Title:
From affine to threshold policies: a new framework in dynamic robust optimization

Abstract:
In many sequential decision problems, uncertainty is revealed over time and we need to make decisions in the face of uncertainty. This is a fundamental problem arising in many applications such as facility location, resource allocation and capacity planning under demand uncertainty. Robust optimization is an approach to model uncertainty where we optimize over the worst-case realization of parameters within an uncertainty set. While computing an optimal solution in dynamic robust optimization is usually intractable, affine policies (or linear decision rules) are widely used as an approximate solution approach. However, there is a stark contrast between the observed good empirical performance and the bad worst-case theoretical performance bounds. In this talk, we address this stark contrast between theory and practice. We introduce a probabilistic approach to analyze the performance of affine policies on randomly generated instances and show they are near-optimal with high probability under reasonable assumptions. We also study these policies under important models of uncertainty such as budget of uncertainty sets and show that affine policies give an optimal approximation matching the hardness of approximation. Furthermore, based on insights from this analysis, we design new tractable policies for dynamic robust optimization, namely piecewise affine and threshold policies, that are scalable and improve significantly over affine policies in many settings.

Relevant papers:

On the optimality of affine policies for budgeted uncertainty sets (MOR 2019)
Beyond worst-case: a probabilistic analysis of affine policies in Dynamic Optimization (NeurIPS 2017/under review in OR)