Machine Learning for Semiconductor Device and Circuit Modeling

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Abstract: Machine learning (ML) algorithms and models are used extensively for image recognition, natural language processing, and recommender systems. EDA is a less mainstream application for ML methods, although that may be changing as evidenced by Google's recent announcement that its engineers developed a chip floor planning tool that utilizes reinforcement learning and which completes the placement task more quickly than human designers [Mirhoseini, *Nature*, 2021]. This tutorial focuses on one aspect of EDA – modeling

Optimization is a key element of every ML algorithm. Optimization is also used extensively in hardware modeling, e.g. compact modeling. Those observations may lead one to question how ML-enabled modeling differs from the modeling techniques used by device engineers. This tutorial will attempt to define the term machine learning and explore its commonalities with and differences from conventional physics-based modeling techniques.

The tutorial will focus on ML models that are especially suitable for device and circuit modeling. It will review prior works that applied ML to parameter extraction, TCAD, device modeling or circuit modeling. It is assumed that attendees have some familiarity with semiconductor device modeling (e.g. compact models, reliability models, noise models, etc.) and/or circuit simulation. No prior knowledge of machine learning is required.

Bio: Elyse Rosenbaum is the Melvin and Anne Louise Hassebrock Professor in Electrical and Computer Engineering at the University of Illinois at Urbana-Champaign. She received the Ph.D. degree in electrical engineering from University of California, Berkeley. She is the director of the NSF-supported Center for Advanced Electronics through Machine Learning (CAEML), a joint project of the University of Illinois, Georgia Tech and North Carolina State University. Her current research interests include machine-learning aided behavioral modeling of microelectronic components and systems, compact models, circuit reliability simulation, component and system-level ESD reliability, and ESD-robust high-speed I/O circuit design.

Dr. Rosenbaum has authored or co-authored about 200 technical papers; she has been an editor for *IEEE Transactions on Device and Materials Reliability* and *IEEE Transactions on Electron Devices.* She was the recipient of a Best Student Paper Award from the IEDM, Outstanding and Best Paper Awards from the EOS/ESD Symposium, a Technical Excellence Award from the SRC, an NSF CAREER award, an IBM Faculty Award, and the ESD Association's Industry Pioneer Recognition Award. She is a Fellow of the IEEE.