Package: OofAExp (via r-universe)

October 19, 2026

Title Order-of-Addition Experiments

Version 0.1.0

Description Order-of-addition experiments are often conducted to address research questions in many real-world studies. This package provides a comprehensive toolbox for researchers and practitioners to design and analyze order-of-addition experiments. Detailed comparisons and summary of all statistical methods in this package can be found in Tsai (2026), ``Order-of-addition experiments in R using OofAExp", Journal of Quality Technology (to appear).

Imports AlgDesign, gmp, gtools, MASS, Matrix, unrepx, utils

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Author Shin-Fu Tsai [aut, cre]

Maintainer Shin-Fu Tsai <shinfu@ntu.edu.tw>

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`dat.3drug` *Three-drug combination data*

Description

This dataset contains all treatments and their corresponding responses of the three-drug combination experiment conducted by Wang, Xu and Ding (2020).

Usage

```
dat.3drug
```

Format

A numeric matrix

Details

There are 28 treatments in this order-of-addition two-level factorial experiment. Each treatment is an order-level combination of three chemotherapeutics. The chemotherapeutics `1` and `2` have two dose levels which are shown in `level.1` and `level.2`, where `-1` represents the low dose level and `+1` represents the high dose level. The chemotherapeutic `3` has a constant level. The three chemotherapeutics were added simultaneously when conducting the treatments `t.7`, `t.14`, `t.21` and `t.28`. Their administration orders are represented by `step.1=step.2=step.3=0`. Each treatment has three independent observations which are given in `y.1`, `y.2` and `y.3`. Their average is listed in `avg`.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Paclitaxel (A).

2: Doxorubicin (B).

3: Mitoxantrone (C).

Wang, Xu and Ding (2020) used the labels in the parentheses.

References

Wang, A., Xu, H. and Ding, X. (2020). Simultaneous optimization of drug combination dose-ratio sequence with innovative design and active learning. *Advanced Therapeutics*, 3:1900135.

See Also

`dat.3drug.adapted`, `dat.4drug`, `dat.5drug`

Examples

```
dat.3drug
```

`dat.3drug.adapted` *Adapted three-drug combination data*

Description

This dataset contains all adapted treatments of the three-drug combination experiment conducted by Wang, Xu and Ding (2020). Related summary statistics of their corresponding responses are also provided.

Usage

```
dat.3drug.adapted
```

Format

A numeric matrix

Details

There are 6 adapted treatments in this order-of-addition experiment. Each adapted treatment is an addition order of three chemotherapeutics. Because the dosage effects do not seem to have a significant impact on the responses, all observations with the same addition order in `dat.3drug` are merged by ignoring their dose levels such that each adapted treatment has `rep=12` independent observations. Their average and variance are listed in `avg` and `var`. Some responses in `dat.3drug` were obtained by adding the three chemotherapeutics simultaneously. They are not included in `dat.3drug.adapted`.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Paclitaxel (A).

2: Doxorubicin (B).

3: Mitoxantrone (C).

Wang, Xu and Ding (2020) used the labels in the parentheses.

References

Wang, A., Xu, H. and Ding, X. (2020). Simultaneous optimization of drug combination dose-ratio sequence with innovative design and active learning. *Advanced Therapeutics*, 3:1900135.

See Also

`dat.3drug`, `dat.4drug`, `dat.5drug`

Examples

```
dat.3drug.adapted
```

`dat.4drug` *Four-drug combination data*

Description

This dataset contains all treatments and their corresponding responses of the four-drug combination experiment conducted by Wang, Xu and Ding (2020).

Usage

```
dat.4drug
```

Format

A numeric matrix

Details

There are 25 treatments in this order-of-addition experiment. Each treatment is an addition order of four chemotherapeutics. The four chemotherapeutics were added simultaneously when conducting the treatment `t.25`. Its administration order is represented by `step.1=step.2=step.3=step.4=0`. Each treatment has three independent observations which are given in `y.1`, `y.2` and `y.3`. Their average is listed in `avg`.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Paclitaxel (A).

2: Doxorubicin (B).

3: Mitoxantrone (C).

4: Cisplatin (D).

Wang, Xu and Ding (2020) used the labels in the parentheses.

References

Wang, A., Xu, H. and Ding, X. (2020). Simultaneous optimization of drug combination dose-ratio sequence with innovative design and active learning. *Advanced Therapeutics*, 3:1900135.

See Also

`dat.3drug`, `dat.5drug`

Examples

```
dat.4drug
```

`dat.4paint` *Four-ingredient paint viscosity data*

Description

This dataset contains all treatments and their corresponding responses of the four-ingredient paint viscosity experiment conducted by Voelkel and Gallagher (2019).

Usage

```
dat.4paint
```

Format

A numeric matrix

Details

There are 24 treatments in this order-of-addition experiment. Each treatment is an addition order of four paint ingredients and has a single replicate. The corresponding response listed in `Log.L.H` is equal to $\log_{10}(\texttt{LSV}/\texttt{HSV})$, where `LSV` is the low shear viscosity and `HSV` is the high shear viscosity.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Primary binder resin (R1).

2: Secondary binder resin (R2).

3: Flow and leveling additive (A).

4: Rheology modifier #1 (M1).

Voelkel and Gallagher (2019) used the labels in the parentheses.

References

Voelkel, J. G. (2019). Order of addition experiments: five designs and three datasets. *Mendeley Data*, Version 1, doi: 10.17632/8vyvrkd7tk.1.

Voelkel, J. G. and Gallagher, K. P. (2019). The design and analysis of order-of-addition experiments: An introduction and case study. *Quality Engineering*, 31, 627-638.

See Also

`dat.5paint`, `dat.6paint`

Examples

```
dat.4paint
```

`dat.5drug` *Five-drug combination data*

Description

This dataset contains all treatments and their corresponding responses of the five-drug combination experiment conducted by Wang, Xu and Ding (2020).

Usage

```
dat.5drug
```

Format

A numeric matrix

Details

There are 60 treatments in this order-of-addition two-level factorial experiment. Each treatment is an order-level combination of five chemotherapeutics. The chemotherapeutics `1` to `4` have a constant dose level. The chemotherapeutic `5` has two dose levels which are shown in `level.5`, where `-1` represents the low dose level and `+1` represents the dose high level. The 60 treatments can be divided into three batches of equal size. The batch number of each treatment is shown in `batch`. Each treatment has three independent observations which are given in `y.1`, `y.2` and `y.3`. Their average is listed in `avg`.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Paclitaxel (A).

2: Doxorubicin (B).

3: Mitoxantrone (C).

4: Cisplatin (D).

5: Etoposide (E).

Wang, Xu and Ding (2020) used the labels in the parentheses.

References

Wang, A., Xu, H. and Ding, X. (2020). Simultaneous optimization of drug combination dose-ratio sequence with innovative design and active learning. *Advanced Therapeutics*, 3:1900135.

See Also

`dat.3drug`, `dat.4drug`

Examples

```
dat.5drug
```

`dat.5paint` *Five-ingredient paint viscosity data*

Description

This dataset contains all treatments and their corresponding responses of the five-ingredient paint viscosity experiment conducted by Voelkel and Gallagher (2019).

Usage

```
dat.5paint
```

Format

A numeric matrix

Details

There are 15 treatments in this order-of-addition experiment. Each treatment is an addition order of five paint ingredients and has a single replicate. The corresponding response listed in `Log.L.H` is equal to $\log_{10}(\texttt{LSV}/\texttt{HSV})$, where `LSV` is the low shear viscosity and `HSV` is the high shear viscosity.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Crosslinking resin (X).

2: Primary binder resin (R1).

3: Secondary binder resin (R2).

4: Flow and leveling additive (A).

5: Rheology modifier #1 (M1).

Voelkel and Gallagher (2019) used the labels in the parentheses. Because only the position vectors are given in the data file `PPG5_15.csv` in Voelkel (2019), these position vectors are converted to treatment vectors in `dat.5paint`. In particular, every logarithmic ratio in `PPG5_15.csv` in Voelkel (2019) was obtained by computing $\log_{10}(\log_{10}\texttt{LSV}/\log_{10}\texttt{HSV})$.

References

Voelkel, J. G. (2019). Order of addition experiments: five designs and three datasets. *Mendeley Data*, Version 1, doi: 10.17632/8vyvrkd7tk.1.

Voelkel, J. G. and Gallagher, K. P. (2019). The design and analysis of order-of-addition experiments: An introduction and case study. *Quality Engineering*, 31, 627-638.

See Also

`dat.4paint`, `dat.6paint`

Examples

```
dat.5paint
```

`dat.6paint` *Six-ingredient paint viscosity data*

Description

This dataset contains all treatments and their corresponding responses of the six-ingredient paint viscosity experiment conducted by Voelkel and Gallagher (2019).

Usage

```
dat.6paint
```

Format

A numeric matrix

Details

There are 24 treatments in this order-of-addition experiment. Each treatment is an addition order of six paint ingredients and has a single replicate. The corresponding response listed in `Log.L.H` is equal to $\log_{10}(\texttt{LSV}/\texttt{HSV})$, where `LSV` is the low shear viscosity and `HSV` is the high shear viscosity.

Note

All components are relabeled with positive integers according to the following relabeling scheme.

1: Crosslinking resin (X).

2: Primary binder resin (R1).

3: Secondary binder resin (R2).

4: Flow and leveling additive (A).

5: Rheology modifier #2 (M2).

6: Rheology modifier #1 (M1).

Voelkel and Gallagher (2019) used the labels in the parentheses.

References

Voelkel, J. G. (2019). Order of addition experiments: five designs and three datasets. *Mendeley Data*, Version 1, doi: 10.17632/8vyvrkd7tk.1.

Voelkel, J. G. and Gallagher, K. P. (2019). The design and analysis of order-of-addition experiments: An introduction and case study. *Quality Engineering*, 31, 627-638.

See Also

`dat.4paint`, `dat.5paint`

Examples

```
dat.6paint
```

`des.cat` *Design catalogue for order-of-addition experiments*

Description

This function provides optimal experimental designs for order-of-addition experiments.

Usage

```
des.cat(m, n, class, rand = TRUE)
```

Arguments

m	a positive integer indicating the number of components.
n	a positive integer indicating the number of treatments.
class	a character indicating the class of optimal order-of-addition designs. Available options include order-of-addition orthogonal arrays of strength two ("OofA-OA") and component orthogonal arrays of strength two ("COA").
rand	a logical indicating whether or not the design matrix should be row-randomized. The default value is TRUE.

Value

The output is a list consisting of the following components.

dem	an n $\times$ m design matrix taken from the design catalogue.
ref	a character indicating the reference of this optimal design.

Note

The des.cat function provides optimal order-of-addition design for m $\leq$ 9 and n $\leq$ 200. They are taken from the papers listed below. In particular, the order-of-addition orthogonal arrays of strength two for m $=$ 7 and n $=$ 60, 108, 132, 156, 180 are generated by computer search when developing this package.

References

Schoen, E.D. and Mee, R.W. (2023). Order-of-addition orthogonal arrays to study the effect of treatment ordering. *Annals of Statistics*, 51, 1877-1894.

Tsai, S.-F. (2022). Generating optimal order-of-addition designs with flexible run sizes. *Journal of Statistical Planning and Inference*, 218, 147-163.

Tsai, S.-F. (2023). Dual-orthogonal arrays for order-of-addition two-level factorial experiments. *Technometrics*, 65, 388-395.

Tsai, S.-F. (2025). Characterizing and comparing order-of-addition orthogonal arrays. *Statistica Sinica*, to appear.

Voelkel, J.G. (2019). The design of order-of-addition experiments. *Journal of Quality Technology*, 51, 230-241.

Yang, J.-F., Sun, F. and Xu, H. (2021). A component-position model, analysis and design for order-of-addition experiments. *Technometrics*, 63, 212-224.

Zhao, Y., Li, Z. and Zhao, S. (2021). A new method of finding component orthogonal arrays for order-of-addition experiments. *Metrika*, 84, 805-824.

Zhao, Y., Lin, D.K.-J. and Liu, M.-Q. (2022). Optimal designs for order-of-addition experiments. *Computational Statistics and Data Analysis*, 165:107320.

Examples

```
### OofA-OA(4,12,2) ###
des.cat(4,12,"OofA-OA")

### COA(5,20,2) ###
des.cat(5,20,"COA")
```

`des.pwof.Federov` *Design generator using pairwise order factors and Federov's exchange algorithm*

Description

This function generates order-of-addition designs using pairwise order factors and `optFederov` function in the **AlgDesign** package.

Usage

```
des.pwof.Federov(m, n, rep = 1, aoc = "D")
```

Arguments

`m`	a positive integer indicating the number of components.
`n`	a positive integer indicating the number of treatments.
`rep`	a positive integer indicating the number of repeats. The default value is `1`.
`aoc`	a character indicating the alphabetic-optimality criterion to be used. Available options include the D-optimality criterion (`"D"`) and A-optimality criterion (`"A"`). The default criterion is `"D"`.

Value

The output is a `list` consisting of the following components.

`dem`	an `n` $\times$ `m` design matrix generated by this function.
`ree`	relative efficiency of the output design and the theoretical optimum provided by Peng et al. (2019).
`rid`	row indices of the output design corresponding to the full design generated by `permutations(n=m,r=m,v=1:m)`.

References

Federov, V. V. (1972). Theory of optimal experiments. Academic Press, New York, NY, United States.

Peng, J., Mukerjee, R. and Lin, D. K.-J. (2019). Design of order-of-addition experiments. *Biometrika*, 106, 683-694.

Wheeler, R. E. (2025). **AlgDesign**: Algorithmic experimental design. R package 1.2.1 https://cran.r-project.org/web/packages/AlgDesign/index.html.

See Also

des.pwof.Latinoa

Examples

```
### m=4 and n=12 ###
des.pwof.Federov(4,12)
```

---

des.pwof.Latinoa *Design generator using pairwise order factors and Latin squares*

Description

This function generates order-of-addition designs by using pairwise order factors and juxtaposing isotopic Latin squares. This function is an R implementation of Algorithm 1 of Tsai (2022).

Usage

```
des.pwof.Latinoa(m, nl, ni = 1, nu = 1000)
```

Arguments

m	a positive integer indicating the number of components.
nl	a positive integer indicating the number of isotopic Latin squares.
ni	a positive integer indicating the number of initials. The default value is 1.
nu	a positive integer indicating the number of updates. The default value is 1000.

Value

The output is a list consisting of the following components.

dem	an $n \times m$ design matrix generated by this function, where $n = m \times nl$.
rde	relative D-efficiency of the output design and the theoretical optimum provided by Peng et al. (2019).
rid	row indices of the column permutation sequences corresponding to the candidate set generated by cbind(permutations(n=(m-1),r=(m-1),v=1:(m-1)),m).

Note

A Fortran implementation of Algorithm 1 of Tsai (2022) called Latinoa can be downloaded from his personal website (https://www.shinfu.idv.tw).

References

Peng, J., Mukerjee, R. and Lin, D. K.-J. (2019). Design of order-of-addition experiments. *Biometrika*, 106, 683-694.

Tsai, S.-F. (2022). Generating optimal order-of-addition designs with flexible run sizes. *Journal of Statistical Planning and inference*, 218, 147-163.

See Also

des.pwof.Federov

Examples

```
### m=5 and n=60 ###
des.pwof.Latinoa(5,12,1,50)
```

---

enu.hdd *Enumerator of Hamming distance distributions*

Description

This function enumerates the Hamming distance distribution of all m-element permutations, where the Hamming distance between two permutations is defined based on their pairwise order vectors.

Usage

```
enu.hdd(m)
```

Arguments

m	a positive integer indicating the number of elements.

Value

The output is an integer vector of length $m(m-1)/2+1$.

Note

The output consists of the integer sequence labeled A008302 on the Online Encyclopedia of Integer Sequences (https://oeis.org/A008302). The output consists of many extremely large integers when m is moderately large. Therefore, when m is larger than or equal to 20, the as.bigz function in the **gmp** package is called for such big integer calculations, with the result that the computational speed may be slow.

References

Tsai, S.-F. (2025). Characterizing and comparing order-of-addition orthogonal arrays. *Statistica Sinica*, to appear.

See Also

enu.inn

Examples

```
### OEIS A008302 ###
enu.hdd(3)
```

enu.inn *Enumerator of inversion numbers*

Description

This function enumerates inversion numbers of all m-element permutations in lexicographic order.

Usage

```
enu.inn(m)
```

Arguments

m	a positive integer indicating the number of elements.

Value

The output is an integer vector of length m!.

Note

The output consists of the integer sequence labeled A034968 on the Online Encyclopedia of Integer Sequences (https://oeis.org/A034968). The frequency distribution of all integers in the output is identical to the Hamming distance distribution yielded by the enu.hdd function. In other words, the frequency distribution consists of the integer sequence labeled A008302 on the Online Encyclopedia of Integer Sequences (https://oeis.org/A008302).

References

Tsai, S.-F. (2025). Characterizing and comparing order-of-addition orthogonal arrays. *Statistica Sinica*, to appear.

See Also

enu.hdd

Examples

```
### OEIS A034968 ###
enu.inn(3)

### OEIS A008302 ###
table(enu.inn(3))
```

gen.cp *Generator of component positions*

Description

This function generates component positions.

Usage

```
gen.cp(t)
```

Arguments

t	a treatment vector consisting of the m component labels $\{1, 2, \ldots, m\}$ or an $n \times m$ design matrix consisting of n treatment vectors of length m as its row vectors.

Value

The output is an $1 \times m$ position vector or an $n \times m$ position matrix.

Note

This function can also be used to generate a treatment vector or a treatment matrix when the input is a position vector or a position matrix.

References

Stokes and Xu (2022). A position-based approach for design and analysis of order-of-addition experiments. *Statistica Sinica*, 32, 1467-1488.

Yang, J.-F., Sun, F. and Xu, H. (2021). A component-position model, analysis and design for order-of-addition experiments. *Technometrics*, 63, 212-224.

See Also

gen.pf

Examples

```
gen.cp(c(1,4,2,3))
gen.cp(gen.cp(c(1,4,2,3)))
```

`gen.pf` *Generator of pseudo factors*

Description

This function generates pseudo factors.

Usage

```
gen.pf(t, method)
```

Arguments

`t`	a treatment vector consisting of the `m` component labels $\{1, 2, \ldots, m\}$ or an $n \times m$ design matrix consisting of `n` treatment vectors of length `m` as its row vectors.
`method`	a character indicating the pseudo factors to be used. Available options include pairwise order factors ("`pwof`"), linear component-position factors ("`lcpf`") and quadratic component-position factors ("`qcpf`").

Value

The output is a numeric vector or a numeric matrix.

References

Stokes and Xu (2022). A position-based approach for design and analysis of order-of-addition experiments. *Statistica Sinica*, 32, 1467-1488.

Van Nostrand, R. C. (1995). Design of experiments where the order of addition is important. *ASA Proceedings of the Section on Physical and Engineering Sciences*, 155-160. American Statistical Association, Alexandria, VA, United States.

Voelkel, J. G. (2019). The design of order-of-addition experiments. *Journal of Quality Technology*, 51, 230-241.

Yang, J.-F., Sun, F. and Xu, H. (2021). A component-position model, analysis and design for order-of-addition experiments. *Technometrics*, 63, 212-224.

See Also

`gen.cp`

Examples

```
### treatment 1423 ###
gen.pf(c(1,4,2,3),"pwof")
gen.pf(c(1,4,2,3),"lcpf")
gen.pf(c(1,4,2,3),"qcpf")
```

gen.qf *Generator of quasi-foldover vectors*

Description

This function generates quasi-foldover vectors and related index sets with respect to a user-specified requirement set for a given order-of-addition design.

Usage

```
gen.qf(t, req)
```

Arguments

t	an n × m design matrix consisting of n treatment vectors of length m as its row vectors.
req	a character vector indicating the requirement set in which "z.i.j" is used to denote the pairwise order factor of components i and j.

Value

The output is a list consisting of the following components.

v	all possible (+1,-1)-vectors.
pst	index pairs of positive quasi foldover vectors.
nst	index pairs of negative quasi foldover vectors.
ist	index sets of treatments.

References

Tsai, S.-F. (2023). Analyzing dispersion effects from order-of-addition experiments. *Journal of Quality Technology*, 55, 271-288.

Tsai, S.-F. and He, S.-S. (2024). Testing multiple dispersion effects from unreplicated order-of-addition experiments. *Australian and New Zealand Journal of Statistics*, 66, 228-248.

See Also

test.pwof.dp.u

Examples

```
### Example 2 of Tsai and He (2024) ###
gen.qf(dat.6paint[,1:6],c("z.1.2","z.4.6"))
```

`test.cpf.lo` *Standard t-tests for component-position location effects*

Description

This function implements standard t-tests for identifying active linear and quadratic component-position location effects from order-of-addition experiments.

Usage

```
test.cpf.lo(t, y, cpf)
```

Arguments

`t`	an `n` $\times$ `m` design matrix consisting of `n` treatment vectors of length `m` as its row vectors.
`y`	a response vector of length `n`.
`cpf`	a character indicating the component position factors to be used. Available options includes the linear component-position factors ("`lcpf`") and quadratic component-position factors ("`qcpf`").

Value

The output is a numeric matrix consisting of all least squares estimates, t-statistics and their p-values.

Note

Based on the hierarchy-of-effects assumption, both linear and quadratic component-position effects will be tested when the `cpf` argument is set to "`qcpf`".

References

Stokes and Xu (2022). A position-based approach for design and analysis of order-of-addition experiments. *Statistica Sinica*, 32, 1467-1488.

See Also

`test.pwof.lo`

Examples

```
### linear component-position model in (3.6) of Stokes and Xu (2022) ###
library(gtools)
t<-permutations(n=4,r=4,v=1:4)
y<-c(41.1,37.5,55.4,56.5,43.3,51.2,46.1,27.8,39.5,46.4,34.4,39.4,
     53.5,51.2,50.8,51.4,52.9,53.4,39.1,46.4,37.2,42.1,46.8,41.8)
test.cpf.lo(t,y,"lcpf")
```

`test.pwof.dp.r` *Frequentist test for identifying active pairwise order dispersion effects from replicated order-of-addition experiments*

Description

This function implements frequentist (approximate) z-tests for identifying active pairwise order dispersion effects from replicated order-of-addition experiments.

Usage

```
test.pwof.dp.r(t, v, r)
```

Arguments

`t`	an `n` $\times$ `m` design matrix consisting of `n` treatment vectors of length `m` as its row vectors.
`v`	a vector of length `n` consisting of sample variances.
`r`	a positive integer indicating the number of replicates.

Value

The output is a numeric matrix consisting of all least squares estimates, z-statistics and their p-values.

References

Bartlett, M. S. and Kendall, D. G. (1946). The statistical analysis of variance-heterogeneity and the logarithmic transformation. *Supplement to the Journal of the Royal Statistical Society*, 8, 128-138.

Tsai, S.-F. (2023). Analyzing dispersion effects from replicated order-of-addition experiments. *Journal of Quality Technology*, 55, 271-288.

See Also

`test.pwof.dp.u`

Examples

```
### the first three p-values in Table 4 of Tsai (2023) ###
test.pwof.dp.r(dat.3drug.adapted[,1:3],dat.3drug.adapted[,6],12)
```

`test.pwof.dp.u` *Fiducial test for identifying active pairwise order dispersion effects from unreplicated order-of-addition experiments*

Description

This function implements fiducial tests for identifying active pairwise order dispersion effects from unreplicated order-of-addition experiments.

Usage

```
test.pwof.dp.u(t, y, ale, req, nmc = 5000)
```

Arguments

`t`	an `n` $\times$ `m` design matrix consisting of `n` treatment vectors of length `m` as its row vectors.
`y`	a response vector of length `n`.
`ale`	a character vector indicating the active location effects in which "`z.i.j`" is used to denote the pairwise order factor of components `i` and `j`.
`req`	a character vector indicating the requirement set in which "`z.i.j`" is used to denote the pairwise order factor of components `i` and `j`.
`nmc`	a positive integer indicating the number of Monte-Carlo samples to be generated. The default value is `5000`.

Value

The output is a numeric vector consisting of all approximate p-values.

Note

Before implementing the `test.pwof.dp.u` function, as noted in Tsai and He (2024), all active location effects must be listed in the `ale` argument.

References

Tsai, S.-F. and He, S.-S. (2024). Testing multiple dispersion effects from unreplicated order-of-addition experiments. *Australian and New Zealand Journal of Statistics*, 66, 228-248.

See Also

`test.pwof.dp.r`

Examples

```
### analysis results in Section 5 of Tsai and He (2024) ###
l<-c("z.1.2","z.2.4","z.2.5","z.2.6","z.4.6")
d<-c("z.1.2","z.4.6")
test.pwof.dp.u(dat.6paint[,1:6],dat.6paint[,9],l,d)
```

`test.pwof.lo` *Standard and pseudo t-tests for pairwise order location effects*

Description

This function implements standard and pseudo t-tests for identifying active pairwise order location effects from order-of-addition experiments.

Usage

```
test.pwof.lo(t, y, nmc = 5000, estimator = "Lenth")
```

Arguments

`t`	an $n \times m$ design matrix consisting of `n` treatment vectors of length `m` as its row vectors.
`y`	a response vector of length `n`.
`nmc`	a positive integer indicating the number of Monte-Carlo samples to be generated. The default value is `5000`.
`estimator`	a character indicating the pseudo standard error to be used. Because the `PSE` function in the **unrepx** package is used to get the pseudo standard error, several estimators can be used to compute the pseudo t-statistics. Available options include `"Daniel"`, `"Dong"`, `"JuanPena"`, `"Lenth"`, `"RMS"`, `"SMedian"`, `"WZhan"`, and `"Zhan"`. The default value is `"Lenth"`.

Value

The output is a numeric matrix consisting of all least squares estimates and their p-values, where the p-values listed in `p.value.t`, `p.value.u` and `p.value.c` are computed based on the standard t-statistics, U and C methods.

Note

The standard t-test will not be implemented when $n = m(m-1)/2 + 1$.

References

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Tsai, S.-F. (2026). Order-of-addition experiments in R using **OofAExp**. *Journal of Quality Technology*, to appear.

Zahn, D. A. (1975). Modifications of and revised critical values for the half-normal plot. *Technometrics*, 17, 189-200.

See Also

`test.cpf.lo`

Examples

```
### example 4 in Tsai (2026) ###
test.pwof.lo(dat.4paint[,1:4],dat.4paint[,7],1000)
```

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