfronza argues that modern versions of these utopian plans like the 15-minute city and the nyc 25×25, while rooted in sound principles, also fall into the ideological trap of oversimplification and lack context, leading to misunderstandings and right-wing backlash.

Furthermore, Alfonza sees the smart city movement's potential but also recognizes skepticism among city planners. Many smart city solutions predict current performance without guiding cities on how to achieve their goals. Large-scale models often include irrelevant data, complicating decision-making. City planners face tough choices daily, with limited resources and capacity constraints. Decisions are frequently based on past practices, loud voices, and financial ease rather than data-driven evidence, resulting in stalled or ineffective projects. Collecting data is just the first step, translating it into actionable solutions should be the main goal.

Mariela Alfonzo wants to utilize urban technologies to advance spatial justice. This means coming up with a method to quantify how the design of our built environment influences behaviors, perceptions, attitudes, and choices, which in turn influence the quality of life.

Figure 7: Infographic showing the relationships between State of Place as an urban design strategy, people's behaviors and perceptions, and quality of life.

Alfonzo had already spent over 20 years quantifying the value of place, developing forecasting models to identify effective urban interventions. A study she co-authored involved collecting State of Place and economic data from 16 neighborhoods in the DC metro area. The hierarchical regression analysis revealed that a 20-point increase in the State of Place Index correlated with a $9 rise in office rents, $7 in retail rents, a $300 unit increase in residential rents, an 80% boost in retail revenues, and an $81 per square foot increase in home values. Areas with higher index scores also had residents with lower education levels, lower incomes, and higher concentrations of marginalized populations.

This study highlighted the economic and equity benefits of investing in urban quality. Therefore, State of Place as a tech-enabled platform, is a powerful urban diagnostic tool with a built-in rationale for why investing in place mattered for economics and equity.

In Philadelphia, State of Place helped build an evidence-based narrative around spatial injustices in the city and identify investment opportunities. The team analyzed data from 17 zip codes to highlight spatial injustices affecting vulnerable communities, linking poor urban design to higher rates of chronic diseases, environmental hazards,

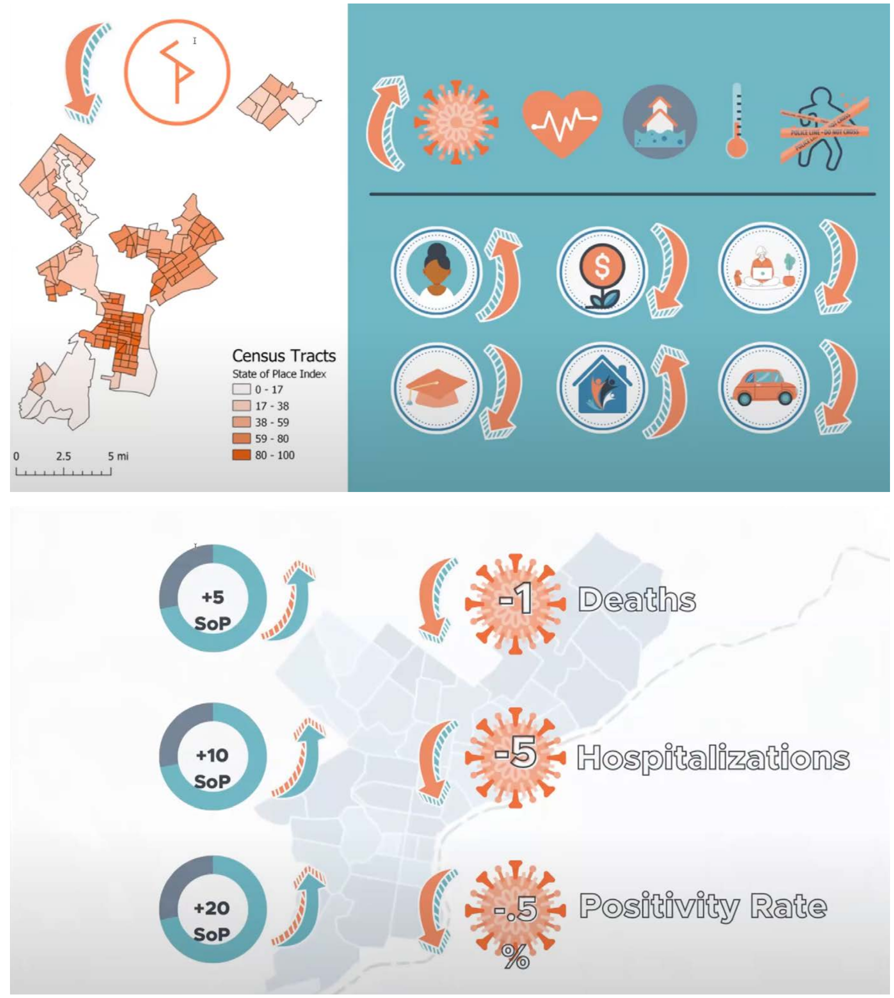

Figure 8: State of Place (SoP) Index of Philadelphia and predicted impact of increasing SoP score.

crime, and COVID-19 impacts. The study found that a 5-point increase in the State of Place Index correlated with one fewer COVID death and five fewer hospitalizations, while a 20-point increase reduced transmission rates by 0.5%. Areas with higher index scores had significantly fewer COVID-19 positivity, hospitalization, and fatality rates (37%, 41%, and 83% lower, respectively) and lower homicide rates (8.7 times less). Additionally, improvements in parks and public spaces reduced temperatures by half a degree, highlighting the tangible benefits of urban design.

In Durham, State of Place supported Vision Zero goals by trying to reduce traffic collisions. They collected built environment data from known collision hotspots and compared it to non-hotspots. Their analysis showed that for every one point increase on the State of Place Index, the odds of a collision were reduced by 12.3% on average. Specifically, parks and public spaces correlated with a 25% reduction in collision rates per point increase. The findings of this study not only identify intersections for safety improvements and predict potential hotspots before accidents occurred, but also advocates for urban design with more parks and public spaces.

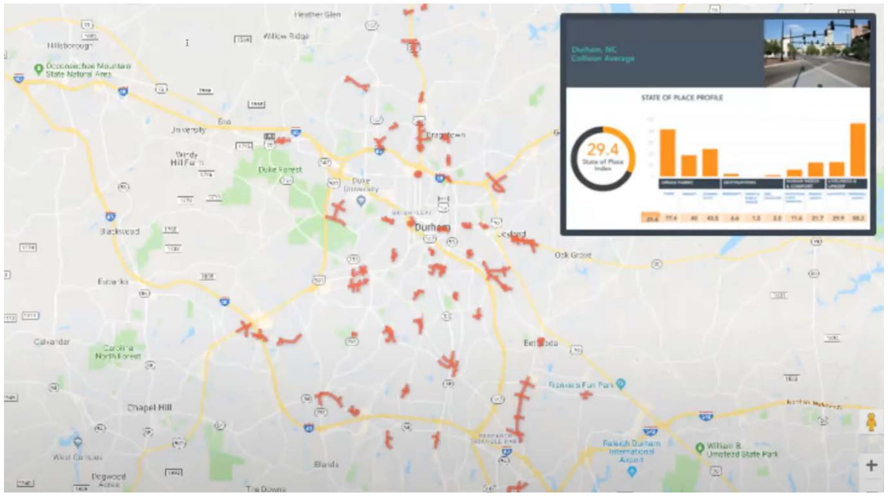

Figure 9: State of Place's identification of collision hotpots on street intersections

The State of Place software converts data-heavy academic findings into actionable recommendations and priorities for urban design improvements that effectively and cost-efficiently lead to desired outcomes. Based on their forecasting models, the algorithm identifies which urban design features are most impactful depending on the community's goals. For example, certain features may be more effective in driving retail revenues, while others are better suited for reducing asthma rates. Instead of starting with specific design features, the software allows users to indicate which quality of life outcomes they want to improve. Users can also indicate how feasible it is to modify certain urban features in their unique geopolitical context.

"[State of Place] translates what would normally be pretty cool but academic findings into practical actionable recommendations that are most likely to help city makers achieve their goals and optimize value," Alfonzo says.

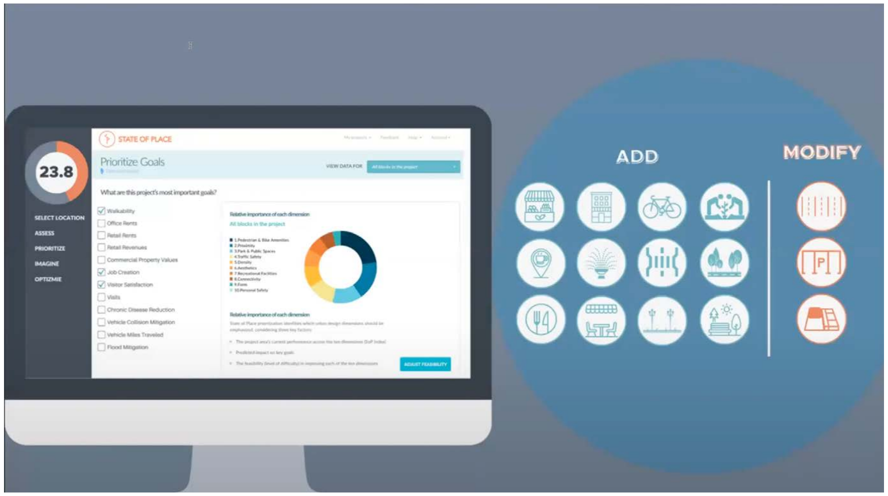

Figure 12: Interface of the State of Place software that allows users to prioritize goals, add or modify urban features

State of Place's platform also includes tools for co-creating urban design solutions with residents, ensuring that improvements reflect the community's needs and priorities.

The software provides a SimCity-like tool for community engagement and project scenario testing. Users can input their State of Place data for proposed redevelopment areas. This feature enables users to visualize existing conditions and collaboratively develop project and investment ideas with multiple stakeholders. They can test built environment recommendations, such as adding parks, street trees, bike lanes, or crosswalk markings, and see real-time impacts on the State of Place Index.

This helps predict real-life outcomes like increased tax revenues, fewer collisions, reduced chronic disease, less violence, and lower vehicle miles traveled. This approach ensures investments are optimized, clearly communicates impacts, and builds necessary trust and buy-in from the community.

For example, the city of Tigard near Portland, Oregon, used this scenario tool to enhance their community engagement process. By involving an underserved part of the city, they were able to co-create project ideas with community members, ensuring that the development reflected the priorities and needs of those who would be directly affected.

Figure 13: Analyze Scenario Sim-City like function of the State of Place software that allows knowledge co-creation

Finally, the software's forecasting tool calculates both the impact and the return on investment (ROI) of proposed projects. This helps city makers justify their decisions and secure necessary funding. For example, real estate developers have used before-and-after data to gain City Council approval and financing, and to refine their plans to increase community value. By quantifying the economic impact, including potential rent increases, city makers can address displacement risks with policies like community land trusts or benefit agreements, ensuring affordability despite rising rents.

As a preview of upcoming projects, State of Place is in the final phases of collaborating with the DC Transit Authority (WMATA) and the University of Maryland. The project involves integrating State of Place data into WMATA's transit ridership models, enhancing their predictability and actionability. This integration will help WMATA identify capital improvements along their stations, boosting both quality of life and ridership. Additionally, the team is embarking on the second phase of the original Brookings study in the Washington D.C metro area, which will provide before-and-after data spanning 10 years, offering valuable insights into urban design impacts.

"We're really excited about this opportunity, that this first of its kind longitudinal data set on these microscale urban design features unlocks," Alfronzo says.

AI holds immense potential for transforming urban planning. By embracing data-driven, community-led approaches, cities can become more just, thriving, and resilient. Alfonzo envisions a future where AI not only helps design better cities but also ensures that where we live no longer predetermines how well we live. The journey towards spatial justice is complex, but with the right tools and commitment, it is achievable.

Conclusion

The Future Is A Blank Prompt

Anthony Townsend, Urbanist in Residence, Jacobs Urban Tech Hub

The fast rise of AI is redrawing our long-held pictures of the future. Some see a new world of abundance, powered by superintelligence. Others see nothing but danger and deprivation. A lot of experts have simply given up on trying to forecast what comes next.

I prefer to dig in. AI is process as much as product. And we are still at the center of that process. AI isn't just reshaping our expectations, its changing how we bring our dreams and fears to life. The future is a blank prompt waiting for us. What will we ask of it?

This isn't a rhetorical question. Learning how to interrogate an LLM to get the result you want—prompt engineering, as its known—is now a critical thinking skill. Much as the pilots of automated aircraft actually need more training, we all need to get smarter to use intelligent machines. As it turns out, thinking with machines involves a great deal of telling a machine *how* to think as well as *what* the result should be.

Prompt engineering isn't just about avoiding hallucinations. LLMs aren't entirely predictable. Ask one the same question twice, and you may not get the same answer. In geek parlance, this means they're *non-deterministic*. LLMs constrained randomness is what makes them so creative. But it has bred great anxiety among many of us. Why don't these powerful machines work like *machines*?

Urbanists, on the other hard, are in familiar territory. Cities are full of non-deterministic systems, complex networks that generate sophisticated but unpredictable effects. When we draft design guidelines or cultivate consensus around an urban master plan, we're engineering prompts for entire populations to process and respond to, their billions of everyday decisions doing the computations of city-making over time. More than any other field, we're ready for the weird way that AI works.

This puts us in a powerful position. Our successes and failures with AI will inspire and inform others. The new views we develop on AI's benefits and its risks, and the new ways we express them, are likely to impact the AI field itself, too. It wouldn't be the first time we've shaped the computer culture. Christopher Alexander's writings in the 1970s on the grammar of vernacular architecture, a "pattern language" as he called it, inspired object-oriented programming, a fundamental leap in software engineering that powers our world today.

It's easy to point out AI's flaws, and those of its creators. Its much harder to step into their shoes and try to write a different story. But that's what makes a blank prompt so intoxicating. You only have to focus on spelling out where you want to go. The machine can fill in the rest.

Urban AI

UrbanAI is a Paris-based think tank dedicated to the emerging field of Urban Artificial Intelligence. Given the highly complex and human-centered nature of urban systems, scholarship and practical implementation of artificial intelligence technologies in cities requires a uniquely multidisciplinary lens. Urban AI seeks to generate a holistic body of knowledge on urban artificial intelligence by federating and collaborating with a growing, global community of researchers, public servants, start-ups, and urban subject matter experts, who work at the intersection of cities and technology. Together, they carry out multidisciplinary projects to better understand and assess the impacts of artificial intelligence on urban life and vice versa.

Visit urbanai.fr

Urban Tech Hub

The Jacobs Urban Tech Hub at Cornell Tech is a new academic center in New York City that generates applied research, fosters an expanding tech ecosystem, and cultivates a new generation of urban technology leaders. We bring a human-centered approach to research and education with the aim of building a better world through increased access and opportunity within the technology sector.

Based at the Jacobs Technion-Cornell Institute at Cornell Tech, the Urban Tech Hub leverages the resources of Cornell University and brings together researchers, engineers, scientists, urban tech companies, government agencies, and community organizations to address the challenges facing cities today.

Visit urban.tech.cornell.edu