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Optimization under Uncertainty via Tractable Probabilistic Models

Optimization under uncertainty often relies on sampling the uncertainty to evaluate some expectations or to work with probability constraints. As the dimension of the random variable grows, the applicability of this approach diminishes, as achieving non-trivial precision through sampling may require too many samples to be practical.
We propose an alternative approach, where the probability distributions are represented by tractable probabilistic models (TPM). By formulating the inference within a trained probabilistic model with integer linear constraints, we can utilize the TPM probabilistic constraints of a stochastic (integer) optimization problem. Following a recent mixed-integer linear formulation approximating a sum-product network (same authors, ICLR 2025), we generalize the work to the domain of stochastic optimization. We provide computational experiments to evaluate the efficacy, compare the proposed method to other stochastic optimization methods, and summarize the advantages of either approach.

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