Workshop on Mathematical Optimization

by

Dr. Manish Bansal

LECTURE DETAILS

Prerequisites
Basic knowledge of linear algebra, probability & statistics, and convex analysis

LECTURE 1
Deterministic Integer Programs: Modeling and Algorithms

LECTURE 2
Stochastic Integer Programs

LECTURES 3 AND 4
Distributionally Robust Programs, Stackelberg Games and Network Interdiction Problems under Uncertainty

This workshop will present several mathematical optimization tools that can be utilized to address various real-world optimization problems across domains such as power systems, healthcare, aerospace structures, and inventory management. The session will begin with an introduction to integer programming, a powerful method for formulating and solving combinatorial optimization problems. Since solving integer programs with large-scale deterministic data can be computationally expensive, cutting plane-based approaches and dynamic programming methods for certain classes of problems will also be discussed. In many applications, strategic long-term planning decisions, such as locating warehouses, emergency healthcare or evacuation centers, need to be made under uncertain input data parameters. To address uncertainty in optimization problems, stochastic, robust, and distributionally robust programming approaches have gained significant attention in both research and industry. The workshop will highlight the advantages of these modeling frameworks and present algorithms for solving them, along with challenges and possible solutions. For network resilience, vulnerability analysis plays a crucial role for decision-makers. A unique aspect of this analysis is dealing with limited historical data for events such as natural disasters and cyber/physical attacks, combined with varying risk appetites of decision-makers. The workshop will introduce distributionally ambiguous interdiction problems, characterized as Stackelberg games played between two non-cooperative players, and will explore how these problems can be addressed.

About the Author

Dr. Manish Bansal is an Associate Professor, Grado Early Career Faculty Fellow, and Operations Research Program Area Lead with Grado Department of Industrial and Systems Engineering at Virginia Tech. He did bachelor's in electrical engineering from National Institute of Technology in India, and M.S. with thesis and Ph.D. from Department of Industrial and Systems Engineering at Texas A&M University. Prior to joining Virginia Tech, he was a postdoctoral fellow in the Department of Industrial Engineering and Management Sciences at Northwestern University. His research is focused on the theory of mixed integer programming, stochastic and distributionally ambiguous optimization, game theory, and location science along with their applications in logistics and supply chain management. He has received multiple grants from the National Science Foundation, Department of Defense, Automotive Research Center at University of Michigan Ann Arbor, and Commonwealth Cyber Initiatives. He has published papers in journals such as Discrete Applied Mathematics, SIAM Journal on Optimization, Journal on Global Optimization, and Mathematical Programming, among others. Dr. Bansal has served as president of INFORMS Junior Faculty Interest Group and Engineering Faculty Organization at Virginia Tech, and currently, he is a senator in the faculty senate of Virginia Tech. He is also an affiliate faculty with the National Security Institute, and Center for AI and Data Analytics at Virginia Tech.