Package 'iarm'

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Title Item Analysis in Rasch Models

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Description Tools to assess model fit and identify misfitting items for Rasch models (RM) and partial credit models (PCM). Included are item fit statistics, item characteristic curves, item-restscore association, conditional likelihood ratio tests, assessment of measurement error, estimates of the reliability and test targeting as described in Christensen et al. (Eds.) (2013, ISBN:978-1-84821-222-0).

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`iarm-package` *iarm: A package for item analysis in Rasch models*

Description

Tools to assess model fit and identify misfitting items for Rasch models (RM) and partial credit models (PCM). Included are item fit statistics, item-restscore association, conditional likelihood ratio tests, assessment of measurement error, estimates of the reliability and test targeting.

Item Fit statistics

Item fit statistics are used to assess whether individual items fit the Rasch model. Outfit and infit mean squares are well-known and much used statistics. They summarize standardized response residuals comparing observed responses to items to the expected responses. To avoid bias expected responses are calculated under the conditional distribution of responses given the total score. Parametric bootstrapping is used to assess the significance of misfitting items. The item restscore gamma coefficient is used to assess differential item discrimination.

Conditional likelihood ratio tests (CLR)

The conditional likelihood ratio test of Andersen is an overall test of fit of data to the model. The test compares conditional maximum likelihood estimates of item parameters in different subgroups to the estimates for the complete sample of persons. Subgroups are defined by outcomes of the total score (test of homogeneity) or by outcomes of an exogenous variable (test of no differential item functioning, DIF).

References

Andersen, E. B. (1973) A goodness of fit test for the Rasch model. *Psychometrika*, 38, 123-140.

Kreiner, S. & Christensen, K. B. (2011) Exact evaluation of Bias in Rasch model residuals. *Advances in Mathematics Research*, 12, 19-40.

Mueller, M. & Kreiner, S. (2015) Item Fit Statistics in Common Software for Rasch Analysis. Research Report 15-06, Department of Biostatistics, University of Copenhagen.

amts *Abbreviated Mental Test Score (AMTS)*

Description

A dataset containing the responses of 197 persons to the ten questions of the Abbreviated Mental Test Score (AMTS). The AMTS is used to identify patients with dementia. One point is given for each correct answer, a score of 6 or less suggests that the patient has some mental impairment.

Format

A data frame with 197 rows and 13 variables.

id id number of the patient.

agegrp a factor with levels 16-65, 66-75, 76-85, 86+ for the age of the patient.

sex a factor with levels male, female of the patient.

age age of patient, with 1 if the respondent knows his/her own age and 0 otherwise.

time time (nearest hour), with 1 if correct and 0 otherwise.

address address, with 1 if correct and 0 otherwise.

name name of hospital (or area of town if at home) , with 1 if correct and 0 otherwise.

year current year, with 1 if correct and 0 otherwise.

dob date of birth of patient, with 1 if correct and 0 otherwise.

month month, with 1 if correct and 0 otherwise.

firstww date of first world war, with 1 if correct and 0 otherwise.

monarch name of monarch, with 1 if correct and 0 otherwise.

countbac count backwards 20-1, with 1 if correct and 0 otherwise.

References

Slade, A., Fear, J. & Tennant, A. (2006) Identifying patients at risk of nursing home admission: The Leeds Elderly Assessment Dependency Screening tool (LEADS). *BMC Health Services Research*, 6:31.

Examples

```
data(amts)
str(amts)
```

boot_fit *Computes Bootstrapping P Values for Outfit and Infit Statistics*

Description

Computes Bootstrapping P Values for Outfit and Infit Statistics

Usage

```
boot_fit(
  object,
  B,
  p.adj = c("BH", "holm", "hochberg", "hommel", "bonferroni", "BY", "none")
)
```

Arguments

object	an object of class "Rm" (output of RM or PCM) or class "pcmodel"
B	Number of replications.
p.adj	Correction method for multiple testing. The methods are "BH","holm", "hochberg", "hommel", "bonferroni", "BY", "none". See p.adjust.

Value

object of class bootfit with outfit and infit statistics and corresponding p values.

clr_tests *Conditional Likelihood Ratio Tests (CLR)*

Description

The conditional likelihood ratio tests compare item parameters in low and high score groups for an overall test of homogeneity, and in groups defined by the levels of exogenous factors for tests of no differential item functioning (DIF).

Usage

```
clr_tests(dat.items, dat.exo = NULL, model = c("RM", "PCM"))
```

Arguments

dat.items	A data frame with the responses to the items.
dat.exo	A single factor or a data frame consisting of one or more exogenous factor variables.
model	If model="RM" a Rasch model will be fitted, if model="PCM" a partial credit model for polytomous items is used.

Value

matrix with test statistics, df and p values.

Author(s)

Marianne Mueller

References

Andersen, E.B. (1973). A goodness of fit test for the Rasch model. *Psychometrika*, 38, 123-140.

Examples

```
#CLR overall test and test of  no DIF for agegrp and sex
clr_tests(amts[,4:13],amts[,2:3])
```

`desc2` *Depression Screening DESC-II*

Description

A dataset containing the responses of 799 patients (indication group psychiatry, otolaryngology, cardiology, neurology) to the short form DESC-II with 10 items. There are 5 response categories from 0 = never to 4 = always. A higher score is supposed to mean a higher depression.

Format

A data frame with 799 rows and 14 variables.

code id number of the patient

group a factor with levels psychiatry, otolaryngology, cardiology, neurology for the indication group of the patient.

gender a factor with levels female, male of the patient.

agegroup a factor with levels 18-34, 35-49, 50-59, 60-87 for the age of the patient.

DESC_2_1 feeling not to be needed

DESC_2_2 loss of interest in other people

DESC_2_3 disheartened

DESC_2_4 no pleasure doing things

DESC_2_5 feeling to be no good

DESC_2_6 uninspired

DESC_2_7 pessimistic

DESC_2_8 discouraged

DESC_2_9 withdrawal

DESC_2_10 thinking of taking one's life

References

Forkmann et al. (2009) Development and validation of the Rasch-based Depression Screening (DESC) using Rasch analysis and structural equation modelling. *J Behav Ther Exp Psychiatry*, 40(3): 468-78.

Examples

```
data(desc2)
str(desc2)
```

`ICCplot` *Item Characteristic Curves*

Description

Plots Item Characteristic Curves for dichotomous and polytomous items. The plot can display observed scores as total scores (method="score") or as average scores within adjacent class intervals (method="cut"). Class intervals can be useful when the sample size is not large enough to contain an adequate number of respondents with the same total score for each possible total score. The function includes the option to plot observed scores according to values of an exogenous variable to evaluate differential item functioning (dif="yes").

Usage

```
ICCplot(
  data,
  itemnumber,
  pallete = "Paired",
  xticks = 1,
  yticks = 0.5,
  thetain = -6,
  thetaend = 6,
  method = "score",
  grid = "yes",
  cinumber = 6,
  itemdescrip = "",
  axis.rumm = "yes",
  dif = "no",
  difvar = NA,
  diflabels = c("Group1", "Group 2", "Group 3", "Group 4", "Group5"),
  difstats = "yes",
  title = "Item Characteristic Curve",
  icclabel = "yes",
  xaxistitle = "Theta",
  yaxistitle = "Item Score"
)
```

Arguments

data	An object of class "data.frame" containing the items (include all items present in the model). The variables need to be numeric.
itemnumber	A numeric vector indicating the columns of the data (the items) which ICCs are going to be plotted. Maximum of four items per plot.
pallete	An object of class "character". Choose a pre-made color pallete from package RColorBrewer. Only available for dif="no".
xticks	A numeric scalar. Specify x-axis tick values.
yticks	A numeric scalar. Specify y-axis tick values.
thetain	A numeric scalar. Specify minimum theta values for person parameters.
thetaend	A numeric scalar. Specify maximum theta values for person parameters.
method	The method for displaying observed scores. Choose "score" to plot total scores. Choose "cut" to plot class intervals.
grid	Chooses whether the background grid should be displayed. Options are "yes" or "no".
cinumber	A numeric scalar. The number of adjacent class intervals in which participants will be divided. Notice that the number of class intervals cannot be higher than the number of total scores.
itemdescrip	A character vector indicating the description of the plotted items. Maximum of four descriptions (one description per item plotted).
axis.rumm	Configures whether the plot should display the entire trait range or solely the trait range close to the observed scores (similar to private software RUMM2030). Options are "yes" or "no".
dif	Configures whether the observed scores will be plotted according to values of an exogenous variable to evaluate differential item function. Options are "yes" or "no".
difvar	Chooses the variable which will be used to evaluate differential item functioning. Only necessary when dif="yes".
diflabels	A character vector indicating the labels to values of the variable chosen to evaluate differential item functioning. Only necessary when dif="yes".
difstats	Displays the partial gamma coefficient to indicate the magnitude of differential item functioning. Options are "yes" or "no". Only necessary when dif="yes".
title	A character vector. The title of the plot.
icclabel	Displays the labels of Expected Item Score and Observed Item Score. Options are "yes" or "no".
xaxistitle	A character vector. The x-axis title.
yaxistitle	A character vector. The y-axis title.

Author(s)

Pedro Henrique Ribeiro Santiago <pedro.ribeirosantiago@adelaide.edu.au>, Marianne Mueller

Examples

```
## Not run: # Creates a plot for Item 1 using total scores
ICCplot(desc2[,5:13], itemnumber=1, method="score", itemdescrip="Item 1")

# Creates a plot for Item 1 using 8 class intervals
ICCplot(desc2[,5:13], itemnumber=1, method="cut", cinumber=8, itemdescrip="Item 1")

# Creates a plot for Item 1 using 8 class intervals without RUMM style axis
ICCplot(desc2[,5:13], itemnumber=1, method="cut", cinumber=8, itemdescrip="Item 1", axis.rumm="no")

# Creates a plot for Item 3 using 8 class intervals and evaluating DIF according to gender
ICCplot(desc2[,5:13], itemnumber=3, method="cut", cinumber=8, itemdescrip="Item 3",
dif="yes", difvar=desc2$gender, diflabels=c("Men", "Women"))

# Creates a plot with three items using 5 class intervals and evaluating DIF according to gender
ICCplot(desc2[,5:13], itemnumber=1:3, method="cut", cinumber=5,
itemdescrip=c("Item 1","Item 2","Item 3"), dif="yes"
difvar=desc2$gender, diflabels=c("Men", "Women"))

## End(Not run)
```

`item_obsexp` *Observed and Expected Item Mean Scores*

Description

Homogeneity of item responses in the low and high score groups is analyzed by looking at observed and expected item mean scores together with standardized residuals. If the Andersen's CLR test has shown some evidence against homogeneity, this comparison can indicate which items might be responsible.

Usage

```
item_obsexp(object)
```

Arguments

`object`	An object of class "Rm", a fitted Rasch model or partial credit model using the functions RM or PCM in package eRm, or an object of class "pcmodel", a fitted partial credit model using the function pcmodel in package psychotools.

Value

list with observed and expected mean scores together with standardized residuals for the two score groups.

Author(s)

Marianne Mueller

Examples

```
rm.mod <- RM(amts[,4:13])
item_obsexp(rm.mod)
## Not run:
pc.mod <- PCM(desc2[,5:14])
item_obsexp(pc.mod)

## End(Not run)
```

`item_restscore` *Item Restscore Association*

Description

The observed Gamma coefficient between the score of a single item and the total score of the remaining items is compared with the corresponding expected Gamma coefficient under the Rasch model.

Usage

```
item_restscore(
  object,
  p.adj = c("BH", "holm", "hochberg", "hommel", "bonferroni", "BY", "none")
)
```

Arguments

`object`	An object of class "Rm", a fitted Rasch model or partial credit model using the functions RM or PCM in package eRm, or an object of class "pcmodel", a fitted partial credit model using the function pcmodel in package psychotools.
`p.adj`	Correction method for multiple testing. The methods are "BH","holm", "hochberg", "hommel", "bonferroni", "BY", "none". See `p.adjust`.

Value

a matrix containing:

`observed`	observed gamma coefficients
`expected`	expected gamma coefficients
`se`	standard errors
`pvalue`	p values (under normal distribution assumption)
`padj`	adjusted p values if selected
`sig`	significance stars: 0 " *** " 0.001 " ** " 0.01 " * " 0.05 " . " 0.1 " " 1

Author(s)

Marianne Mueller

References

Kreiner, S. (2011). A note on item-restscore association in Rasch models. *Applied Psychological Measurement*, 35, 557-561.

Examples

```
rm.mod <- RM(amts[,4:13])
item_restscore(rm.mod)
```

`item_target` *Computation of Item Targets for Polytomous Models*

Description

The item target is the value of the person parameter where item information is maximized.

Usage

```
item_target(obj)
```

Arguments

`obj`	An object of class "eRm" (but not "dRm"), a fitted partial credit model using the function PCM in package eRm or of class "pcmodel" (from package psychotools).

Value

vector with item targets.

Author(s)

Marianne Mueller

Examples

```
## Not run:
 pc.mod <- PCM(desc2[, 5:14])
 item_target(pc.mod)

## End(Not run)
```

out_infit *Item Outfit and Infit Statistics*

Description

To avoid bias observed item responses are compared to expected responses under the conditional distribution of responses given the total score. This leads to standardized residuals which can be summarized to outfit and infit statistics in the usual way.

Usage

```
out_infit(
  object,
  se = TRUE,
  p.adj = c("BH", "holm", "hochberg", "hommel", "bonferroni", "BY", "none")
)
```

Arguments

object	An object of class "Rm", a fitted Rasch model or partial credit model using the functions RM or PCM in package eRm, or an object of class "pcmodel", a fitted partial credit model using the function pcmodel in package psychotools.
se	If TRUE the standard errors will be included.
p.adj	Correction method for multiple testing. The methods are "BH","holm", "hochberg", "hommel", "bonferroni", "BY", "none". See p.adjust.

Details

The fit statistics and their standard errors are calculated as described in Christensen et al. P values are are based on the normal distribution of the standardized fit statistics.

Value

an object of class outfit containing:

outfit	outfit statistics
outfit.se	standard errors of outfit statistics
out.pvalue	p values of outfit statistics
out.pvalue.adj	adjusted p values of outfit statistics if selected
infit	infit statistics
infit.se	standard errors of infit statistics
in.pvalue	p values of infit statistics
in.pvalue.adj	adjusted p values of infit statistics if selected
padj	adjustment method

Author(s)

Marianne Mueller

References

Christensen, K. B. , Kreiner, S. & Mesbah, M. (Eds.) *Rasch Models in Health*. Iste and Wiley (2013), pp. 86 - 90.

Kreiner, S. & Christensen, K. B. (2011) Exact evaluation of Bias in Rasch model residuals. *Advances in Mathematics Research*, 12, 19-40.

Examples

```
rm.mod <- RM(amts[,4:13])
out_infit(rm.mod)
```

`partgam` *Conditional and Partial Gamma Coefficients*

Description

Calculates conditional and partial Gamma coefficients for x and y given z with confidence intervals.

Usage

```
partgam(x, y, z, conf.level = 0.95)
```

Arguments

`x, y, z`	Three numeric vectors or factors.
`conf.level`	Confidence level for the returned confidence interval.

Value

data frame with estimates, standard errors and confidence interval limits.

Author(s)

Marianne Mueller

References

Davis, J. A. A Partial coefficient for Goodman and Kruskal's Gamma. *Journal of the American Statistical Association*, 62 (317), 1967, pp. 189-193.

See Also

`partgam_DIF`, `partgam_LD`

partgam_DIF *Partial Gamma to detect Differential Item Functioning (DIF)*

Description

Items should function in the same way for all subgroups of persons. An item shows differential item functioning (DIF) if there is a significant association between the item score and an exogenous variable, controlling for the scale score. Partial Gamma coefficients are used as test statistics.

Usage

```
partgam_DIF(
  dat.items,
  dat.exo,
  p.adj = c("BH", "holm", "hochberg", "hommel", "bonferroni", "BY", "none")
)
```

Arguments

dat.items	A data frame with the responses to the items.
dat.exo	A single grouping factor or a data frame consisting of several exogenous factor variables.
p.adj	Correction method for multiple testing. The methods are "BH","holm", "hochberg", "hommel", "bonferroni", "BY", "none". See p.adjust.

Value

data frame with Gamma coefficients, standard errors, p values, adjusted p values if an adjustment method has be chosen, and confidence limits for every pair of an item and an exogenous variable.

Author(s)

Marianne Mueller

References

Bjorner, J., Kreiner, S., Ware, J., Damsgaard, M. and Bech, P. Differential item functioning in the Danish translation of the SF-36. *Journal of Clinical Epidemiology*, 51 (11), 1998, pp. 1189-1202.

See Also

partgam_LD

Examples

```
partgam_DIF(amts[,4:13],amts[,2:3])
```

partgam_LD *Partial Gamma to detect Local Dependence (LD)*

Description

Rasch models assume locally independent items. There should be no substantial correlation left between two items once the underlying factor has been taken into account. Partial Gamma coefficients between pairs of items controlled for the rest score can be used to assess this requirement. The rest score is calculated as the score without the second item.

Usage

```
partgam_LD(
  dat.items,
  p.adj = c("BH", "holm", "hochberg", "hommel", "bonferroni", "BY", "none")
)
```

Arguments

dat.items	A data frame with the responses to the items.
p.adj	Correction method for multiple testing. The methods are "BH","holm", "hochberg", "hommel", "bonferroni", "BY", "none". See p.adjust.

Details

Because it matters which of the two items of a pair is subtracted from the total score to give the rest score, calculations are done for each pair in both ways. Results are stored in two different data frames.

Value

list of two data frames with Gamma coefficients, standard errors, p values, adjusted p values if an adjustment method has be chosen, and confidence limits for every pair of items.

Author(s)

Marianne Mueller

References

Christensen, K. B. , Kreiner, S. & Mesbah, M. (Eds.) *Rasch Models in Health*. Iste and Wiley (2013), pp. 133 - 135.

See Also

partgam_DIF

Examples

```
partgam_LD(amts[,4:13])
```

`person_estimates` *Person Estimates with MLE and WLE*

Description

Computes Person estimates with maximum likelihood estimation (MLE) and weighted likelihood estimation (WLE) for raw scores 0 to m.

Usage

```
person_estimates(object, properties = F, allperson = F)
```

Arguments

`object`	An object of class "Rm", a fitted Rasch model or partial credit model using the functions RM or PCM in package eRm, or an object of class "raschmodel" or "pcmodel", a fitted Rasch model or partial credit model using the functions raschmodel or pcmodel in package psychotools.
`properties`	If TRUE additional properties of the estimates are given (see below).
`allperson`	If TRUE person estimates (MLE and WLE) for all persons in the data set are delivered.

Value

If properties = False a matrix containing:

`Raw score`	raw score
`MLE`	MLE of person parameters
`WLE`	WLE of person parameters

If properties = TRUE a list with two components, one for MLE and the other for WLE. Each component contains:

`Raw score`	raw score
`MLE or WLE`	person estimates
`SEM`	standard error of measurement
`Bias`	bias
`RMSE`	root mean square error
`Score.SEM`	score sem

Author(s)

Marianne Mueller

References

Christensen, K. B. , Kreiner, S. & Mesbah, M. (Eds.) *Rasch Models in Health*. Iste and Wiley (2013), pp. 63 - 70.

Examples

```
rm.mod <- RM(amts[,4:13])
person_estimates(rm.mod)
```

---

print.bootfit *Print Method for the Output of boot_fit*

Description

Print Method for the Output of boot_fit

Usage

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

Arguments

x	object of class bootfit.
...	arguments passed to other functions.

---

print.outfit *Print Method for the Output of out_infit*

Description

Print Method for the Output of out_infit

Usage

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

Arguments

x	object of class outfit.
...	arguments passed to other functions.

score_groups *Generate two Score Groups*

Description

Creates a grouping variable which divides the sample in two groups (high and low scorers) of roughly equal size, without taking into account persons with extreme scores.

Usage

```
score_groups(dat.items, label = FALSE)
```

Arguments

dat.items	A data frame with the responses to the items.
label	If TRUE the levels of the group factor are named according to the split used, if FALSE (default) the group factor has levels 1 and 2.

Details

The score groups are used for tests of item homogeneity.

Value

Score group variable, a factor with two levels.

test_prop *Properties of the Test*

Description

Information summarizing measurement quality of the test and test targeting.

Usage

```
test_prop(object)
```

Arguments

object	An object of class "Rm", a fitted Rasch model or partial credit model using the functions RM or PCM in package eRm, or an object of class "pcmodel", a fitted partial credit model using the function pcmodel in package psychotools.

Value

a list containing:

`Separation reliability`
: the person separation reliability as calculated in package eRm for objects of class "Rm".

`Test difficulty`
: person value with an expected score equal to half of the maximum score.

`Test target`
: person value where test information is maximized.

`Test information`
: maximal value of the test information

Author(s)

Marianne Mueller

References

Christensen, K. B. , Kreiner, S. & Mesbah, M. (Eds.) *Rasch Models in Health*. Iste and Wiley (2013), pp. 63 - 70.

Examples

```
rm.mod <- RM(amts[,4:13])
test_prop(rm.mod)
```

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