Machine Learning and Cognition-Driven Approaches to Microwave Design

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Abstract: Machine learning technologies have contributed to the phenomenal progress in computer-based vision, speech processing, control and more. In the microwave design automation area, the learning and generalization features of neural networks have provided a unique capability to address challenges in modeling and design. With significant progress in electromagnetic and device modeling, along with dramatic changes in the computing environment, high-fidelity electromagnetic/device modeling and optimization are now an essential part of RF/microwave design. However new design challenges continue to rise. Design requirements are becoming more stringent, components and circuits are becoming more complex, and frequency is getting higher. More sophistication in multi-physics modeling and design are becoming increasingly necessary. Meaningful design problems easily become computationally prohibitive.

In this talk, we explore the application of artificial neural networks and machine learning technologies for electromagnetic and nonlinear device modeling and optimization. We will highlight emerging directions of knowledge-based, cognition-driven design. Incorporating traditional design knowledge and engineering empirical equations into artificial neural networks, knowledge-based and machine-learning-based computational technologies are producing fine-grained modeling and design solutions for problems where no formulas are available. Deep neural networks solve nonlinear problems in higher dimensions. Neural networks are also formulated to provide instant solutions to microwave inverse modeling problems addressing the challenges of non-uniqueness in inverse modeling.

About the Speaker: Qi-jun Zhang received the B. Eng. Degree from Nanjing University of Science and Technology, Nanjing, China in 1982, and the Ph.D. Degree in Electrical Engineering from McMaster University, Hamilton, Canada, in 1987. He was a research engineer with Optimization Systems Associates Inc., Dundas, Ontario during 1988-1990, developing advanced commercial software for microwave optimization. He joined the Department of Electronics, Carleton University, Ottawa, Canada in 1990 where he is presently a Chancellor's Professor. He has served as the Chair of Department of Electronics during 2009-2011. On leave from Carleton University, he has also been with the School of Microelectronics, Tianjin University, Tianjin, China. His research interests are modeling, optimization, neural network and machine-learning technologies for high-speed/high-frequency electronic design, and has published over 300 papers in the area. He is an author of *Neural Networks for RF and Microwave Design* (Boston: Artech House, 2000), a coeditor of *Modeling and Simulation of High-Speed VLSI Interconnects* (Boston: Kluwer, 1994), a coeditor of *Simulation-Driven Design Optimization and Modeling for Microwave Engineering* (London: Imperial College Press, 2013), and an Associate Editor of IEEE Transactions on MTT. He is a founding executive of IEEE MTT society's annual conference on Numerical Electromagnetic/Multiphysics Modeling and Optimization (NEMO) and a General Chair of NEMO-2015. Dr. Zhang is the Chair of the Technical Committee on Design Automation (MTT-2) of the IEEE MTT Society. He is a Fellow of the IEEE, and a Fellow of the Canadian Academy of Engineering.