Assessing Spatial Spillover Effects in Mediation Analysis with Areal Data

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ABSTRACT

We consider a spatial mediation analysis that enables us to systematically capture the influence of neighboring regions on exposure-outcome relationships with areal data. We introduce a new framework of Linear Random Effects Spatial Structural Equation Model (LRES-SEM) that helps untangle the pathways under a directed acyclic graph (DAG) involving spatially distributed exposure, mediator and outcome. This new methodology allows to assess spatial spillover effects between spatially linked neighbors, extending the classical mediation analysis under the assumption of independent sampling units. Applying the LRES-SEM to analyze the county-level COVID-19 data across the U.S., we explore how political affiliation impacts mortality rates, both directly and through its influence mediated by vaccination hesitancy. Our results demonstrate the importance of accounting for the spatial connectivity, providing data evidence how political and social determinants may collectively impact health outcomes during a public health crisis like the COVID-19 pandemic.

Keywords: Causal pathway; Political ideology; Structural equation model; Vaccination hesitancy

Differentially Private Inference for Longitudinal Linear Regression

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ABSTRACT

Differential Privacy (DP) provides a rigorous framework for releasing statistics while protecting individual information present in a dataset. Although substantial progress has been made on differentially private linear regression, existing methods almost exclusively address the item-level DP setting, where each user contributes a single observation. Many scientific and economic applications instead involve longitudinal or panel data, in which each user contributes multiple dependent observations; in these settings, item-level DP offers inadequate protection, and user-level DP - shielding an individual's entire trajectory - is the appropriate privacy notion. We develop a comprehensive framework for estimation and inference in longitudinal linear regression under user-level DP. We propose a user-level private regression estimator based on aggregating local regressions, and we establish finite-sample guarantees and asymptotic consistency under short-range dependence. For inference, we develop user-level private estimators of asymptotic covariance matrices via a privatized, bias-corrected covariance estimator that is automatically heteroskedasticity- and autocorrelation-consistent. These results provide the first unified framework for practical user-level DP estimation and inference in longitudinal linear regression under dependence, with strong theoretical guarantees and promising empirical performance.

Keywords: User-level differential privacy; Strong mixing; Concentration inequalities; Heteroscedasticity and autocorrelation consistent inference.

Learning from Shifted Data via a Semiparametric Selection Bias Model

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ABSTRACT

Data shifts can occur in various forms, such as changes in covariates, label or prior distributions, domains, or data changes resulting from selection bias. This talk introduces some recent advances in treating data with potential selection bias and explores how these connect to broader data shift frameworks, including co-moving shifts. We present the estimation and testing procedures, demonstrating their effectiveness through theory, simulation studies, and applications to astronomy, and/or heart transplant data, time permitting.

Keywords: Data shifts, selection bias, isotonic inference, smoothing splines, heart transplant, SDSS