

Package ‘toscca’

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Title Thresholded Ordered Sparse CCA

Version 0.1.1

Description

Performs Thresholded Ordered Sparse Canonical Correlation Analysis (CCA). For more details see Senar, N. (2024) <[doi:10.1093/bioadv/vbae021](https://doi.org/10.1093/bioadv/vbae021)> and Senar, N. et al. (2025) <[doi:10.48550/arXiv.2503.15140](https://doi.org/10.48550/arXiv.2503.15140)>.

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cpev.toscca	<i>Calculates cpev</i>
-------------	------------------------

Description

This function calculates cpev w.r.t. a chosen origin.

Usage

```
cpev.toscca(mat, weights)
```

Arguments

mat	A matrix.
weights	A numeric vector of canonical weights.

Value

Returns cpev values for the kth or 1:K components.

fastEigen	<i>Performs eigen decomposition of a matrix in PS space.</i>
-----------	--

Description

Performs eigen decomposition of a matrix in PS space.

Usage

```
fastEigen(A)
```

Arguments

A	A square matrix nxn.
---	----------------------

Value

Matrix. Positive definite matrix.

getCanSubspace	<i>Performs matrix residualisation over estimated canonical vectors by using the null space of the estimated canonical vector to construct a new matrix.</i>
----------------	--

Description

Performs matrix residualisation over estimated canonical vectors by using the null space of the estimated canonical vector to construct a new matrix.

Usage

```
getCanSubspace(mat, vec)
```

Arguments

mat	An nxp matrix.
vec	A vector of dimensions nxk.

Details

For nxp matrix

$$\mathbf{A}$$

and pxk vector

$$\alpha$$

, the canonical is compute as $\mathbf{A}_{sub} = \mathbf{A}\alpha(\alpha^T\alpha)\alpha^T$.

Value

An $n \times k$ matrix.

getWhich	<i>Get location of required.</i>
----------	----------------------------------

Description

Get location of required.

Usage

```
getWhich(data, fun)
```

Arguments

data	Numeric matrix.
fun	Function to search data.

Value

Returns value matching function fun.

Examples

```
getWhich(rnorm(100), max)
```

initialiseCanVar	<i>Initialised the canonical vector for the iterative process based on positive eigen values. Then, SVD is performed on that PS matrix.</i>
------------------	---

Description

Initialised the canonical vector for the iterative process based on positive eigen values. Then, SVD is performed on that PS matrix.

Usage

```
initialiseCanVar(A, B)
```

Arguments

A	An $n \times p$ matrix.
B	An $n \times q$ matrix.

Value

An pzp vector.

Examples

```
#sample size etc
N = 10
p = 25
q = 5
# noise
X0 = sapply(1:p, function(x) rnorm(N))
Y0 = sapply(1:q, function(x) rnorm(N))

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,1)

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.3)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.3)
cv = initialiseCanVar(X0, Y0)
```

modes

Calculates mode.

Description

Calculates mode.

Usage

```
modes(d)
```

Arguments

d density object.

`myHeatmap`*Plot heatmap of cv w.r.t. the penalty parameter performance.*

Description

This function plots cca for different thresholds

Usage

```
myHeatmap(  
  mat,  
  palette_values = mpalette,  
  blue = NULL,  
  xlab = "",  
  ylab = "",  
  show_axes = TRUE,  
  show_labels = TRUE,  
  K = NULL  
)
```

Arguments

<code>mat</code>	A matrix.
<code>palette_values</code>	Character string. Vector of colour values for the heatmap. Default is package's palette.
<code>blue</code>	Logical. If TRUE, use only scale of blues from palette.
<code>xlab</code>	Character. Label for x axis.
<code>ylab</code>	Character. Label for y axis.
<code>show_axes</code>	Logic. Default is True.
<code>show_labels</code>	Logic. Default is True.
<code>K</code>	Numeric. Number of components.

Value

No return value, called for plotting heatmap.

Examples

```
mat <- matrix(rexp(200, rate=.1), ncol=20)/200  
myHeatmap(mat)
```

`plt.selstab`*Plot selection stability for penalty parameter performance.*

Description

This function plots cv for different thresholds

Usage

```
plt.selstab(  
  object,  
  X,  
  Y,  
  nonz_x,  
  nonz_y,  
  palette_values = mpalette,  
  blue = TRUE,  
  k = 1  
)
```

Arguments

<code>object</code>	A toscca object.
<code>X</code>	<code>nxp</code> matrix. Observation matrix.
<code>Y</code>	A <code>nxq</code> matrix. Observation matrix.
<code>nonz_x</code>	Numeric vector. Sparsity levels of <code>X</code> .
<code>nonz_y</code>	Numeric vector. Sparsity levels of <code>Y</code> .
<code>palette_values</code>	Character. Name of a palette for the heatmap. Default is "Teal".
<code>blue</code>	Logical. If TRUE, use only scale of blues from palette.
<code>k</code>	Numeric. Component, default <code>k=1</code> .

Value

No return value, called for selection stability pot.

Examples

```
# example code  
#sample size etc  
N = 10  
p = 25  
q = 5  
# noise  
X0 = sapply(1:p, function(x) rnorm(N))  
Y0 = sapply(1:q, function(x) rnorm(N))
```

```

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,10)

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.03)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.03)

# performa toscca
X = standardVar(X0)
Y = standardVar(Y0)
K = 2 # number of components to be estimated
nonz_x = c(2,5, 10, 20) # number of nonzero variables for X
nonz_y = c(2, 3, 4) # number of nonzero variables for Y
init = "uniform" # type of initialisation
cca_toscca = toscca(X, Y, nonz_x, nonz_y, K, alpha_init = init, type =1,
combination = TRUE, K=1, silent = TRUE, toPlot = FALSE)
plt <- plt.selstab(cca_toscca,X, Y, nonz_x = nonz_x, nonz_y = nonz_y)

```

powerMethod

Performs power method.

Description

Performs power method.

Usage

```
powerMethod(mat, vec, tol = 10-6, maxIter = 500, silent = TRUE)
```

Arguments

mat	A square matrix nxn.
vec	A vector of dimensions nx1.
tol	Convergence criterion. Default is 10 ⁻⁶ .
maxIter	Maximum iterations. Default is 500.
silent	Logical. If TRUE, convergence performance will be printed.

Value

List: vec: eigen vector; lambda: eigen value; t: total iterations.

progressBar	<i>Progress bar</i>
-------------	---------------------

Description

Shows progress of a process.

Usage

```
progressBar(end, round)
```

Arguments

end	maximum number of times a process will run.
round	current round

Value

Display in consol of current status.

residualisation	<i>Performs matrix residualisation over estimated canonical vectors. There are three types: basic (subtracts scaled estimated latent variable from data), null (uses the null space of the estimated canonical vector to construct a new matrix) and LV (uses SVD to residualise).</i>
-----------------	--

Description

Performs matrix residualisation over estimated canonical vectors. There are three types: basic (subtracts scaled estimated latent variable from data), null (uses the null space of the estimated canonical vector to construct a new matrix) and LV (uses SVD to residualise).

Usage

```
residualisation(
  mat,
  vec,
  spaceMat = NULL,
  type = c("LV", "null", "basic"),
  na.allow = TRUE
)
```

Arguments

mat	An nxp matrix.
vec	A vector of dimensions nxk.
spaceMat	Only for "null" type residualisation. Default is NULL.
type	Character. It can be LV, null or basic depending on which type of residualisation will be performed.
na.allow	Logical. If TRUE, NAs will be allowed.

Value

Matrix.

scaledResidualMat	<i>Performs scaling for matrix residualisation based on calculated coefficients.</i>
-------------------	--

Description

Performs scaling for matrix residualisation based on calculated coefficients.

Usage

```
scaledResidualMat(A)
```

Arguments

A	An nxp matrix.
---	----------------

Value

scaled matrix.

scale_rm	<i>Standardises matrices with multiple measurements per individual.</i>
----------	---

Description

This function standardises matrices with multiple measurements w.r.t. a chosen origin.

Usage

```
scale_rm(mat, origin = NULL, centre = FALSE)
```

Arguments

mat A matrix.
 origin Measurement of reference for standardisation.
 centre Logical. TRUE to centre data. Default is FALSE.

Value

Returns scaled and/or centred values for repeated measurements.

Examples

```
#sample size etc
N = 10
p = 25
q = 5
# noise
X0 = sapply(1:p, function(x) rnorm(N))
Y0 = sapply(1:q, function(x) rnorm(N))

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,1)

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.3)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.3)

X = standardVar(X0)
Y = standardVar(Y0)
```

 standardVar

Standardise a matrix

Description

This function standardises a matrix or a vector and gives the option to centre or normalise (only vectors).

Usage

```
standardVar(mat, centre = TRUE, normalise = FALSE)
```

Arguments

mat	Matrix or vector to be standardise.
centre	Logical, if true, centre to mean zero.
normalise	Logical, if true, performs vector normalisation.

Value

A matrix or vector with the preferred standardisation

Examples

```
#sample size etc
N = 10
p = 25
q = 5
# noise
X0 = sapply(1:p, function(x) rnorm(N))
Y0 = sapply(1:q, function(x) rnorm(N))

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,1)

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.3)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.3)

X = standardVar(X0)
Y = standardVar(Y0)
```

summary.toscca_object *Plot heatmap of cv w.r.t. the penalty parameter performance.*

Description

This function plots cca for different thresholds

Usage

```
## S3 method for class 'toscca_object'  
summary(object, ...)
```

Arguments

object toscca object.
... further arguments passed to or from methods.

Value

No return value, called for plotting heatmap.

Examples

```
# example code  
#sample size etc  
N = 10  
p = 25  
q = 5  
# noise  
X0 = sapply(1:p, function(x) rnorm(N))  
Y0 = sapply(1:q, function(x) rnorm(N))  
  
colnames(X0) = paste0("x", 1:p)  
colnames(Y0) = paste0("y", 1:q)  
  
# signal  
Z1 = rnorm(N,0,10)  
  
#Some associations with the true signal  
alpha = (6:10) / 10  
beta = -(2:3) / 10  
  
loc_alpha = 1:length(alpha)  
loc_beta = 1:length(beta)  
  
for(j in 1:length(alpha))  
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.03)
```

```

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.03)

# performa toscca
X = standardVar(X0)
Y = standardVar(Y0)
K = 2 # number of components to be estimated
nonz_x = c(2,5, 10, 20) # number of nonzero variables for X
nonz_y = c(2, 3, 4) # number of nonzero variables for Y
init = "uniform" # type of initialisation
cca_toscca = toscca(X, Y, nonz_x, nonz_y, K, alpha_init = init, type =1,
combination = TRUE, K=1, silent = TRUE, toPlot = FALSE)
summary(cca_toscca)

```

toscamm.perm

Computes permutated cc for TOSCCA-MM

Description

This function estimates sparse canonical vectors for permuted matrices with multiple measurements.

Usage

```

toscamm.perm(
  A,
  B,
  nonzero_a,
  nonzero_b,
  K = 1,
  folds = 1,
  toPlot = FALSE,
  draws = 1000,
  cancor,
  bootCCA = NULL,
  silent = TRUE,
  parallel_logic = TRUE,
  nuisanceVar = 0,
  testStatType = "CC",
  model = "lme",
  lmeformula = " ~ 0 + poly(time,3) + (1|id)",
  arformula = NULL,
  ncores = NULL
)

```

Arguments

A	A matrix.
B	A matrix.
nonzero_a	Integer. Threshold parameter for A.
nonzero_b	Integer. Threshold parameter for B.
K	Integer. Number of components.
folds	Integer. Indicates number of folds to perform.
toPlot	Logical. Indicates if plots will be produced. Default is FALSE.
draws	Integer. Number of draws in permutation.
cancor	Numeric vector of length K with estimated canonical correlations.
bootCCA	deprecated.
silent	Logical. TRUE to keep silent output messages. Default is FALSE.
parallel_logic	Logical. TRUE to parallelise folds. Default is FALSE.
nuisanceVar	Numeric. Number of nuisance variables.
testStatType	Character. Choice of test-statistic c("CC", "Wilks", "Roy").
model	Character. c("lme", "ar"). Model to fit longitudinal latent space.
lmeformula	Character. LME formula. Default is " ~ -1 + time + (1 id)".
arformula	Numeric vector. Choice of ARIMA. Default is c(1,0,0).
ncores	numeric. Number of cores to use in parallelisation. Default is detectCores() -1.

Value

Permuted canonical correlation for ell K and p-values.

List with permuted correlations and p-values.

Examples

```
# example code

# dont run due to parallel processes
#sample size etc
N = 10
p = 25
q = 5
X0 = list()
Y0 = list()

#Some associations with the true signal
cwa = (6:10) / 10
cwb = -(2:3) / 10

alpha = rep(0, p)
beta = rep(0, q)
```

```

loc_alpha = 1:length(alpha)
loc_beta  = 1:length(beta)

alpha[loc_alpha] = cwa
beta[loc_beta] = cwb

sg = matrix(c(1, 0.6, 0.3, rep(0, 2),
             0.6, 1, 0.6, 0.3, rep(0, 1),
             0.3, 0.6, 1, 0.6, 0.3,
             rep(0,1), 0.3, 0.6, 1, 0.6,
             rep(0,2), 0.3, 0.6, 1), ncol = 5)

for(i in 1:N)
{
  times = 1:5
  Zi1 = (sin(100*times))^times + times * 0.65 + rnorm(1,0,0.95)
  Zi = cbind(Zi1)
  #Simulate data and add some noise
  X0i = sapply(1:p, function(a) MASS::mvrnorm(1, (Zi %>% t(alpha))[a], Sigma = sg))
  Y0i = sapply(1:q, function(a) MASS::mvrnorm(1, (Zi %>% t(beta))[a], Sigma = sg))

  colnames(X0i) = paste0("X", 1:ncol(X0i))
  colnames(Y0i) = paste0("Y", 1:ncol(Y0i))
  #Check the simulated cross correlation
  #image(cor(X0i, Y0i))

  #Remove some observations
  # p_observed = 1
  X0i = cbind(id=i, time=times, X0i)#[rbinom(length(times),1,p_observed)==1,]
  Y0i = cbind(id=i, time=times, Y0i)#[rbinom(length(times),1,p_observed)==1,]

  X0[[i]] = X0i
  Y0[[i]] = Y0i
}

X0 = do.call("rbind", X0)
Y0 = do.call("rbind", Y0)

X = data.frame(X0); Y = data.frame(Y0)
nonz_a = c(2, 5, 10, 20)
nonz_b = c(2, 3, 4)

mod <- toscca(X, Y, folds = 2, nonzero_a = nonz_a, nonzero_b = nonz_b, silent = TRUE, type = 2)
nza <- mod$nonzero_a
nzb <- mod$nonzero_b
cc <- mod$cancor
perm_cc <- toscamm.perm(X,Y, nonzero_a=nza, nonzero_b=nzb,cancor=cc, ncores=2, draws = 10)

```

Description

Sparse Canonical Correlation Analysis. Computation of CC via NIPALS with soft thresholding.

Usage

```
toscca(
  A,
  B,
  nonzero_a,
  nonzero_b,
  K = 1,
  alpha_init = c("eigen", "random", "uniform"),
  folds = 1,
  type = NA,
  silent = FALSE,
  toPlot = TRUE,
  typeResid = "basic",
  combination = FALSE,
  parallel_logic = FALSE,
  model = "lme",
  lmeformula = " ~ -1 + time + (1|id)",
  predictor = NULL,
  arformula = c(1, 0, 0)
)
```

Arguments

A, B	Data matrices.
nonzero_a, nonzero_b	Numeric. Scalar or vector over the number of nonzeros allowed for a correlation estimate.
K	Numeric. Number of components to be computed.
alpha_init	Character. Type initialisation for α . . Default is "eigen".
folds	Numeric. Number of folds for the cross-validation process.
type	Numeric. Takes values 1 (standard), 2 (dynamic) or 3 (dynamic for multiple datasets) depending of the toscca variation implemented.
silent	Logical. If FALSE, a progress bar will appear on the console. Default is FALSE.
toPlot	Logical. If TRUE, plot will be generated automatically showing the estimated canonical weights. Default is TRUE.
typeResid	Character. Choice of residualisation technique. Options are basic (default), null and LV.
combination	Logical. If TRUE, the algorithm will search for the best combination of sparsity choice nonzero_a and nonzero_b for each component. This should be used for exploratory analysis. Default is FALSE.

parallel_logic Logical. If TRUE, cross-validation is done in parallel. Default is FALSE.
 model Character. If type == 2, then lme can take values "lme" or "arima".
 lmeformula Character. Lme type formula to be used if type ==2 and model == "lme".
 predictor data.frame object with variables id and/or time to be used in lmeformula.
 arformula Numeric vector indicating arima parametrisation if type == 2 and model == "arima".

Value

a list with the following elements:
 List with estimated toscca parameters.

Examples

```
#sample size etc
N = 10
p = 25
q = 5
# noise
X0 = sapply(1:p, function(x) rnorm(N))
Y0 = sapply(1:q, function(x) rnorm(N))

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,1)

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.3)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.3)

X = standardVar(X0)
Y = standardVar(Y0)
K = 2 # number of components to be estimated
nonz_x = c(2,5, 10, 20) # number of nonzero variables for X
nonz_y = c(2, 3, 4) # number of nonzero variables for Y
init = "uniform" # type of initialisation
cca_toscca = toscca(X, Y, nonz_x, nonz_y, K, alpha_init = init,
silent = TRUE, toPlot = FALSE, type = 1)
```

toscca.core	<i>Sparse Canonical Correlation Analysis. Computation of CC via NIPALS with soft thresholding.</i>
-------------	--

Description

Sparse Canonical Correlation Analysis. Computation of CC via NIPALS with soft thresholding.

Usage

```
toscca.core(
  alphaInit,
  A,
  B,
  nonzero_a,
  nonzero_b,
  iter = 20,
  tol = 10-6,
  silent = FALSE
)
```

Arguments

alphaInit	Character. Type initialisation for α .
A, B	Data matrices.
nonzero_a, nonzero_b	Numeric. Scalar or vector over the number of nonzeros allowed for a correlation estimate.
iter	Numeric. Maximum number of iterations. Default is 20.
tol	Numeric. Tolerance threshold. Default is 10^6 .
silent	Logical. If FALSE, a progress bar will appear on the console. Default is FALSE.

Value

a list with the following elements:

toscca.folds	<i>Sparse Canonical Correlation Analysis. Computation of CC via NIPALS with soft thresholding.</i>
--------------	--

Description

Sparse Canonical Correlation Analysis. Computation of CC via NIPALS with soft thresholding.

Usage

```
toscca.folds(
  A,
  B,
  nonzero_a,
  nonzero_b,
  alpha_init,
  folds = 1,
  parallel_logic = FALSE,
  silent = FALSE,
  toPlot = TRUE,
  ATest_res = NULL,
  BTest_res = NULL
)
```

Arguments

A, B	Data matrices.
nonzero_a, nonzero_b	Numeric. Scalar or vector over the number of non zeroes allowed for a correlation estimate.
alpha_init	Character. Type initialisation for α . . Default is "eigen".
folds	Integer. Indicates number of folds to perform.
parallel_logic	Logical. TRUE to parallelise folds. Default is FALSE.
silent	Logical. TRUE to keep silent output messages. Default is FALSE.
toPlot	Logical. TRUE to plot results.
ATest_res	NULL. Keep NULL.
BTest_res	NULL. Keep NULL.

Value

a list with the following elements:

toscca.lv	<i>Get latent variables</i>
-----------	-----------------------------

Description

Gets latent variables from data and estimates.

Usage

```
toscca.lv(data, alpha, beta)
```

Arguments

data	List containint both observation amtrices.
alpha	px1 numeric vector. canonical weights for X.
beta	qx1 numeric vector. canonical weights for Y.

toscca.perm	<i>Permutation testing for toscca</i>
-------------	---------------------------------------

Description

This function performs permutation testing on CC estimates.

Usage

```
toscca.perm(
  A,
  B,
  nonzero_a,
  nonzero_b,
  K,
  alpha_init = c("eigen", "random", "uniform"),
  folds = 1,
  toPlot = FALSE,
  draws = 20,
  cancor,
  silent = TRUE,
  parallel_logic = TRUE,
  nuisanceVar = 0,
  testStatType = "CC",
  ncores = NULL
)
```

Arguments

A, B	Data matrices.
nonzero_a, nonzero_b	Numeric. Scalar or vector over the number of nonzeros allowed for a correlation estimate.
K	Numeric. Number of components to be computed.
alpha_init	Character. Type initialisation for α . . Default is "eigen".
folds	Numeric. Number of folds for the cross-validation process.
toPlot	Logical. If TRUE, plot will be generated automatically showing the estimated canonical weights. Default is TRUE.
draws	Numeric. Number of permutations for each component.
cancor	Numeric. Scalar or vector: anonical correlation estimate(s).
silent	Logical. If FALSE, a progress bar will appear on the console. Default is FALSE.
parallel_logic	Logical. If TRUE, cross-validation is done in parallel. Default is FALSE.
nuisanceVar	Data with nuisance variables. For statistic type.
testStatType	Character. Choice of statistic. Options are CC (default), Wilks and Roy.
ncores	numeric. Number of cores to use in parallelisation. Default is detectCores() -1.

Details

For a exploratory analysis nonzero_a and nonzero_b can be vectors. The algorithm will then search for the best combination of sparsity choice nonzero_a and nonzero_b for each component.

Value

Matrix with permutation estimates.

List with permuted correlations and p-values.

Examples

```
#sample size etc
N = 10
p = 25
q = 5
# noise
X0 = sapply(1:p, function(x) rnorm(N))
Y0 = sapply(1:q, function(x) rnorm(N))

colnames(X0) = paste0("x", 1:p)
colnames(Y0) = paste0("y", 1:q)

# signal
Z1 = rnorm(N,0,1)
```

```

#Some associations with the true signal
alpha = (6:10) / 10
beta = -(2:3) / 10

loc_alpha = 1:length(alpha)
loc_beta = 1:length(beta)

for(j in 1:length(alpha))
  X0[, loc_alpha[j]] = alpha[j] * Z1 + rnorm(N,0,0.3)

for(j in 1:length(beta))
  Y0[, loc_beta[j]] = beta[j] * Z1 + rnorm(N,0,0.3)

X = standardVar(X0)
Y = standardVar(Y0)
K = 2 # number of components to be estimated
nonz_x = c(2,5, 10, 20) # number of nonzero variables for X
nonz_y = c(1, 2, 3, 4) # number of nonzero variables for Y
init = "uniform" # type of initialisation
cca_toscca = toscca(X, Y, nonz_x, nonz_y, K, alpha_init = init,
silent = TRUE, toPlot = FALSE, type = 1)

#dont run due to parallelisation.
cc = cca_toscca$cancor
perm_toscca = toscca.perm(X, Y, nonz_x, nonz_y, K = K, init, draws = 10,
cancor = cc, ncores = 2)

```

toscca.tStat

Get the statistic for the permutations.

Description

Get the statistic for the permutations.

Usage

```
toscca.tStat(cancor, A, B, C = 0, type = c("CC", "Wilks", "Roy"))
```

Arguments

cancor	Numeric. Canonical Correlation estimate.
A	An nxp matrix.
B	An nxq matrix.
C	An nxs matrix. Confounding variables.
type	Character. Choice of statistic: Canonical correlation, Wilks's statistic or Roy's statistic.

Value

Statistic

tosccamm

*Computes TOSCCA-MM***Description**

This function estimates sparse canonical vectors for matrices with multiple measurements and the trajectories of the latent variables.

Usage

```
tosccamm(
  A,
  B,
  nonzero_a,
  nonzero_b,
  folds = 1,
  parallel_logic = FALSE,
  toPlot = TRUE,
  silent = FALSE,
  ATest_res = NULL,
  BTest_res = NULL,
  model = "lme",
  lmeformula = " ~ -1 + time + (1|id)",
  predictor = NULL,
  arformula = c(1, 0, 0)
)
```

Arguments

A	A data.frame with id and time as first two columns.
B	A data.frame with id and time as first two columns.
nonzero_a	Integer. Threshold parameter for A.
nonzero_b	Integer. Threshold parameter for B.
folds	Integer. Indicates number of folds to perform.
parallel_logic	Logical. TRUE to parallelise folds. Default is FALSE.
toPlot	Logical. If TRUE, plot will be generated automatically showing the estimated canonical weights. Default is TRUE.
silent	Logical. TRUE to keep silent output messages. Default is FALSE.
ATest_res	NULL. Keep NULL.
BTest_res	NULL. Keep NULL.

<code>model</code>	Character. <code>c("lme", "ar")</code> . Model to fit longitudinal latent space.
<code>lmeformula</code>	Character. LME formula. Default is <code>" ~ -1 + time + (1 id)"</code> .
<code>predictor</code>	<code>data.frame</code> object with variables <code>id</code> and/or <code>time</code> to be used in <code>lmeformula</code> .
<code>arformula</code>	Numeric vector. Choice of ARIMA. Default is <code>c(1,0,0)</code> .

Value

List with estimated `tosccamm` parameters.

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