Posterior-Predictive Treatment Assignments and the Estimation of Causal Effects

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Abstract

Estimating causal effects with propensity scores relies upon the availability of treated and untreated units observed at each value of the estimated propensity score. Lack of so-called "overlap" in propensity score distributions can undermine the empirical basis for estimating causal effects. We propose a Bayesian procedure designed to estimate causal effects in settings where there is limited overlap in propensity score distributions. Our method relies on the posterior predictive treatment assignment (PPTA), a quantity that is derived from the propensity score but serves different role in estimation of causal effects. We use the PPTA to estimate causal effects by marginalizing over the uncertainty in whether each observation is a member of an unknown subset for which treatment assignment can be assumed unconfounded. The resulting posterior distribution depends on the empirical basis for estimating a causal effect for each observation. We show that the PPTA approach can be construed as a stochastic version of existing ad-hoc approaches such as pruning based on the propensity score or truncation of inverse probability of treatment weights, and highlight several practical advantages including uncertainty quantification and improved finite-sample performance. We illustrate by estimating the causal health impacts of an air quality regulatory program on Medicare mortality.