

Granger causality has been used for the investigation of the inter-dependence structure of the underlying systems of multivariate time series. In particular, the direct causal effects are commonly estimated by the conditional Granger causality index (CGCI). In the presence of many observed variables and relatively short time series, CGCI may fail because it is based on vector autoregressive models (VAR) involving a large number of coefficients to be estimated. In this paper, the VAR is restricted by a scheme that modifies the recently developed method of backward-in-time selection (BTS) of the lagged variables and the CGCI is combined with BTS. Further, the proposed approach is compared favorably to other restricted VAR representations, such as the top-down strategy, the bottom-up strategy, and the least absolute shrinkage and selection operator (LASSO), in terms of sensitivity and specificity of CGCI. This is shown by using simulations of linear and nonlinear, low- and high-dimensional systems and different time series lengths. For nonlinear systems, CGCI from the restricted VAR representations are compared with analogous nonlinear causality indices. Further, CGCI in conjunction with BTS and other restricted VAR representations is applied to multichannel scalp electroencephalogram (EEG) recordings of epileptic patients containing epileptiform discharges. CGCI on the restricted VAR, and BTS in particular, could track the changes in brain connectivity before, during and after epileptiform discharges, which was not possible using the full VAR representation.