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Title:

Bayesian inference of causal effects from observational data in Gaussian graphical models

Abstract:

We assume that multivariate observational data are generated from a distribution whose conditional independencies are encoded in a Directed Acyclic Graph (DAG). For any given DAG, the causal effect of a variable onto another one can be evaluated through intervention calculus. A DAG is typically not identifiable from observational data alone. However, its Markov equivalence class (a collection of DAGs) can be estimated from the data. As a consequence, for a given intervention, a set of causal effects, one for each DAG in the equivalence class, can be evaluated. In this paper, we propose a fully Bayesian methodology to make inference on the causal effects. Main features of our method are: (a) both uncertainty on the equivalence class and the causal effects are jointly modeled; (b) priors on the parameters of the modified Cholesky decomposition of the precision matrices across all DAG models are constructively assigned starting from a unique prior on the complete (unrestricted) DAG; (c) an efficient algorithm to sample from the posterior distribution on graph space is adopted; (d) an objective Bayes approach, requiring virtually no user specification, is used throughout. We demonstrate the merits of our methodology in simulation studies, wherein comparisons with current state-of-the-art procedures turn out to be highly satisfactory. Finally we examine a real data set of gene expressions for *Arabidopsis thaliana*.

This is joint work with Federico Castelletti