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Additional Information

Social and Intelligent Applications for Future Cities: Current advances

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Abstract

Cities face many challenges concerning their management, security, transportation, public health, the distribution of resources, sustainability, energy efficiency, and many more. As cities grow larger, it is only expected that these problems become more acute and, therefore, they will need solutions to tackle or smooth these problems. With the rise of technologies such as artificial intelligence and the increasing number of social applications that allow citizens to participate in the urban digital ecosystem, researchers and policymakers have seen an opportunity in the application of these technologies to tackle urban challenges. In this editorial article, we review some relevant contributions to this special issue to social and intelligent applications for future cities.

Keywords: artificial intelligence, smart cities, social computing, big data, future cities

1. Introduction

In recent years, with the rise of technology, scholars, practitioners, and politicians have seen the opportunity to overcome, or at least ease, many of the challenges and problems faced nowadays by cities. As a result, there has been a first incursion of information technologies with the phenomenon coined as *smart cities*. The first urban applications have introduced sensors, mobile applications, networks, and data-based applications as main actors in the new revolution for cities [8, 4, 6, 20].

The new breaking advances in the area of artificial intelligence, propelled by the abundance of data and computing power, now present in the digital world, have the potential to positively impact critical domains such as industry, health, and the way we manage cities. In addition to this, in a future city that is supported by many digital services, we cannot ignore citizens' behavior. Understanding the inherent behavior of humans in these new systems will play a crucial role towards optimizing the use of technologies in the management of future cities. Therefore, we expect, in the next few years, for both artificial intelligence and social applications to gradually change our cities. This special issue gathers some of the latest advances and contributions of artificial intelligence and social applications to cities' management and daily activities. In this editorial, we analyze, summarize, and categorize the contributions of authors to this special issue. Finally, we conclude with some remarks and potential future areas of research.

2. A brief overview of applications for future cities

In this section, we categorize and summarize the contributions of authors of this special issue to key areas of future cities. The contributions are categorized according to the impact area

in a city [3]: (i) public health; (ii) informed people & public participation; (iii) city management & economic development; (iv) energy efficiency; (v) transport & CO2 emission; (vi) security & emergency services; (vii) water & waste management; (viii) and general architectures for smart city applications.

2.1. Public Health

As show by the work of Serrano et al. [24], artificial intelligence may enhance the detection of diseases and clinical problems. The article proposes the use of predictive methods for diagnosing cases in social services. More specifically, the approach evaluates thousand Neural Networks architectures for the automatic diagnosis of chronic social exclusion. Moreover, the article discusses many advantages for Deep Learning techniques to provide future cities with intelligent social services.

Similarly, the authors in [27] present a new deep learning architecture that aims to segment images and contour learning. The architecture is composed by two parallel branches that extract different sets of features from an image, and then, the features are combined to carry out the segmentation and contour learning tasks. The proposed architecture is tested in a cancer detection setting.

2.2. Informed people & public participation

The contributions presented in this special issue are a good example of how citizens may benefit from intelligent applications. On the one hand, the work presented in [16] takes the user context into account, in the form of the location and orientation, to create personalized recommendations about social events to visit. Similarly, [11] presents a point of interest recommendation algorithm that considers the current geographical context apart from preferences. On the other hand, the work

presented in [10] deals with the problem of identifying influential nodes in social networks. The research presented in this article extends the influence maximization problem to location-based social networks. The proposed technique can be applied to identify social and spatial influential nodes and it can be used for recommending location-based events in cities.

2.3. City management & Economic development

There have been different proposals in this special issue that aim to support policymakers in future cities. For instance, in [28], authors propose a smart campus system, which makes use of big data analytics to identify poverty-stricken students. The information gathered by the analytics tools is then employed to support the decision-making on the subsidy for students. The system has significantly improved the efficiency and quality of student management and reduced the workload of college staff.

As another example, Palanca et al. [17] tackle the problem of planning the deployment of charging stations for electric vehicles in Lima (Peru) by means of a multi-objective genetic algorithm. The proposed algorithm takes into consideration both the utility of deploying stations in specific locations and the deployment cost. By using a specific version of NSGA-II, the authors provide with near Pareto optimal decisions attending to cost and utility to decision-makers.

Another example of how user-generated data may help cities is presented in [21]. The authors of this study propose a path analysis algorithm that can detect how citizens move throughout the city. The algorithm is based on gravitational models and geolocated messages in social networks. The experiments carried out show that the proposed algorithm is capable of better detecting trajectories than state of the art methods. The data provided may be employed for analyzing urban mobility and, therefore, make city management decisions.

The article presented in [22] proposes a solution for the assortment planning problem. This problem consists of ordering the right amount of quality of goods from suppliers to match market demands. The authors model this problem under a game-theoretic framework in which two prospective meta-strategies are available: choosing the highest quality brand, modelled as a non-cooperative Stackelberg game where the suppliers are the leader, or choosing a lower quality brand, modelled as a classic assortment planning problem. The game theory analysis shows how small suppliers should advocate for the high-quality brand for its most attracting products, while they should choose lower quality brands for less attracting products.

2.4. Energy Efficiency

In this special issue, authors in [9] focus on predicting energy consumption for individual residences. With that purpose, the authors combine and optimally select multiple time series algorithms such as Holt-Winters and ARIMA, and other regression mechanisms such as Long Short-Term Memory and TESLA to predict energy demand. Another energy demand prediction is presented in this special issue is [14]. Differently to the previous approach, the authors in this article propose for data acquisition, processing, and analytics to be carried out in the edge

devices instead of centralized approaches. In this case, the regression mechanism deployed in the system is based on a deep learning architecture that aims to predict short-term demands. The experiments show that online deep learning architectures can achieve high accuracy in many simulated scenarios.

2.5. Transport & CO2 emission

The work presented in [12] is focusing on modeling user satisfaction by starting from the premise that it is the key ingredient required for a widespread adoption of ridesharing. In this sense, the paper presents a satisfaction-oriented assignment method (i.e., Simsat), and shows that it outperforms brute-force assignments using simpler user-satisfaction. Authors use deep learning to model user satisfaction based upon data collected from actual human subjects. In similar lines, the work presented in [23] analyzes lines of research that have led to the creation of Adaptive Interface Ecosystems (AIE), and the technologies that enable them in Smart Cities. As a case of study, the authors present a platform for intelligent traffic control that obtains information from public databases to improve the traffic congestion that occurs at rush hour. The traffic control platform has a web application where the use of AIE has been applied.

2.6. Security and Emergency services

The work presented in [1] deals with the problem of safety of medical data and equipment in today's world of Medical Internet of Things (MIoT). In this sense, the approach identifies several serious security vulnerabilities against lightweight RFID mutual authentication protocol and proposes a lightweight authentication scheme (called SecLAP) that overcomes those vulnerabilities.

In [25] a review of Edge Computing Reference Architectures is presented. Moreover, the paper presents a proposal for a tiered architecture with a modular approach that allows managing the complexity of solutions not only for Industry 4.0 environments but also for other scenarios such as smart cities, smart energy, healthcare or precision agrotechnology. The main contributions of the proposed architecture reside in the security and privacy provided by blockchain technologies. Finally, the proposed reference architecture is tested by building an IoT platform in a smart agroindustry scenario to reduce bandwidth costs between the Edge and the Cloud.

2.7. Water & waste management

The authors in [13] propose a multi-agent system that employs ontology matching, multi-agent negotiation, and cooperation to manage medical waste transportation. More specifically, the authors propose a new tree-based algorithm for managing commitments between agents that can act in real-time.

2.8. General architectures for smart city applications

The work presented in [7] reviews applications that combine multiagent systems (MAS) and cloud computing. The study has identified a set of application related to smart cities that may benefit from the integration of MAS and cloud computing systems. Another review is presented in [26]. In this case, the

authors analyze and investigate context-aware crowd sensing systems for urban environments. The analysis is carried from multiple perspectives such as context-awareness and deployed functionalities. As a result of this analysis, a new reference architecture for mobile crowd sensing systems is proposed, along with new research lines. Additionally, [19] investigates to what extent a service satisfies the defined service pillar in SaaS by using machine learning models.

With the increasing deployment of sensors, there is also an increasing wave of applications that aim to leverage those sensors. Therefore, it is expected for multiple sensing applications to coexist. Of course, not every application is equally critical, and optimization mechanisms are required for determining what sensors support what applications. The authors in [5] propose an optimization mechanism for mapping sensors to applications that take into consideration current events in the city and the priority of the application for the city. The increasing deployment of sensors and devices with communication capabilities poses additional challenges: designing physical data acquisition frameworks that can optimize available network resources. If networks resources are employed in an inefficient way, network congestion, information loss, and long response times are unavoidable. The authors in [2] propose a novel data acquisition framework that automatically optimizes the selection of a network depending on the context of the application and the network itself.

Another issue in future cities is heterogeneity. It is expected that many prospective platforms, systems, and users exchange information daily. A challenge that arises in this context is enabling the exchange information between heterogeneous entities. The authors in [18] provide a machine language mediation framework that allows for the automatic translation of documents/information between the sender's semantic ontology and the receiver's semantic ontology. Finally, the authors in [15] propose a micro-service architecture for smart environments. A microservice architecture allows for autonomy, composability, scalability, and fault-tolerance compared to monolithic approaches. The architecture incorporates a novel algorithm that builds graphs of service dependencies and performs automatic regression testing. In addition, the architecture incorporates a retrieval method that eases the creation of new services.

3. Discussion & conclusions

In this special issue, we have focused on gathering some relevant advancements in the use of artificial intelligence and social applications to future cities. The contributions of authors of this special issue have focused in the areas of public health, informed people & public participation, city management & economic development, energy efficiency, transport & CO2 emission, security & emergency services, water & waste management, and architectures for smart city applications.

Current contributions show a wide range of techniques to support the construction of social and intelligent applications: multi-agent systems, deep learning and neural networks, algorithm portfolios, recommender systems, optimization techniques, game theory, information fusion, and so forth. The edi-

tors would also like to highlight the notable number of contributions in the area of general architectures for smart applications in cities. This denotes both the importance and the necessity to have access to standardized platforms that ease the development and deployment of intelligent and social applications in cities.

With the increasing number of autonomous technologies and the increasing trust in these, we expect the next wave of social and intelligent applications to rely more on autonomous technologies such as robotics, multi-agent systems, and adaptive technologies for managing cities.

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