Imperial College London

Centre for Process Systems Engineering

UCL

2018 Seminar Series: New Frontiers in Systems Engineering

Prof. Fengqi You (Cornell University)

When Machine Learning Meets Robust Optimization: Data-driven Adaptive Robust Optimization Models, Algorithms & Applications

Abstract:
Data-driven decision-making uncertainty is an emerging paradigm that integrates model-based and data-driven systems for optimization under uncertainty. This organic integration of machine learning and mathematical programming leads to fundamentally more powerful and efficient data-driven optimization frameworks that close the loop between data analytics and decision support. In this presentation, we will introduce a data-driven adaptive robust optimization framework, which leverages Bayesian nonparametric methods to derive flexible data-driven uncertainty sets that were previously intractable for conventional robust optimization. The machine learning model is seamlessly integrated with adaptive robust optimization approach through a novel multi-level optimization framework, which explicitly accounts for the correlation, asymmetry and multimode of uncertainty data and automatically adjusts its complexity based on the data structure and complexity. The data-driven adaptive robust optimization framework is further extended to systematically and automatically handle labeled multi-class uncertainty data through a stochastic robust optimization approach with a bi-level structure. Tailored decomposition algorithms are further developed to solve the resulting multi-level optimization problem efficiently. Applications to real-time optimization, short-term scheduling of batch processes, strategic planning of process networks, and design of biomass processing network will be presented to demonstrate the applicability of the proposed frameworks.

Biography:
Fengqi You is the Roxanne E. and Michael J. Zak Professor at Cornell University, and is affiliated with Smith School of Chemical and Biomolecular Engineering, Operations Research and Information Engineering Field, Center of Applied Mathematics, and Systems Engineering Program. He served on the faculty of Northwestern University from 2011 to 2016, and worked at Argonne National Laboratory as an Argonne Scholar from 2009 to 2011. He has published more than 100 peer-reviewed articles in leading journals, and has an *h*-index of 43. Some of his research results have been editorially highlighted in *Nature*, featured on journal covers (e.g. *Energy & Environmental Science*, *ACS Sustainable Chemistry & Engineering*, and *Industrial & Engineering Chemistry Research*), and covered by major media outlets (e.g. *The New York Times*, *BBC*, *BusinessWeek*, and *National Geographic*). His recent awards include American Institute of Chemical Engineers (AIChE) W. David Smith, Jr. Publication Award (2011), Northwestern-Argonne Early Career Investigator Award (2013), National Science Foundation CAREER Award (2016), AIChE Environmental Division Early Career Award (2017), AIChE Sustainable Engineering Research Excellence Award (2017), and ACS Sustainable Chemistry & Engineering Lectureship Award (2018), as well as a number of best paper awards and most-cited article recognitions. He is currently an Associate Editor of *Computers & Chemical Engineering*, a Consulting Editor of *AIChE Journal*, and an editorial board member of several leading journals (e.g. *ACS Sustainable Chemistry & Engineering*). His research focuses on the development of novel computational models, optimization algorithms, statistical machine learning methods, and systems analysis tools for process manufacturing, smart agriculture, energy systems, and sustainability. For more information about his research group: www.peese.org

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