PID-LASSO toolbox

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The Matlab toolbox allows to compute analytically the parameters of a VAR model exploring the combined approach of LASSO regression and State space (SS) models. Then, all the information measures composing the Partial Information Decomposition (PID) and conditional Transfer Entropy (cTE) are computed for multivariate stochastic process elaborating the results provided in [1]-[2]-[3].

[1]-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, 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.

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

Demonstration scripts

test_simulation - Computes PID measures with OLS and LASSO for a simulated Gaussian 4-variate process, according to Sect. 3 in [1]

test_simulation2 - Performs VAR identification with OLS and LASSO and computes conditional TE (pairwise conditional Granger Causality) for a 5-variate process (TimeSeries.mat) with the methodology described in Sim II [1]. Due to the high computational time required, the analysis is restricted to a 5-variate process

test_applicationPID - Performs the VAR identification with OLS and LASSO and analyze brain-body interactions during stressful task, according to the description of Sect. IV (TimeSeriesStress). Note that the analysis was reduced to one single subject due to the high computational time required for the entire procedure.

Functions

SparseID_MVAR - identification of VAR model with LASSO regression

GCV_criterion - estimation of λ_{opt} with Generalized Cross-Validation criterion as described in Sect. II

cTEsurrogate - performs the evaluation of null distribution for cTE values with Iterative Adjusted Fourier Transform (IAAFT). Includes surriaafft and surrshuf for its purpose

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 cTE 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/

PID-LASSO requires Statistics and Machine Learning Toolbox of Matlab for computing lasso solution.

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