

# Package: MRTSampleSizeBinary (via r-universe)

August 30, 2024

**Type** Package

**Title** Sample Size Calculator for MRT with Binary Outcomes

**Version** 0.1.2

**Author** Eliot Wong-Toi, Thabat Dahdoul, Tianchen Qian

**Maintainer** Tianchen Qian <t.qian@uci.edu>

**Description** Provides a sample size calculator for micro-randomized trials (MRTs) with binary outcomes based on Cohn et al. (2023) <doi:10.1002/sim.9748>. Also provides a power calculator when the sample size is input by the user.

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**RoxygenNote** 7.2.3

**Suggests** testthat, knitr, rmarkdown

**Imports** ggplot2, Matrix, stats

**Depends** R (>= 2.10)

**VignetteBuilder** knitr

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2023-12-03 16:50:03 UTC

## Contents

alpha_1 . . . . .	2
beta_1 . . . . .	2
compute_m_sigma . . . . .	3
compute_ncp . . . . .	3
f_t_1 . . . . .	4
g_t_1 . . . . .	4

is_full_column_rank . . . . .	5
max_samp . . . . .	5
min_samp . . . . .	6
mrt_binary_power . . . . .	6
mrt_binary_ss . . . . .	7
m_matrix_1 . . . . .	8
power_summary . . . . .	9
power_vs_n_plot . . . . .	10
p_t_1 . . . . .	11
sigma_matrix_1 . . . . .	12
tau_t_1 . . . . .	12

**Index** **13**

---

alpha\_1 *Vector that defines the success probability null curve.*

---

**Description**

Vector that defines the success probability null curve.

**Usage**

alpha\_1

**Format**

a length 2 vector

The matrix multiplication of this vector with g\_t\_1 defines the MEE under the null hypothesis.

---

beta\_1 *Vector that defines the MEE under the alternative hypothesis.*

---

**Description**

Vector that defines the MEE under the alternative hypothesis.

**Usage**

beta\_1

**Format**

a length 2 vector

The matrix multiplication of this vector with f\_t\_1 defines the MEE under the alternative hypothesis.

---

compute_m_sigma	<i>Computes "M" and "Sigma" matrices for the sandwich estimator of variance-covariance matrix.</i>
-----------------	--

---

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

---

**Description**

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

**Usage**

```
compute_ncp(x, beta, m_matrix, sigma_matrix)
```

**Arguments**

x	Sample size
beta	Marginal excursion effect, assumed dimension p
m_matrix	"Bread" of sandwich estimator for variance
sigma_matrix	"Meat" of sandwich estimator for variance

**Value**

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

**Examples**

```
compute_ncp(300, beta_1, m_matrix_1, sigma_matrix_1)
```

---

f_t_1	<i>A matrix defining the MEE under the alternative hypothesis.</i>
-------	--

---

**Description**

A matrix defining the MEE under the alternative hypothesis.

**Usage**

```
f_t_1
```

**Format**

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

---

g_t_1	<i>A matrix defining the success probability null curve.</i>
-------	--

---

**Description**

A matrix defining the success probability null curve.

**Usage**

```
g_t_1
```

**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	<i>Compute minimum sample size.</i>
----------	-------------------------------------

---

**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	<i>Calculate power for binary outcome MRT</i>
------------------	---

---

**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 $m \times p$ .
g_t	Defines success probability null curve together with alpha. Assumed to be matrix of size $m \times q$ .

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
n	Sample size

**Value**

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

**Examples**

```
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	<i>Calculate sample size for binary outcome MRT</i>
---------------	---

---

**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**

```
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,
              0.05, .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
```



**Format**

A 2 by 2 matrix  
Generated from a toy example.

---

power_summary	<i>Calculate sample size at a range of power levels.</i>
---------------	--

---

**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**

```
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	<i>Returns a plot of power vs sample size in the context of a binary outcome MRT. See the vignette for more details.</i>
-----------------	--

---

**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
min_n	Minimum of range of sample sizes to plot. Should be greater than the sum of the dimensions of alpha and beta.
max_n	Maximum of range of sample sizes to plot. Should be greater than min_n.

**Value**

Plot of power and sample size

**Examples**

```
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.*

---

**Description**

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

**Usage**

sigma\_matrix\_1

**Format**

A 2 by 2 matrix  
Generated from a toy example.

---

tau\_t\_1      *Vector that holds the average availability at each time point.*

---

**Description**

Vector that holds the average availability at each time point.

**Usage**

tau\_t\_1

**Format**

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

# Index

## \* datasets

alpha\_1, 2

beta\_1, 2

f\_t\_1, 4

g\_t\_1, 4

m\_matrix\_1, 8

p\_t\_1, 11

sigma\_matrix\_1, 12

tau\_t\_1, 12

alpha\_1, 2

beta\_1, 2

compute\_m\_sigma, 3

compute\_ncp, 3

f\_t\_1, 4

g\_t\_1, 4

is\_full\_column\_rank, 5

m\_matrix\_1, 8

max\_samp, 5

min\_samp, 6

mrt\_binary\_power, 6

mrt\_binary\_ss, 7

p\_t\_1, 11

power\_summary, 9

power\_vs\_n\_plot, 10

sigma\_matrix\_1, 12

tau\_t\_1, 12