Electric Power and Power Electronics Institute

INVITED SEMINAR
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Data Analytics for Power Systems: Embedding Physical Laws and System Pattern into Learning

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Abstract

The emerging large-scale power system introduces unprecedented uncertainties and computational difficulty as new unconventional resources are deployed. In this talk, I will show how to use physical understanding and data pattern to improve the current state estimation process at aggregated level and how to improve baseline estimation in demand response for individual customers. I start by characterizing the performance of currently used state estimation, which is known to be non-convex and hard to solve exactly. An extended state space representation is found to be particularly useful to improve and evaluate state estimator. Then, an example of how to embed such representation into learning to further refine estimation accuracy is illustrated. To incorporate data, physical laws, and learning into a formal way, a graphical model description of power grid is subsequently proposed, which quantifies system stochastic property and embeds measurement equations. Under such a framework, distributed message passing with probabilistic estimate is achieved, leading to significant economic saving when comparing to traditional deterministic estimate. Further, when a highly accurate state estimate is required, the idea of adding redundancy for improving estimation is explored based on cleared and filtered historical data, where physical understanding is once again shown to play an important role. To implement this data-driven approach online, data analysis of power system was conducted. The key observation is that the periodic pattern of power system not only produces useful similar measurement-state pairs in the past, but also creates data clusters, showing great potential for inquiring data in a much lower dimensional space. Therefore, techniques such as dimension reduction and k-dimensional tree indexing are employed with 1000 times speedup in simulations with a highly accurate state estimate. Finally, besides state estimation at aggregated level, we talked about how to conduct estimation for individual customer by embedding data patterns in an automatic way.

Speakers Bio

Yang Weng is currently a postdoctoral scholar at Stanford University. He received a Ph.D. degree in Electrical and Computer Engineering and a M.S. degree in Machine Learning from Carnegie Mellon University. Before that, he received a M.S. Degree in Statistics from University of Illinois at Chicago. He received his Bachelor Degree in Electrical Engineering from Huazhong University of Science and Technology (HUST), China. His research interest is in the estimation and optimization of power system, especially the link behind physics and data. He won the Best Paper Award in 2012 International Conference on Smart Grid Communication. In 2013, his paper was ranked first at the same conference. In 2014, his paper is among Best Papers at IEEE Power and Energy Society General Meeting. His work was recognized by an ABB fellowship.