Causal mediation analysis in presence of multiple mediators uncausally related

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Abstract

Mediation analysis aims at disentangling the effects of a treatment on an outcome through alternative causal mechanisms and has become a popular practice in biomedical and social science applications. The causal framework based on counterfactuals is currently the standard approach to mediation, with important methodological advances introduced in the literature in the last decade, especially for simple mediation, that is with one mediator at the time. Among a variety of alternative approaches, K. Imai et al. showed theoretical results and developed an R package to deal with simple mediation as well as with multiple mediation involving multiple mediators conditionally independent given the treatment and baseline covariates. This approach does not allow to consider the often encountered situation in which an unobserved common cause induces a spurious correlation between the mediators. In this context, which we refer to as mediation with uncausally related mediators, we show that, under appropriate hypothesis, the natural direct and joint indirect effects are non-parametrically identifiable. Moreover, we adopt the quasi-Bayesian algorithm developed by Imai et al. and propose a procedure based on the simulation of counterfactual distributions to estimate not only the direct and joint indirect effects but also the indirect effects through individual mediators. We study the properties of the proposed estimators through simulations. As an illustration, we apply our method on a real data set from a large cohort to assess the effect of hormone replacement treatment on breast cancer risk through three mediators, namely dense mammographic area, nondense area and body mass index.