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GUEST EDITORIAL

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# Soft computing applications in the field of industrial and environmental enterprises

## 1 | INTRODUCTION

Artificial Intelligence (AI) has proved to be a promising field of study that can greatly contribute to the development of computational systems that successfully address an increasing number of challenges. From the very beginning, when the term was coined in 1956 during the Dartmouth Summer Research Project, researchers from this field have shared a vision that computers can be made to perform intelligent tasks (Moor, 2006). A vast array of different techniques has been proposed so far to implement such intelligent systems, ranging from expert or knowledge-based systems (some of the earlier products of AI) to cutting-edge proposals such us deep and machine learning.

Among all the branches of the AI tree, in last decades, there has been significant progress in soft computing (Karray & De Silva, 2004). As pointed out by Zadeh (1994), while hard computing focuses on precision, certainty, and rigour, soft computing requires that computation, reasoning, and decision making exploit a tolerance for imprecision and uncertainty wherever possible (Zadeh, 1994). Soft computing can be seen as a family consisting of many members, including evolutionary computation, fuzzy logic, and connectionist models among others (Pratihar, 2007). Its fascinating ability to simulate human intelligence has made it favourable in various scientific and technological disciplines (Chakraverty, Sahoo, & Mahato, 2019) such as computer science, mathematics, control theory, structural engineering, medical, and psychology.

One of the domains where soft computing can arguably be of greatest utility is in the field of business. The current environment for businesses is increasingly complex and demanding. Companies are affected by multiple internal and external variables that have an impact on the various areas that make up the value chain, and this is exacerbated for those managing operations in multiple countries (i.e., exports, imports, and foreign direct investments). Decision takers within the companies can significantly benefit from and demand tools to analyse and extract the most knowledge from the large datasets generated by the interrelated activities that companies conduct.

Soft computing can be of particular value for industrial and environmental companies. Compared to other sectors such as retailing, where individual-level determinants are key to understand the buyer, industrial companies are characterized by a more critical role of operations efficiency in order to succeed in the market. Likewise, given the large volume of information that is now available for environmental firms, competition in this field is also more and more determined by a strategic and sophisticated use of data analytics.

Overall, soft computing represents a potentially key source of competitive advantage sustainable over time that organizations, especially in the industrial and environmental field, can employ to outperform competitors, achieve higher returns, and ensure their own viability (Wernerfelt, 1984; Barney, 1991). By complementing broad analytical tools (such as Porter's five forces PESTLE or Blue Ocean; Porter, 1979; Kim & Mauborgne, 2014), soft computing may allow firms to materialize tangible resources from strategic advantages.

This special issue compiles recent applications of soft computing techniques to the management of enterprise within industrial and environmental sectors. It is aimed at both researchers and practitioners from academia and industry who are engaged in deploying soft computing solutions for real-life enterprise problems. Five papers are included in this special issue, covering a wide variety of case studies, ranging from photovoltaic solar systems to forest biomass estimation. For each different soft computing, techniques have been applied, namely, unsupervised neural networks, deep learning, regression models, multiagent systems, and case-based reasoning. Thanks to the wide-range panoramic view presented by these complementary works, readers can get a feel for developing up-to-date soft computing systems to solve present problems in enterprise contexts.

## 2 | CONTENTS OF THE SPECIAL ISSUE

In the paper by Jove, Casteleiro-Roca, Quintián, Méndez-Pérez, and Calvo-Rolle (2019), a novel approach for fault detection in industrial processes, by means of unsupervised and projectionist techniques, is proposed. The proposed system is tested in a laboratory plant built with industrial equipment where anomalies have to be detected without any previous knowledge of the data. This system was designed to control the level of liquid in a tank where the liquid is initially stored in a different tank placed at a lower level, and it is boosted by a three-phase pump driven by a variable frequency driver. The objective tank has also two built-in output valves; one of them is a proportional electric, and the other one is manual. In such a system, considered failures are water leaks from the main water tank to the lower tank through a valve. The correct operation of the plant meant that the output electrovalve had to be completely closed. The feasibility of the proposed method was checked by opening the electrovalve and simulating a water leak.

In order to address such a problem, dimensionality reduction techniques are applied to support the visualization of the operation point in a two-dimensional graph regardless of the number of variables. More precisely, data are analysed by means of Principal Component Analysis (PCA), Maximum Likelihood Hebbian Learning (MLHL), Beta Hebbian Learning algorithm (BHL), curvilinear Component Analysis (CCA), and ISOMAP. As the industrial plants usually work in one or a few working points, all the visualized data in an operation point should be near to each other. The data are projected into two-dimension graph, and the user could define a contour in the data. With the defined contour, the proposed algorithm detects whether the working point is out of the previously defined working area. To validate the proposed system, two datasets with different levels of complexity (in terms of quantity and quality of information) have been used. The obtained results have been satisfactory, although the accuracy varies depending on the employed technique and the complexity of the dataset (the higher the complexity of the data, the less accurate the results are).

Torres, Troncoso, Koprinska, Wang, and Martínez-Álvarez (2019) propose a Deep Learning approach, based on feed-forward neural networks for big data time series, for predicting the electricity power generated by photovoltaic solar systems for the next day (at half-hourly intervals). As it is well known, solar energy is highly variable as it depends on meteorological conditions (solar radiation, cloud cover, rainfall, and temperature). This dependency creates uncertainty about the amount of solar power that will be generated, which makes it difficult to integrate solar power into the electricity grid and electricity markets. Hence, an accurate prediction of the generated solar power is a task of utmost importance and relevance for both energy managers and electricity traders, in order to minimize uncertainty and ensure reliable electricity supply at acceptable cost. Day ahead predictions are one of the most common industry-requested operational forecasts, as they are needed for operational planning, switching sources, programming backups, short-term power purchases, and for planning of reserve usage and peak load matching.

To perform such a short-term forecast of big solar-power time series data, a solution based on Deep Learning (DL) feed-forward neural networks is conceived. To find a good combination of hyper-parameters of the applied neural network, the H20 grid search method is applied. The proposed DL solution is compared to the Pattern Sequence-based Forecasting (PSF) algorithm, which uses clustering and similarity of patterns, and a neural network-based model with one hidden layer, used as a reference method. All these models are applied to Australian solar power data gathered during 2 years and compared in terms of the Mean Absolute Error and the Root Mean Squared Error. The accuracy of the applied methods is compared when using weather and weather forecast data as an additional input, taking into account different scenarios corresponding to different percentages of noise in the weather forecast data. Finally, the effect of varying the size of the historical window is also studied.

In peer-to-peer lending, it is important to predict the repayment of the borrower to reduce the lender's financial loss. Such a topic is addressed in the paper by J.-Y. Kim and Cho (2019) that proposes a deep dense convolutional network for repayment prediction in social lending. It maintains the borrower's semantic information and obtains a good representation by automatically extracting important low- and high-level features simultaneously. The proposed model classifies the loan status of a borrower by learning the pattern while maintaining and extracting discriminative features according to the loan status and improves the overall performance with a good representation.

Authors assume that it would be easier to predict the loan status in the feature space if the network captures the inherent properties of the lending data of a borrower and generalizes them to other borrowers. Consequently, the feature space is learned by a DenseNet network that consists of several dense blocks and transition layers, in order to obtain a good representation from the social lending data of many borrowers. The lending data are then projected onto the learned feature space using the trained network and are predicted using the softmax classifier. Extensive experiments are conducted on data coming from the U.S. Lending Club.

Torre-Tojal, Lopez-Guede, and Graña Romay (2019) propose the application of machine-learning-based predictive systems for the extraction of biomass information from Light Detection and Ranging (LiDAR) data. LiDAR is a remote sensing tool that retrieves surface elevation measurements at high spatial resolutions, even in rough terrains and heavily forested areas. It is based on the emission of pulses by an infrared laser sensor emitting pulses and recording of the echoes returning to the sensor after being reflected by ground surfaces. Authors of this paper focus on the application of LiDAR for forest biomass estimation, what may have economic value owing to the use of biomass as a source of energy source or as the raw material for a wide variety of elaborate products such as construction materials, furniture, and paper.

In order to predict the forest biomass from LiDAR data, three predictive machine learning approaches are applied, namely, Multiple Linear Regression, Random Forest, and Support Vector Regression. To test such models, they have been applied (under a fivefold cross-validation schema) to the *Pinus radiata* species using public data gathered from a LiDAR flight conducted by the Basque Government (Spain) in 2012 and the dendometric data coming from the Fourth National Forestal Inventory that were gathered in 2011. The modelling performance results obtained in this study are comparable with those in other studies concerning plot-level biomass estimations.

Finally, a job-offer recommender system for careers is proposed by Rivas, Chamoso, González-Briones, Casado-Vara, and Corchado (2019). It is a hybrid system whose architecture is based on a multiagent system that consists of (a) a Case-Based Reasoning (CBR) system powered by a series of metrics that calculate the affinity between job offers and users and (b) an argumentation framework that extends the functionality of the CBR, thus making it possible for agents to have a dialogue. Individual solutions proposed by each one of the agents are first debated and settled before a single final suggestion is obtained.

The proposed hybrid intelligent system is able to carry out analyses of user profiles and job offers found on the beBee social network. Consequently, it has been evaluated on a sample set of such users actively searching for employment in periods of 15 days during 4 months. As a result of the activity, a total of 118,882 recommendations have been made. The acceptance rate average of users who did interact with the proposed system is 75.81% out of the 42,478 user applications. There has been an evolution of the analysed rates during the 4 months in which the evaluation has been performed; the users' acceptance rate has increased from 73.72% to 78.6%, while the rejection rate has decrease from 26.28% to 21.4% in the last month. On the other hand, the interaction of companies has been also studied; their acceptance rate has increased from 21.74% to 24.03% during the 4 months.

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## CONFLICT OF INTEREST

None.

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## REFERENCES

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Chakraverty, S., Sahoo, D. M., & Mahato, N. R. (2019). *Concepts of soft computing: Fuzzy and ANN with programming*. Singapore: Springer. https://doi.org/10.1007/978-981-13-7430-2

Jove, E., Casteleiro-Roca, J.-L., Quintián, H., Méndez-Pérez, J. A., & Calvo-Rolle, J. L. (2019). A fault detection system based on unsupervised techniques for industrial control loops. *Expert Systems*, e12395.

Karray, F. O., & De Silva, C. W. (2004). *Soft computing and intelligent systems design: Theory, tools, and applications*. New York: Pearson Education.

Kim, J.-Y., & Cho, S.-B. (2019). Predicting repayment of borrows in peer-to-peer social lending with deep dense convolutional network. *Expert Systems*, e12403.

Kim, W. C., & Mauborgne, R. A. (2014). *Blue ocean strategy, expanded edition: How to create uncontested market space and make the competition irrelevant*. Boston, Massachusetts: Harvard business review Press.

Moor, J. (2006). The Dartmouth College artificial intelligence conference: The next fifty years. *AI Magazine*, *27*(4), 87–87.

Porter, M. E. (1979). The structure within industries and companies' performance. *The Review of Economics and Statistics*, *61*(2), 214–227. https://doi.org/10.2307/1924589

Pratihar, D. K. (2007). *Soft computing*. Oxford, UK: Alpha Science International, Ltd.

Rivas, A., Chamoso, P., González-Briones, A., Casado-Vara, R., & Corchado, J. M. (2019). Hybrid job offer recommender system in a social network. *Expert Systems*, e12416.

Torres, J. F., Troncoso, A., Koprinska, I., Wang, Z., & Martínez-Álvarez, F. (2019). Big data solar power forecasting based on deep learning and multiple data sources. *Expert Systems*, e12394.

Torre-Tojal, L., Lopez-Guede, J. M., & Graña Romay, M. M. (2019). Estimation of forest biomass from light detection and ranging data by using machine learning. *Expert Systems*, e12399.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180. https://doi.org/10.1002/smj.4250050207

Zadeh, L. A. (1994). Fuzzy logic, neural networks, and soft computing. *Communications of the ACM*, *37*(3), 77–85. https://doi.org/10.1145/175247.175255