

Soft Computing: Theory Innovations and Problem-Solving Benefits Minitrack

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The term soft computing is used in reference to a family of preexisting techniques, namely fuzzy logic, neuro-computing, probabilistic reasoning, evolutionary computation, and so on. Taking profit from the main advantages of each individual technique, they can work in a cooperative way to solve lots of complex real-world problems: those for which more conventional methods have not yielded low cost, analytic, and complete solutions. Earlier computational approaches could model and precisely analyze only relatively simple systems. However, more complex systems arising in biology, health, economy, digital world, and similar fields, often remained intractable to conventional mathematical and analytical methods. Therefore, the advances in soft computing techniques play an important role in analyzing and modeling more complex systems. Soft computing deals with imprecision, uncertainty, partial truth, and approximation to achieve computability, robustness, and low solution cost, which can better deal with large-scale, fast, and unstructured changes that occur as part of the digital world.

This minitrack aims to attract researchers with an interest in the research area described above. Specifically, not only contributions on theoretical innovations are welcome, but also those describing different problem-solving benefits by using soft computing-based methodologies in the fields of digital world, digital coaching, digital health, digital economy, cognitive computing, and design and manage of digital services and service systems. We are interested in the contributions where the applied/defined methodologies used are either analysis- or systems-oriented. They may have an experimental or empirical focus. Innovative studies based on explainable methods are favored, which combine innovative theoretical results with a careful empirical verification, or good empirical problem solving, planning or decision making with innovative theory building. A common denominator for all studies is the building and use of soft computing-based models.

The first paper of this minitrack, “A Study of Different Protocols of Distribution of Information

Granularity to Build Consensus in Fuzzy Group Decision-Making”, discusses how the existing protocols of distribution of information granularity, and their ensuing optimization, can be applied to build consensus in group decision-making problems with fuzzy preference relations. The protocols that are analyzed are: a uniform and symmetric distribution of information granularity, a uniform but asymmetric distribution of information granularity, a non-uniform but symmetric distribution of information granularity, and a non-uniform and asymmetric distribution of information granularity. Some numerical experiments are also conducted to analyze the performance and efficiency of these protocols to build consensus.

The second paper of this minitrack, “Methodology Based on Linguistic Protoforms for Activity Detection in Patients with Type 2 Diabetes Mellitus”, proposes a methodology based on linguistic protoforms for activity detection in the context of patients with diabetes. To do it, the fuzzy logic is used through general linguistic protoforms and commercial Internet of Things (IoT) devices. This methodology addresses one of the main challenges of this type of systems, multi-occupancy, and, for this purpose, it incorporates an indoor localization system. A case study of a real home is illustrated to monitor patients affected by type 2 diabetes mellitus with the objective of enabling health care professionals to check the degree of compliance with the therapeutic contract.

The third paper of this minitrack, “EllipScape: A Genetic Algorithm Based Approach to Non-Photorealistic Colored Image Reconstruction for Evolutionary Art”, presents EllipScape, a genetic algorithm based non-photorealistic image reconstruction algorithm that takes in a colored image and reconstructs the image with circles of different sizes and colors such that it represents the general subjects of the original image. This creates an effect like the pointillism art style, where the further away from the picture you are, the more of the original image a viewer can recognize. The experiments conducted show that the performance of this algorithm scales well and executes in a reasonable amount of time for an arbitrarily sized image.

Finally, the fourth paper of this minitrack, “Explainable Intrusion Detection System in IoT Scenarios: A Cross-Device Model Training and Evaluation for Traffic Classification”, discusses an IoT scenario in which a set of smart devices are connected to a home network and generate packet traffic flows. With the objective of protecting the network from malicious traffic, which can be generated if some devices are infected by a botnet, the authors design, develop, and test an explainable Intrusion Detection System to be implemented on an edge node of the network. The explainability of the system is ensured by incorporating a multi-way fuzzy decision tree (FDT) for real-time traffic classification. A novel cross-device approach for FDT training and evaluation is proposed to distinguish network traffic between authentic and malicious. Using this approach, FDT is constructed by using historical and labeled traffic data extracted from devices connected to an IoT network. The results show that with the proposed cross-device approach, the traffic flow generated by new devices added to the IoT network can be classified correctly, without the need to retrain or update the traffic classification model.