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SenSIP Seminar Series

Enhancing Analysis of Cyberphysical Systems with Stochastic Optimization

Presenter: Giulia Pedrielli
Assistant Professor of Industrial Engineering
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Abstract

Technological advancement, including Artificial Intelligence, Advanced Learners, has led to the development of new classes of systems that pose new challenges for optimal design and control. In the area of control of Cyber Physical Systems (CPSs), stochastic optimization has started to attract increasing attentions. In fact, several next generation systems do not satisfy assumptions that allow to apply traditional methods to verify the stability/quality of the developed designs/control strategies. As a result, industries that are increasingly marketing CPSs (e.g., automotive, additive manufacturing) have a compelling need for new methods with provable guarantees about the quality and safety of the devices. The ability to formulate and prove probabilistic guarantees efficiently is replacing traditional analysis from formal theory.

In this talk, we refer at large to Stochastic Optimization methods, where the focus is on families of algorithms that deliberately inject randomness in the search process (whether or not the original dynamics is stochastic). We develop algorithms to be applied in the cases where, (1) there is no homogeneous dynamics of the systems, (2) high dimensions need to be considered (and they all matter!), and (3) we can construct clever approximations of the system behavior. Three new algorithms will be presented: (1) alternate local and global search to make use of local knowledge while exploring the space of possible solutions; (2) decompose the original problem and try to learn, from lower dimensional formulations, good guesses for the original problem; (3) use information coming from approximations of the original problem that are either very quick to evaluate or are easy to optimize over. The common aspect among the proposed methods show the promises to adapt to the information incrementally available from the sampling process. Specifically, the first approach uses the information dynamically gathered to define when local exploration should be stopped in favor of global search. The second method uses key information to adaptively modify the decomposition of the original space into new subspaces. Finally, the last method learns the relationship between the approximations and the original model to inform sampling decisions and choose the switching time from cheap approximations to expensive simulations. A key aspect of the developed methods is the ability to guarantee asymptotic performance, but also, and primarily due to the applications discussed, the promise to provide finite time guarantees.

Biography:

Giulia Pedrielli is currently an Assistant Professor of Industrial Engineering from the School of Computing Informatics System Design Systems Engineering at Arizona State University. She graduated from the Department of Mechanical Engineering of Politecnico di Milano. She develops her research in stochastic methods for performance evaluation and simulation based optimization of next generation cyber physical systems. She is focusing on real time control problems and how to extend simulation based algorithms for applications related to individualized cancer care, bio-manufacturing, design and control of self-assembled RNA structures, and unmanned vehicles control verification.

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