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From Smart to Cognitive Cities: Intelligence and Urban Utopias

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"We are out of reality when we accept the current conditions as constant data and we force humans do machines' labor. We force him to cease being human, trying to perfect an already dead system."
Takis Ch. Zenetos, Electronic Urbanism
(Kalafati and Papalexopoulos, 2006)

Abstract
Recent approaches in human intelligence have provided us with a broader understanding about its multiplicity and its dynamic nature. The human capacity to imagine beyond the existing has led to the creation of utopias as a way to fantasize about future societies and future cities. The current article explores how the concept of human intelligence is reflected in urban utopias. More specifically, it focuses on two current urban utopias, which are the predominant urban visions for the digital era: Smart and Cognitive cities. The vision of smart cities, grounded in the intensive use of information and communication technologies (ICT) for the sustainable development of cities, gained a lot of popularity and a wide range of smart city initiatives have been implemented across the world. Apart from the criticism for the technological determinism of smart cities and for endorsing a corporate vision of cities, it is argued that the dominant approach of smart cities consider intelligence as a mainly technological function. Based on advances in cognitive computing, cognitive cities expand the concept of smart cities through the introduction of cognition and learning. The article concludes with some thoughts on intelligence and the function of utopian thinking, and underlines the role of technology as one among many interrelated elements that compose our cities.

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From intelligence to utopian thinking

Intelligence is considered a fundamental element of the brain that integrates several cognitive functions such as perception, attention, memory, language. When we refer to humans, the term 'human intelligence' is usually employed, since other forms of intelligence have been also studied, like animal intelligence. There has been a long history of research and debate on how intelligence can be defined and whether there can be a single standard definition for it. In their extensive work, Legg and Hutter present a collection of 70 distinct definitions of intelligence (Legg and Hutter, 2007), assuming that there is no objective sense in which one could be the correct one.

Reasoning, problem solving and learning are considered among the most crucial facets of human intelligence. However, they are not the only ones and many approaches of the previous century, including the intelligence testing (I.Q.) movement, the Piagetian and the information-processing approaches have focused on one view of human intellect. There have been several attempts to provide a more comprehensive description of intelligence and focus precisely on the neglected areas. Howard Gardner suggested the 'theory of multiple intelligences' in which he describes nine distinct types of intelligence, each of which is composed of a number of separate sub capacities: logical-mathematical, linguistic, spatial, musical, kinesthetic, interpersonal, intrapersonal, naturalist and existential. He describes spatial intelligence as the ability "to perceive the visual world accurately, to perform transformations and modifications upon one's initial perceptions, and to be able to re-create aspects of one's visual experience" (Gardner, 2011). According to this theory, each one of these types is related to different parts of the human brain and their distribution varies significantly per person. Emotional intelligence was the last type to be defined by David Goleman who provided novel insights into the brain architecture underlying emotion and rationality (Goleman, 1995).

"Intelligences" are not static; they continuously evolve through practice and learning. They are highly interrelated among them and, at the same time, directly intertwined with the concepts of imagination and creativity; they involve "operations of creating inner environments into which to place echoes of external patterns" (Novak, 1997). The capacity to imagine beyond the present and beyond the existing world is considered one of the driving forces for the evolution of humankind. Harari argues that the ability to imagine things collectively gave Sapiens the ability to cooperate flexibly in large numbers, found cities with thousands of population and, therefore, rule the world (Harari, 2014). In their attempt to make sense of the world that surrounds them, humans are able to envision something that does not exist, transcend the present and fantasize about the future.

The ultimate expression of humans' ability to imagine beyond the existing is utopian thinking; since the very beginning of human thought, humans have been imagining ideal societies and perfect worlds as a way to express their desire for change. However, utopias cannot be seen out of their historical context. In any time period, utopian thinking is derived from the specific socio-political conditions of the era and reflect different approaches to the notion of the "ideal". Both Plato's Republic and Thomas Moore's Utopia, described the ideal society as an instrument of education and ethics. During the Renaissance, utopian thinking expresses the greatness of the city as well as the absolute power of the king. In more contemporary approaches, utopian thinking seems to be a critical tool for questioning the existing status quo

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and revealing deficient aspects of existing societies. Another expression of utopian thinking is dystopia, referring to societies that are undesirable and terrifying. Dystopias have been extensively explored in literature and cinema, as a means to underline problematic social and political practices of societies.

This article explores how the concept of human intelligence is reflected in urban utopias. This exploration is based on two axes. On the one hand, considering utopian thinking as the ultimate expression of human intelligence, it briefly presents two contemporary visions of the ideal city for the digital era: Smart and Cognitive cities. Undoubtedly, several approaches can be found in the literature on how digital technologies can be employed in cities, such as the virtual city (Ingram et al., 1996), the digital city (Schuler, 2002), the sentient city (Shepard, 2011). However, it is out of the scope of this article to comparatively present contemporary approaches on urban utopias. Therefore, it focuses on smart cities, as the predominant urban vision that adapts the concept of intelligence in cities, and on cognitive cities as a vision that expands the smart city approach. On the other hand, this article argues that our understanding of human intelligence determines our approach on non-human intelligence, such as city intelligence and artificial intelligence. In this context, it examines how the concept of city intelligence has evolved through these visions.

Smart cities as a new Utopia

Utopian thinking has been particularly interested in cities and has played a central role in the literature on urban planning. It focuses on cities not only in the level of organization and morphology but also in the level of symbolism and representation of social values; from Giovanni Battista Piranesi's engravings glorifying the splendor of Ancient Rome, the visionary work of Étienne-Louis Boullée challenging the limits of construction and the industrial complex designed by Claude-Nicolas Ledoux in Chaux, to Garden Cities by Ebenezer Howard and Le Corbusier's Ville Radieuse. More humanistic approaches that exploit the potential of technology questioning our perception of the urban environment have also been presented during the 20th century, as in the case of Constant Neuwenhuys's New Babylon and Electronic Urbanism Takis Ch. Zenetos.

During the last decade, globalization, urbanization and a rapidly increasing growth of Information and Communication Technologies (ICT) have given rise to a new generation of cities, a new Utopia promising to tackle urban challenges in the Information Era: smart cities. Another widely accepted term referring to this generation of cities is intelligent cities (Komninos, 2015). However, it is out of the scope of this article to dig deeper in the conceptual framework of these terms, so they will be used as complementary. Briefly, smart cities emerged as a new paradigm for urban development based on the utilization of human, collective and technological capital towards the enhancement of prosperity in urban agglomerations (Angelidou, 2014).

The global interest on smart cities has exponentially increased during the last fifteen years (Komninos and Mora, 2018), and this does not necessarily imply that smart cities have never existed before. On the contrary, there are scientific approaches demonstrating that ancient Rome was a smart city (de Rita and Häuber, 2015). However, what substantially differentiates ancient cities that probably were smart, is that the contemporary notion of smart cities is

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grounded in the intensive use of ICT for the sustainable development of cities.

Today, over half of the world population is online and there is a fast growth of internet penetration worldwide[1]. Daily human activity on the internet has led to the production of huge amounts of data. At the same time, integrating and analyzing this data with the enhanced capabilities of ubiquitous and pervasive computing revealed a new horizon of opportunities. In this context, 'smart cities' emerged as a new urban vision capable of addressing these challenges; a new utopia aiming to improve the functioning of cities, enhancing their efficiency, improving their competitiveness, and providing new ways to deal with poverty, social deprivation, and environmental degradation. Since the emergence of the smart city paradigm, a wide range of tools and applications have been developed regarding several aspects of urban life. The technological advancements of the last decades have facilitated the development of applications that use ICTs to improve urban function management in transportation, energy, water, waste but also healthcare and governance; from sensor-based solutions to monitor and increase efficiency in waste management to online reporting platforms and participatory tools for urban governance[2]. We could claim that, considering smart city as a utopia, it has been the first time that reality got so close to such a vision. Not many years ago, the idea that a city could be smart was considered a science fiction and now it is difficult to find a region of the planet where some form of smart city initiative has not been embarked (Almirall et al., 2016). Nevertheless, there has been a tremendous divergence in these approaches in both objective and outcome: from dealing with traffic congestion, parking and energy efficiency issues, to introducing novel governance schemes that support citizen participation. At the same time, despite the wide range of these implementations, the promise for an ideal smart society moved even further away, as new challenges appeared and dark sides of 'smartness' were highlighted.

1. https://wearesocial.com/blog/2018/01/global-digital-report-2018 (Access 25 May 2018).

2. More information regarding smart city applications can be found on ICOS, an open meta-repository of existing applications for smart cities, some of which are open-source. http://icos.urenio.org/ (Accessed: 19 June 2018).

Smart cities as a new Dystopia

The criticism on smart cities already counts more than a decade. One of the main axes of this critique is related to the technocratic focus on the concept of 'smartness', and therefore, the concept of 'intelligence'. In the notion of smart city, many urban problems are reduced to efficiency problems, problems that can be tackled mainly through the use of ICT (Kitchin, 2013). Assuming there is an automatically positive impact of ICT on cities, smart city solutions combine sensors and data with sophisticated algorithms to minimize costs, optimize functions and maximize

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benefits. Similar to our previous understandings of human intelligence as a set of cognitive functions that can be measured and evaluated through I.Q. tests, smart cities have adopted this view of intelligence in the context of cities. Assuming complex urban phenomena can be dismantled into clearly defined problems, they can be solved or optimized through computation, what is defined as 'solutionism' (Morozov, 2013) or 'instrumental rationality' (Mattern, 2013). As Hill (Hill, 2013) says, smart city thinking "betrays a technocratic view that the city is something we might understand in detail, if only we had enough data – like an engine or a nuclear power station – and thus master it through the brute force of science and engineering."

Another aspect of the criticism on smart cities refers to the subjection of urban development and urban governance to corporate interests of multinational companies. More specifically, since urban problems and solutions are framed in this narrative of complexity and efficiency, public authorities lack the necessary expertise to deal with them, and therefore, high-tech companies become central actors of the smart city vision. So far, the smart city agenda is largely promoted by some of the world's biggest software and hardware companies and this has given rise to a significant concerns regarding the marketization of public services (Hollands, 2008) and the creation of technological lock-ins that bound cities to particular platforms and providers (Kitchin, 2013). At the same time, as data is commonly considered the oil of the digital era, further concerns on data ownership and privacy are still vulnerable points in the smart city debate (Greenfield, 2013).

The smart city movement has also been widely criticized for neglecting its social as well as democratic dimension on the expense of understanding more technological and policy aspects (Chourabi et al., 2012; De Lange and De Waal, 2013). This criticism lies on the idea that smart cities' rhetoric for citizen participation and democratic decision-making is essentially limited since private interests are highly prioritized. Social tensions and conflicts tend to be reproduced and magnified (Graham, 2002) while little space seems to be left for people to do anything other than adjust to the conditions of the smartmentality (Vanolo, 2014). Moreover, solutions tested and implemented in smart city initiatives worldwide entail the danger of deepening inequality by sharpening the digital divide with the exclusion of digitally marginalized groups, the offline populations as they are sometimes called.

More recent approaches of smart city literature recognize the above criticism and acknowledge that technology-driven implementations of smart cities prove inadequate in exploiting the human and social dimension of cities. In turn, they try to reframe the concept of 'smartness' putting citizens in the center and prioritizing citizen engagement in the making of smart city. These approaches are framed under different labels implying that they are improvements of the smart city concept. Among them, there is a call for 'human smart cities', where co-design and co-production of social and technological innovation is supported by the city government (Oliveira and Campolargo, 2015), as well as for 'social smart cities' that focuses on strategies for participatory governance (Effing and Groot, 2016), or even 'smarter cities' (Afzalan, Sanchez and Evans-Cowley, 2017).
However, going back to the concept of human intelligence and utopian thinking as one of its ultimate forms of expression, we could detect an inherent danger in the concept of smart cities. Briefly, smart cities are envisioned as cities of the future that offer a high quality of life for people in terms of welfare, culture and entertainment as well as security and other aspects of everyday life. So, apart from the technological determinism of smart cities, it is assumed

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that this future of work, consumption and leisure is a common desire of everyone (Hollands, 2015). In this way, urban visions are increasingly reduced to a single technology-centric vision for the city of tomorrow; the horizon of other possible imaginative approaches is restricted and there seems to be no alternative solutions to the problems of today and tomorrow (Vanolo, 2014). Intelligence and smartness are mainly technological and institutional functions of the smart city whereas individual intelligence seems to remain neglected.

From Smart to Cognitive Cities

Understand the functioning of human brain and intelligence has always been among the ultimate goals of science. Although we still have only a rudimentary understanding of how human brain works, there have been remarkable advances both in cognitive neuroscience and in computer science during the last decades. Cognitive computing, referring to hardware and software that mimics the functioning of human brain, has transformed the way we interact with machines and has opened a whole new world of possibilities. Natural language processing, artificial neural networks and image recognition are among the main technologies in this field. Briefly, cognitive systems are systems capable of sensing, perceiving and responding to changes in their environment, and therefore, adapting to it (Moyser and Uffer, 2016). To achieve this level of computing, cognitive systems have to be (1) adaptive, (2) interactive, (3) iterative and stateful and (4) contextual (Feldman and Reynolds, 2014).

In this context, the concept of "cognitive city" appears as an attempt to expand the limits of smart city and overcome its weaknesses by introducing cognitive theory[3] while at the same time builds on learning cities (Larsen, 1999; Longworth, 2006). Initially described by Mostashari (2011), the cognitive city approach underlines the role of learning, memory creation, experience retrieval and adaptability as fundamental processes for coping with current urban challenges (Alonso and Mencar, 2017). These processes are embedded in the city and ICT are leveraged to continuously improve their functioning. As suggested by the theory of connectivism[4], people do not only learn based on their own experiences but also based on the experiences of others. Similarly, in a cognitive city learning is a process related not only to people but to any system that generate and handle information and is acquired through constant interaction between people and ICT, so that common existing knowledge increases (Siemens, 2005). Institutional learning is also a fundamental pillar of cognitive cities and it reflects the capacity of the city to absorb and produce and

3. Cognitive theory or cognitivism is a theoretical framework in psychology suggesting that individual's knowledge is partly acquired through memory creation based on observing others within the context of social interactions and experiences. Behaviorism, cognitivism, and constructivism are three broad learning theories commonly used in the creation of instructional environments (Siemens, 2005).

4. Connectivism is a learning theory of the digital age that underlines the importance of social and cultural context in how learning occurs. According to Siemens, learning does not occur entirely under the control of the individua, but within and across networks. Connectivism integrates principles explored by chaos, network, complexity and self-organization theories (Siemens, 2005).

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knowledge and innovation through cooperation and competitiveness (Komninos, 2002).

As Moyser and Uffer explain (2016) the information flow in smart cities is usually unidirectional; for example, citizens and governments receive real-time information on urban traffic conditions and they are notified in case there is any emergency or outage. On the contrary, the information flow in cognitive cities is multidirectional; citizens and governments not only receive information but also deliver information to others, such as other devices and sensors, operating platforms or other humans, so that the systems learn and adapt their behavior. Figure 1 illustrates the flow of data, analysis and decision between infrastructure systems, data centers and users for transportation infrastructure.

Cognitive cities approach is not a technocratic approach to urban management and urban governance; it combines the concepts of smart and learning cities and introduces the human factor in our understanding of cities. Cognition and creativity together with the ability to learn become central components that can make it easier for cities to deal with the main challenges of our age: efficiency, sustainability and resilience (Finger and Portmann,

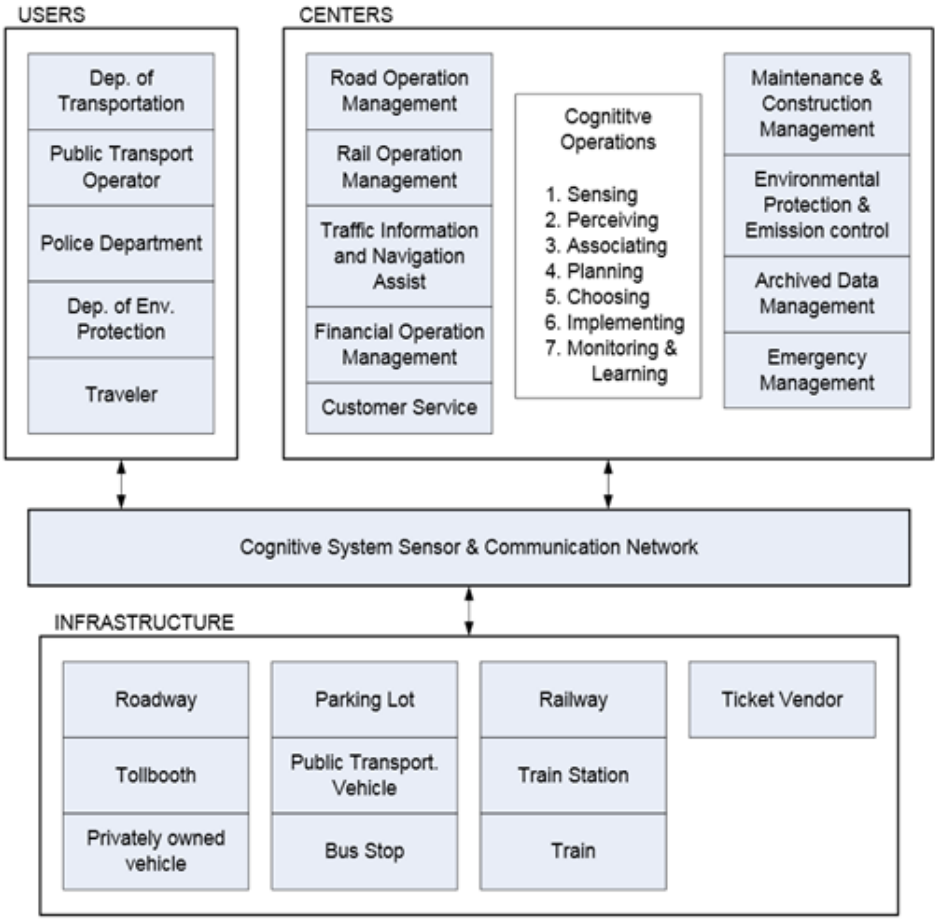

Figure 1.

A cognitive system for transportation infrastructure (Mostashari, 2011).

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2016). Unlike smart cities approach, urban problems are not treated as solely efficiency problems and cities are regarded complex sociotechnical systems where people, technology and institutions co-evolve. Moreover, ICT is not considered only an optimizing tool, but a tool for collective learning of and by urban systems. Built upon the theory of connectivism, knowledge development is formed through networks and ICT connects different actors among them, people with each other but also with institutions and organizations. According to Finger and Portmanm, a city's resilience results from the ability of every single actor in a city to develop autonomously through ICT networks (Finger and Portmann, 2016).

The current debate on cognitive cities is still rather limited, as research on the topic is quite recent. There are already several examples of this "urban labelling" phenomenon where a new urban vision emerges as ideal or utopic and is initially self-reported as an improved version of previous visions. Moyser and Uffer (2016) analyze the challenges of adopting technological solutions within the cognitive city vision, which are political, regulatory, economic, social and technological. In general, despite disapproving the technocratic focus of smart cities, we can argue that the concept of cognitive cities is also grounded in adopting advanced ICT, like big data and artificial intelligence. However, there is a two-fold difference in how technology is viewed through the lens of cognitive cities. On the one hand, cognition becomes the central core of any computer system and their function resembles the human brain. In this context, soft computing has emerged as an attempt to enhance traditional techniques by exploiting the tolerance for imprecision and uncertainty (Zadeh, 1994), basic elements of the human behavior. On the other hand, the role of the individual citizen is fundamental and not inferior to that of ICT, and city's cognition results as a derivative of their constant interaction.

Epilogue

Our understanding of human intelligence has significantly advanced during the last century. Although we are far from clearly understanding the functioning of human brain as a whole, we have managed to apply certain functions of it for the development of computation, as a direct extension of our intellect (Novak, 1997). At the same time, considering the multiplicity of intelligences, we have been able to envision a quite wider spectrum than previous approaches including the intelligence quotient. This theory of multiplicity has also allowed us to consider imagination and creativity as central elements of human intelligence. Utopian thinking as the ultimate expression of imagination, has been historically linked with cities and urban planning. People tend to create visions about the future, fantasizing how cities could evolve based on specific political, economic and cultural circumstances. The main function of utopian thinking lies on the transformative power of intelligence to think beyond the existing, and in this way, to evolve.

Assuming our understanding of human intelligence significantly affects our approach on city intelligence, it is argued that the transition from smart to cognitive cities reflects the evolution of our understanding of human intelligence. Both smart and cognitive cities emerge as ideal models of cities that could tackle current urban challenges, exploiting the potential of the technological achievements of ICT in order for cities to acquire some sort of intelligence. However, the smart city approach adopts a technocratic view of intelligence, similar to our logical-mathematical intelligence, an intelligence that is homogeneous, quantifiable and 'optimizable'. On the contrary, the cognitive city approach adopts a more holistic perspective

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on intelligence; introducing the concepts of cognition and learning but also imprecision and uncertainty, intelligence becomes dynamic, heterogeneous and multi-faceted, closer to Gardner's approach on multiple intelligences (Gardner, 2011). Cognitive cities cannot be created from scratch, they emerge through the continuous interaction among people, institutions and technology.

Undoubtedly, technology has a great potential to support tackling the challenges of our rapidly growing cities. However, technological solutions on their own are not going to solve the deep rooted structural problems in cities since they do not address their root causes (Kitchin, 2013). Taking a closer look in the short history of humankind, we witness the double reality of technology; technological developments have contributed, at the same time, to some of the best and some of the worst features in our lives (Sloman, 1978). In other words, technology is able to produce, integrate and destroy cultural phenomena (Bain, 1937); technology extend itself and ourselves far beyond the original problems that gave rise to it (Novak, 1997).

The subversive nature of ICT and their tremendous impact on our lives have been frequently featured in the literature for cities. However, reality is still far from Zenetos' humanistic vision of Electronic Urbanism, where the extensive use of ICT leads to the emancipation of the individual and the dematerialization of cities and architecture (Kalafati and Papalexopoulos, 2006). Yet, technology was a means to this vision, an enabler, a catalyst. So, although it significantly affects how we envision the cities of tomorrow, technology should be considered in its actual dimension; as one structural layer among many other interrelated elements that compose our cities.

Concluding, the contribution of smart cities theory and practice has definitely widened our visible horizon both for possible challenges and risks but also for significant solutions and useful tools in urban context. Cognitive cities appear as an improved approach that is able to overcome the aforementioned weaknesses of smart cities. However, since both theory and practice related to cognitive cities is still quite limited, it remains unknown whether this vision for cities will help us face current urban challenges and, therefore, whether it will help us evolve.

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