

Package ‘rgTest’

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Title Robust Graph-Based Two-Sample Test

Version 0.1

Description Useful tools for determining whether two samples are from the same distribution. Utilizes a robust method to address the problematic structure of the similarity graph constructed from high-dimensional data. The method is provided in Yichuan Bai and Lynna Chu (2023) <[arXiv:2307.12325](https://arxiv.org/abs/2307.12325)>.

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example0

Example

Description

This example contains a dataset, the label of the observations in the dataset, the distance matrix of the dataset using L2 distance, and the edge matrix generated by 5-MST.

Usage

```
example0
```

Format

An object of class `list` of length 4.

Details

`data` pooled dataset of two samples sampling from two different t-distributions.

`label` label of the observations. 'sample 1' denotes the observations in sample 1. 'sample 2' denotes the observations in sample 2.

`distance` the distance matrix of the pooled dataset using L2 distance.

`edge` edge matrix generated by 5-MST.

getdis*Get distance matrix*

Description

This function returns the distance matrix using L2 distance.

Usage

```
getdis(y)
```

Arguments

`y` dataset of the pooled data

Value

A distance matrix based on the L2 distance.

Examples

```
data(example0)
data = as.matrix(example0$data)    # pooled dataset
getdis(data)
```

| | |
|----------------------|---|
| <code>rg.test</code> | <i>Robust graph-based two sample test</i> |
|----------------------|---|

Description

Performs robust graph-based two sample test.

Usage

```
rg.test(data.X, data.Y, dis = NULL, E = NULL, n1, n2, k = 5, weigh.fun, perm.num = 0,
test.type = list("ori", "gen", "wei", "max"), progress_bar = FALSE)
```

Arguments

| | |
|---------------------------|---|
| <code>data.X</code> | a numeric matrix for observations in sample 1. |
| <code>data.Y</code> | a numeric matrix for observations in sample 2. |
| <code>dis</code> | a distance matrix of the pooled dataset of sample 1 and sample 2. The indices of observations in sample 1 are from 1 to n1 and indices of observations in sample 2 are from 1+n1 to n1+n2 in the pooled dataset. |
| <code>E</code> | an edge matrix representing a similarity graph. Each row represents an edge and records the indices of two ends of an edge in two columns. The indices of observations in sample 1 are from 1 to n1 and indices of observations in sample 2 are from 1+n1 to n1+n2. |
| <code>n1</code> | number of observations in sample 1. |
| <code>n2</code> | number of observations in sample 2. |
| <code>k</code> | parameter in K-MST, with default 5. |
| <code>weigh.fun</code> | weighted function which returns weights of each edge and is a function of node degrees. |
| <code>perm.num</code> | number of permutations used to calculate the p-value (default=1000). Use 0 for getting only the approximate p-value based on asymptotic theory. |
| <code>test.type</code> | type of graph-based test. This must be a list containing elements chosen from "ori", "gen", "wei", and "max", with default 'list("ori", "gen", "wei", "max")'. "ori" refers to robust original edge-count test, "gen" refers to robust generalized edge-count test, "wei" refers to robust weighted edge-count test and "max" refers to robust max-type edge-count tests. |
| <code>progress_bar</code> | a logical evaluating to TRUE or FALSE indicating whether a progress bar of the permutation should be printed. |

Details

The input should be one of the following:

1. datasets of the two samples;
2. the distance matrix of the pooled dataset;
3. the edge matrix generated from a similarity graph.

Typical usages are:

```
rg.test(data.X, data.Y, n1, n2, weigh.fun, ...)
```

```
rg.test(dis, n1, n2, weigh.fun, ...)
```

```
rg.test(E, n1, n2, weigh.fun, ...)
```

If the data matrices or the distance matrix are used, the similarity graph is generated using K-MST.

Value

A list containing the following components:

| | |
|--------------------------------|---|
| <code>asy.ori.statistic</code> | the asymptotic test statistic using robust original graph-based test. |
| <code>asy.ori.pval</code> | the asymptotic p-value using robust original graph-based test. |
| <code>asy.gen.statistic</code> | the asymptotic test statistic using robust generalized graph-based test. |
| <code>asy.gen.pval</code> | the asymptotic p-value using robust generalized graph-based test. |
| <code>asy.wei.statistic</code> | the asymptotic test statistic using robust weighted graph-based test. |
| <code>asy.wei.pval</code> | the asymptotic p-value using robust weighted graph-based test. |
| <code>asy.max.statistic</code> | the asymptotic test statistic using robust max-type graph-based test. |
| <code>asy.max.pval</code> | the asymptotic p-value using robust max-type graph-based test. |
| <code>perm.ori.pval</code> | the p-value based on permutation using robust original graph-based test. |
| <code>perm.gen.pval</code> | the p-value based on permutation using robust generalized graph-based test. |
| <code>perm.wei.pval</code> | the p-value based on permutation using robust weighted graph-based test. |
| <code>perm.max.pval</code> | the p-value based on permutation using robust max-type graph-based test. |

Examples

```
## Simulated from Student's t-distribution.
## Observations for the two samples are from different distributions.
data(example0)
data = as.matrix(example0$data)      # pooled dataset
label = example0$label              # label of observations
s1 = data[label == 'sample 1', ]    # sample 1
s2 = data[label == 'sample 2', ]    # sample 2
num1 = nrow(s1)                     # number of observations in sample 1
num2 = nrow(s2)                     # number of observations in sample 2

## Graph-based two sample test using data as input
rg.test(data.X = s1, data.Y = s2, n1 = num1, n2 = num2, k = 5, weigh.fun = weiMax, perm.num = 0)

## Graph-based two sample test using distance matrix as input
dist = example0$distance
rg.test(dis = dist, n1 = num1, n2 = num2, k = 5, weigh.fun = weiMax, perm.num = 0)

## Graph-based two sample test using edge matrix of the similarity graph as input
E = example0$edge
rg.test(E = E, n1 = num1, n2 = num2, weigh.fun = weiMax, perm.num = 0)
```

weiArith

*Weighted function***Description**

This weight function returns the inverse of the arithmetic average of the node degrees of an edge.

Usage

```
weiArith(a, b)
```

Arguments

| | |
|---|---------------------------------------|
| a | node degree of one end of an edge |
| b | node degree of another end of an edge |

Value

The weight uses the arithmetic average of the node degrees of an edge.

Examples

```
# For an edge where one end has a node degree of 5
# another end has a node degree of 6
weiArith(6, 5)
```

weiGeo

Weighted function

Description

This weight function returns the inverse of the geometric average of the node degrees of an edge.

Usage

```
weiGeo(a, b)
```

Arguments

| | |
|---|---------------------------------------|
| a | node degree of one end of an edge |
| b | node degree of another end of an edge |

Value

The weight uses the geometric average of the node degrees of an edge.

Examples

```
# For an edge where one end has a node degree of 5  
# another end has a node degree of 6  
weiGeo(6, 5)
```

weiMax*Weighted function*

Description

This weight function returns the inverse of the max node degree of an edge.

Usage

```
weiMax(a, b)
```

Arguments

| | |
|---|---------------------------------------|
| a | node degree of one end of an edge |
| b | node degree of another end of an edge |

Value

The weight uses the max node degrees of an edge.

weiMax

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Examples

```
# For an edge where one end has a node degree of 5  
# another end has a node degree of 6  
weiMax(6, 5)
```

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