Package 'bfpwr'

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Title Power and Sample Size Calculations for Bayes Factor Analysis

Description Implements z-test, t-test, and normal moment prior Bayes factors based on summary statistics, along with functionality to perform corresponding power and sample size calculations (Pawel and Held, 2024) <doi:10.48550/arXiv.2406.19940>.

License GPL-3

Encoding UTF-8

Imports lamW

Suggests roxygen2, tinytest, knitr

VignetteBuilder knitr

NeedsCompilation no

RoxygenNote 7.3.1

URL https://github.com/SamCH93/bfpwr

BugReports https://github.com/SamCH93/bfpwr/issues

Contents

`bf01` *z-test Bayes factor*

Description

This function computes the Bayes factor that quantifies the evidence that the data (in the form of an asympotically normally distributed parameter estimate with standard error) provide for a point null hypothesis with a normal prior assigned to the parameter under the alternative. The standard error is assumed to be known.

Usage

```
bf01(estimate, se, null = 0, pm, psd, log = FALSE)
```

Arguments

`estimate`	Parameter estimate
`se`	Standard error of the parameter estimate
`null`	Parameter value under the point null hypothesis. Defaults to 0
`pm`	Mean of the normal prior assigned to the parameter under the alternative
`psd`	Standard deviation of the normal prior assigned to the parameter under the alternative. Set to 0 to obtain a point prior at the prior mean
`log`	Logical indicating whether natural logarithm of the Bayes factor should be returned. Defaults to `FALSE`

Value

Bayes factor in favor of the null hypothesis over the alternative (BF > 1 indicates evidence for the null hypothesis, whereas BF < 1 indicates evidence for the alternative)

Author(s)

Samuel Pawel

Examples

```
bf01(estimate = 0.2, se = 0.05, null = 0, pm = 0, psd = 2)
```

nbf01 *Sample size determination for z-test Bayes factor*

Description

This function computes the required sample size to obtain a Bayes factor (bf01) more extreme than a threshold k with a specified target power.

Usage

```
nbf01(
  k,
  power,
  sd,
  null = 0,
  pm,
  psd,
  dpm = pm,
  dpsd = psd,
  nrange = c(1, 10^5),
  lower.tail = TRUE,
  integer = TRUE,
  analytical = TRUE,
  ...
)
```

Arguments

k	Bayes factor threshold
power	Target power
sd	Standard deviation of one unit
null	Parameter value under the point null hypothesis. Defaults to 0
pm	Mean of the normal prior assigned to the parameter under the alternative in the analysis
psd	Standard deviation of the normal prior assigned to the parameter under the alternative in the analysis. Set to 0 to obtain a point prior at the prior mean
dpm	Mean of the normal design prior assigned to the parameter. Defaults to the same value as specified for the analysis prior pm
dpsd	Standard deviation of the normal design prior assigned to the parameter. Set to 0 to obtain a point prior at the prior mean. Defaults to the same value as specified for the analysis prior psd
nrange	Sample size search range over which numerical search is performed. Defaults to c(1, 10^5)
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE

integer	Logical indicating whether only integer valued sample sizes should be returned. If TRUE the required sample size is rounded to the next larger integer. Defaults to TRUE
analytical	Logical indicating whether analytical (if available) or numerical method should be used. Defaults to TRUE
...	Other arguments passed to stats::uniroot

Value

The required sample size to achieve the specified power

Author(s)

Samuel Pawel

See Also

pbf01, powerbf01, bf01

Examples

```
## point alternative (analytical and numerical solution available)
nbf01(k = 1/10, power = 0.9, sd = 1, null = 0, pm = 0.5, psd = 0,
      analytical = c(TRUE, FALSE), integer = FALSE)

## standardized mean difference (unit sd = sqrt(2), effective sample size = per group size)
nbf01(k = 1/10, power = 0.9, sd = sqrt(2), null = 0, pm = 0, psd = 1)
## this is the sample size per group (assuming equally sized groups)

## z-transformed correlation (unit sd = 1, effective sample size = n - 3)
nbf01(k = 1/10, power = 0.9, sd = 1, null = 0, pm = 0.2, psd = 0.5)
## have to add 3 to obtain the actual sample size

## log hazard/odds ratio (unit sd = 2, effective sample size = total number of events)
nbf01(k = 1/10, power = 0.9, sd = 2, null = 0, pm = 0, psd = sqrt(0.5))
## have to convert the number of events to a sample size
```

---

nmbf01 *Normal moment prior Bayes factor*

Description

This function computes the Bayes factor that quantifies the evidence that the data (in the form of an asympotically normally distributed parameter estimate with standard error) provide for a point null hypothesis with a normal moment prior assigned to the parameter under the alternative.

Usage

```
nmbf01(estimate, se, null = 0, psd, log = FALSE)
```

Arguments

`estimate`	Parameter estimate
`se`	Standard error of the parameter estimate
`null`	Parameter value under the point null hypothesis. Defaults to 0
`psd`	Spread of the normal moment prior assigned to the parameter under the alternative. The modes of the prior are located at $\pm\sqrt{2}\,$`psd`
`log`	Logical indicating whether natural logarithm of the Bayes factor should be returned. Defaults to `FALSE`

Details

A normal moment prior has density $f(x \mid \texttt{null}, \texttt{psd}) = N(x \mid \texttt{null}, \texttt{psd}^2) \times (x - \texttt{null})/\texttt{psd}^2$ with $N(x \mid m, v)$ the normal density with mean m and variance v evaluated at x.

Value

Bayes factor in favor of the null hypothesis over the alternative (BF > 1 indicates evidence for the null hypothesis, whereas BF < 1 indicates evidence for the alternative)

Author(s)

Samuel Pawel

References

Johnson, V. E. and Rossell, D. (2010). On the use of non-local prior densities in Bayesian hypothesis tests. Journal of the Royal Statistical Society: Series B (Statistical Methodology), 72(2):143–170. doi:10.1111/j.14679868.2009.00730.x

Pramanik, S. and Johnson, V. E. (2024). Efficient alternatives for Bayesian hypothesis tests in psychology. Psychological Methods, 29(2):243–261. doi:10.1037/met0000482

See Also

nmbf01, pnmbf01, nnmbf01, powernmbf01

Examples

```
nmbf01(estimate = 0.25, se = 0.05, null = 0, psd = 0.5/sqrt(2)) # mode at 0.5
```

nnmbf01 *Sample size determination for normal moment prior Bayes factor*

Description

This function computes the required sample size to obtain a normal moment prior Bayes factor (nbf01) more extreme than a threshold k with a specified target power.

Usage

```
nnmbf01(
  k,
  power,
  sd,
  null = 0,
  psd,
  dpm,
  dpsd,
  nrange = c(1, 10^5),
  lower.tail = TRUE,
  integer = TRUE,
  ...
)
```

Arguments

k	Bayes factor threshold
power	Target power
sd	Standard deviation of one unit
null	Parameter value under the point null hypothesis. Defaults to 0
psd	Spread of the normal moment prior assigned to the parameter under the alternative in the analysis. The modes of the prior are located at $\pm\sqrt{2}$ psd
dpm	Mean of the normal design prior assigned to the parameter
dpsd	Standard deviation of the normal design prior assigned to the parameter. Set to 0 to obtain a point prior at the prior mean
nrange	Sample size search range over which numerical search is performed. Defaults to c(1, 10^5)
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE
integer	Logical indicating whether only integer valued sample sizes should be returned. If TRUE the required sample size is rounded to the next larger integer. Defaults to TRUE
...	Other arguments passed to stats::uniroot

Value

The required sample size to achieve the specified power

Author(s)

Samuel Pawel

See Also

nmbf01, pnmbf01, powernmbf01

Examples

```
nnmbf01(k = 1/10, power = 0.9, sd = 1, null = 0, psd = 0.5/sqrt(2), dpm = 0.5, dpsd = 0)
```

---

ntbf01 *Sample size calculations for t-test Bayes factor*

Description

This function computes the required sample size to obtain a t-test Bayes factor (tbf01) more extreme than a threshold k with a specified target power.

Usage

```
ntbf01(
  k = 1/10,
  power,
  null = 0,
  plocation = 0,
  pscale = 1/sqrt(2),
  pdf = 1,
  type = c("two.sample", "one.sample", "paired"),
  alternative = c("two.sided", "less", "greater"),
  dpm = plocation,
  dpsd = pscale,
  lower.tail = TRUE,
  integer = TRUE,
  nrange = c(2, 10^4),
  ...
)
```

Arguments

k	Bayes factor threshold. Defaults to 1/10, Jeffreys' threshold for 'strong evidence' against the null hypothesis
power	Target power
null	Standardized mean difference under the point null hypothesis. Defaults to 0
plocation	Analysis t prior location. Defaults to 0
pscale	Analysis t prior scale. Defaults to 1/sqrt(2)
pdf	Analysis t prior degrees of freedom. Defaults to 1 (a Cauchy prior)
type	The type of test. One of "two.sample", "one.sample", "paired". Defaults to "two.sample"
alternative	Direction of the test. Can be either "two.sided" (default), "less" , or "greater". The latter two truncate the analysis prior to negative and positive effects, respectively. If set to "less" or "greater", the power is only computed based on data with effect estimates in the direction of the alternative
dpm	Mean of the normal design prior assigned to the standardized mean difference. Defaults to the analysis prior location
dpsd	Standard deviation of the normal design prior assigned to the standardized mean difference. Set to 0 to obtain a point prior at the design prior mean. Defaults to the analysis prior scale
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE
integer	Logical indicating whether only integer valued sample sizes should be returned. If TRUE the required sample size is rounded to the next larger integer. Defaults to TRUE
nrange	Sample size search range over which numerical search is performed. Defaults to c(2, 10^4)
...	Other arguments passed to stats::uniroot

Value

Object of class "power.bftest", a list of the arguments (including the computed one) augmented with method and note elements

Author(s)

Samuel Pawel

See Also

ptbf01, powertbf01, tbf01

Examples

```
## example from Schönbrodt and Wagenmakers (2018, p.135)
ntbf01(k = 1/6, power = 0.95, dpm = 0.5, dpsd = 0, alternative = "greater")
ntbf01(k = 1/6, power = 0.95, dpm = 0.5, dpsd = 0.1, alternative = "greater")
ntbf01(k = 6, power = 0.95, dpm = 0, dpsd = 0, alternative = "greater",
       lower.tail = FALSE, nrange = c(2, 10000))
```

---

pbf01 *Cumulative distribution function of the z-test Bayes factor*

Description

This function computes the probability of obtaining a Bayes factor (bf01) more extreme than a threshold k with a specified sample size.

Usage

```
pbf01(k, n, sd, null = 0, pm, psd, dpm = pm, dpsd = psd, lower.tail = TRUE)
```

Arguments

k	Bayes factor threshold
n	Sample size
sd	Standard deviation of one unit
null	Parameter value under the point null hypothesis. Defaults to 0
pm	Mean of the normal prior assigned to the parameter under the alternative in the analysis
psd	Standard deviation of the normal prior assigned to the parameter under the alternative in the analysis. Set to 0 to obtain a point prior at the prior mean
dpm	Mean of the normal design prior assigned to the parameter. Defaults to the same value as the analysis prior pm
dpsd	Standard deviation of the normal design prior assigned to the parameter. Defaults to the same value as the analysis prior psd
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE

Value

The probability that the Bayes factor is less or greater (depending on the specified lower.tail) than the specified threshold k

Author(s)

Samuel Pawel

See Also

nbf01, powerbf01, bf01

Examples

```
## point alternative (psd = 0)
pbf01(k = 1/10, n = 200, sd = 2, null = 0, pm = 0.5, psd = 0)

## normal alternative (psd > 0)
pbf01(k = 1/10, n = 100, sd = 2, null = 0, pm = 0.5, psd = 2)

## design prior is the null hypothesis (dpm = 0, dpsd = 0)
pbf01(k = 10, n = 1000, sd = 2, null = 0, pm = 0.3, psd = 2, dpm = 0, dpsd = 0, lower.tail = FALSE)

## draw a power curve
nseq <- round(exp(seq(log(10), log(10000), length.out = 100)))
plot(nseq, pbf01(k = 1/10, n = nseq, sd = 2, null = 0, pm = 0.3, psd = 0), type = "l",
     xlab = "n", ylab = bquote("Pr(BF"["01"] <= 1/10 * ")"), ylim = c(0, 1),
     log = "x", las = 1)

## standardized mean difference (unit sd = sqrt(2), effective sample size = per group size)
n <- 30
pbf01(k = 1/10, n = n, sd = sqrt(2), null = 0, pm = 0, psd = 1)

## z-transformed correlation (unit sd = 1, effective sample size = n - 3)
n <- 100
pbf01(k = 1/10, n = n - 3, sd = 1, null = 0, pm = 0.2, psd = 0.5)

## log hazard/odds ratio (unit sd = 2, effective sample size = total number of events)
nevents <- 100
pbf01(k = 1/10, n = nevents, sd = 2, null = 0, pm = 0, psd = sqrt(0.5))
```

---

plot.power.bftest *Plot method for class* "power.bftest"

Description

Plot method for class "power.bftest"

Usage

```
## S3 method for class 'power.bftest'
plot(x, nlim = c(2, 500), ngrid = 100, plot = TRUE, nullplot = TRUE, ...)
```

Arguments

x	Object of class "power.bftest"
nlim	Range of samples sizes over which the power should be computed. Defaults to c(2, 500)
ngrid	Number of grid point for which power should be computed. Defaults to 100
plot	Logical indicating whether data should be plotted. If FALSE only the data used for plotting are returned.
nullplot	Logcal indicating whether a second plot with the power in favor of the null (using a Bayes factor threshold of 1/k) should be created. Defaults to TRUE
...	Other arguments (for consistency with the generic)

Value

Plots power curves (if specified) and invisibly returns a list of data frames containing the data underlying the power curves

Author(s)

Samuel Pawel

See Also

powerbf01, powertbf01, powernmbf01

Examples

```
ssd1 <- powerbf01(k = 1/6, power = 0.95, pm = 0, psd = 1/sqrt(2), dpm = 0.5, dpsd = 0)
plot(ssd1, nlim = c(1, 8000))

power1 <- powerbf01(k = 1/2, n = 120, pm = 0, psd = 1/sqrt(2), dpm = 0.5, dpsd = 0)
plot(power1, nlim = c(1, 1000))
```

---

pnmbf01 *Cumulative distribution function of the normal moment prior Bayes factor*

Description

This function computes the probability of obtaining a normal moment prior Bayes factor (nmbf01) more extreme than a threshold k with a specified sample size.

Usage

```
pnmbf01(k, n, sd, null = 0, psd, dpm, dpsd, lower.tail = TRUE)
```

Arguments

k	Bayes factor threshold
n	Sample size
sd	Standard deviation of one unit
null	Parameter value under the point null hypothesis. Defaults to 0
psd	Spread of the normal moment prior assigned to the parameter under the alternative in the analysis. The modes of the prior are located at $\pm\sqrt{2}$ psd
dpm	Mean of the normal design prior assigned to the parameter
dpsd	Standard deviation of the normal design prior assigned to the parameter. Set to 0 to obtain a point prior at the prior mean
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE

Value

The probability that the Bayes factor is less or greater (depending on the specified lower.tail) than the specified threshold k

Author(s)

Samuel Pawel

See Also

nmbf01, nnmbf01, powernmbf01

Examples

```
## point desing prior (psd = 0)
pnmbf01(k = 1/10, n = 200, sd = 2, null = 0, psd = 0.5/sqrt(2), dpm = 0.5, dpsd = 0)

## normal design prior to incorporate parameter uncertainty (psd > 0)
pnmbf01(k = 1/10, n = 200, sd = 2, null = 0, psd = 0.5/sqrt(2), dpm = 0.5, dpsd = 0.25)

## design prior is the null hypothesis (dpm = 0, dpsd = 0)
pnmbf01(k = 10, n = 200, sd = 2, null = 0, psd = 0.5/sqrt(2), dpm = 0, dpsd = 0, lower.tail = FALSE)
```

---

powerbf01 *Power and sample size calculations for z-test Bayes factor*

Description

Compute probability that z-test Bayes factor is smaller than a specified threshold (the power), or determine sample size to obtain a target power

Usage

```
powerbf01(
  n = NULL,
  power = NULL,
  k = 1/10,
  sd = 1,
  null = 0,
  pm,
  psd,
  type = c("two.sample", "one.sample", "paired"),
  dpm = pm,
  dpsd = psd,
  nrange = c(1, 10^5)
)
```

Arguments

n	Sample size. Has to be NULL if power is specified. Defaults to NULL
power	Target power. Has to be NULL if n is specified. Defaults to NULL
k	Bayes factor threshold. Defaults to 1/10, Jeffreys' threshold for 'strong evidence' against the null hypothesis
sd	Standard deviation of one observation (for type = "two.sample" or type = "one.sample") or of one difference within a pair of observations (type = "paired"). Is assumed to be known. Defaults to 1
null	Mean difference under the point null hypothesis. Defaults to 0
pm	Mean of the normal prior assigned to the mean difference under the alternative in the analysis
psd	Standard deviation of the normal prior assigned to the mean difference under the alternative in the analysis. Set to 0 to obtain a point prior at the prior mean
type	The type of test. One of "two.sample", "one.sample", "paired". Defaults to "two.sample"
dpm	Mean of the normal design prior assigned to the mean difference. Defaults to the same value as the analysis prior pm
dpsd	Standard deviation of the normal design prior assigned to the mean difference. Defaults to the same value as the analysis prior psd
nrange	Sample size search range over which numerical search is performed (only taken into account when n is NULL). Defaults to c(1, 10^5)

Value

Object of class "power.bftest", a list of the arguments (including the computed one) augmented with method and note elements

Note

An error message will be displayed in case that the specified target power is not achievable under the specified analysis and design priors.

Author(s)

Samuel Pawel

See Also

plot.power.bftest, nbf01, pbf01, bf01

Examples

```
## determine power
powerbf01(n = 100, pm = 0, psd = 1, dpm = 0.5, dpsd = 0)

## determine sample size
powerbf01(power = 0.99, pm = 0, psd = 1, dpm = 0.5, dpsd = 0)
```

`powernmbf01` *Power and sample size calculations for normal moment prior Bayes factor*

Description

Compute probability that normal moment prior Bayes factor is smaller than a specified threshold (the power), or determine sample size to obtain a target power

Usage

```
powernmbf01(
  n = NULL,
  power = NULL,
  k = 1/10,
  sd = 1,
  null = 0,
  psd,
  type = c("two.sample", "one.sample", "paired"),
  dpm,
  dpsd,
  nrange = c(1, 10^5)
)
```

Arguments

`n`	Sample size. Has to be `NULL` if `power` is specified. Defaults to `NULL`
`power`	Target power. Has to be `NULL` if `n` is specified. Defaults to `NULL`
`k`	Bayes factor threshold. Defaults to `1/10`, Jeffreys' threshold for 'strong evidence' against the null hypothesis

sd	Standard deviation of one observation (for type = "two.sample" or type = "one.sample") or of one difference within a pair of observations (type = "paired"). Is assumed to be known. Defaults to 1
null	Mean difference under the point null hypothesis. Defaults to 0
psd	Spread of the normal moment prior assigned to the parameter under the alternative in the analysis. The modes of the prior are located at $\pm\sqrt{2}$ psd
type	The type of test. One of "two.sample", "one.sample", "paired". Defaults to "two.sample"
dpm	Mean of the normal design prior assigned to the parameter
dpsd	Standard deviation of the normal design prior assigned to the parameter. Set to 0 to obtain a point prior at the prior mean
nrange	Sample size search range over which numerical search is performed (only taken into account when n is NULL). Defaults to c(1, 10^5)

Value

Object of class "power.bftest", a list of the arguments (including the computed one) augmented with method and note elements

Author(s)

Samuel Pawel

See Also

plot.power.bftest, nnmbf01, pnmbf01, nmbf01

Examples

```
## determine power
powernmbf01(n = 100, psd = 1, dpm = 0.5, dpsd = 0)

## determine sample size
powernmbf01(power = 0.99, psd = 1, dpm = 0.5, dpsd = 0)
```

---

powertbf01 *Power and sample size calculations for t-test Bayes factor*

Description

Compute probability that t-test Bayes factor is smaller than a specified threshold (the power), or determine sample size to obtain a target power

Usage

```
powertbf01(
  k = 1/10,
  n = NULL,
  power = NULL,
  null = 0,
  plocation = 0,
  pscale = 1/sqrt(2),
  pdf = 1,
  type = c("two.sample", "one.sample", "paired"),
  alternative = c("two.sided", "less", "greater"),
  dpm = plocation,
  dpsd = pscale,
  nrange = c(2, 10^4)
)
```

Arguments

k	Bayes factor threshold. Defaults to 1/10, Jeffreys' threshold for 'strong evidence' against the null hypothesis
n	Sample size (per group for two-sample tests). Has to be NULL if power is specified. Defaults to NULL
power	Target power. Has to be NULL if n is specified. Defaults to NULL
null	Standardized mean difference under the point null hypothesis. Defaults to 0
plocation	Analysis t prior location. Defaults to 0
pscale	Analysis t prior scale. Defaults to 1/sqrt(2)
pdf	Analysis t prior degrees of freedom. Defaults to 1 (a Cauchy prior)
type	The type of test. One of "two.sample", "one.sample", "paired". Defaults to "two.sample"
alternative	Direction of the test. Can be either "two.sided" (default), "less" , or "greater". The latter two truncate the analysis prior to negative and positive effects, respectively. If set to "less" or "greater", the power is only computed based on data with effect estimates in the direction of the alternative
dpm	Mean of the normal design prior assigned to the standardized mean difference. Defaults to the analysis prior location
dpsd	Standard deviation of the normal design prior assigned to the standardized mean difference. Set to 0 to obtain a point prior at the design prior mean. Defaults to the analysis prior scale
nrange	Sample size search range over which numerical search is performed (only taken into account when n is NULL). Defaults to c(2, 10^4)

Value

Object of class "power.bftest", a list of the arguments (including the computed one) augmented with method and note elements

Author(s)

Samuel Pawel

See Also

plot.power.bftest, ptbf01, ntbf01, tbf01

Examples

```
## determine power
powertbf01(k = 1/6, n = 146, dpm = 0.5, dps = 0, alternative = "greater")

## determine sample size
powertbf01(k = 1/6, power = 0.95, dpm = 0.5, dps = 0, alternative = "greater")
```

---

print.power.bftest *Print method for class* "power.bftest"

Description

Print method for class "power.bftest"

Usage

```
## S3 method for class 'power.bftest'
print(x, digits = getOption("digits"), ...)
```

Arguments

x	Object of class "power.bftest"
digits	Number of digits for formatting of numbers
...	Other arguments (for consistency with the generic)

Value

Prints text summary in the console and invisibly returns the "power.bftest" object

Note

Function adapted from stats:::print.power.htest written by Peter Dalgaard

Author(s)

Samuel Pawel

See Also

powerbf01

Examples

```
powerbf01(power = 0.95, pm = 0, psd = 1, dpm = 0.5, dpsd = 0)
powerbf01(power = 0.95, pm = 0, psd = 1, dpm = 0.5, dpsd = 0, type = "one.sample")
powerbf01(power = 0.95, pm = 0, psd = 1, dpm = 0.5, dpsd = 0, type = "paired")
powerbf01(power = 0.95, pm = 1, psd = 0, dpm = 0.8, dpsd = 0, type = "paired")
```

---

ptbf01 *Cumulative distribution function of the t-test Bayes factor*

Description

This function computes the probability of obtaining a t-test Bayes factor (tbf01) more extreme than a threshold k with a specified sample size.

Usage

```
ptbf01(
  k = 1/10,
  n,
  n1 = n,
  n2 = n,
  null = 0,
  plocation = 0,
  pscale = 1/sqrt(2),
  pdf = 1,
  dpm = plocation,
  dpsd = pscale,
  type = c("two.sample", "one.sample", "paired"),
  alternative = c("two.sided", "less", "greater"),
  lower.tail = TRUE,
  drange = "adaptive",
  ...
)
```

Arguments

k	Bayes factor threshold. Defaults to 1/10, Jeffreys' threshold for 'strong evidence' against the null hypothesis
n	Sample size (per group)
n1	Sample size in group 1 (only required for two-sample t-test with unequal group sizes)

n2	Sample size in group 2 (only required for two-sample t-test with unequal group sizes)
null	Standardized mean difference under the point null hypothesis. Defaults to 0
plocation	Analysis t prior location. Defaults to 0
pscale	Analysis t prior scale. Defaults to 1/sqrt(2)
pdf	Analysis t prior degrees of freedom. Defaults to 1
dpm	Mean of the normal design prior assigned to the standardized mean difference. Defaults to the analysis prior location
dpsd	Standard deviation of the normal design prior assigned to the standardized mean difference. Set to 0 to obtain a point prior at the design prior mean. Defaults to the analysis prior scale
type	The type of test. One of "two.sample", "one.sample", "paired". Defaults to "two.sample"
alternative	Direction of the test. Can be either "two.sided" (default), "less", or "greater". The latter two truncate the analysis prior to negative and positive effects, respectively. If set to "less" or "greater", the power is only computed based on data with effect estimates in the direction of the alternative
lower.tail	Logical indicating whether Pr(BF $\leq$ k) (TRUE) or Pr(BF $>$ k) (FALSE) should be computed. Defaults to TRUE
drange	Standardized mean difference search range over which the critical values are searched for. Can be either set to a numerical range or to "adaptive" (default) which determines the range in an adaptive way from the other input parameters
...	Other arguments passed to stats::uniroot

Value

The probability that the Bayes factor is less or greater (depending on the specified lower.tail) than the specified threshold k

Author(s)

Samuel Pawel

See Also

tbf01, ntbf01, powertbf01

Examples

```
## example from Schönbrodt and Wagenmakers (2018, p. 135)
ptbf01(k = 1/6, n = 146, dpm = 0.5, dpsd = 0, alternative = "greater")
ptbf01(k = 6, n = 146, dpm = 0, dpsd = 0, alternative = "greater",
       lower.tail = FALSE)

## two-sided
ptbf01(k = 1/6, n = 146, dpm = 0.5, dpsd = 0)
ptbf01(k = 6, n = 146, dpm = 0, dpsd = 0, lower.tail = FALSE)
```

```
## one-sample test
ptbf01(k = 1/6, n = 146, dpm = 0.5, dpsd = 0, alternative = "greater", type = "one.sample")
```

---

tbf01 *t-test Bayes factor*

Description

This function computes the Bayes factor that forms the basis of the informed Bayesian t-test from Gronau et al. (2020). The Bayes factor quantifies the evidence that the data provide for the null hypothesis that the standardized mean difference (SMD) is zero against the alternative that the SMD is non-zero. A location-scale t-distribution is assumed for the SMD under the alternative hypothesis. The Jeffreys-Zellner-Siow (JZS) Bayes factor (Rouder et al., 2009) is obtained as a special case by setting the location of the prior to zero and the prior degrees of freedom to one, which is the default.

The data are summarized by t-statistics and sample sizes. The following types of t-statistics are accepted:

- Two-sample t-test where the SMD represents the standardized mean difference between two group means (assuming equal variances in both groups)
- One-sample t-test where the SMD represents the standardized mean difference to the null value
- Paired t-test where the SMD represents the standardized mean change score

Usage

```
tbf01(
  t,
  n,
  n1 = n,
  n2 = n,
  plocation = 0,
  pscale = 1/sqrt(2),
  pdf = 1,
  type = c("two.sample", "one.sample", "paired"),
  alternative = c("two.sided", "less", "greater"),
  log = FALSE,
  ...
)
```

Arguments

t	t-statistic
n	Sample size (per group)
n1	Sample size in group 1 (only required for two-sample t-test with unequal group sizes)

n2	Sample size in group 2 (only required for two-sample t-test with unequal group sizes)
plocation	t prior location. Defaults to 0
pscale	t prior scale. Defaults to 1/sqrt(2)
pdf	t prior degrees of freedom. Defaults to 1 (a Cauchy prior)
type	Type of t-test associated with t-statistic. Can be "two.sample" (default), "one.sample", or "paired"
alternative	Direction of the test. Can be either "two.sided" (default), "less", or "greater"
log	Logical indicating whether natural logarithm of the Bayes factor should be returned. Defaults to FALSE
...	Additional arguments passed to stats::integrate

Details

The Bayes factor is implemented as in equation (5) in Gronau et al. (2020), and using suitable truncation in case of one-sided alternatives. Integration is performed numerically with stats::integrate.

Value

Bayes factor in favor of the null hypothesis over the alternative (BF > 1 indicates evidence for the null hypothesis, whereas BF < 1 indicates evidence for the alternative)

Author(s)

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References

Rouder, J. N., Speckman, P. L., Sun, D., Morey, R. D., Iverson, G. (2009). Bayesian t tests for accepting and rejecting the null hypothesis. Psychonomic Bulletin & Review, 16(2):225-237. doi:10.3758/PBR.16.2.225

Gronau, Q. F., Ly., A., Wagenmakers, E.J. (2020). Informed Bayesian t-Tests. The American Statistician, 74(2):137-143. doi:10.1080/00031305.2018.1562983

See Also

powertbf01, ptbf01, ntbf01

Examples

```
## analyses from Rouder et al. (2009):
## values from Table 1
tbf01(t = c(0.69, 3.20), n = 100, pscale = 1, type = "one.sample")
## examples from p. 232
tbf01(t = c(2.24, 2.03), n = 80, pscale = 1, type = "one.sample")

## analyses from Gronau et al. (2020) section 3.2:
## informed prior
```

```
tbf01(t = -0.90, n1 = 53, n2 = 57, plocation = 0.350, pscale = 0.102, pdf = 3,
      alternative = "greater", type = "two.sample")
## default (one-sided) prior
tbf01(t = -0.90, n1 = 53, n2 = 57, plocation = 0, pscale = 1/sqrt(2), pdf = 1,
      alternative = "greater", type = "two.sample")
```

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