

Special Issue “Applications of Artificial Intelligence Systems”

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1. Introduction

Artificial Intelligence, a term that was seen as an obscure subject, only to be studied by mathematicians or computer scientists, without much real-life application, less than 20 years ago, has become a pervasive term in our everyday life. It has come to revolutionize key disciplines for our societies, such as industrial manufacturing—since it is one of the main components of Industry 4.0—healthcare, energy production and consumption, or agriculture and livestock breeding, to name a few. Not only that, it has also revolutionized humanity-related disciplines that help us understand our society better, by analysing how we communicate—with various applications, such as Natural Language Processing—or creating systems that can help disabled people to improve their daily lives.

Our current ability to collect and store massive amounts of data, coupled with the development of hardware and software tools to manage it, has facilitated the propelling of this area of knowledge to the exponential growth that it is experiencing now. But this growth on raw data availability and resources would not justify this revolution without the engineers and practitioners that invent, design and implement novel applications of these techniques, to solve new and ever-growing complex problems and, therefore, help these advancements fulfil their potential to reach society and its individuals.

This Special Issue aims to serve as a small showcase of the wide range of the application this area of knowledge can offer and a humble incentive for the further development of the discipline, by means of the publication of interesting success cases.

2. Applications of Artificial Intelligence and Machine Learning

The current Issue includes a total of eight contributions, seven new research publications and a review, illustrating the different directions in which Artificial Intelligence is being developed nowadays, and how this can be applied to different engineering use cases. In that sense, the contents of the Special Issue can be organized attending to their fields of application.

2.1. Industrial Applications

An Incremental Grey-Box Current Regression Model for Anomaly Detection of Resistance Mash Seam Welding in Steel Mills [1], presents an application of grey-box models, which can be regarded as algorithms that combine both theoretical knowledge about the behaviour of a system and a data-driven approach to the characterization of said models, to the problem of the automated detection of anomalies in the industrial process of welding on steel mills. De Paepe et al., presents the results of the use of this technique, including the corresponding details about the steel processing facilities, the data acquired and the evaluation of the model, both in a batch and incremental approaches to the problem, making this a very interesting demonstration of soft-computing techniques for industrial processes.



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Influence of Environmental Noise on Quality Control of HVAC Devices Based on Convolutional Neural Network [2], presents a system that tackles a similar problem to the second one but using a different technique to do so. In this case, Sikora et al., aimed at assessing the quality of several industrial HVAC (Heat, Ventilation, and Air-Conditioning) devices at the end of the assembly line, to determine the capacity of the models to do so by using only the sound expression of the devices. Authors Sikora et al., propose the use of deep learning techniques to train a system that can handle sound information, translated into images by means of a spectrogram, to discriminate between working and defective devices, without human intervention. A comprehensive testing on how the surrounding noise from the industrial facility can affect the capabilities of the system is included as proof of the capabilities of the system.

Development of Ground Special Vehicle PHM with Case-Based Reason Model [3], also focuses on the prognostics and evaluation of machine components. In this case, the automated analysis is based on the Case-Based Reasoning (CBR) scheme, supported by a data-driven approach. Wu et al., applied this methodology for the assessment of the functioning state of a ground special vehicle, used in satellite transportation. In this case, previous cases or states registered on the sensors, attached to the vehicle, provide the system with good insight into its current condition. The contribution complements theoretical explanations with the comparison of three different variants of the CBR architecture, depending on the calculation of the weights to the different parameters registered on each case, providing a good insight into the capabilities of each.

2.2. Healthcare and Ergonomics Applications

Neuronal Constraint-Handling Technique for the Optimal Synthesis of Closed-Chain Mechanisms in Lower Limb Rehabilitation [4], deals with the automatic generation of rehabilitation routines, adapted for lower limbs. These routines must comply with certain constraints that are very difficult or impossible to meet using conventional computation techniques, so authors Muñoz-Reina et al., have devised a novel hybrid soft-computing system, combining two bio-inspired models, such as differential evolution and artificial neural networks, to propose a system that can achieve state-of-the-art results, in two presented cases (four-bar and cam-linkage mechanisms). The contribution includes a detailed comparison on the performance of this model, with other four well-known techniques for this problem, showcasing an interesting example of the utility of the models for healthcare applications.

sEMG-Based Continuous Estimation of Finger Kinematics via Large-Scale Temporal Convolutional Network [5], proposes a novel solution to a specific problem, in the area of Human–Robot Cooperation, working through communication with an artificial system, using physiological signals, such as the surface electromyogram (sEMG), generated by action neurons in muscle. In order to do so, Chen et al., proposed an Artificial Neural Network model, inscribed in the field of a Deep Learning denominated large-scale temporal convolutional network (LS-TCN), enabling one to estimate the angles of the main joints of the human hand in real time. The authors include both extensive theoretical explanations and a complete comparison of the presented model, including the source public dataset used for the experiments, as valuable takeaways for practitioners.

2.3. Software Applications

Automated Classification of Unstructured Bilingual Software Bug Reports: An Industrial Case Study Research [6], tackles the problem of the automated classification of software bug reports, which inscribes it in the field of Natural Language Processing. Authors Köksal and Tekinerdogan propose a system architecture that includes the pre-processing of the texts, in order to convert unstructured information into structured, and enables the usage of a wide array of automated machine learning models, in order to complete the classification task. The contribution provides a complete comparison between different models, revealing

the strengths and weaknesses of each, and providing a detailed base of experience for developers of future similar systems.

Optimization of a Depiction Procedure for an Artificial Intelligence-Based Network Protection System Using a Genetic Algorithm [7], presents an application related to cybersecurity and the combination of two different approaches to AI, to design a novel solution. Dolezel et al., proposed the utilization of the Convolutional Neural Network (CNN) family of algorithms to automatically classify the flow of data traffic traversing a computer network, in order to determine the quality of service (QoS) provided by it and, therefore, alert the administrator or act as a firewall rule, in case of an anomalous situation. The other main contribution is the use of a different bio-inspired technique, the Genetic Algorithm, to optimize the depiction of the data obtained from the traffic to be fed onto the classification CNN. The authors extend the previous works and theoretical explanation with an extensive set of tests, including the use of specialized hardware to prove the final applicability of the proposal.

2.4. Reviews

Artificial Intelligence Marketing (AIM) for Enhancing Customer Relationships [8], presents a review that provides an overview to the application of Artificial Intelligence (AI) methods, to the area of Marketing, and how these approaches can improve the relationships of companies and consumers. Yau et al. collected a significant amount of relevant previous research publications related to this topic in the text, but further, they present a step forward in this field by proposing an Artificial Intelligence Marketing (AIM) framework, paving the way for an autonomous system that is able to collect big data information and transform it into knowledge, to be disseminated and applied within customer relations real-world use cases.

3. Future of the Field

Although we have reached the end of this Special Issue, the application of new developments in Artificial Intelligence continues to be a profoundly relevant topic, which is pervasive to many aspects and scientific disciplines in our societies. The advancements in this field are expected to go on appearing in growing numbers and sharing space with other knowledge areas, not only technical but related to the humanities. A good deal of attention will also need to be focused on the final use that we decide to give to these technologies, with users and workers being the central stakeholders of the changes to come.

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