Scenario-Based Financial Value-at-Risk Optimization

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Abstract

Simulation and optimization are tools and techniques to model, evaluate, hedge and optimally re-balance portfolios of financial instruments. The main challenge of practical financial models is minimizing risk in the presence of uncertainty. The primary goal of simulation is to model uncertainty in asset values over time. Optimization techniques help to minimize risk and maximize performance of financial portfolios.

In financial risk management Value-at-Risk (VaR) is a popular tail-based risk measure which forms the basis for regulatory capital according to Basel II and III Accords. The problem is that VaR is a quantile of the loss distribution, which is a chance-constrained problem. Since the loss distribution is typically unknown or computationally impractical, VaR optimization usually uses a finite sample approximation to the distribution by means of scenarios, so that an estimate of the VaR over a sample scenario set is optimized. This requires mixed-integer optimization, which makes the problem difficult. To improve solution time, different heuristic techniques can be used during optimization. We develop and test heuristic algorithms for scenario-based VaR optimization. Due to high computational complexity of VaR optimization, we utilize Conditional Value-at-Risk (CVaR) - based proxies for VaR objectives and constraints. Our heuristic algorithm allows obtaining robust results with low computational complexity.