# Package 'PSSIM'

January 20, 2025

**Type** Package

**Title** Test of Independence & Image Structural Similarity Measure PSSIM

**Version** 0.1.0

**Author** Luann C. Jung, Haiyan Wang, Diego Maldonado, Sharad Silwal, Siti Tolos, Suojin Wang

**Maintainer** Haiyan Wang <hwang@ksu.edu>

**Description** Test-based Image structural similarity measure and test of independence.
This package implements the key functions of two tasks: (1) computing
image structural similarity measure PSSIM of Wang, Maldonado and
Silwal (2011) <DOI:10.1016/j.csda.2011.04.021>;
and (2) test of independence between a response and
a covariate in presence of heteroscedastic treatment effects
proposed by Wang, Tolos, and Wang (2010) <DOI:10.1002/cjs.10068>.

**License** GPL-2

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.1.0

**Depends** R (>= 3.5.0)

**Imports** stats, parallel

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2020-09-10 09:50:03 UTC

## Contents

makepseudo *Nearest neighbor augmentatation based on ranks*

## Description

The function makepseudo performs the nearest neighbor augmentation based on the rank of covariate values according to the scheme discribed on page 410-411 of Wang, Tolos and Wang (2010)

## Usage

```
makepseudo(N, n, k, a, alltrt)
```

## Arguments

| | |
|---|---|
| N | total number of covariate values. |
| n | vector of sample sizes from all treatments |
| k | number of nearest neighbors |
| a | number of treatment levels in the data |
| alltrt | a matrix of dimension 3xN, whose first two rows are Y and X, and the third row gives the rank of X values within the same treatment level. |

## Value

A list containing the following: psudo: a 3-d array of the dimension (k, a, N) that stores the augmented observations based on k-nearest neighbor rule in Wang, Tolos and Wang (2010). index: a 3-d array of the dimension (k, a, N) that stores the index of which observation was used for augmentation.

## References

Haiyan Wang, Siti Tolos, and Suojin Wang (2010). A Distribution Free Nonparametric Test to Detect Dependence Between a Response Variable and Covariate in Presence of Heteroscedastic Treatment Effects. The Canadian Journal of Statistics. 38(3), 408433. Doi:10.1002/cjs.10068

## Examples

```
a=2; n=c(7,9); N=sum(n);  X=runif(N);
trt=c(rep(1,n[1]), rep(2, n[2])); e=rnorm(N, 0, 0.1)
Y=ifelse(trt==1, 4*(X-0.5)^2+e, 2*X+e)
ranksuse=unlist(tapply(X, trt, rank) )
alltrt=rbind(Y, X, ranksuse )
aug=makepseudo(N,n, k=3, a, alltrt)
```

## mapindex *Index in one vector mapped to treatment and observation index*

### Description

Function mapindex() maps the 1-d index r=1,...,N to 2-d index i=1, ...a, j=1, ..., ni. Generally the covariate values from all treatments are stored together in one vector and r=1,...,N enumerates the values. For any integer between 1 and N, mapindex tells which treatment the rth value belongs to, and which observation in the identified treatment.

### Usage

```
mapindex(r, n)
```

### Arguments

| | |
|---|---|
| r | an integer between 1 and sum(n). |
| n | a vector of the sample sizes. |

### Value

the 2-d index, where the first gives which treatment the value belongs to and the second gives which observation in that treatment.

### Examples

```
r=5; n=c(7, 8); mapindex(r, n)
r=7; n=c(7, 8); mapindex(r, n)
r=9; n=c(7, 8); mapindex(r, n)
```

## miniimagematrix *Mini-image data matrice for example*

### Description

The matrices are grayscale images in matrix format.

### Usage

```
data(miniimagematrix)
```

### Format

A list with two grayscale image matrices

**A** A matrix for one image

**B** A matrix for a second image

## Examples

```
data(miniimagematrix)
miniimagematrix$A
```

---

`NPtest_indept` *Test of independence in presence of heteroscedastic treatments*

---

## Description

NPtest_indept performs the test of independence between the response variable and a single covariate when there is potentially heteroscedastic treatment effects present (see Wang, Tolos and Wang (2010)).

## Usage

```
NPtest_indept(dat, k = 7)
```

## Arguments

| | |
|---|---|
| `dat` | A data frame with three columns named X, trt, and Y, where X is the covarite, trt is the treatment level, and Y is the response variable. |
| `k` | An odd integer to specify the number of nearest neighbors to be used in augmentation. Generally recommend to use 3, 5, or 7. |

## Value

A list containing the following variables:

Asys_var: the asymptotic variance for the test statistics

Tstat: the test statistic

pvalue: the p-value of the test under H0: independence between X and Y.

## References

Haiyan Wang, Siti Tolos, and Suojin Wang (2010). A Distribution Free Nonparametric Test to Detect Dependence Between a Response Variable and Covariate in Presence of Heteroscedastic Treatment Effects. The Canadian Journal of Statistics. 38(3), 408433. Doi:10.1002/cjs.10068

## Examples

```
n=64;  X=runif(n); trt=gl(2, n/2)
e=rnorm(n, 0, 0.1)
Y=ifelse(trt==1, 4*(X-0.5)^2+e, 2*X+e)
dat=data.frame(X, Y, trt)
NPtest_indept(dat, k=7)
```

PSSIM_snow *Image structural similarity measure PSSIM based on hypothesis test*

## Description

PSSIM_snow computes image structural similarity PSSIM of Wang, Maldonado and Silwal (2011) using parallel programming.

## Usage

```
PSSIM_snow(
  A,
  A1,
  nprocess = min(8, parallel::detectCores()),
  b = 64,
  a = 2,
  vs = 32,
  wavecoeff = FALSE,
  cs = 2,
  dyn = FALSE
)
```

## Arguments

| | |
|---|---|
| A | a grayscale image stored as a matrix. |
| A1 | grayscale image stored as a matix. Same dimension as A. |
| nprocess | number of cores (workers) to use for parallel computation. Note: In personal computer, nprocess =detectCores() is good to use. On cluster machine, nprocess need to be specified to a number that is no more than its number of cores (for courtesy) |
| b | Number of columns in each block. Suggest to use default value 64. |
| a | Number of rows in each block. Suggest to use default value 2. |
| vs | Block shift size. Suggest to use default value 32. |
| wavecoeff | logical of whether the input matrices are wavelet coefficients. Currently, wavelet version is not implemented. This parameter is a placeholder for future implementation. |
| cs | dividing factor to split index. |
| dyn | logical, whether dynamic scheduling should be used. |

## Value

: Image structural similarity based on PSSIM. The value is in [0,1] with values close to 0 meaning the two images are different and values close to 1 meaning the two iamges are similar.

## References

Haiyan Wang, Diego Maldonado, and Sharad Silwal (2011). A Nonparametric-Test-Based Structural Similarity Measure for Digital Images. Computational Statistics and Data Analysis. 55: 2925-2936. Doi:10.1016/j.csda.2011.04.021

## Examples

```
A=miniimagematrix$A
B=miniimagematrix$B
# see it with image(A, axes=FALSE, col  = gray((0:255)/256) )
PSSIM_snow(A, B, nprocess=2)
```

---

`trt_position` *Starting and ending position in a vector*

---

## Description

Function trt_position() gives the starting and ending index of covariate values in the i1th group if all the covariate values from all treatment groups are together in a vector. E.g., covariate values in group 1 start from 1st value to the n1 th value; those in group 2 start from n1+1 and end at (n1+n2)th value. This function is for retrieving the position of an observations when the covariate values from all treatments are stored together in one vector.

## Usage

```
trt_position(i1, n)
```

## Arguments

| | |
|---|---|
| `i1` | an integer between 1 and length(n). |
| `n` | the vector of sample sizes. |

## Examples

```
i = 2; n=c(7, 8); trt_position(i, n)
```

# Index