

Package ‘dabestr’

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Type Package

Title Data Analysis using Bootstrap-Coupled Estimation

Version 0.2.0

Maintainer Joses W. Ho <joseshowh@gmail.com>

Description Data Analysis using Bootstrap-Coupled ESTimation.

Estimation statistics is a simple framework that avoids the pitfalls of significance testing. It uses familiar statistical concepts: means, mean differences, and error bars. More importantly, it focuses on the effect size of one's experiment/intervention, as opposed to a false dichotomy engendered by P values.

An estimation plot has two key features:

1. It presents all datapoints as a swarmplot, which orders each point to display the underlying distribution.
2. It presents the effect size as a bootstrap 95% confidence interval on a separate but aligned axes.

Estimation plots are introduced in Ho et al (2018) <doi:10.1101/377978>.

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Author Joses W. Ho [cre, aut],
Tayfun Tumkaya [aut]

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R topics documented:

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|--------|---|
| dabest | <i>Differences between Groups with Bootstrap Confidence Intervals</i> |
|--------|---|

Description

dabest applies a summary function (func, default [mean](#)) to the groups listed in `idx`, which are factors/strings in the `x` column of `.data`. The first element of `idx` is the control group. The difference between `func(group_n)` and `func(control)` is computed, for every subsequent element of `idx`.

For each comparison, a bootstrap confidence interval is constructed for the difference, and bias correction and acceleration is applied to correct for any skew. dabest uses bootstrap resampling to compute non-parametric assumption-free confidence intervals, and visualizes them using estimation plots with a specialized [plot.dabest](#) function.

Usage

```
dabest(.data, x, y, idx, paired = FALSE, id.column = NULL, ci = 95,
       reps = 5000, func = mean, seed = 12345)
```

Arguments

| | |
|-------------------------|--|
| <code>.data</code> | A <code>data.frame</code> or <code>tibble</code> . |
| <code>x, y</code> | Columns in <code>.data</code> . |
| <code>idx</code> | A vector containing factors or strings in the <code>x</code> columns. These must be quoted (ie. surrounded by quotation marks). The first element will be the control group, so all differences will be computed for every other group and this first group. |
| <code>paired</code> | boolean, default <code>FALSE</code> . If <code>TRUE</code> , the two groups are treated as paired samples. The <code>control_group</code> group is treated as pre-intervention and the <code>test_group</code> group is considered post-intervention. |
| <code>id.column,</code> | default <code>NULL</code> . A column name indicating the identity of the datapoint if the data is paired. This must be supplied if <code>paired</code> is <code>TRUE</code> . |
| <code>ci</code> | float, default 95. The level of the confidence intervals produced. The default <code>ci = 95</code> produces 95% CIs. |

| | |
|------|--|
| reps | integer, default 5000. The number of bootstrap resamples that will be generated. |
| func | function, default mean. This function will be applied to control and test individually, and the difference will be saved as a single bootstrap resample. Any NaNs will be removed automatically with <code>na.omit</code> . |
| seed | integer, default 12345. This specifies the seed used to set the random number generator. Setting a seed ensures that the bootstrap confidence intervals for the same data will remain stable over separate runs/calls of this function. See set.seed for more details. |

Details

Estimation statistics is a statistical framework that focuses on effect sizes and confidence intervals around them, rather than P values and associated dichotomous hypothesis testing.

Value

A list with 7 elements: `data`, `x`, `y`, `idx`, `id.column`, `result`, and `summary`.

`data`, `x`, `y`, `id.column`, and `idx` are the same keywords supplied to `dabest` as noted above.

`x` and `y` are quoted variables for tidy evaluation by `plot`.

`summary` is a [tibble](#) with `func` applied to every group specified in `idx`. These will be used by `plot()` to generate the estimation plot.

`result` is a [tibble](#) with the following 15 columns:

| | |
|--|--|
| <code>control_group</code> , <code>test_group</code> | The name of the control group and test group respectively. |
| <code>control_size</code> , <code>test_size</code> | The number of observations in the control group and test group respectively. |
| <code>func</code> | The <code>func</code> passed to <code>bootdiff</code> . |
| <code>paired</code> | Is the difference paired (TRUE) or not (FALSE)? |
| <code>difference</code> | The difference between the two groups; effectively <code>func(test_group) - func(control_group)</code> . |
| <code>variable</code> | The variable whose difference is being computed, ie. the column supplied to <code>y</code> . |
| <code>ci</code> | The <code>ci</code> passed to the <code>bootdiff</code> . |
| <code>bca_ci_low</code> , <code>bca_ci_high</code> | The lower and upper limits of the Bias Corrected and Accelerated bootstrap confidence interval. |
| <code>pct_ci_low</code> , <code>pct_ci_high</code> | The lower and upper limits of the percentile bootstrap confidence interval. |
| <code>bootstraps</code> | The array of bootstrap resamples generated. |

References

[Bootstrap Confidence Intervals](#). DiCiccio, Thomas J., and Bradley Efron. *Statistical Science*: vol. 11, no. 3, 1996. pp. 189–228.

[An Introduction to the Bootstrap](#). Efron, Bradley, and R. J. Tibshirani. 1994. CRC Press.

See Also

[plot.dabest](#), which generates an estimation plot from the dabest object.

Examples

```
# Performing unpaired (two independent groups) analysis.
unpaired_mean_diff <- dabest(iris, Species, Petal.Width,
                             idx = c("setosa", "versicolor"),
                             paired = FALSE)

# Display the results in a user-friendly format.
unpaired_mean_diff

# Produce an estimation plot.
plot(unpaired_mean_diff)

# Performing paired analysis.
# First, we munge the `iris` dataset so we can perform a within-subject
# comparison of sepal length vs. sepal width.

new.iris <- iris
new.iris$ID <- 1: length(new.iris)
setosa.only <-
  new.iris %>%
  tidyr::gather(key = Metric, value = Value, -ID, -Species) %>%
  dplyr::filter(Species %in% c("setosa"))

paired_mean_diff <- dabest(
  setosa.only, Metric, Value,
  idx = c("Sepal.Length", "Sepal.Width"),
  paired = TRUE, id.col = ID
)

# Computing the median difference.
unpaired_median_diff <- dabest(
  iris, Species, Petal.Width,
  idx = c("setosa", "versicolor", "virginica"),
  paired = FALSE,
  func = median
)

# Producing a 90% CI instead of 95%.
unpaired_mean_diff_90_ci <- dabest(
  iris, Species, Petal.Width,
  idx = c("setosa", "versicolor", "virginica"),
  paired = FALSE,
  ci = 0.90
)
```

```

# Using pipes to munge your data and then passing to `dabest`.
# First, we generate some synthetic data.
set.seed(12345)
N      <- 70
c      <- rnorm(N, mean = 50, sd = 20)
t1     <- rnorm(N, mean = 200, sd = 20)
t2     <- rnorm(N, mean = 100, sd = 70)
long.data <- tibble::tibble(Control = c, Test1 = t1, Test2 = t2)

# Munge the data using `gather`, then pass it directly to `dabest`

meandiff <- long.data %>%
  tidyr::gather(key = Group, value = Measurement) %>%
  dabest(x = Group, y = Measurement,
        idx = c("Control", "Test1", "Test2"),
        paired = FALSE)

```

dabestr

dabestr: A package for producing estimation plots.

Description

The dabestr package provides a function to construct bootstrap confidence intervals for differences between groups [dabest](#) and a function to generate estimation plots [plot.dabest](#).

lsat_scores

LSAT Scores.

Description

This dataset is taken from Thomason et al. (2014) who studied a group of 12 students who underwent a course in critical thinking. Their scores on the Logical Reasoning section of the Law School Aptitude Test (LSAT) were assessed before and after training.

Usage

```
lsat_scores
```

Format

A list with two elements: pretrain and posttrain.

Details

It is also found in Chapter 8 "The Paired Design" (pp 195 - 199) of Introduction to the New Statistics (Routledge, 2017), by Geoff Cumming and Robert Calin-Jageman.

Source

Thomason, N. R., Adajian, T., Barnett, A. E., Boucher, S., van der Brugge, E., Campbell, J., Knorpp, W., Lempert, R., Lengbeyer, L., Mandel, D. R., Rider, Y., van Gelder, T., & Wilkins, J. (2014). *Critical thinking final report*. The University of Melbourne, N66001-12-C-2004.

plot.dabest

Estimation Plot

Description

An estimation plot has two key features.

1. It presents all datapoints as a **swarmplot** or **sinaplot**, which orders each point to display the underlying distribution.
2. It presents the effect size as a bootstrap 95 percent confidence interval on a separate but aligned axes.

Estimation plots emerge from estimation statistics, an intuitive framework that avoids the pitfalls of significance testing. It uses familiar statistical concepts: means, mean differences, and error bars. More importantly, it focuses on the effect size of one's experiment/intervention, as opposed to a false dichotomy engendered by P values. This function takes the output of the **dabest** function and produces an estimation plot.

Usage

```
## S3 method for class 'dabest'
plot(x, ..., color.column = NULL, palette = "Set1",
     float.contrast = TRUE, slopegraph = TRUE,
     group.summaries = "mean_sd", rawplot.type = c("swarmplot",
     "sinaplot"), rawplot.ylim = NULL, rawplot.ylabel = NULL,
     rawplot.markersize = 2, rawplot.groupwidth = 0.3,
     effsize.ylim = NULL, effsize.ylabel = NULL, effsize.markersize = 4,
     theme = ggplot2::theme_classic(), tick.fontsize = 11,
     axes.title.fontsize = 14, swarmplot.params = NULL,
     sinaplot.params = NULL, slopegraph.params = NULL)
```

Arguments

x A dabest object, generated by the function of the same name.

... Signature for S3 generic function.

| | |
|---------------------|---|
| color.column | default NULL. This is a column in the data.frame passed to the dabest function. This column will be treated as a factor and used to color the datapoints in the rawdata swarmplot. |
| palette | default "Set1". Accepts any one of the ggplot2 palettes. See the "Palettes" section in scale_color_brewer . |
| float.contrast | default TRUE. If idx in the dabest object contains only 2 groups, float.contrast = TRUE will plot the effect size and the bootstrap confidence interval in a horizontally-aligned axes (also known as a Gardner-Altman plot .) |
| slopegraph | boolean, default TRUE. If the dabest object contains paired comparisons, slopegraph = TRUE will plot the rawdata as a Tuftes slopegraph . |
| group.summaries | "mean_sd", "median_quartiles", or NULL. Plots the summary statistics for each group. If 'mean_sd', then the mean and standard deviation of each group is plotted as a gapped line beside each group. If 'median_quartiles', then the median and 25th & 75th percentiles of each group is plotted instead. If group.summaries = NULL, the summaries are not shown. |
| rawplot.type | default "beeswarm". Accepts either "beeswarm" or "sinaplot". See geom_quasirandom and geom_sina for more information. |
| rawplot.ylim | default NULL. Enter a custom y-limit for the rawdata plot. Accepts a vector of length 2 (e.g. c(-50, 50)) that will be passed along to coord_cartesian . |
| rawplot.ylabel | default NULL. Accepts a string that is used to label the rawdata y-axis. If NULL, the column name passed to y is used. |
| rawplot.markersize | default 2. This is the size (in points) of the dots used to plot the individual datapoints. There are 72 points in one inch. See this article for more info. |
| rawplot.groupwidth | default 0.3. This is the maximum amount of spread (in the x-direction) allowed, for each group. |
| effsize.ylim | default NULL. Enter a custom y-limit for the effect size plot. This parameter is ignored if float.contrast = TRUE. Accepts a vector of length 2 (e.g. c(-50, 50)) that will be passed along to coord_cartesian . |
| effsize.ylabel | default NULL. Accepts a string that is used to label the effect size y-axis. If NULL, this axes will be labeled "(un)paired func difference", where func is the function passed to dabest. |
| effsize.markersize | default 4. This is the size (in points) of the dots used to indicate the effect size. |
| theme | default theme_classic . |
| tick.fontsize | default 11. This controls the font size (in points) of all tick labels. |
| axes.title.fontsize | default 14. This determines the font size (in points) of the axes titles. |
| swarmplot.params | default NULL. Supply list of keyword = value pairs to geom_quasirandom . |
| sinaplot.params | default NULL. Supply list of keyword = value pairs to <code>ggforce::geom_sina()</code> . |

slopegraph.params

default NULL. Supply list of keyword = value pairs to `ggplot2::geom_line()`. This controls the appearance of the lines plotted for a paired slopegraph.

Value

A ggplot object.

References

[Moving beyond P values: Everyday data analysis with estimation plots.](#) (2018) Joses Ho, Tayfun Tumkaya, Sameer Aryal, Hyungwon Choi, Adam Claridge-Chang

See Also

The [dabest](#) function.

Run `vignette("Using dabestr", package = "dabestr")` in the console to read more about using parameters to control the plot features.

Examples

```
# Performing unpaired (two independent groups) analysis.
unpaired_mean_diff <- dabest(iris, Species, Petal.Width,
                             idx = c("setosa", "versicolor"),
                             paired = FALSE)

# Create a Gardner-Altman estimation plot.
plot(unpaired_mean_diff)

# Comparing versicolor and virginica petal width to setosa petal width.
shared_control_data <- dabest(iris, Species, Petal.Width,
                              idx = c("setosa", "versicolor", "virginica")
                              )

# Create a Cumming estimation plot.
plot(shared_control_data)
```

print.dabest

Print a 'dabest' object

Description

Print a 'dabest' object

Usage

```
## S3 method for class 'dabest'  
print(x, ..., signif_digits = 3)
```

Arguments

x A dabest object, generated by the function of the same name.

... Signature for S3 generic function.

signif_digits integer, default 3. All numerical values in the printout will be rounded to this many significant digits.

Value

A summary of all the relevant effect sizes computed.

Examples

```
# Performing unpaired (two independent groups) analysis.  
unpaired_mean_diff <- dabest(iris, Species, Petal.Width,  
                             idx = c("setosa", "versicolor"),  
                             paired = FALSE)  
  
# Display the results in a user-friendly format.  
print(unpaired_mean_diff)
```

transcription_scores *Transcription Scores.*

Description

This dataset is taken from Mueller and Oppenheimer (2014), comparing the percentage of notes that was verbatim transcribed during a lecture by two independent groups of students: one using pen and paper, and one using laptops.

Usage

```
transcription_scores
```

Format

A list with two elements: pen and laptop.

Details

It is also found in Chapter 7 "The Independent Groups Design" (pp 160 - 166) of Introduction to the New Statistics (Routledge, 2017), by Geoff Cumming and Robert Calin-Jageman.

Source

Mueller, Pam A., and Daniel M. Oppenheimer. "The Pen Is Mightier than the Keyboard: Advantages of Longhand over Laptop Note Taking." *Psychological Science*, vol. 25, no. 6, June 2014, pp. 1159–68, doi:10.1177/0956797614524581.

wellbeing_ind *Wellbeing Scores (2 independent groups).*

Description

This is a synthetic dataset from Geoff Cumming. 20 students were randomly assigned to spend the afternoon reading in the library—the Control condition—or reading in the local botanical gardens—the Test condition. At the end of the session, each student completed a measure of his or her perceived well-being.

Usage

wellbeing_ind

Format

A list with two elements: control and test.

Details

It is found in Chapter 11 "The Paired Design" (page 286) of *Understanding the New Statistics* (Routledge, 2012) by Geoff Cumming.

Source

Cumming, G. *Understanding the New Statistics: Effect Sizes, Confidence Intervals, and Meta-Analysis*. Routledge 2012. <https://books.google.com/books?id=AVBDYgEACAAJ>

wellbeing_paired *Wellbeing Scores (Before and after design).*

Description

This is a synthetic dataset from Geoff Cumming. A single group of 10 students first completed a well-being questionnaire (before), spent the afternoon reading in the botanical gardens, then gave well-being scores once again (after).

Usage

wellbeing_paired

Format

A list with two elements: before and after.

Details

It is found in Chapter 11 "The Paired Design" (page 291) of Understanding the New Statistics (Routledge, 2012) by Geoff Cumming.

Source

Cumming, G. Understanding the New Statistics: Effect Sizes, Confidence Intervals, and Meta-Analysis. Routledge 2012. <https://books.google.com/books?id=AVBDYgEACAAJ>

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