

Package ‘Keng’

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Title Knock Errors Off Nice Guesses

Version 2025.9.1

Description Miscellaneous functions and data used in psychological research and teaching. Keng currently has a built-in dataset `depress`, and could (1) scale a vector; (2) compute the cut-off values of Pearson's r with known sample size; (3) test the significance and compute the post-hoc power for Pearson's r with known sample size; (4) conduct a priori power analysis and plan the sample size for Pearson's r ; (5) compare `lm()`'s fitted outputs using `R-squared`, `f_squared`, post-hoc power, and PRE (Proportional Reduction in Error, also called partial `R-squared` or partial `Eta-squared`); (6) calculate PRE from partial correlation, Cohen's f , or `f_squared`; (7) conduct a priori power analysis and plan the sample size for one or a set of predictors in regression analysis; (8) conduct post-hoc power analysis for one or a set of predictors in regression analysis with known sample size; (9) randomly pick numbers for Chinese Super Lotto and Double Color Balls; (10) assess course objective achievement in Outcome-Based Education.

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assess_coa	<i>Assess course objective achievement</i>
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Description

Assess course objective achievement

Usage

```
assess_coa(data, session_weights, objective_weights1, ...)
```

Arguments

data	A wide-format data.frame that only contains student's grades of each session. assess_coa assumes the highest score for each session and the final grade is 100, given that weights are assigned by users.
session_weights	A vector that Weights sessions for the final grade. The length of session_weights is the number of sessions. Typically, the final grade is based on the regular grade and final exam grade, in which condition the length of session_weights is 2. The range of each weight should be 0-1. The sum of session_weights should be 1.
objective_weights1	A vector that Weights course objectives for session 1. The length of objective_weights1 is the number of course objectives. The range of each weight should be 0-1. The sum of objective_weights1 should be 1.

... objective_weights2, objective_weights3, ... Other vectors that Weight course objectives for session1, session2, ... The number of objective_weights* arguments should be equal to the length of session_weights.

Value

A data.frame containing grades of each session, final grades, and achievements of each objective. This data.frame also has an attribute named "weights" that contains a list of session_weights, objective_weights_matrix, and weighted_objective_weights_matrix

Examples

```
data <- data.frame(session1 = 60 + sample.int(40, 100, 1), session2 = 60 + sample.int(40, 100, 1))
session_weights <- c(0.4, 0.6)
objective_weights1 <- c(0.5, 0.3, 0.2)
objective_weights2 <- c(0.1, 0.3, 0.6)
coa <- assess_coa(data, session_weights, objective_weights1, objective_weights2)
head(coa)
attr(coa, "weights")
colMeans(coa[row.names(attr(coa, "weights"))[[2]])
```

calc_PRE

Calculate PRE from Cohen's f, f_squared, or partial correlation

Description

Calculate PRE from Cohen's f, f_squared, or partial correlation

Usage

```
calc_PRE(f = NULL, f_squared = NULL, r_p = NULL)
```

Arguments

f	Cohen's f. Cohen (1988) suggested ≥ 0.1 , ≥ 0.25 , and ≥ 0.40 as cut-off values of f for small, medium, and large effect sizes, respectively.
f_squared	Cohen's f_squared. Cohen (1988) suggested ≥ 0.02 , ≥ 0.15 , and ≥ 0.35 as cut-off values of f for small, medium, and large effect sizes, respectively.
r_p	Partial correlation.

Value

A list including PRE, the absolute value of r_p (partial correlation), Cohen's f_squared, and f.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Examples

```

calc_PRE(f = 0.1)
calc_PRE(f_squared = 0.02)
calc_PRE(r_p = 0.2)

```

compare_lm

Compare lm()'s fitted outputs using PRE and R-squared.

Description

Compare lm()'s fitted outputs using PRE and R-squared.

Usage

```

compare_lm(
  fitC = NULL,
  fitA = NULL,
  n = NULL,
  PC = NULL,
  PA = NULL,
  SSEC = NULL,
  SSEA = NULL
)

```

Arguments

fitC	The result of lm() of the Compact model (model C).
fitA	The result of lm() of the Augmented model (model A).
n	Sample size of the model C or model A. Model C and model A must use the same sample, and hence have the same sample size. Non-integer n would be converted to be an integer using as.integer().
PC	The number of parameters in model C. Non-integer PC would be converted to be an integer using as.integer().
PA	The number of parameters in model A. Non-integer PA would be converted to be an integer using as.integer(). as.integer(PA) should be larger than as.integer(PC).
SSEC	The Sum of Squared Errors (SSE) of model C.
SSEA	The Sum of Squared Errors of model A.

Details

compare_lm() compares model A with model C using PRE (Proportional Reduction in Error), R-squared, f_squared, and post-hoc power. PRE is partial R-squared (called partial Eta-squared in Anova). There are two ways of using compare_lm(). The 1st is giving compare_lm() fitC and fitA. The 2nd is giving n, PC, PA, SSEC, and SSEA. The 1st way is more convenient, and it

minimizes precision loss by omitting copying-and-pasting. Note that the F-tests for PRE and that for R-squared change are equivalent. Please refer to Judd et al. (2017) for more details about PRE, and refer to Aberson (2019) for more details about f_squared and post-hoc power.

Value

A matrix with 12 rows and 4 columns. The 1st column reports information for the baseline model (intercept-only model). the 2nd for model C, the third for model A, and the fourth for the change (model A vs. model C). SSE (Sum of Squared Errors), sample size n, df of SSE, and the number of parameters for baseline model, model C, model A, and change (model A vs. model C) are reported in rows 1-3. The information in the 4th column are all for the change; put differently, these results could quantify the effect of one or a set of new parameters model A has but model C doesn't. If fitC and fitA are not inferior to the intercept-only model, R-squared, Adjusted R-squared, PRE, PRE_adjusted, and f_squared for the full model (compared with the baseline model) are reported for model C and model A. If model C or model A has at least one predictor, F-test with p, and post-hoc power would be computed for the corresponding full model.

References

- Aberson, C. L. (2019). *Applied power analysis for the behavioral sciences*. Routledge.
- Judd, C. M., McClelland, G. H., & Ryan, C. S. (2017). *Data analysis: A model Comparison approach to regression, ANOVA, and beyond*. Routledge.

Examples

```
x1 <- rnorm(193)
x2 <- rnorm(193)
y <- 0.3 + 0.2*x1 + 0.1*x2 + rnorm(193)
dat <- data.frame(y, x1, x2)
# Fix the intercept to constant 1 using I().
fit1 <- lm(I(y - 1) ~ 0, dat)
# Free the intercept.
fit2 <- lm(y ~ 1, dat)
compare_lm(fit1, fit2)
# One predictor.
fit3 <- lm(y ~ x1, dat)
compare_lm(fit2, fit3)
# Fix the intercept to 0.3 using offset().
intercept <- rep(0.3, 193)
fit4 <- lm(y ~ 0 + x1 + offset(intercept), dat)
compare_lm(fit4, fit3)
# Two predictors.
fit5 <- lm(y ~ x1 + x2, dat)
compare_lm(fit2, fit5)
compare_lm(fit3, fit5)
# Fix the slope of x2 to 0.05 using offset().
fit6 <- lm(y ~ x1 + offset(0.05*x2), dat)
compare_lm(fit6, fit5)
```

`cut_r`*Cut-off values of Pearson's correlation r with known sample size n.*

Description

Cut-off values of Pearson's correlation r with known sample size n.

Usage

```
cut_r(n)
```

Arguments

`n` Sample size of Pearson's correlation r. n should be larger than

Details

Given n and p, t and then r could be determined. The formula used could be found in `test_r()`'s documentation.

Value

A data.frame including the cut-off values of r at the significance levels of $p = 0.1, 0.05, 0.01, 0.001$. r with the absolute value larger than the cut-off value is significant at the corresponding significance level.

Examples

```
cut_r(193)
```

`depress`*Depression and Coping*

Description

A subset of data from research about depression and coping.

Usage

```
depress
```

Format

depress:

A data frame with 94 rows and 237 columns:

id Participant id

class Class

grade Grade

elite Elite classes

intervene 0 = Control group, 1 = Intervention group

gender 0 = girl, 1 = boy

age Age in year

cope1i1p Cope scale, Time1, Item1, Problem-focused coping, 1 = very seldom, 5 = very often

cope1i3a Cope scale, Time1, Item3, Avoidance coping

cope1i5e cope scale, Time1, Item5, Emotion-focused coping

cope2i1p Cope scale, Time2, Item1, Problem-focused coping

depr1i1 Depression scale, Time1, Item1, 1 = very seldom, 4 = always

ecr1avo ECR-RS scale, Item1, attachment avoidance, 1 = very disagree, 7 = very agree

ecr2anx ECR-RS scale, Item2, attachment anxiety

dm1 Depression, Mean, Time1

pm1 Problem-focused coping, Mean, Time1

em1 Emotion-focused coping, Mean, Time1

am1 Avoidance coping, Mean, Time1

avo Attachment avoidance, Mean

anx Attachment anxiety, Mean

Source

Keng package.

pick_dcb

Pick Double Color Balls

Description

Pick Double Color Balls

Usage

```
pick_dcb(size = 1L, verbose = TRUE)
```

Arguments

size The size of sets of Super Lotto numbers to pick.
verbose A logical value. Print the numbers picked or not.

Value

Print the numbers picked, and return the invisible balls list that stored these numbers.

Examples

```
pick_dcb(10)
out <- pick_dcb(10, verbose = FALSE)
out
```

pick_sl	<i>Pick Super Lotto numbers</i>
---------	---------------------------------

Description

Pick Super Lotto numbers

Usage

```
pick_sl(size = 1L, verbose = TRUE)
```

Arguments

size	An integer. The size of sets of Super Lotto numbers to pick.
verbose	A logical value. Print the numbers picked or not.

Value

Print the numbers picked, and return the invisible balls list that stored these numbers.

Examples

```
# Example 1
pick_sl(10)
# Example 2
out <- pick_sl(10, verbose = FALSE)
out
# Example 3
# create an empty list
balls <- list(c(front = rep(NA, 5),
                 back = rep(NA, 2))
)
luck <- list(c(front = c(10L, 13L, 14L, 19L, 27L),
               back = c( 6L, 10L)))
# limit the max number of draws
max <- 9999
# try
# count the number of draws
i <- 0
while (!identical(balls, luck, max)) {
```

```
i = i + 1
balls = pick_sl(verbose = FALSE)
if (identical(balls, luck)) {
  print(i)
  print(balls)
}
else
  if (i == max) {
    cat(i, "failed\n")
    break}
}
```

`plot.Keng_power`

Plot the power against the sample size for the Keng_power class

Description

Plot the power against the sample size for the Keng_power class

Usage

```
## S3 method for class 'Keng_power'
plot(x, ...)
```

Arguments

`x` The output object of `power_r()` or `power_lm()`.
`...` Further arguments passed to or from other methods.

Value

A plot of power against sample size.

Examples

```
plot(power_lm())
out <- power_r(0.2, n = 193)
plot(out)
```

power_lm	<i>Conduct post hoc and a priori power analysis, and plan the sample size for regression analysis</i>
----------	---

Description

Conduct post hoc and a priori power analysis, and plan the sample size for regression analysis

Usage

```
power_lm(
  PRE = 0.02,
  PC = 1,
  PA = 2,
  sig_level = 0.05,
  power = 0.8,
  power_ul = 1,
  n_ul = 1.45e+09,
  n = NULL
)
```

Arguments

PRE	Proportional Reduction in Error. PRE = The square of partial correlation. Cohen (1988) suggested ≥ 0.02 , ≥ 0.13 , and ≥ 0.26 as cut-off values of PRE for small, medium, and large effect sizes, respectively.
PC	Number of parameters of model C (compact model) without focal predictors of interest. Non-integer PC would be converted to be an integer using <code>as.integer()</code> .
PA	Number of parameters of model A (augmented model) with focal predictors of interest. Non-integer PA would be converted to be an integer using <code>as.integer()</code> . <code>as.integer(PA)</code> should be larger than <code>as.integer(PC)</code> .
sig_level	Expected significance level for effects of focal predictors.
power	Expected statistical power for effects of focal predictors.
power_ul	The upper limit of power below which the minimum sample size is searched. <code>power_ul</code> should be larger than <code>power</code> , and the maximum <code>power_ul</code> is 1.
n_ul	The upper limit of sample size below which the minimum required sample size is searched. Non-integer <code>n_ul</code> would be converted to be an integer using <code>as.integer()</code> . <code>as.integer(n_ul)</code> should be at least <code>as.integer(PA) + 1</code> .
n	The current sample size. Non-integer <code>n</code> would be converted to be an integer using <code>as.integer()</code> . Non-NULL <code>as.integer(n)</code> should be at least <code>as.integer(PA) + 1</code> .

Details

`power_ul` and `n_ul` determine the total times of `power_lm()`'s attempts searching for the minimum required sample size, hence the number of rows of the returned power table `priori` and the right limit of the horizontal axis of the returned power plot. `power_lm()` will keep running and gradually raise the sample size to `n_ul` until the sample size pushes the power level to `power_ul`. When PRE is very small (e.g., less than 0.001) and power is larger than 0.8, a huge increase in sample size only brings about a trivial increase in power, which is cost-ineffective. To make `power_lm()` omit unnecessary attempts, you could set `power_ul` to be a value less than 1 (e.g., 0.90), and/or set `n_ul` to be a value less than $1.45e+09$ (e.g., 10000).

Value

A `Keng_power` class, also a list. If sample size `n` is not given, the following results would be returned: `[[1]]` PRE; `[[2]]` `f_squared`, Cohen's `f_squared` derived from PRE; `[[3]]` PC; `[[4]]` PA; `[[5]]` `sig_level`, expected significance level for effects of focal predictors; `[[6]]` power, expected statistical power for effects of focal predictors; `[[7]]` `power_ul`, the upper limit of power; `[[8]]` `n_ul`, the upper limit of sample size; `[[9]]` `minimum`, the minimum sample size `n_i` required for focal predictors to reach the expected statistical power and significance level, and corresponding `df_A_C`(the df of the numerator of the F-test, i.e., the difference of the dfs between model C and model A), `df_A_i`(the df of the denominator of the F-test, i.e., the df of the model A at the sample size `n_i`), `F_i`(the *F*-test of PRE at the sample size `n_i`), `p_i`(the p-value of `F_i`), `lambda_i`(the non-centrality parameter of the F-distribution for the alternative hypothesis, given PRE and `n_i`), `power_i`(the actual power of PRE at the sample size `n_i`); `[[10]]` `priori`, a priori power table with increasing sample sizes (`n_i`) and `power(power_i)`.

If sample size `n` is given, the following results would also be returned: Integer `n`, the `F_test` of PRE at the sample size `n` with `df_A_C`, `df_A` (the df of the model A at the sample size `n`), `F` (the *F*-test of PRE at the sample size `n`), `p` (the p-value of *F*-test at the sample size `n`), and the post-hoc power analysis with `lambda_post` (the non-centrality parameter of *F* at the sample size `n`), and `power_post` (the post-hoc power at the sample size `n`).

By default, `print()` prints the primary but not all contents of the `Keng_power` class. To inspect more contents, use `print.AsIs()` or list extracting.

References

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Examples

```
power_lm()
print(power_lm())
plot(power_lm())
```

power_r	<i>Conduct post hoc and a priori power analysis, and plan the sample size for r.</i>
---------	--

Description

Conduct post hoc and a priori power analysis, and plan the sample size for r.

Usage

```
power_r(
  r = 0.2,
  sig_level = 0.05,
  power = 0.8,
  power_ul = 1,
  n_ul = 1.45e+09,
  n = NULL
)
```

Arguments

r	Pearson's correlation. Cohen(1988) suggested ≥ 0.1 , ≥ 0.3 , and ≥ 0.5 as cut-off values of Pearson's correlation r for small, medium, and large effect sizes, respectively.
sig_level	Expected significance level.
power	Expected statistical power.
power_ul	The upper limit of power. power_ul should be larger than power, and the maximum power_ul is 1.
n_ul	The upper limit of sample size below which the minimum required sample size is searched. Non-integer n_ul would be converted to be an integer using <code>as.integer()</code> . n_ul should be at least 3.
n	The current sample size. Non-integer n would be converted to be an integer using <code>as.integer()</code> . n should be at least 3.

Details

Power_r() follows Aberson (2019) approach to conduct power analysis. power_ul and n_ul determine the total times of power_r()'s attempts searching for the minimum required sample size, hence the number of rows of the returned power table `priori` and the right limit of the horizontal axis of the returned power plot. power_r() will keep running and gradually raise the sample size to n_ul until the sample size pushes the power level to power_ul. When r is very small and power is larger than 0.8, a huge increase of sample size only brings about a trivial increase in power, which is cost-ineffective. To make power_r() omit unnecessary attempts, you could set power_ul to be a value less than 1 (e.g., 0.90), and/or set n_ul to be a value less than 1.45e+09 (e.g., 10000).

Value

A `Keng_power` class, also a list. If `n` is not given, the following results would be returned: [[1]] `r`, the given `r`; [[2]] `d`, Cohen's `d` derived from `r`; Cohen (1988) suggested ≥ 0.2 , ≥ 0.5 , and ≥ 0.8 as cut-off values of `d` for small, medium, and large effect sizes, respectively; [[3]] `sig_level`, the expected significance level; [[4]] `power`, the expected power; [[5]] `power_ul`, The upper limit of power; [[6]] `n_ul`, the upper limit of sample size; [[7]] `minimum`, the minimum planned sample size `n_i` and corresponding `df_i` (the `df` of t-test at the sample size `n_i`, `df_i = n_i - 2`), `SE_i` (the SE of `r` at the sample size `n_i`), `t_i` (the t-test of `r`), `p_i` (the p-value of `t_i`), `delta_i` (the non-centrality parameter of the t-distribution for the alternative hypothesis, given `r` and `n_i`), `power_i` (the actual power of `r` at the sample size `n_i`); [[8]] `priori`, a priori power table with increasing sample sizes (`n_i`) and `power(power_i)`. [[9]] A plot of power against sample size `n`.

If sample size `n` is given, the following results would also be returned: Integer `n`, the `t_test` of `r` at the sample size `n` with `df`, SE of `r`, `p` (the p-value of t-test), and the post-hoc power analysis with `delta_post` (the non-centrality parameter of the t-distribution for the alternative hypothesis), and `power_post` (the post-hoc power of `r` at the sample size `n`).

By default, `print()` prints the primary but not all contents of the `Keng_power` class. To inspect more contents, use `print.AsIs()` or list extracting.

References

Aberson, C. L. (2019). *Applied power analysis for the behavioral sciences*. Routledge.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Examples

```
power_r(0.2)
print(power_r(0.04))
plot(power_r(0.04))
```

```
print.Keng_power      Print primary but not all contents of the Keng_power class
```

Description

Print primary but not all contents of the `Keng_power` class

Usage

```
## S3 method for class 'Keng_power'
print(x, ...)
```

Arguments

`x` The output object of `power_r()` or `power_lm()`.
`...` Further arguments passed to or from other methods.

Value

None (invisible NULL).

Examples

```
power_lm()
power_lm(n = 200)
print(power_lm(n = 200))
x <- power_r(0.2, n = 193)
x
```

Scale

Scale a vector

Description

Scale a vector

Usage

```
Scale(x, m = NULL, sd = NULL, oadvances = NULL)
```

Arguments

x	The original vector.
m	The expected Mean of the scaled vector.
sd	The expected Standard Deviation (unit) of the scaled vector.
oadvances	The distance the Origin of x advances by.

Details

To scale x, its origin, or unit (sd), or both, could be changed.

If m = 0 or NULL, and sd = NULL, x would be mean-centered.

If m is a non-zero number, and sd = NULL, the mean of x would be transformed to m.

If m = 0 or NULL, and sd = 1, x would be standardized to be its z-score with m = 0 and m = 1.

The standardized score is not necessarily the z-score. If neither m nor sd is NULL, x would be standardized to be a vector whose mean and standard deviation would be m and sd, respectively.

To standardize x, the mean and standard deviation of x are needed and computed, for which the missing values of x are removed if any.

If oadvances is not NULL, the origin of x will advance with the standard deviation being unchanged.

In this case, Scale() could be used to pick points in simple slope analysis for moderation models.

Note that when oadvances is not NULL, m and sd must be NULL.

Value

The scaled vector.

Examples

```
(x <- rnorm(10, 5, 2))
# Mean-center x.
Scale(x)
# Transform the mean of x to 3.
Scale(x, m = 3)
# Transform x to its z-score.
Scale(x, sd = 1)
# Standardize x with m = 100 and sd = 15.
Scale(x, m = 100, sd = 15)
# The origin of x advances by 3.
Scale(x, oadvances = 3)
```

test_r	<i>Test the significance, analyze the power, and plan the sample size for r.</i>
--------	--

Description

Test the significance, analyze the power, and plan the sample size for r.

Usage

```
test_r(r = NULL, n = NULL, sig_level = 0.05, power = 0.8)
```

Arguments

r	Pearson's correlation. Cohen(1988) suggested ≥ 0.1 , ≥ 0.3 , and ≥ 0.5 as cut-off values of Pearson's correlation r for small, medium, and large effect sizes, respectively.
n	Sample size of r. Non-integer n would be converted to be a integer using <code>as.integer()</code> . n should be at least 3.
sig_level	Expected significance level.
power	Expected statistical power.

Details

To test the significance of the r using the one-sample t-test, the SE of r is determined by the following formula: $SE = \sqrt{(1 - r^2)/(n - 2)}$. Another way is transforming r to Fisher's z using the following formula: $fz = \text{atanh}(r)$ with the SE of fz being $\sqrt{n - 3}$. Fisher's z is commonly used to compare two Pearson's correlations from independent samples. Fisher's transformation is presented here only to satisfy the curiosity of users who are interested in the difference between t-test and Fisher's transformation.

The post-hoc power of r's t-test is computed through the way of Aberson (2019). Other software and R packages like SPSS and pwr give different power estimates due to underlying different formulas. Keng adopts Aberson's approach because this approach guarantees the equivalence of r and PRE.

Value

A list with the following results: `[[1]]` r, the given r; `[[2]]` d, Cohen's d derived from r; Cohen (1988) suggested ≥ 0.2 , ≥ 0.5 , and ≥ 0.8 as cut-off values of d for small, medium, and large effect sizes, respectively. `[[3]]` Integer n; `[[4]]` t-test of r (incl., r, df of r, SE_r, t, p_r), 95% CI of r based on t-test (LLCI_r_t, ULCI_r_t), and post-hoc power of r (incl., delta_post, power_post); `[[5]]` Fisher's z transformation (incl., fz of r, z-test of fz [SE_fz, z, p_fz], and 95% CI of r derived from fz.

Note that the returned CI of r may be out of r's valid range [-1, 1]. This "error" is deliberately left to users, who should correct the CI manually in reports.

References

Aberson, C. L. (2019). *Applied power analysis for the behavioral sciences*. Routledge.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge.

Examples

```
test_r(0.2, 193)

# compare the p-values of t-test and Fisher's transformation
for (i in seq(30, 200, 10)) {
  cat(c("n = ", i, ", difference between ps = ",
        format(
          abs(test_r(0.2, i)[["t_test"]][["p_r"]] - test_r(0.2, i)[["Fisher_z"]][["p_fz"]]),
          nsmall = 12,
          scientific = FALSE)),
      sep = "",
      fill = TRUE)
}
```

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