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Causal inference in longitudinal studies with history-restricted marginal structural models

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Abstract

A new class of Marginal Structural Models (MSMs), History-Restricted MSMs (HRMSMs), was recently introduced for longitudinal data for the purpose of defining causal parameters which may often be better suited for public health research or at least more practicable than MSMs (6, 2). HRMSMs allow investigators to analyze the causal effect of a treatment on an outcome based on a fixed, shorter and user-specified history of exposure compared to MSMs. By default, the latter represent the treatment causal effect of interest based on a treatment history defined by the treatments assigned between the study's start and outcome collection. We lay out in this article the formal statistical framework behind HRMSMs. Beyond allowing a more flexible causal analysis, HRMSMs improve computational tractability and mitigate statistical power concerns when designing longitudinal studies. We also develop three consistent estimators of HRMSM parameters under sufficient model assumptions: the Inverse Probability of Treatment Weighted (IPTW), G-computation and Double Robust (DR) estimators. In addition, we show that the assumptions commonly adopted for identification and consistent estimation of MSM parameters (existence of counterfactuals, consistency, time-ordering and sequential randomization assumptions) also lead to identification and consistent estimation of HRMSM parameters.

Keywords: causal inference, counterfactual, marginal structural model, longitudinal study, IPTW, G-computation, Double Robust.

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