Package ‘MRTSampleSizeBinary’

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Type  Package
Title  Sample Size Calculator for MRT with Binary Outcomes
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Description  Provides a sample size calculator for micro-randomized trials (MRTs) with binary outcomes based on methodology developed in Qian et al. (2020) <doi:10.1093/biomet/asaa070>. Also provides a power calculator when the sample size is input by the user.
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Vector that defines the MEE under the alternative hypothesis.

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compute_m_sigma

Computes "M" and "Sigma" matrices for the sandwich estimator of variance-covariance matrix.

Description
A helper function for mrt_binary_power() and mrt_binary_ss().

Usage
compute_m_sigma(avail_pattern, f_t, g_t, beta, alpha, p_t)

Arguments
- avail_pattern: A vector of length T that is the average availability at each time point
- f_t: Defines marginal excursion effect MEE(t) under alternative together with beta. Assumed to be matrix of size T*p.
- g_t: Defines success probability null curve together with alpha. Assumed to be matrix of size T*q.
- beta: Length p vector that defines marginal excursion effect MEE(t) under alternative together with f_t.
- alpha: Length q vector that defines success probability null curve together with g_t.
- p_t: Length T vector of randomization probabilities at each time point

Value
List containing two matrices. The first is the M matrix and the second is the Sigma matrix.

Examples
compute_m_sigma(tau_t_1, f_t_1, g_t_1, beta_1, alpha_1, p_t_1)

compute_ncp

Computes the non-centrality parameter for an F distributed random variable in the context of a MRT with binary outcome.

Description
A helper function for mrt_binary_power() and mrt_binary_ss().

Usage
compute_ncp(x, beta, m_matrix, sigma_matrix)
Arguments

\begin{itemize}
  \item \texttt{x} \quad \text{Sample size}
  \item \texttt{beta} \quad \text{Marginal excursion effect, assumed dimension p}
  \item \texttt{m_matrix} \quad \text{"Bread" of sandwich estimator for variance}
  \item \texttt{sigma_matrix} \quad \text{"Meat" of sandwich estimator for variance}
\end{itemize}

Value

Returns non-centrality parameter for an F distributed random variable.

Examples

\begin{verbatim}
compute_ncp(300, beta_1, m_matrix_1, sigma_matrix_1)
\end{verbatim}

\begin{verbatim}
f_t_1
\end{verbatim}

\textit{A matrix defining the MEE under the alternative hypothesis.}

Description

A matrix defining the MEE under the alternative hypothesis.

Usage

\begin{verbatim}
f_t_1
\end{verbatim}

Format

a 10 by 2 matrix
  In this example it is a log-linear trend.

\begin{verbatim}
g_t_1
\end{verbatim}

\textit{A matrix defining the success probability null curve.}

Description

A matrix defining the success probability null curve.

Usage

\begin{verbatim}
g_t_1
\end{verbatim}

Format

a 10 by 2 matrix
  In this example it is a log-linear trend.
is_full_column_rank

Check if a matrix is full column rank.

Description

Used in checking if p_t*f_t is in the linear span of g_t.

Usage

is_full_column_rank(mat)

Arguments

mat A matrix.

Value

Boolean TRUE/FALSE for if matrix is full column rank.

Examples

is_full_column_rank(diag(4))

max_samp

Returns default maximum sample size to end power_vs_n_plot().

Description

Returns default maximum sample size to end power_vs_n_plot().

Usage

max_samp(min_samp)

Arguments

min_samp The starting sample size of the plot.

Value

A default maximum sample size to end power_vs_n_plot().

Examples

max_samp(100)
**min_samp**

*Compute minimum sample size.*

**Description**

Returns a default minimum sample size to start power_vs_n_plot() at.

**Usage**

`min_samp(alph, bet)`

**Arguments**

- `alph` Vector to describe the MEE under the alternative.
- `bet` Vector to describe the MEE under the null.

**Value**

A default minimum sample size to start power_vs_n_plot() at.

**Examples**

`min_samp(alpha_1, beta_1)`

---

**mrt_binary_power**

*Calculate power for binary outcome MRT*

**Description**

Returns power of the hypothesis test of marginal excursion effect (see Details) given a specified sample size in the context of an MRT with binary outcomes with small sample correction using F-distribution. See the vignette for more details.

**Usage**

`mrt_binary_power(avail_pattern, f_t, g_t, beta, alpha, p_t, gamma, n)`

**Arguments**

- `avail_pattern` A vector of length m that is the average availability at each time point
- `f_t` Defines marginal excursion effect MEE(t) under alternative together with beta. Assumed to be matrix of size m*p.
- `g_t` Defines success probability null curve together with alpha. Assumed to be matrix of size m*q.
mrt_binary_ss

- **beta**: Length p vector that defines marginal excursion effect MEE(t) under alternative together with f_t.
- **alpha**: Length q vector that defines success probability null curve together with g_t.
- **p_t**: Length m vector of Randomization probabilities at each time point.
- **gamma**: Desired Type I error
- **n**: Sample size

**Value**

Power of the test for fixed null/alternative and sample size.

**Examples**

```r
mrt_binary_power(tau_t_1, f_t_1, g_t_1, beta_1, alpha_1, p_t_1, 0.05, 100)
```

---

**mrt_binary_ss**

*Calculate sample size for binary outcome MRT*

**Description**

Returns sample size needed to achieve a specified power for the hypothesis test of marginal excursion effect (see Details) in the context of an MRT with binary outcomes with small sample correction using F-distribution. See the vignette for more details.

**Usage**

```r
mrt_binary_ss(
  avail_pattern,
  f_t,
  g_t,
  beta,
  alpha,
  p_t,
  gamma,
  b,
  exact = FALSE,
  less_than_10_possible = FALSE
)
```

**Arguments**

- **avail_pattern**: A vector of length m that is the average availability at each time point
- **f_t**: Defines marginal excursion effect MEE(t) under alternative together with beta. Assumed to be matrix of size m*p.
g_t Defines success probability null curve together with alpha. Assumed to be matrix of size m*q.

beta Length p vector that defines marginal excursion effect MEE(t) under alternative together with f_t.

alpha Length q vector that defines success probability null curve together with g_t.

p_t Length m vector of Randomization probabilities at each time point.

gamma Desired Type I error

b Desired Type II error

exact Determines if exact n or ceiling will be returned

less_than_10_possible If TRUE, returns sample size (instead of error) even if the calculated sample size is <= 10. Setting to TRUE is not recommended. Defaults to FALSE.

Details
When the calculator finds out that a sample size less than or equal to 10 is sufficient to attain the desired power, the calculator does not output the exact sample size but produces an error message. This is because the sample size calculator is based on an asymptotic result, and in this situation the sample size result may not be as accurate. (A small sample correction is built in the calculator, but even with the correction the sample size result may still be inaccurate when it is <= 10.) In general, when the output sample size is small, one might reconsider the following: (1) whether you are correctly or conservatively guessing the average of expected availability, (2) whether the duration of study is too long, (3) whether the treatment effect is overestimated, and (4) whether the power is set too low.

Value
Sample size to achieve desired power.

Examples
mrt_binary_ss(tau_t_1, f_t_1, g_t_1, beta_1, alpha_1, p_t_1, .05, .2, FALSE)

m_matrix_1 An example matrix for "bread" of sandwich estimator of variance.

Description
An example matrix for "bread" of sandwich estimator of variance.

Usage
m_matrix_1
power_summary

Format

A 2 by 2 matrix

Generated from a toy example.

power_summary Calculate sample size at a range of power levels.

Description

Returns sample sizes needed to achieve a range of power levels for the hypothesis test of marginal excursion effect (see Details) in the context of an MRT with binary outcomes with small sample correction using F-distribution. See the vignette for more details.

Usage

```r
power_summary(
    avail_pattern, f_t, g_t, beta, alpha, p_t, gamma,
    power_levels = seq(from = 0.6, to = 0.95, by = 0.05)
)
```

Arguments

- `avail_pattern`: A vector of length T that is the average availability at each time point.
- `f_t`: Defines marginal excursion effect MEE(t) under alternative together with beta. Assumed to be matrix of size T*p.
- `g_t`: Defines success probability null curve together with alpha. Assumed to be matrix of size T*q.
- `beta`: Length p vector that defines marginal excursion effect MEE(t) under alternative together with f_t.
- `alpha`: Length q vector that defines success probability null curve together with g_t.
- `p_t`: Length T vector of Randomization probabilities at each time point.
- `gamma`: Desired Type I error
- `power_levels`: Vector of powers to find sample size for.
Details

The sample size calculator is based on an asymptotic result with a small sample correction. When the calculator finds out that a sample size less than or equal to 10 is sufficient to attain the desired power, the calculator does not output the exact sample size but produces an error message, because in this situation the sample size result may not be as accurate. In general, when the output sample size is small, one might reconsider the following: (1) whether you are correctly or conservatively guessing the average of expected availability, (2) whether the duration of study is too long, (3) whether the treatment effect is overestimated, and (4) whether the power is set too low.

Value

Dataframe containing needed sample size to achieve user-specified power values.

Examples

```
    power_summary(tau_t_1, f_t_1, g_t_1,
                  beta_1, alpha_1, p_t_1, 0.05)
```

```
    power_vs_n_plot(avail_pattern, f_t, g_t, beta, alpha, p_t, gamma,
                     min_n = max(min_samp(alpha, beta), 11),
                     max_n = max_samp(min_n))
```

Description

Returns a plot of power vs sample size in the context of a binary outcome MRT. See the vignette for more details.

Usage

```
    power_vs_n_plot(
        avail_pattern,
        f_t,
        g_t,
        beta,
        alpha,
        p_t,
        gamma,
        min_n = max(min_samp(alpha, beta), 11),
        max_n = max_samp(min_n)
    )
```

Arguments

- `avail_pattern` A vector of length T that is the average availability at each time point
- `f_t` Defines marginal excursion effect MEE(t) under alternative together with beta. Assumed to be matrix of size T*p.
\( g_t \) Defines success probability null curve together with alpha. Assumed to be matrix of size T*q.

\( \beta \) Length p vector that defines marginal excursion effect MEE(t) under alternative together with \( f_t \).

\( \alpha \) Length q vector that defines success probability null curve together with \( g_t \).

\( p_t \) Length T vector of Randomization probabilities at each time point.

\( \gamma \) Desired Type I error

\( \text{min}_n \) Minimum of range of sample sizes to plot. Should be greater than the sum of the dimensions of \( \alpha \) and \( \beta \).

\( \text{max}_n \) Maximum of range of sample sizes to plot. Should be greater than \( \text{min}_n \).

### Value

Plot of power and sample size

### Examples

```r
power_vs_n_plot(tau_t_1, f_t_1, g_t_1, beta_1, alpha_1, 
p_t_1, 0.05, 15, 700)
```

---

\( p_t_1 \) A vector of randomization probabilities for each time point.

### Description

A vector of randomization probabilities for each time point.

### Usage

\( p_t_1 \)

### Format

a length T vector

Vector of randomization probabilities.
**sigma_matrix_1**

An example matrix for "meat" of sandwich estimator of variance.

**tau_t_1**

Vector that holds the average availability at each time point.

**Description**

An example matrix for "meat" of sandwich estimator of variance.

**Usage**

sigma_matrix_1

tau_t_1

**Format**

A 2 by 2 matrix

Generated from a toy example.

vector of length T

A vector of length T that is the average availability at each decision point.
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