A Stability Result for Linear Markov Decision Processes

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The approximation of stochastic processes is an important topic in multistage stochastic optimization. In this paper we focus on the approximation of Markov processes by lattices. We measure the quality of the approximation by a distance between Markov processes.

To this end, we introduce a semi-metric for Markov processes that allows to bound optimal values of linear Markov Decision Processes (MDPs). Similarly to existing notions of distance for general stochastic processes our distance is based on transportation metrics. We take into account the effect of the information, which, in contrast to similar approaches for general stochastic processes, includes only the last state and not the whole history of the process. Apart from the specialization to MDPs, our contribution is to make the distance problem specific, i.e., explicitly dependent on the data of the problem whose objective value we want to bound. As a result, we are able to consider problems with randomness in the constraints as well as in the objective function and therefore relax an assumption in the extant literature. We compare our distance for lattices with approach presented in [1], where the distance between trees was considered and demonstrate its use in a stylized numerical example.

Finally we present an algorithm for the generation of scenario lattice for multistage stochastic optimization. Similarly to approach presented in [2] the structure of the lattice is not predetermined, but dynamically adapted to meet the distance criterion which insures the quality of the approximation.

References

[1] G.Ch. Pflug, A. Pichler, *A distance for multistage stochastic optimization models*, SIAM J. Optim. 22(1), 1-23 (2012). DOI: 10.1137/110825054

[2] G.Ch. Pflug, A. Pichler, *Dynamic generation of scenario trees*, Computational Optimization and Applications 62(3), 641-668 (2015). DOI: 10.1007/s10589-015-9758-0