S-MVAR toolbox

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The Matlab toolbox allows to compute analytically the parameters of a VAR model exploring the combined approach of Sparse regressions and state-space (SS) models. In particular, the sparse methodologies investigated are: Ordinary Least square analysis, LASSO regression, Elastic Net regression, Fused LASSO regression and Sparse Group LASSO regression. Then the conditional Granger causality (cGC) is computed for multivariate stochastic process elaborating the results provided in [1]-[2]-[3]-[4]-[5].

[1]- Antonacci, Y.; Minati, L.; Faes L.; Pernice R.; Nollo G,; J.Toppi, A.Pietrabissa; Astolfi L.; Estimation of Granger causality through Artificial Neural Networks: applications to physiological systems and chaotic electronic oscillators, PeerJ Computer Science 2020, sub.

[2]-Faes, L.; Marinazzo, D.; Stramaglia, S. Multiscale information decomposition: Exact computation for multivariate Gaussian processes. Entropy 2017, 19, 408.

[3]-Barnett, L.; Seth, A.K. Granger causality for state-space models. Phys. Rev. E 2015, 91, 040101.

[4]-Antonacci, Y.; Astolfi, L.; Nollo, G.; Faes L.; Information Transfer in Linear Multivariate Processes Assessed through Penalized Regression Techniques: Validation and Application to Physiological Networks. Entropy 2020, 22(7), 732.

[5] Liu, J., Ji, S., & Ye, J. (2009). SLEP: Sparse learning with efficient projections. Arizona State University, 6(491), 7.

 To get started, we recommend that you run and work through the two demonstration scripts.

Demonstration scripts

test_simulation - Performs VAR identification with OLS, LASSO, Elastic Net, Fused LASSO and Sparse Group LASSO and computes conditional GC (pairwise conditional Granger Causality) for a 5-variate process (TimeSeries.mat) with the methodology described in Sim II [4]. Due to the high computational time required, the analysis is restricted to a 5-variate process.

Functions

- SparseID_MVAR_LASSO - identification of VAR model with LASSO regression
- SparseID_MVAR_E_NET - identification of VAR model with Elastic Net regression
- SparseID_MVAR_F_LASSO - identification of VAR model with Fused LASSO regression
- SparseID_MVAR_SG_LASSO - identification of VAR model with Sparse Group LASSO regression.
- GCV_criterion_LASSO - estimation of λ_{opt} with Generalized Cross-Validation criterion as described in Sect. II [4] for LASSO regression.
- GCV_criterion_E_NET - estimation of λ_{opt} and α_{opt} with Generalized Cross-Validation criterion for Elastic Net regression
- GCV_criterion_F_LASSO - estimation of $\lambda 1_{opt}$ and $\lambda 2_{opt}$ with Generalized Cross-Validation criterion for Fused LASSO regression
- GCV_criterion_SG_LASSO - estimation of $\lambda 1_{opt}$ and $\lambda 2_{opt}$ with Generalized Cross-Validation criterion for Sparse group LASSO regression.
- idMVAR - identification of a VAR model with OLS
- varma2iss - Compute parameters of an innovations form state space model from the parameters of the equivalent vector ARMA model
- iss_PCOV - Calculate partial variances from the innovations form state space parameters
- ss2iss - Compute innovations form parameters for a general state space model by solution of a discrete algebraic Riccati equation (DARE)
- plot_pw -plot conditional GC networks containing causal relationships
- suptitle - adds text to the top of the figure
- getWorkersAvailable - check the availability of Parallel computing toolbox

NOTE:

- ss2iss function is taken from the State-Space Granger Causality Matlab Toolbox - http://users.sussex.ac.uk/ lionelb/downloads/ssgc.zip
- idMVAR, iss_PCOV, varma2iss are taken from the Matlab Tool for multiscale Information Decomposition http://www.lucafaes.net/msID.html
- plot_pw is taken from multivariate Granger Causality Matlab toolboox - http://www.sussex.ac.uk/sackler/mvgc/
- SLEP package used for the identification procedure of VAR model is taken from: https://github.com/jiayuzhou/SLEP. Reading the document in [5] is strongly recommended especially for understanding the definition of the different methodologies used.

Contacts

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