A General Method for Deriving Tight Symbolic Bounds on Causal Effects

 Abstract
A causal query will commonly not be identifiable from observed data, in which case no estimator of the query can be contrived without further assumptions or measured variables, regardless of the amount or precision of the measurements of observed variables. However, it may still be possible to derive symbolic bounds on the query in terms of the distribution of observed variables. Bounds, numeric or symbolic, can often be more valuable than a statistical estimator derived under implausible assumptions. Symbolic bounds, however, provide a measure of uncertainty and information loss due to the lack of an identifiable estimand even in the absence of data. We develop and describe a general approach for computation of symbolic bounds and characterize a class of settings in which our method is guaranteed to provide tight valid bounds. This expands the known settings in which tight causal bounds are solutions to linear programs to include multicategorical variables, cross-world nested counterfactuals queries, and missing data problems.