Preface

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Intelligent Systems encompasses both theoretical and applied developments based on artificial and computational intelligence, including natural computing. Intelligent Systems is considered as one of the most relevant leading vehicles towards a new cultural and technological revolution. In particular, in Brazil, there is a strong ongoing effort to integrate theoretical and applied developments, including also industry and business initiatives.

In this context, the Brazilian Conference on Intelligent Systems (BRACIS) series provides the Brazilian researchers an opportunity to promote and disseminate theory, methodologies and applications of artificial and computational intelligence, discussing the state of the art and the future directions of the area. The BRACIS conference series, sponsored by the Brazilian Computer Society (SBC), started in 2012 as a merge of the Brazilian Symposium on Artificial Intelligence (21 editions) and the Brazilian Symposium on Neural Network (12 editions). In 2019, BRACIS was held together with the National Meeting on Artificial and Computational Intelligence (ENIAC—from Portuguese *Encontro Nacional de Inteligência Artificial e Computacional*) and the Symposium on Information and Human Language Technology (STIL). The proceedings were published by IEEE Conference Publishing Services and are available online at IEEE Xplore (<https://doi.org/10.1109/BRACIS49209.2019>).

This special issue of Natural Computing presents the revised and extended versions of selected papers presented at BRACIS 2019. The 4 selected papers are of interdisciplinary character and focused on optimization techniques.

The first paper, entitled “Multi-Region Symbolic Regression: Combining Functions under a Multi-objective Approach”, is related to multi-objective optimization and Multi-Region Symbolic Regression (MR-SR). In this paper, the authors modeled the function generation problem of MR-SR based on a multi-objective approach, where each objective corresponds to the quality of the evolved function in a region, and the number of objectives is equal to the number of regions of the data input space. An empirical analysis was conducted and the proposed MR-SR was tested in two scenarios with different objectives. In the first one, the proposed approach was applied to solve the symbolic regression problem with a standard Genetic Programming (GP), with the main objective of reducing the error rate. In the second one, a variation of GP, namely Geometric Semantic Genetic Programming (GSGP), was used. The obtained results showed that the method using clustering k-means and a model switching strategy yields better results in 5 out of 10 datasets for GP with 2 regions. In addition, in the second scenario, the framework turned out to be less effective due to the lack of diversity of the solutions evolved.

The second paper, entitled “Saving Computational Budget in Bayesian Network-based Evolutionary Algorithms”, is related to one type of optimization technique, Bayesian Optimization Algorithm (BOA). More specifically, a new BOA-based optimization approach (FBOA) is proposed, which explores the fact that patterns of Probabilistic Graph Model (PGM) adjustments can be used as a guide to reduce the frequency of PGM updates, because significant changes in PGM structure might not occur so frequently, and because they can be particularly sparse at the end of evolution. In addition, the proposed approach is assessed in the search space of an NK-landscape optimization problem for medium and large-size instances. In this analysis, average gaps and success rates as well as the correlation between the landscape ruggedness of the problem and the expected runtime of FBOA and BOA are presented for medium-size instances. For large-size instances, optimization results from FBOA and BOA are compared. The results of the empirical analysis show that,

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although the proposed approach is almost three times faster than BOA, it still produces competitive optimization results.

The third paper, entitled “Stock Market Trend Detection and Automatic Decision-Making Through a Network Based Classification Model”, is an application paper. This paper presents a model which uses connector hubs to detect price trend reversals and to automatize decision-making processes in stock market trading operations for selecting a good investment strategy and improve the returns. The proposed model starts by mapping the historical stock price time series as a network, where each node represents a price variation range and the edges are generated according to the time sequential order in which these ranges occur. In the next step, communities of the network constructed so far are detected, which represent the up and down trends of the stock prices. Then, the proposed model has two main phases: (1) Trend detection phase, where the price trend communities are detected and trend labels are generated; and (2) Operating phase, where the trend labels to future stock prices are predicted, in such a way that these trends can be used as triggers to perform buying and selling operations of the stock. In the empirical assessment, the proposed model was applied to historical data from 10 of the most traded stocks from both NYSE and the Brazilian Stock Exchange (Bovespa). The obtained results are promising, with the proposed model’s best returns being able to outperform the stock price returns for the same period in 15 out of the 20 cases.

In contrast to the papers described above, the last paper performs an exploratory search for the best selection strategy to define the optimal ensemble structure. This paper is entitled “A Study of Model and Hyper-parameter Selection Strategies for Classifier Ensembles: a robust analysis on different optimization algorithms and extended results”. It is well known that Machine Learning (ML) techniques have been playing an important role in several real world applications. However, one of the main

challenges is the selection of the most accurate technique to be used in a specific application. In the classification context, for instance, two main approaches can be applied, model selection and hyper-parameter selection. This paper performed a wide and robust comparative analysis of two approaches for Classifier Ensembles. The first approach selects the best classification algorithm for a given input dataset, by doing a heuristic search in a large space of candidate classification algorithms and their corresponding hyper-parameter settings. It is referred to as model selection and also called Automated Machine Learning (Auto-ML). The second approach defines one classification system and performs an extensive search to select the best hyper-parameters for this model. In the exploratory analysis, two methods of the first approach (Auto-WEKA and H₂O) are compared to four methods of the second approach (Genetic Algorithm, Particle Swarm Optimization, Tabu Search and GRASP). The main aim of this analysis was to determine which of these techniques generate more accurate Classifier Ensembles, given a time constraint. Their findings indicate that the use of a hyper-parameter selection method provides the most accurate classifier ensembles, but this improvement was not detected by the statistical test.

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