

# Package ‘splithalfr’

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**Title** Estimate Split-Half Reliabilities

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**Description** Estimates split-half reliabilities for scoring algorithms of cognitive tasks and questionnaires. The 'splithalfr' supports researcher-provided scoring algorithms, with six vignettes illustrating how on included datasets. The package provides four splitting methods (first-second, odd-even, permuted, Monte Carlo), the option to stratify splits by task design, a number of reliability coefficients, the option to sub-sample data, and bootstrapped confidence intervals.

**Depends** R (>= 3.6.0)

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**Suggests** knitr (>= 1.20), rmarkdown (>= 1.10), testthat (>= 2.1.0),  
MASS (>= 7.3.51)

**Imports** dplyr (>= 1.0.7), tibble (>= 2.1.1), psych (>= 1.8.12), boot  
(>= 1.3.31), rlang (>= 0.4.0)

**RoxygenNote** 7.3.2

**VignetteBuilder** knitr

**URL** <https://github.com/tpronk/splithalfr>

**BugReports** <https://github.com/tpronk/splithalfr/issues>

**NeedsCompilation** no

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angoff_feldt	<i>Calculate Angoff-Feldt coefficient</i>
--------------	---

---

### Description

Angoff-Feldt reliability coefficient. Formula obtained from Warrens (2015) <[doi:10.1007/s11634-01501986](https://doi.org/10.1007/s11634-01501986)>

### Usage

```
angoff_feldt(x, y)
```

### Arguments

x	(vector) a numeric vector
y	(vector) a numeric vector with compatible dimensions to x

**Value**

(numeric) Angoff-Feldt coefficient

**See Also**

Other splithalfr coefficients: [assmd\(\)](#), [flanagan\\_rulon\(\)](#), [sdregi\(\)](#), [short\\_icc\(\)](#), [spearman\\_brown\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate coefficient
angoff_feldt(vars[,1], vars[,2])
```

---

apply\_split\_indexes\_to\_strata

*Split each element of a list of strata based on a list of indexes*

---

**Description**

Splits each element of `strata` into two parts based on a list of indexes. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

**Usage**

```
apply_split_indexes_to_strata(strata, indexes)
```

**Arguments**

`strata` (list) list of strata to split  
`indexes` (list) list of indexes, which can be generated via [get\\_split\\_indexes\\_from\\_strata](#)

**Value**

(list) A list with two elements, containing the first and second split of `strata`.

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

**Examples**

```
# Stratify a data frame, then split it odd-even
ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
strata <- stratify(ds, ds$condition)
split_indexes <- get_split_indexes_from_strata(strata, method = "odd_even")
apply_split_indexes_to_strata(strata, split_indexes)
```

---

`apply_split_indexes_to_stratum`*Split a stratum based on a list of indexes*

---

**Description**

Splits `stratum` into two parts based on a list of indexes. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

**Usage**

```
apply_split_indexes_to_stratum(stratum, indexes_1, indexes_2)
```

**Arguments**

`stratum` (data frame, tibble, list, or vector) stratum to split  
`indexes_1` (vector) indexes for first split, which can be generated via [get\\_split\\_indexes\\_from\\_stratum](#)  
`indexes_2` (vector) indexes for second split, which can be generated via [get\\_split\\_indexes\\_from\\_stratum](#)

**Value**

(list) List with two elements that contain `stratum` split in two parts.

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

**Examples**

```
# Random split-half. One of the splits gets 4 elements and the other 5
stratum = letters[1:9]
indexes = get_split_indexes_from_stratum(stratum)
apply_split_indexes_to_stratum(stratum, indexes[[1]], indexes[[2]])
```

---

`assmd`*Calculate Absolute Strictly Standardized Mean Difference (ASSMD)*

---

**Description**

Returns the absolute difference of the mean of `x` and `y` divided by their shared standard deviation. Since the resulting difference is absolute, the larger of the two means is always used as minuend and the smallest as subtrahend. Based on Zhang (2012) <[doi:10.1016/j.ygeno.2006.12.014](https://doi.org/10.1016/j.ygeno.2006.12.014)>

**Usage**

```
assmd(x, y)
```

**Arguments**

```
x          (vector) a numeric vector
y          (vector) a numeric vector with compatible dimensions to x
```

**Value**

(numeric) Absolute SSMD

**See Also**

Other splithalfr coefficients: [angoff\\_feldt\(\)](#), [flanagan\\_rulon\(\)](#), [sdregi\(\)](#), [short\\_icc\(\)](#), [spearman\\_brown\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate Absolute SSMD
assmd(vars[,1], vars[,2])
```

---

by\_split

*Calculate split scores per participant*


---

**Description**

Calculates split scores, by applying `fn_score` to subsets of data as specified via participants. It provides a range of additional arguments for different splitting methods and to support parallel processing. To learn more about writing scoring algorithms for use with the `splithalfr`, see the included vignettes. `by_split` is modeled after the `by` function, accepting similar values for the first three arguments (`data`, `INDICES`, `FUN`). For more information about different methods for splitting data, see [get\\_split\\_indexes\\_from\\_stratum](#). For more information about stratification, see [split\\_df](#)

**Usage**

```
by_split(
  data,
  participants,
  fn_score,
  stratification = NULL,
  replications = 1,
  method = c("random", "odd_even", "first_second"),
  replace = FALSE,
```

```

split_p = 0.5,
subsample_p = 1,
subsample_n = NULL,
careful = TRUE,
match_participants = FALSE,
ncores = detectCores(),
seed = NULL,
verbose = TRUE
)

```

## Arguments

data	(data frame) data frame containing data to score. Data should be in long format, with one row per combination of participant and trial or item.
participants	(vector) Vector that identifies participants in data.
fn_score	(function) This function receives split data and should return a single number.
stratification	(vector). Vector that identifies which subsets of data should be split separately (denoted as strata in splitting functions) in order to ensure they are evenly distributed between parts. By default, the dataset of a participant forms a single stratum.
replications	(numeric) Number of replications that split scores are calculated.
method	(character) Splitting method. Note that <code>first_second</code> and <code>odd_even</code> splitting method will only deliver a valid split with default settings for other arguments ( <code>split_p = 0.5</code> , <code>replace = FALSE</code> , <code>subsample_p = 1</code> )
replace	(logical) If TRUE, stratum is sampled with replacement.
split_p	(numeric) Desired length of both parts, expressed as a proportion of the length of the data per participant. If <code>split_p</code> is larger than 1 and <code>careful</code> is FALSE, then parts are automatically sampled with replacement.
subsample_p	(numeric) Subsample a proportion of stratum before splitting. See Figure 1 of Pronk et al. (2023) < <a href="https://doi.org/10.3758/s13428022018856">doi:10.3758/s13428022018856</a> >
subsample_n	(numeric) Subsample a number of participants before splitting.
careful	(boolean) If TRUE, stop with an error when called with arguments that may yield unexpected splits
match_participants	(logical) Default FALSE. If FALSE, the split-halves are newly randomized for each iteration and participant. If TRUE, the split-halves are newly randomized for each replication, but within a replication the same randomization is applied across participants. If the order of rows of datasets per participant denotes similar observations (such as items in a questionnaire), <code>match_participants</code> can be set to TRUE to ensure that per iteration, the same items are assigned to each part of the split-halves across participants. If method is "odd_even" or "first_second", splits are based on row number, so <code>match_participants</code> generally has little effects. If TRUE, each stratum should have the same number of rows, as checked via <a href="#">check_strata</a> .

ncores	(integer). By default, all available CPU cores are used. If 1, split replications are executed serially (via <code>lapply</code> ). If greater than 1, split replications are executed in parallel, via (via <code>parLapply</code> ).
seed	(integer). When split replications are executed in parallel, seed can be used to specify a random seed to generate random seeds from for each worker via <code>clusterSetRNGStream</code> .
verbose	(logical) If TRUE, reports progress. Note that progress across split replications is not displayed when these are executed in parallel.

### Value

(data frame) Returns a data frame with a column for participant, a column replication that counts split replications, and score\_1 and score\_2 for the score calculated of each part via `fn_score`.

### Examples

```
# N.B. This example uses R script from the vignette: "rapi_sum"
data("ds_rapi", package = "splithalfr")
# Convert to long format
ds_long <- reshape(
  ds_rapi,
  varying = paste("V", 1 : 23, sep = ""),
  v.names = "answer",
  direction = "long",
  idvar = "twnr",
  timevar = "item"
)
# Function for RAPI sum score
rapi_fn_score <- function (data) {
  return (sum(data$answer))
}
# Calculate scores on full data
by(
  ds_long,
  ds_long$twnr,
  rapi_fn_score
)
# Permutation split, one iteration, items matched across participants
split_scores <- by_split(
  ds_long,
  ds_long$twnr,
  rapi_fn_score,
  ncores = 1,
  match_participants = TRUE
)
# Mean flanagan-rulon coefficient across splits
fr <- mean(split_coefs(split_scores, flanagan_rulon))
```

---

check_strata	<i>Check whether two strata have the same structure</i>
--------------	---

---

### Description

Checks strata against strata\_left. Each element of strata\_left should also be present in strata, be of a similar type (data frame/tibble or list/vector), and be of similar size (`nrow` for data frames/tibbles or `length` for lists/vectors). Stops with an error if any checks fail.

### Usage

```
check_strata(strata_left, strata_right)
```

### Arguments

strata\_left (list) strata to check against  
 strata\_right (list) strata to check

### Value

None

### See Also

Other splitting functions: `apply_split_indexes_to_strata()`, `apply_split_indexes_to_stratum()`, `get_split_indexes_from_strata()`, `get_split_indexes_from_stratum()`, `split_df()`, `split_strata()`, `split_stratum()`, `stratify()`

### Examples

```
check_strata(list(1 : 4), list(1 : 4))
```

---

ds_aat	<i>Example Approach Avoidance Task (AAT) Measurement Data in JAS-MIN2 Format</i>
--------	--

---

### Description

The JASMIN1 AAT was an irrelevant feature task, in which participants were instructed to approach/avoid left/right rotated stimuli. This particular AAT was administered (and described in detail) in Boffo et al. (2018) <[doi:10.1111/add.14071](https://doi.org/10.1111/add.14071)>. Participants were presented stimuli from a "test" category, which were gambling-related pictures, and from a "control" category, which were pictures unrelated to gambling. It registered approach responses by participants pressing (and holding) the arrow down key, while avoid responses were given via the arrow up key. Upon a response, the stimulus zoomed in or out, until it disappeared from the screen. The first response to a stimulus was logged. The dataset contains one row per trial. This dataset was graciously provided by Eva Schmitz.

**Usage**

ds\_aat

**Format**

An object of class `data.frame` with 6528 rows and 12 columns.

**Details**

Overview of columns:

- `UserID`. Identifies participants
- `approach_tilt`. If "left", participants were instructed to approach left rotated stimuli. If "right", participants were instructed to approach right rotated stimuli.
- `block_type`. Type of block: "practice" for practice trials with neutral stimuli, "assess" for assessment trials with salient stimuli
- `block`. Counts blocks, starting at zero
- `trial`. Counts trials in blocks, starting at zero
- `appr`. If "yes", this trial was an approach trial. If "no", this trial was an avoid trial.
- `tilt`. Whether the stimulus was rotated to the "left" or to the "right"
- `cat`. Stimulus category: "practice", "test", or "control"
- `stim`. Stimulus ID
- `response`. Response; 1 = correct, 2 = incorrect, 3 = timeout (no response in 4000 ms), 4 = invalid key
- `rt`. Response time in milliseconds
- `sust`. Was approach or avoid response sustained until the stimulus was completely zoomed in or out?

---

`ds_gng`*Example Go/No Go data*

---

**Description**

The Go/No Go is a task in which participants respond to one set of stimuli, but withhold a response to another set of stimuli. This particular dataset is from the first session of a study that is described in detail in Hedge et al. (2018) <[doi:10.1016/j.tate.2019.102887](https://doi.org/10.1016/j.tate.2019.102887)>. It was graciously provided by Craig Hedge and can be obtained from <https://osf.io/cwzds>.

**Usage**

ds\_gng

**Format**

An object of class `data.frame` with 28200 rows and 7 columns.

## Details

Overview of columns:

- block. Block number
- trial. Trial number
- stim. Stimuli set used in that block
- condition. 0 = go, 2 = no go
- response. Correct (1) or incorrect (0)
- rt. Reaction time (seconds)
- participant. Participant ID

---

ds\_iat

*Example Implicit Association Task (IAT) Data in JASMIN2 Format*

---

## Description

The JASMIN2 IAT closely followed the original IAT procedure (Greenwald, McGhee, & Schwartz, 1998), except that target and attribute trials did not alternate. Upon a correct response, the next trial started. Upon an incorrect response, the current trial was repeated. The response to each trial was logged. This particular dataset is from a Ethnicity-Valence IAT, which was administered (and described in detail) in Abacioglu et al. (2019) <doi:10.1016/j.tate.2019.102887>. This dataset was graciously provided by Fadie Hanna and Marjolein Zee.

## Usage

ds\_iat

## Format

An object of class `data.frame` with 9696 rows and 11 columns.

## Details

Overview of columns:

- participation\_id Identifies participants
- t1\_left. If TRUE, the first combination block had target 1 on the left (and target 2 on the right)
- a1\_left. If TRUE, the first combination block had attribute 1 on the left (and attribute 2 on the right)
- block\_type. Type of block
- block. Counts blocks, starting at zero
- trial. Counts trials in blocks, starting at zero
- attempt. Counts attempts (responses) in trials, starting at zero

- cat. Category that stimulus belonged to
- stim. Stimulus
- response. Response; 1 = correct, 2 = incorrect, 3 = timeout (no response in 4000 ms), 4 = invalid key
- rt. Response time in milliseconds. Note that some response times may exceed the timeout window due to clock errors on the computer that the IAT was administered

The variable `block_type` can have these values:

- tar\_discr: target discrimination
- att\_discr: attribute discrimination
- tar1att1\_1: target 1 with attitude 1, practice block
- tar1att1\_2: target 1 with attitude 1, test block
- tar\_rev: reverse target discrimination
- tar1att2\_1: target 1 with attitude 2, practice block
- tar1att2\_2: target 1 with attitude 2, test block

---

ds\_rapi

*Example 23-item Rutgers Alcohol Problem Inventory (RAPI) data*

---

## Description

The RAPI is a questionnaire which asks how often a participant experienced each of 23 alcohol-related problems within the last year (White & Labouvie, 1989 <[doi:10.15288/jsa.1989.50.30](https://doi.org/10.15288/jsa.1989.50.30)>). The dataset contains one row per participant.

## Usage

ds\_rapi

## Format

An object of class `data.frame` with 426 rows and 24 columns.

## Details

The dataset contains the following columns:

- twnr. Identifies participants
- V1 to V23. Answers on each of the 23 RAPI items

Each item is answered on a four-point scale with the following answer options:

- 0 = None
- 1 = 1-2 times
- 2 = 3-5
- 3 = More than 5 times

---

ds\_sst *Example Stop Signal Task data*

---

### Description

The Stop Signal Task is a task in which participants responded whether a stimulus was a square or a circle. On 25 This particular dataset is from the first session of a study that is described in detail in Hedge et al. (2018) <doi:10.1016/j.tate.2019.102887>. It was graciously provided by Craig Hedge and can be obtained from <https://osf.io/cwzds>.

### Usage

ds\_sst

### Format

An object of class `data.frame` with 27000 rows and 7 columns.

### Details

Overview of columns:

- block. Block number
- trial. Trial number
- ssd. Stop signal delay
- condition. 0 = go, 1 = stop
- response. Correct (1) or incorrect (0)
- rt. Reaction time (milliseconds)
- participant. Participant ID

---

ds\_vpt *Example Visual Probe Task (VPT) Measurement Data in JASMIN1 Format*

---

### Description

The JASMIN1 VPT distinguished between "test" stimuli, which are in some way assumed to be salient to the participant and "control" stimuli, which are not. Test and control stimuli were presented in pairs, with one left and one right, followed by a probe that was an arrow pointing up or down. Participants needed to indicate whether the arrow pointed up or down. Upon a correct response the next trial started and upon an incorrect response the current trial was repeated. Only the first response to a new trial was logged. This particular VPT was part of the pre-measurement of a cognitive bias modification study. The "test" stimuli were alcoholic beverages and the "control" stimuli were non-alcoholic beverages, selected from the Amsterdam Beverage Picture Set (Pronk et al., 2015) <doi:10.1111/acer.12853>. The dataset contains one row per trial. This dataset was graciously provided by Marilisa Boffo.

**Usage**

```
ds_vpt
```

**Format**

An object of class `data.frame` with 19520 rows and 12 columns.

**Details**

Overview of columns:

- `UserID`. Identifies participants
- `patt`. Probe-at-test. If "yes", the probe was positioned at the test stimulus. If "no", the probe was positioned at the control stimulus.
- `phor`. Probe horizontal position. Values: "left" or "right"
- `thor`. Test horizontal position. Values: "left" or "right"
- `keep`. If "yes" the probe was superimposed on the stimuli. If "no" the probe replaced the stimuli.
- `pdir`. Probe direction. Values: "up" or "down"
- `stim`. Stimulus
- `response`. Response; 1 = correct, 2 = incorrect, 3 and NA = timeout (no response in 5000 ms), 4 = invalid key
- `rt`. Response time in milliseconds
- `block`. Counts blocks, starting at zero
- `trial`. Counts trials in blocks, starting at zero
- `block_type`. Type of block: "assess" for assessment trials with salient stimuli

---

```
flanagan_rulon
```

```
Calculate Flanagan-Rulon coefficient
```

---

**Description**

Flanagan-Rulon reliability coefficient. Formula obtained from Warrens (2015) <[doi:10.1007/s11634-01501986](https://doi.org/10.1007/s11634-01501986)>

**Usage**

```
flanagan_rulon(x, y)
```

**Arguments**

- `x` (vector) a numeric vector
- `y` (vector) a numeric vector with compatible dimensions to `x`

**Value**

(numeric) Flanagan-Rulon coefficient

**See Also**

Other splithalfr coefficients: [angoff\\_feldt\(\)](#), [assmd\(\)](#), [sdregi\(\)](#), [short\\_icc\(\)](#), [spearman\\_brown\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate coefficient
flanagan_rulon(vars[,1], vars[,2])
```

---

```
get_split_indexes_from_strata
```

*Generate indexes for splitting strata*

---

**Description**

Generates indexes for splitting each element of strata into two parts. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

**Usage**

```
get_split_indexes_from_strata(strata, ...)
```

**Arguments**

<code>strata</code>	(list) Strata to split
<code>...</code>	Arguments passed on to <a href="#">get_split_indexes_from_stratum</a>
	<code>method</code> (character) Splitting method. Note that <code>first_second</code> and <code>odd_even</code> splitting method will only deliver a valid split with default settings for other arguments ( <code>subsample_p = 1</code> , <code>split_p = 1</code> , <code>replace = TRUE</code> )
	<code>replace</code> (logical) If <code>FALSE</code> , splits are constructed by sampling from stratum without replacement. If <code>TRUE</code> , stratum is sampled with replacement.
	<code>split_p</code> (numeric) Desired joint size of both parts, expressed as a proportion of the size of the subsampled stratum. If <code>split_p</code> is larger than 1, and <code>careful</code> is <code>FALSE</code> , then parts are automatically sampled with replacement
	<code>subsample_p</code> (numeric) Subsample a proportion of stratum to be used in the split.
	<code>careful</code> (boolean) If <code>TRUE</code> , stop with an error when called with arguments that may yield unexpected splits

**Value**

(list) A list with two elements, containing the first and second part of strata.

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

**Examples**

```
# Stratify a data frame, then split it odd-even
ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
strata <- stratify(ds, ds$condition)
split_indexes <- get_split_indexes_from_strata(strata, method = "odd_even")
apply_split_indexes_to_strata(strata, split_indexes)
```

---

```
get_split_indexes_from_stratum
```

*Generate indexes that can be used to split a stratum into two parts*

---

**Description**

`get_split_indexes_from_stratum` returns a list with indexes for splitting its `stratum` argument in two parts. The splits differ at most by one in size. With default arguments, a random split-half is returned, which samples elements for each part from `stratum` without replacement. Via additional arguments to `get_split_indexes_from_stratum` a range of other splitting methods can be applied.

**Usage**

```
get_split_indexes_from_stratum(
  stratum,
  method = c("random", "odd_even", "first_second"),
  replace = FALSE,
  split_p = 0.5,
  subsample_p = 1,
  careful = TRUE
)
```

**Arguments**

<code>stratum</code>	(data frame, tibble, list, or vector) Object to split; dataframes and tibbles are counted and split by row. All other data types are counted and split by element
<code>method</code>	(character) Splitting method. Note that <code>first_second</code> and <code>odd_even</code> splitting method will only deliver a valid split with default settings for other arguments ( <code>subsample_p = 1</code> , <code>split_p = 1</code> , <code>replace = TRUE</code> )

<code>replace</code>	(logical) If FALSE, splits are constructed by sampling from <code>stratum</code> without replacement. If TRUE, <code>stratum</code> is sampled with replacement.
<code>split_p</code>	(numeric) Desired joint size of both parts, expressed as a proportion of the size of the subsampled <code>stratum</code> . If <code>split_p</code> is larger than 1, and <code>careful</code> is FALSE, then parts are automatically sampled with replacement
<code>subsample_p</code>	(numeric) Subsample a proportion of <code>stratum</code> to be used in the split.
<code>careful</code>	(boolean) If TRUE, stop with an error when called with arguments that may yield unexpected splits

### Details

The following rounding rules apply to subsample size and split size:

- If the size of the subsample, calculated as `subsample_p` times size of `stratum`, is a fraction, then subsample size is rounded up.
- If the joint size of the two parts, calculated as  $2 * \text{split\_p}$  times size of the subsampled `stratum`, is a fraction, the part size is rounded up.
- If the joint size of the two parts is odd and `replace` is FALSE, then one of the parts randomly gets one more element than the other part.
- If the joint size of the two parts is odd and `replace` is TRUE, part size is rounded up to the next whole number, so each of the splits has the same size.

### Value

(list) List with two elements that contain indexes that can be used to split the `stratum` in two parts two splits of `stratum`.

### See Also

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

### Examples

```
# Split-half. One of the splits gets 4 elements and the other 5
stratum = letters[1:9]
indexes = get_split_indexes_from_stratum(stratum)
apply_split_indexes_to_stratum(stratum, indexes[[1]], indexes[[2]])
```

---

sdregi	<i>SD ratio of equalities or greater inequalities</i>
--------	---

---

**Description**

Returns the ratio of the SDs of  $x$  and  $y$ , using the largest SD of the two as denominator. Hence, the result is always 1 (ratio of equalities) or greater than 1 (ratio of greater inequalities). If  $x$  or  $y$  have less than two elements, NA is returned.

**Usage**

```
sdregi(x, y)
```

**Arguments**

$x$  (vector) a numeric vector  
 $y$  (vector) a numeric vector with compatible dimensions to  $x$

**Value**

(numeric) SD ratio

**See Also**

Other splithalfr coefficients: [angoff\\_feldt\(\)](#), [assmd\(\)](#), [flanagan\\_rulon\(\)](#), [short\\_icc\(\)](#), [spearman\\_brown\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate SD ratio of left and right variables
sdregi(vars[,1], vars[,2])
# Calculate SD ratio of right and left variables; should give same result
sdregi(vars[,1], vars[,2])
```

---

short_icc	<i>Calculate Intraclass Correlation Coefficient (ICC)</i>
-----------	---

---

**Description**

Wrapper for ICCs calculated via [ICC](#). If  $x$  or  $y$  have less than two elements, NA is returned.

**Usage**

```
short_icc(
  x,
  y,
  type = c("ICC1", "ICC2", "ICC3", "ICC1k", "ICC2k", "ICC3k"),
  ...
)
```

**Arguments**

x (vector) a numeric vector

y (vector) a numeric vector with compatible dimensions to x

type (character) type of ICC to calculate, see [ICC](#)

... Arguments passed to [ICC](#)

**Value**

(numeric) Value of ICC coefficient

**See Also**

Other splithalfr coefficients: [angoff\\_feldt\(\)](#), [assmd\(\)](#), [flanagan\\_rulon\(\)](#), [sdregi\(\)](#), [spearman\\_brown\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate ICC1
short_icc(vars[,1], vars[,2], type = "ICC1", lmer = FALSE)
```

---

spearman_brown	<i>Calculate Spearman-brown coefficient</i>
----------------	---

---

**Description**

Spearman-Brown reliability coefficient for doubling test length. Formula obtained from Warrens (2015) <[doi:10.1007/s1163401501986](https://doi.org/10.1007/s1163401501986)>

**Usage**

```
spearman_brown(x, y, fn_cor = cor, ...)
```

**Arguments**

x	(vector) a numeric vector
y	(vector) a numeric vector with compatible dimensions to x
fn_cor	(function) a function returning a correlation coefficient
...	Arguments passed to fn_cor

**Value**

(numeric) Spearman-Brown coefficient

**See Also**

Other splithalfr coefficients: [angoff\\_feldt\(\)](#), [assmd\(\)](#), [flanagan\\_rulon\(\)](#), [sdregi\(\)](#), [short\\_icc\(\)](#)

**Examples**

```
# Generate two variables with different means, variances and a correlation of about 0.5
library(MASS)
vars = mvrnorm(30, mu = c(0, 2), Sigma = matrix(c(5, 2, 2, 3), ncol = 2), empirical = TRUE)
# Calculate coefficient based on Pearson correlation
spearman_brown(vars[,1], vars[,2])
# Calculate coefficient based on ICC, two-way, random effects, absolute agreement, single rater
spearman_brown(vars[,1], vars[,2], short_icc, type = "ICC1", lmer = FALSE)
```

---

splithalfr

*splithalfr: Split-Half Reliabilities*


---

**Description**

Estimates split-half reliabilities for scoring algorithms of cognitive tasks and questionnaires.

**Getting started**

We've got six short vignettes to help you get started. You can open a vignette by running the corresponding code snippet (`vignette(...)`) in the R console.

- `vignette("rapi_sum")` Sum-score for data of the 23-item version of the Rutgers Alcohol Problem Index (White & Labouvie, 1989 <[doi:10.15288/jsa.1989.50.30](https://doi.org/10.15288/jsa.1989.50.30)>)
- `vignette("vpt_diff_of_means")` Difference of mean RTs for correct responses, after removing RTs below 200 ms and above 520 ms, on Visual Probe Task data (Mogg & Bradley, 1999 <[doi:10.1080/026999399379050](https://doi.org/10.1080/026999399379050)>)
- `vignette("aat_double_diff_of_medians")` Double difference of medians for correct responses on Approach Avoidance Task data (Heuer, Rinck, & Becker, 2007 <[doi:10.1016/j.brat.2007.08.010](https://doi.org/10.1016/j.brat.2007.08.010)>)
- `vignette("iat_dscore_ri")` Improved d-score algorithm for data of an Implicit Association Task that requires a correct response in order to continue to the next trial (Greenwald, Nosek, & Banaji, 2003)

- vignette("sst\_ssrti") Stop-Signal Reaction Time integration method for data of a Stop Signal Task (Logan, 1981)
- vignette("gng\_dprime") D-prime for data of a Go/No Go task (Miller, 1996 <doi:10.3758/BF03205476>)

### Splitting methods

The splithalfr supports a variety of methods for splitting your data. We review and assess each method in the compendium paper (Pronk et al., 2021 <doi:10.3758/s13423021019483>), but based on more recent concerning findings with Monte Carlo splitting (Kahveci et al., 2025 <doi:10.3758/s1342302402597y>; Pronk et al., 2023 <doi:10.3758/s13428022018856>), I now only recommend permuted splitting and not Monte Carlo splitting. This vignette illustrates how to apply each splitting method via the splithalfr: ‘vignette("splitting\_methods")’

- first-second and odd-even (Green et al., 2016 <doi:10.3758/s1342301509683>; Webb, Shavelson, & Haertel, 1996 <doi:10.1016/S01697161(06)260048>; Williams & Kaufmann, 2012 <doi:10.1016/j.jesp.2012.03.001>)
- stratified (Green et al., 2016 <doi:10.3758/s1342301509683>)
- permuted/bootstrapped/random sample of split halves (Kopp, Lange, & Steinke, 2021 <doi:10.1177/1073191119866257>; Parsons, Kruijt, & Fox, 2019 <doi:10.1177/2515245919879695>; Williams & Kaufmann, 2012 <doi:10.1016/j.jesp.2012.03.001>)
- Monte Carlo (Williams & Kaufmann, 2012 <doi:10.1016/j.jesp.2012.03.001>)

### Citing the splithalfr

Please cite the compendium paper (Pronk et al., 2022 <doi:10.3758/s13423021019483>]) and the software. To cite the software, type ‘citation("splithalfr")’ in R, or use the reference below.

Pronk, T. (2025). *splithalfr: Estimates split-half reliabilities for scoring algorithms of cognitive tasks and questionnaires* (Version 3.0.0) [Computer software]. <doi:10.5281/zenodo.7777894>

### Validation of split-half estimations

Part of the splithalfr algorithm has been validated via a set of simulations that are not included in this package. The R script for these simulations can be found [here](#).

### Related packages

These R packages offer bootstrapped split-half reliabilities for specific scoring algorithms and are available via CRAN at the time of this writing: [multicon](#), [psych](#), [splithalf](#), and [rapidsplithalf](#).

### Acknowledgments

I would like to thank Craig Hedge, Eva Schmitz, Fadie Hanna, Helle Larsen, Marilisa Boffo, and Marjolein Zee for making datasets available for inclusion in the splithalfr. Additionally, I would like to thank Craig Hedge and Benedict Williams for sharing R-scripts with scoring algorithms that were adapted for splithalfr vignettes. Finally, I would like to thank Mae Nuijs and Sera-Maren Wiechert for spotting bugs in earlier versions of this package.

**Author(s)**

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**See Also**

Useful links:

- <https://github.com/tpronk/splithalfr>
- Report bugs at <https://github.com/tpronk/splithalfr/issues>

---

split\_ci

*Generate bootstrap replicates of a coefficient split-half reliability estimate by sampling participants*

---

**Description**

Generates bootstrap replicates via [boot](#). The parameter `ds` should be a data frame as returned by [by\\_split](#): Each unique value of the column `participant` is considered a independent sample of the target population. For each unique value of the column `split` in `ds`, it selects the corresponding rows in `ds`, and passes the values in the columns `score_1` and `score_2` as the first and second argument to `fn_coef`. Any row in `ds` for which `score_1` or `score_2` is NA is pairwise removed before passing the data to `fn_coef`. Any coefficient that is NA is removed before passing the data to `fn_summary`.

**Usage**

```
split_ci(
  ds,
  fn_coef,
  fn_average,
  bootstrap_replications = 1000,
  parallel = "snow",
  ncpus = detectCores(),
  ...
)
```

**Arguments**

<code>ds</code>	(data frame) a data frame with columns <code>split</code> , <code>score_1</code> , and <code>score_2</code>
<code>fn_coef</code>	(function) a function that calculates a bivariate (reliability) coefficient
<code>fn_average</code>	(function) a function that calculates an average across coefficients
<code>bootstrap_replications</code>	(integer) number of bootstrap replications
<code>parallel</code>	(character) Type of parallel processing (if any) used for bootstrapping. See <a href="#">boot</a>
<code>ncpus</code>	(character) Number of cores for parallel processing. See <a href="#">boot</a>
<code>...</code>	Additional arguments passed to <a href="#">boot</a>

**Details**

For a practical example, see one of the vignettes for getting started with the `splithalf`. Also, note that the `boot` package supports parallel processing via the parameters `'parallel'` and `'ncpus'`.

For averaging internal consistency coefficients, see Feldt and Charter (2006). For more information about bias-corrected and accelerated bootstrap confidence intervals, see Efron (1987).

**Value**

Confidence interval

**References**

Efron, B. (1987). Better bootstrap confidence intervals. *Journal of the American statistical Association*, 82(397), 171-185. doi:10.1080/01621459.1987.10478410

Feldt, L. S., & Charter, R. A. (2006). Averaging internal consistency reliability coefficients. *Educational and Psychological Measurement*, 66(2), 215-227. doi:10.1177/0013164404273947

**See Also**

Other split aggregation functions: `split_coefs()`

**Examples**

```
# Import boot library
library(boot)
# Generate five splits with scores that are correlated 0.00, 0.25, 0.5, 0.75, and 1.00
library(MASS)
ds_splits = data.frame(V1 = numeric(), V2 = numeric(), split = numeric())
for (r in 0:4) {
  vars = mvrnorm(10, mu = c(0, 0), Sigma = matrix(c(10, 3, 3, 2), ncol = 2), empirical = FALSE)
  ds_splits = rbind(ds_splits, cbind(vars, r, 1 : 10))
}
names(ds_splits) = c("score_1", "score_2", "replication", "participant")
# Conduct bootstrap
bootstrap_result <- split_ci(ds_splits, cor, mean, parallel = "no")
# Get boosted and accelerated confidence intervals
print(boot.ci(bootstrap_result, type="bca"))
```

---

split\_coefs

Calculate a bivariate coefficient for each split-half replication

---

**Description**

Calculates a bivariate coefficient across participants for each split-half replication and returns their values calculated across replications. `ds` should be a data frame as returned by `by_split`: For each unique value of the column `split` in `ds`, it selects the corresponding rows in `ds`, and passes the values in the columns `score_1` and `score_2` as the first and second argument to `fn_coef`. Any row in `ds` for which `score_1` or `score_2` is NA is pairwise removed before passing the data to `fn_coef`. For averaging internal consistency coefficients, see Feldt and Charter (2006).

**Usage**

```
split_coefs(ds, fn_coef, ...)
```

**Arguments**

`ds` (data frame) a data frame with columns `split`, `score_1`, and `score_2`

`fn_coef` (function) a function that calculates a bivariate coefficient.

`...` Additional arguments passed to `fn_coef`

**Value**

Coefficients per split calculated via `fn_coef`.

**References**

Feldt, L. S., & Charter, R. A. (2006). Averaging internal consistency reliability coefficients. *Educational and Psychological Measurement*, 66(2), 215-227. doi:10.1177/0013164404273947

**See Also**

Other split aggregation functions: [split\\_ci\(\)](#)

**Examples**

```
# Generate five splits with scores that are correlated 0.00, 0.25, 0.5, 0.75, and 1.00
library(MASS)
ds_splits = data.frame(score_1 = numeric(), score_2 = numeric(), replication = numeric())
for (r in 0:4) {
  vars = mvrnorm(10, mu = c(0, 0), Sigma = matrix(c(10, 3, 3, 2), ncol = 2), empirical = FALSE)
  ds_splits = rbind(ds_splits, cbind(vars, r))
}
names(ds_splits) = c("score_1", "score_2", "replication")
# Pearson correlations
split_coefs(ds_splits, cor)
# Spearman-brown corrected Pearson correlations
split_coefs(ds_splits, spearman_brown)
# Flanagan-Rulon coefficient
split_coefs(ds_splits, flanagan_rulon)
# Angoff-Feldt coefficient
split_coefs(ds_splits, angoff_feldt)
# Spearman-Brown corrected ICCs
split_coefs(
  ds_splits,
  spearman_brown,
  short_icc,
  type = "ICC1",
  lmer = FALSE
)
```

---

split_df	<i>Split a data frame into two parts</i>
----------	--

---

### Description

Splits data, Applies a stratified split to a data frame and returns each part. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

### Usage

```
split_df(data, stratification = NULL, ...)
```

### Arguments

data	(data frame) Data to split, in long format, with one row per observation.
stratification	(vector). Vector that identifies which subsets of data should be split separately (denoted as strata in splitting functions) in order to ensure they are evenly distributed between parts. If NULL, all data is considered a single stratum.
...	Arguments passed on to <a href="#">get_split_indexes_from_stratum</a>
method	(character) Splitting method. Note that first_second and odd_even splitting method will only deliver a valid split with default settings for other arguments (subsample_p = 1, split_p = 1, replace = TRUE)
replace	(logical) If FALSE, splits are constructed by sampling from stratum without replacement. If TRUE, stratum is sampled with replacement.
split_p	(numeric) Desired joint size of both parts, expressed as a proportion of the size of the subsampled stratum. If split_p is larger than 1, and careful is FALSE, then parts are automatically sampled with replacement
subsample_p	(numeric) Subsample a proportion of stratum to be used in the split.
careful	(boolean) If TRUE, stop with an error when called with arguments that may yield unexpected splits

### Value

(list) List with two elements that each contain one of two parts.

### See Also

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

**Examples**

```

ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
split_df(ds, method = "random")
split_df(ds, method = "odd_even")
split_df(ds, method = "first_second")
split_df(ds, stratification = ds$condition, method = "random")
split_df(ds, stratification = ds$condition, method = "odd_even")
split_df(ds, stratification = ds$condition, method = "first_second")
ds <- data.frame(condition = rep(c("a", "b"), 4), score = 1 : 8)
split_df(ds, method = "random")
split_df(ds, method = "odd_even")
split_df(ds, method = "first_second")
split_df(ds, stratification = ds$condition, method = "random")
split_df(ds, stratification = ds$condition, method = "odd_even")
split_df(ds, stratification = ds$condition, method = "first_second")

```

---

split_strata	<i>Split each stratum into two parts</i>
--------------	--

---

**Description**

Splits each element of strata into two parts. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

**Usage**

```
split_strata(strata, ...)
```

**Arguments**

strata	(list) list of strata to split
...	Arguments passed on to <a href="#">get_split_indexes_from_stratum</a>
method	(character) Splitting method. Note that first_second and odd_even splitting method will only deliver a valid split with default settings for other arguments (subsample_p = 1, split_p = 1, replace = TRUE)
replace	(logical) If FALSE, splits are constructed by sampling from stratum without replacement. If TRUE, stratum is sampled with replacement.
split_p	(numeric) Desired joint size of both parts, expressed as a proportion of the size of the subsampled stratum. If split_p is larger than 1, and careful is FALSE, then parts are automatically sampled with replacement
subsample_p	(numeric) Subsample a proportion of stratum to be used in the split.
careful	(boolean) If TRUE, stop with an error when called with arguments that may yield unexpected splits

**Value**

(list) A list with two elements, containing the first and second split of strata.

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_stratum\(\)](#), [stratify\(\)](#)

**Examples**

```
# Stratify a data frame, then split it odd-even
ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
strata <- stratify(ds, ds$condition)
split_strata(strata, method = "odd_even")
```

---

split_stratum	<i>Split a stratum into two parts</i>
---------------	---------------------------------------

---

**Description**

Splits stratum into two parts. For more information about splitting options, and an extensive list of examples, see [get\\_split\\_indexes\\_from\\_stratum](#).

**Usage**

```
split_stratum(stratum, ...)
```

**Arguments**

stratum	(data frame, tibble, list, or vector) Stratum to split; dataframes and tibbles are counted and split by row. All other data types are counted and split by element
...	Arguments passed on to <a href="#">get_split_indexes_from_stratum</a>
method	(character) Splitting method. Note that <code>first_second</code> and <code>odd_even</code> splitting method will only deliver a valid split with default settings for other arguments ( <code>subsample_p = 1</code> , <code>split_p = 1</code> , <code>replace = TRUE</code> )
replace	(logical) If <code>FALSE</code> , splits are constructed by sampling from stratum without replacement. If <code>TRUE</code> , stratum is sampled with replacement.
split_p	(numeric) Desired joint size of both parts, expressed as a proportion of the size of the subsampled stratum. If <code>split_p</code> is larger than 1, and <code>careful</code> is <code>FALSE</code> , then parts are automatically sampled with replacement
subsample_p	(numeric) Subsample a proportion of stratum to be used in the split.
careful	(boolean) If <code>TRUE</code> , stop with an error when called with arguments that may yield unexpected splits

**Value**

(list) List with two elements that contain each of the two parts of stratum split in two.

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [stratify\(\)](#)

**Examples**

```
# Split stratum odd-even
ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
split_stratum(ds, method = "odd_even")
```

---

stratify	<i>Stratify a data frame</i>
----------	------------------------------

---

**Description**

Split a dataframe into strata formed by each a unique value of stratification.

**Usage**

```
stratify(ds, stratification = NULL)
```

**Arguments**

**ds** (data frame) data to split into strata

**stratification** (vector). Vector that identifies which subsets of data should be split separately (denoted as strata in splitting functions) in order to ensure they are evenly distributed between pairs. If NULL, all data is considered a single stratum.

**Value**

(list) List of strata

**See Also**

Other splitting functions: [apply\\_split\\_indexes\\_to\\_strata\(\)](#), [apply\\_split\\_indexes\\_to\\_stratum\(\)](#), [check\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_strata\(\)](#), [get\\_split\\_indexes\\_from\\_stratum\(\)](#), [split\\_df\(\)](#), [split\\_strata\(\)](#), [split\\_stratum\(\)](#)

**Examples**

```
# Stratify a data frame, then split it odd-even
ds <- data.frame(condition = rep(c("a", "b"), each = 4), score = 1 : 8)
strata <- stratify(ds, ds$condition)
split_strata(strata, method = "odd_even")
```

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