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Estimation and Prediction Procedures for Unified Robust Decision Models

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Over the past two decades, robust optimization techniques have efficiently addressed decision problems under uncertainty, offering high assurance of feasibility without being overly conservative. However, research on estimating parameters for these robust decision models from data has been lacking. In this paper, we focus on a unified framework for robust decision models that integrate robust optimization and robust satisficing paradigms. In particular, we identify two layers of uncertainty: outcome uncertainty, involving deviations from specified inputs based on historical data, and estimation uncertainty, addressing deviations from latent input vectors, such as the unobservable true mean. We introduce estimation and prediction procedures tailored to reduce conservativeness while enhancing feasibility within this unified robust decision framework. The concept of minimum volume confidence set is introduced, which minimizes the size of the outcome confidence set while considering the likelihood of infeasibility, thereby improving the precision of uncertainty characterization. This method also accommodates asymmetric uncertainty by adjusting the confidence set accordingly. Additionally, our framework incorporates an affine predictive model that leverages side information to improve input vector predictions, seamlessly integrating into robust decision models. Our method has been implemented in the algebraic modeling toolbox, RSOME, facilitating practical applications.

Bio: Dr Melvyn Sim is Professor in the Department of Analytics and Operations (DAO) at the National University of Singapore (NUS) Business School. His research interests broadly encompass decision-making and optimisation under uncertainty, with applications in finance, supply chain management, healthcare, and engineered systems. He currently serves as a Department Editor for Management Science and Operations Management (MSOM).