Sparse Hierarchical Vector Autoregression for Estimating Granger–Causal Graphs from Behavioral Panel Data

Spyros E. Balafas

Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, University of Groningen (RUG), Bernoulliborg, Nijenborgh 9, 9747 AG, Groningen, The Netherlands.

E-mail: s.balafas@rug.nl

Marco A. Grzegorczyk

Bernoulli Institute for Mathematics, Computer Science and Artificial Intelligence, University of Groningen (RUG), Bernoulliborg, Nijenborgh 9, 9747 AG, Groningen, The Netherlands.

Ernst C. Wit

Faculty of Science and Informatics, Universita della Svizzera Italiana (USI), Via Buffi 13, 6900 Lugano, Switzerland.

Summary. Recently, research in psychiatry and clinical psychology moved towards a network conceptualization of complex mental processes, where causal interactions between psychological variables are responsible for behavioral phenomena. These interactions are not known a priori and need to be estimated from data. A model that allows to explore psychometric network structures from psychological time series is the graphical VAR (GVAR) model. In GVARs, temporal partial correlations are visualized by means of a graph and fulfill the temporal requirement of causality (i.e. a cause will precede its effect), which is known as Granger–causality. Here we are focused on studying Granger–causal interactions from data obtained from an ongoing longitudinal study called Mapping Individual Routes of Risk and Resilience (MIRORR). In order to model the heterogeneity in these data and treat the "curse of dimensionality" in VARs we suggest a hierarchical framework with random effects and an L_1 penalty on the fixed–effect coefficients. The model uses regularized penalized quasi–likelihood (RPQL), which is maximized via a coordinate–ascent algorithm.