ELECTRICAL & COMPUTER ENGINEERING RESEARCH SEMINAR Fall 2019

Copositive Programming Approaches for Robust Optimization and Löwner-John Ellipsoid Problems

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Abstract: In this talk, we study copositive programming reformulations of two intractable optimization problems. We first study the robust quadratic programs where the uncertain problem parameters can comprise both continuous and integer components. Under the natural boundedness assumption on the uncertainty set, we show that these problems are amenable to exact copositive programming reformulations of polynomial size. The emerging convex optimization problems are NP-hard but admit a conservative semidefinite programming (SDP) approximation that can be solved efficiently. We prove that this approximation is stronger than the popular S-Procedure for problem instances with only continuous uncertainty. We also show that all results can be extended to the two-stage robust optimization setting if the problem has complete recourse. We assess the effectiveness of our proposed SDP reformulations and demonstrate their superiority over the state-of-the-art solution schemes on least squares, project management, and multi-item newsvendor problems. Next, we study the problem of finding the Löwner-John ellipsoid, i.e., an ellipsoid with minimum volume that contains a given convex set. We reformulate the problem as a generalized copositive program, and use that reformulation to derive tractable SDP approximations for instances where the set is defined by affine and quadratic inequalities. We prove that our method always provides an ellipsoid of same or lower volume than the one obtained by scaling the maximum volume inscribed ellipsoid, as well as the one provided by the application of the S-procedure. We provide empirical comparisons with the exact solution scheme, as well as the other state-of-the-art approximation schemes. We apply our method to find ellipsoidal approximations to the set of reachable states in a linear dynamical system when the control set is a polytope.

Biography: Grani A. Hanasusanto is an Assistant Professor of Operations Research and Industrial

Engineering at The University of Texas at Austin (UT). Before joining UT, he was a postdoctoral researcher at the College of Management of Technology at École Polytechnique Fédérale de Lausanne. He holds a PhD degree in Operations Research from Imperial College London and an MSc degree in Financial Engineering from the National University of Singapore. He is the recipient of the 2018 NSF CAREER Award. His research focuses on the design and analysis of tractable solution schemes for decision-making problems under uncertainty, with applications in operations management, energy systems, machine learning and data analytics.