Bocconi
Università Commerciale Luigi Bocconi

Department of Decision Sciences

Statistics Seminar

Objective Bayesian Search of Gaussian Directed Acyclic Graphical Models for Ordered Variables with Non-Local Priors

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12:30pm Room 3-E4-SR03 Via Rontgen 1 Milano

Abstract

Directed Acyclic Graphical (DAG) models are increasingly employed in the study of physical and biological systems to model direct influences between variables. Identifying the graph from data is a challenging endeavor, which can be more reasonably tackled if the variables are assumed to satisfy a given ordering; in this case we simply have to estimate the presence or absence of each potential edge. Working under this assumption, we propose an objective Bayesian method for searching the space of Gaussian DAG models, which provides a rich output from minimal input. We base our analysis on non-local parameter priors, which are especially suited for learning sparse graphs, because they allow a faster learning rate, relative to ordinary local parameter priors, when the true unknown sampling distribution belongs to a simple model.
We implement an efficient stochastic search algorithm, which deals effectively with data sets having sample size smaller than the number of variables, and apply our method to a variety of simulated and real data sets. Our approach compares favorably to current state-of-the-art frequentist methods relying on the assumption of ordered variables, and this assumption is shown to give us a competitive advantage with respect to the PC-algorithm, which can be considered as a frequentist benchmark for unordered variables. Importantly, with reference to learning the skeleton of the DAG, we find that our method mantains this advantage when the ordering of the variables is only moderately mis-specified. Prospectively, our method could be coupled with a strategy to learn the order of the variables, thus dropping the known ordering assumption.

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