



# Editorial to special issue on hybrid artificial intelligence and machine learning technologies in intelligent systems

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Artificial intelligence (AI) has grown widely across domains. The current trends of AI and machine learning (ML) techniques are centered toward hybridization to improve performance of the systems. Our society will shortly become populated with intelligent systems that are able to perform tasks without human intervention and communicate with their surroundings, which totally transforming the century-old traditional human-based system. Despite the immense growth of the various AI and ML techniques, there are many challenges and threats which limit the performance of these techniques. However, due to the increasing demands, we have noticed the evolution of the intelligent systems which are empowered by AI and ML techniques, some of them are hybrid metaheuristic algorithms, classification, clustering, Bayesian hierarchical modeling, deep learning and re-enforcements learning. There exist several scientific projects in progress for the development/enhancement of intelligent systems. We also noticed that few on-going scientific projects are based on simulation hypothesis where biological inspired dream simulation mechanism has been incorporated to handle off-line simulation.

The aim of this special issue is to take the opportunity to introduce current developments, the progress, and the advancements of not only the technical elements of the intelligent system empowered by the AI and ML technologies but also the innovative hybrid AI and ML techniques combined with the domain knowledge of the systems, from both theoretical and practical perspectives. This special issue of neural computing and applications can

be a flagship issue to draw the attention of the technical and scientific communities to the AI technologies studied and applied in relation to the new generation of intelligent systems.

The following articles in this special issue introduce a variety of AI, ML and hybrid methods for the development of intelligent systems. Most of the articles in this special issue address the problem of intelligent system development.

The article title “*Density-based semi-supervised online sequential extreme learning machine*” by Min Xia, Jie Wang, Jia Liu, Liguang Weng & Yiqing Xu, presents a novel semi-supervised online sequential learning model, which can realize online learning of unlabeled samples chunk by chunk. In this work, unlabeled patterns are selected by pattern distance and density distribution for online learning, so as to speed up training and improve accuracy.

The article title “*A distant supervision method based on paradigmatic relations for learning word embeddings*” by Jianquan Li, Renfen Hu, Xiaokang Liu, Prayag Tiwari, Hari Mohan Pandey, Wei Chen, Benyou Wang, Yaohong Jin, Kaicheng Yang, discuss the potential to incorporate linguistic resources in neural networks in natural language processing (NLP) tasks. Recently, neural networks in NLP usually directly use word vectors as basic features which are based a learnable paradigm without explicit linguistic knowledge. However, such knowledge is vital for NLP tasks. In this paper, the authors propose to leverage human-labeled antonym and synonym resources in word vectors to overcome the inherent limitation that antonyms are also close in word vector space. Extensive computational experiments have been conducted to evidence its effectiveness.

The article title “*Fault coverage-based test suite optimization method for regression testing: learning from mistakes-based approach*” by Arun Prakash Agrawal, Ankur Choudhary, Arvinder Kaur, Hari Mohan Pandey demonstrate a novel method for regression test suite optimization following the phenomenon of “learning from

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mistakes”. The performance of the proposed approach was measured against five benchmarked test suite reduction methods (Greedy method, Additional Greedy, HGS and Enhanced HGS) with respect to performance measures: fault coverage, execution time and reduced optimized test suite size. Statistical analysis of results demonstrated the superiority of the proposed approach over the compared ones.

The article title “*Lessons learned from longitudinal modeling of mobile-equipped visitors in a complex museum*” by Francesco Piccialli, Yuji Yoshimura, Paolo Benedusi, Carlo Ratti & Salvatore Cuomo present an user modeling method which can embrace non-invasive, interactive and even mixed scenarios, where information gathered from multiple types of passive and interactive devices can be combined. The proposed methodology has been assessed within the cultural heritage domain in order to support decisions and check the effectiveness of initiatives geared toward the improvement of user engagement and the evolution of cultural offerings.

The article title “*Analysis of Boolean functions based on interaction graphs and their influence in system biology*” by Ranjeet Kumar Rout, Santi P. Maity, Pabitra Pal Choudhury, Jayanta Kumar Das, Sk. Sarif Hassan & Hari Mohan Pandey highlight on a novel Boolean function decomposition technique has been discussed which is also used to reduce the network state space of the cell cycle network of fission yeast for finding the singleton attractors. Some special classes of Boolean functions with respect to the interaction graphs have been discussed. Identification of biologically relevant Boolean functions is possible from 1-variable to  $n$ -variable recursively. A unique recursive procedure is devised that uses the Cartesian product of sets starting from the set of one-variable Boolean functions. Interaction graphs generated with these Boolean functions have only positive/negative edges, and the corresponding BN state spaces have periodic attractors with length one/two.

The article title “*Improved prediction of daily pan evaporation using Deep-LSTM model*” by Babita Majhi, Diwakar Naidu, Ambika Prasad Mishra & Suresh Chandra Satapathy investigated the potential of deep neural network architecture with long short-term memory cell (Deep-LSTM) to estimate daily pan evaporation with available input features in different agro-climatic zones (ACZ) in east Central India. It is demonstrated that the proposed Deep-LSTM structure can successfully model the daily evaporation losses with improved accuracy as compared to multilayer artificial neural network (MLANN) and some empirical approach (Hargreaves and Blaney–Criddle) in the study locations.

The article title “*A wrapper-filter feature selection technique based on ant colony optimization*” by Manosij

Ghosh, Ritam Guha, Ram Sarkar & Ajith Abraham presents a combined wrapper-filter variant of ant colony optimization algorithm called WFACOFs. A filter-based feature subset evaluation procedure has been introduced in WFACOFs to reduce computation complexity of the overall model. The proposed algorithm uses a feature dimension-dependent pheromone update scheme to perform feature selection in multi-objective fashion. The algorithm has been tested on several UCI machine learning repository datasets and NIPS 2003 FS challenge datasets using K-nearest neighbor and multilayer perceptron as the classifiers.

The article title “Hybrid intrusion detection and signature generation using Deep Recurrent Neural Networks” by Sanmeet Kaur & Maninder Singh discuss on a deep learning-based system for hybrid intrusion detection and signature generation of unknown web attacks referred as D-Sign. D-Sign is capable of successfully detecting and generating attack signatures with high accuracy, sensitivity and specificity. It has been for attack detection and signature generation of web-based attacks. D-Sign has reported significantly low false positives and false negatives.

The article title “*Understanding NFC-Net: a deep learning approach to word-level handwritten Indic script recognition*” by Soumyadeep Kundu, Sayantan Paul, Pawan Kumar Singh, Ram Sarkar & Mita Nasipuri demonstrates a deep learning architecture for resource-constrained environments, called non-fully-connected network or NFC-Net, based on convolutional neural network (CNN) architecture to solve the problem of Indic script recognition from handwritten word images. Previous approaches to this problem include handcrafted features such as structure-based features and texture-based features. In contrast, proposed model learns relatively different features from raw input pixels using NFC-Net. To evaluate the performance of the NFC-Net with suitable parameter estimation, a dataset of 18,000 handwritten multiscript word images consisting of 1500 text words from each of the 12 officially recognized Indic scripts has been considered and a maximum script recognition accuracy of 96.30% is noted. It has been additionally tested on the RaFD and BHCCD datasets with improved results to prove dataset independency of the proposed model.

The article title “Genetic algorithm-optimized multi-channel convolutional neural network for stock market prediction” by Hyejung Chung & Kyung-shik Shin showed the representative deep learning techniques multi-channel convolutional neural networks (CNNs) to predict the fluctuation of the stock index. Furthermore, it optimizes the network topology of CNN to improve the model performance.

The article title “Recurrent neural network with attention mechanism for language model” by Mu-Yen Chen,

Hsiu-Sen Chiang, Arun Kumar Sangaiah & Tsung-Che Hsieh assumed that the words contain “the meaning in sentences” and “the position of grammar.” In this study a recurrent neural network with attention mechanism to establish a language model is proposed. This study uses Penn Treebank, WikiText-2, and NLPCC2017 text datasets. According to these datasets, the proposed models provide the better performance by the perplexity.

The article title “Hybrid optimization scheme for intrusion detection using considerable feature selection” by S. Velliangiri & P. Karthikeyan shows a hybrid optimization scheme (HOS) is designed for combining adaptive artificial bee colony (AABC) with adaptive particle swarm optimization (APSO) for detecting intrusive activities. HOS provides the local optimal solutions and globally optimal solutions are equalized to acquire increased and worthy outcomes. The effectiveness of the designed scheme is evaluated with existing machine learning schemes such as Naive Bayes, AABC, APSO, and support vector machine, which outperform the HOS.

The article title “*A nature-inspired biomarker for mental concentration using a single-channel EEG*” by

Sebastián Basterrech & Pavel Krömer presents a novel biomarker system based on a single channel EEG that can estimate the mental concentration. The device combines traditional classification techniques with evolutionary computation. The developed system has several advantages, it is reliable, personalized for each subject, fast-learning, non-invasive, and it is created using a portable and low-cost device.

The article title “Deep learning-based sign language recognition system for static signs” by Ankita Wadhawan & Parteek Kumar deals with robust modeling of static signs in the context of sign language recognition using deep learning-based convolutional neural networks (CNN). In this research, total 35,000 sign images of 100 static signs are collected from different users. The efficiency of the proposed system is evaluated on approximately 50 CNN models.

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