Package 'weightedGCM'

December 12, 2025

Type Package

Title Weighted Generalised Covariance Measure Conditional Independence Test

Version 0.1.1

Description A conditional independence test that can be applied both to univariate and multivariate random variables. The test is based on a weighted form of the sample covariance of the residuals after a nonlinear regression on the conditioning variables. Details are described in Scheidegger, Hoerrmann and Buehlmann (2022) ``The Weighted Generalised Covariance Measure'' <http://jmlr.org/papers/v23/21-1328.html>. The test is a generalisation of the Generalised Covariance Measure (GCM) implemented in the R package 'GeneralisedCovarianceMeasure' by Jonas Peters and Rajen D. Shah based on Shah and Peters (2020) ``The Hardness of Conditional Independence Testing and the Generalised Covariance Measure'' <doi:10.1214/19-AOS1857>.

License GPL-2

Imports methods, mgcv, stats, xgboost (>= 3.1.2.1)

Suggests testthat (>= 3.0.0)

Config/testthat/edition 3

Encoding UTF-8

RoxygenNote 7.3.3

NeedsCompilation no

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`wgcm.est` *Weighted Generalised Covariance Measure (WGCM) With Estimated Weight Function Conditional Independence Test*

Description

The Weighted Generalised Covariance Measure (WGCM) with Estimated Weight Function is a test for conditional independence. It is a generalisation of the Generalised Covariance Measure implemented in the R package GeneralisedCovarianceMeasure.

Usage

```
wgcm.est(X, Y, Z, beta = 0.3, regr.meth, regr.pars = list(), nsim = 499)
```

Arguments

`X`	A (n x d_X) numeric matrix with n observations of d_X variables.
`Y`	A (n x d_Y) numeric matrix with n observations of d_Y variables.
`Z`	A (n x d_Z) numeric matrix with n observations of d_Z variables.
`beta`	A real number between 0 and 1 indicating the fraction of the sample used to estimate the weight function.
`regr.meth`	One of "gam" and "xgboost" indicating the regression method used to estimate the conditional expectations E[X|Z] and E[Y|Z] and the weight function sign(E[(X-E[X|Z])(Y-E[Y|Z])|Z]).
`regr.pars`	Optional additional regression parameters if ‘regr.meth == "xgboost"‘: can specify ‘max_nrounds‘, ‘k_cv‘, ‘early_stopping_rounds‘, and vectors ‘eta‘ and ‘max_depth‘.
`nsim`	Number of samples used to calculate the p-value using simulation. Only used if max(d_X, d_Y) > 1.

Value

A p-value for the null hypothesis of conditional independence of X and Y given Z.

References

Please cite the following papers. Cyrill Scheidegger, Julia Hoerrmann, Peter Buehlmann: "The Weighted Generalised Covariance Measure" <http://jmlr.org/papers/v23/21-1328.html>

Rajen D. Shah, Jonas Peters: "The Hardness of Conditional Independence Testing and the Generalised Covariance Measure" <doi:10.1214/19-AOS1857>

Examples

```
set.seed(1)
n <- 200
Z <- rnorm(n)
X <- Z + 0.3*rnorm(n)
Y1 <- Z + 0.3*rnorm(n)
Y2 <- Z + 0.3*rnorm(n) + 0.3*X
Y3 <- Z + 0.3*rnorm(n) + 0.15*X^2
wgcm.est(X, Y1, Z, beta = 0.3, regr.meth = "gam")
wgcm.est(X, Y2, Z, beta = 0.3, regr.meth = "gam")
wgcm.est(X, Y3, Z, beta = 0.3, regr.meth = "gam")
```

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wgcm.fix — *Weighted Generalised Covariance Measure (WGCM) With Fixed Weight Functions Conditional Independence Test*

Description

The Weighted Generalised Covariance Measure (WGCM) with Fixed Weight Functions is a test for conditional independence. It is a generalisation of the Generalised Covariance Measure implemented in the R package GeneralisedCovarianceMeasure.

Usage

```
wgcm.fix(
  X,
  Y,
  Z,
  regr.meth,
  regr.pars = list(),
  weight.num,
  weight.meth = "sign",
  nsim = 499
)
```

Arguments

X	A (n x d_X) numeric matrix with n observations of d_X variables.
Y	A (n x d_Y) numeric matrix with n observations of d_Y variables.

Z	A (n x d_Z) numeric matrix with n observations of d_Z variables.
regr.meth	One of "gam" and "xgboost" indicating the regression method used to estimate the conditional expectations E[X|Z] and E[Y|Z].
regr.pars	Optional additional regression parameters if ‘regr.meth == "xgboost"‘: can specify ‘max_nrounds‘, ‘k_cv‘, ‘early_stopping_rounds‘, and vectors ‘eta‘ and ‘max_depth‘.
weight.num	Number k_0 of weight functions per dimension of Z to be used additionally to the constant weight function w(z) = 1. The total number of weight functions will be 1 + k_0 * d_Z. In case of max(d_X, d_Y) > 1, the same 1 + k_0 * d_Z weight functions are used for every combination of the components of X and Y.
weight.meth	String indicating the method to choose the weight functions. Currently, only "sign" is implemented.
nsim	Number of samples used to calculate the p-value using simulation.

Value

A p-value for the null hypothesis of conditional independence of X and Y given Z.

References

Please cite the following papers. Cyrill Scheidegger, Julia Hoerrmann, Peter Buehlmann: "The Weighted Generalised Covariance Measure" <http://jmlr.org/papers/v23/21-1328.html>

Rajen D. Shah, Jonas Peters: "The Hardness of Conditional Independence Testing and the Generalised Covariance Measure" <doi:10.1214/19-AOS1857>

Examples

```
set.seed(1)
n <- 200
Z <- rnorm(n)
X <- Z + 0.3*rnorm(n)
Y1 <- Z + 0.3*rnorm(n)
Y2 <- Z + 0.3*rnorm(n) + 0.3*X
Y3 <- Z + 0.3*rnorm(n) + 0.15*X^2
wgcm.fix(X, Y1, Z, regr.meth = "gam", weight.num = 7, weight.meth = "sign")
wgcm.fix(X, Y2, Z, regr.meth = "gam", weight.num = 7, weight.meth = "sign")
wgcm.fix(X, Y3, Z, regr.meth = "gam", weight.num = 7, weight.meth = "sign")
```

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