

Package ‘pwrANOVA’

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Title Power Analysis of Flexible ANOVA Designs and Related Tests

Version 1.0.3

Description Provides functions for conducting power analysis in ANOVA designs, including between-, within-, and mixed-factor designs, with full support for both main effects and interactions. The package allows calculation of statistical power, required total sample size, significance level, and minimal detectable effect sizes expressed as partial eta squared or Cohen's f for ANOVA terms and planned contrasts. In addition, complementary functions are included for common related tests such as t-tests and correlation tests, making the package a convenient toolkit for power analysis in experimental psychology and related fields.

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Encoding UTF-8

URL <https://github.com/mutopsy/pwrANOVA>,
<https://mutopsy.github.io/pwrANOVA/>

BugReports <https://github.com/mutopsy/pwrANOVA/issues>

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cohensf_to_peta2	<i>Convert Cohen's f to Partial Eta Squared</i>
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Description

Converts Cohen's f to partial eta squared (η_p^2) using the standard definition in Cohen (1988).

Usage

```
cohensf_to_peta2(f)
```

Arguments

f A numeric vector of Cohen's f values. Each value must be greater than or equal to 0.

Details

The conversion is defined as:

$$\eta_p^2 = \frac{f^2}{1 + f^2}$$

This follows from the relationship: $f = \sqrt{\eta_p^2 / (1 - \eta_p^2)}$

Value

A numeric vector of partial eta squared values.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

See Also

[peta2_to_cohensf](#)

Examples

```
# Convert a single Cohen's f value
cohensf_to_peta2(0.25)

# Convert multiple values
cohensf_to_peta2(c(0.1, 0.25, 0.4))
```

peta2_to_cohensf	<i>Convert Partial Eta Squared to Cohen's f</i>
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Description

Converts partial eta squared (η_p^2) to Cohen's f using the standard definition in Cohen (1988).

Usage

```
peta2_to_cohensf(peta2)
```

Arguments

peta2	A numeric vector of partial eta squared values. Each value must be within the range of 0 to 1.
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Details

The conversion is defined as:

$$f = \sqrt{\eta_p^2 / (1 - \eta_p^2)}$$

This follows from the inverse relationship:

$$\eta_p^2 = \frac{f^2}{1 + f^2}$$

Value

A numeric vector of Cohen's f values.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

See Also

[cohensf_to_peta2](#)

Examples

```
# Convert a single partial eta squared value
peta2_to_cohensf(0.06)

# Convert multiple values
peta2_to_cohensf(c(0.01, 0.06, 0.14))
```

Description

Computes power, required total sample size, alpha, or minimal detectable effect size for fixed-effects terms in between-/within-/mixed-factor ANOVA designs.

Usage

```
pwrANOVA(
  nlevels_b = NULL,
  nlevels_w = NULL,
  n_total = NULL,
  alpha = NULL,
  power = NULL,
  cohensf = NULL,
  peta2 = NULL,
  epsilon = 1,
  target = NULL,
  max_nfactor = 6,
  nlim = c(2, 10000)
)
```

Arguments

nlevels_b	Integer scalar or vector. Numbers of levels for between-subjects factors. Omit or set NULL if there is no between-subjects factor.
nlevels_w	Integer scalar or vector. Numbers of levels for within-subjects factors. Omit or set NULL if there is no within-subjects factor.
n_total	Integer scalar or vector. Total sample size across all groups. If NULL, the function solves for n_total.
alpha	Numeric in (0, 1). If NULL, it is solved for.
power	Numeric in (0, 1). If NULL, it is computed; if n_total is NULL, n_total is solved to achieve this power.
cohensf	Numeric (non-negative). Cohen's f . If NULL, it is derived from peta2 when available. If both effect-size arguments (cohensf and peta2) are NULL, the effect size is treated as unknown and solved for given n_total, alpha, and power.
peta2	Numeric in (0, 1). Partial eta squared. If NULL, it is derived from cohensf when available.
epsilon	Numeric in (0, 1]. Nonsphericity parameter applied to within-subjects terms with $df_1 \geq 2$. Ignored if there is no within-subjects factor or if all within factors have two levels.
target	Character vector of term labels to compute (e.g., "B1", "W1", "B1:W1", ...). If NULL, all terms are returned.

max_factor	Integer. Safety cap for the total number of factors.
nlim	Integer length-2. Search range of total n when solving sample size.

Details

- Fixed-effects, balanced designs are assumed. All groups/cells have equal cell sizes and effects are tested with standard fixed-effects ANOVA models.
- Numerator degrees of freedom for within-subjects terms with $df_1 \geq 2$ are adjusted by the nonsphericity parameter epsilon.
- Denominator degrees of freedom follow standard mixed-ANOVA formulas and are multiplied by the same epsilon for within-subjects terms.
- Critical values are computed from the central F -distribution; power uses the noncentral F -distribution with noncentrality parameter $\lambda = f^2 \cdot n_{\text{total}}$.
- Effect-size inputs can be given as Cohen's f or partial eta-squared η_p^2 (internally converted via $f = \sqrt{\eta_p^2 / (1 - \eta_p^2)}$). If both are NULL, the minimal detectable effect size is solved for given n_{total} , alpha, and power.
- Exactly one of n_{total} , an effect-size specification (cohensf/peta2), alpha, or power must be NULL; that quantity is then solved.
- **Validation against GPower:** For the subset of designs supported by GPower (between-, within-, and mixed-factor ANOVA with equal cell sizes), pwrANOVA() was validated to produce results identical to those of GPower.

Value

A data frame with S3 class:

- "cal_power" when power is calculated given n_{total} , alpha, and effect size;
- "cal_n" or "cal_ns" when n_{total} is solved;
- "cal_alpha" or "cal_alphas" when alpha is solved;
- "cal_es" when minimal detectable effect sizes are solved.

Columns include term, df_num, df_denom, n_{total} , alpha, power, cohensf, peta2, F_{critical} , ncp, epsilon.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Examples

```
# One between factor (k = 3), one within factor (m = 4), compute power
pwrANOVA(nlevels_b = 3, nlevels_w = 4, n_total = 60,
          cohensf = 0.25, alpha = 0.05, power = NULL, epsilon = 0.8)

# Solve required total N for target power
pwrANOVA(nlevels_b = 2, nlevels_w = NULL, n_total = NULL,
          peta2 = 0.06, alpha = 0.05, power = 0.8)
```

pwrcontrast	<i>Power Analysis for Planned Contrast in Between- or Within-Factor ANOVA</i>
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Description

Computes power, required total sample size, alpha, or minimal detectable effect size for a **single planned contrast** (1 df) in between-participants or paired/repeated-measures settings.

Usage

```
pwrcontrast(
  weight = NULL,
  paired = FALSE,
  n_total = NULL,
  cohensf = NULL,
  peta2 = NULL,
  alpha = NULL,
  power = NULL,
  nlim = c(2, 10000)
)
```

Arguments

weight	Numeric vector (length $K \geq 2$). Contrast weights whose sum must be zero.
paired	Logical. FALSE for between-subjects (default), TRUE for paired/repeated-measures.
n_total	Integer or integer vector. Total sample size(s). If NULL, the function solves for n_total.
cohensf	Numeric (non-negative). Cohen's f . If NULL, it is derived from peta2 when available.
peta2	Numeric in (0, 1). Partial eta squared. If NULL, it is derived from cohensf when available.
alpha	Numeric in (0, 1). If NULL, it is solved for.
power	Numeric in (0, 1). If NULL, it is computed; if n_total is NULL, n_total is solved to achieve this power.
nlim	Integer length-2. Search range of total n when solving sample size.

Details

For a contrast with weights w_1, \dots, w_K that sum to zero, the numerator df is 1. The denominator df is $n - K$ for between-subjects (unpaired) designs and $n - 1$ for paired/repeated-measures designs. Power uses the noncentral F -with $\lambda = f^2 \cdot n_{\text{total}}$.

- Contrast weights (weight) are not centered internally; only the zero-sum condition is enforced (up to numerical tolerance).

- When `paired = FALSE`, the total sample size `n_total` must be a multiple of the number of contrast groups K .
- Exactly one of `n_total`, an effect-size specification (`cohensf/peta2`), `alpha`, or `power` must be `NULL`; that quantity is then solved.
- Critical values are computed from the central F -distribution; power is based on the noncentral F -distribution with noncentrality parameter $\lambda = f^2 \cdot n_{\text{total}}$.
- Effect-size inputs can be given as Cohen's f or partial eta-squared η_p^2 (internally converted via $f = \sqrt{\eta_p^2 / (1 - \eta_p^2)}$). If both are `NULL`, the minimal detectable effect size is solved for given `n_total`, `alpha`, and `power`.

Value

A one-row data frame with class:

- `"cal_power"` when power is calculated given `n_total`, `alpha`, and effect size;
- `"cal_n"` when `n_total` is solved;
- `"cal_alpha"` when `alpha` is solved;
- `"cal_es"` when minimal detectable effect sizes are solved.

Columns: `term` (always `"contrast"`), `weight` (comma-separated string), `df_num`, `df_denom`, `n_total`, `alpha`, `power`, `cohensf`, `peta2`, `F_critical`, `ncp`.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Examples

```
# Two-group contrast (1, -1), between-subjects: compute power
pwrcontrast(weight = c(1, -1), paired = FALSE,
             n_total = 40, cohensf = 0.25, alpha = 0.05)

# Four-level contrast (e.g., Helmert-like), solve required N for target power
pwrcontrast(weight = c(3, -1, -1, -1), paired = FALSE,
             n_total = NULL, peta2 = 0.06, alpha = 0.05, power = 0.80)

# Paired contrast across K=3 conditions
pwrcontrast(weight = c(1, 0, -1), paired = TRUE,
             n_total = NULL, cohensf = 0.2, alpha = 0.05, power = 0.9)
```

pwrctest

*Power Analysis for Pearson Correlation***Description**

Computes statistical power, required total sample size, α , or the minimal detectable correlation coefficient for a Pearson correlation test. Two computational methods are supported: exact noncentral t (method = "t") and Fisher's z -transformation with normal approximation (method = "z").

Usage

```
pwrctest(
  alternative = c("two.sided", "one.sided"),
  n_total = NULL,
  alpha = NULL,
  power = NULL,
  rho = NULL,
  method = c("t", "z"),
  bias_correction = FALSE,
  nlim = c(2, 10000)
)
```

Arguments

alternative	Character. Either "two.sided" or "one.sided".
n_total	Integer scalar. Total sample size (n). Must be ≥ 3 for method = "t" and ≥ 4 for method = "z". If NULL, the function solves for n_total.
alpha	Numeric in (0, 1). If NULL, it is solved for.
power	Numeric in (0, 1). If NULL, it is computed; if n_total is NULL, n_total is solved to attain this power.
rho	Numeric correlation coefficient in $(-1, 1)$, nonzero. If NULL, rho is solved for given the other inputs.
method	Character. Either "t" (noncentral t -distribution) or "z" (Fisher's z transformation with normal approximation).
bias_correction	Logical. Applies only to method = "z". If TRUE, uses the bias-corrected Fisher z -transformation $z_p = \operatorname{atanh}(r) + r/(2(n-1))$.
nlim	Integer vector of length 2. Search range of n_total when solving sample size.

Details

- Exactly one of n_total, rho, alpha, or power must be NULL; that quantity is then solved.
- For method = "t", computations are based on the noncentral t -distribution with noncentrality parameter $\lambda = \frac{\rho}{\sqrt{1-\rho^2}}\sqrt{n}$.

- For method = "z", computations use Fisher's z transformation of the population correlation, $z_\rho = \text{atanh}(\rho)$. Let $W = \sqrt{n-3} z$. Under the alternative hypothesis, $W \sim \text{Normal}(\mu, 1)$ with $\mu = \sqrt{n-3} z_\rho$. If bias_correction = TRUE, ρ is first bias-corrected before applying Fisher's transform. Critical values are taken from the central normal distribution under $H_0 : \rho = 0$ (i.e., $W \sim \text{Normal}(0, 1)$ under the null). The returned ncp equals μ .
- **Validation against GPower:** Results have been confirmed to match those produced by GPower for equivalent correlation tests using the noncentral t -distribution.
- *Note:* Results from method = "z" will not exactly match `pwr::pwr.r.test`, because `pwr` uses a hybrid approach combining the Fisher- z approximation with a t -based critical value.

Value

A one-row data.frame with class "cal_power", "cal_n", "cal_alpha", or "cal_es", depending on the solved quantity. Columns:

- df (only for method = "t")
- n_total, alpha, power
- rho, t_critical or z_critical
- ncp (noncentrality parameter or mean under the alternative: see Details)

Examples

```
# (1) Compute power for rho = 0.3, N = 50, two-sided test
pwrctest(alternative = "two.sided", n_total = 50, rho = 0.3, alpha = 0.05)

# (2) Solve required N for target power, using Fisher-z method
pwrctest(method = "z", rho = 0.2, alpha = 0.05, power = 0.8)

# (3) Solve minimal detectable correlation
pwrctest(n_total = 60, alpha = 0.05, power = 0.9, rho = NULL)
```

pwrctest

Power Analysis for One-/Two-Sample and Paired t Tests

Description

Computes statistical power, required total sample size, α , or the minimal detectable effect size for a t -test in one of three designs: one-sample, two-sample (independent), or paired/repeated measures.

Usage

```
pwrctest(
  paired = FALSE,
  onesample = FALSE,
  n_total = NULL,
  alpha = NULL,
```

```

power = NULL,
delta = NULL,
cohensf = NULL,
peta2 = NULL,
alternative = c("two.sided", "one.sided"),
nlim = c(2, 10000)
)

```

Arguments

paired	Logical. FALSE for two-sample (independent; default), TRUE for paired/repeated-measures. Ignored when onesample = TRUE.
onesample	Logical. TRUE for the one-sample t -test; if TRUE, paired is ignored.
n_total	Integer scalar. Total sample size. If NULL, the function solves for n_total.
alpha	Numeric in (0, 1). If NULL, it is solved for given the other inputs.
power	Numeric in (0, 1). If NULL, it is computed; if n_total is NULL, n_total is solved to attain this power.
delta	Numeric (non-negative). Cohen's d -type effect size. If NULL, it is derived from cohensf or peta2 when available. If all three effect-size arguments (delta, cohensf, peta2) are NULL, then the effect size is treated as the unknown quantity and is solved for given n_total, alpha, and power. The exact definition depends on the design: <ul style="list-style-type: none"> • <i>One-sample</i>: Cohen's $d = (\mu - \mu_0)/\sigma$. • <i>Paired</i>: Cohen's $d_z = \bar{d}/s_d$, i.e., the mean of the difference scores divided by their standard deviation. • <i>Two-sample (equal allocation)</i>: Cohen's d is defined as the mean difference divided by the pooled standard deviation; internally related to f via $d = 2f$. If NULL, delta is derived from cohensf or peta2 when available.
cohensf	Numeric (non-negative). Cohen's f . If NULL, it can be derived from delta; if delta is supplied, cohensf is ignored. Effect-size relations by design: <ul style="list-style-type: none"> • Two-sample (equal allocation): $d = 2f$ • Paired: $d_z = f$ • One-sample: f and η_p^2 are not supported
peta2	Numeric in (0, 1). Partial eta squared. If NULL, it can be derived from cohensf; if delta is supplied, peta2 is ignored. Not defined for one-sample designs.
alternative	Character. Either "two.sided" or "one.sided".
nlim	Integer vector of length 2. Search range of total n when solving sample size.

Details

- If multiple effect-size arguments are supplied (delta, cohensf, peta2), precedence is delta > cohensf > peta2; the rest are ignored with a warning.
- For the two-sample design, equal allocation is assumed; n_total must be even when provided, and the solved n_total will be an even number.

- For the paired design, the effect size is interpreted as d_z .
- Computations use the central and noncentral t -distributions (stats::qt, stats::pt); root finding uses stats::uniroot() where needed.
- Results have been validated to match those produced by G*Power for equivalent one-sample, paired, and two-sample t tests.

Value

A one-row data.frame with class "cal_power", "cal_n", "cal_alpha", or "cal_es", depending on the solved quantity. Columns: df, n_total, alpha, power, delta, cohensf, peta2, t_critical, ncp.

Examples

```
# (1) Two-sample (independent), compute power given N and d
pwrtest(paired = FALSE, onesample = FALSE, alternative = "two.sided",
        n_total = 128, delta = 0.50, alpha = 0.05)

# (2) Paired t-test, solve required N for target power
pwrtest(paired = TRUE, onesample = FALSE, alternative = "one.sided",
        n_total = NULL, delta = 0.40, alpha = 0.05, power = 0.90)

# (3) One-sample t-test, solve alpha given N and power
pwrtest(onesample = TRUE, alternative = "two.sided",
        n_total = 40, delta = 0.40, alpha = NULL, power = 0.80)

# (4) Two-sample, specify effect via f or partial eta^2 (converted internally)
pwrtest(paired = FALSE, cohensf = 0.25, n_total = NULL, alpha = 0.05, power = 0.80)
```

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