Scenario trees vs. Scenario Lattices in Stochastic Optimization

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Scenario lattices are natural discretizations of Markov processes and can be used to formulate discrete time Markov decision processes. While lattices are a much more efficient representation of Markov processes than the more commonly used scenario trees, solving a stochastic dynamic decision problem based on a scenario lattice requires the use of decomposition algorithms such as Approximate Dual Dynamic Programming (ADDP). We compare the out-of-sample performance of scenario tree based approaches from the extant literature and scenario lattice based ADDP on a range of typical stochastic optimization problems. In order to conduct this study, we create a framework for such comparisons and argue why this framework allows us to make a definite statement about the relative performance of both methods.

We find that ADDP consistently outperforms tree based policies, especially in high-dimensional problem instances with a large number of decision epochs and/or a large amount of random variables involved. Moreover, we use statistical testing methods to show that there is a significant difference in distributions of out-of-sample payoffs between those generated by a tree-based policy as compared to those generated by a lattice-based policy using Approximate Dual Dynamic Programming. We conclude that there is strong empirical evidence suggesting that the usage of lattice-based discretization together with the ADDP method provides the decision-maker with clear advantages.

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