

# Package ‘lordif’

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**Type** Package

**Title** Logistic Ordinal Regression Differential Item Functioning using IRT

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

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

**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

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lordif-package	<i>Logistic Ordinal Regression Differential Item Functioning using IRT</i>
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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).

## 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	<i>calculates item response probabilities</i>
----------	---

---

**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

[probgm](#), [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")
```

---

<code>calctheta</code>	<i>calculates EAP theta estimates and associated standard errors</i>
------------------------	--

---

## 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

<code>ipar</code>	a data frame containing the following columns: a, cb1, cb2,..., cb(maxCat)
<code>resp.data</code>	a data frame containing item responses
<code>theta</code>	a theta grid (quadrature points)
<code>prior.mean</code>	prior mean
<code>prior.sd</code>	prior standard deviation
<code>model</code>	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

<code>EAP</code>	Expected A Posteriori estimates of theta
<code>SE</code>	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**

<code>resp</code>	a vector of item responses
<code>group</code>	a vector of group designations
<code>minCell</code>	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	<i>extracts IRT item parameters</i>
---------	-------------------------------------

---

**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	<i>performs Logistic Ordinal Regression Differential Item Functioning using IRT</i>
--------	---

---

## 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 <a href="#">mirt</a> function in the <b>mirt</b> 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 <a href="#">lrm</a> function in the <b>rms</b> 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 <a href="#">lordif</a>
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**

[permut](#), [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)
```

---

permut

*performs permutation test for empirical cutoff thresholds*

---

**Description**

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

**Usage**

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

**Arguments**

obj	an object returned from <a href="#">lordif</a>
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 <code>lordif</code>
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**

<code>x</code>	an object of class <code>lordif.MC</code> returned from <a href="#">montecarlo</a>
<code>mfrow</code>	number of rows and columns per page for multi-fane plots
<code>width</code>	width of the canvas of the plotting device in inches
<code>height</code>	height of the canvas of the plotting device in inches
<code>...</code>	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)**

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](#), [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

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

---

recode	<i>recodes item responses</i>
--------	-------------------------------

---

## 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	<i>runs ordinal logistic regression DIF</i>
--------	---

---

**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 pseudo R-square for Model 1
pseudo2.CoxSnell	Cox & Snell pseudo R-square for Model 2
pseudo3.CoxSnell	Cox & Snell pseudo R-square for Model 3

```

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)**

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**

[rundif](#), [lordif](#), [rms](#)

**Examples**

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

---

separate	<i>splits item response vectors of DIF items by group</i>
----------	---

---

**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	<i>computes a test characteristic curve (tcc)</i>
-----	---

---

**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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