

Graphical tools for selecting efficient conditional instrumental sets

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The two-stage least squares (2SLS) estimator is a popular tool for total causal effect estimation in the presence of unmeasured or latent confounding. It is well known that the 2SLS estimator is only consistent if the covariates used to compute it are appropriately chosen, in which case we refer to them as a conditional instrumental set. The choice of conditional instrumental set also impacts the estimator's asymptotic variance.

In this talk we consider the problem of how to choose conditional instrumental sets to obtain a 2SLS estimator that is not just consistent but also efficient. We do so in the setting of a Gaussian causal linear model described by a known acyclic directed mixed graph. We derive a graphical criterion that allows for qualitative asymptotic variance comparisons between certain pairs of conditional instrumental sets and gives interesting insights. Building on this we provide two easy to use graphical tools for efficient conditional instrumental set selection. First, a greedy asymptotic variance decreasing growth procedure that can be applied to any conditional instrumental set and relies only on validity checks. Second, we show that a graphically identifiable asymptotically optimal set does not exist in general. Instead we provide a conditional instrumental set guaranteed to be as close to optimal as it possible with graphical information alone; a property we refer to as graphical optimality. In particular this set is asymptotically optimal whenever a graphically identifiable asymptotically optimal set exists.