# PREFACE

Special issue on

*Future Perspectives for AI in Complex Health Modelling*

Things are changing in the world of healthcare with the fast-changing landscape of solving complex health issues with innovative solutions. Such challenges were previously embraced with mathematics and statistics, and with more recent advancements in AI, this domain has undergone a new paradigm. Complex mathematical and statistical methods are used to explain a real-life problem, and AI-powered mathematical modelling approaches are disrupting the future of healthcare. Such approaches enable healthcare professionals to make more informed decisions and achieve better outcomes for patients. This special issue features ten high quality papers on state-of-the-art applications and technical developments of AI. This editorial highlights four interlinked theme plans for the future of complex health issues: (i) AI and machine learning for infectious disease detection and early diagnosis, (ii) social-media and multimodal data for health risk assessment, (iii) image-based diagnostic developments in animal and human medicine, and (iv) automated detection and screening & diagnostic research for chronic and neurological disorders.

In the realm of AI and machine learning for infectious disease detection and early diagnosis, W. Zhang *et al.* address the critical need for early sepsis diagnosis in ICU patients, essential for improving survival rates. Traditional diagnostic approaches rely on clinical experience, and machine learning models often face limitations due to labor-intensive feature engineering and limited dataset knowledge. Their study introduces a novel approach, transforming structured clinical data into unstructured textual descriptions, allowing sepsis prediction to be framed as a text classification problem. By leveraging pre-trained language models like RoBERTa, their method utilizes embedded semantic knowledge to enhance prediction accuracy. Using real ICU data, the proposed model achieved an F1 score of 79.03%, a five-point improvement over traditional machine learning models. Results show that this approach not only improves early sepsis diagnosis performance but also offers valuable insights for clinical applications.

In a related study, M. Ahsan *et al.* highlight the global impact of infectious diseases on mortality, emphasizing the diagnostic challenges posed by complex symptoms. Their research introduces three AI-based decision-making techniques to improve diagnostic accuracy using medical images. This approach relies on a mathematical model for disease identification through a multi-criteria decision-making (MCDM) framework. An innovative use of hypersoft sets (HSSs) within a fuzzy context forms a basis for AI-driven methodologies. This study suggests potential applications in deciding on isolation, quarantine, or hospital admission based on infection severity. Visual tools are employed to clarify the method's benefits. Findings reveal the potential of the proposed approach in areas such as machine learning, deep learning, and pattern recognition.

In the realm of social-media and multimodal data for health risk assessment, R. Geethanjali and A. Valarmathi introduce maternal health risk factor detection using a deep learning approach (MHRFD-DLA), a novel method combining convolutional neural networks (CNNs), long short-term memory (LSTM), and an attention mechanism. This hybrid approach enhances maternal health risk detection by extracting visual features with CNNs, processing sequential text with LSTMs, and focusing on key data with the attention mechanism. MHRFD-DLA is designed for real-time monitoring across social media platforms, identifying sentiments related to prenatal care, nutrition, mental health, and other maternal well-being factors. The model's findings can benefit global public health initiatives aimed at improving maternal and child health. Simulations on various social network datasets validate the model's effectiveness by outperforming existing methods in terms of recall, accuracy, precision, and F1 score. The results demonstrate that MHRFD-DLA effectively captures complex sentiment patterns in social media data related to maternal health risks.

In the realm of image-based diagnostic advancements in medical and veterinary medicine, M. Awais *et al.* highlight the importance of accurately identifying leukocyte subtypes for disease diagnosis and management in medical image analysis. Convolutional neural networks are promising for image classification but face high computational demands. Post-training feature selection is essential to improve performance and reduce feature sets. This study presents a methodology for leukocyte classification by first building deep features using transfer learning from EfficientNet-B0 and DenseNet201. A Bayesian-based wrapper feature selection technique, incorporating a tailored estimate from the distribution algorithm, is introduced to optimize feature selection and avoid local optima. The reduced feature set is classified using soft-voting predictions from various classifiers. Experiments on benchmark peripheral blood smear datasets show a classification accuracy above 99%, with a significant reduction in the feature size. The proposed method outperforms or matches existing studies in WBC classification, demonstrating superior performance and efficiency.

On the other hand, M. Wieczorek *et al.* highlight the importance of understanding the origin and characteristics of healthy tissues for detecting abnormalities in veterinary medicine. While the tissue origin is often noted during sampling, mislabeling can occur, particularly in educational settings where students may lack the necessary expertise. Although skilled professionals can sometimes identify tissue origins, this is not always feasible due to similarities between tissues from different species or organs. The authors propose an automatic classification system using a custom deep learning model, capable of classifying tissues with high accuracy (98.34%) based on light microscope imagery. The dataset includes 3680 images of healthy tissues from various organs and species. This system can outperform human specialists, especially when visual differences are minimal. The dataset also offers a foundation for abnormality detection and is one of the first such models in veterinary medicine, with most of the existing research focused on human medicine.

In a parallel effort, A. Paulauskaite-Taraseviciene *et al.* developed image processing techniques for identifying various skin lesions, addressing the challenge of multi-class prediction where lesion types are often unknown. The study emphasized the importance of utilizing diverse features and selecting the most significant ones for visual diagnostics. A small dataset of skin lesions from Lithuania was used for both binary and five-class classification tasks. The model was trained using 662 features, including conventional image and graph-based features derived from the Delaunay triangulation. The study also examined the impact of feature importance through SHAP values, achieving a weighted F1-score of 92.48% for binary classification and 71.21% for multi-class prediction.

Finally, in the realm of automated detection and screening for chronic and neurological disorders, S. Abbas *et al.* explore autism spectrum disorder (ASD), which affects individuals with symptoms like anxiety, depression, and epilepsy, impacting relationships, learning, and employment. With no confirmed treatments or diagnoses, the focus is on improving individual capacities through symptom management. The study investigates autism screening in adults and toddlers using deep learning and AI techniques, including feature prediction, label encoding, and optimization methods. The authors employed machine learning models for feature prediction, which were then fused with original data and trained using deep long short-term memory (DLSTM) networks for autism detection. Data analysis identified anomalies and outliers, while label encoding converted categorical data to numeric values. After hyper-tuning DLSTM model parameters, the method demonstrated superior performance, achieving a 0.999% accuracy for toddlers and 0.99% for adults, thus outperforming other techniques.

In a related study, A. Ramakrishnan *at al.* address the challenges of early diagnosis and intervention in autism spectrum disorder by utilizing machine learning for efficient identification and treatment. Feature selection plays a key role in improving classifier performance by retaining relevant features and removing unnecessary ones, leading to enhanced computational efficiency and accuracy. The paper proposes a chaotic binary butterfly optimization algorithm-based feature selection and data classification (CBBOAFS-DC) technique, which includes pre-processing, feature selection, and data classification. A binary variant of chaotic BOA (CBOA) is used to select optimal features, minimizing the feature set while improving classification accuracy. Additionally, the bacterial colony optimization with a stacked sparse auto-encoder (BCO-SSAE) model is employed for data classification. Experiments on an ASD dataset demonstrate that the CBBOAFS-DC technique outperforms benchmarked methods, showcasing its effectiveness in improving classification performance.

In a parallel effort, Sri Sravya *et al.* highlight the fact that diabetic retinopathy (DR), caused by diabetes, leads to visual impairment and blindness. DR results from factors like hyperglycemia-induced microvascular damage, oxidative stress, and inflammation. Common screening methods include fundus photography, optical coherence tomography (OCT), and fluorescein angiography. Diabetic macular edema (DME) is a key cause of vision loss in DR patients. The study proposes an automated, cost-effective method for detecting DR lesions using region-based convolutional neural networks (R-CNNs). After preprocessing and annotating data for training, a faster R-CNN is employed to categorize lesions into five groups. Using 88704 images from a Kaggle dataset, the model achieves a high accuracy of 98.38%. The proposed method demonstrates superior robustness in disease localization and classification compared to existing techniques. Cross-dataset evaluations on Kaggle and APTOS datasets further validate its exceptional performance in both training and testing stages.

On the other hand, W. Akbar *et al.* emphasize the importance of chest X-rays for diagnosing pneumonia, a crucial test for distinguishing between its types. Vulnerable groups, including those with asthma, compromised immune systems, hospitalized infants, and elderly individuals on ventilators, face greater risks from misdiagnosis or delayed detection. Early detection is key to effective treatment and improved survival rates. Despite existing methods, there is a need for more accurate diagnostics. This paper introduces CNN models to detect pneumonia in chest X-rays, training 20 distinct models. The most accurate and efficient model, EfficientNet-B0, achieved an accuracy of 93.59%, with the precision, recall, and

F-score metrics of 93.30%, 92.99%, and 93.14%, respectively. This research highlights the potential of advanced neural network models to enhance pneumonia diagnosis through increased accuracy and efficiency.

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*Marcin Woźniak*
Silesian University of Technology, Gliwice, Poland

*Yogesh Kumar*
Pandit Deendayal Energy University, Gandhinagar, India

*Muhammad Fazal Ijaz*
Melbourne Institute of Technology, Australia

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**Marcin Woźniak** holds an MSc degree in applied mathematics, a PhD and a DSc degree in computational intelligence, and a full professorial title in engineering and technology. He is presently a full professor with the Faculty of Applied Mathematics, Silesian University of Technology, and has in the past been a visiting professor with several universities abroad. His current research interests include neural networks and their applications, together with various aspects of fuzzy logic and control, applied computational intelligence accelerated by evolutionary computation and federated learning models. Professor Woźniak has authored/coauthored over 300 research papers in international conference proceedings and journals, and has actively participated in numerous international research projects. He has been granted various ministerial awards for his scientific achievements, and has been repeatedly presented among Top 2% Scientists in the World by Stanford University for his career achievements. He is also among the Best Computer Science Scientists in Poland according to `Research.com`. Professor Woźniak is an editorial board member or an editor for *Biomedical Signal Processing and Control, Sensors, Machine Learning with Applications, Pattern Analysis and Applications*, and has guest edited special issues of reputable journals. He has also served as a session chair at various international conferences and symposiums.

**Yogesh Kumar,** an IEEE member, is currently an assistant professor in the Computer Science and Engineering Department at Pandit Deendayal Energy University, Gandhinagar. His research interests include explainable artificial intelligence, machine learning, deep learning, speech recognition systems, and health informatics. Doctor Kumar's expertise encompasses the diagnosis and detection of communicable and non-communicable diseases. Notably, he has been placed among the top 2% of researchers worldwide, according to Stanford University's 2023 and 2024 scientist ranking.

**Muhammad Fazal Ijaz** holds a PhD degree in industrial and systems engineering from Dongguk University, Seoul, South Korea. He has so far been a research assistant, a visiting guest professor, and an assistant professor with tertiary institutes, including Dongguk University, Technology De Monterrey, Mexico, Sejong University, Seoul, and the University of Melbourne, Australia. He has published numerous research articles in several international peer-reviewed journals, including *IEEE Transactions on Industrial Informatics, IEEE Internet of Things Journal, IEEE Transactions on Consumer Electronics, Artificial Intelligence Review, Scientific Reports, Biomedical Signal Processing and Control*. His research interests include medical informatics, machine learning and AI, and data science.