Editorial

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Biographical notes: Deepak Gupta received his BTech degree from the Guru Gobind Singh Indraprastha University, Delhi, India in 2006. He received his ME degree from the Delhi Technological University, India in 2010, and PhD from Dr. APJ Abdul Kalam Technical University (AKTU), Lucknow, India in 2017. He has co-authored more than 207 journal articles, including 168 SCI papers and 45 conference articles. He has authored/edited 60 books, published by IEEE-Wiley, Elsevier, Springer, Wiley, CRC Press, DeGruyter and Katsons. He has filled four Indian patents. He is the recipient of the 2021 IEEE System Council Best Paper Award. He has been featured in the list of top 2% scientist/researcher databases worldwide. He has accomplished productive collaborative research with grants of approximately $144,000 from various international funding agencies, and he is a Co-PI in an International Indo-Russian Joint Project of Rs1.31CR from the Department of Science and Technology.

Oscar Castillo holds a Doctor in Science in Computer Science from the Polish Academy of Sciences. He is a Professor of Computer Science in the Graduate Division, Tijuana Institute of Technology, Tijuana, Mexico. Currently, he is the President of the Hispanic American Fuzzy Systems Association (HAFSA) and Past President of International Fuzzy Systems Association (IFSA). He is also the Chair of the Mexican Chapter of the Computational Intelligence Society (IEEE). He has published over 300 journal papers, ten authored books, 40 edited books, 200 papers in conference proceedings, and more than 300 chapters in edited books, in total 910 publications according to Scopus (H index = 63), and more than 1,050 publications according to Research Gate (H index = 74 in Google Scholar).

Utku Kose received his BS degree from the Computer Education of Gazi University, Turkey as a Faculty Valedictorian. He received his MS in 2010 from the Afyon Kocatepe University, Turkey in the field of Computer and DS/PhD in 2017 from Selcuk University, Turkey in the field of Computer Engineering. Between 2009 and 2011, he has worked as a Research Assistant in the Afyon Kocatepe University and Assistant Professor in Suleyman Demirel University between 2017 and 2019. Currently, he is an Associate Professor in the Suleyman Demirel University, Turkey. He has more than 100 publications including articles, authored and edited books, proceedings and reports. He is also one of the series editors of the *Biomedical and Robotics Healthcare Series* by CRC Press.

Over the last decade, deep learning (DL) has dramatically reformed many research and application domains. All DL models, using different architectures and algorithms, utilise multiple processing layers for extracting a hierarchy of abstractions of raw data. Their remarkable successes notwithstanding, these powerful computational models are facing many challenges. Firstly, designing an optimal deep structure for a particular problem requires a deep domain knowledge, which is not necessarily held by end-users. In addition, the problem of searching for the optimal structure could be non-convex and non-differentiable, and existing accurate methods are incapable of addressing it well. Furthermore, the deep structure defined for a specific task is not reusable, i.e., a new one must be redesigned for data with a slightly changed scenario and/or unseen data.

Evolutionary computation (EC) comprises optimisation techniques that are useful when problems are complex or poorly understood, or insufficient information about the problem domain is available. Thanks to their powerful abilities in searching for global optima, EC has proven very effective in solving real-world problems with challenging characteristics such as non-convexity, nonlinearity, noise and irregularity, which dampen the performance of most classic optimisation schemes. In this regard, DL structures designed by EC approaches, i.e., evolutionary deep learning (EDL), also referred to as evolutionary-computation-based network architecture search (ENAS), is an important research topic. However, most existing EC methods currently work only on relatively shallow structures, and consequently, exhibit some difficulties in providing satisfactory results when dealing with deep structures.

A related approach to face this task comes from the field of neuro-evolution, i.e., the use of evolutionary algorithms to optimise DL architectures and their weights at the same time. Neuro-evolution has the potential to achieve better performance with respect to DL-based models, considering it can optimise the whole architecture, its weights, its hyperparameters and the learning algorithm. Yet, neuro-evolution has proven itself effective for small-scale and median-scale neural networks, while its use for DL is up to now limited due to the huge amount of computational effort it requires. Fortunately, in recent years, the wider and wider availability of sets of more and more powerful computing devices has made the use of parallel and distributed versions of evolutionary algorithms practical for many problems for which evolutionary methods seemed unsuitable just few years ago. This has practical implications for neuro-evolution too, as effective DL structures are being found for learning problems, thanks to evolution.

The objective of this special issue is to invite active researchers in the field of DL to present original research articles that focus on the development and application of new DL architectures for addressing complex problems in the fields of biomedical

applications. Hybrid techniques combining both DL with neuro-evolution are particularly welcome. Also, papers reporting advancements in open neuro-evolution issues as diversity and search for novelty, indirect encoding and capture of regularities, meta-learning and synaptic plasticity and neuromodulation, are of particular interest, especially when proposed within biomedical fields.

From around 14 submitted articles to this particular section, four papers were selected based on the reviews. Each paper was reviewed by at least two reviewers and went through at least two rounds of reviews. The brief contributions of these papers are discussed below.

The first paper in this special issue authored by M. Padmapriya, S. Pasupathy, R. Sumathi and V. Punitha and entitled 'A deep learning model framework for diabetic retinopathy detection', examines a DL model (ResNet) for medical DR detection. The dataset of Asia Pacific Tele-Ophthalmology Society (APTOS) 2019 was used to train and test the DL model. To demonstrate the vitality of the chosen ResNet model, performance measures and testing accuracy like recall, precision, and F1 score were determined. The modified ResNet model reduced the training time and computational complexity and attained a testing accuracy of around 84%.

The second paper authored by Rakesh Kumar Pattanaik, Rinky Dwivedi and Mihir Narayan Mohanty and entitled 'Application of nonlinear system identification for EEG modelling using VMD-based deep random vector functional link network', considers EEG signal for the development of the model. As the signal is nonlinear and non-stationary, the model is designed accordingly that is similar to nonlinear dynamic system identification. Initially, the signal is decomposed by a robust variational mode decomposition method for which the basic noise components are eliminated. Based on its clean coefficient, the model is developed using RVFLN for identification. Further, the same are utilised in deep RVFLN to enhance the prediction and detection. The use of deep RVFLN provides better results as compared to simple RVFLN as explained in the result section.

The study in the third paper of the special issue authored by R. Raja and B. Ashok and entitled 'Evolutionary optimisation with outlier detection-based deep learning model for biomedical data classification', introduces a new hyperparameter tuned convolutional neural network-recurrent neural network (HPT-CNN-RNN) model for medical data classification. The proposed HPT-CNN-RNN model includes pre-processing step to transform the actual healthcare data into useful format. Besides, SVM-SMOTE approach was executed to handle the class imbalance problems. In addition, outlier detection process is performed using extreme gradient boosting (XGBoost) model. Moreover, bacterial foraging optimisation algorithm (BFOA) with CNNRNN model is employed to categorise medical data. Furthermore, the BFOA is utilised to optimally choose the hyperparameter values of the CNNRNN model. The experimental outcomes designated the better performance of the HPT-CNN-RNN model over the other methods.

The final paper of the special issue authored by Indresh Kumar Gupta, Abha Choubey and Siddhartha Choubey and entitled 'Salp swarm optimisation with deep transfer learning enabled retinal fundus image classification model', develops a salp swarm optimisation with deep transfer learning enabled retinal fundus image classification (SSODTL-RFIC) model. The proposed SSODTL-RFIC model examines the retinal fundus image for the existence of diseases. In addition, a median filtering (MF) approach is employed for the noise removal process and graph cut (GC) segmentation is applied.

Besides, MobileNetv1 feature extractor is involved to produce feature vectors. Finally, SSO with cascade forward neural network (CFNN) model is applied for recognition and classification process. A widespread experimentation process is performed on benchmark datasets to examine the enhanced performance of the SSODTL-RFIC model, an extensive comparative examination pointed out the supremacy of the SSODTL-RFIC model over the recent approaches with maximum accuracy of 98.71% and 99.12% on the test ARIA and STARE datasets, respectively.

To conclude, this special issue publishes four papers out of a total of around 14 submitted papers. The guest editors hope that the research contributions and findings in this special issue would benefit the readers in enhancing their knowledge and encouraging them to work on various aspects related to biomedical applications.

We want to express our sincere thanks to the Editor-in-Chief for allowing us to organise this particular issue. The editorial office staffs are excellent, and thanks for their support. We are also thankful to all the authors who made this special issue possible, and to the reviewers for their thoughtful contributions.