Package 'cofad'

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Type Package

Title Contrast Analyses for Factorial Designs

Version 0.4.0

Description Contrast analysis for factorial designs provides an alternative to the traditional ANOVA approach, offering the distinct advantage of testing targeted hypotheses. The foundation of this package is primarily rooted in the works of Rosenthal, Rosnow, and Rubin (2000, ISBN: 978-0521659802) as well as Sedlmeier and Renkewitz (2018, ISBN: 978-3868943214).

License LGPL (>= 3)

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BugReports https://github.com/johannes-titz/cofad/issues

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Author Johannes Titz [aut, cre], Markus Burkhardt [aut], Mirka Henninger [ctb], Simone Malejka [ctb]

Maintainer Johannes Titz <johannes.titz@gmail.com>

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akan *Data from Akan et al. (2018), experiment 2B*

Description

Data contains information from a within-subjects experiment with N = 90 participants. The goal of the experiment was to investigate the benefits of retrieval practice on memory performance. For the entire dataset and analysis scripts see: https://osf.io/bqr5f/. The data was licensed under CC-BY 4.0 Melisa Akan, Aaron Benjamin.

Usage

```
data(akan)
```

Format

a data frame with 270 rows and 3 variables:

subject subject id

condition experimental condition (test, restudy, control)

contexts dependent variable

Source

Akan, M., Stanley, S. E., & Benjamin, A. S. (2018). Testing enhances memory for context. Journal of Memory and Language, 103, 19–27. doi:10.1016/j.jml.2018.07.003

---

calc_contrast *Calculate contrast analysis for factorial designs*

Description

Calculate contrast analysis for factorial designs

Usage

```
calc_contrast(
  dv,
  between = NULL,
  lambda_between = NULL,
  within = NULL,
  lambda_within = NULL,
  ID = NULL,
  id = NULL,
  data = NULL,
  within_score = c("L", "r")
)
```

Arguments

dv	dependent variable. Values must be numeric.
between	independent variable that divides the data into independent groups. Vector must be a factor.
lambda_between	contrast weights must be a named numeric. Names must match the levels of between. If lambda_between does not sum up to zero, this will be done automatically.

within	independent variable which divides the data into dependent groups. This must be a factor.
lambda_within	contrast must be a named numeric. Names must match the levels of within. If lambda_within does not sum up to zero, this will be done automatically.
ID	deprecated, use id instead
id	identifier for cases or subjects is needed for within- and mixed contrast analysis.
data	optional argument for the data.frame containing dv and groups.
within_score	participant-level score for a within-subjects contrast: ‘"L"‘ (the default) retains response magnitude, whereas ‘"r"‘ measures agreement between each participant's response pattern and the contrast weights.

Details

For multi-factorial designs, the lambda weights of the factors must be connected.

Note that cofad returns one-sided p-values for t-tests.

Value

an object of type cofad_bw or cofad_wi or cofad_mx, including p-value, F-value, contrast weights, and different effect sizes. Call summary on this object to get a nice overview of all relevant statistics. Call print to get a short text that can be used for a report.

References

Rosenthal, R., Rosnow, R.L., & Rubin, D.B. (2000). Contrasts and effect sizes in behavioral research: A correlational approach. New York: Cambridge University Press.

Examples

```
# Example for between-subjects design Table 3.1 from
# Rosenthal, Rosnow and Rubin (2000)

data(rosenthal_tbl31)
contr_bw <- calc_contrast(
   dv = dv,
   between = between,
   lambda_between = c("A" = -3, "B" = -1, "C" = 1, "D" = 3),
   data = rosenthal_tbl31)
contr_bw
summary(contr_bw)

# Example for within-subjects design Calculation 16.6 from
# Sedlmeier and Renkewitz (2018, p. 537)

data(sedlmeier_p537)
contr_wi <- calc_contrast(
   dv = reading_test,
   within = music,
   id = participant,
```

```
   lambda_within = c(
     "without music" = 1.25,
     "white noise" = 0.25,
     "classic" = -0.75,
     "jazz" = -0.75
   ),
   data = sedlmeier_p537
 )
contr_wi
summary(contr_wi, ci = .90)

# Example for mixed-design Table 5.3 from
# Rosenthal, Rosnow and Rubin (2000)

data(rosenthal_tbl53)

contr_mx <- calc_contrast(dv = dv, between = between,
              lambda_between = c("age8" = -1, "age10" = 0, "age12" = 1),
              within = within,
              lambda_within = c("1" = -3, "2" = -1,"3" = 1, "4" = 3),
              id = id, data = rosenthal_tbl53
              )
contr_mx
summary(contr_mx)
```

`calc_contrast_aggregated` *Calculate between contrast analysis from aggregated data (means, sds and ns)*

Description

Calculate between contrast analysis from aggregated data (means, sds and ns)

Usage

```
calc_contrast_aggregated(means, sds, ns, between, lambda_between, data = NULL)
```

Arguments

`means`	numeric vector of mean values for every condition
`sds`	numeric vector of standard deviation values for every condition
`ns`	numeric vector of sample size values for every condition
`between`	factor for the independent variable that divides the data into independent groups
`lambda_between`	numeric vector for contrast weights. Names must match the levels of `between`. If `lambda_between` does not sum up to zero, this will be done automatically (centering).
`data`	optional argument for the `data.frame` containing all variables except for lambda_between

Value

an object of type cofad_bw, including p-value, F-value, contrast weights, different effect sizes

References

Rosenthal, R., Rosnow, R.L., & Rubin, D.B. (2000). Contrasts and effect sizes in behavioral research: A correlational approach. New York: Cambridge University Press.

Examples

```
furr_agg <- aggregate(
  empathy ~ major, furr_p4,
  function(x) c(mean = mean(x), sd = sd(x), n = length(x))
)
furr_agg <- data.frame(
  major = furr_agg$major, mean = furr_agg$empathy[, "mean"],
  sd = furr_agg$empathy[, "sd"], n = furr_agg$empathy[, "n"]
)
lambdas <- c("psychology" = 1, "education" = -1, "business" = 0,
             "chemistry" = 0)
calc_contrast_aggregated(mean, sd, n, major, lambdas, furr_agg)
```

---

calc_r_alerting *Calculate r_alerting from r_contrast and r_effectsize*

Description

Convenience function to transform effect sizes in contrast analyses.

Usage

```
calc_r_alerting(r_contrast, r_effectsize)
```

Arguments

r_contrast	what it says
r_effectsize	what it says

`calc_r_alerting_from_f` *Calculate r_alerting from F-values*

Description

Convenience function to calculate effect sizes in contrast analyses.

Usage

```
calc_r_alerting_from_f(f_contrast, f_between, df_between)
```

Arguments

`f_contrast`	F value from contrast analysis
`f_between`	F value from ANOVA (one between variable!)
`df_between`	degrees of freedom of ANOVA

`calc_r_contrast` *Calculate r_contrast from r_alerting and r_effectsize*

Description

Convenience function to transform effect sizes in contrast analyses.

Usage

```
calc_r_contrast(r_alerting, r_effectsize)
```

Arguments

`r_alerting`	what it says
`r_effectsize`	what it says

calc_r_effectsize *Calculate r_effectsize from r_contrast and r_alerting*

Description

Convenience function to transform effect sizes in contrast analyses.

Usage

```
calc_r_effectsize(r_alerting, r_contrast)
```

Arguments

r_alerting	what it says
r_contrast	what it says

detect_design *Suggest roles for a contrast-analysis data set*

Description

Uses the replication and nesting structure of a long-format data frame to suggest a dependent variable, participant identifier, and within- and between-subjects factors. Suggestions are intended as editable defaults; they cannot recover design intent that is not represented in the data.

Usage

```
detect_design(data)
```

Arguments

data	A data frame in long format.

Value

A list containing the suggested design and variable names, a confidence score, and role diagnostics.

furr_p4 *Empathy data set by Furr (2004)*

Description

fictitious data set on empathy ratings of students from different majors

Usage

```
data(furr_p4)
```

Format

a data frame with 20 rows and 2 columns

empathy Empathy rating

major major of student

Source

Furr, R. M. (2004). Interpreting effect sizes in contrast analysis. Understanding Statistics, 3, 1–25. https://doi.org/10.1207/s15328031us0301_1

haans_within1by4 *Haans within data example*

Description

Fictitious data set from Haans, A. (2018). Contrast Analysis: A Tutorial. https://doi.org/10.7275/7DEY-ZD62

Usage

```
data(haans_within1by4)
```

Format

a data frame with 20 rows and 3 variables:

person person id

name group name (sitting row 1 to 4)

value dv, final exam grade

lambda_diff *Calculate lambdas for two competing hypotheses*

Description

If you want to test two competing hypotheses, you can use this helper function to create the correct difference lambdas. There is no magic here. The two contrasts are z-standardized first and then subtracted (lambda_favored - lambda_rival). You can use the new difference lambdas as the input for calc_contrast.

Usage

```
lambda_diff(
  lambda_favored = NULL,
  lambda_rival = NULL,
  labels = NULL,
  lambda_preferred = NULL,
  lambda_competing = NULL
)
```

Arguments

lambda_favored	Lambdas of the favored hypothesis. Has to be a named vector with the names corresponding with the groups in the analyzed data set. Alternatively, use the parameter 'labels'.
lambda_rival	Lambdas of the rival hypothesis. Has to be a named vector with the names corresponding with the groups in the analyzed data set. Alternatively, use the parameter 'labels'.
labels	If you provide lambdas without names, you can set the group labels for both contrasts here.
lambda_preferred	Deprecated. Use 'lambda_favored' instead.
lambda_competing	Deprecated. Use 'lambda_rival' instead.

Value

Lambdas for difference between lambda_favored and lambda_rival

Examples

```
lambda <- lambda_diff(lambda_favored = c("A" = 1, "B" = 2, "C" = 3),
                      lambda_rival = c("A" = 1, "B" = 2, "C" = 6))
lambda
# same result
lambda2 <- lambda_diff(lambda_favored = c(1, 2, 3),
                       lambda_rival = c(1, 2, 6),
```

```
                        labels = c("A", "B", "C"))
lambda2
```

`maraver` *Data from Maraver et al. (2021)*

Description

The dataset originates from a between-subjects experiment with N = 120 participants. The experiment aimed to examine whether instructions to imagine the study material could reduce false memories. Full dataset and analysis scripts are available at: https://osf.io/v8apj/?view_only=9969d17536f54053a72be19c050c4767.

Usage

```
data(maraver)
```

Format

a data frame with 120 rows and 3 variables:

id subject id

condition experimental condition (imagine, memorize, pay_attention)

prop_recalled dependent variable

Source

Maraver, M. J., Lapa, A., Garcia-Marques, L., Carneiro, P., & Raposo, A. (2021). Imagination Reduces False Memories for Everyday Action Sentences: Evidence From Pragmatic Inferences. Frontiers in Psychology, 12. doi:10.3389/fpsyg.2021.668899

`print.cofad_bw` *Output of between-subject design contrast analysis*

Description

Output of between-subject design contrast analysis

Usage

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

Arguments

`x`	output of calc_contrast
`...`	further arguments

Value

Displays the significance of the contrast analysis. The contrast weights, the corresponding group and an effectsize are given.

`print.cofad_mx` *Output of a mixed design contrast analysis*

Description

Output of a mixed design contrast analysis

Usage

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

Arguments

`x`	output of calc_contrast
`...`	further arguments

Value

Displays the significance of the contrast analysis. The contrast weights, the corresponding group, and an effect size are given.

`print.cofad_wi` *Output of a within subject design contrast analysis*

Description

Output of a within subject design contrast analysis

Usage

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

Arguments

`x`	output of calc_contrast
`...`	further arguments

Value

Displays the significance of the contrast analysis. The contrast weights, the corresponding group, and an effect size are given.

rosenthal_chap5_q2 *Complexity data set by Rosenthal and Rosnow (2000)*

Description

Exercise 2 from Chapter 5 (table on p. 147) in Rosenthal and Rosnow (2000)

Usage

```
data(rosenthal_chap5_q2)
```

Format

a data frame with 12 rows and 4 columns

dv dependent variable: rating of degree of complexity of social interaction from a series of clips

id unique identifier of participant

within within variable: complexity of interaction (low, medium high)

between between variable: cognitive complexity of participant (high or low)

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

rosenthal_p141 *Data set by Rosenthal and Rosnow (2000)*

Description

Fictitious example corresponding to aggregated data set on p. 141 in Rosenthal and Rosnow (2000)

Usage

```
data(rosenthal_p141)
```

Format

a data frame with 12 rows and 4 columns

id unique identifier of participant

dv dependent variable

within within variable

between between variable

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

`rosenthal_tbl31` *Data set by Rosenthal and Rosnow (2000)*

Description

Table 3.1 in Rosenthal and Rosnow (2000) on p. 38.

Usage

```
data(rosenthal_tbl31)
```

Format

a data frame with 20 rows and 2 columns

dv dependent variable

between group (A, B, C, D))

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

`rosenthal_tbl53` *Children data set by Rosenthal and Rosnow (2000)*

Description

Table 5.3 in Rosenthal and Rosnow (2000) on p. 129.

Usage

```
data(rosenthal_tbl53)
```

Format

a data frame with 36 rows and 4 columns

dv dependent variable

between age group (8, 10, 12 years)

id unique identifier for child

within measurement (1, 2, 3, 4)

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

`rosenthal_tbl54` *Response-profile data by Rosenthal et al. (2000)*

Description

Table 5.4 contrasts two fictitious children's four-condition profiles. It illustrates that participant L scores retain response magnitude whereas participant r scores measure agreement with the shape of the contrast.

Usage

```
data(rosenthal_tbl54)
```

Format

a data frame with 8 rows and 3 columns

id participant identifier (A or B)

dv dependent variable

within four-level within-subjects factor

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

`rosenthal_tbl59` *Therapy data set by Rosenthal and Rosnow (2000)*

Description

Table 5.9 in Rosenthal and Rosnow (2000)

Usage

```
data(rosenthal_tbl59)
```

Format

a data frame with 12 rows and 4 columns

id unique identifier

dv dependent variable

med within variable: medication (treatment or placebo)

pt between variable: psychotherapy (treatment or placebo)

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

---

rosenthal_tbl68 *Data set by Rosenthal and Rosnow (2000)*

Description

Fictitious example of children ability, Table 6.8 in Rosenthal and Rosnow (2000)

Usage

```
data(rosenthal_tbl68)
```

Format

a data frame with 32 rows and 4 columns

id unique identifier of participant

dv dependent variable

within within variable

between between variable

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

rosenthal_tbl68_mixed *Corrected mixed-design Table 6.8 data by Rosenthal et al. (2000)*

Description

This version assigns the first four children to the girl group and the last four to the boy group, as described in the source. The legacy ‘rosenthal_tbl68‘ object is retained unchanged for backward compatibility.

Usage

```
data(rosenthal_tbl68_mixed)
```

Format

a data frame with 32 rows and 4 columns

id unique participant identifier

dv dependent variable

within four-level within-subjects factor

between between-subjects group (girl or boy)

Source

Rosenthal, R., Rosnow, R. L., & Rubin, D. B. (2000). Contrasts and Effect Sizes in Behavioral Research: A Correlational Approach. Cambridge University Press.

run_app *Start the cofad Shiny app*

Description

Start the cofad Shiny app

Usage

```
run_app()
```

schwoebel *Data from Schwoebel et al. (2018)*

Description

For the entire dataset and analysis scripts see:

Usage

```
data(schwoebel)
```

Format

a data frame with 64 rows and 2 variables:

condition experimental condition (massed-same, massed-different, spaced-same, spaced-different)

percent_recalled dependent variable

Source

Schwoebel, J., Depperman, A. K., & Scott, J. L. (2018). Distinct episodic contexts enhance retrieval-based learning. Memory, 26(9), 1291–1296. doi:10.1080/09658211.2018.1464190

sedlmeier_p525 *Problem solving data set by Sedlmeier & Renkewitz (2018)*

Description

Example 16.2, Table 16.1 in Sedlmeier & Renkewitz (2018). Fictitious data set with 15 boys divided into three groups (no training, boys-specific material, girls-specific training material). The DV is the number of solved problem tasks. Table 16.2 in the book repeats these observations and adds the three sets of contrast weights discussed in the example.

Usage

```
data(sedlmeier_p525)
```

Format

a data frame with 15 rows and 3 columns

lsg dv, number of solved exercises

between group, KT=no training, JT=boys-specific, MT=girls-specific

lambda lambdas used for this example

Source

Sedlmeier, P., & Renkewitz, F. (2018). Forschungsmethoden und Statistik für Psychologen und Sozialwissenschaftler (3rd ed.). Pearson Studium.

`sedlmeier_p537` *Music data set by Sedlmeier & Renkewitz (2018)*

Description

Example 16.6, table 16.5 in Sedlmeier & Renkewitz (2018). Fictitious data set with 8 participants that listened to no music, white noise, classical music, and jazz music (within). The DV is a reading test.

Usage

```
data(sedlmeier_p537)
```

Format

a data frame with 32 rows and 3 columns

reading_test dependent variable

participant unique id

music within variable

Source

Sedlmeier, P., & Renkewitz, F. (2018). Forschungsmethoden und Statistik für Psychologen und Sozialwissenschaftler (3rd ed.). Pearson Studium.

`summary.cofad_bw` *Summary of between subject design contrast analysis*

Description

Summary of between subject design contrast analysis

Usage

```
## S3 method for class 'cofad_bw'
summary(object, ...)
```

Arguments

`object`	output of calc_contrast
`...`	further arguments

Value

Displays type of contrast analysis, lambdas, t-table, ANOVA table and typical effect sizes. If you assign this to a variable, it will be a list with the elements Lambdas, tTable, FTable, Effects.

---

summary.cofad_mx *Summary of a mixed design contrast analysis*

Description

Summary of a mixed design contrast analysis

Usage

```
## S3 method for class 'cofad_mx'
summary(object, ...)
```

Arguments

object	output of calc_contrast
...	further arguments

Value

Displays type of contrast analysis, lambdas, t-table, ANOVA table and typical effect sizes. If you assign this to a variable, it will be a list with the elements Lambdas, tTable, FTable, Effects.

---

summary.cofad_wi *Summary of within subject design contrast analysis*

Description

Summary of within subject design contrast analysis

Usage

```
## S3 method for class 'cofad_wi'
summary(object, ci = 0.95, ...)
```

Arguments

object	output of calc_contrast
ci	confidence interval for the composite score (L values)
...	further arguments

Value

Displays type of contrast analysis, lambdas, t-table and typical effect sizes. If you assign this to a variable, it will be a list with the elements Lambdas, tTable, Effects.

`testing_effect` *Testing Effect data*

Description

This dataset originates from a study conducted as part of a research seminar in the Psychology B.Sc. program of the University of Cologne. The study participants learned a list of 20 non-associated word pairs. Each half of the word pair was associated with one of two sources (imagining the word pair in the sky or underwater). The final memory test (cued recall) was conducted two days later. Cued recall means that one word of the word pair was presented, and the participant had to recall the other word. The participants were randomly assigned into one of three between-participant conditions: restudy, source test, item test.

Usage

```
data(testing_effect)
```

Format

a data frame with 60 rows and 3 variables:

subject the participant's id

condition the between-participant condition

recalled the number of words recalled in the cued-recall test

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