JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Department of Biostatistics

BIOSTATISTICS SEMINAR

Permutation Weighting: A Classification-based Approach to Balancing Weights

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Abstract:

This work provides a new lens through which to view balancing weights for observational causal inference as approximating a notional target trial. We formalize this intuition and show that our approach -- Permutation Weighting -- provides a new way to estimate many existing balancing weights. This allows the estimation of weights through a standard binary classifier (no matter the cardinality of treatment). Arbitrary probabilistic classifiers may be used in this method; the hypothesis space of the classifier corresponds to the nature of the balance constraints imposed through the resulting weights. We provide theoretical results which bound bias and variance in terms of the regret of the classifier, show that these disappear asymptotically and demonstrate that our classification problem directly minimizes imbalance. Since a wide variety of existing methods may be estimated through this regime, the approach allows for direct model comparison between balancing weights (both existing methods and new ones) based on classifier loss as well as hyper-parameter tuning using cross-validation. We compare estimating weights with permutation weighting to minimizing the classifier risk of a propensity score model for inverse propensity score weighting and show that the latter does not necessarily imply minimal imbalance on covariates. Finally, we demonstrate how the classification-based view provides a flexible mechanism to define new balancing weights; we demonstrate this with balancing weights based on gradient-boosted decision trees and neural networks. Simulation and empirical evaluations indicate that permutation weighting outperforms existing weighting methods for causal effect estimation.

Imposed through the resulting weights. Since a wide variety of existing methods may be estimated through this regime, the approach allows for direct model comparison between balancing weights (both existing methods and new ones) based on classifier loss as well as hyper-parameter tuning using cross-validation.

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