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SEMINAR

A Neural Network-Based Distributional Constraint Learning Methodology for Mixed-Integer Stochastic Optimization

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The use of machine learning methods helps to improve decision making in different fields. In particular, the idea of bridging predictions (machine learning models) and prescriptions (optimization problems) is gaining attention within the scientific community. One of the main ideas to address this trade-off is the so-called Constraint Learning (CL) methodology, where the structures of the machine learning model can be treated as a set of constraints to be embedded within the optimization problem, establishing the relationship between a direct decision variable x and a response variable y. However, most CL approaches have focused on making point predictions for a certain variable, not taking into account the statistical and external uncertainty faced in the modeling process. In this paper, we extend the CL methodology to deal with uncertainty in the response variable y. The novel Distributional Constraint Learning (DCL) methodology makes use of a piece-wise linearizable neural network-based model to estimate the parameters of the conditional distribution of y (dependent on decisions x and contextual information), which can be embedded within mixed-integer optimization problems. In particular, we formulate a stochastic optimization problem by sampling random values from the estimated distribution by using a linear set of constraints. In this sense, DCL combines both the high predictive performance of the neural network method and the possibility of generating scenarios to account for uncertainty within a tractable optimization model. The behavior of the proposed methodology is tested in a real-world problem in the context of electricity systems, where a Virtual Power Plant seeks to optimize its operation, subject to different forms of uncertainty, and with price-responsive consumers.

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