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Solving influence diagrams with MILPs - Recent advances and future directions

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An influence diagram is a graph representation of a decision problem that models interdependencies between random events, consequences, and decisions. Recently, two frameworks have been developed to find the optimal decision strategy by transforming the influence diagram into a mixed-integer linear program (MILP). Decision programming (Salo et al., EJOR 299/2, 2022) directly translates the influence diagram into a MILP model, resulting in an exponential number of constraints and variables with respect to the number of nodes in the influence diagram. In contrast, the rooted junction tree framework (Parmentier et al., Informs Journal on Optimization, 2/3, 2020) performs an additional clustering step for the influence diagram before formulating the MILP model. Compared to traditional solution methods, these frameworks offer enormous flexibility in what they can represent through simple modifications to the objective function and constraints. In this presentation, we discuss recent developments related to these frameworks, including new and more efficient reformulations and added modeling flexibility for finding risk-averse decision strategies for influence diagrams. We conclude by presenting our future aspirations for these frameworks to increase the modeling flexibility of influence diagrams as a general framework for structuring and solving sequential decision-making problems involving uncertainty.

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