Cognitive Computation
https://doi.org/10.1007/s12559-022-10049-9

Guest Editorial: Advances in Deep Learning for Clinical and Healthcare Applications

Cosimo Ieracitano[1] · Francesco Carlo Morabito[1] · Stefano Squartini[2] · Kaizhu Huang[3] · Xuelong Li[4] · Mufti Mahmud[5]

Accepted: 8 August 2022

In recent years, cutting-edge computational technologies are increasingly being applied in clinical settings to improve healthcare delivery. This has been possible due to the huge amount of biomedical data that is continuously acquired and stored from ever-accurate medical devices [1]. However, in the scientific research community, there is a growing need to develop more optimized methodologies that can process these big biomedical data and extract discriminating parameters (known as *features*) for more effective and predictive diagnosis of specific pathologies [2]. To this end, biologically inspired computational intelligence techniques have widely been applied in this field [3]. Particularly, recent advances in the so-called deep learning (DL) techniques [4]—including, among others, convolutional neural networks, stacked autoencoders, deep reinforcement learning, adversarial learning, transfer learning, meta-learning, end-to-end learning, life-long learning, and (semi-/un-) supervised learning with weakly labeled data, graph neural networks—have emerged as promising technologies in the clinical and biomedical research domains [5–8].

This guest Special Issue encompasses fifteen papers devoted to recent developments in the field of deep learning and cognitive systems for healthcare applications. All the accepted fifteen original contributions have been thoroughly revised by two or more expert reviewers through at least two revision rounds. These studies, published in the current Special Issue, are briefly summarized as follows.

- In *TraMiner: Vision-Based Analysis of Locomotion Traces for Cognitive Assessment in Smart-Homes* by Zolfaghari et al., the authors investigate the use of sensor data and DL techniques to recognize symptoms of cognitive decline based on the analysis of indoor movements. Experiments were carried out with a large real-world dataset acquired from cognitively healthy seniors, subjects with mild cognitive impairment, and people with dementia. Results showed that the proposed system (referred to as *TraMiner*) achieved good accuracy for long-term cognitive assessment and outperforms state-of-the-art approaches.
- In *Cascade Regression-Bared Face Frontalization for Dynamic Facial Expression Analysis* by Wang et al., the authors focused on the facial expression Recognition (FER) and its importance in human–computer interaction and health care. They addressed the challenging issue of accurate frontal facial shape prediction developing an adaptive cascade regression learning model and an ensemble learning strategy to enhance the prediction performance. Experimental results showed that the proposed methodology can successfully boost the performance of FER and it is suitable for in-the-wild facial analysis.
- In *What You Say or How You Say It? Depression Detection Through Joint Modeling of Linguistic and Acoustic Aspects of Speech* by Aloshban et al., the authors developed an approach based on bidirectional long-short term memory networks and multimodal analysis methodolo-

✉ Cosimo Ieracitano
cosimo.ieracitano@unirc.it

Francesco Carlo Morabito
morabito@unirc.it

Stefano Squartini
s.squartini@univpm.it

Kaizhu Huang
kaizhu.huang@dukekunshan.edu.cn

Xuelong Li
xuelong_li@ieee.org

Mufti Mahmud
mufti.mahmud@ntu.ac.uk

[1] DICEAM, University Mediterranea of Reggio Calabria, Reggio Calabria, Italy

[2] Università Politecnica delle Marche, Ancona, Italy

[3] Duke Kunshan University, Suzhou, China

[4] Northwestern Polytechnical University, Xi'an, China

[5] Nottingham Trent University, Nottingham, UK

Published online: 17 August 2022

gies to discriminate between depressed and nondepressed Italian speakers. Simulation results reported not only an accuracy above 80% but showed also that multimodal approaches perform better than unimodal ones.

- In *Automatic Detection of Melanins and Sebums from Skin Images Using a Generative Adversarial Network* by Hu et al., the authors proposed an automatic detection algorithm, namely DAME, to recognize melanins and sebums from skin images via a pix2pix-based generative adversarial network model able to learn their structural and contextual information. Achieved results demonstrated that DAME allowed to accurately detect melanins and sebums in a supervised scheme, outperforming competitive baseline approaches.
- In *A Novel IoT-Fog-Cloud-based Healthcare System for Monitoring and Preventing Encephalitis* by Bhatia and Kumari, the authors designed a spatio-temporal-based temporal-recurrent neural network prediction model to monitor and prevent the spread of encephalitis. To this end, a IoT-fog-cloud framework was introduced, and a fuzzy C-means classifier was used to analyze the category of a patient through health-related parameters. Experimental results demonstrated that he proposed system was able to outperform other decision systems in terms of statistical parameters including accuracy, f-measure, and reliability.
- In *Deep Transfer Learning for Improved Detection of Keratoconus using Corneal Topographic Maps,* Al-Timemy et al. proposed an ensemble approach of deep transfer learning (EDTL) based on the analysis of corneal topographic maps with the aim to support ophthalmologist's diagnosis and enhance the keratoconus (KCN) detection. To this end, four pretrained networks (SqueezeNet, AlexNet, ShuffleNet, and MobileNet-v2) were considered and fine tuned on a dataset of KCN and normal cases. The Pentacam indices classifier was also considered. Results reported the effectiveness of the EDTL strategy achieving improved detection accuracy.
- In *A Novel Probabilistic-Based Deep Neural Network: Toward the Selection of Wart Treatment,* Mishra et al. proposed a probabilistic deep neural network (PDNN)-based wart treatment identification system to recognize the best treatment method with better prediction accuracy for removing plantar and standard wart. The developed PDNN outperformed baseline classifiers and existing state-of-the-art wart treatment systems.
- In *A Novel Approach for Tuning of Fluidic Resistance in Deterministic Lateral Displacement Array for Enhanced Separation of Circulating Tumor Cells,* Bhattacharjee et al. focused on the circulating tumor cells (CTCs) and introduced a cognitive clinical decision support system for detection of CTCs based on an unconventional approach that uses an analogous resistive network to alter the fluidic resistance toward a better seclusion of CTCs from white blood cells.
- In *Quantum Machine Learning Architecture for COVID-19 Classification Based on Synthetic Data Generation Using Conditional Adversarial Neural Network*, Amin et al. explored the quantum machine learning (QML) for the analysis of COVID-19 images. A conditional adversarial network was also used to generate synthetic CT of COVID-19/healthy images and augment the dataset. The developed QML system outperformed common ML and latest published works in this research field.
- In *A Comparison of Deep Learning Techniques for Arterial Blood Pressure Prediction,* Paviglianiti et al. proposed a cuffless, non-intrusive approach for the continuous measurement of the arterial blood pressure (ABP). In particular, different DL techniques were used to infer ABP using the photoplethysmogram and electrocardiogram signals. Results showed that the ResNet followed by three LSTM layers achieved the best performance.
- In *Deep Learning Approach for Early Detection of Alzheimer's Disease* by Helaly et al., the authors proposed an end-to-end framework based on convolutional neural networks for medical image classification and Alzheimer's disease (AD) detection. Two methods were introduced: one based on simple CNN; one based on transfer learning and pre-trained VGG19 model. The developed DL architectures achieved promising performance for multi-class AD stage classifications.
- In *Dense Tissue Pattern Characterization using Deep Neural Network*, Kumar et al. proposed a deep neural network–based dense tissue pattern classification framework for prediction of breast tissue pattern, by processing the region of interest (ROI) of the mammogram image under analysis. The proposed method outperformed existing works by achieving an accuracy of 92.3% and the kappa coefficient value of 0.846.
- In *Deep Learning for Reliable Classification of COVID-19, MERS, and SARS from Chest X-ray Images,* Tahir et al. proposed a COVID-19 recognition system able to detect lung regions using a CNN segmentation model (U-Net) and classify the segmented lung images as COVID-19, MERS, or SARS by means of a pre-trained CNN classifier. Score-CAM was also applied for interpreting the achieved results. The finding reported high COVID-19 sensitivity with segmented lung images.
- In *Automated Detection Approaches to Autism Spectrum Disorder Based on Human Activity Analysis: A Review,* Rahman et al. discussed qualitatively and quantitatively methods, challenges, resources, and future perspec-

tives about the existing automated diagnosis systems for autism spectrum disorder (ASD) with human activity analysis (HAA), analyzing the literature from 2011 onward. The authors concluded that the fully automated HAA systems for ASD diagnosis show promise but are still in developmental stage.

- In *Survey on Machine Learning and Deep Learning Applications in Breast Cancer Diagnosis* by Chugh et al., the authors explored 81 peer-reviewed papers related to the development of classification algorithms for breast cancer detection, concluding that DL outperforms conventional machine learning in diagnosing breast carcinoma when the dataset is broad.

In summary, this special issue has addressed several key challenges in healthcare and reported novel advanced computational systems with potential deployment in clinical settings. We would like to express our deepest gratitude to the Editor-in-Chief of Cognitive Computation, Prof. Amir Hussain, for his insightful suggestions and continuous support during the preparation of this issue. We greatly thank all the authors who participated in the issue and the anonymous expert reviewers who helped us to select the submissions with the highest quality.

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