Introduction to the Thematic Issue
on Artificial Intelligence for Industry 4.0

This thematic issue of *Computación y Sistemas (CYS)* contains a selection of eight papers presenting advances in the field of Artificial Intelligence (AI) for industry 4.0.

AI can be defined as the ability of machines to carry out certain reasoning. It can also be defined as the science and engineering of machines that act intelligently.

The most advanced industries of the world are using AI techniques to control and optimize the processes of the production lines. AI techniques are also being used to analyze a large amount of data that sensors and machinery produce daily. The use of this technique in the production lines is known as industry 4.0.

The guest editors carefully selected the papers of this thematic issue. Each paper was reviewed by at least three members of the scientific committee. The features considered by the reviewers to accept a paper include originality, contribution to the field, soundness, and technical quality. In the following paragraphs, we provide an overview of the papers that made up this volume.

G. Chanchí et al. from Colombia proposed the design and the implementation of Internet of Things (IoT) software architecture for monitoring, analysis, and visualization of the main variables of interest in indoor plants. The proposed architecture was composed of three views (business, functional, and implementation) and four layers (capture, storage, analysis, and visualization), considering the Lambda architecture. A prototype was developed for monitoring temperature, humidity, and luminance for the Chinese Evergreen indoor plant. Unsupervised methods from weka were used for decision-making. The results revealed that the Evergreen plant should be reallocated due to the low level of luminance.

M. León and F. Rodríguez from Mexico presented a security analysis of five Post-Quantum Cryptography (PQC) digital signature algorithms accepted for the third round of the National Institute of Standards and Technology (NIST) Post-Quantum Cryptography Competition. The algorithms considered were: Crystals-Dilithium, Falcon, Rainbow classical, CZ-Rainbow, and Rainbow compressed. The analysis was based on the performance and a fair evaluation. The authors explained that none of the algorithms analyzed meets all the requirements established by the Mexican Digital Invoices by Internet (CFDI). The digital signature primitive was based on the Rivest-Shamir-Adleman (RSA). However, with the arrival of quantum computers, this algorithm will be vulnerable to cryptographic attacks.

A. Rodríguez et al. from Mexico proposed a two stages methodology for high-resolution orthomosaic reconstruction using aerial images. In the first stage, high-resolution input images were used to extract features and correspondence key points. The correspondences were used to stitch the images and obtain low-resolution orthophotography. The resulting low-resolution images were employed in the second stage to estimate a high-resolution image. The output of the second stage is used as input of the first stage to build a complete high-resolution orthomosaic. Both stages were based on Convolutional Neural Networks (CNNs). The results revealed that the methodology provides similar results to those obtained by an expert in orthophotography but in high-resolution.

R. Ochoa et al. from Mexico discussed an approach of symbolic learning called brain programming for the recognition of subtypes of leukemia in color images. The methodology was composed of two parts. The first employed the algorithm of Artificial Visual Cortex (AVC) for the task of feature extraction. The second uses brain programming to tune each visual operator embedded in the AVC. Finally, a Multilayer Perceptron (MLP) was employed as a classifier.

The dataset used was composed of bone marrow smear images from three subtypes of Acute Lymphoblastic Leukemia (ALL): L1, L2, and L3. The experimental results showed that the multi-class recognition task was achieved through the solutions discovered from multiples runs of the bioinspired model.

T. Guerrero and J. Sossa from Mexico proposed a method applied to image classifiers that allow the understanding, in a non-subjective visual manner, of the background of a prediction. The proposed method identifies the regions of the input image that are most relevant for the classifier's prediction and categorizes them as significant, relevant, and futile. The pre-trained InceptionResnet CNN was employed as a classifier. The validity of the proposal was demonstrated with Kaggle, Microsoft COCO, and Places365 datasets. The proposal solved the problem of subjectivity which is present in other explainability methods. The performance of the proposal is useful not only for correctly trained models but also helps to understand the model prediction, which sometimes goes against human intuition and thus be able to correct the model.

E. López et al. from Mexico showed a reactive navigation scheme for a mobile robot that integrates a module for battery-level monitoring. The proposal employed rules-based reinforcement learning architecture with three entries; 1) the robot's battery level, 2) the distance to the desti-nation, and 3) the distance to the battery charging station. The proposed navigation technique demonstrated that the robot could fulfill its goal to reach a predetermined destination maintaining the battery charge level in proper conditions based on a decision-making methodology. According to the simulations, the robot learns to select an appropriate action to accomplish the displacement task to some destination. However, sometimes, the robot took a deviation to the battery charger station to maintain its battery in conditions to finish the started task.

M. Pérez and E. Bárcenas from Mexico addressed a family of formal languages called multi-valued logic that can be applied in the field of AI. The proposal showed that the 3-valued logics $\mathbf{G}'_3$ and $\mathbf{CG}'_3$ are algebrizable in the sense of Blok and Pigozzi. $\mathbf{G}'_3$ is a 3-valued logic with a single represented truth value by 1, while $\mathbf{CG}'_3$ is a paraconsistent, 3-valued logic that extends $\mathbf{G}'_3$ with two truth values represented by 1 and 2. The paper explains the main definitions, studies the $\mathbf{G}'_3$ and $\mathbf{CG}'_3$ logics, and describes a list of open problems to be studied in the future. The results demonstrated that paraconsistent logic could be applied in many fields of computer science, such as electrical circuits, non-monotonous reasoning, control systems, automation, and robotics. More-over, the results may help in the development of paraconsistent reasoning systems.

J. Sossa et al. from Mexico presented an analysis of several works regarding the use of Artificial Intelligence in Iberoamerican countries. The selection of works was aligned to the pillar technologies that support industry 4.0, including robotics, Internet of things, big data, additive manufacturing and simulation, cloud computing, cybersecurity, virtual and augmented reality, and horizontal and vertical integration. In addition to the analysis of the works, the paper presented a discussion of AI and industry 4.0. Finally, several recommendations to implement AI for industry 4.0 in Iberoamerican countries were offered as a result of the perusal.

We are convinced that this thematic issue will be of interest to students researchers and company managers working in the areas of AI applied in industry 4.0.

This volume also contains several regular papers of the journal and several extended and re-reviewed papers from the MICAI 2021 conference.

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