Design of Features and Classifiers for Neuro-Psychiatric Disorders via Machine Learning

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Abstract: Reverse engineering the brain has been identified as one of the grand challenge problems by the National Academies. Advances in sensor technologies and imaging modalities such as (scalp) electroencephalogram (EEG), intra-cranial electroencephalogram (iEEG), magnetoencephalogram (MEG), and functional magnetic resonance imaging (MRI) allow us to collect data from hundreds of electrodes from the brain at sample rates ranging from 256 Hz to 15kHz. These data can be key to not only understanding brain functioning and brain connectivity at macro and micro levels in healthy subjects but also in identifying patients with neurological and mental disorders. Extracting the appropriate biomarkers using spectral-temporal-spatial signal processing approaches and classifying states using machine learning approaches can assist clinicians in predicting and detecting seizures in epileptic patients, and in identifying patients with mental disorders such as schizophrenia, depression and borderline personality disorder. The biomarkers can be tracked to design personalized therapy and effectiveness of therapy by closed loop drug delivery or closed loop neuromodulation, i.e., brain stimulation either by invasive or non-invasive means using electrical or magnetic stimulation. I will describe approaches that combine signal processing and machine learning to extract biomarkers for epilepsy, schizophrenia, borderline personality disorder, obsessive compulsive disorder and major depressive disorder.

Bio:

Keshab K. Parhi received the B.Tech. degree from the Indian Institute of Technology (IIT), Kharagpur, in 1982, the M.S.E.E. degree from the University of Pennsylvania, Philadelphia, in 1984, and the Ph.D. degree from the University of California, Berkeley, in 1988. He has been with the University of Minnesota, Minneapolis, since 1988, where he is currently Distinguished McKnight University Professor and Edgar F. Johnson Professor in the Department of Electrical and Computer Engineering. He has published over 600 papers, is the inventor of 29 patents, and has authored the textbook *VLSI Digital Signal Processing Systems* (Wiley, 1999) and coedited the reference book *Digital Signal Processing for Multimedia Systems* (Marcel Dekker, 1999). His current research addresses VLSI architecture design of signal processing systems, hardware security, data-driven neuroscience and molecular computing. Dr. Parhi is the recipient of numerous awards including the 2017 Mac Van Valkenburg award and the 2012 Charles A. Desoer Technical Achievement award from the IEEE Circuits and Systems Society, the 2004 F. E. Terman award from the American Society of Engineering Education, the 2003 IEEE Kiyo Tomiyasu Technical Field Award, the 2001 IEEE W. R. G. Baker prize paper award, and a Golden Jubilee medal from the IEEE Circuits and Systems Society in 2000. He was elected a Fellow of IEEE in 1996 and a Fellow of the AAAS in 2017.