Guest Editorial: IEEE-BIBE 2017 Special Issue "Advances on Neuro-Informatics"

NEURO-INFORMATICS is one of the most attractive research fields for scientists, engineers, practitioners and physicians due to its profound importance in healthcare and in our lives. Human curiosity, the BRAIN project in USA with a very large funding budget, and the exponential evolution of computational informatics and nanotech during the last two decades have inspired and motivated many researchers around the globe to contribute with their research to the "last frontier," the brain. Fig. 1 briefly shows a hierarchy that associates brain (fMRI) images to neuro-images and molecular images [items 1)–3) in the Appendix]. It represents a framework on which researchers try to connect these layers to better understand the structure and functions of the human brain.

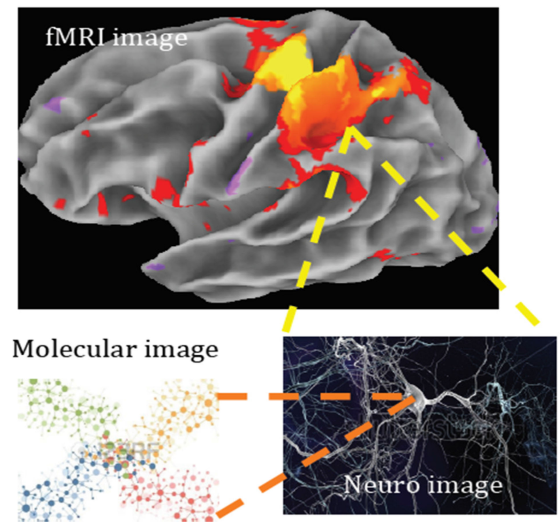

Fig. 1. Hierarchical association – from brain (fMRI) image to neuro-image and molecular image.

Although there are significant research efforts worldwide leading neuro and brain discoveries, more scientists are needed from different fields to provide new contributions that may lead faster to the desirable goals. The aim of this special issue is to motivate researchers and scientists to contribute to neuro-informatics and associated fields with state-of-the-art methodologies and devices addressing neuro and brain imaging (EEG, fMRI, PET, CT, other), brain functions (memory, learning, decision-making, emotion, consciousness) brain diseases (mental, deficiencies, diagnosis), and brain stimulation (implantable, micro-nano techniques) [item 4) in the Appendix], [item 5) in the Appendix].

The Special Issue on Neuro-Informatics is associated to IEEE BIBE-2017 Conference. The IEEE BIBE Conference series was created very early in the genomics revolution, with the mission to bring together the disruptive developments in the area of bioinformatics with the exciting field of bioengineering. Nearly two decades after BIBE's inception, this goal remains as elusive as ever.

The IEEE BIBE-2017 Conference received 150 full-paper submissions; after a thorough review process 90 papers were accepted to be presented at the Conference. Twenty one papers were invited for submission to the JBHI special issue. After rigorous peer evaluation, three papers - significantly extended versions beyond the original conference submissions - were accepted for publication in this special issue.

The first paper, "Aberrant brain connectivity in Schizophrenia detected via a fast Gaussian graphical model" by Zhang *et al.*, deals with schizophrenia (SZ), a chronic and severe mental disorder that affects how a person thinks, feels, and behaves [item 6) in the Appendix]. New developments in the fMRI field have enabled further exploration of brain connectivity and verified that SZ is related to disrupted brain connectivity. The authors adopt a novel high-dimensional Gaussian Graphical Model (GGM) – ψ-learning method, which can help ease computational burden while providing more accurate inference for underlying networks. The proposed method has been proven to be an equivalent measure of the partial correlation coefficient and thus is flexible for network comparison through statistical tests. The employed fMRI data were collected by the Mind Clinical Imaging Consortium (MCIC) from 92 SZ patients and 116 healthy controls during an auditory task. Network connectivity is studied at three different scales by using global measures, community structure, and edge-wise comparisons within the networks. Besides computational efficiency achieved by the ψ-learning method, the results reveal, at voxel resolution, sets of distinct aberrant patterns, which are supported by previous studies for SZ patients. Additionally, more precise local structures within regions of interest are identified, which are of biological significance for further investigation.

The second paper, "Binary Classification Using Neural and Clinical Features: An Application in Fibromyalgia with Likelihood based Decision Level Fusion" by Gokcay *et al.*, proposes a binary classification method, that merges small samples from multiple sites so that a large cohort which better describes the features of the disease can be built [item 7) in the Appendix]. The authors implemented a simple and robust framework for detection of fibromyalgia, using likelihood during decision level fusion. This framework supports sharing

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of classifier applications across clinical sites and arrives at a decision by fusing results from multiple classifiers. If there are missing opinions from some classifiers due to inability to collect their input features, such degradation in information is tolerated. They implemented this method using fNIRS data collected from fibromyalgia patients across three different tasks. Functional connectivity maps are derived from these tasks as features. In addition, self-reported clinical features are also used. Five classifiers are trained using kNN, LDA and SVM. Fusion of classification opinions from multiple classifiers based on log likelihood outperformed other fusion methods reported in the literature for detection of FM. When 2, 3, 4 and 5 classifiers are fused, sensitivity and specificity figures of 100% could be obtained based on the choice of the classifier set.

The third paper, entitled "Multi-level feature representation of FDG-PET brain images for diagnosing Alzheimer's disease" by Pan *et al.*, uses a single imaging modality (FDG-PET) to diagnose Alzheimer's Disease (AD) or Mild Cognitive Impairment (MCI) [item 8) in the Appendix]. The authors present a novel method based on a multi-level feature, which considers both region properties and connectivity between regions to discriminate AD or MCI from normal control subjects. First, post-processed FDG-PET images are segmented into 116 Regions of Interest according to an Automated Anatomical Labeling atlas. Next, three levels of features are extracted including: mean intensity and standard deviation of each region (in the first-level); connectivity between regions (second-level); graph-based features (third-level). Then, the second-level feature is decomposed into three different sets of features according to a proposed similarity-driven ranking method, which can not only reduce the feature dimension but also increase the classifier's diversity. Last, after feeding the three levels (or seven types) of features to seven classifiers, a new classifier selection strategy, maximum Mean squared error, is developed to select a pair of classifiers with high diversity. In order to implement majority voting, a decision-making scheme -a nested cross validation technique, is applied to choose another classifier according to the achieved accuracy. Experiments on Alzheimer's Disease Neuroimaging Initiative (ADNI) database show that the proposed method outperforms other FDG-PET-based classification algorithms, especially for classifying progressive MCI from stable MCI.

The guest editors of this special issue would like to thank the Program Committee of the IEEE BIBE-2017 Conference and the external reviewers for carefully reviewing all the submissions and offering detailed reports, thus making easier the guest editors' work to select high quality papers for the special issue. Moreover, we truly appreciate the authors' rigorous efforts to extensively enrich their conference papers and provide insightful scientific content for this special issue.

We also thank the Editor-in-Chief and the editorial staff of JBHI who made this special issue possible.

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APPENDIX
RELATED WORK

1) N. Bourbakis, "The next generation challenges in brain research: Connecting the dots," in *Tutorial 2010*. Baltimore, MD, USA: Neuroscience Dept., Nat. Inst. Aging, Mar. 2010.
2) K. Michalopoulos, M. Zervakis, M.-P. Deiber, and N. Bourbakis, "Classification of EEG single trial microstates using local global graphs and discrete hidden markov models," *Int. J. Neural Syst.*, vol. 26, no. 62016, Art. no. 1650036.
3) K. Michalopoulos and N. Bourbakis, "Combining EEG microstates with fMRI structural features for modeling brain activity," *Int. J. Neural Syst.*, vol. 25, no. 8, 2015, Art. no. 1550041.
4) K. P. Michmizos *et al.*, "Computational neuromodulation: Future challenges for deep brain stimulation," *IEEE Signal Process. Mag.*, vol. 34, no. 2, pp. 114–119, Mar. 2017.
5) A. Kiourti and K. S. Nikita, "A review of in-body biotelemetry devices: Impantables, ingestibles, and injectables," *IEEE Trans. Biomed. Eng.*, vol. 64, no. 7, pp. 1422–1430, Jul. 2017.
6) A. Zhang, J. Fang, F. Liang, V. D. Calhoun, and Y.-P. Wang, "Aberrant brain connectivity in Schizophrenia detected via a fast Gaussian graphical model," *IEEE J. Biom. Health Inform.*, to be published, doi: 10.1109/JBHI.2018.2854659.
7) D. Gokcay, A. Eken, S. Baltaci, "Binary classification using neural and clinical features: An application in fibromyalgia with likelihood based decision level fusion," *IEEE J. Biomed. Health Inform.*, to be published, doi: 10.1109/JBHI.2018.2844300.
8) X. Pan, M. Adel, C. Fossati, T. Gaidon and E. Guedj, "Multi-level feature representation of FDG-PET brain images for diagnosing Alzheimer's disease," *IEEE J. Biomed. Health Inform.*, to be published, doi: 10.1109/JBHI.2018.2857217.