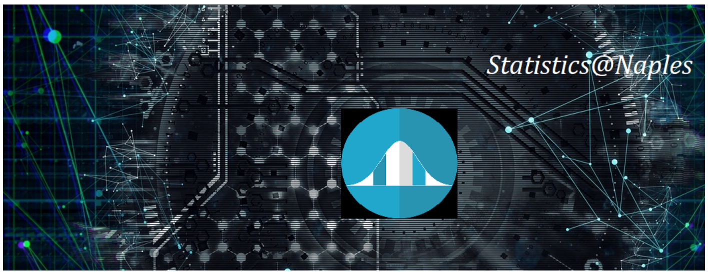

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Bayesian learning of network structures from interventional experimental data

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Directed Acyclic Graphs (DAGs) provide an effective framework for learning causal relationships among variables given multivariate observations. Under pure observational data, DAGs encoding the same conditional independencies cannot be distinguished and are collected into Markov equivalence classes. In many contexts however, observational measurements are supplemented by interventional data that improve DAG identifiability and enhance causal effect estimation. We propose a Bayesian framework for multivariate data partially generated after stochastic interventions. To this end, we introduce an effective prior elicitation procedure leading to a closed-form expression for the DAG marginal likelihood and guaranteeing score equivalence among DAGs that are Markov equivalent post intervention. Under the Gaussian setting we show, in terms of posterior ratio consistency, that the true network will be asymptotically recovered, regardless of the specific distribution of the intervened variables and of the relative asymptotic dominance between observational and interventional measurements. We validate our theoretical results in simulation and we implement on both synthetic and biological protein expression data a Markov chain Monte Carlo sampler for posterior inference on the space of DAGs.

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