Generalized Interventional Approach for Causal Mediation Analysis with Causally Ordered Multiple Mediators

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Abstract

Causal mediation analysis has shown the advantage of mechanism investigation. Under conditions with causally ordered mediators, path-specific effect (PSE) is introduced for specifying the effect mediated by a certain combination of mediators. However, most of PSEs are unidentifiable. To address this issue, an alternative approach, called interventional analogue of PSE (iPSE), is widely applied to effect decomposition. Previous literatures for multiple mediators mainly focused on discussing the case of two mediators due to the complexity of the mediation formula. A generalized method under the settings with the arbitrary number of mediators is attractive to study the causal parameter identification as well as statistical estimation. This paper proposed a generalized interventional approach to discussing the effect mediated by ordered multiple mediators. It provides a general definition of iPSE by a recursive formula, assumptions for non-parametric identification, and a regression-based method and a G-computation algorithm to estimate all iPSEs. This approach is applied to a Taiwanese cohort study for exploring the mechanism among hepatitis C virus on mortality through hepatitis B Virus, liver function, and hepatocellular carcinoma.

Keyword: mediation analysis, causal inference, causally ordered multiple mediator, g-computation algorithm.