Machine Learning Systems: Low-Energy VLSI Architectures and Applications

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Abstract

Machine learning and data analytics continue to expand the fourth industrial revolution and affect many aspects of our lives. This talk will explore machine learning applications in data-driven neuroscience, and low-energy implementations of machine learning systems. Data-driven neuroscience can exploit machine learning approaches including deep learning to generate hypotheses associated with biomarkers for specific neuro-psychiatric disorders. In the first part, I will talk about use of machine learning to find biomarkers for epilepsy and adolescent mental disorders such as borderline personality disorder (BPD), using electroencephalogram (EEG) and functional magnetic resonance imaging (fMRI), respectively. In the second part of the talk, I will talk about approaches for energy-efficient implementations for both traditional machine learning and deep learning systems. I will talk about the roles of feature ranking and incremental-precision approaches to reduce energy consumption of traditional machine learning systems. I will then talk about our recent work on Perm-DNN based on permuted-diagonal interconnections in deep convolutional neural networks and how structured sparsity can reduce energy consumption associated with memory access in these systems.

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 of Electronic Communication in the Department of Electrical and Computer Engineering. He has published over 645 papers, is the inventor of 30 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 machine learning systems, hardware security, data-driven neuroscience and molecular/DNA 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 1999. He served as the Editor-in-Chief of *the IEEE Trans. Circuits and Systems, Part-I* during 2004 and 2005. He was elected a Fellow of IEEE in 1996 and a Fellow of the American Association for Advancement of Science (AAAS) in 2017.