Guest Editorial: Special Issue on Emerging Computational Intelligence Techniques to Address Challenges in Biomedical Data and Imaging

Computational intelligence, particularly deep neural networks, plays a key role in the recent bloom of data- driven automation, which can be viewed as one of the most emerging fields of artificial intelligence over the last decade. It has achieved great success in different tasks in computer vision, image processing, biomedical analysis and related fields. Researchers in deep and shallow machine learning including those working in the above fields can play a significant role in understanding and processing of complex medical data in order to improve the care of patients. Healthcare and biomedical sciences have become data-intensive fields, with a strong need for sophisticated data mining methods to extract the knowledge from the available information. The analysis of biomedical data still entails many challenges including high dimensionality, class imbalance and low numbers of samples. Although the current research in this field has shown promising results, several research issues remain to be explored. There is a need to explore novel feature selection methods to improve predictive performance along with interpretation, and address the scalability to large scale data in biomedical sciences.

This special issue intends to prompt emerging computational intelligence (CI) techniques for biomedical data and imaging. Special attention devoted to handling feature selection, class imbalance, bias, uncertainty modeling and data fusion in medical imaging. This is of special interest for medical experts who have access to interesting sources of data but lack expertise in using computational intelligence techniques effectively. To achieve the goal of this special issue, the guest editors have comprehensively evaluated the originality, technical novelties, presentation quality and relevance of all the submitted papers. Through a rigorous and careful review process, four high-quality papers have been selected for publication. Overall, these four papers provide emerging computational intelligence techniques for biomedical data and imaging. A brief summary of each paper is introduced below.

Conventional clustering techniques for neuroimaging applications usually focus on capturing differences between given subjects, while neglecting arising differences between features and the potential bias caused by degraded data quality. The paper entitled "ADCoC: Adaptive Distribution Modeling Based Collaborative Clustering for Disentangling Disease Heterogeneity from Neuroimaging Data" by Liu et al. exploits the underlying heterogeneous clusters of features to serve as weak supervision for improved clustering of subjects, which is achieved by simultaneously clustering subjects and features via non-negative matrix trifactorization. In order to suppress noise, an adaptive regularization based on coefficient distribution modeling is introduced. The proposed approach is expected to be more effective and robust against noise. The proposed method is compared with the baseline techniques and recently published methods demonstrating superior clustering performance on synthetic data with known ground truth labels. Furthermore, the proposed technique is applied to magnetic resonance imaging (MRI) data from a cohort of patients with Parkinson's disease.

The computer-aided diagnosis of focal liver lesions (FLLs) can help improve workflow and enable correct diagnoses; FLL detection is the first step in such a computer- aided diagnosis. By introducing an attention-guided multi- phase alignment in feature space, the paper entitled "Robust End-to-End Focal Liver Lesion Detection Using Unregistered Multiphase Computed Tomography Images" by Lee et al. presents a fully automated, end-to-end learning framework for detecting FLLs from multiphase computed tomography (CT) images. The proposed method is robust to misaligned multiphase images owing to its complete learning-based approach, which reduces the sensitivity of the model's performance to the quality of registration and enables a standalone deployment of the model in clinical practice. Evaluation on a large-scale dataset with 280 patients confirmed that the proposed approach outperformed previous state-of-the-art methods and significantly reduced the performance degradation for detecting FLLs using misaligned multiphase CT images.

Distant metastasis (DM) is the leading cause of death in advanced lung cancer, which is diagnosed by positron emission tomography (PET) scanning. However, most existing methods only analyze tumor regions to extract local features for DM prediction, which neglects the rich whole- lung information. To alleviate this problem, the paper entitled "A Novel Deep Learning Framework Based Mask- Guided Attention Mechanism for Distant Metastasis Prediction of Lung Cancer" by Li et al. proposed a novel deep learning framework based mask-guided attention mechanism called Mask-Guided Two-stream Attention network (MGTA) for DM prediction, including a 3D pseudo-siamese feature pyramid network (PSFPN) to learn both global features in the whole lung and local features in tumor;

Date of current version 27 March 2023.
Digital Object Identifier 10.1109/TETCI.2023.3254840

and a deep cascaded attention module (DCAM) for further feature fusion. The proposed deep cascade attention module can effectively leverage the complementary multi-level features in PSFPN to enhance the feature recognition capacity of small tumors. Extensive experiments on a large-scale DM dataset including 2814 lung cancer patients show that the MGTA outperforms state-of-the-art lung cancer diagnosis methods and the commonly used tumor-based methods. Furthermore, the MGTA shows large improvement especially when the training data size is small.

Vein contraction and venous compression typically caused by low temperature and excessive placement pressure can blur the captured finger vein images and severely impair the quality of extracted features. To improve the quality of captured finger vein image, the paper entitled ”Finger Vein Image Deblurring Using Neighbors-Based Binary-GAN (NB-GAN)” by He et al. proposed a 26-layer generator network constrained by Neighbors-based Binary Patterns (NBP) texture loss to recover the clear image (guessing the original clear image). NBP texture loss is used for training the generator to enhance the deblurring ability of the network on images. Theoretical analysis and simulation results show that the proposed neighbors-based binary- GAN (NB-GAN) can achieve better deblurring performance than the the-state-of-the-art approaches.

M. TANVEER, *Guest Editor*
Department of Mathematics, Indian Institute of Technology Indore Simrol 453552, India

CHIN-TENG LIN, *Guest Editor*
Computational Intelligence and Brain Computer Interface Lab, University of Technology Sydney
Ultimo, NSW 2007, Australia

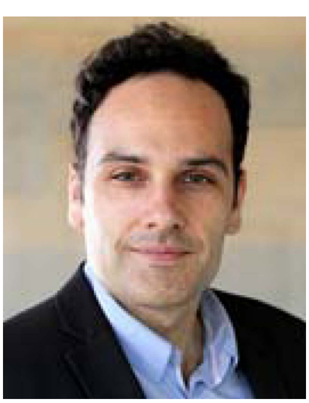
CHUAN-KANG TING, *Associate Editor*
Department of Power Mechanical Engineering, National Tsing Hua University
Hsinchu 300, Taiwan

JAVIER ANDREU-PEREZ, *Guest Editor*
School of Computer Science and Electronic Engineering, University of Essex
Colchester CO4 3SQ, U.K.

M. Tanveer (Senior Member, IEEE) received the Ph.D. degree in computer science from Jawaharlal Nehru University, New Delhi, India. He is currently an Associate Professor and Ramanujan Fellow with the Department of Mathematics, Indian Institute of Technology Indore, Indore, India. Prior to that, he was a Postdoctoral Research Fellow with the Rolls-Royce@NTU Corporate Lab, Nanyang Technological University, Singapore. He has authored or coauthored more than 120 referred journal papers of international repute. His publications have more than 3500 citations with H index 31 (Google Scholar, January 2023). His research interests include support vector machines, optimization, machine learning, deep learning, applications to Alzheimer’s disease and dementias. Recently, he has been listed in the world’s top 2% scientists in the study carried out by Stanford University, Stanford, CA, USA. He was on review boards for more than 100 scientific journals and served for scientific committees of various national and international conferences. He was the recipient of the 2022 Asia Pacific Neural Network Society Young Researcher Award, 2017 SERB-Early Career Research Award in Engineering Sciences and the only recipient of 2016 DST- Ramanujan Fellowship in Mathematical Sciences. He is also an Associate Editor for IEEE TRANSACTIONS ON NEURAL NETWORKS AND LEARNING SYSTEMS, Associate Editor of *Pattern Recognition*, Elsevier, Action Editor of *Neural Networks*, Elsevier, Board of Editors of *Engineering Applications of Artificial Intelligence*, Elsevier, Associate Editor of *Neurocomputing*, Elsevier, Associate Editor of *Cognitive Computation*, Springer, Editorial Board of *Applied Soft Computing*, Elsevier, Associate Editor of *International Journal of Machine Learning,* and *Cybernetics*, Springer. He has organized many international/national conferences/symposium/workshop as General Chair/Organizing Chair/Coordinator, and delivered talks as Keynote/Plenary/invited speaker in many international conferences and Symposiums. Amongst other distinguished, international conference chairing roles, he was the General Chair for 29th International Conference on Neural Information Processing (ICONIP2022). He has organized several special sessions in top-ranked conferences including WCCI, IJCNN, IEEE SMC, IEEE SSCI, ICONIP. He is the Principal Investigator (PI) or Co-PI of 12 major research projects funded by Government of India including DST, SERB, CSIR, MHRD-SPARC, ICMR.

Chin-Teng Lin (Fellow, IEEE) received the Bachelor of Science degree from the National Chiao-Tung University (NCTU), Hsinchu, Taiwan, in 1986, and the master's and Ph.D. degrees in electrical engineering from Purdue University, West Lafayette, IN, USA, in 1989 and 1992, respectively. He is currently a distinguished Professor and the Co-Director with the Australian Artificial Intelligence Institute, Faculty of Engineering and Information Technology, University of Technology Sydney, Ultimo NSW, Australia. He is also an Honorary Chair Professor of electrical and computer engineering with NCTU. Prof. Lin was the recipient of the Fellowship with the IEEE for his contributions to biologically inspired information systems in 2005, and with the International Fuzzy Systems Association (IFSA) in 2012, and IEEE Fuzzy Systems Pioneer Award in 2017. He has held notable positions as the Editor-in-Chief of IEEE TRANSACTIONS ON FUZZY SYSTEMS from 2011 to 2016, seats on Board of Governors for the IEEE Circuits and Systems (CAS) Society from 2005to 2008, IEEE Systems, Man, Cybernetics (SMC) Society from 2003 to 2005, IEEE Computational Intelligence Society from 2008 to 2010, Chair of the IEEE Taipei Section from 2009 to 2010, Chair of IEEE CIS Awards Committee from 2022 to 2023, Distinguished Lecturer with the IEEE CAS Society from 2003 to 2005, and the CIS Society from 2015 to 2017, Chair of the IEEE CIS Distinguished Lecturer Program Committee from 2018 to 2019, Deputy Editor- in-Chief of IEEE TRANSACTIONS ON CIRCUITS AND SYSTEMS-II from 2006 to 2008, Program Chair of the IEEE International Conference on Systems, Man, and Cybernetics in 2005, and General Chair of the 2011 IEEE International Conference on Fuzzy Systems. Prof. Lin is also the Co-author of *Neural Fuzzy Systems* (Prentice-Hall) and the author of *Neural Fuzzy Control Systems with Structure and Parameter Learning* (World Scientific). He has authored or coauthored more than 425 journal papers including about 200 IEEE journal papers in the areas of neural networks, fuzzy systems, brain- computer interface, multimedia information processing, cognitive neuro- engineering, and human-machine teaming, that have been cited more than 32000 times. His H-index is 87, and i10-index is 388.

Chuan-Kang Ting (Senior Member, IEEE) received the B.S. degree from the National Chiao Tung University, Hsinchu, Taiwan, in 1994, the M.S. degree from the National Tsing Hua University, Hsinchu, Taiwan, in 1996, and the Dr. rer. nat. degree in computer science from Paderborn University, Paderborn, Germany, in 2005. He is currently a Professor and the Chair with the Department of Power Mechanical Engineering, National Tsing Hua University, Hsinchu, Taiwan. His research interests include evolutionary computation, computational intelligence, memetic computing, machine learning, and their applications in manufacturing, ethics, music, and arts. Dr. Ting is also the Editor-in-Chief of *IEEE Computational Intelligence Magazine*, the Editor-in-Chief of *Memetic Computing*, Associate Editor for IEEE TRANSACTIONS ON EMERGING TOPICS IN COMPUTATIONAL INTELLIGENCE, and Editorial Board Member of *Soft Computing*. He was the IEEE Computational Intelligence Society (CIS) Newsletter Editor, IEEE CIS Webmaster, Chair of IEEE CIS Chapters Committee, and the Chair of IEEE CIS Creative Intelligence Task Force. He is an Executive Board Member of the Taiwanese Association for Artificial Intelligence.



Javier Andreu-Perez (Senior Member, IEEE) received the Ph.D. degree, in 2012. He is currently a Senior Lecturer and the Chair of the Centre for Computational Intelligence, Smart Health Technologies Group, University of Essex, Colchester, U.K. He has authored or coauthored his research in prestigious journals from IEEE, Nature, Springer, and Elsevier publishers, mostly in top artificial intelligence and neuroscience journals. His work in artificial intelligence and biomedical engineering has attracted nearly 3000 citations. His main expertise is in employing and developing novel artificial intelligence methods for neuro/bio-engineering and health informatics. His research interests include deep learning, fuzzy systems, and human-centered artificial intelligence, particularly developing novel methods focusing on trustworthy and explainable AI to work along with humans. He is also the primary investigator of projects funded by the U.K. research councils, international organizations, and corporations. He also contributes as an Associate Editor-in-Chief of the *Journal Neurocomputing* (Elsevier) and other editorials from other prestigious journals in computational intelligence and emerging technologies. He was the recipient of the several personal research awards (fellowships).