Package: permutest (via r-universe)

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Title Run Permutation Tests and Construct Associated Confidence Intervals

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Description Implements permutation tests for any test statistic and randomization scheme and constructs associated confidence intervals as described in Glazer and Stark (2024) <doi:10.48550/arXiv.2405.05238>.

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Contents

`adjust_p_value` *Adjust p-values for multiple testing*

Description

This function takes an array of p-values and returns adjusted p-values using user-inputted FWER or FDR correction method

Usage

```
adjust_p_value(pvalues, method = "holm-bonferroni")
```

Arguments

`pvalues`	Array of p-values
`method`	The FWER or FDR correction to use, either 'holm-bonferroni', 'bonferroni', or 'benjamini-hochberg'

Value

Adjusted p-values

Examples

```
adjust_p_value(pvalues = c(.05, .1, .5), method='holm-bonferroni')
```

`diff_in_means` *Calculate difference in means*

Description

This function takes a data frame, and group and outcome column names as input and returns the difference in mean outcome between the two groups

Usage

```
diff_in_means(df, group_col, outcome_col, treatment_value = NULL)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_col	The name of the column in df that corresponds to the outcome variable
treatment_value	The value of group_col to be considered 'treatment'

Value

The difference in mean outcome between the two groups

Examples

```
data <- data.frame(group = c(rep(1, 4), rep(2, 4)),
                   outcome = c(rep(3, 4), rep(5, 4)))

diff_in_means(df = data,
              group_col = "group",
              outcome_col = "outcome",
              treatment_value = 1)
```

---

diff_in_medians *Calculate difference in medians*

Description

This function takes a data frame, and group and outcome column names as input and returns the difference in median outcome between the two groups

Usage

```
diff_in_medians(df, group_col, outcome_col, treatment_value = NULL)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_col	The name of the column in df that corresponds to the outcome variable
treatment_value	The value of group_col to be considered 'treatment'

Value

The difference in median outcome between the two groups

Examples

```
data <- data.frame(group = c(rep(1, 4), rep(2, 4)),
                   outcome = c(rep(3, 4), rep(5, 4)))

diff_in_medians(df = data,
              group_col = "group",
              outcome_col = "outcome",
              treatment_value = 1)
```

`fisher` *Fisher combining function*

Description

This function takes an array of p-values and returns a combined p-value using fisher's combining function: $-2\sum_i \log(p_i)$

Usage

```
fisher(pvalues)
```

Arguments

`pvalues`	Array of p-values

Value

Combined p-value using fisher's method

Examples

```
fisher(pvalues = c(.05, .1, .5))
```

`liptak` *Liptak combining function*

Description

This function takes an array of p-values and returns a combined p-value using Liptak's combining function: $\sum_i \Phi^{-1}(1-p_i)$ where Φ is the CDF of the Normal distribution

Usage

```
liptak(pvalues)
```

Arguments

pvalues	Array of p-values

Value

Combined p-value using Liptak's method

Examples

```
liptak(pvalues = c(.05, .1, .5))
```

---

npc *Run NPC*

Description

This function takes a data frame and group and outcome column names as input and returns the nonparametric combination of tests (NPC) omnibus p-value

Usage

```
npc(
  df,
  group_col,
  outcome_cols,
  strata_col = NULL,
  test_stat = "diff_in_means",
  perm_func = permute_group,
  combn = "fisher",
  shift = 0,
  reps = 10000,
  perm_set = NULL,
  complete_enum = FALSE,
  seed = NULL
)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_cols	The names of the columns in df that corresponds to the outcome variable
strata_col	The name of the column in df that corresponds to the strata
test_stat	Test statistic function
perm_func	Function to permute group, default is permute_group which randomly permutes group assignment

combn	Combining function method to use, takes values 'fisher', 'tippett', or 'liptak', or a user defined function
shift	Value of shift to apply in one- or two-sample problem
reps	Number of iterations to use when calculating permutation p-value
perm_set	Matrix of permutations to use instead of reps iterations of perm_func
complete_enum	Boolean, whether to calculate P-value under complete enumeration of permutations
seed	An integer seed value

Value

The omnibus p-value

Examples

```
data <- data.frame(group = c(rep(1, 4), rep(2, 4)),
out1 = c(0, 1, 0, 0, 1, 1, 1, 0),
out2 = rep(1, 8))
output <- npc(df = data, group_col = "group",
              outcome_cols = c("out1", "out2"), perm_func = permute_group,
              combn = "fisher", reps = 10^4, seed=42)
```

---

one_sample *One-sample permutation test*

Description

This function runs a permutation test for the one-sample problem by calling the permutation_test function using the one-sample mean test statistic.

Usage

```
one_sample(x, shift = 0, alternative = "greater", reps = 10^4, seed = NULL)
```

Arguments

x	array of data
shift	Value of shift to apply in one-sample problem
alternative	String, two-sided or one-sided (greater or less) p-value
reps	Number of iterations to use when calculating permutation p-value
seed	An integer seed value

Value

The permutation test p-value

Examples

```
one_sample(x = c(-1, 1, 2), seed = 42)
```

`one_sample_mean` *Calculate the one-sample problem test statistic*

Description

This function takes a data frame, and group and outcome column names as input and returns the mean of the product of the outcome and group. This test statistic is used for the one-sample problem.

Usage

```
one_sample_mean(df, group_col, outcome_col)
```

Arguments

`df`	A data frame
`group_col`	The name of the column in df that corresponds to the group label
`outcome_col`	The name of the column in df that corresponds to the outcome variable

Value

The one-sample problem test statistic: the mean of the product of the outcome and group

Examples

```
data <- data.frame(group = c(rep(1, 4), rep(2, 4)),
                   outcome = c(rep(3, 4), rep(5, 4)))

one_sample_mean(df = data,
              group_col = "group",
              outcome_col = "outcome")
```

one_way_anova_stat *Calculate one-way anova test statistic*

Description

This function takes a data frame, and group and outcome column names as input and returns the one-way anova test statistic

Usage

```
one_way_anova_stat(df, group_col, outcome_col)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_col	The name of the column in df that corresponds to the outcome variable

Value

The one-way anova test statistic: $\sum_{g=1}^{G} n_g(\overline{X_g} - \overline{X})^2$ where g indexes the groups

permutation_test *Run permutation test*

Description

Run permutation test with user inputted data, test statistic, and permutation function

Usage

```
permutation_test(
  df,
  group_col,
  outcome_col,
  strata_col = NULL,
  test_stat = "diff_in_means",
  perm_func = permute_group,
  alternative = "two-sided",
  shift = 0,
  reps = 10000,
  perm_set = NULL,
  complete_enum = FALSE,
  return_test_dist = FALSE,
  return_perm_dist = FALSE,
  seed = NULL
)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_col	The name of the column in df that corresponds to the outcome variable
strata_col	The name of the column in df that corresponds to the strata
test_stat	Test statistic function
perm_func	Function to permute group
alternative	String, two-sided or one-sided (greater or less) p-value; options are 'greater', 'less', or 'two-sided'
shift	Value of shift to apply in one- or two-sample problem
reps	Number of iterations to use when calculating permutation p-value
perm_set	Matrix of group assignments to use instead of reps iterations of perm_func
complete_enum	Boolean, whether to calculate P-value under complete enumeration of permutations
return_test_dist	Boolean, whether to return test statistic distribution under permutations
return_perm_dist	Boolean, whether to return a matrix where each row is the group assignment under that permutation
seed	An integer seed value

Value

p_value: the permutation test p-value

test_stat_dist: array, the distribution of the test statistic under the set of permutations, if return_test_dist is set to TRUE

perm_indices_mat: matrix, each row corresponds to a permutation used in the permutation test calculation

Examples

```
data <- data.frame(group = c(rep(1, 10), rep(2, 10)), outcome = c(rep(1, 10), rep(1, 10)))

permutation_test(df = data, group_col = "group", outcome_col = "outcome",
test_stat = "diff_in_means", perm_func = permute_group, alternative = "greater",
shift = 0, reps = 10, return_perm_dist = TRUE, return_test_dist = TRUE, seed = 42)
```

`permutation_test_ci` *Construct confidence interval by inverting permutation tests*

Description

This function constructs a confidence interval by inverting permutation tests and applying the method in Glazer and Stark, 2024.

Usage

```
permutation_test_ci(
  df,
  group_col,
  outcome_col,
  strata_col = NULL,
  test_stat = "diff_in_means",
  perm_func = permute_group,
  upper_bracket = NULL,
  lower_bracket = NULL,
  cl = 0.95,
  e = 0.1,
  reps = 10000,
  perm_set = NULL,
  seed = 42
)
```

Arguments

`df`	A data frame
`group_col`	The name of the column in df that corresponds to the group label
`outcome_col`	The name of the column in df that corresponds to the outcome variable
`strata_col`	The name of the column in df that corresponds to the strata
`test_stat`	Test statistic function
`perm_func`	Function to permute group
`upper_bracket`	Array with 2 values that bracket upper confidence bound
`lower_bracket`	Array with 2 values that bracket lower confidence bound
`cl`	Confidence level, default 0.95
`e`	Maximum distance from true confidence bound value
`reps`	Number of iterations to use when calculating permutation p-value
`perm_set`	Matrix of group assignments to use instead of reps iterations of perm_func
`seed`	An integer seed value

Value

A list containing the permutation test p-value, and the test statistic distribution if applicable

Examples

```
x <- c(35.3, 35.9, 37.2, 33.0, 31.9, 33.7, 36.0, 35.0, 33.3, 33.6, 37.9, 35.6, 29.0, 33.7, 35.7)
y <- c(32.5, 34.0, 34.4, 31.8, 35.0, 34.6, 33.5, 33.6, 31.5, 33.8, 34.6)
df <- data.frame(outcome = c(x, y), group = c(rep(1, length(x)), rep(0, length(y))))
permutation_test_ci(df = df, group_col = "group", outcome_col = "outcome", strata_col = NULL,
                    test_stat = "diff_in_means", perm_func = permute_group,
                    upper_bracket = NULL, lower_bracket = NULL,
                    cl = 0.95, e = 0.01, reps = 10^3, seed = 42)
```

---

permute_group *Unstratified group permutation*

Description

This function takes a data frame and group column name as input and returns the dataframe with the group column randomly permuted

Usage

```
permute_group(df, group_col, strata_col = NULL, seed = NULL)
```

Arguments

df	A data frame
group_col	String, the name of the column in df that corresponds to the group label
strata_col	The name of the column in df that corresponds to the strata, should be NULL for unstratified permutation
seed	An integer seed value

Value

The inputted data frame with the group column randomly shuffled

Examples

```
data <- data.frame(group_label = c(1, 2, 2, 1, 2, 1), outcome = 1:6)
permute_group(df = data, group_col = "group_label", strata_col = NULL, seed = 42)
```

permute_sign *Sign permutation*

Description

This function takes a data frame and group and outcome column name as input and returns the dataframe with the group column replaced with randomly assigned signs

Usage

```
permute_sign(df, group_col, strata_col = NULL, seed = NULL)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
strata_col	The name of the column in df that corresponds to the strata, should be NULL for this function
seed	An integer seed value

Value

The inputted data frame with the group column replaced with randomly assigned signs

Examples

```
data <- data.frame(group_label = rep(1, 6), outcome = 1:6)
permute_group(df = data, group_col = "group_label", strata_col = NULL, seed = 42)
```

strat_permute_group *Stratified group permutation*

Description

This function takes a data frame and group and strata column name as input and returns the dataframe with the group column randomly permuted by strata

Usage

```
strat_permute_group(df, group_col, strata_col, seed = NULL)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
strata_col	The name of the column in df that corresponds to the strata
seed	An integer seed value

Value

The inputted data frame with the group column randomly shuffled by strata

Examples

```
data <- data.frame(group_label = c(1, 2, 2, 1, 2, 1), stratum = c(1, 1, 1, 2, 2, 2), outcome = 1:6)
permute_group(df = data, group_col = "group_label", strata_col = "stratum", seed = 42)
```

---

tippett *Tippett combining function*

Description

This function takes an array of p-values and returns a combined p-value using Tippett's combining function: $\max_i\{1 - p_i\}$

Usage

```
tippett(pvalues)
```

Arguments

pvalues	Array of p-values

Value

Combined p-value using Tippett's method

Examples

```
tippett(pvalues = c(.05, .1, .5))
```

ttest_stat *Calculate t-test statistic*

Description

This function takes a data frame, and group and outcome column names as input and returns the t test statistic

Usage

```
ttest_stat(df, group_col, outcome_col)
```

Arguments

df	A data frame
group_col	The name of the column in df that corresponds to the group label
outcome_col	The name of the column in df that corresponds to the outcome variable

Value

The t test statistic

two_sample *Two-sample permutation test*

Description

This function runs a permutation test with difference in means test statistic for the two-sample problem by calling the permutation_test function.

Usage

```
two_sample(x, y, shift = 0, alternative = "greater", reps = 10^4, seed = NULL)
```

Arguments

x	array of data for treatment group
y	array of data for control group
shift	Value of shift to apply in two-sample problem
alternative	String, two-sided or one-sided (greater or less) p-value; options are 'greater', 'less', or 'two-sided'
reps	Number of iterations to use when calculating permutation p-value
seed	An integer seed value

Value

The permutation test p-value

Examples

```
two_sample(x = c(10, 9, 11), y = c(12, 11, 13), alternative = "less", seed = 42)
```

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