Package ‘pwrRasch’

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aid_st2

Sample of test data from subtest 2 of the Adaptive Intelligence Diagnosticum (AID3; Kubinger & Holocher-Ertl, 2014)

Description
A dataset containing the test data of 300 children (drawn randomly from the original dataset). The variables are as follows:

Usage
aid_st2

Format
A data frame with 300 rows and 28 variables:
- ID: ID variable of each testee
- age_in_month: the age of the testperson in month
- sex: gender of the testee
- country: country of the testee
- stage: stage of the data collection
- it1...it18: items of the subtest 2

aov.rasch

Three-Way Analysis of Variance with Mixed Classification for Testing the Rasch Model

Description
This function applies the three-way analysis of variance with mixed classification for testing the Rasch model.

Usage
aov.rasch(data, group = "group", person = "person", item = "item", response = "response", output = TRUE)

Arguments
- data: A data frame in which the variables specified in the model will be found. Note that data needs to be in 'long' format.
- group: Column name of the data frame containing the grouping variable.
- person: Column name of the data frame containing the person number variable.
- item: Column name of the data frame containing the item number variable.
- response: Column name of the data frame containing the response variable.
- output: If TRUE, an output will be shown on the console.
Details

The F-test in a three-way analysis of variance design (A > B) x C with mixed classification (fixed factor A = subgroup, random factor B = testees, and fixed factor C = items) is used to test the Rasch model. Rasch model fitting means that there is no interaction A x C. A statistically significant interaction A x C indicates differential item functioning (DIF) of the items with respect of the two groups of testees Note, if a main effect of A (subgroup) exists, an artificially high type I risk of the A x C interaction F-test results - that is, the approach works as long as no statistically significant main effect of A occurs. Note that in case of unbalanced groups computation can take a long time.

Value

Returns an ANOVA table

Author(s)

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References


See Also

reshape.rasch, pwr.rasch

Examples

## Not run:

# simulate Rasch model based data
# 100 persons, 20 items,
dat &lt;- simul.rasch(100, items = seq(-3, 3, length.out = 20))
# reshape simulated data into 'long' format with balanced assignment
# of testees into two subgroups
dat.long &lt;- reshape.rasch(dat, group = rep(0:1, each = nrow(dat) / 2))
# apply three-way analysis of variance with mixed classification for testing the Rasch model
aov.rasch(dat.long)

# extract variable names of items
vnames &lt;- grep("it", names(aid_st2), value = TRUE)
# reshape aid subtest 2 data into 'long' format with split criterium sex
aid_long.sex &lt;- reshape.rasch(aid_st2[, vnames], group = aid_st2[, "sex"],
# apply three-way analysis of variance with mixed classification for testing the Rasch model
aov.rasch(aid_long.sex)

## End(Not run)
## itemtable

### Summary of DIF items

**Description**

This function builds a table of DIF items specified in the `pwrrasch` object.

**Usage**

```r
itemtable(object, all = FALSE, digits = 2)
```

**Arguments**

- `object`: `pwrrasch` object
- `all`: If `TRUE`, all items are included in the table.
- `digits`: Integer indicating the number of decimal places.

**Author(s)**

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

**Examples**

```r
## Not run:
# item parameters
ipar2 <- ipar1 <- seq(-3, 3, length.out = 20)
# model differential item function (DIF)
# simulation for b = 100
simres <- pwr.rasch(100, ipar = list(ipar1, ipar2))
itemtable(simres)
## End(Not run)
```

## plot.pwrrasch

### Plot Statistical Power Curve

**Description**

Generic plot function for the `pwrrasch` object, which plots the statistical power curve relating statistical power to sample size.
## Usage

### S3 method for class 'pwrrasch'

```r
plot(x, plot.sig.level = TRUE, type = c("b", "b"),
    pch = c(19, 17), lty = c(1, 3), lwd = c(1, 1), legend = "topleft",
    bty = "o", ...)
```

### Arguments

- **x** : `pwrrasch` object.
- **plot.sig.level** : If `TRUE`, nominal significance level is plotted.
- **type** : Vector indicating type of plot for the statistical power curve and the type 1 risk curve.
- **pch** : Vector indicating plotting symbol for the statistical power curve and the type 1 risk curve.
- **lty** : Vector indicating line type for the statistical power curve and the type 1 risk curve.
- **lwd** : Vector indicating line width for the statistical power curve and the type 1 risk curve.
- **legend** : Location of the legend. If `FALSE`, legend is omitted.
- **bty** : Type of box to be drawn around the legend.
- **...** : Additional arguments affecting the summary produced.

### Details
- **Graphical parameters are:**
  - **type** : The following values are possible: "p" for points, "l" for lines, "b" for both point and lines
  - **pch** : see `points`
  - **lty** : Line types can be specified as an integer (0 = blank, 1 = solid, 2 = dashed, 3 = dotted, 4 = dotdash, 5 = longdash, 6 = twodash)
  - **lwd** : Positive numbers indicating line widths
  - **legend** : Either the x and y coordinates to be used to position the legend or keyword from the list "bottomright", "bottom", "bottomleft", "left", "topleft", "top", "topright", "right" and "center"
  - **bty** : Allowed values are "o" (draw box around legend) and "n" (do not draw box around legend).

### Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>
References


Examples

```r
# Not run:

# item parameters
ipar2 <- ipar1 <- seq(-3, 3, length.out = 20)
# model differential item function (DIF)
# simulation for b = 100, 200, 300, 400, 500
simres <- pwr.rasch(seq(100, 500, by = 100), ipar = list(ipar1, ipar2))
plot(simres)

## End(Not run)
```

pwr.rasch

*Simulation to Estimate Statistical Power of a Rasch Model Test*

Description

This function conducts a simulation to estimate statistical power of a Rasch model test for user-specified item and person parameters.

Usage

```r
pwr.rasch(b, ipar = list(), ppar = list("rnorm(b, mean = 0, sd = 1.5)",
"rnorm(b, mean = 0, sd = 1.5)"), runs = 1000, H0 = TRUE,
sig.level = 0.05, method = c("loop", "vectorized"), output = TRUE)
```

Arguments

- `b`: Either a vector or an integer indicating the number of observations in each group.
- `ipar`: Item parameters in both groups specified in a list.
- `ppar`: Person parameters specified by a distribution for each group.
- `runs`: Number of simulation runs.
- `H0`: If TRUE, null hypothesis condition is simulated.
- `sig.level`: Nominal significance level.
- `method`: Simulation method: for-loop or vectorized.
- `output`: If TRUE, output is shown.
Details

The F-test in a three-way analysis of variance design \( (A > B) \times C (A > B) \times C \) with mixed classification (fixed factor A = subgroup, random factor B = testee, and fixed factor C = items) is used to simulate statistical power of a Rasch model test. This approach using a F-distributed statistic, where the sample size directly affects the degree of freedom enables determination of the sample size according to a given type I and type II risk, and according to a certain effect of model misfit which is of practical relevance. Note, that this approach works as long as there exists no main effect of A (subgroup). Otherwise an artificially high type I risk of the A x C interaction F-test results - that is, the approach works as long as no statistically significant main effect of A occurs.

Value

Returns a list with following entries:

- `b`  number of observations in each group
- `ipar`  item parameters in both subgroups
- `c`  number of items
- `ppar`  distribution of person parameters
- `runs`  number of simulation runs
- `sig.level`  nominal significance level
- `H0.AC.p`  \( p \)-values of the interaction A x C in the null hypothesis condition (if \( H_0 = \text{TRUE} \))
- `H1.AC.p`  \( p \)-values of the interaction A x C in the alternative hypothesis condition
- `power`  estimated statistical power
- `type1`  estimated significance level

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

References


See Also

aov.rasch

Examples

```r
## Not run:

# item parameters
ipar2 <- ipar1 <- seq(-3, 3, length.out = 20)
# model differential item function (DIF)
```
# simulation for b = 200
pwr.rasch(200, ipar = list(ipar1, ipar2))

# simulation for b = 100, 200, 300, 400, 500
pwr.rasch(seq(100, 500, by = 100), ipar = list(ipar1, ipar2))

# simulation for b = 100, 200, 300, 400, 500
# uniform distribution [-3, 3] of person parameters
pwr.rasch(200, ipar = list(ipar1, ipar2), ppar = list("runif(b, -3, 3)", "runif(b, -3, 3)"))

## End(Not run)

---

**pwrRasch**

*Statistical Power Simulation for Testing the Rasch Model*

**Description**

Statistical power simulation for testing the Rasch Model based on a three-way analysis of variance design with mixed classification.

**Author(s)**

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Maintainer: Takuya Yanagida <takuya.yanagida@univie.ac.at>

**References**


**See Also**

aov.rasch, pwr.rasch
Description

This function reshapes a matrix from 'wide' into a 'long' format. This is necessary for the three-way analysis of variance with mixed classification for testing the Rasch model.

Usage

reshape.rasch(data, group)

Arguments

data  Matrix or data frame in 'wide' format.
group Vector which assigns each person to a certain subgroup (external split criterion). Note, that this function is restricted to A = 2 subgroups.

Details

In order to apply the three-way analysis of variance with mixed classification for testing the Rasch model, data need to be in 'long' format. That is, Rasch model data design is interpreted as a analysis of variance design (A > B) x C, where items are levels of a fixed factor C and the testees are levels of a random factor B, nested within a fixed factor A of different subgroups.

Value

Returns a data frame with following entries:

<table>
<thead>
<tr>
<th>Entry</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>group</td>
<td>fixed factor A (subgroup)</td>
</tr>
<tr>
<td>person</td>
<td>random factor B (testees)</td>
</tr>
<tr>
<td>item</td>
<td>fixed factor C (items)</td>
</tr>
<tr>
<td>response</td>
<td>dependent variable, 0 (item not solved) and 1 (item solved)</td>
</tr>
</tbody>
</table>

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

References


Simulate data according to the Rasch model

This function simulates data according to the Rasch model based on user-specified item and person parameters.

Usage

```
simul.rasch(persons, items, sum0 = TRUE)
```

Arguments

- **persons**: Either a vector of specified person parameters or an integer indicating the number of persons.
- **items**: Either a vector of specified item parameters or an integer indicating the number of items.
- **sum0**: If TRUE, specified item parameters need to be normalized to sum-0.

Details

If persons is an integer value, the corresponding parameter vector is drawn from N(0, 1.5). If items is an integer value, the corresponding parameter vector is equally spaced between [-3, 3]. Note that item parameters need to be normalized to sum-0. This precondition can be overruled using argument `sum0 = FALSE`. 

Examples

```r
# simulate Rasch model based data
# 100 persons, 20 items,
dat <- simul.rasch(100, items = seq(-3, 3, length.out = 20))
# reshape simulated data into 'long' format with balanced assignment
# of testees into two subgroups.
dat.long <- reshape.rasch(dat, group = rep(0:1, each = nrow(dat) / 2))
head(dat.long)

# extract variable names of items
vnames <- grep("it", names(aid_st2), value = TRUE)
# reshape aid subtest 2 data into 'long' format with split criterium sex
aid_long.sex <- reshape.rasch(aid_st2[, vnames], group = aid_st2[, "sex"])
```

```
## End(Not run)
```
Value

Returns a 0-1 matrix according to the Rasch model.

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

References


See Also

aov.rasch, pwr.rasch

Examples

## Not run:

# simulate Rasch model based data
# 100 persons, 20 items,
# person parameter drawn from a normal distribution: N(0,1.5)
# item parameters equally spaced between [-3, 3]
simul.rasch(100, items = 20)

# simulate Rasch model based data
# 100 persons, 17 items
# person parameter drawn from a uniform distribution: U[-4, 4]
# item parameters: [-4.0, -3.5, -3.0, ... , 3.0, 3.5, 4.0]
simul.rasch(runif(100, -4, 4), items = seq(-4, 4, by = 0.5))

## End(Not run)

description.aovrasch

Generic summary function for the aovrasch object

Usage

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

Object Summary

Value

Returns a 0-1 matrix according to the Rasch model.

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

References


See Also

aov.rasch, pwr.rasch

Examples

## Not run:

# simulate Rasch model based data
# 100 persons, 20 items,
# person parameter drawn from a normal distribution: N(0,1.5)
# item parameters equally spaced between [-3, 3]
simul.rasch(100, items = 20)

# simulate Rasch model based data
# 100 persons, 17 items
# person parameter drawn from a uniform distribution: U[-4, 4]
# item parameters: [-4.0, -3.5, -3.0, ... , 3.0, 3.5, 4.0]
simul.rasch(runif(100, -4, 4), items = seq(-4, 4, by = 0.5))

## End(Not run)
summary.pwrrasch

Arguments

object  aovrasch object
...  Additional arguments affecting the summary produced.

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>

Examples

```r
## Not run:
# simulate Rasch model based data
# 100 persons, 20 items,
dat <- simul.rasch(100, items = seq(-3, 3, length.out = 20))
# reshape simulated data into 'long' format with balanced assignment
# of examinees into two subgroups.
dat.long <- reshape.rasch(dat, group = rep(0:1, each = nrow(dat) / 2))
# apply three-way analysis of variance with mixed classification for testing the Rasch model.
res <- aov.rasch(dat.long)
summary(res)
## End(Not run)
```

Description

Generic summary function for the pwrrasch object

Usage

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

Arguments

object  pwrrasch object
...  Additional arguments affecting the summary produced.

Author(s)

Takuya Yanagida <takuya.yanagida@univie.ac.at>, Jan Steinfeld <jan.steinfeld@univie.ac.at>
Examples

```r
## Not run:

# item parameters
ipar2 <- ipar1 <- seq(-3, 3, length.out = 20)
# model differential item function (DIF)
# simulation for b = 100
simres <- pwr.rasch(100, ipar = list(ipar1, ipar2))
summary(simres)

# item parameters
ipar2 <- ipar1 <- seq(-3, 3, length.out = 20)
# model differential item function (DIF)
# simulation for b = 100, 200, 300, 400, 500
simres <- pwr.rasch(seq(100, 500, by = 100), ipar = list(ipar1, ipar2))
summary(simres)

## End(Not run)
```
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