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Editorial

Advances in Sustainable Smart Cities and Territories

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The smart city concept refers to the implementation of disruptive technologies in the urban environment, with the aim of creating an optimal citizen experience. Since the term was first coined at the beginning of the 21st century, it has become broader and more sophisticated, due to the steadfast scientific research that has been carried out in this area over the last decade.

The International Conference on Sustainable Smart Cities and Territories, which took place in Doha in 2021, has examined the latest developments in this field. On this occasion, leading researchers, academics and industrial experts came together to share their knowledge and experience of real smart city implementations, of new trends and concepts in the shift towards smart territories [1]. The research articles that have been selected for publication in this editorial are a good representation of the breadth and depth of the topics addressed at the conference.

The conference has examined how trends in the digitization of cities have changed over time. Initially, the focus was on transforming big, metropolitan areas. However, their vast and highly dynamic environment makes it more difficult for smart city projects to have a real impact on city life. This has resulted in many cities being termed as "smart" despite only implementing technology in a small part of their processes, which has made these advances unperceivable for the majority of their citizens. Thus, there has been a gradual change in this trend and the scientific community is now focusing on the development of smart micro-territories or satellite towns near megacities.

Estimates for the year 2050 show that the global population will rise to approximately 9.7 billion. As migration from rural to urban areas continues, the overpopulation of cities becomes a real threat to the quality of life of the people living in them. If optimal solutions are not implemented, cities will face a myriad of problems in the near future, such as growing economic crises, poverty, contamination, disease, inefficient services and processes, unsustainable use of natural resources, as well as problems associated with inequality and violence.

Artificial intelligence (AI) and the Internet of Things (IoT) are fundamental for the construction of truly intelligent cities. These technologies make it possible to design citizen-centric smart city models by obtaining large amounts of data from all the smart city services and facilities, automating processes within a city to improve efficiency and promote sustainable urban development, supporting the economy, creating opportunities for citizens, and respecting the environment. The advantage of both IoT and AI is that they enable real-time analysis and responses to problems, which are key to the improvement of all the processes within a smart city. In the past, data collection was very expensive, because sensing and IoT technology had not been standardized yet. However, current progress means that the prices of sensors, computing and storage are much more affordable, making their implementation across cities feasible [2]. Furthermore, due to the progress made, it is becoming increasingly frequent to use multicore processing (in the form of symmetric multiprocessing (SMP) and

Citation: Corchado, J.M.; Trabelsi, S. Advances in Sustainable Smart Cities and Territories. *Electronics* **2022**, *11*, 1280. https://doi.org/10.3390/electronics11081280

Received: 2 April 2022
Accepted: 14 April 2022
Published: 18 April 2022

asymmetric multiprocessing (AMP)), with embedded multicore CPUs, and their use is estimated to increase sixfold over the coming years (Venture Development Corporation). In addition, the computational power of Field Programmable Gate Arrays (FPGAs) has increased substantially, attaining a level of speed that is equivalent to that of Application Specific Integrated Circuits (ASICs) at a much lower cost.

Paraconsistent analysis has been performed to evaluate the use of neural networks from the standpoint of Explainable AI [3]. This research takes an exploratory approach to determining whether paraconsistent analysis can help understand neural networks and whether the scientific community should carry out further research on this subject. The findings show that paraconsistent analysis, through a mature formal framework, offers detailed prediction visualization, creating a basis for reasoning. Paraconsistent analysis has been considered for the management of projects involving neural network development and two experiments have been carried out to this end [3]. The objective of the initial experiment was to institute the connection between paraconsistency and neural networks, and it was based on MNIST. The objective of the latter experiment was to establish whether the paraconsistent framework may be scaled to problems on the level of the industry. This initial research has revealed the potential of this topic and the need for its further exploration.

Technological advances have brought with them countless paradigms, approaches, protocols, communication technologies and manufacturers, making today's smart cities technologically heterogenous [4,5]. Moreover, the concept of a "smart" city may vary from one city to another. However, all smart cities require careful planning, resource management, security, continuous modernization, as well as dynamic operational improvements. Moreover, all smart cities require a potent and comprehensive ICT platform; it is what enables cities to meet their objectives and to operate successfully.

The continuous search for innovative ICT solutions is fundamental for the sustenance of cities. As new problems and needs arise, new technologies and models are required if a city is to continue operating optimally and evolving in accordance. Data collection and analysis are at the very core of any smart city because it is what provides them with intelligence. As large amounts of data are complex to work with, it is important to develop data management systems that can process large amounts of information, eliminate noise and rapidly extract knowledge of value for timely decision making in cities [6–8]. There are a range of smart city management platforms available that facilitate the secure collection and processing of data in large-scale implementations. These platforms are capable of extracting data from multiple sources, as well as merging, processing and analyzing data. They have collaborative features for results sharing and transfer, etc. However, a smart city is a complex environment that may not depend on a single platform. Thus, it must be possible to connect smart city platforms to other types of platforms and data management systems. Although extensive research has been carried out in the field of smart cities and smart territories in recent years, further research is required on the development of an efficient and scalable system that would be easy to implement and integrate with other platforms.

Some of the current solutions [1] provide substantial flexibility in terms of data management, however, all offer different advantages. There are platforms that offer good data modelling capabilities and others that work optimally with data derived from sensors. The platforms chosen for smart city projects must be carefully analyzed so that they meet the needs of the project and can be integrated with other platforms and technologies in the future. Moreover, they must be flexible, efficient, and scalable. A platform implementing high performance AI models, known as Deepint, has strong data collection and data management abilities, it is scalable and can be integrated with other platforms. The main advantage of this platform is that it streamlines the process of developing smart urban and rural management systems and has the capacity to work with any data source. It delivers services that are centered on the user and provides smart features for the creation of dashboards. The platform implements a wizard who assists the user in the its operation.

This means that users with no knowledge of intelligent systems can use Deepint to develop their smart city models for different services [1], by combining high-level algorithms.

Considering the costs and the importance of sustainability, all smart city projects must have robust risk prevention and mitigation plans. It is especially important for cities to anticipate the risks associated with the technological infrastructure they are based on. Any technological vulnerability poses a serious threat to the city's data, whose breach would have far-reaching consequences, affecting all city processes and the citizens. Therefore, to minimize the vulnerability of smart cities, risks need to be identified and assessed, and risk management mechanisms must be put in place. A risk assessment approach to smart city planning, using Dempster–Shafer theory, is proposed in [9], as part of a smart city use case carried out in Qatar. In it, Dempster–Shafer theory was used to analyze the experts' perception of potential risks. The data obtained from risk assessment were analyzed using the principal component analysis method. An Intrusion Detection System (IDS) for protection against attacks over the Internet of Things (IoT) protocol Message Queuing Telemetry Transport (MQTT) is proposed in [5]. It implements a series of one-class algorithms, which have been trained using real datasets, achieving high accuracy in attack detection.

Fulfilling the needs of the citizens must be central to any smart city, and as the citizens' needs and wants evolve, so must the smart city models. The approaches may vary, but currently, cities generally strive towards becoming greener and having diverse wildlife, creating better career and educational opportunities, fostering health, and providing timely healthcare services with faster and more accurate diagnoses.

Smart cities must also tackle problems associated with mobility, as poor management leads to congestion, which wastes fuel and entails a big loss of time for citizens. Moreover, it creates inefficiencies in the logistics sector. The shared transportation solution has the potential to not only reduce traffic, but also to lower the emission of harmful gases into the atmosphere. Commuting by means of shared solutions has been examined in [8]. The authors have explored the usefulness of a demand-responsive shared transportation system. In this solution, the vehicles operate in a distributed environment while maintaining their information private. The system operates on the basis of the self-interest of the vehicles. The proposed system can be integrated within platforms for autonomous drivers.

As people continue to emigrate from rural to urban environments, cities must optimize their low-capacity transportation services in such a way that they can respond to the growing demand in the best possible way. In a highly dynamic environment, it is important for systems to be dynamic too, assigning resources according to the needs that emerge in real-time and giving priority to the transport that is going to be of greatest social benefit, i.e., meeting the biggest demand at the lowest pollution rate, as argued in [7], where time-unlimited transportation elements are presented. The authors carried out two case studies to verify the operation of this system, the first one involved vehicle-specific dynamic access restriction in city centers based on parking space occupation levels, and the second one focused on assuring air quality in the city. The SUMO traffic simulation tool was used to assess the performance of the proposal under dynamic conditions where transport usage time was unknown a priori.

In the area of logistics, the use of autonomous vehicles was proposed in [6] for the delivery of parcels in areas destined for pedestrian use. A well-structured methodology is presented, which takes into account each stakeholder within the logistics process, beginning with the CEP (courier, express, and parcel services) provider, traffic participants, until the parcel reaches the customer.

Interaction among all these players is central to this methodology, and technology is the enabler of this interaction. Moreover, the designed autonomous vehicles that are suited for operation in pedestrian areas and are equipped with localization and navigation strategies.

Another dimension of smart cities is ensuring the safety and health of their citizens. Human falls prevention is an area that has been of interest to the research community, given that older persons and persons with mobility problems may be more prone to falling, which may lead to serious injury or death. Technology can help prevent falls by monitoring vulnerable persons in real time, so that medical attention may be provided as rapidly as possible. This would help mitigate the damage caused during a fall and could even save a person's life. Research in this area has focused on developing devices that would monitor users without interfering with their daily activities. Devices based on the Internet of Things technology may be used to monitor users as they move around their home, as described in [4]. The developed device could also be deployed in nursing homes, rehabilitation centers and hospitals. This solution for the detection of human falls, is based on edge, fog, and cloud layers, which offer rapid response capabilities, among other benefits. The research presents two approaches and compares their results. The first approach was a mathematical model using the Morlet wavelet, and the second approach was an artificial intelligence model using artificial neural networks. It was discovered that the integration of both approaches rendered the best results, obtaining an accuracy of 92.5% with no false negatives.

Responsible urban innovation will lead to the development of efficient smart cities that have a real and positive impact on the lives of the people who live in them. To this end, robust conceptual frameworks must be developed, considering the aspects discussed in the editorial [10]. The seven articles selected for this Special Issue provide great insight into the current state of smart cities with a special focus on practical aspects and real-life use cases. IoT and AI are the technologies that enable urban development. Continuous innovation in those fields is required to ensure the sustenance and evolution of smart cities. Furthermore, cities must continue working on improving their vertical services, such as mobility and transport, while mitigating risks through careful planning and cybersecurity solutions.

Author Contributions: Editorial coordination and papers evaluation J.M.C. and S.T. All authors have read and agreed to the published version of the manuscript.

Funding: This research was founded by the AGRARIA project granted by the Ministry of Economic Affairs and Digital Transformation (File No. MIA.2021.M01.0004.E24), as part of the Funds for the Recovery, Resilience and Transformation Plan.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The work presented in this paper has been supported by the Agraria project. The AGRARIA project has received funding from the Ministry of Economic Affairs and Digital Transformation (File No. MIA.2021.M01.0004.E24), as part of the Funds for the Recovery, Resilience and Transformation Plan. El proyecto AGRARIA ha recibido financiación del Ministerio de Asuntos Económicos y Transformación Digital (Nº expediente MIA.2021.M01.0004.E24), correspondiente a los fondos del Plan de Recuperación, Resiliencia y Transformación.

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

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