**Rare Chance Constrained Optimization: Controlling Cascading Failures**

Cascading failures are the central cause of blackouts in power transmission systems. Their rare occurrence, however, implies that preventing them during system operation (e.g., generation dispatch) requires solving optimization problems constrained by probabilities of rare, yet high-impact, events. Classical solution methods for such problems entail severe sampling and computational requirements that render them impractical. This talk will introduce a novel sampling-free method (using tools from large deviation theory, convex analysis, and numerical linear algebra) for solving rare chance constrained optimization problems under Gaussian mixture distributions, and illustrate its application to cascading failure control in nonconvex optimal power flow models. Time permitting, we illustrate its applicability to linear, nonlinear and PDE-constrained problems from other application domains as well. This is joint work with Mihai Anitescu (Argonne and University of Chicago), Vishwas Rao (Argonne), Jacob Roth (University of Minnesota), and Shanyin Tong (New York University).