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EDITORIAL

Convergence of deep machine learning and parallel computing environment for bio-engineering applications

1 | INTRODUCTION

Deep machine learning is an emergent area in the field of computational intelligence (CI) research concerned with the analysis and design of learning algorithms and representations of data at multiple levels of abstraction. Deep learning is a technique for implementing machine learning that provides an effective solution for parallel computing environment in bi-engineering problems that encompasses artificial intelligence (AI), artificial neural networks, reasoning, and natural language processing, helping the human intelligence and decision making process. The heterogeneous parallel computing architectures have been considered as "keys" for real-time bio-engineering applications, needing the design of a high-level operating system for matching the processing tasks to the appropriate machine learning paradigm in a mixed-machine parallel system. This effort finds to investigate the feasibility of a deep machine learning technique for implementing a high-level operating system for heterogeneous parallel computers.

The new frontier research era and convergence of deep machine learning and parallel computing with reference to bio-engineering have three main streams that need to be addressed in the current scenario: bio informatics, medical imaging, and sustainable engineering. This special issue is integrating machine learning, cognitive neural computing, parallel computing paradigms, advanced data analytics, and optimization opportunities to bring more computers to the bio-engineering problems and challenges. Furthermore, it is important to make a note that the convergence of parallel computing architectures, deep machine learning, and its intelligence techniques has not been adequately investigated from the perspective of bio engineering research streams (bio-informatics, medical imaging, and sustainable engineering) and their related research issues. Furthermore, there are many noteworthy issues (health informatics, bio-image informatics, and energy efficiency) that need to be addressed in the context of deep machine learning, parallel computing, and bio engineering. Obviously, these challenges also create immense opportunities for researchers. For the aforementioned reasons, this special issue focuses to address the comprehensive nature of cognitive neural computing and parallel computing, and emphasizes its character in human intelligence and learning systems, complex analysis tasks, mimicking human cognition and learning behavior, and prediction and control of bio-engineering systems.

2 | THEME OF THIS SPECIAL ISSUE

This special issue intends to give an overview of the state-of-the-art of issues and solution guidelines in the new era of deep machine learning paradigm and its recent trends of techniques for bio engineering. The accepted papers present novel in depth fundamental research contributions either from a methodological/application perspective in understanding the fusion of deep machine learning paradigms and their capabilities in solving a diverse range of problems for bio-engineering or focus on real-world applications. The set of accepted papers can be organized under the following key subjects and subsections, and are briefly described in the remaining parts of this section.

2.1 | Machine learning and deep learning in imaging

Shankar et al[1] have investigated optimal feature level fusion based Adaptive Neuro-Fuzzy Interface System (ANFIS) Classifier for Brain Magnetic Resonance Imaging (MRI) Classification. This paper has addressed the brain tumor image classification from MRI medical image datasets. For identifying and visualizing the tumor in the MRI brain images, two important models such as Feature Selection (FS) and Machine Learning classification techniques were utilized. The Optimal Feature Level Fusion (OFLF) was used to fuse the low and high-level features of brain image. Once the feature extraction was completed, the ANFIS classifier was proposed to classify the brain images as class 1 (Benign) or class 2 (Malignant). Therefore, the error rate was minimized as well as increased the classification accuracy. Thus, the proposed ANFIS method achieved better classification accuracy compared to the existing works. This promising technique can be applied to the general execution of alternate classifiers utilized at the place of ANFIS in enhancing the precision.

Bo et al[2] have proposed a novel fuzzy clustering recognition algorithm for medical image with multi-resolution. The main contributions of the paper include the following. (a) An image acquisition scheme is determined from the acquisition time, angle, and other acquisition methods; (b) a new background segmentation and feature extraction method is presented for medical images. The segmentation and background features are extracted by form of medical images which was a basis for medical image recognition with a subsequent fuzzy clustering method, and finally,

(c) medical image pixels were clustered together through the provided fuzzy clustering to achieve medical identification and reached better recognition ratio.

Yong-lian[3] has investigated a multi-feature computerized tomography (CT) medical image recognition method with deep learning based on single feature information such as color, morphology, and texture. First, preliminary recognition with a classifier based on single features was used. Then, basic probability assignment was constructed by output as independent evidence. A deep learning method was also used to effectively fuse all image information. Finally, the recognition result was obtained according to the classification decision rule. Experimental results showed that the recognition rate of this method is more than 98%. The proposed method had high accuracy and stability, when compared with the single feature CT image recognition method.

Liu et al[4] have discussed the relationship between image semantic segmentation and animal image research based on the actual situation, and found that animal image processing technology plays a more important role in the field of protecting precious animals. The end-to-end network training of this paper has consisted of Fully Convolutional Network (FCN) for the front end and Conditional Random Fields as Recurrent Neural Networks (CRF-RNN) for the back end via comparing a variety of research methods. The experiments achieved a desired outcome for the semantic segmentation of animal images by utilizing the Caffe deep learning framework and explained the implementation details from the aspects of training and testing.

Bai et al[5] have addressed a novel deep learning method for extracting unspecific biomedical relation. This paper has proposed a Multiple Attention Long Short-Term Memory (MAT-LSTM) model to extract unspecific relation from short text in biomedical literatures. Experiments on two Biocreative benchmark datasets and one Bionlp benchmark dataset were made to measure the validity of the proposed model MAT-LSTM, and better performance has achieved. The MAT-LSTM model has also been applied practically in extracting unspecific relation contained in the PubMed literatures. The results extracted from PubMed by using the proposed model were verified by experts mostly, indicating the practical value of a MAT-LSTM model.

Zhu et al[6] have introduced the Boosted Tree (BT) based algorithm to analyze DNA molecular specific hybridization. The core of the existing methods is to traverse combinatorial state space. The new approach has an acceptable analytical accuracy, which has declined slightly in exchange for a substantial increase in analytical efficiency. As a result, the more complex the DNA molecules involved in the hybridization become, the more significant the comparative advantage of the new methods is. The experiment results showed that the new method had an average accuracy of 94.2%, and an average efficiency of 90839 times higher than that of the existing representative approaches.

Wang et al[7] investigated cerebral micro bleeding (CMB) identification based on nine-layer convolutional neural network with stochastic pooling. In this paper, the authors have proposed using a convolution neural network (CNN) with stochastic pooling for the CMB detection. CNN has good performance in image and video recognition, recommender system, and nature language processing. Based on the collected subject, the experiment result shows that the six-convolution layer and three fully connected layer CNN, nine layers in total, achieved sensitivity, specificity, accuracy, and precision as 97.22%, 97.35%, 97.28%, and 97.35% in average of ten runs, which shows better performance than five state-of-the-art methods.

Asharindavida et al[8] proposed a forecasting tool for prediction of epileptic seizures using a machine learning approach. This research focuses on analysis of ECG and EEG signals applying a deep learning technique to study early prediction of epileptic seizure. Signal processing methods like Empirical Mode Decomposition, spectral analysis, and statistical methods were used. The algorithms were implemented in MATLAB and the EEG and ECG data were collected from Physiobank and EPILEPSIAE databases. In the window-based analysis of low frequency spectral area of EEG signals, 78.5% of the cases displayed a significant change as the windows progressed and the onset of seizure was approached.

Arunkumar et al[9] proposed a fully automatic model-based segmentation and classification approach for MRI brain tumor using artificial neural networks. This paper has addressed a new segmentation approach for brain tissues using MR images. The method includes three computer vision fiction strategies, which are enhancing and segmenting images, and filtering out non-region of interest (ROI) based on the texture and HOG features. A fully automatic model-based trainable segmentation and classification approach for MRI brain tumor is employed using artificial neural networks to precisely identify the location of the ROI. Therefore, filtering out a non-ROI process has been used in view of histogram investigation to avert the non-ROI and select the correct object in brain MRI.

Wei et al[10] investigated improving the resolution of medical images with deep dense convolutional neural networks. The authors have applied a deep dense SR (DDSR) convolutional neural networks model to two types of medical images, including Computerized Tomography (CT) and Magnetic Resonance imaging (MRI) images. This network densely connects every hidden layer to learn high-level features, which was first proposed for object recognition. A set of medical images are used for experiments. This research has compared the performance of DDSR with three state-of-the-art SR network models, including SR Convolutional Neural Network (SRCNN), Fast SR Convolutional Neural Network (FSRCNN), and Very Deep SR Convolutional Neural Network (VDSR). The results show that the proposed network has better performances both on CT and MRI images.

2.2 | Multimedia/bio-informatics data security

Aithal[11] has addressed generation of pseudo random number sequence from discrete oscillating samples of equally spread objects and application for stream cipher system. This work has proposed a novel method generating the pseudorandom number, which is based on discrete equally spread oscillating points viewed orthogonally, as an envelope has been considered for the generation. Depending on the number of samples, it is

possible to get the higher length of the sequence. The random patterns generated by the discrete points of a moving wave are used to generate non-binary random numbers. These numbers are used as key in a stream cipher system. These are having greater advantages like one time padding to achieve perfect security in cryptographic applications. The same non-binary key sequence generated is applied for the cryptographic applications, and the security parameters of the result obtained from cryptographic applications are also evaluated to observe the strength of security level.

Kumar et al[12] proposed a multiple watermarking technique using a combination of redundant discrete wavelet transforms (RDWT), non-subsampled contourlet transform (NSCT), set partitioning in hierarchical tree (SPIHT), and singular value decomposition (SVD). The security aspect of the proposed method is enhanced by using Arnold transform. Since then, RDWT and NSCT are both shift invariant in nature; therefore, they are suitable for multiple image watermarking. Furthermore, the proposed method provides flexibility in selection of appropriate sub-bands for watermark embedding and recovery. Experimental results and analysis reveal that the proposed technique gives maximum PSNR, NC, and SSIM value up to 40.97 dB, 1, and 0.9994, respectively.

Liu et al[13] have proposed a parallel generated method in transcriptional regulatory networks. Firstly, two datasets, Michigan Cancer Foundation – 7 (MCF-7) and Cardiomyocytes (CM), were applied. Then, a parallel method was used to generate a transcriptional regulatory network with their transcription factors (TFs) and target genes (TGs). Finally, experimental results showed that 61% regulatory relations in MCF-7 were validated in the Gene Expression Omnibus (GEO), whereas 29% results needed further experimental verification. In this paper, the main considered factors were the expression of TFs and the motif binding of TFs on TG.

2.3 | Sustainable data engineering

Wang et al[14] have analyzed a green resource allocation method for intelligent medical treatment-oriented service in a 5G mobile network. The authors have proposed green spectrum resource allocation strategy based on the Hungarian method to optimize system spectrum efficiency while considering the fairness among users under the assumption that all resources are fully shared by traditional cellular and newly introduced Device-to-Device (D2D) users. To validate the performance of the proposed algorithm, a system-level Monte Carlo simulation is also conducted, which shows the favorable performance of the proposed algorithm over the traditional greedy algorithm.

Ganapathi et al[15] have investigated constrained ear detection using an ensemble based convolutional neural network model. The authors have proposed an ear detection technique using the ensemble of CNN. The first part of the technique trains three models of CNN on a given dataset, whereas in the later part, the weighted average of the outputs of trained models is utilized to detect the ear regions. The used ensemble models show better performance as compared to the case when each individual model is used standalone. The proposed technique is being evaluated on two databases, viz, IIT Indore-Collection A (IIT-Col A) database and annotated web ear (AWE) database. Experimental results of ear detection demonstrate the superior performance of the proposed technique over other state-of-the-art techniques in handling illumination, occlusion, and pose variations.

Kumar and Jaiswal[16] presented a systematic literature review to collate, explore, understand, and analyze the efforts and trends in a well-structured manner to identify research gaps defining the future prospects of this coupling. The contribution of this paper is significant because firstly the primary focus is to study and evaluate the use of soft computing techniques for sentiment analysis on Twitter, and secondly, as compared to the previous reviews, we adopt a systematic approach to identify and gather empirical evidence, interpret results, and critically analyze and integrate the findings of all relevant high-quality studies to address specific research questions pertaining to the defined research domain.

Yu and Fu[17] have analyzed the distributed database access path prediction based on recurrent neural network in Internet of Things (IoT). This paper proposes a database access path prediction method based on recurrent neural network. The first step is to obtain alternative transit data centers based on the analytic hierarchy process. The second step is to build the candidate path evaluation grade objective function to obtain the optimal access path and complete the database access path prediction.

Hoang and Pham[18] proposed a novel generalized logistic dependent model with considerations of the dependence among selected biomarkers for breast cancer detection based on a set of nine biomarker predictors such as age, glucose, BMI, resistin, HOMA, MCP-1, leptin, insulin, and adiponectin. Their research findings demonstrate that the proposed model has the potential to predict breast cancer in women just based on five biomarkers: glucose, age, BMI, resistin, and MCP-1. They also compared their model results to several other machine-learning modeling approaches including SVM, logistic regression, random forest, and multiple regression analyses using various training datasets (60%, 70%, and 80% of all data) and all the datasets. It shows that the inclusion of the dependence among those five predictors in the proposed model is worth the extra model complexity and effort for achieving a significant accuracy prediction level of breast cancer detection in women.

Liu et al[19] have proposed an automatic cloud service testing and bottleneck detection system that ensures the high Quality of Service for cloud services. A testing environment can be generated automatically by using the proposed test module, and the weak point of the target service can be eliminated efficiently by using the proposed bottleneck detection algorithm. In the experiments, the authors have used two Web interaction mix modes of TPC-W benchmark to test a target three-tiered Web service. The experimental results reveal that the proposed system can accurately detect potential bottleneck resources, and that overall performance can be improved after scaling up the bottleneck resources in the target service. The proposed system has demonstrated to be suitable for application by service providers for evaluating their system performance prior to its release.

3 | CONCLUSION

The articles presented in this special issue highlighted the recent research fields such as deep machine learning, data security, and sustainable data engineering. In particular, the submissions presented novel in-depth fundamental research contributions either from a methodological/application perspective in understanding the fusion of deep machine learning paradigms and their capabilities in solving a diverse range of problems for bio-engineering or their real-world applications. We hope that the readers can benefit from the perspectives presented in this special issue and will add to these strategically important, exciting, and emerging research areas.

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