Semester Program Workshop

Trends in Computational Discrete Optimization

Poster Session Abstracts

April 24, 2023

4:00 pm – 5:00 pm

Periodicity of Mixed Integer Programming Gap Functions

Rachael Alfant, Rice University

A critical measure of the quality of a mixed integer programming (MIP) model with fixed data is the difference, or gap, between the optimal objective value of the linear programming relaxation and that of the corresponding MIP. In many contexts, only an approximation of the right-hand side may be available, or there may be multiple right-hand sides of interest. Yet, there is currently no consensus on appropriate measures for MIP model quality over a range of right-hand sides. We provide conditions under which absolute MIP gap functions are periodic, as well as formulations of optimization problems that represent the expectation and extrema of absolute and relative MIP gap functions over finite discrete sets. Thus, we provide a framework by which to evaluate a MIP model's quality over multiple right-hand sides.

Enhancing classification and regression trees via mathematical optimization

Cristina Molero-Río, École Polytechnique

Contrary to classic classification and regression trees, built in a greedy heuristic manner, designing the tree model through an optimization problem allows us to easily include desirable properties in Machine Learning in addition to prediction accuracy. In this talk, we present a Continuous Optimization approach that is scalable with respect to the size of the training sample, and illustrate this flexibility to model several important issues in Explainable and Fair Machine Learning. These include sparsity, as a proxy for interpretability, by reducing the amount of information necessary to predict well; fairness, by aiming to avoid predictions that discriminate against sensitive features such as gender or race; the cost-sensitivity for groups of individuals in which prediction errors are more critical, such as patients of a disease, by ensuring an acceptable accuracy performance for them; local explainability, where the goal is to identify the predictor variables that have the largest impact on the individual predictions; as well as data complexity in the form of observations of functional nature. The performance of our approach is illustrated on real and synthetic data sets.

An analysis of alternative perspective reformulations for piecewise-convex optimization

Renan Spencer Trindade, École Polytechnique, France

Our research focuses on mixed integer nonlinear programming problems (MINLP) in which all nonconvex functions are univariable and separable. We employ the Sequential Convex MINLP technique to solve this class of problems to obtain a global optimal solution.
This method uses piecewise linear relaxation, where only the concave parts are replaced by linear functions. In contrast, the convex intervals are handled by generating cut planes using the perspective cuts.
This work presents a comprehensive theoretical and computational analysis of the different possible reformulations to the original problem.
We show and demonstrate that while they are equivalent in the case of purely linear problems, they are not equivalent when considering nonlinear convex intervals.

Pre-trained Solution Methods for Unit Commitment

Nagisa Sugishita, the University of Edinburgh

This study aims to improve the solution methods for the unit commitment problem, a short-term planning problem in the energy industry. In particular, we focus on Dantzig-Wolfe decomposition with a regularised column generation procedure.

Firstly, initialisation methods of the column generation procedure based on machine learning techniques are studied. After offline training, for each unit commitment problem, the method outputs dual values which can be used to warmstart the solution method, leading to a significant saving of computational time.

Secondly, the column generation procedure is extended to handle incremental generation of columns. Instead of generating columns for all the components in each iteration, our method generates a subset of them and updates the dual variable using the partially updated restricted master problem. Convergence analysis of the method is given under various conditions.

These enhancements are tested on large-scale test instances.

Computation and Certification of Ramsey-type Numbers

Jack Wesley, UC Davis

Given a linear equation E and positive integer k, the k-color Rado number R_k(E) is the smallest number n such that every k-coloring of {1,2,...,n} contains a monochromatic solution to E. For positive integers r and s, the classical Ramsey number is the smallest n such that every edge 2-coloring of the edges of K_n contains either a clique of size r in the first color or a clique of size s in the second color. Both of these numbers are extremely difficult to compute in general. We study how to compute these numbers and certify their values using Boolean formulas and algebraic geometry.