

# Package ‘GCnetinf’

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**Type** Package

**Title** GCnetinf - Granger causality tests for network inference

**Version** 1.0

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**Description** Takes as input a multiple time series, returns dynamic causality scores between variables.

**Imports** tseries, ppcor, randomForest, lars

**License** GPL-3

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## Description

This package computes dynamic causality scores between variables from a multiple time series matrix. Consists of two main functions, described below. The first function is "gcausal" and estimates linear Granger causality (GC) scores. Bivariate and conditional (1 order) GC tests are available, returning a matrix of z-scores, where the element [i,j] is the score from variable i to j. The conditional GC score from a cause to effect is the minimum 1 order conditional GC score obtained, for all individual conditioning variables. An heuristic is applied in order to speed up this search, as described in Lopes 2015. Options for lag selection and integrated variables are also available. The second function is "netinf1l" and implements dynamic versions (1-lag) of state of the art network inference algorithms: bivariate mutual information, aracne, mrmr, cmim, mimr, random forests, and lasso/least angle regression (assessed in Lopes 2015).

## Details

Package: GCnetinf  
 Type: Package  
 Version: 1.0  
 Date: 2015-05-03  
 License: GPL3

See the entries on gcausal and netinf11 on how to use this package.

### Author(s)

Miguel Lopes

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### References

Lopes 2015 (PhD Thesis)

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gcausal

*Granger causality (GC) tests for multiple time series.*

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### Description

This function estimates bivariate and conditional (1 order) linear Granger causality between each pair of variables in the dataset. Returns a p times p matrix of GC z-scores, obtained with an F-test on the residuals of restricted and unrestricted models. The conditional GC scores are the minimum of first order conditional GC scores (a score designated by GC3 herein). In order to improve its speed in the large variable case, an approximation is implemented based on a search heuristic (described in Lopes 2015). Its accuracy and speed can be controlled with a user given parameter (see below). It is possible to filter variable pairs which are identified as having common causes (siblings). This identification is described in Lopes 2015, where it is referred to as co-regulation identification in the context of gene regulations. In this case, scores between siblings are assigned NA values.

GC tests may consider multiple lags and may be corrected to consider integrated variables (Toda-Yamamoto modification). The default option is to consider a single first lag, but this may be modified (see below).

The methods implemented are described in detail in Lopes 2015 (PhD thesis).

### Usage

```

gcausal(datamatrix,
  type = "conditional",
  lagmethod = "first",
  maxnumlags = 1,
  maxlag = 1,
  crit = "aicc",
  ty.test = FALSE,
  stat.pars,
  sibling.filter=FALSE,
  sf.mincor=0.7,
  sf.maxlag=2 ,

```

```
sf.matrix,
gc3rank.method="dynamic",
gc3rank.approx=3,
gc3rank.matrix)
```

### Arguments

<code>datamatrix</code>	A numeric matrix of dimension $n$ times $p$ (samples are rows, variables are columns). No NA or Inf values allowed.
<code>type</code>	Character string, either "bivariate" or "conditional" (default).
<code>lagmethod</code>	Character string, either "first" (default) or "fsel". The lag(s) of the target are always the first (its number may be estimated by AIC). Then, an equal number of predictor lags are considered. However, these may be selected in a forward selection procedure, instead of being the first. For instance, the lags returned by "first" may be 1,2,3, and the lags returned by "fsel" 2,1,4.
<code>maxnumlags</code>	Integer (default 1). This parameter defines the maximum number of lags (of a variable) to be included in the GC model.
<code>maxlag</code>	Integer (default 1). This parameter defines the maximum lag to be included in the GC model (it may be different than <code>maxnumlags</code> when <code>lagmethod="fsel"</code> ).
<code>crit</code>	Character string, either "aicc" (default), "aic" or "bic". This parameter defines the criterion to assess linear models.
<code>ty.test</code>	Logical, TRUE or FALSE (default FALSE). If TRUE, the Toda-Yamamoto modified GC test is used (deals with integrated variables).
<code>stat.pars</code>	Named list of parameters to estimate the order of integration and assess stationarity. Elements in the list should be named "maxorder", "method" and "cutoff". "maxorder" is integer and defines the maximum order of integration in the integration tests; "method" is a character string, and defines the method to test the null hypothesis of stationarity (either "KPSS" or "adf"); "cutoff" is numeric, and defines the p-value level below which stationarity is rejected. Default is <code>list(maxorder=2, method="KPSS", cutoff=0.05)</code> .
<code>sibling.filter</code>	Logical, TRUE or FALSE (default). If TRUE scores between siblings (variables with common causes) are filtered (the respective scores are NA). Sibling identification is as described in Lopes 2015.
<code>sf.mincor</code>	Numeric (default 0.7). This parameter defines the minimum linear correlation for sibling identification.
<code>sf.maxlag</code>	Integer (default 2). This parameter defines the maximum considered lag in sibling identification.
<code>sf.matrix</code>	(optional) $p$ times $p$ sibling matrix (if already computed). Non zero elements indicate siblings.
<code>gc3rank.method</code>	Character string, either "static" or "dynamic" (default). This parameter defines the method to compute the ranking in GC3.
<code>gc3rank.approx</code>	Integer (default 3). This parameter controls the speed of the GC3 search ("t" in Lopes 2015). The lower the faster, and less precise. Maximum is $p$ (equivalent to the full search).
<code>gc3rank.matrix</code>	(optional) Ranking matrix for GC3 (if already computed)

### Value

A  $p$  times  $p$  matrix of GC z-scores. Score  $[i,j]$  is from element  $i$  to element  $j$ .

**Author(s)**

Miguel Lopes

**References**

Lopes 2015 (PhD Thesis)

**Examples**

```
#datamatrix=mat.or.vec(50,20)+rnorm(50*20,0,1)
#gcscores=gcausal(datamatrix, type="bivariate")
```

netinf11

*1-lag dynamic network inference algorithms for time series.***Description**

This function implements 1-lag dynamic network inference algorithms for time series. For each target, predictors are lagged (1 lag), and scored according to the selected model. Returns a p times p matrix of scores. Score [i,j] is from variable i to j.

Implemented methods are bivariate mutual information, clr, aracne, mrmr, cmim, mimr, random forests (RF), and lasso/least angle regression (lars). The last two call the packages randomForest and lars.

In RF, variable importance is measured with the mean decrease in node impurity ("IncNodePurity", in the case of regression, measured with RSS). The arguments of the function randomForest may be passed through the argument rf.pars.

In lars, scores are obtained as the average of predictor coefficients for various lambda values. The arguments of the lars functions may be passed through the arguments lars.pars and predict.lars.pars.

As described in PhD thesis Lopes 2015.

**Usage**

```
netinf11(datamatrix, Methods, mi.cutoff = 0.05, rf.pars, lars.pars, predict.lars.pars)
```

**Arguments**

datamatrix	A numeric matrix of dimension n times p (samples are rows, variables are columns). No NA or Inf values allowed.
Methods	Character string, either "mi" (mutual information) "aracne", "clr", "mrmr", "cmim", "mimr", "rf" (random forests), or "lars" (least angle regression). This parameter selects the used inference method. Multiple methods may be selected.
mi.cutoff	Numeric (default 0.05). The mutual information is estimated as a function of the linear correlation (Gaussian assumption). This value is the significance cut-off for the statistical test on linear correlations.
rf.pars	Named list of parameters for the function randomForest::randomForest. Default is list(mtry=sqrt(number of variables), ntree=1000).
lars.pars	Named list of parameters for the function lars::lars. Default is list(type="lasso", use.gram=TRUE)
predict.lars.pars	Named list of parameters for the function lars::predict.lars. Default is list(type="coefficients", mode="fraction", s=seq(0.1,1,0.01))

**Value**

A list in which element is a p times p matrix of network scores (relative to a method). Score [i,j] is from element i to element j.

**Author(s)**

Miguel Lopes

**References**

Lopes 2015 (PhD Thesis)

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