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Ph.D. DISSERTATION DEFENSE

Candidate: Yunxuan Yi
Degree: Doctor of Philosophy
School/Department: Charles V. Schaefer, Jr. School of Engineering and Science, Department of Mathematical Sciences

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Title: Sequential stochastic dominance and approximations in optimization

Chairperson: Darinka Dentcheva, Advisor (Department of Mathematical Sciences)

Committee Members:

Xiaohu Li (Department of Mathematical Sciences)
Kathrin Smetana (Mathematical Sciences)
Jia Xu (Department of Computer Sciences)
Andrzej Ruszczynski (Rutgers University, RBS)

ABSTRACT

Stochastic orders provide a way to compare random variables and offer an alternative to risk measures for modeling risk preferences in optimization problems. While optimization with stochastic order constraints has been widely studied in two-stage settings, relatively little attention has been given to the multi-stage case. This dissertation focuses on the analysis and improvement of multi-stage optimization problems under stochastic order constraints.

In the multi-stage setting, a time-consistent sequential stochastic order must be defined for comparing random sequences. Optimality conditions have been analyzed through utility functions. An augmented multi-cut method is proposed to address the resulting optimization problem.

A key challenge lies in selecting a benchmark representing an acceptable distribution. Frequently, the selected benchmarks lead to optimization problems that are infeasible or the order constraint is inactive. To address this issue, we propose a relaxation based on the Monge-Kantorovich transportation distance that guarantees feasibility for any choice of benchmark random variables. Instead of requiring a strong stochastic dominance relationship between the target variable and the benchmark, we measure the distance from the target variable to the acceptance set defined by the benchmark. Two explicit characterizations of the resulting penalty term is derived and expressed through the Lorenz functions and the expected shortfall functions involved.

A multi-cut method is developed and tested on relaxations of two-stage stochastic optimization problems with a constraint on the recourse function. The numerical results illustrate the effectiveness of the proposed relaxation.