RRAM Devices for Data Storage and In-Memory Computing

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Abstract: Neural Networks (NNs) are now widely used in artificial intelligence (AI) applications. However, NNs often come with high computation and energy cost when implemented using existing hardware. In-memory computing (IMC) systems can potentially offer orders of magnitude improvements in energy consumption and throughput. In this talk I will discuss such systems based on an emerging device – resistive-random access memory (RRAM). An RRAM is a two-terminal electronic device with an inherent memory effect, driven by internal ion re-distribution within a solid-state switching medium. As a memory device, RRAM is being commercialized by several fabs for applications such as embedded memory and stand-alone data storage. They are also widely considered as a promising candidate for in-memory computing and neuromorphic computing hardware due to RRAM's ability to simultaneously store weights and process information at the same physical locations. Prototype RRAM-based IMC circuits can already perform tasks such as feature extraction, data clustering and image analysis by utilizing the efficient MAC operations offered by IMC circuits. Direct RRAM/CMOS integration further allows all functions to be implemented in an integrated chip and re-programmable for different tasks. Approaches towards a scalable IMC system will be introduced to address device non-idealities and accommodate practical AI models.

Wei D. Lu is a Professor in the Electrical Engineering and Computer Science department at the University of Michigan. He received B.S. in physics from Tsinghua University, Beijing, China, in 1996, and Ph.D. in physics from Rice University, Houston, TX in 2003. From 2003 to 2005, he was a postdoctoral research fellow at Harvard University, Cambridge, MA. He joined the faculty of the University of Michigan in 2005. His research interest includes resistive-random access memory (RRAM), RRAM/memristor-based in-memory computing and logic circuits, neuromorphic computing systems, aggressively scaled transistor devices, and electrical transport in low-dimensional systems. To date Prof. Lu has published over 200 journal and conference articles with 30,000 citations and h-factor of 78. He is a recipient of the NSF CAREER award, an IEEE Fellow, and co-founder of Crossbar Inc, and MemryX Inc.