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Editorial

Artificial Intelligence Solutions and Applications for Distributed Systems in Smart Spaces

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1. Introduction

This editorial presents a summary of the Special Issue on Artificial Intelligence Solutions and Applications for Distributed Systems in Smart Spaces, presented in the "Computer Science & Engineering" section of *Electronics* (ISSN 2079-9292).

The concept of smart cities has expanded beyond urban boundaries as considering both urban and rural regions is vital for the overall welfare of the citizens and the attainment of economic, social, and environmental goals.

The application of artificial intelligence (AI) in distributed environments has become a research area of high-added value and economic potential. In fact, intelligent distributed computing plays an increasingly significant role in modern signal/data processing, information fusion, and electronics engineering. Most computing systems, ranging from personal laptops to cluster/grid/cloud computing systems, possess the capability for parallel and distributed computing. This means that non-urban regions can also benefit from distributed computing capabilities.

The exploration of intelligent distributed systems has progressed considerably in the past decade, resulting in the successful implementation of a series of applications across urban and rural landscapes. The combination of AI and machine learning (ML) technologies in distributed systems has allowed for the creation of solutions such as "smart spaces", which provide flexible, adaptable, and seamless cloud-edge decision making, regardless of the users' location.

2. The Present Issue

This Special Issue consists of seven papers that address pivotal topics in the field of AI solutions for distributed systems and their applications. These articles, presented during a series of conferences, namely, PAAMS, DCAI, PACBB, and BLOCKCHAIN 2022, are noteworthy for their highly innovative results and trends. The symposiums were organized by the Bioinformatics, Intelligent System, and Educational Technology Research Group (https://bisite.usal.es/en (7 July 2023)) of the University of Salamanca. The international forums presented and discussed scientific developments and their effective applications to assess the impact of current approaches and facilitate technology transfer. The exchange of ideas between scientists and technicians from both academic and business areas is key to the

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development of systems that meet the demands of today's society. This issue consists of an extended selection of the best papers presented at the aforementioned conferences, focusing on artificial intelligence, distributed computing, and their applications in smart spaces.

In the first paper, Mateos-García et al. [Contribution 1] present the findings of their study, in which they used biometric sensors in a multimodal approach to capture signals in the recognition of stressful situations. The combination of AI, signal acquisition devices, and virtual reality (VR) enables the generation of useful knowledge even in challenging, daily situations, such as driving. The main goal of this work was to combine the use of sensors and the possibilities offered by VR for the creation of a system for recognizing stress in a vehicle during different driving situations. The authors explored the feasibility of detecting stress in individuals using physiological signals collected by incorporating a photoplethysmography (PPG) sensor into a commonly used wristwatch. Data collected using sensors in the VR simulations were inputted in several models, previously trained using ML algorithms, to obtain a system that performs driver stress detection and high-precision classification in real time.

In the second paper, Zbigniew Juzoń et al. [Contribution 2] discuss the issues associated with production optimization in companies and the production environment. In this process, it is necessary to consider the enterprise, and the interaction between its key elements, both in the technological and business layers. The authors suggest the use of an enterprise architecture, which facilitates the interaction of these layers in the production optimization process. As a result, a proprietary meta-model of enterprise architecture was developed, which, based on good practices and the assumptions of enterprise architecture, facilitates the construction of detailed optimization models in planning, scheduling, resource allocation, and routing, tackling the computational complexity associated with the optimization model. An alternative approach is introduced that involves the use of an artificial neural network (ANN). This method enables the estimation of potential outcomes by leveraging the model's structure and a given data instance even before the optimization process commences. The practical implementation of this approach is demonstrated through a case study involving the optimization of production in a sample production cell, where factors such as storage costs, unfulfilled orders, and maintenance were optimized.

In the third paper, Guimarães et al. [Contribution 3] propose the use of distributed learning algorithms, which can learn in a distributed manner, from distributed datasets. Although there have been significant advances in the field of ML, it is still a developing field of research experiencing many technical challenges. Primarily, these challenges arise from the management of big data and streaming data, which necessitate frequent updates or model retraining, often resulting in substantial computational resource requirements. Specifically, the authors address the issue of predicting the training time of a given model, given its characteristics and the characteristics of the data. Assuming that the creation of an ensemble may imply the training of hundreds of base models, information about the predicted duration of each of these individual tasks is paramount for the efficient management of the cluster's computational resources and for minimizing makespan, i.e., the time it takes to train the whole ensemble.

In the fourth paper, Palanca et al. [Contribution 4] introduce an agent architecture called flexible agent architecture (FAA) that supports the development of multiagent systems, where each agent can define its actions in terms of different computational models (belief–desire–intention (BDI), procedural, neural networks, etc.), and combine these behaviors for the achievement of its goals. Throughout time, the practicality of multiagent system (MAS) technologies has become evident in the development of distributed applications that emphasize autonomous intelligent processes. To facilitate this, various frameworks have been created to support multiagent systems, typically designed with a specific agent architecture in mind, such as reactive or deliberative agents. For example, many multiagent platforms that endorse the BDI model tend to exclusively offer support for this specific agent model. While existing agent platforms typically allow for the development of either behavior-based agents or deliberative agents based on the BDI cycle, they do not provide

the capability for agents to integrate both approaches. Consequently, there is a noticeable lack of flexibility when agents are required to engage in decision-making processes following the BDI paradigm while simultaneously requiring behaviors that do not necessitate such deliberation.

In the fifth paper, Guerrero-Ulloa et al. [Contribution 5] propose IdeAir, a low-cost IoT-based air quality monitoring system, which was designed as a proof of concept. The system captures the concentrations of harmful gases in indoor environments and was developed following the test-driven development methodology for IoT-based systems (TDDM4IoTS). This methodology, together with the tool established as a result, is used to automate the development of IoT-based systems, facilitating the work of developers. The emergence of innovative technologies, such as the Internet of Things (IoT) and cloud computing, plays a crucial role in enabling individuals to enhance their lifestyles and achieve a healthier and more comfortable life. Monitoring pollution levels is of utmost importance in the prevention of exposure to harmful fine particles and in regulating the impact of human activities on the natural environment. Indoor environments are also a significant source of hazardous gas emissions. For example, carbon monoxide (CO), known as a silent killer due to its lethal nature, is emitted by water heaters and fossil-fuel-based heaters. However, existing solutions for indoor pollution monitoring face limitations that hinder their implementation in households with limited financial resources.

In the sixth paper, Yongchao Wu et al. [Contribution 6] present the results of several experiments they conducted and reveal that topic-aware BERT achieves a strong automated essay scoring (AES) performance compared with the previous best neural-based AES methods, demonstrating effectiveness in identifying key topical sentences in argumentative essays. In recent times, researchers have contributed to significant advances in enhancing the performance of automated essay scoring (AES) through the application of neural-based approaches. These methods primarily rely on deep neural networks to establish a connection between student essays and essay scores. However, their focus is often limited to generating a predicted holistic score, which falls short of providing comprehensive pedagogical insights, such as automated writing evaluation (AWE). In this study, the authors introduced a novel approach called topic-aware BERT, which aims to learn the relationships between scores, student essays, and the topical information present in essay instructions.

In the last paper, Sanchez-Cartas and Sancristobal [Contribution 7] explicate the study of the effect of different levels of information on two biology-inspired metaheuristics (differential evolution and particle swarm optimization algorithms) that were programmed to set prices on multisided platforms. The authors assumed that one platform always formed correct expectations (human platform), while the competitor always used a generic version of particle swarm optimization or differential evolution algorithms. In the dominion of digital platforms, algorithms are increasingly being employed to carry out fundamental functions such as pricing. These platforms face the challenge of establishing prices that effectively coordinate multiple interdependent parties, such as developers and users, or buyers and sellers. Consequently, it becomes crucial to develop accurate expectations regarding the behavior of both sides to achieve successful coordination.

3. Conclusions

In this Special Issue, we sought high-quality research contributions that present emerging solutions and/or applications based on AI techniques, such as machine learning, which address the recent challenges in intelligent distributed systems. The papers amassed in this issue present innovative solutions based on the use of AI in distributed environments. Nevertheless, technological problems have also been addressed in these studies, including biometric sensors, production optimization, or the use of computational resources for the benefit of all the entities involved.

4. List of Contributions

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6. Wu, Y.; Henriksson, A.; Nouri, J.; Duneld, M.; Li, X. Beyond Benchmarks: Spotting Key Topical Sentences While Improving Automated Essay Scoring Performance with Topic-Aware BERT. *Electronics* **2023**, *12*, 150. https://doi.org/10.3390/electronics12010150.
7. Sanchez-Cartas, J.M.; Sancristobal, I.P. Limitations of Nature-Inspired Algorithms for Pricing on Digital Platforms. *Electronics* **2022**, *11*, 3927. https://doi.org/10.3390/electronics11233927.

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