Package 'lordif'

March 3, 2016

Type Package

Title Logistic Ordinal Regression Differential Item Functioning using IRT

Version 0.3-3

Date 2016-03-3

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Description Analysis of Differential Item Functioning (DIF) for dichotomous and polytomous items using an iterative hybrid of ordinal logistic regression and item response theory (IRT).

Depends R (>= 2.7.0), mirt, rms

Imports stats4

License GPL (>= 2)

LazyLoad yes

NeedsCompilation no

Repository CRAN

Date/Publication 2016-03-03 05:56:21

R topics documented:

`lordif-package` *Logistic Ordinal Regression Differential Item Functioning using IRT*

Description

Analysis of Differential Item Functioning (DIF) for dichotomous and polytomous items, using an iterative hybrid of (ordinal) logistic regression and item response theory (IRT).

Details

Package:	lordif
Type:	Package
Version:	0.3-3
Date:	2016-3-3
License:	GPL (>=2)
LazyLoad:	yes

Ordinal logistic regression (OLR) provides a flexible framework for detecting various types of DIF. Previous efforts extended the framework by substituting the matching variable based on sum scores with IRT based trait scores and by employing an iterative process of purifying the matching variable with the use of group-specific item parameters (Crane et. al., 2006). This package represents an effort to integrate both statistical and IRT procedures into a single program. A Monte Carlo simulation approach was incorporated to derive empirical threshold values for various DIF statistics and effect size measures.

Author(s)

Seung W. Choi, with contributions from Laura E. Gibbons and Paul K. Crane

Maintainer: Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

Crane, P. K., Gibbons, L. E., Jolley, L., & van Belle, G. (2006). Differential item functioning analysis with ordinal logistic regression techniques: DIF detect and difwithpar. Medical Care, 44(11 Suppl 3), S115-S123.

See Also

mirt, rms

Examples

```
##load PROMIS Anxiety sample data (n=766)
## Not run: data(Anxiety)
##age : 0=younger than 65 or 1=65 or older
##gender: 0=Male or 1=Female
##education: 0=some college or higher 1=high school or lower
##run age-related DIF on all 29 items (takes about a minute)
## Not run: age.dif <- lordif(Anxiety[paste("R",1:29,sep="")], Anxiety$age)
##with sample weights - produces the same results as above, i.e., with equal weights
## Not run: age.dif <- lordif(Anxiety[paste("R",1:29,sep="")], Anxiety$age, weights=rep(1/766,766))
##print output
## Not run: print(age.dif)
##print extended output
## Not run: summary(age.dif)
##generate plots for DIF items (reference group: <65)
## Not run: plot(age.dif,labels=c("Younger","Older"))
##run Monte Carlo simulations for threshold values
##this may take several minutes
## Not run: age.dif.MC<-montecarlo(age.dif,alpha=0.05,nr=100)
##print output
## Not run: print(age.dif.MC)
##print extended output
## Not run: summary(age.dif.MC)
##generate plots for Monte Carlo threshold values
## Not run: plot(age.dif.MC)
##run DFIT analysis
## Not run: age.dif.DFIT<-DFIT(age.dif)
```

`Anxiety` *A Measure of Anxiety*

Description

The data contains responses from 766 people sampled from a general population to the PROMIS Anxiety scale (http://www.nihpromis.org) composed of 29 Likert-type questions with a common rating scale (1=Never, 2=Rarely, 3=Sometimes, 4=Often, and 5=Always).

Usage

```
data(Anxiety)
```

Format

A data frame with 766 observations on the following 32 variables.

`age` 0=younger than 65 and 1=65 and older

`gender` 0=Male and 1=Female

`education` 0=some college or higher and 1=high school or lower

`R1` I felt fearful

`R2` I felt frightened

`R3` It scared me when I felt nervous

`R4` I felt anxious

`R5` I felt like I needed help for my anxiety

`R6` I was concerned about my mental health

`R7` I felt upset

`R8` I had a racing or pounding heart

`R9` I was anxious if my normal routine was disturbed

`R10` I had sudden feelings of panic

`R11` I was easily startled

`R12` I had trouble paying attention

`R13` I avoided public places or activities

`R14` I felt fidgety

`R15` I felt something awful would happen

`R16` I felt worried

`R17` I felt terrified

`R18` I worried about other people's reactions to me

`R19` I found it hard to focus on anything other than my anxiety

`R20` My worries overwhelmed me

`R21` I had twitching or trembling muscles

`R22` I felt nervous

`R23` I felt indecisive

`R24` Many situations made me worry

`R25` I had difficulty sleeping

`R26` I had trouble relaxing

`R27` I felt uneasy

`R28` I felt tense

`R29` I had difficulty calming down

Source

http://www.nihpromis.org

References

PROMIS Cooperative Group. Unpublished Manual for the Patient-Reported Outcomes Measurement Information System (PROMIS) Version 1.1. October, 2008: http://www.nihpromis.org

Examples

```
## Not run: data(Anxiety)
```

---

calcprob *calculates item response probabilities*

Description

Calculates item response probabilities over a theta grid according to either the GRM or the GPCM.

Usage

```
calcprob(ipar, theta, model = "GRM")
```

Arguments

ipar	a data frame containing the following columns: a, cb1, cb2,..., cb(maxCat-1)
theta	a grid of theta values, e.g., theta <- seq(-4,4,.1)
model	IRT model, either "GRM" or "GPCM"

Details

Calculates an array of item response probabilities according to either the Graded Response Model (GRM: Samejima, 1969) or the Generalized Partial Credit Model (GPCM: Muraki, 1992) over a grid of theta values. The two required input objects are ipar and theta. ipar is a data frame containing item parameters in the following order: a, cb1, cb2,..., cb(maxCat-1). Items may have different numbers of categories. The variable maxCAT is the maximum number of response categories across all items. theta is a vector containing a grid of theta values. The IRT model can be either "GRM" or "GPCM".

Value

Returns an array of item response probabilities of dimension, c(nq, ni, maxCAT-1), where nq is the length of the theta grid, ni is the number of items in ipar, i.e., nrow(ipar), and maxCAT is the maximum number of response categories across all items.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. Psychometrika Monograph, 17.

Muraki, E. (1992). A generalized partial credit model: Application of an EM algorithm. Applied Psychological Measurement, 16, 159-176.

See Also

probgrm, probgpcm

Examples

```
##item.par<-read.csv(fn,head=F,col.names=c("a","cb1","cb2","cb3","cb4"))
##theta <- seq(-4,4,.1)
## Not run: calcprob(item.par,theta,model="GPCM")
```

---

calctheta *calculates EAP theta estimates and associated standard errors*

Description

Calculates Expected A Posteriori (EAP) theta estimates and associated standard error estimates (posterior standard deviations).

Usage

```
calctheta(ipar, resp.data, theta, prior.mean = 0, prior.sd = 1, model = "GRM")
```

Arguments

ipar	a data frame containing the following columns: a, cb1, cb2,..., cb(maxCat)
resp.data	a data frame containing item responses
theta	a theta grid (quadrature points)
prior.mean	prior mean
prior.sd	prior standard deviation
model	IRT model, either "GRM" or "GPCM")

Details

Calculates EAP theta estimates and standard error estimates based on the input item parameters (ipar), the item response data (resp.data), and the IRT model specified ("GRM" or "GPCM").

Value

A list object with the following components

EAP	Expected A Posteriori estimates of theta
SE	Standard Error estimates

Note

Some missing item responses (NA) are allowed.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Bock, R. D. & Mislevy, R. J. (1982). Adaptive EAP Estimation of Ability in a Microcomputer Environment. Applied Psychological Measurement, 6(4), 431-444.

See Also

`calcprob`, `probgrm`, `probgpcm`

Examples

```
## Not run: calctheta(ipar,resp.data,model="GPCM")
```

---

collapse *collapses response categories*

Description

Collapses response categories if cell frequencies by group are below a minimum threshold specified by minCell and returns a vector of recoded responses.

Usage

```
collapse(resp, group, minCell)
```

Arguments

`resp`	a vector of item responses
`group`	a vector of group designations
`minCell`	a minimum cell frequency

Details

Collapses item response categories in resp if the two-way contingency table (resp x group) has cell frequencies less than the minimum cell count threshold specified by minCell.

Value

a numeric vector of the same length as resp with collapsed/recoded values.

Note

The lowest item response category/score should be coded as 1 not 0 (e.g., 1, 2, 3, 4, 5; and not 0, 1, 2, 3, 4). There must be at least two unique categories after collapsing/recoding.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

See Also

recode

Examples

```
r1 <- c(1,1,2,1,1,2,2,1,2,2,1,2,2,1,1,2,1,2,2,3,3,1,2,3)
gr <- c(0,0,0,1,1,0,1,1,0,0,1,0,1,1,0,1,0,1,0,1,0,1,0,1)
collapse(r1,gr,2) #minCell=2
## returns  c(1,1,2,1,1,2,2,1,2,2,1,2,2,1,1,2,1,2,2,2,2,1,2,2)
## response categories 2 and 3 are collapsed
```

DFIT *calculates DFIT statistics*

Description

Calculates DFIT statistics using an object of class "lordif"

Usage

```
DFIT(obj)
```

Arguments

obj	an object of class "lordif"

Details

Calculates DFIT statistics, including the compensatory differential item functioning (CDIF), the non-compensatory differential item functioning (NCDIF), and the differential test functioning (DTF), based on an object returned from lordif.

Value

CDIF	a data frame of dimension ni by (ng-1), containing compensatory differential item functioning statistics for ni items and (ng-1) groups
NCDIF	a data frame containing non-compensatory differential item functioning statistics
DTF	the Differential Test Functioning (DTF) statistic (Raju, van der Linden, & Fleer, 1995)
ipar	a list of item parameter estimates by group
TCC	a list of test characteristic functions by group

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Oshima, T., & Morris, S. (2008). Raju's differential functioning of items and tests (DFIT). Educational Measurement: Issues and Practice, 27, 43-50.

Raju, N. S., van der Linden, W. J., & Fleer, P. F., (1995). An IRT-based internal measure of test bias with application of differential item functioning. Applied Psychological Measurement, 19, 353-368.

See Also

lordif

Examples

```
##load PROMIS Anxiety sample data (n=766)
## Not run: data(Anxiety)
##age : 0=younger than 65 or 1=65 or older
##run age-related DIF on all 29 items (takes about a minute)
## Not run: age.DIF <- lordif(Anxiety[paste("R",1:29,sep="")],Anxiety$age)
##run DFIT
## Not run: age.DIF.DFIT <- DFIT(age.DIF)
```

---

equate *performs Stocking-Lord Equating*

Description

Computes linear transformation constants to equate a set of GRM/GPCM item parameters to a target scale using a test characteristic curve equating procedure (Stocking & Lord, 1983)

Usage

```
equate(ipar.to, ipar.from, theta, model = "GRM", start.AK = c(1, 0),
lower.AK = c(0.5, -2), upper.AK = c(2, 2))
```

Arguments

ipar.to	a data frame containing target item parameters in the following order: a, cb1, cb2,..., cb(maxCat-1)
ipar.from	a data frame containing to-be-equated item parameters in the following order: a, cb1, cb2,..., cb(maxCat-1)
theta	a theta grid
model	IRT model, either "GRM" or "GPCM"
start.AK	a vector of starting values, c(A, K) where A is a multiplicative constant and K is an additive constant
lower.AK	a vector of lower limits, c(A, K) where A is a multiplicative constant and K is an additive constant
upper.AK	a vector of upper limits, c(A, K) where A is a multiplicative constant and K is an additive constant

Details

Computes linear transformation constants (A and K) that equate a set of item parameters (ipar.from) to the scale defined by a target item parameters (ipar.to) by minimizing the squared difference between the test characteristic curves (Stocking & Lord, 1983). The minimization is performed by the nlminb function (in stats).

Value

returns a vector of two elements, c(A, K) where A is a multiplicative constant and K is an additive constant

Note

The item parameters are assumed to be on the theta metric (0,1). The number of category threshold parameters may differ across items but not greater than (maxCat-1).

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Stocking, M. L. & Lord, F. M. (1983). Developing a Common Metric in Item Response Theory. Applied Psychological Measurement, 7(2), 201-210.

See Also

tcc

Examples

```
##ipar.to is a data frame containing "target" item parameters
##ipar.from is a data frame containing "to-be-equated" item parameters
## Not run: AK <- equate(ipar.to,ipar.from)
#AK[1] contains the multiplicative constant
#AK[2] contains the additive constant
```

`extract` *extracts IRT item parameters*

Description

Extracts IRT item parameter estimates from an output returned from `mirt`

Usage

```
extract(ipar)
```

Arguments

`ipar`	output from the `mirt` function of the mirt package

Details

similar to the coef function in the mirt package

Value

a data frame containing item parameter estimates in the order of a, cb1, cb2,..., cb(maxCat-1).

Author(s)

Seung W. Choi <choi.phd@gmail.com>

See Also

`lordif`, `mirt`

Examples

```
##calib.sparse <- mirt(sparse.matrix,1,itemtype="gpcm")
## Not run: ipar.sparse <- extract(calib.sparse)
```

getcutoff *determines a cutoff threshold*

Description

Determines an empirical cutoff value for statistics generated from a Monte Carlo simulation.

Usage

```
getcutoff(stat, alpha, reverse)
```

Arguments

stat	a vector containing statistics sampled from a Monte Carlo simulation
alpha	a p-value specifying the quantile of the statistics to be determined, e.g., (alpha x 100)th percentile
reverse	if TRUE, the quantile is determined by (1-alpha)

Details

Calculates the quantile value of statistics sampled from a Monte Carlo simulation. For example, when alpha = 0.1 the function determines the 1st percentile of the statistics. Conversely, if reverse is True, the function determines the 99th percentile, i.e., (1-alpha) x 100.

Value

returns a scalar corresponding to the quantile of the statistics determined by alpha or (1-alpha)

Author(s)

Seung W. Choi <choi.phd@gmail.com>

See Also

montecarlo, permute

Examples

```
#top 1 percent
getcutoff(runif(1000),0.01,TRUE)
#bottom 1 percent
getcutoff(runif(1000),0.01,FALSE)
```

lordif *performs Logistic Ordinal Regression Differential Item Functioning using IRT*

Description

performs iterative hybrid ordinal logistic regression/IRT DIF

Usage

```
lordif(resp.data, group, selection = NULL, criterion = c("Chisqr", "R2", "Beta"),
pseudo.R2 = c("McFadden", "Nagelkerke", "CoxSnell"), alpha = 0.01, beta.change = 0.1,
R2.change = 0.02, maxIter = 10, minCell = 5, minTheta = -4, maxTheta = 4, inc = 0.1,
control = list(), model = "GRM", anchor = NULL, MonteCarlo = FALSE, nr = 100,
weights = NULL, normwt = TRUE)
```

Arguments

resp.data	data frame or matrix containing item responses
group	a vector of group designations
selection	a vector specifying a subset of items to be analyzed or NULL for all items
criterion	criterion for flagging (i.e., "Chisqr", "R2", or "Beta")
pseudo.R2	pseudo R-squared measure (i.e., "McFadden", "Nagelkerke", or "CoxSnell")
alpha	significance level for Chi-squared criterion
beta.change	proportionate change for Beta criterion
R2.change	R-squared change for pseudo R-squared criterion
maxIter	maximum number of iterations for purification
minCell	minimum cell frequency to avoid collapsing
minTheta	minimum for theta grid
maxTheta	maximum for theta grid
inc	increment for theta grid
control	a list of control variables (refer to the mirt function in the **mirt** package)
model	IRT model of choice, either "GRM" or "GPCM" (default: "GRM")
anchor	a vector specifying items to be used as anchors or NULL to determine anchors through purification
MonteCarlo	TRUE to trigger Monte Carlo simulations to determine empirical thresholds
nr	number of replications for Monte Carlo simulations
weights	an optional vector (same length as nobs) of fractional case weights (refer to the lrm function in the **rms** package which currently generates warning messages)
normwt	set to TRUE to scale weights so they sum to nobs

Details

Performs an ordinal (common odds-ratio) logistic regression differential item functioning (DIF) analysis using IRT theta estimates as the conditioning variable. The graded response model (GRM) or the generalized partial credit model (GPCM) is used for IRT trait estimation. Items flagged for DIF are treated as unique items and group-specific item parameters are obtained. Non-DIF items serve as anchor items to the initial single-group calibration. The procedure runs iteratively until the same set of items is flagged over two consecutive iterations, unless anchor items are specified.

Value

Returns an object (list) of class "lordif" with the following components:

`call`	calling expression
`options`	options used for the run
`selection`	all or a subset of items analyzed
`stats`	matrix containing output statistics
`flag`	logical vector of final flags indicating whether each item is displaying DIF or not
`recoded`	data frame containing recoded item responses
`group`	vector of group designation values
`ng`	scalar for the number of groups
`ncat`	vector of the number of response categories for each item after collapsing/recoding
`calib`	vector of theta estimates based on the overall (non-group-specific) item parameters
`calib.sparse`	vector of theta estimates based on the DIF-free and group-specific item parameters
`iteration`	scalar for the number of iterations
`ipar`	data frame of the overall (non-group-specific) item parameter estimates
`ipar.sparse`	data frame of the group-specific item parameter estimates
`stats.raw`	matrix containing output statistics (the same components as stats above but based on raw scores)
`meanraw`	vector containing mean raw scores
`flag.raw`	logical vector of final DIF flags based on raw scores
`DFIT`	place-holder for DFIT analysis output
`anchor`	vector of items used as anchors
`MonteCarlo`	place-holder for Monte Carlo analysis output

Note

requires the **mirt** and **rms** packages

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

Crane, P. K., Gibbons, L. E., Jolley, L., and van Belle, G. (2006). Differential item functioning analysis with ordinal logistic regression techniques: DIF detect and difwithpar. Medical Care, 44(11 Suppl 3), S115-S123.

See Also

rundif

Examples

```
## Not run: data(Anxiety)
## Not run: resp.data <- Anxiety[paste("R",1:29,sep="")]
## Not run: age <- Anxiety$age
## Not run: age.DIF <- lordif(resp.data,age,model="GPCM",anchor=c(1:5,7,8,10,12:17,19:23,25:29))
## Not run: print(age.DIF)
```

`montecarlo` *performs Monte Carlo simulations to generate empirical distributions*

Description

performs Monte Carlo simulations under no-DIF conditions to generate empirical distributions of statistics

Usage

```
montecarlo(obj, alpha = 0.01, nr = 100)
```

Arguments

`obj`	an object returned from `lordif`
`alpha`	desired significance level (e.g., .01)
`nr`	number of replications

Details

Simulated datasets are generated under no-DIF conditions and have the same dimensions as the empirical dataset. Group n-sizes and differences (impact) in theta estimates are preserved in the simulated datasets. Returns empirical distributions and thresholds for various statistics and effect size measures.

Value

Returns an object (list) of class "lordif.MC" with the following components:

`call`	calling expression
`chi12`	prob associated with the LR Chi-square test comparing Model 1 vs. 2
`chi13`	prob associated with the LR Chi-square test comparing Model 1 vs. 3
`chi23`	prob associated with the LR Chi-square test comparing Model 2 vs. 3
`pseudo12.CoxSnell`	Cox & Snell pseudo R-square change from Model 1 to 2
`pseudo13.CoxSnell`	Cox & Snell pseudo R-square change from Model 1 to 3
`pseudo23.CoxSnell`	Cox & Snell pseudo R-square change from Model 2 to 3
`pseudo12.Nagelkerke`	Nagelkerke pseudo R-square change from Model 1 to 2
`pseudo13.Nagelkerke`	Nagelkerke pseudo R-square change from Model 1 to 3
`pseudo23.Nagelkerke`	Nagelkerke pseudo R-square change from Model 2 to 3
`pseudo12.McFadden`	McFadden pseudo R-square change from Model 1 to 2
`pseudo13.McFadden`	McFadden pseudo R-square change from Model 1 to 3
`pseudo23.McFadden`	McFadden pseudo R-square change from Model 2 to 3
`beta12`	proportional beta change from Model 1 to 2
`alpha`	significance level
`nr`	number of replications
`cutoff`	thresholds for the statistics

Note

nr must be a large integer (e.g., 500) to generate smooth distributions.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

See Also

permute, lordif

Examples

```
##load PROMIS Anxiety sample data (n=766)
## Not run: data(Anxiety)
##age : 0=younger than 65 or 1=65 or older
##run age-related DIF on all 29 items (takes about a minute)
## Not run: age.DIF <- lordif(Anxiety[paste("R",1:29,sep="")],Anxiety$age)
##the following takes several minutes
## Not run: age.DIF.MC <- montecarlo(age.DIF,alpha=0.01,nr=100)
```

---

permute *performs permutation test for empirical cutoff thresholds*

Description

performs permutation tests under no-DIF conditions to generate empirical distributions of DIF statistics

Usage

```
permute(obj, alpha = 0.01, nr = 100)
```

Arguments

obj	an object returned from lordif
alpha	desired significance level (e.g., .01)
nr	number of replications

Details

The vector of group designations is randomly shuffled nr times to estimate the sampling distribution of the statistics when the null hypothesis is true. Returns empirical distributions and thresholds for various statistics and effect size measures.

Value

Returns an object (list) of class "lordif.MC" with the following components:

call	calling expression
chi12	prob associated with the LR Chi-square test comparing Model 1 vs. 2
chi13	prob associated with the LR Chi-square test comparing Model 1 vs. 3
chi23	prob associated with the LR Chi-square test comparing Model 2 vs. 3
pseudo12.CoxSnell	Cox & Snell pseudo R-square change from Model 1 to 2

`pseudo13.CoxSnell`
: Cox & Snell pseudo R-square change from Model 1 to 3

`pseudo23.CoxSnell`
: Cox & Snell pseudo R-square change from Model 2 to 3

`pseudo12.Nagelkerke`
: Nagelkerke pseudo R-square change from Model 1 to 2

`pseudo13.Nagelkerke`
: Nagelkerke pseudo R-square change from Model 1 to 3

`pseudo23.Nagelkerke`
: Nagelkerke pseudo R-square change from Model 2 to 3

`pseudo12.McFadden`
: McFadden pseudo R-square change from Model 1 to 2

`pseudo13.McFadden`
: McFadden pseudo R-square change from Model 1 to 3

`pseudo23.McFadden`
: McFadden pseudo R-square change from Model 2 to 3

`beta12`
: proportional beta change from Model 1 to 2

`alpha`
: significance level

`nr`
: number of replications

`cutoff`
: thresholds for the statistics

Note

nr must be a large integer (e.g., 500) for smooth distributions.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

See Also

`montecarlo`, `lordif`

Examples

```
##load PROMIS Anxiety sample data (n=766)
## Not run: data(Anxiety)
##age : 0=younger than 65 or 1=65 or older
##run age-related DIF on all 29 items (takes about a minute)
## Not run: age.DIF <- lordif(Anxiety[paste("R",1:29,sep="")],Anxiety$age)
##the following takes several minutes
## Not run: age.DIF.MC <- permute(age.DIF,alpha=0.01,nr=100)
```

`plot.lordif` *Plot method for lordif class*

Description

plots diagnostic graphs for items flagged for DIF

Usage

```
  ## S3 method for class 'lordif'
plot(x, labels = c("Reference", "Focal"), width = 7, height = 7, ...)
```

Arguments

`x`	output from `lordif`
`labels`	labels for group levels, e.g., c("Male","Female")
`width`	width of the canvas of the plotting device in inches
`height`	height of the canvas of the plotting device in inches
`...`	extra graphical parameters

Details

Generates the following graphs IF there is one or more DIF items: 1. Trait Distributions - density graphs for groups 2. Item True Score Functions - true score functions by theta for groups 3. Differences in Item True Score Functions - unsigned differences 4. Item Response Functions - item response function for groups 5. Impact (Weighted by Density) - unsigned differences weighted by theta distributions for the focal group 6. Comparison of TCCs by group based on all items and DIF items 7. Impact on Theta Estimates - theta estimates by group before and after accounting for DIF

Graphs 2-5 are generated for each DIF item Graphs 1, 6 and 7 are generated for the whole analysis

Value

Returns no object.

Note

Produces graphs only if x contains DIF items. No graphs if no DIF items are present.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

See Also

lordif

Examples

```
##run lordif first
## Not run: age.dif <- lordif(Anxiety[paste("R",1:29,sep="")],Anxiety$age)
## Not run: plot(age.dif,labels=c("Younger","Older"),width=8,height=7,cex=0.8,lwd=1)
```

---

plot.lordif.MC *Plot method for Monte Carlo simulation output*

Description

Produces plots for Monte Carlo output

Usage

```
  ## S3 method for class 'lordif.MC'
plot(x, mfrow = c(3, 1), width = 7, height = 7, ...)
```

Arguments

x	an object of class lordif.MC returned from montecarlo
mfrow	number of rows and columns per page for multi-fane plots
width	width of the canvas of the plotting device in inches
height	height of the canvas of the plotting device in inches
...	extra graphical parameters

Details

Generates the following graphs: 1. thresholds for Chi-square probability for Model 1 vs. 2 2. thresholds for Chi-square probability for Model 1 vs. 3 3. thresholds for Chi-square probability for Model 2 vs. 3 4. pseudo R-square change from Model 1 to 2 5. pseudo R-square change from Model 1 to 3 6. pseudo R-square change from Model 2 to 3 7. proportional beta change from Model 1 to 2

Value

Returns no object.

Note

x is an object of class lordif.MC returned from montecarlo

Author(s)

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References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

See Also

lordif, montecarlo, permute

Examples

```
## s3 plot method for class 'lordif.MC':
## Not run: age.dif <- lordif(Anxiety[paste("R",1:29,sep="")],Anxiety$age)
## Not run: age.dif.MC <- montecarlo(age.dif,alpha=.05,nr=500)
## Not run: plot(age.dif.MC,mfrow=c(1,1),width=8,height=7)
```

---

probgpcm *calculates item response probabilities according to GPCM*

Description

Calculates a matrix of item response probabilities over a grid of theta values for an item

Usage

```
probgpcm(theta, a, cb)
```

Arguments

theta	a vector of theta values (e.g., quadrature points)
a	a slope parameter value
cb	a vector of category threshold values

Details

The Generalized Partial Credit Model (Muraki, 1992) is assumed.

Value

Returns a matrix of item response probabilities. The first dimension corresponds to the length of theta.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Muraki, E. (1992). A generalized partial credit model: Application of an EM algorithm. Applied Psychological Measurement, 16, 159-176.

See Also

calcprob, probgrm

Examples

```
probgrm(seq(-4,4,.1), 1.5, c(-1.2,0.5,1.5))
```

---

probgrm *calculates item response probabilities according to GRM*

Description

Calculates a matrix of item response probabilities over a grid of theta values for an item

Usage

```
probgrm(theta, a, cb)
```

Arguments

theta	a vector of theta values (e.g., quadrature points)
a	a slope parameter value
cb	a vector of category threshold values

Details

The Graded Response Model (Samejima, 1969) is assumed.

Value

Returns a matrix of item response probabilities. The first dimension corresponds to the length of theta.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Samejima, F. (1969). Estimation of latent ability using a response pattern of graded scores. Psychometrika Monograph, 17.

See Also

calcprob, probgpcm

Examples

```
probgrm(seq(-4,4,.1), 1.5, c(-1.2,0.5,1.5))
```

---

recode *recodes item responses*

Description

Recodes item responses as specified by original and modified

Usage

```
recode(vec, original, modified)
```

Arguments

vec	a vector of item responses to be recoded
original	original item response categories, e.g., c(0,1,2,3)
modified	modified item response categories, e.g., c(1,2,3,4)

Details

vec, original, and modified must be of the same mode. original and modified must be of the same length.

Value

Returns a vector of the same length and mode as vec with recoded values.

Author(s)

Seung W. Choi <choi.phd@gmail.com>

Examples

```
x <- c(0,1,2,3,4,0,1,2,3,4)
y <- c(0,1,2,3,4)
z <- c(1,2,3,4,5)
recode(x,y,z)
##returns c(1,2,3,4,5,1,2,3,4,5)
```

`rundif` *runs ordinal logistic regression DIF*

Description

Runs ordinal logistic regression DIF

Usage

```
rundif(item, resp, theta, gr, criterion, alpha, beta.change, pseudo.R2, R2.change, wt)
```

Arguments

`item`	a selection of items to be analyzed
`resp`	a data frame containing item responses
`theta`	a conditioning (matching) variable
`gr`	a vector of group identifiers
`criterion`	criterion for flagging (i.e., "CHISQR", "R2", or "BETA")
`alpha`	significance level for Chi-squared criterion
`beta.change`	proportional change for Beta criterion
`pseudo.R2`	pseudo R-squared measure (i.e., "McFadden", "Nagelkerke", or "CoxSnell")
`R2.change`	R-squared change for pseudo R-squared criterion
`wt`	optional sample weights

Details

The argument item lists the column numbers of the data frame resp to be included in the analysis.

Value

Returns a list of the following components:

`stats`	a data frame containing output statistics
`flag`	a logical vector of DIF flags

Author(s)

Seung W. Choi <choi.phd@gmail.com>

References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

Crane, P. K., Gibbons, L. E., Jolley, L., and van Belle, G. (2006). Differential item functioning analysis with ordinal logistic regression techniques: DIF detect and difwithpar. Medical Care, 44(11 Suppl 3), S115-S123.

See Also

runolr, lordif

Examples

```
## Not run: rundif(item,resp,theta,gr)
```

---

runolr *runs ordinal logistic regression models*

Description

Runs ordinal logistic regression models and produces DIF statistics and effect size measures

Usage

```
runolr(rv, ev, gr, wt)
```

Arguments

rv	a response variable
ev	an explanatory variable (e.g., conditioning variable)
gr	a vector of group identifiers
wt	a vector of optional sample weights

Details

Model 1: ev

Model 2: ev + gr

Model 3: ev*gr or equivalently ev + gr + ev*gr

Value

Returns a list of the following components:

chi12	prob for the LR Chi-square comparing Model 1 vs. Model 2
chi13	prob for the LR Chi-square comparing Model 1 vs. Model 3
chi23	prob for the LR Chi-square comparing Model 2 vs. Model 3
beta12	proportional change in the coefficient for ev
pseudo1.CoxSnell	Cox & Snell psudo R-square for Model 1
pseudo2.CoxSnell	Cox & Snell psudo R-square for Model 2
pseudo3.CoxSnell	Cox & Snell psudo R-square for Model 1

`pseudo1.Nagelkerke`
: Nagelkerke psudo R-square for Model 1

`pseudo2.Nagelkerke`
: Nagelkerke psudo R-square for Model 2

`pseudo3.Nagelkerke`
: Nagelkerke psudo R-square for Model 3

`pseudo1.McFadden`
: McFadden psudo R-square for Model 1

`pseudo2.McFadden`
: McFadden psudo R-square for Model 2

`pseudo3.McFadden`
: McFadden psudo R-square for Model 3

`pseudo12.CoxSnell`
: Cox & Snell R-square change from Model 1 to Model 2

`pseudo13.CoxSnell`
: Cox & Snell R-square change from Model 1 to Model 3

`pseudo23.CoxSnell`
: Cox & Snell R-square change from Model 2 to Model 3

`pseudo12.Nagelkerke`
: Nagelkerke R-square change from Model 1 to Model 2

`pseudo13.Nagelkerke`
: Nagelkerke R-square change from Model 1 to Model 3

`pseudo23.Nagelkerke`
: Nagelkerke R-square change from Model 2 to Model 3

`pseudo12.McFadden`
: McFadden R-square change from Model 1 to Model 2

`pseudo13.McFadden`
: McFadden R-square change from Model 1 to Model 3

`pseudo23.McFadden`
: McFadden R-square change from Model 2 to Model 3

`df12`
: df for the LR Chi-square comparing Model 1 and Model 2

`df13`
: df for the LR Chi-square comparing Model 1 and Model 3

`df23`
: df for the LR Chi-square comparing Model 2 and Model 3

Author(s)

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References

Choi, S. W., Gibbons, L. E., Crane, P. K. (2011). lordif: An R Package for Detecting Differential Item Functioning Using Iterative Hybrid Ordinal Logistic Regression/Item Response Theory and Monte Carlo Simulations. Journal of Statistical Software, 39(8), 1-30. URL http://www.jstatsoft.org/v39/i08/.

Crane, P. K., Gibbons, L. E., Jolley, L., & van Belle, G. (2006). Differential item functioning analysis with ordinal logistic regression techniques: DIF detect and difwithpar. Medical Care, 44(11 Suppl 3), S115-S123.

See Also

rundif, lordif, rms

Examples

```
## Not run: runolr(rv, ev, gr)
```

`separate` *splits item response vectors of DIF items by group*

Description

Splits item response vectors of DIF items into separate group-specific vectors.

Usage

```
separate(resp, flag, gr)
```

Arguments

`resp`	a data frame (or matrix) of item responses
`flag`	a vector of DIF flags
`gr`	a vector of group identifiers

Details

To obtain group specific item calibrations, response vectors of DIF items are split into multiple vectors by group and treated as separate items.

Value

Returns a data frame with item response vectors for non-DIF items followed by separated item response vectors for DIF items

Author(s)

Seung W. Choi <choi.phd@gmail.com>

Examples

```
## Not run: separate(resp,flag,gr)
```

tcc *computes a test characteristic curve (tcc)*

Description

computes a test characteristic curve (tcc) from input item parameters

Usage

```
tcc(a, cb, theta, model = "GRM")
```

Arguments

a	a vector of slope parameters
cb	a matrix of category boundary/threshold parameters
theta	a grid of theta values
model	IRT model, either "GRM" or "GPCM"

Details

Either the graded response model (GRM) or the generalized partial credit model (GPCM) can be specified. The lowest response/score for each item is coded as 0 not 1.

Value

Retruns a vector of tcc values over a theta grid

Author(s)

Seung W. Choi <choi.phd@gmail.com>

See Also

probgrm, probgpcm

Examples

```
## Not run: tcc(a,cb,theta,model="GRM")
## Not run: tcc(a,cb,theta,model="GPCM")
```

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