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Editorial

Artificial Intelligence Applications to Smart City and Smart Enterprise

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Abstract: Smart cities work under a more resource-efficient management and economy than ordinary cities. As such, advanced business models have emerged around smart cities, which have led to the creation of smart enterprises and organizations that depend on advanced technologies. In this Special Issue, 21 selected and peer-reviewed articles contributed in the wide spectrum of artificial intelligence applications to smart cities. Published works refer to the following areas of interest: vehicular traffic prediction; social big data analysis; smart city management; driving and routing; localization; and safety, health, and life quality.

Keywords: smart city; artificial intelligence; vehicular traffic; surveillance video; big data analysis; computer vision; autonomous driving; life quality; healthcare; sensors; machine learning; pattern recognition

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1. Introduction

The existence of smart cities requires a new organization structure that considers many aspect of how a city runs. Smart cities work under a more resource-efficient management and economy than ordinary cities. As such, advanced business models have emerged around smart cities, which have led to the creation of smart enterprises or organizations that depend on advanced software and computer applications. Smart cities and smart enterprises deal with the integration of artificial intelligence, web technologies, smart mobile platforms, telecommunications, e-commerce, e-business, and other technologies. Fields of applications are related to services for users and citizens, such as transportation, buildings, e- health, utilities, etc.

The works submitted within the scope of this Special Issue can be aggregated into six macro categories: traffic prediction; social and big data analysis; smart city management; driving and routing applications; indoor and outdoor localization and related technologies; and safety, health, and quality of life.

2. Contribution

In this Special Issue, a total of 21 papers have been published. Topics range from vehicular traffic monitoring and prediction to integrated healthcare systems, and are mainly focused on artificial intelligence applications. In the following, published papers are classified based on their core topic.

2.1. Vehicular Traffic Prediction

Within this topic, Ge et al. [1] used Global Spatial-Temporal Graph Convolutional Network (GSTGCN), for urban traffic speed prediction. The model consists of three spatial-temporal components with the same structure used to model the recent, daily-periodic, and weekly-periodic spatial-temporal correlations of the traffic data, respectively. Experimental results demonstrated that the proposed GSTGCN outperforms the state-of-the-art baselines.

A novel generative deep learning architecture, called TrafficWave, is proposed by Impedovo et al. [2] and applied to vehicular traffic prediction. The technique is compared with the best performing state-of-the-art approaches: stacked auto encoders, long short-term memory, and gated recurrent unit. Results show that the proposed system performs a valuable Mean Absolute Percentage Error (MAPE) reduction when compared with other state of art techniques.

In reference [3], the authors propose a Grassmann-manifold-based neural network model to analyze traffic surveillance videos. The approach is able to consider the inner relation among adjacent cameras. The accuracy of the traffic congestion evaluation is improved, compared with several traditional methods. Experimental results also report the effects of different factors on performance.

While the previous works are centered on generic vehicular traffic flow analysis, authors of [4] explore bus traffic flow and its specific scenario patterns. A spatio-temporal residual network is used for prediction aims. Fully connected neural networks capture the bus scenario patterns, and improved residual networks capture the bus traffic flow spatio-temporal correlation. Experiments on Beijing transportation smart card data demonstrate the viability of the proposed solution also being able to outperform four baseline methods.

2.2. Social and Big Data Analysis

A big data analytics tool for healthcare in the Kingdom of Saudi Arabia (KSA) is presented in [5]. The tool, named Sehaa, uses Naive Bayes, Logistic Regression, and multiple feature extraction methods to detect various diseases analyzing Twitter data. More specifically, authors analyzed 18.9 million tweets collected from November 2018 to September 2019, reporting that the top five diseases in KSA are heart diseases, hypertension, cancer, and diabetes.

In reference [6], authors present a process to evaluate proper locations to install or relocate sensors within an IoT scenario. More specifically, two algorithms have been considered: the first one produces a matrix with frequencies along with territorial adjacencies, and the second one adopts machine learning techniques to generate the best georeferenced locations for sensors. The process has been applied to a Mexico area where, during the last twenty years, air quality has been monitored through sensors in different locations.

2.3. Smart City Management

Barletta et al. [7] propose a smart city integrated model together with a smart program management approach to manage interdependencies between project, strategy, and execution. Authors investigate the potential benefits that derive from using them. The results obtained show that the current scenario has a reduced level of integration, so that the adoption of a smart integrated model and smart program management appears to be very important in the context of a smart city.

In reference [8], authors propose a conceptual framework for a disaster management tool. The tool uses big data collected from open application programming interface (API) and artificial intelligence (AI) to help decision-makers. Authors provide an example of use based on convolutional neural network (CNN) to detect fires using surveillance video. The system also considers connecting to open-source intelligence (OSINT) to identify vulnerabilities, mitigate risks, and develop more robust security policies than those currently in place to prevent cyber-attacks.

2.4. Driving and Routing Applications

In reference [9], authors propose a new model for potential pedestrian risky event (PPRE) analysis, using video footage gathered by road security cameras already installed at crossings. The system automatically detects vehicles and pedestrians, calculates trajectories, and extracts frame-level behavioral features. K-means and decision tree algorithms are then used to classify six different classes, which are further investigated to show how they may or may not contribute to pedestrian risk. The system has been tested using video footage from unsignalized crosswalks in Osan city, South Korea.

Shin et al. [10] implemented two kinds of deep learning techniques to reflect human driving behavior for automated car driving. A deep neural network (DNN) and a recurrent neural network (RNN) were designed by neural architecture search (NAS). NAS is used to automatically design the individual driver's neural network for efficient and effortless design process while ensuring training performance. Sequential trends in the host vehicle's state can be incorporated through RNN. It has been shown from human-centered risk assessment simulations that two successfully designed deep learning driver models can provide conservative and progressive driving behavior similar to a manual human driver in both acceleration and deceleration situations.

In reference [11], authors propose a solution to the routing problem in vehicular delay tolerant network (VDTN) based on deep learning. The approach adopts an algorithm that leverages the power of neural networks to learn from local and global information to make smart forwarding decisions on the best next hop and best next message. Experimental results show that the proposal is able to gain improvements in network overhead and hop count if compared to other popular routers.

In reference [12], authors propose a methodology to detect texting and driving behavior of drivers. A ceiling mounted wide angle camera is used to acquire data, and a convolutional neural network (CNN) is adopted for classification aims. The CNN is constructed by the Inception V3 deep neural network, trained and validated on a dataset of 85,401 images achieving valuable results.

Perez-Murueta et al. [13] propose a routing system able to continuously monitor traffic flow status providing congestion detection and warning service. The proposed system also considers situations in which information that has not been updated is made available by using a real-time prediction model based on a deep neural network. The results obtained from simulations in various scenarios have shown that the proposal is capable of reducing the average travel time (ATT) by up to 19%, benefiting a maximum of 38% of the vehicles.

2.5. Indoor and Outdoor Localization and Related Technologies

Authors of [14] investigated the possibility to identify the nationality of tourist users on the basis of their motion trajectories, adopting large-scale motion traces of short-term foreign visitors. This task was not trivial, relying on the hypothesis that foreign tourists of different nationalities may not only visit different locations but also move in a different way between the same locations. Authors adopted a long short-term memory (LSTM) neural network trained on vector representations of locations, in order to capture the underlying user mobility patterns. Experiments conducted on a real-world big dataset demonstrate that the proposed method achieves considerably higher performances than baseline and traditional approaches.

In reference [15], authors propose a simulator for converting datasets to time series data with changeable feature numbers or adaptive features, and a new version of the online sequential extreme learning machine (OSELM) to deal with cyclic dynamic scenarios, and time series. The proposed approach is made up of two parts: the transfer learning part is responsible for carrying information from one neural network to another when the number of features change; and an external memory part responsible for restoring previous knowledge from old neural networks when the knowledge is needed in the current one. Approach has been tested on UJIndoorLoc, TampereU, and KDD 99 datasets.

3. Safety, Health and Quality of Life

This is a huge topic in Smart Cities. Six papers fall within this category.

In reference [16], the authors focused on the application of long short-term memory (LSTM) neural network enabling patient health status prediction focusing the attention on diabetes. The proposed topic is an upgrade of a multilayer perceptron (MLP) algorithm that can be fully embedded into an enterprise resource planning (ERP) platform integrating a decision support systems (DSSs) suitable for homecare assistance and for dehospitalization processes.

Authors of [17] present a firearms detection system for surveillance videos. The system is made up of two parts: the "Front End" and "Back End". The Front End is comprised of the YOLO object detection and localization system, while the Back End is made up of the firearms detection model. The performance of the proposed firearm detection system has been analyzed using multiple convolutional neural network (CNN) architectures, finding values up to 86% in metrics like recall and precision in a network configuration based on VGG Net using grayscale images.

Li et al. [18] propose a deep network with dynamic weights and joint loss function for pedestrian key attribute recognition. First, a new multilabel and multiattribute pedestrian dataset, which is named NEU-dataset, is built. Second, they propose a new deep model based on DeepMAR model. The new network develops a loss function, which joins the sigmoid function and the softmax loss to solve the multilabel and multiattribute problem. Furthermore, the dynamic weight in the loss function is adopted to solve the unbalanced samples problem. The experimental results show that the new attribute recognition method has good generalization performance.

In reference [19], authors focused on the development of a supervised machine-learning model able to predict the life satisfaction score of a specific country based on a set of given parameters. More specifically, different machine-learning approaches are combined to obtain a meta-machine-learning model that further aids in maximizing prediction accuracy. Experiments have been performed on a regional statistics dataset with four years of data, from 2014 to 2017. Compared to other models, the proposed model resulted in more precise and consistent predictions.

A bacterial foraging optimization algorithm (BFOA) to optimize an isolated microgrid (IMG) is proposed in reference [20]. The IMG model includes renewable energy sources and a conventional generation unit. Two novel versions of the BFOA have been implemented and tested: two-swim modified BFOA (TS-MBFOA) and normalized TS-MBFOA (NTS-MBFOA). Results showed that first one obtained better numerical solutions than the second one and the other state-of-the-art solution. However, authors report that NTS-MBFOA favors the lifetime of the IMG, resulting in economic savings in the long term.

Elbaz et al. [21] developed an efficient multiobjective optimization model to predict shield performance during the tunneling process. The model includes the adaptive neurofuzzy inference system (ANFIS) and genetic algorithm (GA). The hybrid model uses shield operational parameters as inputs and computes the advance rate as output. GA enhances the accuracy of ANFIS for runtime parameters tuning by multiobjective fitness function. The tunneling case for Guangzhou metro line has been adopted to verify the applicability of the system.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Ge, L.; Li, S.; Wang, Y.; Chang, F.; Wu, K. Global Spatial-Temporal Graph Convolutional Network for Urban Traffic Speed Prediction. *Appl. Sci.* **2020**, *10*, 1509. [CrossRef]
2. Impedovo, D.; Dentamaro, V.; Pirlo, G.; Sarcinella, L. TrafficWave: Generative Deep Learning Architecture for Vehicular Traffic Flow Prediction. *Appl. Sci.* **2019**, *9*, 5504. [CrossRef]
3. Qin, P.; Zhang, Y.; Wang, B.; Hu, Y. Grassmann Manifold Based State Analysis Method of Traffic Surveillance Video. *Appl. Sci.* **2019**, *9*, 1319. [CrossRef]
4. Liu, P.; Zhang, Y.; Kong, D.; Yin, B. Improved Spatio-Temporal Residual Networks for Bus Traffic Flow Prediction. *Appl. Sci.* **2019**, *9*, 615. [CrossRef]
5. Alotaibi, S.; Mehmood, R.; Katib, I.; Rana, O.; Albeshri, A. Sehaa: A Big Data Analytics Tool for Healthcare Symptoms and Diseases Detection Using Twitter, Apache Spark, and Machine Learning. *Appl. Sci.* **2020**, *10*, 1398. [CrossRef]
6. Estrada, E.; Vargas, M.P.M.; Gómez, J.; Negrón, A.P.P.; López, G.L.; Maciel, R. Smart Cities Big Data Algorithms for Sensors Location. *Appl. Sci.* **2019**, *9*, 4196. [CrossRef]
7. Barletta, V.; Caivano, D.; DiMauro, G.; Nannavecchia, A.; Scalera, M. Managing a Smart City Integrated Model through Smart Program Management. *Appl. Sci.* **2020**, *10*, 714. [CrossRef]

8. Jung, D.; Tuan, V.T.; Tran, D.Q.; Park, M.; Park, S. Conceptual Framework of an Intelligent Decision Support System for Smart City Disaster Management. *Appl. Sci.* **2020**, *10*, 666. [CrossRef]
9. Noh, B.; No, W.; Lee, J.; Lee, D. Vision-Based Potential Pedestrian Risk Analysis on Unsignalized Crosswalk Using Data Mining Techniques. *Appl. Sci.* **2020**, *10*, 1057. [CrossRef]
10. Shin, D.; Kim, H.-G.; Park, K.-M.; Yi, K. Development of Deep Learning Based Human-Centered Threat Assessment for Application to Automated Driving Vehicle. *Appl. Sci.* **2019**, *10*, 253. [CrossRef]
11. Hernández-Jiménez, R.; Cardenas, C.; Rodríguez, D.M. Modeling and Solution of the Routing Problem in Vehicular Delay-Tolerant Networks: A Dual, Deep Learning Perspective. *Appl. Sci.* **2019**, *9*, 5254. [CrossRef]
12. Celaya-Padilla, J.M.; Galván-Tejada, C.E.; Lozano-Aguilar, J.S.A.; Zanella-Calzada, L.A.; Luna-García, H.; Galván-Tejada, J.I.; Gamboa-Rosales, N.K.; Rodriguez, A.V.; Gamboa-Rosales, H. "Texting & Driving" Detection Using Deep Convolutional Neural Networks. *Appl. Sci.* **2019**, *9*, 2962.
13. Perez-Murueta, P.; Gómez-Espinosa, A.; Cardenas, C.; Gonzalez-Mendoza, M. Deep Learning System for Vehicular Re-Routing and Congestion Avoidance. *Appl. Sci.* **2019**, *9*, 2717. [CrossRef]
14. Crivellari, A.; Beinat, E. Identifying Foreign Tourists' Nationality from Mobility Traces via LSTM Neural Network and Location Embeddings. *Appl. Sci.* **2019**, *9*, 2861. [CrossRef]
15. Salih, A.; Ahmad, M.R.; Isa, A.B.A.M.; Esa, M.M.; Al-Saffar, A.; Hassan, M.H. Feature Adaptive and Cyclic Dynamic Learning Based on Infinite Term Memory Extreme Learning Machine. *Appl. Sci.* **2019**, *9*, 895.
16. Massaro, A.; Maritati, V.; Giannone, D.; Convertini, D.; Galiano, A. LSTM DSS Automatism and Dataset Optimization for Diabetes Prediction†. *Appl. Sci.* **2019**, *9*, 3532. [CrossRef]
17. Romero, D.; Salamea, C. Convolutional Models for the Detection of Firearms in Surveillance Videos. *Appl. Sci.* **2019**, *9*, 2965. [CrossRef]
18. Li, Y.; Tong, G.; Li, X.; Wang, Y.; Zou, B.; Liu, Y. PARNet: A Joint Loss Function and Dynamic Weights Network for Pedestrian Semantic Attributes Recognition of Smart Surveillance Image. *Appl. Sci.* **2019**, *9*, 2027. [CrossRef]
19. Kaur, M.; Dhalaria, M.; Sharma, P.K.; Park, J.H. Supervised Machine-Learning Predictive Analytics for National Quality of Life Scoring. *Appl. Sci.* **2019**, *9*, 1613. [CrossRef]
20. Hernández-Ocaña, B.; Hernández-Torruco, J.; Chávez-Bosquez, O.; Yáñez, M.B.C.; Flores, E.A.P. Bacterial Foraging-Based Algorithm for Optimizing the Power Generation of an Isolated Microgrid. *Appl. Sci.* **2019**, *9*, 1261. [CrossRef]
21. Elbaz, K.; Shen, S.-L.; Zhou, A.; Yuan, D.; Shen, S.-L. Optimization of EPB Shield Performance with Adaptive Neuro-Fuzzy Inference System and Genetic Algorithm. *Appl. Sci.* **2019**, *9*, 780. [CrossRef]