



Minimal enumeration of all possible total effects in a Markov equivalence class

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Abstract:

In observational studies, when a total causal effect of interest is not identified, the set of all possible effects can be reported instead. This typically occurs when the underlying causal directed acyclic graph (DAG) is only known up to a Markov equivalence class, or a refinement thereof due to background knowledge. As such, the class of possible causal DAGs is represented by a maximally oriented partially directed acyclic graph (MPDAG), which contains both directed and undirected edges. We characterize the minimal additional edge orientations required to identify a given total effect. A recursive algorithm is then developed to enumerate subclasses of DAGs, such that the total effect in each subclass is identified as a distinct functional of the observed distribution. This resolves an issue with existing methods, which often report possible total effects with duplicates, namely those that are numerically distinct due to sampling variability but are in fact causally identical.

Keywords:

causal inference; causal identification; total effects; Markov equivalence class;