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### Artificial Intelligence and Big Data Challenges in Smart Cities

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# Artificial Intelligence and Big Data Challenges in Smart Cities

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**Abstract.** Smart city combines technologies with information to facilitate and improve daily life of citizens on different areas like transport, healthcare, education, environment impact, energy save and other. Big Data as technology to collect, store and analyze massive amounts of data, and Artificial Intelligence to extract the values from those data, have received a lot of attention recently. The aim of this paper is to discuss and highlight the challenges that engineers, scientists and other stakeholders can face practically in the development of smart city, and to enhance the integration of both Big Data and Artificial Intelligence.

**Keywords:** AI, Big Data, development smart city, challenges

## Introduction

According to United Nations Population Divisions, currently 55% of the world's population lives in urban areas, a proportion that is expected to increase to 68% by 2050. Projections show that urbanization, the gradual shift in residence of the human population from rural to urban areas, combined with the overall growth of the world's population could add another 2.5 billion people to urban areas by 2050 [1].

Big Data and Artificial Intelligence (AI) have received more attention recently. In Fig.1 is shown the comparison of Big Data, Smart City, and Artificial Intelligence (AI) that contains both search terms and topics, which are measured differently from 2004 to 2020, from Google Trend [2].



Big Data Smart City AI

**Fig.1** Trend of search term and topics of Big Data, Smart City and AI [2]

The concept of smart city is to make their citizen's lives easier. Smart city uses technology to improve quality of live for its citizen's, increase operational efficiency and solve city problems, share information with public, improve social and economic quality, transportation and accessibility and other.

Advances in information and communication technologies including Big Data, Artificial Intelligence (AI), Internet of Things (IoT), Virtual Reality (VR), cloud etc. enable and help to become a smart city. Big Data technologies are used to handle data engineering challenges, and AI are used to extract value from the data.

The objective of this research paper is to highlight the challenges of Big Data and AI in the development of smart city.

The rest of paper is organized as follows. Section 2 presents related work, Section 3 describes a brief overview of Artificial Intelligence and Big Data. Section 4 presents case studies of smart cities, and Section 5 presents Big Data and AI challenges. The paper closes with conclusions and future works.

## **Related Work**

Antonova et al. [3] presented an analysis of the currently available smart city indicators (SCIs) by classifying them in six thematic areas, namely Smart Nature, Smart Living, Smart Mobility, Smart Governance, Smart People and Smart Economy. Freitas et al. [4] investigated how the emerging Big Data landscape is defining new requirements for data curation infrastructures and how curation infrastructures are evolving to meet these challenges. Silva et al. [5] presented a brief overview of smart cities, followed by the features and characteristics, generic architecture, composition, and real-world implementations of smart cities. Monzon [6] presented a selection of Smart City initiatives in order to establish relations between the identified city challenges and real Smart Projects designed to solve them. As a result of the project, a Projects Guide has been developed as a tool for the implementation of Smart City projects that efficiently respond to complex and diverse urban challenges without compromising their sustainable development and while improving the quality of life of their citizens. Zhang et al. [7] have investigated the smart city, and discussed the security and privacy challenges in emerging smart city applications. Elmaghraby et al. [8] examined two important and entangled challenges: security and privacy. Security includes illegal access to information and attacks causing physical disruptions in service availability. Baig et al. [9] presented a holistic view of the security landscape of a smart city, identifying security threats and providing deep insight into digital investigation in the context of the smart city. Scuotto et. al. [10] emerged how IBM: a) has a clear vision of Smart Cities and IoT; b) adopt a worldwide Open Innovation (OI) approach to Smart Cities; c) delineate specific strategies and create Open Innovation Units ad hoc for Smart Cities' Projects.

## **Big Data and Artificial Intelligence**

Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation [11]. Big Data technologies are used to handle data engineering challenges, and AI are used to extract value from

the data.



Fig. 2. Big Data value chain [12]

A growing number of companies are active in the data business. However, strengthening an economic Big Data Value ecosystem by bringing organizations together along the Big Data Value chain at the European level is required. The Big Data Value Chain can be used to model the high-level activities that comprise an information system [12], Fig.2.

Data usage is growing, but it is handled in a fragmented way by both the business and science. It is witnessing the emergence of a new stack, where Big Data technologies are used to handle core data engineering challenges, and machine learning is used to extract value from the data in the form of analytical insights, or actions, Fig 3. Big Data provides the pipes, and AI provides the smart [13].



Fig. 3 Big Data landscape [13]

The recent advances in Artificial Intelligence (AI) improve on how digital and physical worlds come across.

### Smart Cities – the cases of Helsinki, Stockholm and Barcelona

In this section are presented three case studies among many others, that have implemented smart city, and show how Big Data, Artificial Intelligence, IoT and other

technologies are applied.

The Smart City of Helsinki focused primarily on the development of digital services, mobile applications, and open data services. Helsinki Smart City initiatives aim to open public data, and contribute indirectly by creating a specific environment in which Smart City services and solutions can be developed and achieve a reduction of CO<sub>2</sub> emissions and improve energy efficiency. Opening up data for public plays an important role in city developments. The data are free of charge and can be used by businesses, academia and research institutes, or citizens. In 2013 over 1300 databases were available at the website, covering a wide range of urban phenomena, like living conditions, employment, transport etc. [14].

The Smart City of Stockholm included many goals such as being fossil fuel free, made possible through initiatives such as energy efficient transportation, food waste becoming biogas as well as reuse and circulation of water, waste and energy within district [14]. As a project covered all aspects of sustainability such as biodiversity and creating green-design buildings, implemented smart management and smart applications to address traffic and environmental issues.

The Smart City of Barcelona aim to be efficient in city management and public services, to be environment sustainable, create opportunities for people, integrate the information technology in the city etc. The model of Barcelona Smart City can be summarized into four groups [15]:

- Smart Governance: involves a major initiative such as Open Data, and mainly aim is to provide better access to government information
- Smart Economy: involves creation of innovative cluster concept where companies, faculties and citizens can interact and collaborate
- Smart Living: mainly targeting new technology adoptions that are initiated by municipal police and tool developments for public transport
- Smart People: involves training programs for digital literacy for the Barcelona City Hall; have built corporate fiber optic network, Wi-Fi mesh network, sensors network, and public Wi-Fi network.

## **Big Data and AI - the challenges**

The Big Data era and AI in the Smart City has opened new opportunities, but there are many challenges too. The challenges in creating a good Big Data environment and to be sustainable, have different dimensions like: availability of data and access to data sources concerns; the availability of skilled people who have an excellent understanding of the Big Data best practices and technologies; processing of data and analytics in real time, low latency; more efficient use and getting deep insights from Big Data etc.

The main challenges of Big Data and AI in Smart City that have been highlighted are as follows, Fig.4:

- Manage the data
- Data analytics
- The insights of data
- Data privacy and data security

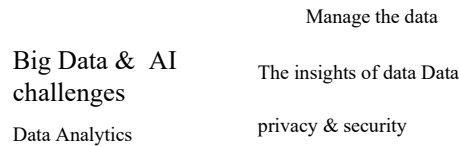


Fig.4 The challenges of Big Data and AI in Smart City

The main challenges on the data management are as follows:

- Semantic of data: the data can be unstructured and semi-structured and need to be processed, and to be semantically annotated
- The quality of data: need to be created methods for improving assessing data quality, improve human-data interaction etc.
- Data lifecycle management: the data increases in volume, variety and velocity, and need integrate data lifecycle
- Integration of data and business process: conceptual and technical integration of results from analytics
- Data as a service: the capability of interpreting and process the data and software to the customer

The main challenges on the data analytics are as follows:

- Processing real time data from various sources and in different format ·  
Dynamic data processing
- Processing data in motion and data in rest
- Semantic analysis
- Event and pattern discovery
- Multimedia (unstructured) data mining
- Predictive and prescriptive analytics

The main challenges on data insights:

- Data visualization approaches and tools
- Collaborative, 3D and cross-platform data visualization frameworks ·  
Domain-specific data visualization approaches

The main challenges on data privacy and security:

- Data protection framework: need create a mechanism to protect the data
- Data mining algorithms: data mining algorithm
- Data privacy: methods to analyze the data about privacy threats, privacy risk to share the data etc.
- Data security: data to be distributed among several parties securely etc.

## Conclusions

Smart city combines technologies with information to facilitate and improve daily life of citizens on different areas like transport, healthcare, education, environment impact, energy save and other. The aim of this paper is to highlight the challenges that engineers, scientists and other stakeholders can face practically in the development of

Smart City, and to enhance the integration of both Big Data and Artificial Intelligence, with main focus on: manage the data, data analytics, the insights of data, and data privacy and data security.

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