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SEMINAR

Bayesian Framework for Optimization of Structures in Microsystems Integration

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Abstract: Increasing complexity and higher integration of electronics leads to new challenges in system optimization. This is because modern systems contain structures with multi-scale geometries whose responses are determined by multi-physics simulations and often times contain components that are electromagnetically coupled. In practice, use of optimization algorithms in the design cycle of such systems is limited to fine tuning an already good design, which requires substantial human intervention and CPU time to arrive at an optimum solution. This is mainly due to lack of methods capable of handling high dimensionality while at the same time converging to the global optimum regardless of the initial point selection. In this talk, we present a Bayesian Framework that enables black-box optimization by making use of machine learning techniques. These methods start with zero training data and ensure convergence to the global optimum in the minimum amount of CPU time. They fall under the special category of active learning based machine learning.

The method presented uses a hierarchical partitioning tree combined with learning acquisition functions to separate the design space into fast exploration and detailed exploitation stages. To further reduce the computational overhead we propose the use of an additive Gaussian process as a predictive model since it helps in reducing the amount of training data required. We demonstrate the advantage of using these methods on several practical problems such as: 1) electrical-thermal optimization in 3DICs; 2) inductor optimization in integrated voltage regulators, 3) maximizing energy harvesting in wireless devices, 4) increasing the eye opening in high speed channels and 5) design of substrate integrated waveguides. The common bottleneck for all these problems is that they are of high dimensionality, require complex electromagnetic modeling, require the capturing of interactions between signal-power-thermal effects and are computationally expensive. We demonstrate the advantage of the methods developed by comparing it to well-known optimization techniques such as non-linear solver and particle swarm. In addition, the advantages gained as compared to available Bayesian based machine learning techniques will also be discussed.

Bio: Madhavan Swaminathan is the John Pippin Chair in Microsystems Packaging & Electromagnetics in the School of Electrical and Computer Engineering (ECE) and Founding Director of the Center for Co-Design of Chip, Package, System (C3PS), Georgia Tech. He formerly held the position of Joseph M. Pettit Professor in Electronics in ECE and Deputy Director of the NSF Microsystems Packaging Research Center, Georgia Tech. Prior to joining Georgia Tech, he was with IBM working on packaging for supercomputers. He is the author of 450+ refereed technical publications, holds 30 patents, primary author and co-editor of 3 books, founder and co-founder of two start-up companies and founder of the IEEE Conference Electrical Design of Advanced Packaging and Systems (EDAPS), a premier conference sponsored by the EPS society in the Asian region. His research work has been recognized through several awards including 22 best paper and best student paper awards and 2014 Outstanding Sustained Technical Contribution Award from IEEE EPS Society. He is an IEEE Fellow and has served as the Distinguished Lecturer for the IEEE EMC society. He received his MS/PhD degrees in Electrical Engineering from Syracuse University in 1989 and 1991, respectively.

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