Package ‘pwrRasch’

September 28, 2015

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Author   Takuya Yanagida [cre, aut],
         Jan Steinfeld [aut],
         Thomas Kiefer [ctb]
Maintainer Takuya Yanagida <takuya.yanagida@univie.ac.at>
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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)

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

References


See Also

- `reshape.rasch`, `pwr.rasch`

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 testees 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
aov.rasch(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 criterion sex
aid_long.sex <- 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**

```
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**
```r
## S3 method for class 'pwrrasch'
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 \((A > B) x C(A > B) x C\) 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 \(H0\) = 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)**

Takuya Yanagida [aut,cre]<takuya.yanagida@univie.ac.at>, Jan Steinfeld [aut]<jan.steinfeld@univie.ac.at>, Thomas Kiefer [ctb]

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

**References**


**See Also**

aov.rasch, pwr.rasch
Reshape data frame in wide format into a long format

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:

- **group**: fixed factor A (subgroup)
- **person**: random factor B (testees)
- **item**: fixed factor C (items)
- **response**: dependent variable, 0 (item not solved) and 1 (item solved)

Author(s)

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

References


See Also
  aov.rasch

Examples

## 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 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"])
```

---

**simul.rasch**

*Simulate data according to the Rasch model*

Description

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`. 
.summary.aovrasch

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

```r
## 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.aovrasch Object Summary

Description

Generic summary function for the aovrasch object

Usage

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

## 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)

summary.pwrrasch  Object Summary

Description

Generic summary function for the pwrrasch object

Usage

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