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EDITORIAL

Deep learning methods for biomedical information analysis

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Due to numerous biomedical information-sensing devices (Yu et al. 2019), such as Computed Tomography (CT), Magnetic Resonance (MR) Imaging, Ultrasound, Single Photon Emission Computed Tomography (SPECT) (Okudan et al. 2019), Positron Emission Tomography (PET), Magnetic Particle Imaging (Graser et al. 2022), EE/MEG, Optical Microscopy (Traeger et al. 2023) and Tomography, Photoacoustic Tomography (Schneider et al. 2022), Electron Tomography (Chakrabarti et al. 2022), and Atomic Force Microscopy (Phan et al. 2023), etc.

A large amount of biomedical information was gathered over these years. However, developing new advanced imaging methods and computational models for efficient data processing (Guo et al. 2022), analysis, and modeling from the collected data is important for clinical applications and understanding the underlying biological process (Slawinska et al. 2023).

Deep learning (Fatima et al. 2023) has been rapidly developed in recent years in terms of both methodological development and practical applications in biomedical information analysis (BIA) (Xia et al. 2018). It provides computational models of multiple processing layers to learn and represent data with multiple levels of abstraction (Han 2023). It can capture intricate structures of large-scale data implicitly (Mukhopadhyay et al. 2023) and is ideally suited to some of the hardware architectures that are currently available.

This special issue aims to provide a diverse but complementary set of contributions to demonstrate new developments and applications of deep learning and computational machine learning to solve problems in BIA. The ultimate goal is to promote research and development of deep learning for multimodal biomedical images by publishing high-quality research articles and reviews in this rapidly growing interdisciplinary field.

We received, in total, 217 submissions, and finally, 31 papers were accepted with an acceptance ratio of 14.2%. All of them were subjected to a rigorous peer review process specific to the Ambient Intelligence and Humanized Computing Journal. A variety of innovative topics are included in the agenda of the published papers in this special issue, including topics such as:

- Theoretical understanding of deep learning in biomedical engineering.
- Transfer learning and multi-task learning.
- Joint semantic segmentation, object detection, and scene recognition on biomedical images.
- Improvising the computation of a deep network; exploiting parallel computation techniques and GPU programming.
- Multimodal imaging techniques: data acquisition, reconstruction; 2D, 3D, 4D imaging, etc.)
- Translational multimodality imaging and biomedical applications (e.g., detection, diagnostic analysis, quantitative measurements, image guidance of ultrasonography).
- Optimization by deep neural networks, multi-dimensional deep learning.
- New models of the new structure of convolutional neural networks.

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- Visualization and explainable deep neural network.

There are many optimization algorithms to help BIA. Hajieskandar et al. (2020) use hybrid neural networks and a grey wolf algorithm. Lu et al. (2020) propose a diagnosis system combing VGG and an extreme learning machine. Their model is trained by the Gaussian map bat algorithm. To classify the extracted features of the diabetic retinopathy dataset, Gadekallu et al. (2020) use the principal component analysis-based deep neural network model using the grey wolf optimization (GWO) algorithm.

Clustering technique is helpful in BIA. Jiao et al. (2019) use a weighted clustering ensemble for module partitioning. Sheng et al. (2020) propose a stylistic data-driven possibilistic fuzzy clustering technique.Li et al. (2021a, b, c) build a continuous objective function that combines soft-partition clustering with deep embedding.

Long short-term memory (LSTM) contributes to BIA. Edara et al. (2019) use LSTM for sentiment analysis and text categorization of cancer medical records. Kumar and Garg (2019) use LSTM and its variant Bi-directional LSTM applying GloVe (i.e., Global Vectors for Word Representation) for building semantic word embeddings and learning context. Deng et al. (2020) present a hybrid ARIMA-LSTM model optimized by BP to forecast outpatient visits.

Detection is the most reported application field in this special issue. Tavakoli et al. (2019) detect abnormalities in mammograms using deep features. Pradeepa et al. (2020) propose DEODORANT for early detection and prevention of polycystic ovary syndrome. Melekoodappattu and Subbian (2020) realize the automated breast cancer detection using a hybrid extreme learning machine classifier. Liu et al. (2020) propose a novel m^6A site detection method called Dm6A-TSVM. Wang et al. (2020) propose video detection of foreign objects on the belt surface. Li et al. (2021a, b, c) propose a dedicated model called the multi-view Takagi–Sugeno–Kang fuzzy system (MV-TSK-FS) for epilepsy EEG detection. Ibrahim et al. (2021) propose a COV-CAF for abnormality detection and intelligent severity assessment.

Classification is the second most reported application field in BIA. Ni et al. (2020) propose a transfer-discriminative dictionary learning with label consistency (TDDLLC) algorithm for EEG signal classification. Li et al. (2021a, b, c) report a structured discriminative analysis dictionary learning (ADL) algorithm for image classification. Huang et al. (2020) propose fast compression residual convolutional neural networks to classify ECG arrhythmia accurately. Luo et al. (2020) propose an effective vitiligo intelligent classification system.

Diagnosis, segmentation, estimation, recognition, identification, monitoring, recommendation, and clustering are other critical application fields. Gianchandani et al. (2020) use ensemble deep-transfer-learning models for rapid COVID-19 diagnosis. Guo (2021) presents a detail-preserving network (DPN) with high-resolution representation for efficient segmentation of retinal vessels. Davoodnia et al. (2020) explore pervasive BMI estimation, and identity recognition in smart beds by deep multitask learning. Vasavi et al. (2019) report a medical assistive system for the automatic identification of prescribed medicines by visually challenged from the medicine box. Motwani et al. (2021) present a novel framework based on deep learning and cloud analytics for smart patient monitoring and recommendation. Qiu et al. (2021) present a semi-supervised recommender system for bone implant ratio recommendation.

Some other AI models can be used in different ways. Liu et al. (2019) present a diffusion tensor imaging denoising method based on Riemann nonlocal similarity. Boukhari and Omri (2020) present a DL-VSM-based document indexing approach for information retrieval. Jiao et al. (2020) perform the extraction and analysis of brain-functional statuses for early mild cognitive impairment using a variational auto-encoder. Chen et al. (2021) present an image inpainting algorithm based on an improved total variation minimization method.

Finally, a review paper is included in this special issue. Murthy and Bethala (2021) provide a review of research direction toward cancer prediction and prognosis using machine learning and deep learning models.

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