# Emerging Research in Industrial and Systems Engineering: Perspectives from PhD Students

This document highlights the abstracts and bios of three distinguished PhD students who will present their cutting-edge research in Industrial and Systems Engineering. The event serves as an opportunity to showcase diverse approaches to optimization, data science applications, and energy forecasting.

Speaker 1: Man Yiu (Tim) Tsang
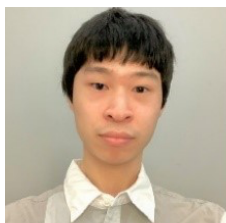
Title:

An Inexact Column-and-Constraint Generation Method to Solve Two-Stage Robust Optimization Problems

Abstract:

We propose a new inexact column-and-constraint generation (i-C&CG) method to solve general two-stage robust optimization problems. In contrast to the original C&CG method, i-C&CG allows solving potentially challenging master problems to a certain time limit or gap. Moreover, we equip i-C&CG with a backtracking routine that controls the trade-off between computational gains and inaccuracies from solving master problems inexactly. We derive theoretical guarantees on the finite convergence and the solution quality of i-C&CG. Finally, we conduct numerical experiments comparing the computational performance of i-C&CG and C&CG.

Bio:

Man Yiu (Tim) Tsang is a Ph.D. candidate in Industrial and Systems Engineering at Lehigh University under the supervision of Prof. Karmel S. Shehadeh. He obtained his BSc and MPhil in Risk Management Science from the Chinese University of Hong Kong. His methodological research interests and expertise center around data-driven stochastic optimization, which includes proposing and analyzing different uncertainty modeling paradigms and designing computationally efficient algorithms to solve large-scale stochastic optimization models. His primary application areas are financial risk management, healthcare operations research, and transportation systems. His research has been recognized with the Van Hoesen Family Best Publication Award (winner) and Junior Faculty Interest Group Paper Prize (finalist with advisor Karmel S. Shehadeh). He has been selected as one of the IISE Future Faculty Program Fellows for the 2023—2024.

Speaker 2: Yakun Wang

Title:

Inference in Higher-Order Undirected Graphical Models and Binary Polynomial Optimization

Abstract:

We consider the problem of inference in higher-order undirected graphical models with binary labels. We formulate this problem as a binary polynomial optimization problem and propose several linear programming relaxations for it. We compare the strength of the proposed linear programming relaxations theoretically. Finally, we demonstrate the effectiveness of these relaxations by performing a computational study for two important applications, namely, image restoration and decoding error-correcting codes.

Bio:

A third-year Ph.D. candidate in the Department of Industrial and Systems Engineering at Lehigh University, working with Prof. Aida Khajavirad. He received his MSc from Lehigh University and his BSc from Southwest Jiaotong University in China. His research interest lies in mixed-integer nonlinear optimization for data science applications.

Speaker 3: Feng Ye
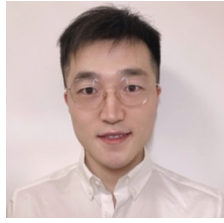
Title:

DeepMIDE: A Multivariate Spatio-Temporal Method for Ultra-Scale Offshore Wind Energy Forecasting

Abstract:

To unlock access to stronger winds, the offshore wind industry is advancing with significantly larger and taller wind turbines. This massive upscaling motivates a departure from univariate wind forecasting methods that traditionally focused on a single representative height. To fill this gap, we propose DeepMIDE—a statistical deep learning method which jointly models the offshore wind speeds across space, time, and height. DeepMIDE is formulated as a multi-output integro-difference equation model with a multivariate, nonstationary, and state-dependent kernel characterized by a set of advection vectors that encode the physics of wind field formation and propagation. Embedded within DeepMIDE, an advanced deep learning architecture learns these advection vectors from high-dimensional streams of exogenous weather information, which, along with other parameters, are plugged back into the statistical model for probabilistic multi-height space-time forecasting. Tested on real-world data from future offshore wind energy sites in the Northeastern United States, the wind speed and power forecasts from DeepMIDE are shown to outperform those from prevalent time series, spatio-temporal, and deep learning methods.

Bio:

Feng Ye is currently pursuing a Ph.D. in Industrial & Systems Engineering and has obtained a MSc in Statistics at Rutgers-New Brunswick. The overall topic of his research work is to develop statistical and machine learning methods to improve the forecasting, operations and maintenance (O&M) of offshore wind energy, with a particular focus on the wind energy areas in the U.S. Mid and North Atlantic. He is working closely with collaborators from the Rutgers University Center for Ocean Observing Leadership (RUCOOL) to develop a physics-informed data science model for wind energy forecasting. He is the winner of the QCRE Best Student Poster Competition at the 2024 IISE Annual Meeting, the Best Paper of the Energy Systems Track at the 2023 IISE Annual Meeting, and the Best Student Paper Competition of the Sustainability Track at the 2022 INFORMS Annual Meeting. He is also a recipient of the New Jersey Wind Institute Fellowship. Besides, Feng is an active member in INFORMS, IISE and IEEE.