Approaches to Risk in Optimization Under Uncertainty

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Abstract. Decisions often need to be made before all the facts are in. A facility must be built to withstand storms, floods, or earthquakes of magnitudes that can only be guessed at from historical records. A portfolio must be purchased in the face of only statistical knowledge, at best, about how markets will perform. In optimization, this implies that constraints may need to be envisioned in terms of safety margins instead of exact requirements. But what does that really mean in model formulation? What guidelines make sense, and what are the consequences for optimization structure and computation?

The notion of a coherent measure of risk, in terms of surrogates for "potential loss" in a probability framework, has been developed in recent years for applications in financial engineering. But it holds promise for a far wider range of applications in which the traditional approaches to uncertainty have been subject to criticism.

In these lectures, the general ideas and main facts will be laid out along with some background in optimization and especially the role of convex analysis. Connections will also be made with stochastic dominance and the pros and cons of utility theory in decision making. Ideas related to generalized statistics will be brought in as well.