"Decomposition: Exploiting Structure in Chemical Systems to Solve Challenging Decision-Making Problems"

Wednesday
February 19, 2020
3:00 pm
Wu and Chen Auditorium
Levine Hall

Andrew Allman
Postdoctoral Associate
Chemical Engineering
University of Minnesota

Abstract

Computational optimal decision-making tools are essential for ensuring that systems are designed, operated, and controlled in an economic and sustainable manner. Using optimization to make decisions for chemical and energy systems is particularly challenging due to the inherent presence of nonlinear process physics, both integer and continuous decisions, uncertainties in important parameters, and multiple relevant time scales. This talk addresses the method of decomposition, which solves large, computationally challenging decision-making problems through a set of smaller, easier-to-solve subproblems. The first half of this talk addresses the problem of identifying smaller subproblems that make the large problem easy to solve. An algorithmic framework for automatically doing so using community detection, a concept from network theory, is presented. The superiority of using community-based decompositions to solve optimization problems, compared to other intuition-based decompositions, is showcased through an optimal model predictive control case study. The ability of the algorithm to identify subproblems when an intuitive decomposition does not exist is also demonstrated. The second part of the talk addresses the challenge of coordinating subproblems to arrive at a solution of the original problem. Here, a branch-and-price algorithm which can solve certain classes of nonconvex mixed integer nonlinear programs (the most challenging type of optimization problem to solve) to global optimality is presented. The applicability of this algorithm to many problems of chemical engineering interest, including process design under uncertainty, multiperiod capacity planning, dynamic facility location, and task assignment to process units, is demonstrated.

Bio

Andrew Allman is currently a postdoctoral associate at the University of Minnesota working in collaboration with Prof. Qi Zhang. Prior to this, he obtained his Ph.D. in Chemical Engineering from the University of Minnesota under the guidance of Prof. Prodromos Daoutidis in 2018 with a thesis entitled "Enabling distributed renewable energy and chemical production through process systems engineering," and his B.S. with high distinction in chemical engineering with a focus in energy and fuels from Penn State University in 2013. His honors include the 2018 AIChE Computing and Systems Technology Director's award for best student presentation, the 2019 FOCAPD Best Poster Contribution award, and two outstanding teaching assistant awards at the University of Minnesota. His research interests include developing theory and methods for the optimal design, control, planning, and scheduling of chemical and energy systems. He is particularly interested in applications in distributed manufacturing, sustainable water and energy usage, power to chemicals systems, and ammonia production.

Spring 2020 CBE Seminar Series

Penn Engineering