Package ‘difR’

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Description Provides a collection of standard methods to detect differential item functioning among dichotomously scored items. Methods for uniform and non-uniform DIF, based on test-score or IRT methods, for comparing two or more than two groups of respondents, are available (Magis, Beland, Tuerlinckx and De Boeck, A General Framework and an R Package for the Detection of Dichotomous Differential Item Functioning, Behavior Research Methods, 42, 2010, 847-862 <doi:10.3758/BRM.42.3.847>).
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difR-package

Collection of methods to detect dichotomous differential item functioning (DIF) in psychometrics

Description

The difR package contains several traditional methods to detect DIF in dichotomously scored items. Both uniform and non-uniform DIF effects can be detected, with methods relying upon item response models or not. Some methods deal with more than one focal group.

Methods currently available are:

1. Transformed Item Difficulties (TID) method (Angoff and Ford, 1973)
2. Mantel-Haenszel (Holland and Thayer, 1988)
3. Standardization (Dorans and Kulick, 1986)
5. Logistic regression (Swaminathan and Rogers, 1990)
7. Raju’s area (Raju, 1990)
8. Likelihood-ratio test (Thissen, Steinberg and Wainer, 1988)

The difR package is further described in Magis, Beland, Tuerlinckx and De Boeck (2010).

Details

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References


**See Also**

Other useful packages can be found in the *R Psychometric* task view.

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**breslowDay**

**Breslow-Day DIF statistic**

**Description**

Computes Breslow-Day statistics for DIF detection.

**Usage**

`breslowDay(data, member, anchor = 1:ncol(data), BDstat = "BD")`
breslowDay

Arguments

data | numeric: the data matrix (one row per subject, one column per item).
member | numeric: the vector of group membership with zero and one entries only. See Details.
anchor | a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.
bdstat | character specifying the DIF statistic to be used. Possible values are "BD" (default) and "trend". See Details.

Details

breslowDay computes one of the Breslow-Day statistics (1980) in the specific framework of differential item functioning. It forms the basic command of difbd and is specifically designed for this call.

The data are supplied by the data argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership, specified by the member argument, must hold only zeros and ones, a value of zero corresponding to the reference group and a value of one to the focal group.

Option anchor sets the items which are considered as anchor items for computing Breslow-Day DIF statistics. Items other than the anchor items and the tested item are discarded. anchor must hold integer values specifying the column numbers of the corresponding anchor items. It is primarily designed to perform item purification.

Two test statistics are available: the usual Breslow-Day statistic for testing homogeneous association (Aguerri, Galibert, Attorresi and Maranon, 2009) and the trend test statistic for assessing some monotonic trend in the odds ratios (Penfield, 2003). The DIF statistic is supplied by the bdstat argument, with values "BD" (default) for the usual statistic and "trend" for the trend test statistic.

Value

A list with two arguments:

res | A matrix with one row per item and three columns: the first one contains the Breslow-Day statistic values, the second column indicates the degrees of freedom, and the last column displays the asymptotic p-values.
bdstat | the value of the bdstat argument.

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References


See Also
difBD, dichodif

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)

# With all items as anchor items
breslowDay(verbal[,1:24], verbal[,26])

# With all items as anchor items and trend test statistic
breslowDay(verbal[,1:24], verbal[,26], BDstat = "trend")

# Removing item 3 from the set of anchor items
breslowDay(verbal[,1:24], verbal[,26], anchor = c(1:5, 7:24))

## End(Not run)
```
Description

This command sets the appropriate contrast matrix \( C \) for computing the generalized Lord’s chi-squared statistics in the framework of DIF detection among multiple groups.

Usage

\[
\text{contrastMatrix(nrfocal, model)}
\]

Arguments

- `nrfocal` numeric: the number of focal groups.
- `model` character: the logistic model to be fitted (either "1PL", "2PL", "3PL" or "3PLc"). See Details.

Details

The contrast matrix \( C \) is necessary to calculate the generalized Lord’s chi-squared statistic. It is designed to perform accurate tests of equality of item parameters across the groups of examinees (see Kim, Cohen and Park, 1995). This is a subroutine for the command `genLordChi2` which returns the DIF statistics.

The number of focal groups has to be specified by the argument `nrfocal`. Moreover, four logistic IRT models can be considered: the 1PL, 2PL and 3PL models can be set by using their acronyms (e.g. "1PL" for 1PL model, and so on). It is also possible to consider the constrained 3PL model, where all pseudo-guessing values are equal across the groups of examinees and take some predefined values which do not need to be supplied here. This model is specified by the value "3PLc" for argument `model`.

Value

A contrast matrix designed to test equality of item parameter estimates from the specified `model` and with `nrfocal` focal groups. The output matrix has a number of rows equal to `nrfocal` times the number of tested parameters (one for 1PL model, two for 2PL and constrained 3PL models, three for 3PL model). The number of columns is equal to \((nrfocal+1)\) times the number of tested parameters. See Kim, Cohen and Park (1995) for further details.

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References


See Also
genLordChi2, difGenLord

Examples

## Not run:

# Contrast matrices with 1PL model and several focal groups
c contrastMatrix(2, "1PL")
c contrastMatrix(3, "1PL")
c contrastMatrix(4, "1PL")

# Contrast matrices with 2PL, constrained and unconstrained 3PL models and three focal groups
c contrastMatrix(3, "2PL")
c contrastMatrix(3, "3PLc")
c contrastMatrix(3, "3PL")

## End(Not run)

---

dichoDif

Comparison of DIF detection methods

Description

This function compares the specified DIF detection methods with respect to the detected items.
dichoDif

Usage

dichoDif(Data, group, focal.name, method, anchor = NULL, props = NULL,
thrtID = 1.5, alpha = 0.05, MHstat = "MHchisq", correct = TRUE,
exact = FALSE, stdWeight = "focal", thrSTD = 0.1, BDstat = "BD",
member.type = "group", match = "score", type = "both", criterion = "LRT",
model = "2PL", c = NULL, engine = "ltm", discr = 1, irtParam = NULL,
same.scale = TRUE, signed = FALSE, purify = FALSE, nIter = 10,
p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
## S3 method for class 'dichoDif'
print(x, ...)
type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
criterion a character string specifying which DIF statistic is computed. Possible values are "LRT" (default) or "Wald". See Details.
model character: the IRT model to be fitted (either "1PL", "2PL" or "3PL"). Default is "2PL".
c optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See Details.
engine character: the engine for estimating the 1PL model, either "ltm" (default) or "lme4".
discr either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1PL" and engine is "ltm". See Details.
irtParam matrix with 2J rows (where J is the number of items) and at most 9 columns containing item parameters estimates. See Details.
same.scale logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See Details.
signed logical: should the Raju’s statistics be computed using the signed (TRUE) or unsigned (FALSE, default) area? See Details.
purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
nrIter numeric: the maximal number of iterations in the item purification process (default is 10).
p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
x result from a dichodif class object.
... other generic parameters for the print function.

Details

dichodif is a generic function which calls one or several DIF detection methods and summarize their output. The possible methods are: "TID" for Transformed Item Difficulties (TID) method (Angoff and Ford, 1973), "MH" for mantel-Haenszel (Holland and Thayer, 1988), "Std" for standardization (Dorans and Kulick, 1986), "Logistic" for logistic regression (Swaminathan and Rogers, 1990), "BD" for Breslow-Day method (Penfield, 2003), "Lord" for Lord’s chi-square test (Lord, 1980), "Raju" for Raju’s area method (Raju, 1990), and "LRT" for likelihood-ratio test method (Thissen, Steinberg and Wainer, 1988).

If method has a single component, the output of dichodif is exactly the one provided by the method itself. Otherwise, the main output is a matrix with one row per item and one column per method. For each specified method and related arguments, items detected as DIF and non-DIF are
respectively encoded as "DIF" and "NoDIF". When printing the output an additional column is added, counting the number of times each item was detected as functioning differently (Note: this is just an informative summary, since the methods are obviously not independent for the detection of DIF items).

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from either the computation of the sum-scores, the fitting of the logistic models or the IRT models (according to the method).

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

With the TID method, one can alternatively provide the matrix of proportions of success in for each item in each group. This matrix must have the same format as that provided to the trItemDiff function; see the corresponding help file for further details.

For Lord and Raju methods, one can specify either the IRT model to be fitted (by means of model, c, engine and discr arguments), or the item parameter estimates with arguments irtParam and same.scale. See diflord and difRaju for further details.

The threshold for detecting DIF items depends on the method. For standardization it has to be fully specified (with the thr argument), as well as for the TID method (through the thrTID argument). For the other methods it is depending on the significance level set by alpha.

For Mantel-Haenszel method, the DIF statistic can be either the Mantel-Haenszel chi-square statistic or the log odds-ratio statistic. The method is specified by the argument mhstat, and the default value is "mhchisq" for the chi-square statistic. Moreover, the option correct specifies whether the continuity correction has to be applied to Mantel-Haenszel statistic. See difMH for further details.

By default, the asymptotic Mantel-Haenszel statistic is computed. However, the exact statistics and related P-values can be obtained by specifying the logical argument exact to TRUE. See Agresti (1990, 1992) for further details about exact inference.

The weights for computing the standardized P-DIF statistics are defined through the argument stdweight, with possible values "focal" (default value), "reference" and "total". See stdPDIF for further details.

For Breslow-Day method, two test statistics are available: the usual Breslow-Day statistic for testing homogeneous association (Aguerri, Galibert, Attorresi and Maranon, 2009) and the trend test statistic for assessing some monotonic trend in the odd ratios (Penfield, 2003). The DIF statistic is supplied by the BDstat argument, with values "BD" (default) for the usual statistic and "trend" for the trend test statistic.

For logistic regression, the argument type permits to test either both uniform and nonuniform effects simultaneously (type="both"), only uniform DIF effect (type="udif") or only nonuniform DIF effect (type="nudif"). The criterion argument specifies the DIF statistic to be computed, either the likelihood ratio test statistic (by setting criterion="LRT") or the Wald test (by setting criterion="Wald"). Moreover, the group membership can be either a vector of two distinct values, one for the reference group and one for the focal group, or a continuous or discrete variable that acts as the "group" membership variable. In the former case, the member.type argument is set to "group" and the focal.name defines which value in the group variable stands for the focal group.
In the latter case, `member.type` is set to "cont", `focal.name` is ignored and each value of the group represents one "group" of data (that is, the DIF effects are investigated among participants relying on different values of some discrete or continuous trait). Finally, the matching criterion can be either the test score or any other continuous or discrete variable to be passed in the `Logistik` function. This is specified by the `match` argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to `match` a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix. See `Logistik` for further details.

For Raju’s method, the type of area (signed or unsigned) is fixed by the logical `signed` argument, with default value `FALSE` (i.e. unsigned areas). See `RajuZ` for further details.

Item purification can be requested by specifying `purify` option to `TRUE`. Recall that item purification process is slightly different for IRT and for non-IRT based methods. See the corresponding methods for further information.

Adjustment for multiple comparisons is possible with the argument `p.adjust.method`. See the corresponding methods for further information.

A pre-specified set of anchor items can be provided through the `anchor` argument. For non-IRT methods, anchor items are used to compute the test score (as matching criterion). For IRT methods, anchor items are used to rescale the item parameters on a common metric. See the corresponding methods for further information. Note that anchor argument is not working with "LRT" method.

The output of the `dichodif` function can be stored in a text file by fixing `save.output` and `output` appropriately. See the help file of `selectdif` function (or any other DIF method) for further information.

**Value**

Either the output of one of the DIF detection methods, or a list of class "dichoDif" with the following arguments:

- `DIF` a character matrix with one row per item and whose columns refer to the different specified detection methods. See `Details`.
- `props` the value of the `props` argument.
- `thrTID` the value of the `thrTID` argument.
- `correct` the value of `correct` argument.
- `exact` the value of `exact` argument.
- `alpha` the significance level `alpha`.
- `MHstat` the value of the `MHstat` argument.
- `stdWeight` the value of the `stdWeight` argument.
- `thrSTD` the value of `thrSTD` argument.
- `BDstat` the value of the `BDstat` argument.
- `member.type` the value of the `member.type` argument.
- `match` the value of the `match` argument.
- `type` the value of the `type` argument.
- `criterion` the value of the `criterion` argument.
dichoDif

model  the value of model argument.
c     the value of c argument.
engine The value of the engine argument.
discr the value of the discr argument.
irtParam the value of irtParam argument.
same.scale the value of same.scale argument.
p.adjust.method the value of the p.adjust.method argument.
purification the value of purify argument.
nrPur an integer vector (of length equal to the number of methods) with the number of iterations in the purification process. Returned only if purify is TRUE.
convergence a logical vector (of length equal to the number of methods) indicating whether the iterative purification process converged. Returned only if purify is TRUE.
anchor.names the value of the anchor argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References


See Also
diftID, difMH, difStd, difBD, difLogistic, difLord, difRaju, difLRT

Examples

```r
## Not run:

# Loading of the verbal data
data(verbald)
attach(verbald)

# Excluding the "Anger" variable
verbald <- verbald[!names(verbald) == "Anger"]

# Comparing TID, Mantel-Haenszel, standardization and logistic regression
# TID threshold 1.0
# Standardization threshold 0.08
# no continuity correction,
# with item purification
dichodif(verbald, group = 25, focal.name = 1, method = c("TID", "MH", "Std", "Logistic"), correct = FALSE, thrSTD = 0.08, thrTID = 1, purify = TRUE)

# Same analysis, but using items 1 to 5 as anchor and saving the output into
# the 'dicho' file
dichodif(verbald, group = 25, focal.name = 1, method = c("TID", "MH", "Std", "Logistic"), correct = FALSE, thrSTD = 0.08, thrTID = 1, purify = TRUE, anchor = 1:5, save.output = TRUE, output = c("dicho", "default"))

# Comparing Lord and Raju results with 2PL model and
# with item purification
difBD

```r
dichoDif(verbal, group = 25, focal.name = 1, method = c("Lord", "Raju"),
          model = "2PL", purify = TRUE)
## End(Not run)
```

---

### difBD

**Breslow-Day DIF method**

### Description

Performs DIF detection using Breslow-Day method.

### Usage

```r
difBD(Data, group, focal.name, anchor = NULL, BDstat = "BD", alpha = 0.05,
      purify = FALSE, nrIter = 10, p.adjust.method = NULL,
      save.output = FALSE, output = c("out", "default"))
## S3 method for class 'BD'
print(x, ...)
## S3 method for class 'BD'
plot(x, pch = 8, number = TRUE, col = "red", save.plot = FALSE,
     save.options = c("plot", "default", "pdf"), ...)
```

### Arguments

- **Data**
  numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

- **group**
  numeric or character: either the vector of group membership or the column indicator (within Data) of group membership. See Details.

- **focal.name**
  numeric or character indicating the level of group which corresponds to the focal group.

- **anchor**
  either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.

- **BDstat**
  character specifying the DIF statistic to be used. Possible values are "BD" (default) and "trend". See Details.

- **alpha**
  numeric: significance level (default is 0.05).

- **purify**
  logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

- **nrIter**
  numeric: the maximal number of iterations in the item purification process (default is 10).

- **p.adjust.method**
  either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
x the result from a BD class object.
pch, col type of usual pch and col graphical options.
number logical: should the item number identification be printed (default is TRUE).
save.plot logical: should the plot be saved into a separate file? (default is FALSE).
save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.
... other generic parameters for the plot or the print functions.

Details

The method of Breslow-Day (1980) allows for detecting non-uniform differential item functioning without requiring an item response model approach.

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

Two test statistics are available: the usual Breslow-Day statistic for testing homogeneous association (Aguerri, Galibert, Attorresi and Maranon, 2009) and the trend test statistic for assessing some monotonic trend in the odds ratios (Penfield, 2003). The DIF statistic is supplied by the BDstat argument, with values "BD" (default) for the usual statistic and "trend" for the trend test statistic.

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha, and the degrees of freedom depend on the DIF statistic. With the usual Breslow-Day statistic (BDstat="BD"), it is the number of partial tables taken into account (Aguerri et al., 2009). With the trend test statistic, the degrees of freedom are always equal to one (Penfield, 2003).

Item purification can be performed by setting purify to TRUE. Purification works as follows: if at least one item was detected as functioning differently at the first step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when nIter iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively for.
by "Holm" and "BH") perform best for DIF purposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified.

The output of the difBD, as displayed by the print.BD function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

The plot.BD function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the colour are fixed by the usual pch and col arguments. Option number permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing save.plot to TRUE allows this process. The figure is defined through the components of save.options. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

Value

A list of class "BD" with the following arguments:

BD     a matrix with one row per item and three columns: the first one contains the Breslow-Day statistic value, the second column indicates the degrees of freedom, and the last column displays the asymptotic p-values.
alpha  the significance level for DIF detection.
DIFitems either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
BDstat  the value of the BDstat argument.
p.adjust.method the value of the p.adjust.method argument.
adjusted.p either NULL or the vector of adjusted p-values for multiple comparisons.
purification the value of purify option.
nrPur    the number of iterations in the item purification process. Returned only if purify is TRUE.
difPur   a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the i-th row refer to items which were classified respectively as non-DIF and DIF items at the (i-1)-th step. The
first row corresponds to the initial classification of the items. Returned only if 

purify is TRUE.

convergence logical indicating whether the iterative item purification process stopped before 
the maximal number nrIter of allowed iterations. Returned only if purify is 
TRUE.

names the names of the items.

anchor names the value of the anchor argument.

save.output the value of the save.output argument.

output the value of the output argument.

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See Also

breslowDay, dichoDif
**Examples**

```r
## Not run:

# Loading of the verbal data
data(verbal)

# Excluding the "Anger" variable
verbal<-verbal[colnames(verbal) != "Anger"]

# Three equivalent settings of the data matrix and the group membership
difBD(verbal, group = 25, focal.name = 1)
difBD(verbal, group = "Gender", focal.name = 1)
difBD(verbal[,1:24], group = verbal[,25], focal.name = 1)

# With the BD trend test statistic
difBD(verbal, group = 25, focal.name = 1, BDstat = "trend")

# Multiple comparisons adjustment using Benjamini-Hochberg method
difBD(verbal, group = 25, focal.name = 1, p.adjust.method = "BH")

# With item purification
difBD(verbal, group = "Gender", focal.name = 1, purify = TRUE)
difBD(verbal, group = "Gender", focal.name = 1, purify = TRUE, nrIter = 5)

# With items 1 to 5 set as anchor items
difBD(verbal, group = "Gender", focal.name = 1, anchor = 1:5)
difBD(verbal, group = "Gender", focal.name = 1, anchor = 1:5, purify = TRUE)

# Saving the output into the "BDresults.txt" file (and default path)
r <- difBD(verbal, group = 25, focal.name = 1, save.output = TRUE,
           output = c("BDresults","default"))

# Graphical devices
plot(r)

# Plotting results and saving it in a PDF figure
plot(r, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:/Program Files/
plot(r, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

## End(Not run)
```

---

**difGenLogistic**

**Generalized logistic regression DIF method**

**Description**

Performs DIF detection among multiple groups using generalized logistic regression method.
difGenLogistic

Usage

difGenLogistic(Data, group, focal.names, anchor = NULL, match = "score", type = "both", criterion = "LRT", alpha = 0.05, purify = FALSE, nriter = 10, p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
## S3 method for class 'genLogistic'
print(x, ...)
## S3 method for class 'genLogistic'
plot(x, plot = "lrStat", item = 1, itemFit = "best", pch = 8, number = TRUE, col = "red", colIC = rep("black", length(x$focal.names)+1), ltyIC = 1:(length(x$focal.names)+1), title = NULL, save.plot = FALSE, save.options = c("plot", "default", "pdf"), ref.name = NULL, ...)

Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.
group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
focal.names numeric or character vector indicating the levels of group which correspond to the focal groups.
anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. Ignored if match is not "score". See Details.
match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of Data. See Details.
type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
criterion character: the type of test statistic used to detect DIF items. Possible values are "LRT" (default) and "Wald". See Details.
alpha numeric: significance level (default is 0.05).
purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
nriter numeric: the maximal number of iterations in the item purification process (default is 10).
p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
x the result from a Logistik class object.
plot character: the type of plot, either "lrStat" or "itemCurve". See Details.
item numeric or character: either the number or the name of the item for which logistic curves are plotted. Use only when plot="itemCurve".

itemFit character: the model to be selected for drawing the item curves. Possible values are "best" (default) for drawing from the best of the two models, and "null" for using fitted parameters of the null model $M_0$. Not used if "plot" is "lrStat". See Details.

col, pch character: type of usual pch and col graphical options.

number logical: should the item number identification be printed (default is TRUE).

colIC, ltyIC vectors of elements of the usual col and lty arguments for logistic curves. Used only when plot="itemCurve".

title either a character string with the title of the plot, or NULL (default), for which a specific title is automatically displayed.

save.plot logical: should the plot be saved into a separate file? (default is FALSE).

save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

ref.name either NULL (default) or a character string for the name of the reference group (to be used instead of "Reference" in the legend). Ignored if plot is "lrStat".

... other generic parameters for the plot or the print functions.

Details

The generalized logistic regression method (Magis, Raiche, Beland and Gerard, 2010) allows for detecting both uniform and non-uniform differential item functioning among multiple groups without requiring an item response model approach. It consists in fitting a logistic model with the matching criterion, the group membership and an interaction between both as covariates. The statistical significance of the parameters related to group membership and the group-score interaction is then evaluated by means of the usual likelihood-ratio test. The argument type permits to test either both uniform and nonuniform effects simultaneously (type="both"), only uniform DIF effect (type="udif") or only nonuniform DIF effect (type="nudif"). The identification of DIF items can be performed with either the Wald test or the likelihood ratio test, by setting the criterion argument to "Wald" or "LRT" respectively. See genLogistik for further details.

The matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix.

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from the fitting of the logistic models (see glm for further details).
The vector of group membership must hold at least three values, either as numeric or character. The focal groups are defined by the values of the argument focal.names. If there is a unique focal group, then difGenLogistic returns the output of difLogistic.

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha and with \( J \) (if type="udif" or type="nudif") or \( 2J \) (if type="both") degrees of freedom (\( J \) is the number of focal groups).

Item purification can be performed by setting purify to TRUE. Purification works as follows: if at least one item is detected as functioning differently at the first step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when nrIter iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "BH") perform best for DIF purposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. By default it is NULL so that no anchor item is specified. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). Moreover, if the match argument is not set to "score", anchor items will not be taken into account even if anchor is not NULL.

The measures of effect size are provided by the difference \( \Delta R^2 \) between the \( R^2 \) coefficients of the two nested models (Nagelkerke, 1991; Gomez-Benito, Dolores Hidalgo and Padilla, 2009). The effect sizes are classified as "negligible", "moderate" or "large". Two scales are available, one from Zumbo and Thomas (1997) and one from Jedoin and Gierl (2001). The output displays the \( \Delta R^2 \) measures, together with the two classifications.

The output of the difGenLogistic, as displayed by the print.genLogistic function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

Two types of plots are available. The first one is obtained by setting plot="lrStat" and it is the default option. The likelihood ratio statistics are displayed on the Y axis, for each item. The detection threshold is displayed by a horizontal line, and items flagged as DIF are printed with the color defined by argument col. By default, items are spotted with their number identification (number=TRUE); otherwise they are simply drawn as dots whose form is given by the option pch.

The other type of plot is obtained by setting plot="itemCurve". In this case, the fitted logistic
curves are displayed for one specific item set by the argument `item`. The latter argument can hold either the name of the item or its number identification. If the argument `itemFit` takes the value "best", the curves are drawn according to the output of the best model among $M_0$ and $M_1$. That is, two curves are drawn if the item is flagged as DIF, and only one if the item is flagged as non-DIF. If `itemFit` takes the value "null", then the two curves are drawn from the fitted parameters of the null model $M_0$. See `genLogistik` for further details on the models. The colors and types of traits for these curves are defined by means of the arguments `colIc` and `ltyIc` respectively. These are set as vectors of length $J + 1$, the first element for the reference group and the others for the focal groups. Finally, the `ref.name` argument permits to display the name if the reference group (instead of "Reference") in the legend.

Both types of plots can be stored in a figure file, either in PDF or JPEG format. Fixing `save.plot` to `TRUE` allows this process. The figure is defined through the components of `save.options`. The first two components perform similarly as those of the `output` argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

Value

A list of class "genLogistic" with the following arguments:

- `genLogistik`: the values of the generalized logistic regression statistics.
- `logitPar`: a matrix with one row per item and $2 + J \times 2$ columns, holding the fitted parameters of the best model (among the two tested models) for each item.
- `parM0`: the matrix of fitted parameters of the null model $M_0$, as returned by the `Logistik` command.
- `covMat`: a 3-dimensional matrix of size $p \times p \times K$, where $p$ is the number of estimated parameters and $K$ is the number of items, holding the $p \times p$ covariance matrices of the estimated parameters (one matrix for each tested item).
- `deltaR2`: the differences in Nagelkerke’s $R^2$ coefficients. See Details.
- `alpha`: the value of `alpha` argument.
- `thr`: the threshold (cut-score) for DIF detection.
- `DIFitems`: either the column indicators for the items which were detected as DIF items, or "No DIF item detected".
- `type`: the value of `type` argument.
- `adjusted.p`: either `NULL` or the vector of adjusted p-values for multiple comparisons.
- `purification`: the value of `purify` option.
- `nrPur`: the number of iterations in the item purification process. Returned only if `purify` is `TRUE`.
- `difPur`: a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the $i$-th row refer to items which were classified respectively as non-DIF and DIF items at the ($i$-1)-th step. The first row corresponds to the initial classification of the items. Returned only if `purify` is `TRUE`. 
convergence logical indicating whether the iterative item purification process stopped before the maximal number of nritem allowed iterations. Returned only if purify is TRUE.

names the names of the items.
anchor.names the value of the anchor argument.
focal.names the value of focal.names argument.
criterion the value of the criterion argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References


See Also

`genLogistik, genDichoDif, subtestLogistic`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)
attach(verbatim)

# Creating four groups according to gender ("Man" or "Woman") and
# trait anger score ("Low" or "High")
group <- rep("WomanLow", nrow(verbatim))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<=20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"

# New data set
Verbal <- cbind(verbatim[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")

# Testing both types of DIF effects
# Three equivalent settings of the data matrix and the group membership
r <- difGenLogistic(Verbal, group = 25, focal.names = names)
difGenLogistic(Verbal, group = "group", focal.name = names)
difGenLogistic(Verbal[,1:24], group = Verbal[,25], focal.names = names)

# Using the Wald test
difGenLogistic(Verbal, group = 25, focal.names = names, criterion = "Wald")

# Multiple comparisons adjustment using Benjamini-Hochberg method
difGenLogistic(Verbal, group = 25, focal.names = names, p.adjust.method = "BH")

# With item purification
difGenLogistic(Verbal, group = 25, focal.names = names, purify = TRUE)
difGenLogistic(Verbal, group = 25, focal.names = names, purify = TRUE, nrIter = 5)

# With items 1 to 5 set as anchor items
difGenLogistic(Verbal, group = 25, focal.name = names, anchor = 1:5)

# Testing for nonuniform DIF effect
difGenLogistic(Verbal, group = 25, focal.names = names, type = "nudif")

# Testing for uniform DIF effect
difGenLogistic(Verbal, group = 25, focal.names = names, type = "udif")

# User anger trait score as matching criterion
anger <- verbal[,25]
```
difGenLogistic(Verbal, group = 25, focal.names = names, match = anger)

# Saving the output into the "GLresults.txt" file (and default path)
# saving the output into the BglresultsNtxtB file Hand default path
r <- difGenLogistic(Verbal, group = 25, focal.name = names, save.output = TRUE, output = c("GLresults", "default"))

# Graphical devices
plot(r)
plot(r, plot = "itemCurve", item = 1)
plot(r, plot = "itemCurve", item = 1, itemFit = "best")
plot(r, plot = "itemCurve", item = 6)
plot(r, plot = "itemCurve", item = 6, itemFit = "best")

# Plotting results and saving it in a PDF figure
plot(r, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:/Program Files/
plot(r, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

## End(Not run)

difGenLord

Generalized Lord's chi-squared DIF method

Description

Performs DIF detection among multiple groups using generalized Lord's chi-squared method.

Usage

difGenLord(Data, group, focal.names, model, c = NULL, engine = "ltm",
discr = 1, irtParam = NULL, nrFocal = 2, same.scale = TRUE, anchor = NULL, alpha = 0.05, purify = FALSE, nrIter = 10, p.adjust.method = NULL,
save.output = FALSE, output = c("out", "default"))

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

## S3 method for class 'GenLord'
plot(x, plot = "lordStat", item = 1, pch = 8,
number = TRUE, col = "red", colIC = rep("black",
length(x$focal.names)+1), ltyIC = 1:(length(x$focal.names) + 1), save.plot = FALSE, save.options = c("plot", "default", "pdf"),
ref.name = NULL, ...)
Arguments

- **Data**: numeric; either the data matrix only, or the data matrix plus the vector of group membership. See Details.
- **group**: numeric or character; either the vector of group membership or the column indicator (within `Data`) of group membership. See Details.
- **focal.names**: numeric or character vector indicating the levels of group which correspond to the focal groups.
- **model**: character; the IRT model to be fitted (either "1PL", "2PL" or "3PL").
- **c**: optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See Details.
- **engine**: character; the engine for estimating the 1PL model, either "Bltm" (default) or "BlmeT".
- **discr**: either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if `model` is "1PL" and `engine` is "Bltm". See Details.
- **irtParam**: matrix with $2J$ rows (where $J$ is the number of items) and at most 9 columns containing item parameters estimates. See Details.
- **nrfocal**: numeric; the number of focal groups (default is 2).
- **same.scale**: logical; are the item parameters of the `irtParam` matrix on the same scale? (default is TRUE). See Details.
- **anchor**: either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.
- **alpha**: numeric; significance level (default is 0.05).
- **purify**: logical; should the method be used iteratively to purify the set of anchor items? (default is FALSE).
- **nrIter**: numeric; the maximal number of iterations in the item purification process (default is 10).
- **p.adjust.method**: either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
- **save.output**: logical; should the output be saved into a text file? (Default is FALSE).
- **output**: character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
- **x**: the result from a GenLord class object.
- **plot**: character: the type of plot, either "lordStat" or "itemCurve". See Details.
- **item**: numeric or character: either the number or the name of the item for which ICC curves are plotted. Used only when `plot="itemCurve"`.
- **pch, col**: type of usual `pch` and `col` graphical options.
- **number**: logical: should the item number identification be printed (default is TRUE).
- **colIC, ltyIC**: vectors of elements of the usual `col` and `lty` arguments for ICC curves. Used only when `plot="itemCurve"`. 
save.plot logical: should the plot be saved into a separate file? (default is FALSE).

save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

ref.name either NULL (default) or a character string for the name of the reference group (to be used instead of "Reference" in the legend). Ignored if plot is "lordStat".

... other generic parameters for the plot or the print functions.

Details

The generalized Lord's chi-squared method (Kim, Cohen and Park, 1995), also referred to as $Q_j$ statistic, allows for detecting uniform or non-uniform differential item functioning among multiple groups by setting an appropriate item response model. The input can be of two kinds: either by displaying the full data, the group membership, the focal groups and the model, or by giving the item parameter estimates (with the option irtParam). Both can be supplied, but in this case only the parameters in irtParam are used for computing generalized Lord's chi-squared statistic.

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded for item parameter estimation.

The vector of group membership must hold at least three different values, either as numeric or character. The focal groups are defined by the values of the argument focal.names.

If the model is not the 1PL model, or if engine is equal to "ltm", the selected IRT model is fitted using marginal maximum likelihood by means of the functions from the ltm package (Rizopoulos, 2006). Otherwise, the 1PL model is fitted as a generalized linear mixed model, by means of the glmer function of the lme4 package (Bates and Maechler, 2009).

With the "1pl" model and the "ltm" engine, the common discrimination parameter is set equal to 1 by default. It is possible to fix another value through the argument discr. Alternatively, this common discrimination parameter can be estimated (though not returned) by fixing discr to NULL.

The 3PL model can be fitted either unconstrained (by setting c to NULL) or by fixing the pseudo-guessing values. In the latter case, the argument c is either a numeric vector of same length of the number of items, with one value per item pseudo-guessing parameter, or a single value which is duplicated for all the items. If c is different from NULL then the 3PL model is always fitted (whatever the value of model).

The irtParam matrix has a number of rows equal to the number of groups (reference and focal ones) times the number of items $J$. The first $J$ rows refer to the item parameter estimates in the reference group, while the next sets of $J$ rows correspond to the same items in each of the focal groups. The number of columns depends on the selected IRT model: 2 for the 1PL model, 5 for the 2PL model, 6 for the constrained 3PL model and 9 for the unconstrained 3PL model. The columns of irtParam have to follow the same structure as the output of itemParEst command (the latter can actually be used to create the irtParam matrix). The number of focal groups has to be specified with argument nRFocal (default value is 2).
In addition to the matrix of parameter estimates, one has to specify whether items in the focal groups were rescaled to those of the reference group. If not, rescaling is performed by equal means anchoring (Cook and Eignor, 1991). Argument same.scale is used for this choice (default option is TRUE and assumes therefore that the parameters are already placed on a same scale).

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha and p degrees of freedom. The value of p is the product of the number of focal groups by the number of item parameters to be tested (1 for the 1PL model, 2 for the 2PL model or the constrained 3PL model, and 3 for the unconstrained 3PL model).

Item purification can be performed by setting purify to TRUE. In this case, the purification occurs in the equal means anchoring process: items detected as DIF are iteratively removed from the set of items used for equal means anchoring, and the procedure is repeated until either the same items are identified twice as functioning differently, or when nIter iterations have been performed. In the latter case a warning message is printed. See Candell and Drasgow (1988) for further details.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "BH") perform best for DIF purposes. See p.adjust function for further details.

Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to rescale the item parameters on a common metric. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified. If item parameters are provided through the irtParam argument and if they are on the same scale (i.e. if same.scale is TRUE), then anchor items are not used (even if they are specified).

The output of the difGenLord, as displayed by the print.GenLord function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

Two types of plots are available. The first one is obtained by setting plot="lordStat" and it is the default option. The chi-squared statistics are displayed on the Y axis, for each item. The detection threshold is displayed by a horizontal line, and items flagged as DIF are printed with the color defined by argument col. By default, items are spotted with their number identification (number=TRUE); otherwise they are simply drawn as dots whose form is given by the option pch.

The other type of plot is obtained by setting plot="itemCurve". In this case, the fitted ICC curves are displayed for one specific item set by the argument item. The latter argument can hold either the name of the item or its number identification. The item parameters are extracted from the itemParFinal matrix if the output argument purification is TRUE, otherwise from the itemParInit matrix and after a rescaling of the item parameters using the itemRescale command.
A legend is displayed in the upper left corner of the plot. The colors and types of traits for these curves are defined by means of the arguments `colic` and `ltyic` respectively. These are set as vectors of length 2, the first element for the reference group and the second for the focal group. Finally, the `ref.name` argument permits to display the name if the reference group (instead of "Reference") in the legend.

Both types of plots can be stored in a figure file, either in PDF or JPEG format. Fixing `save.plot` to TRUE allows this process. The figure is defined through the components of `save.options`. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

**Value**

A list of class "GenLord" with the following arguments:

- `genLordChi` the values of the generalized Lord’s chi-squared statistics.
- `alpha` the value of `alpha` argument.
- `thr` the threshold (cut-score) for DIF detection.
- `df` the degrees of freedom of the asymptotic null distribution of the statistics.
- `DIFitems` either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
- `p.adjust.method` the value of the `p.adjust.method` argument.
- `adjusted.p` either `NULL` or the vector of adjusted p-values for multiple comparisons.
- `purification` the value of `purify` option.
- `nrPur` the number of iterations in the item purification process. Returned only if `purify` is TRUE.
- `difPur` a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the i-th row refer to items which were classified respectively as non-DIF and DIF items at the (i-1)-th step. The first row corresponds to the initial classification of the items. Returned only if `purify` is TRUE.
- `convergence` logical indicating whether the iterative item purification process stopped before the maximal number `nIterOf` allowed iterations. Returned only if `purify` is TRUE.
- `model` the value of `model` argument.
- `c` The value of the `c` argument.
- `engine` The value of the `engine` argument.
- `discr` the value of the `discr` argument.
- `itemParInit` the matrix of initial parameter estimates, with the same format as `irtParam` either provided by the user (through `irtParam`) or estimated from the data (and displayed after rescaling).
- `itemParFinal` the matrix of final parameter estimates, with the same format as `irtParam`, obtained after item purification. Returned only if `purify` is TRUE.
difGenLord

estPar  a logical value indicating whether the item parameters were estimated (TRUE) or provided by the user (FALSE).

names  the names of the items.

anchor.names  the value of the anchor argument.

focal.names  the value of the focal.names argument.

save.output  the value of the save.output argument.

output  the value of the output argument.

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References


See Also

itemParEst
Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)
attach(verbatim)

# Creating four groups according to gender ("Man" or "Woman") and trait
# anger score ("Low" or "High")
group <- rep("WomanLow", nrow(verbatim))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"

# New data set
Verbal <- cbind(verbatim[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")

# Three equivalent settings of the data matrix and the group membership
# 1PL model, "ltm" engine
r <- difGenLord(Verbal, group = 25, focal.names = names, model = "1PL")
difGenLord(Verbal, group = "group", focal.name = names, model = "1PL")
difGenLord(Verbal[,1:24], group = Verbal[,25], focal.names = names, model = "1PL")

# 1PL model, "ltm" engine, estimated common discrimination
r <- difGenLord(Verbal, group = 25, focal.names = names, model = "1PL", discr = NULL)

# 1PL model, "lme4" engine
difGenLord(Verbal, group = "group", focal.name = names, model = "1PL", engine = "lme4")

# With items 1 to 5 set as anchor items
difGenLord(Verbal, group = 25, focal.names = names, model = "1PL", anchor = 1:5)

# Multiple comparisons adjustment using Benjamini-Hochberg method
difGenLord(Verbal, group = 25, focal.names = names, model = "1PL", p.adjust.method = "BH")

# With item purification
difGenLord(Verbal, group = 25, focal.names = names, model = "1PL", purify = TRUE)

# Saving the output into the "GLresults.txt" file (and default path)
r <- difGenLord(Verbal, group = 25, focal.names = names, model = "1PL",
               save.output = TRUE, output = c("GLresults", "default"))

# Splitting the data into the four subsets according to "group"
data0<-data1<-data2<-data3<-NULL
for (i in 1:nrow(verbatim)){
    if (group[i]=="WomanLow") data0<-rbind(data0,as.numeric(verbatim[i,1:24]))
    if (group[i]=="WomanHigh") data1<-rbind(data1,as.numeric(verbatim[i,1:24]))
    if (group[i]=="ManLow") data2<-rbind(data2,as.numeric(verbatim[i,1:24]))
    if (group[i]=="ManHigh") data3<-rbind(data3,as.numeric(verbatim[i,1:24]))
```
difGMH

Generalized Mantel-Haenszel DIF method

Description
Performs DIF detection among multiple groups using the generalized Mantel-Haenszel method.

Usage
difGMH(Data, group, focal.names, anchor = NULL, alpha = 0.05, purify = FALSE,
Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

group numeric or character: either the vector of group membership or the column indicator (within Data) of group membership. See Details.

focal.names numeric or character vector indicating the levels of group which correspond to the focal groups.

anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.

alpha numeric: significance level (default is 0.05).

purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

nrIter numeric: the maximal number of iterations in the item purification process (default is 10).

p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.

save.output logical: should the output be saved into a text file? (Default is FALSE).

output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

x the result from a GMH class object.

pch, col type of usual pch and col graphical options.

number logical: should the item number identification be printed (default is TRUE).

save.plot logical: should the plot be saved into a separate file? (default is FALSE).

save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

... other generic parameters for the plot or the print functions.

Details

The generalized Mantel-Haenszel statistic (Somes, 1986) can be used to detect uniform differential item functioning among multiple groups, without requiring an item response model approach (Penfield, 2001).
The data is a matrix whose rows correspond to the subjects and columns to the items. In addition, data can hold the vector of group membership. If so, group indicates the column of data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership must hold at least three value, either as numeric or character. The focal groups are defined by the values of the argument focal.names. If there is a unique focal group, then difGMH returns the output of difMH (without continuity correction).

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha and with as many degrees of freedom as the number of focal groups.

Item purification can be performed by setting purify to TRUE. Purification works as follows: if at least one item detected as functioning differently at the first step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when nIter iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "BH") perform best for DIF purposes. See p.adjust function for further details.

Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified.

The output of the difGMH, as displayed by the print.GMH function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

The plot.GMH function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the colour are fixed by the usual pch and col arguments. Option number permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing save.plot to TRUE allows this process. The figure is defined through the components of save.options. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.
Value

A list of class "GMH" with the following arguments:

GMH the values of the generalized Mantel-Haenszel statistics.
alpha the value of alpha argument.
thr the threshold (cut-score) for DIF detection.
DIFitems either the items which were detected as DIF items, or "No DIF item detected".
p.adjust.method the value of the p.adjust.method argument.
adjusted.p either NULL or the vector of adjusted p-values for multiple comparisons.
purification the value of the purification option.
nrPur the number of iterations in the item purification process. Returned only if 
purify is TRUE.
difPur a binary matrix with one row per iteration in the item purification process and
one column per item. Zeros and ones in the i-th row refer to items which
were classified respectively as non-DIF and DIF items at the (i-1)-th step. The
first row corresponds to the initial classification of the items. Returned only if 
purify is TRUE.
convergence logical indicating whether the iterative item purification process stopped before
the maximal number nriter of allowed iterations. Returned only if 
purify is TRUE.
names the names of the items.
anchor.names the value of the anchor argument.
focal.names the value of focal.names argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References


See Also
difGMH, difMH

Examples

```
# Not run:

# Loading of the verbal data
data(verb)
attach(verb)

# Creating four groups according to gender ("Man" or "Woman") and
# trait anger score ("Low" or "High")
group <- rep("WomanLow", nrow(verb))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"

# New data set
verb <- cbind(verb[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")

# Three equivalent settings of the data matrix and the group membership
difGMH(verb, group = 25, focal.names = names)
difGMH(verb, group = "group", focal.name = names)
difGMH(verb[,1:24], group = verb[,25], focal.names = names)

# Multiple comparisons adjustment using Benjamini-Hochberg method
difGMH(verb, group = 25, focal.names = names, p.adjust.method = "BH")

# With item purification
difGMH(verb, group = 25, focal.names = names, purify = TRUE)
difGMH(verb, group = 25, focal.names = names, purify = TRUE, nIter = 5)
```
# With items 1 to 5 set as anchor items
difMH(Verbal, group = 25, focal.name = names, anchor = 1:5)
difMH(Verbal, group = 25, focal.name = names, anchor = 1:5, purify = TRUE)

# Saving the output into the "GMHresults.txt" file (and default path)
r <- difGMH(Verbal, group = 25, focal.name = names, save.output = TRUE,
        output = c("GMHresults","default"))

# Graphical devices
plot(r)

# Plotting results and saving it in a PDF figure
plot(r, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:/Program Files/
plot(r, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

## End(Not run)

difLogistic  

Logistic regression DIF method

Description

Performs DIF detection using logistic regression method.

Usage

difLogistic(Data, group, focal.name, anchor = NULL, member.type = "group",
        match = "score", type = "both", criterion = "LRT", alpha = 0.05,
        all.cov = FALSE, purify = FALSE, nIter = 10, p.adjust.method = NULL,
        save.output = FALSE, output = c("out", "default"))

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

## S3 method for class 'Logistic'
plot(x, plot="lrStat", item = 1, itemFit = "best", pch = 8, number = TRUE,
      col = "red", colIC = rep("black", 2), ltyIC = c(1, 2), save.plot = FALSE,
      save.options = c("plot", "default", "pdf"), group.names = NULL, ...)

Arguments

Data  numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
focal.name numeric or character indicating the level of group which corresponds to the focal group. Ignored if member.type is not "group".

anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. Ignored if match is not "score". See Details.

member.type character: either "group" (default) to specify that group membership is made of two groups, or "cont" to indicate that group membership is based on a continuous criterion. See Details.

match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of data. See Details.

type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.

criterion a character string specifying which DIF statistic is computed. Possible values are "LRT" (default) or "Wald". See Details.

alpha numeric: significance level (default is 0.05).

all.cov logical: should all covariance matrices of model parameter estimates be returned (as lists) for both nested models and all items? (default is FALSE).

purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE). Ignored if match is not "score".

nIter numeric: the maximal number of iterations in the item purification process. (default is 10).

p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.

save.output logical: should the output be saved into a text file? (Default is FALSE).

output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

x the result from a Logistik class object.

plot character: the type of plot, either "lrStat" (default) or "itemCurve". See Details.

item numeric or character: either the number or the name of the item for which logistic curves are plotted. Used only when plot="itemCurve".

itemFit character: the model to be selected for drawing the item curves. Possible values are "best" (default) for drawing from the best of the two models, and "null" for using fitted parameters of the null model $M_0$. Not used if "plot" is "lrStat". See Details.

pch, col type of usual pch and col graphical options.

number logical: should the item number identification be printed (default is TRUE).

colIC, ltyIC vectors of two elements of the usual col and lty arguments for logistic curves. Used only when plot="itemCurve".

save.plot logical: should the plot be saved into a separate file? (default is FALSE).
save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

group.names either NULL (default) or a vector of two character strings giving the names of the reference group and the focal group (in this order) for display in the legend. Ignored if plot is "lrStat".

... other generic parameters for the plot or the print functions.

Details

The logistic regression method (Swaminathan and Rogers, 1990) allows for detecting both uniform and non-uniform differential item functioning without requiring an item response model approach. It consists in fitting a logistic model with the matching criterion, the group membership and an interaction between both as covariates. The statistical significance of the parameters related to group membership and the group-score interaction is then evaluated by means of either the likelihood-ratio test or the Wald test. The argument type permits to test either both uniform and nonuniform effects simultaneously (type="both"), only uniform DIF effect (type="udif") or only nonuniform DIF effect (type="nudif"). The argument criterion permits to select either the likelihood ratio test (criterion="LRT") or the Wald test (criterion="Wald"). See Logistik for further details.

The group membership can be either a vector of two distinct values, one for the reference group and one for the focal group, or a continuous or discrete variable that acts as the "group" membership variable. In the former case, the member.type argument is set to "group" and the focal.name defines which value in the group variable stands for the focal group. In the latter case, member.type is set to "cont", focal.name is ignored and each value of the group represents one "group" of data (that is, the DIF effects are investigated among participants relying on different values of some discrete or continuous trait). See Logistik for further details.

The matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix.

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from the fitting of the logistic models (see glm for further details).

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha and with one (if type="udif" or type="nudif") or two (if type="both") degrees of freedom.

Item purification can be performed by setting purify to TRUE. Purification works as follows: if at least one item is detected as functioning differently at the first step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when nrIter iterations are run without
obtaining two successive identical classifications. In the latter case a warning message is printed. Note that purification is possible only if the test score is considered as the matching criterion. Thus, purify is ignored when match is not "score".

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "bh") perform best for DIF proposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. By default it is NULL so that no anchor item is specified. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). Moreover, if the match argument is not set to "score", anchor items will not be taken into account even if anchor is not NULL.

The measures of effect size are provided by the difference $\Delta R^2$ between the $R^2$ coefficients of the two nested models (Nagelkerke, 1991; Gomez-Benito, Dolores Hidalgo and Padilla, 2009). The effect sizes are classified as "negligible", "moderate" or "large". Two scales are available, one from Zumbo and Thomas (1997) and one from Jodoin and Gierl (2001). The output displays the $\Delta R^2$ measures, together with the two classifications.

The output of the difLogistic, as displayed by the print.Logistic function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

Two types of plots are available. The first one is obtained by setting plot="lrStat" and it is the default option. The likelihood ratio statistics are displayed on the Y axis, for each item. The detection threshold is displayed by a horizontal line, and items flagged as DIF are printed with the color defined by argument col. By default, items are spotted with their number identification (number=TRUE); otherwise they are simply drawn as dots whose form is given by the option pch.

The other type of plot is obtained by setting plot="itemCurve". In this case, the fitted logistic curves are displayed for one specific item set by the argument item. The latter argument can hold either the name of the item or its number identification. If the argument itemFit takes the value "best", the curves are drawn according to the output of the best model among $M_0$ and $M_1$. That is, two curves are drawn if the item is flagged as DIF, and only one if the item is flagged as non-DIF. If itemFit takes the value "null", then the two curves are drawn from the fitted parameters of the null model $M_0$. See Logistik for further details on the models. The colors and types of traits for these curves are defined by means of the arguments colIC and ltyIC respectively. These are set as vectors of length 2, the first element for the reference group and the second for the focal group. Finally, the argument group.names permits to display the names of the reference and focal groups (instead of "Reference" and "Focal") in the legend.
Both types of plots can be stored in a figure file, either in PDF or JPEG format. Fixing `save.plot` to `TRUE` allows this process. The figure is defined through the components of `save.options`. The first two components perform similarly as those of the `output` argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

**Value**

A list of class "Logistic" with the following arguments:

- `logistik` the values of the logistic regression statistics.
- `logitPar` a matrix with one row per item and four columns, holding the fitted parameters of the best model (among the two tested models) for each item.
- `logitSe` a matrix with one row per item and four columns, holding the standard errors of the fitted parameters of the best model (among the two tested models) for each item.
- `parM0` the matrix of fitted parameters of the null model $M_0$, as returned by the `logistik` command.
- `seM0` the matrix of standard error of fitted parameters of the null model $M_0$, as returned by the `logistik` command.
- `cov.M0` either NULL (if `all.cov` argument is `FALSE`) or a list of covariance matrices of parameter estimates of the "full" model ($M_0$) for each item (if `all.cov` argument is `TRUE`).
- `cov.M1` either NULL (if `all.cov` argument is `FALSE`) or a list of covariance matrices of parameter estimates of the "reduced" model ($M_1$) for each item (if `all.cov` argument is `TRUE`).
- `deltaR2` the differences in Nagelkerke's $R^2$ coefficients. See `Details`.
- `alpha` the value of `alpha` argument.
- `thr` the threshold (cut-score) for DIF detection.
- `DIFitems` either the column indicators for the items which were detected as DIF items, or "No DIF item detected".
- `member.type` the value of the `member.type` argument.
- `match` a character string, either "score" or "matching variable" depending on the `match` argument.
- `type` the value of `type` argument.
- `p.adjust.method` the value of the `p.adjust.method` argument.
- `adjusted.p` either NULL or the vector of adjusted p-values for multiple comparisons.
- `purification` the value of `purify` option.
- `nrPur` the number of iterations in the item purification process. Returned only if `purify` is `TRUE`.
- `difPur` a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the $i$-th row refer to items which were classified respectively as non-DIF and DIF items at the $(i-1)$-th step. The first row corresponds to the initial classification of the items. Returned only if `purify` is `TRUE`. 
convergence logical indicating whether the iterative item purification process stopped before the maximal number of nritem allowed iterations. Returned only if purify is TRUE.
names the names of the items.
anchor.names the value of the anchor argument.
criterion the value of the criterion argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References


See Also

`logistik`, `dichoDif`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)

# Excluding the "Anger" variable
anger <- verbal[, colnames(verbal) == "Anger"]
verbatim <- verbal[, colnames(verbal) != "Anger"]

# Testing both DIF effects simultaneously
# Three equivalent settings of the data matrix and the group membership
r <- diflogistic(verbal, group = 25, focal.name = 1)
diflogistic(verbal, group = "Gender", focal.name = 1)
diflogistic(verbal[, 1:24], group = verbal[, 25], focal.name = 1)

# Returning all covariance matrices of model parameters
diflogistic(verbal, group = 25, focal.name = 1, all.cov = TRUE)

# Testing both DIF effects with the Wald test
r2 <- diflogistic(verbal, group = 25, focal.name = 1, criterion = "Wald")

# Testing nonuniform DIF effect
diflogistic(verbal, group = 25, focal.name = 1, type = "nudif")

# Testing uniform DIF effect
diflogistic(verbal, group = 25, focal.name = 1, type = "udif")

# Multiple comparisons adjustment using Benjamini-Hochberg method
diflogistic(verbal, group = 25, focal.name = 1, p.adjust.method = "BH")

# With item purification
diflogistic(verbal, group = "Gender", focal.name = 1, purify = TRUE)
diflogistic(verbal, group = "Gender", focal.name = 1, purify = TRUE, nrIter = 5)

# With items 1 to 5 set as anchor items
```
difLogReg

General logistic regression DIF method

Description

Performs DIF detection using logistic regression method with either two groups, more than two groups, or a continuous group variable.

Usage

difLogReg(Data, group, focal.name, anchor = NULL, group.type = "group", match = "score", type = "both", criterion = "LRT", alpha = 0.05, purify = FALSE, nIter = 10, p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
focal.name numeric or character indicating the level(s) of group which corresponds to the focal group(s). Ignored if group.type is not "group".
anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.
group.type character: either "group" (default) to specify that group membership is made of two (or more than two) groups, or "cont" to indicate that group membership is based on a continuous criterion. See Details.
match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of Data. See Details.
type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
criterion a character string specifying which DIF statistic is computed. Possible values are "LRT" (default) or "Wald". See Details.
alpha numeric: significance level (default is 0.05).
purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE). Ignored if match is not "score".
nriter numeric: the maximal number of iterations in the item purification process. (default is 10).
p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

Details

The difLogReg function is a meta-function for logistic regression DIF analysis. It encompasses all possible cases that are currently implemented in difR and makes appropriate calls to the function difLogistic or difGenLogistic.

Three situations are embedded in this function.

1. The group membership is defined by two distinct groups. In this case, group.type must be "group" and focal.name must be a single value, referring to the name or label of the focal group.

2. The group membership is defined by a finite, yet larger than two, number of groups. In this case, group.type must be "group" and focal.name must be a vector with the names or labels of all focal groups.
3. The group membership is a continuous or discrete (but treated as continuous) variable. In this case, DIF is tested with respect to this "membership" variable. Furthermore, group.type must be "cont" and focal.name is ignored (though some value must be specified, for instance NULL).

The specification of the data, the options for item purification, DIF statistic selection, and output saving, are identical to the options arising from the diflogistic and difGenLogistic functions.

Value

A list of class "Logistic" (if group.type is "cont" or with the length of focal.name is one) or "genLogistic", with related arguments (see diflogistic and difGenLogistic).

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References


See Also

difLogistic, difGenLogistic, dichoDif, genDichoDif

Examples

```R
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Few examples
```
difLogReg(Data=verbal[,1:24], group=verbal[,26], focal.name=1)
difLogReg(Data = verbal[,1:24], group = verbal[,26], focal.name = 1, match = verbal[,25])
difLogReg(Data = verbal[,1:24], group = verbal[,25], focal.name = 1, group.type = "cont")

group<-rep("WomanLow",nrow(verbal))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<=20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"
names <- c("WomanHigh", "ManLow", "ManHigh")

difLogReg(Data = verbal[,1:24], group = group, focal.name = names)

## End(Not run)

difLord  

Lord’s chi-squared DIF method

Description

Performs DIF detection using Lord’s chi-squared method.

Usage

difLord(Data, group, focal.name, model, c = NULL, engine = "ltm", discr = 1,  
irtParam = NULL, same.scale = TRUE, anchor = NULL, alpha = 0.05,  
purify = FALSE, nrIter = 10, p.adjust.method = NULL, save.output = FALSE,  
output = c("out", "default"))

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

## S3 method for class 'Lord'
plot(x, plot = "lordStat", item = 1, pch = 8, number = TRUE, col = "red",  
colIC = rep("black", 2), ltyIC = c(1, 2), save.plot = FALSE,  
save.options = c("plot", "default", "pdf"), group.names = NULL, ...)

Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.

focal.name numeric or character indicating the level of group which corresponds to the focal group.

model character: the IRT model to be fitted (either "1PL", "2PL" or "3PL").

c optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See Details.
engine character: the engine for estimating the 1PL model, either "ltm" (default) or "1me4".

discr either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1PL" and engine is "ltm". See Details.

irtParam matrix with 2*J rows (where J is the number of items) and at most 9 columns containing item parameters estimates. See Details.

same.scale logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See Details.

anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.

alpha numeric: significance level (default is 0.05).

purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

nIter numeric: the maximal number of iterations in the item purification process (default is 10).

p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.

save.output logical: should the output be saved into a text file? (Default is FALSE).

output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

x the result from a Lord class object.

plot character: the type of plot, either "lordStat" or "itemCurve". See Details.

item numeric or character: either the number or the name of the item for which ICC curves are plotted. Used only when plot="itemCurve".

pch, col type of usual pch and col graphical options.

number logical: should the item number identification be printed (default is TRUE).

colIC, ltyIC vectors of two elements of the usual col and lty arguments for ICC curves. Used only when plot="itemCurve".

save.plot logical: should the plot be saved into a separate file? (default is FALSE).

save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

group.names either NULL (default) or a vector of two character strings giving the names of the reference group and the focal group (in this order) for display in the legend. Ignored if plot is "lordStat".

... other generic parameters for the plot or the print functions.
Details

Lord’s chi-squared method (Lord, 1980) allows for detecting uniform or non-uniform differential item functioning by setting an appropriate item response model. The input can be of two kinds: either by displaying the full data, the group membership and the model, or by giving the item parameter estimates (through the option \texttt{irtParam}). Both can be supplied, but in this case only the parameters in \texttt{irtParam} are used for computing Lord’s chi-squared statistic.

The \texttt{Data} is a matrix whose rows correspond to the subjects and columns to the items. In addition, \texttt{Data} can hold the vector of group membership. If so, \texttt{group} indicates the column of \texttt{Data} which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, \texttt{group} must be a vector of same length as \texttt{nrow(Data)}.

Missing values are allowed for item responses (not for group membership) but must be coded as \texttt{NA} values. They are discarded for item parameter estimation.

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument \texttt{focal}.name.

If the model is not the 1PL model, or if \texttt{engine} is equal to "ltm", the selected IRT model is fitted using marginal maximum likelihood by means of the functions from the \texttt{ltm} package (Rizopoulos, 2006). Otherwise, the 1PL model is fitted as a generalized linear mixed model, by means of the \texttt{glmer} function of the \texttt{lme4} package (Bates and Maechler, 2009).

With the "1PL" model and the "ltm" engine, the common discrimination parameter is set equal to 1 by default. It is possible to fix another value through the argument \texttt{discr}. Alternatively, this common discrimination parameter can be estimated (though not returned) by fixing \texttt{discr} to \texttt{NULL}.

The 3PL model can be fitted either unconstrained (by setting \texttt{c} to \texttt{NULL}) or by fixing the pseudo-guessing values. In the latter case, the argument \texttt{c} holds either a numeric vector of same length of the number of items, with one value per item pseudo-guessing parameter, or a single value which is duplicated for all the items. If \texttt{c} is different from \texttt{NULL} then the 3PL model is always fitted (whatever the value of \texttt{model}).

The \texttt{irtParam} matrix has a number of rows equal to twice the number of items in the data set. The first \(J\) rows refer to the item parameter estimates in the reference group, while the last \(J\) ones correspond to the same items in the focal group. The number of columns depends on the selected IRT model: 2 for the 1PL model, 5 for the 2PL model, 6 for the constrained 3PL model and 9 for the unconstrained 3PL model. The columns of \texttt{irtParam} have to follow the same structure as the output of \texttt{itemParEst} command (the latter can actually be used to create the \texttt{irtParam} matrix).

In addition to the matrix of parameter estimates, one has to specify whether items in the focal group were rescaled to those of the reference group. If not, rescaling is performed by equal means anchoring (Cook and Eignor, 1991). Argument \texttt{same.scale} is used for this choice (default option is \texttt{TRUE} and assumes therefore that the parameters are already placed on the same scale).

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus \texttt{alpha} and \(p\) degrees of freedom (\(p=1\) for the 1PL model, \(p=2\) for the 2PL model or the 3PL model with constrained pseudo-guessing parameters, and \(p=3\) for the unconstrained 3PL model).

Item purification can be performed by setting \texttt{purify} to \texttt{TRUE}. In this case, the purification occurs in the equal means anchoring process. Items detected as DIF are iteratively removed from the set of items used for equal means anchoring, and the procedure is repeated until either the same items are identified twice as functioning differently, or when \texttt{niter} iterations have been performed. In the latter case a warning message is printed. See Candell and Drasgow (1988) for further details.
Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "Holm" and "BH") perform best for DIF purposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of Data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to rescale the item parameters on a common metric. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified. If item parameters are provided through the itemParam argument and if they are on the same scale (i.e. if same.scale is TRUE), then anchor items are not used (even if they are specified).

Under the 1PL model, the displayed output also proposes an effect size measure, which is -2.35 times the difference between item difficulties of the reference group and the focal group (Penfield and Camilli, 2007, p. 138). This effect size is similar Mantel-Haenszel’s $\Delta_{MH}$ effect size, and the ETS delta scale is used to classify the effect sizes (Holland and Thayer, 1985).

The output of the difLord, as displayed by the print.lord function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

Two types of plots are available. The first one is obtained by setting plot="lordStat" and it is the default option. The chi-squared statistics are displayed on the Y axis, for each item. The detection threshold is displayed by a horizontal line, and items flagged as DIF are printed with the color defined by argument col. By default, items are spotted with their number identification (number=TRUE); otherwise they are simply drawn as dots whose form is given by the option pch.

The other type of plot is obtained by setting plot="itemCurve". In this case, the fitted ICC curves are displayed for one specific item set by the argument item. The latter argument can hold either the name of the item or its number identification. The item parameters are extracted from the itemParFinal matrix if the output argument purification is TRUE, otherwise from the itemParInit matrix and after a rescaling of the item parameters using the itemRescale command. A legend is displayed in the upper left corner of the plot. The colors and types of traits for these curves are defined by means of the arguments colIC and ltyIC respectively. These are set as vectors of length 2, the first element for the reference group and the second for the focal group. Finally, the argument group.names permits to display the names of the reference and focal groups (instead of "Reference" and "Focal") in the legend.

Both types of plots can be stored in a figure file, either in PDF or JPEG format. Fixing save.plot to TRUE allows this process. The figure is defined through the components of save.options. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.
Value

A list of class "Lord" with the following arguments:

LordChi the values of the Lord's chi-squared statistics.
alpha the value of alpha argument.
thr the threshold (cut-score) for DIF detection.
DIFitems either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
purification the value of purify option.
nrPur the number of iterations in the item purification process. Returned only if purify is TRUE.
difPur a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the $i$-th row refer to items which were classified respectively as non-DIF and DIF items at the ($i-1$)-th step. The first row corresponds to the initial classification of the items. Returned only if purify is TRUE.
convergence logical indicating whether the iterative item purification process stopped before the maximal number nriter of allowed iterations. Returned only if purify is TRUE.
model the value of model argument.
c The value of the c argument.
engine The value of the engine argument.
discr the value of the discr argument.
p.adjust.method the value of the p.adjust.method argument.
adjusted.p either NULL or the vector of adjusted p-values for multiple comparisons.
itemParInit the matrix of initial parameter estimates, with the same format as irtParam either provided by the user (through irtParam) or estimated from the data (and displayed without rescaling).
itemParFinal the matrix of final parameter estimates, with the same format as irtParam, obtained after item purification. Returned only if purify is TRUE.
estPar a logical value indicating whether the item parameters were estimated (TRUE) or provided by the user (FALSE).
names the names of the items.
anchor.names the value of the anchor argument.
save.output the value of the save.output argument.
output the value of the output argument.
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References


See Also

itemParEst, dichoDif, p.adjust

Examples

## Not run:
# Loading of the verbal data
data(verbal)
attach(verbal)

# Excluding the "Anger" variable
verbal <- verbal[colnames(verbal)!="Anger"]

# Three equivalent settings of the data matrix and the group membership
# (1PL model, "ltm" engine)
r <- diflord(verbal, group = 25, focal.name = 1, model = "1PL")
diflord(verbal, group = "Gender", focal.name = 1, model = "1PL")
diflord(verbal[,1:24], group = verbal[,25], focal.name = 1, model = "1PL")

# With items 1 to 5 set as anchor items
diflord(verbal, group = 25, focal.name = 1, model = "1PL", anchor = 1:5)

# Multiple comparisons adjustment of p-values with Benjamini-Hochberg method
diflord(verbal, group = 25, focal.name = 1, model = "1PL", anchor = 1:5, p.adjust.method = "BH")

# 1PL model, "lme4" engine
diflord(verbal, group = 25, focal.name = 1, model = "1PL", engine = "lme4")

# 2PL model
diflord(verbal, group = "Gender", focal.name = 1, model = "2PL")

# 3PL model with all pseudo-guessing parameters constrained to 0.05
diflord(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05)

# Same models, with item purification
diflord(verbal, group = 25, focal.name = 1, model = "1PL", purify = TRUE)
diflord(verbal, group = "Gender", focal.name = 1, model = "2PL", purify = TRUE)
diflord(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05,
                  purify = TRUE)

# Saving the output into the "LordResults.txt" file (and default path)
r <- diflord(verbal, group = 25, focal.name = 1, model = "1PL",
                  save.output = TRUE, output = c("LordResults","default"))

# Splitting the data into reference and focal groups
nF<sum(Gender)
nR<sum(verbal)-nF
data.ref<-verbal[,1:24][order(Gender),][1:nR,]
data.focal<-verbal[,1:24][order(Gender),][(nR+1):(nR+nF),]

## Pre-estimation of the item parameters (1PL model, "ltm" engine)
item.1PL<-rbind(itemParEst(data.ref, model = "1PL"),
itemParEst(data.focal, model = "1PL"))
diflord(irtParam = item.1PL, same.scale = FALSE)

## Pre-estimation of the item parameters (1PL model, "lme4" engine)
item.1PL<-rbind(itemParEst(data.ref, model = "1PL", engine = "lme4"),
itemParEst(data.focal, model = "1PL", engine = "lme4"))
### Description
Performs DIF detection using Likelihood Ratio Test (LRT) method.

### Usage
```r
difLRT(data, group, focal.name, alpha = 0.05, purify = FALSE, nrIter = 10,
       p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
```

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

#### S3 method for class 'LRT'
```r
plot(x, pch = 8, number = TRUE, col = "red", save.plot = FALSE,
     save.options = c("plot", "default", "pdf"), ...)  
```

### Arguments
- **Data**: numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.
difLRT

- **group**: numeric or character: either the vector of group membership or the column indicator (within `data`) of group membership. See Details.

- **focal.name**: numeric or character indicating the level of group which corresponds to the focal group.

- **alpha**: numeric: significance level (default is 0.05).

- **purify**: logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

- **nIter**: numeric: the maximal number of iterations in the item purification process (default is 10).

- **p.adjust.method**: either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.

- **save.output**: logical: should the output be saved into a text file? (Default is FALSE).

- **output**: character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

- **x**: the result from a `lrt` class object.

- **pch, col**: type of usual pch and col graphical options.

- **number**: logical: should the item number identification be printed (default is TRUE).

- **save.plot**: logical: should the plot be saved into a separate file? (default is FALSE).

- **save.options**: character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.

- **...**: other generic parameters for the plot or the print functions.

**Details**

The likelihood-ratio test method (Thissen, Steinberg and Wainer, 1988) allows for detecting uniform differential item functioning by fitting a closed-form Rasch model and by testing for extra interactions between group membership and item response. Currently only the Rasch model can be used, so only uniform DIF can be detected. Moreover, items are tested one by one and the other items act as anchor items.

The `data` is a matrix whose rows correspond to the subjects and columns to the items. Missing values are allowed but must be coded as NA values. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

The function `glmer` from package lme4 (Bates and Maechler, 2009) is used to fit the closed-form Rasch model. More precisely, the probability that response $Y_{ijg}$ of subject $i$ from group $g$ (focal or reference) to item $j$ is modeled as
logit(Pr(Y_{ijg} = 1) = \theta_{ig} + \gamma_g - \beta_j

where \theta_i is subject’s ability, \beta_j is the item difficulty and \gamma_g is the difference mean ability level between the focal and the reference groups. Subject abilities are treated as random effects, while item difficulties and \gamma_g are treated as fixed effects. Each item is tested by incorporating an interaction term, \delta_{gj}, and by testing its statistical significance using the traditional likelihood-ratio test.

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the chi-squared distribution with lower-tail probability of one minus alpha and one degree of freedom.

Item purification can be performed by setting purify to TRUE. In this case, items detected as DIF are iteratively removed from the set of tested items, and the procedure is repeated (using the remaining items) until no additional item is identified as functioning differently. The process stops when either there is no new item detected as DIF, or when niter iterations are run and new DIF items are nevertheless detected. In the latter case a warning message is printed.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "BH") perform best for DIF proposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

The output of the difLRT, as displayed by the print.LRT function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

The plot.LRT function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the color are fixed by the usual pch and col arguments. Option number permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing save.plot to TRUE allows this process. The figure is defined through the components of save.options. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

Value

A list of class "LRT" with the following arguments:

- lrt the values of the likelihood-ratio statistics.
- alpha the value of alpha argument.
- thr the threshold (cut-score) for DIF detection.
- DIFitems either the items which were detected as DIF items, or "No DIF item detected".
- p.adjust.method the value of the p.adjust.method argument.
adjusted.p
  either NULL or the vector of adjusted p-values for multiple comparisons.

purification
  the value of purify option.

nrPur
  the number of iterations in the item purification process. Returned only if
  purify is TRUE.

convergence
  logical indicating whether the iterative item purification process stopped before
  the maximal number of allowed iterations (10 by default). Returned only if
  purify is TRUE.

names
  the names of the items.

save.output
  the value of the save.output argument.

output
  the value of the output argument.

Note
  Because of the fitting of the modified Rasch model with glmer, the process can be very time
  consuming.

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References
  version 0.999375-31. http://CRAN.R-project.org/package=lme4
  Kim, J., and Oshima, T. C. (2013). Effect of multiple testing adjustment in differential item
  Magis, D., Beland, S., Tuerlinckx, F. and De Boeck, P. (2010). A general framework and an R pack-
  age for the detection of dichotomous differential item functioning. Behavior Research Methods, 42,
  847-862.
  difference in trace lines. In H. Wainer and H. Braun (Eds.), Test validity. Hillsdale, NJ: Lawrence
  Erlbaum Associates.
See Also

LRT, dichoDif

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Excluding the "Anger" variable
verbal <- verbal[,colnames(verbal)!="Anger"]

# Keeping the first 5 items and the first 50 subjects
# (this is an artificial simplification to reduce the computational time)
verbal <- verbal[1:50, c(1:5, 25)]

# Three equivalent settings of the data matrix and the group membership
r <- difLRT(verbal, group = 6, focal.name = 1)
difLRT(verbal, group = "Gender", focal.name = 1)
difLRT(verbal[,1:5], group = verbal[,6], focal.name = 1)

# Multiple comparisons adjustment using Benjamini-Hochberg method
difLRT(verbal, group = 6, focal.name = 1, p.adjust.method = "BH")

# With item purification
difLRT(verbal, group = 6, focal.name = 1, purify = TRUE)

# Saving the output into the "LRTresults.txt" file (and default path)
r <- difLRT(verbal, group = 6, focal.name = 1, save.output = TRUE,
  output = c("LRTresults", "default"))

# Graphical devices
plot(r)

# Plotting results and saving it in a PDF figure
plot(r, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:/Program Files/
plot(r, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

# WARNING: do not trust the results above since they are based on a selected
# subset of the verbal data set!

## End(Not run)
```
**difMH**

**Mantel-Haenszel DIF method**

**Description**

Performs DIF detection using Mantel-Haenszel method.

**Usage**

```r
difMH(data, group, focal.name, anchor = NULL, MHstat = "MHChisq", correct = TRUE, exact = FALSE, alpha = 0.05, purify = FALSE, nIter = 10, 
p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
```

## S3 method for class 'MH'

```r
print(x, ...)
```

## S3 method for class 'MH'

```r
plot(x, pch = 8, number = TRUE, col = "red", save.plot = FALSE, 
save.options = c("plot", "default", "pdf"), ...)
```

**Arguments**

- **Data** numeric: either the data matrix only, or the data matrix plus the vector of group membership. See **Details**.
- **group** numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See **Details**.
- **focal.name** numeric or character indicating the level of group which corresponds to the focal group.
- **anchor** either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See **Details**.
- **MHstat** character: specifies the DIF statistic to be used for DIF identification. Possible values are "MHChisq" (default) and "logOR". See **Details**.
- **correct** logical: should the continuity correction be used? (default is TRUE)
- **exact** logical: should an exact test be computed? (default is FALSE).
- **alpha** numeric: significance level (default is 0.05).
- **purify** logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
- **nIter** numeric: the maximal number of iterations in the item purification process (default is 10).
- **p.adjust.method** either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See **Details**.
- **save.output** logical: should the output be saved into a text file? (Default is FALSE).
The method of Mantel-Haenszel (1959) allows for detecting uniform differential item functioning without requiring an item response model approach.

The data is a matrix whose rows correspond to the subjects and columns to the items. In addition, data can hold the vector of group membership. If so, group indicates the column of data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

The DIF statistic is specified by the mhstat argument. By default, mhstat takes the value "MHChisq" and the Mantel-Haenszel chi-square statistic is used. The other optional value is "logOR", and the log odds-ratio statistic (that is, the log of alphaMH divided by the square root of var(lambda)) is used. See Penfield and Camilli (2007), Philips and Holland (1987) and mantelhaenszel help file.

By default, the asymptotic Mantel-Haenszel statistic is computed. However, the exact statistics and related P-values can be obtained by specifying the logical argument exact to TRUE. See Agresti (1990, 1992) for further details about exact inference.

The threshold (or cut-score) for classifying items as DIF depends on the DIF statistic. With the Mantel-Haenszel chi-squared statistic (mhstat="MHChisq"), it is computed as the quantile of the chi-square distribution with lower-tail probability of one minus alpha and with one degree of freedom. With the log odds-ratio statistic (mhstat="logOR"), it is computed as the quantile of the standard normal distribution with lower-tail probability of 1-alpha/2. With exact inference, it is simply the alpha level since exact P-values are returned.

By default, the continuity correction factor -0.5 is used (Holland and Thayer, 1988). One can nevertheless remove it by specifying correct=FALSE.

In addition, the Mantel-Haenszel estimates of the common odds ratios \( \alpha_{MH} \) are used to measure the effect sizes of the items. These are obtained by \( \Delta_{MH} = -2.35 \log \alpha_{MH} \) (Holland and Thayer, 1985). According to the ETS delta scale, the effect size of an item is classified as negligible if \( |\Delta_{MH}| \leq 1 \), moderate if \( 1 \leq |\Delta_{MH}| \leq 1.5 \), and large if \( |\Delta_{MH}| \geq 1.5 \). The values of the effect sizes
sizes, together with the ETS classification, are printed with the output. Note that this is returned only for asymptotic tests, i.e. when \( \text{exact} = \text{FALSE} \).

Item purification can be performed by setting \( \text{purify} \) to \( \text{TRUE} \). Purification works as follows: if at least one item was detected as functioning differently at some step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when \( n_{\text{iter}} \) iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

Adjustment for multiple comparisons is possible with the argument \( \text{p.adjust.method} \). The latter must be an acronym of one of the available adjustment methods of the \( \text{p.adjust} \) function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "Holm" and "BH") perform best for DIF purposes. See \( \text{p.adjust} \) function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if \( \text{purify} \) is set to \( \text{TRUE} \)). By default it is \( \text{NULL} \) so that no anchor item is specified.

The output of the \( \text{difMH} \), as displayed by the \( \text{print.MH} \) function, can be stored in a text file provided that \( \text{save.output} \) is set to \( \text{TRUE} \) (the default value \( \text{FALSE} \) does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

The \( \text{plot.MH} \) function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the color are fixed by the usual \( \text{pch} \) and \( \text{col} \) arguments. Option \( \text{number} \) permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing \( \text{save.plot} \) to \( \text{TRUE} \) allows this process. The figure is defined through the components of \( \text{save.options} \). The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file. Note that no plot is returned for exact inference.

**Value**

A list of class "MH" with the following arguments:

- \( \text{mh} \) the values of the Mantel-Haenszel DIF statistics (either exact or asymptotic).
- \( \alpha_{\text{MH}} \) the values of the mantel-Haenszel estimates of common odds ratios. Returned only if \( \text{exact} = \text{FALSE} \).
- \( \text{varLambda} \) the values of the variances of the log odds-ratio statistics. Returned only if \( \text{exact} = \text{FALSE} \).
Pval the exact P-values of the exact MH test. Returned only if exact is TRUE.
MHstat the value of the MHstat argument. Returned only if exact is FALSE.
alpha the value of alpha argument.
thr the threshold (cut-score) for DIF detection. Returned only if exact is FALSE.
DIFitems either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
correct the value of correct option.
exact the value of exact option.
p.adjust.method the value of the p.adjust.method argument.
adjusted.p either NULL or the vector of adjusted p-values for multiple comparisons.
purification the value of purify option.
nrPur the number of iterations in the item purification process. Returned only if purify is TRUE.
difPur a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the \(i\)-th row refer to items which were classified respectively as non-DIF and DIF items at the \((i-1)\)-th step. The first row corresponds to the initial classification of the items. Returned only if purify is TRUE.
convergence logical indicating whether the iterative item purification process stopped before the maximal number nrIter of allowed iterations. Returned only if purify is TRUE.
names the names of the items.
anchor.names the value of the anchor argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References


See Also

`mantelHaenszel, dichoDif, p.adjust`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)

# Excluding the "Anger" variable
verbal <- verbal[colnames(verbal) != "Anger"]

# Three equivalent settings of the data matrix and the group membership
r <- difMH(verbal, group = 25, focal.name = 1)
difMH(verbal, group = "Gender", focal.name = 1)
difMH(verbal[,1:24], group = verbal[,25], focal.name = 1)

# With log odds-ratio statistic
```
difRaju

Raju’s area DIF method

Description

Performs DIF detection using Raju’s area method.

Usage

difRaju(Data, group, focal.name, model, c = NULL, engine = "ltm", discr = 1, irtParam = NULL, same.scale = TRUE, anchor = NULL, alpha = 0.05, signed = FALSE, purify = FALSE, nrIter = 10, p.adjust.method = NULL, save.output = FALSE, output = c("out","default"))
## S3 method for class 'Raj'

```r
print(x, ...)  
```

## S3 method for class 'Raj'

```r
plot(x, pch = 8, number = TRUE, col = "red", save.plot = FALSE,  
     save.options = c("plot","default","pdf"), ...)
```

### Arguments

- **Data**
  - numeric: either the data matrix only, or the data matrix plus the vector of group membership. See **Details**.

- **group**
  - numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See **Details**.

- **focal.name**
  - numeric or character indicating the level of group which corresponds to the focal group.

- **model**
  - character: the IRT model to be fitted (either "1PL", "2PL" or "3PL").

- **c**
  - optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See **Details**.

- **engine**
  - character: the engine for estimating the 1PL model, either "ltm" (default) or "lme".

- **discr**
  - either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1PL" and engine is "ltm". See **Details**.

- **irtParam**
  - matrix with $2J$ rows (where $J$ is the number of items) and at most 9 columns containing item parameters estimates. See **Details**.

- **same.scale**
  - logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See **Details**.

- **anchor**
  - either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See **Details**.

- **alpha**
  - numeric: significance level (default is 0.05).

- **signed**
  - logical: should the Raju's statistics be computed using the signed (TRUE) or unsigned (FALSE, default) area? See **Details**.

- **purify**
  - logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

- **nrIter**
  - numeric: the maximal number of iterations in the item purification process (default is 10).

- **p.adjust.method**
  - either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See **Details**.

- **save.output**
  - logical: should the output be saved into a text file? (Default is FALSE).

- **output**
  - character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See **Details**.

- **x**
  - the result from a Raj class object.
Raju’s area method (Raju, 1988, 1990) allows for detecting uniform or non-uniform differential item functioning by setting an appropriate item response model. The input can be of two kinds: either by displaying the full data, the group membership and the model, or by giving the item parameter estimates (with the option irtParam). Both can be supplied, but in this case only the parameters in irtParam are used for computing Raju’s statistic.

By default, the Raju’s Z statistics are obtained by using the unsigned areas between the ICCs. However, these statistics can also be computed using the signed areas, by setting the argument signed to TRUE (default value is FALSE). See rajuz for further details.

The data is a matrix whose rows correspond to the subjects and columns to the items. In addition, data can hold the vector of group membership. If so, group indicates the column of data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded for item parameter estimation.

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

If the model is not the 1PL model, or if engine is equal to “ltm”, the selected IRT model is fitted using marginal maximum likelihood by means of the functions from the ltm package (Rizopoulos, 2006). Otherwise, the 1PL model is fitted as a generalized linear mixed model, by means of the glmer function of the lme4 package (Bates and Maechler, 2009).

With the "1PL" model and the "ltm" engine, the common discrimination parameter is set equal to 1 by default. It is possible to fix another value through the argument discr. Alternatively, this common discrimination parameter can be estimated (though not returned) by fixing discr to NULL.

The 3PL model can be fitted either unconstrained (by setting c to NULL) or by fixing the pseudo-guessing values. In the latter case, the argument c holds either a numeric vector of same length of the number of items, with one value per item pseudo-guessing parameter, or a single value which is duplicated for all the items. If c is different from NULL then the 3PL model is always fitted (whatever the value of model).

The irtParam matrix has a number of rows equal to twice the number of items in the data set. The first J rows refer to the item parameter estimates in the reference group, while the last J ones correspond to the same items in the focal group. The number of columns depends on the selected IRT model: 2 for the 1PL model, 5 for the 2PL model, 6 for the constrained 3PL model and 9 for the unconstrained 3PL model. The columns of irtParam have to follow the same structure as the output of itemParEst command (the latter can actually be used to create the irtParam matrix).
In addition to the matrix of parameter estimates, one has to specify whether items in the focal group were rescaled to those of the reference group. If not, rescaling is performed by equal means anchoring (Cook and Eignor, 1991). Argument same.scale is used for this choice (default option is TRUE and assumes therefore that the parameters are already placed on the same scale).

The threshold (or cut-score) for classifying items as DIF is computed as the quantile of the standard normal distribution with lower-tail probability of $1 - \alpha/2$.

Item purification can be performed by setting purify to TRUE. In this case, the purification occurs in the equal means anchoring process. Items detected as DIF are iteratively removed from the set of items used for equal means anchoring, and the procedure is repeated until either the same items are identified twice as functioning differently, or when n.iter iterations have been performed. In the latter case a warning message is printed. See Candell and Drasgow (1988) for further details.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. The latter must be an acronym of one of the available adjustment methods of the p.adjust function. According to Kim and Oshima (2013), Holm and Benjamini-Hochberg adjustments (set respectively by "holm" and "bh") perform best for DIF purposes. See p.adjust function for further details. Note that item purification is performed on original statistics and p-values; in case of adjustment for multiple comparisons this is performed after item purification.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to rescale the item parameters on a common metric. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified. If item parameters are provided thorough the irtParam argument and if they are on the same scale (i.e. if same.scale is TRUE), then anchor items are not used (even if they are specified).

Under the 1PL model, the displayed output also proposes an effect size measure, which is $-2.35$ times the difference between item difficulties of the reference group and the focal group (Penfield and Camilli, 2007, p. 138). This effect size is similar Mantel-Haenszel's $\Delta_{MH}$ effect size, and the ETS delta scale is used to classify the effect sizes (Holland and Thayer, 1985).

The output of the difRaju, as displayed by the print.Raju function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string; see the Examples section for an illustration.

The plot.Raju function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the color are fixed by the usual pch and col arguments. Option number permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing save.plot to TRUE allows this process. The figure is defined through the components of save.options. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.
Value

A list of class "Raj" with the following arguments:

- **RajuZ**: the values of the Raju's statistics.
- **alpha**: the value of alpha argument.
- **thr**: the threshold (cut-score) for DIF detection.
- **DIFitems**: either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
- **signed**: the value of the signed argument.
- **p.adjust.method**: the value of the `p.adjust.method` argument.
- **adjusted.p**: either NULL or the vector of adjusted p-values for multiple comparisons.
- **purification**: the value of purify option.
- **nrPur**: the number of iterations in the item purification process. Returned only if purify is TRUE.
- **difPur**: a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the i-th row refer to items which were classified respectively as non-DIF and DIF items at the (i-1)-th step. The first row corresponds to the initial classification of the items. Returned only if purify is TRUE.
- **convergence**: logical indicating whether the iterative item purification process stopped before the maximal number `nriter` of allowed iterations. Returned only if purify is TRUE.
- **model**: the value of model argument.
- **c**: The value of the `c` argument.
- **engine**: The value of the engine argument.
- **discr**: the value of the `discr` argument.
- **itemParInit**: the matrix of initial parameter estimates, with the same format as `irtParam` either provided by the user (through `irtParam`) or estimated from the data (and displayed without rescaling).
- **itemParFinal**: the matrix of final parameter estimates, with the same format as `irtParam`, obtained after item purification. Returned only if purify is TRUE.
- **estPar**: a logical value indicating whether the item parameters were estimated (TRUE) or provided by the user (FALSE).
- **names**: the names of the items.
- **anchor.names**: the value of the anchor argument.
- **save.output**: the value of the `save.output` argument.
- **output**: the value of the output argument.
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References


See Also

RajuZ, itemParEst, dichoDif
Examples

## Not run:

```r
# Loading of the verbal data
data(verbal)
attach(verbal)

# Excluding the "Anger" variable
verbal <- verbal[, colnames(verbal) != "Anger"]

# Three equivalent settings of the data matrix and the group membership
# (1PL model, "ltm" engine)
difRaju(verbal, group = 25, focal.name = 1, model = "1PL")
difRaju(verbal[, 1:24], group = verbal[, 25], focal.name = 1, model = "1PL")

c <- c(1, 2)
difRaju(verbal[, c(1, 2)], group = verbal[, 25], focal.name = 1, model = "1PL")

c <- c(1, 2)
difRaju(verbal[, c(2, 1)], group = verbal[, 25], focal.name = 1, model = "1PL")

# Multiple comparisons adjustment using Benjamini-Hochberg method
difRaju(verbal, group = 25, focal.name = 1, model = "1PL", p.adjust.method = "BH")

# With signed areas
difRaju(verbal, group = 25, focal.name = 1, model = "1PL", signed = TRUE)

c <- c(1, 2)
difRaju(verbal[, c(1, 2)], group = verbal[, 25], focal.name = 1, model = "1PL", signed = TRUE)

c <- c(1, 2)
difRaju(verbal[, c(2, 1)], group = verbal[, 25], focal.name = 1, model = "1PL", signed = TRUE)

# With items 1 to 5 set as anchor items
difRaju(verbal, group = 25, focal.name = 1, model = "1PL", anchor = 1:5)

# (1PL model, "lme4" engine)
difRaju(verbal, group = "Gender", focal.name = 1, model = "1PL", engine = "lme4")

# 2PL model, signed and unsigned areas
difRaju(verbal, group = "Gender", focal.name = 1, model = "2PL")
difRaju(verbal, group = "Gender", focal.name = 1, model = "2PL", signed = TRUE)

# 3PL model with all pseudo-guessing parameters constrained to 0.05
# Signed and unsigned areas
difRaju(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05)
difRaju(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05, signed = TRUE)

# Same models, with item purification
difRaju(verbal, group = "Gender", focal.name = 1, model = "1PL", purify = TRUE)
difRaju(verbal, group = "Gender", focal.name = 1, model = "2PL", purify = TRUE)
difRaju(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05, purify = TRUE)

# With signed areas

difRaju(verbal, group = "Gender", focal.name = 1, model = "1PL", purify = TRUE, signed = TRUE)
difRaju(verbal, group = "Gender", focal.name = 1, model = "2PL", purify = TRUE, signed = TRUE)
difRaju(verbal, group = "Gender", focal.name = 1, model = "3PL", c = 0.05, purify = TRUE, signed = TRUE)
```
## difStd

### Standardization DIF method

**Description**

Performs DIF detection using standardization method.
difStd

Usage

difStd(Data, group, focal.name, anchor = NULL, stdWeight = "focal",
        thrSTD = 0.1, purify = FALSE, nrIter = 10, save.output = FALSE,
        output = c("out", "default"))

## S3 method for class 'PDIF'
print(x, ...)
## S3 method for class 'PDIF'
plot(x, pch = 8, number = TRUE, col = "red", save.plot = FALSE,
     save.options = c("plot", "default", "pdf"), ...)

Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.
group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
focal.name numeric or character indicating the level of group which corresponds to the focal group.
anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.
stdWeight character: the type of weights used for the standardized P-DIF statistic. Possible values are "focal" (default), "reference" and "total". See Details.
thrSTD numeric: the threshold (cut-score) for standardized P-DIF statistic (default is 0.10).
purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
nrIter numeric: the maximal number of iterations in the item purification process (default is 10).
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
x the result from a PDIF class object.
pch, col type of usual pch and col graphical options.
number logical: should the item number identification be printed (default is TRUE).
save.plot logical: should the plot be saved into a separate file? (default is FALSE).
save.options character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.
...
other generic parameters for the plot or the print functions.
Details

The method of standardization (Dorans and Kulick, 1986) allows for detecting uniform differential item functioning without requiring an item response model approach.

The data is a matrix whose rows correspond to the subjects and columns to the items. In addition, data can hold the vector of group membership. If so, group indicates the column of data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument focal.name.

The threshold (or cut-score) for classifying items as DIF has to be set by the user by the argument thrstd. Default value is 0.10 but Dorans (1989) also recommends value 0.05. For this reason it is not possible to provide asymptotic p-values.

The weights for computing the standardized P-DIF statistics are defined through the argument stdweight, with possible values "focal" (default value), "reference" and "total". See stdPDIFF for further details.

In addition, two types of effect sizes are displayed. The first one is obtained from the standardized P-DIF statistic itself. According to Dorans, Schmitt and Bleistein (1992), the effect size of an item is classified as negligible if $|St - P - DIF| \leq 0.05$, moderate if $0.05 \leq |St - P - DIF| \leq 0.10$, and large if $|St - P - DIF| \geq 0.10$. The second one is based on the transformation to the ETS Delta Scale (Holland and Thayer, 1985) of the standardized 'alpha' values (Dorans, 1989; Holland, 1985). The values of the effect sizes, together with the Dorans, Schmitt and Bleistein (DSB) and the ETS Delta scale (ETS) classification, are printed with the output.

Item purification can be performed by setting purify to TRUE. Purification works as follows: if at least one item was detected as functioning differently at some step of the process, then the data set of the next step consists in all items that are currently anchor (DIF free) items, plus the tested item (if necessary). The process stops when either two successive applications of the method yield the same classifications of the items (Clauser and Mazor, 1998), or when nriter iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

A pre-specified set of anchor items can be provided through the anchor argument. It must be a vector of either item names (which must match exactly the column names of data argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the test score (matching criterion), including also the tested item. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if purify is set to TRUE). By default it is NULL so that no anchor item is specified.

The output of the difStd, as displayed by the print.PDIFF function, can be stored in a text file provided that save.output is set to TRUE (the default value FALSE does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the output argument (default name is "out"), and the path for saving the text file can be given through the second component of output. The default value is "default", meaning that the file
will be saved in the current working directory. Any other path can be specified as a character string: see the Examples section for an illustration.

The `plot.PDIF` function displays the DIF statistics in a plot, with each item on the X axis. The type of point and the color are fixed by the usual `pch` and `col` arguments. Option `number` permits to display the item numbers instead. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing `save.plot` to TRUE allows this process. The figure is defined through the components of `save.options`. The first two components perform similarly as those of the `output` argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

Value

A list of class "PDIF" with the following arguments:

- `PDIF`: the values of the standardized P-DIF statistics.
- `stdAlpha`: the values of the standardized alpha values (for effect sizes computation).
- `alpha`: the value of `alpha` argument.
- `thr`: the value of the `thrSTD` argument.
- `DIFitems`: either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
- `purification`: the value of `purify` option.
- `nrPur`: the number of iterations in the item purification process. Returned only if `purify` is TRUE.
- `difPur`: a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the `i`-th row refer to items which were classified respectively as non-DIF and DIF items at the `(i-1)`-th step. The first row corresponds to the initial classification of the items. Returned only if `purify` is TRUE.
- `convergence`: logical indicating whether the iterative item purification process stopped before the maximal number `nriter` of allowed iterations. Returned only if `purify` is TRUE.
- `names`: the names of the items.
- `anchor.names`: the value of the `anchor` argument.
- `stdWeight`: the value of the `stdWeight` argument.
- `save.output`: the value of the `save.output` argument.
- `output`: the value of the `output` argument.

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References


See Also

stdPDIF, dichoDif

Examples

## Not run:

# Loading of the verbal data
data(verbatim)

# Excluding the "Anger" variable
verbatim<verbatim[, !colnames(verbatim) %in% c("Anger")]

# Three equivalent settings of the data matrix and the group membership
difStd(verbatim, group = 25, focal.name = 1)
difStd(verbatim, group = "Gender", focal.name = 1)
difStd(verbatim[,1:24], group = verbal[,25], focal.name = 1)

# With other weights
difStd(verbatim, group = "Gender", focal.name = 1, stdWeight = "reference")
difStd(verbatim, group = "Gender", focal.name = 1, stdWeight = "total")
# With item purification
difStd(verb, group = "Gender", focal.name = 1, purify = TRUE)
difStd(verb, group = "Gender", focal.name = 1, purify = TRUE, nrIter = 5)

# With items 1 to 5 set as anchor items
difStd(verb, group = "Gender", focal.name = 1, anchor = 1:5)
difStd(verb, group = "Gender", focal.name = 1, anchor = 1:5, purify = TRUE)

# With detection threshold of 0.05
difStd(verb, group = "Gender", focal.name = 1, thrSTD = 0.05)

# Saving the output into the "STDresults.txt" file (and default path)
r <- difStd(verb, group = 25, focal.name = 1, save.output = TRUE, output = c("STDresults", "default"))

# Graphical devices
plot(r)

# Plotting results and saving it in a PDF figure
plot(r, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:/Program Files/"
plot(r, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

## End(Not run)

---

difTID

**Transformed Item Difficulties (TID) DIF method**

**Description**

Performs DIF detection using Transformed Item Difficulties (TID) method.

**Usage**

difTID(Data, group, focal.name, anchor = NULL, props = NULL, thrTID = 1.5,
       purify = FALSE, nrIter = 10, save.output = FALSE,
       output = c("out", "default"))

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

## S3 method for class 'TID'
plot(x, plot = "dist", pch = 8, number = TRUE, col = "red",
     save.plot = FALSE, save.options = c("plot", "default", "pdf"), ...)

Arguments

- **Data**: numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.
- **group**: numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
- **focal.name**: numeric or character indicating the level of group which corresponds to the focal group.
- **anchor**: either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.
- **props**: either NULL (default) or a two-column matrix with proportions of success in the reference group and the focal group. See Details.
- **thrTID**: numeric: the threshold for detecting DIF items (default is 1.5).
- **purify**: logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
- **nrIter**: numeric: the maximal number of iterations in the item purification process (default is 10).
- **save.output**: logical: should the output be saved into a text file? (Default is FALSE).
- **output**: character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.
- **x**: the result from a TID class object.
- **plot**: character: either "dist" (default) to display the perpendicular distances, or "delta" for the Delta plot. See Details.
- **pch, col**: type of usual pch and col graphical options.
- **number**: logical: should the item number identification be printed (default is TRUE).
- **save.plot**: logical: should the plot be saved into a separate file? (default is FALSE).
- **save.options**: character: a vector of three components. The first component is the name of the output file, the second component is either the file path or "default" (default value), and the third component is the file extension, either "pdf" (default) or "jpeg". See Details.
- **...**: other generic parameters for the plot or the print functions.

Details

The Transformed Item Difficulties (TID) method, also known as Angoff’s Delta method (Angoff, 1982; Angoff and Ford, 1973) allows for detecting uniform differential item functioning without requiring an item response model approach.

The **Data** is a matrix whose rows correspond to the subjects and columns to the items. In addition, **Data** can hold the vector of group membership. If so, **group** indicates the column of **Data** which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, **group** must be a vector of same length as nrow(**Data**).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from the computation of proportions of success.
The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the value of the argument `focal.name`.

Alternatively, one can provide the matrix of proportions of success in for each item in each group. This matrix must have the same format as that provided to the `trItemDiff` function; see the corresponding help file for further details.

The threshold (or cut-score) for classifying items as DIF must be supplied through the `thrTID` argument. The default value is 1.5, as being one of the most commonly used values (e.g., Facon and Nuchadee, 2010; Muniz, Hambleton, and Xing, 2001; Robin, Sirecci, and Hambleton, 2003). Other values can be specified instead.

Item purification can be performed by setting `purify` to `TRUE`. Purification works as follows: if at least one item was detected as functioning differently at some step of the process, then the intercept and slope parameters of the major axis are re-computed by discarding all items previously flagged as DIF. All perpendicular distances are then re-computed for all items. The process stops when either two successive applications of the method yield the same classifications of the items, or when `nIter` iterations are run without obtaining two successive identical classifications. In the latter case a warning message is printed.

A pre-specified set of anchor items can be provided through the `anchor` argument. It must be a vector of either item names (which must match exactly the column names of `data` argument) or integer values (specifying the column numbers for item identification). In case anchor items are provided, they are used to compute the intercept and slope parameters of the major axis. None of the anchor items are tested for DIF: the output separates anchor items and tested items and DIF results are returned only for the latter. Note also that item purification is not activated when anchor items are provided (even if `purify` is set to `TRUE`). By default it is `NULL` so that no anchor item is specified.

The output of the `difTID`, as displayed by the `print.TID` function, can be stored in a text file provided that `save.output` is set to `TRUE` (the default value `FALSE` does not execute the storage). In this case, the name of the text file must be given as a character string into the first component of the `output` argument (default name is "out"), and the path for saving the text file can be given through the second component of `output`. The default value is "default", meaning that the file will be saved in the current working directory. Any other path can be specified as a character string: see the `Examples` section for an illustration.

Two types of plots are available through the `plot.TID` function. If the argument `plot` is set to "dist" (the default value), then the perpendicular distances are represented on the Y axis of a scatter plot, with each item on the X axis. If `plot` is set to "delta", the Delta plot is returned, that is, the scatter plot of pairs of Delta scores for each item, with the reference group on the X axis and the focal group on the Y axis. The type of point and the color are fixed by the usual `pch` and `col` arguments. Option `number` permits to display the item numbers instead. Detection thresholds are also printed. Also, the plot can be stored in a figure file, either in PDF or JPEG format. Fixing `save.plot` to `TRUE` allows this process. The figure is defined through the components of `save.options`. The first two components perform similarly as those of the output argument. The third component is the figure format, with allowed values "pdf" (default) for PDF file and "jpeg" for JPEG file.

**Value**

A list of class "TID" with the following arguments:
Dj the values of the perpendicular distances.
prop the matrix of proportions of success.
delta the matrix of Delta scores, in the same format as the prop matrix.
axisPar a vector of length two with the intercept and slope parameters of the major axis of Delta points.
thr the threshold (cut-score) for DIF detection.
DIFitems either the column indicators of the items which were detected as DIF items, or "No DIF item detected".
purification the value of purify option.
nrPur the number of iterations in the item purification process. Returned only if purify is TRUE.
difPur a binary matrix with one row per iteration in the item purification process and one column per item. Zeros and ones in the i-th row refer to items which were classified respectively as non-DIF and DIF items at the (i-1)-th step. The first row corresponds to the initial classification of the items. Returned only if purify is TRUE.
convergence logical indicating whether the iterative item purification process stopped before the maximal number nrIter of allowed iterations. Returned only if purify is TRUE.
names the names of the items.
anchor.names the value of the anchor argument.
save.output the value of the save.output argument.
output the value of the output argument.

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References
See Also

triItemDiff, dichoDiff

Examples

## Not run:

```r
# Loading of the "verbal" data
data(verbal)

# Excluding the "Anger" variable
verbal <- verbal[rownames(verbal) != "Anger"]

# Three equivalent settings of the data matrix and the group membership
r <- difTID(verbal, group = 25, focal.name = 1)
difTID(verbal, group = "Gender", focal.name = 1)
difTID(verbal[,1:24], group = verbal[,25], focal.name = 1)

# With item purification and threshold 1
r2 <- difTID(verbal, group = "Gender", focal.name = 1, purify = TRUE, thrTID = 1)

# With items 1 to 5 set as anchor items
difTID(verbal, group = "Gender", focal.name = 1, anchor = 1:5)
difTID(verbal, group = "Gender", focal.name = 1, anchor = 1:5, purify = TRUE)

# Saving the output into the "TIDresults.txt" file (and default path)
difTID(verbal, group = 25, focal.name = 1, save.output = TRUE,
output = c("TIDresults", "default"))

# Providing the proportions of success only
props <- cbind(colMeans(verbal[,25]==0,1:24),
colMeans(verbal[,25]==1,1:24))
difTID(prop = props)

# Graphical devices
plot(r2)
plot(r2, plot = "delta")

# Plotting results and saving it in a PDF figure
plot(r2, save.plot = TRUE, save.options = c("plot", "default", "pdf"))

# Changing the path, JPEG figure
path <- "c:\Program Files/"
plot(r2, save.plot = TRUE, save.options = c("plot", path, "jpeg"))

## End(Not run)
```
Comparison of DIF detection methods among multiple groups

Description
This function compares the specified DIF detection methods among multiple groups, with respect to the detected items.

Usage
```
(genDichoDif(Data, group, focal.names, method, anchor = NULL, match = "score", type = "both", criterion = "LRT", alpha = 0.05, model = "2PL", c = NULL, engine = "ltm", discr = 1, irtParam = NULL, nrFocal = 2, same.scale = TRUE, purify = FALSE, nrIter = 10, p.adjust.method = NULL, save.output = FALSE, output = c("out", "default")))
```

Arguments
- **Data**: numeric: either the data matrix only, or the data matrix plus the vector of group membership. See **Details**.
- **group**: numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See **Details**.
- **focal.names**: numeric or character vector indicating the levels of group which correspond to the focal groups.
- **method**: character: the name of the selected methods. See **Details**.
- **anchor**: either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See **Details**.
- **match**: specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of Data. See **Details**.
- **type**: a character string specifying which DIF effects must be tested (default is "both"). See **Details**.
- **criterion**: character: the type of test statistic used to detect DIF items with generalized logistic regression. Possible values are "LRT" (default) and "Wald". See **Details**.
- **alpha**: numeric: significance level (default is 0.05).
- **model**: character: the IRT model to be fitted (either "1PL", "2PL" or "3PL"). Default is "2PL".
- **c**: optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See **Details**.
- **engine**: character: the engine for estimating the 1PL model, either "ltm" (default) or "lme4".
discr

either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1PL" and engine is "ltm". See Details.

irtParam

matrix with 2J rows (where J is the number of items) and at most 9 columns containing item parameters estimates. See Details.

nrFocal

numeric: the number of focal groups (default is 2).

same.scale

logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See Details.

purify

logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).

nrIter

numeric: the maximal number of iterations in the item purification process (default is 10).

p.adjust.method

either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.

save.output

logical: should the output be saved into a text file? (Default is FALSE).

output

character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

x

result from a genDichoDif class object.

... other generic parameters for the print function.

Details

genDichoDif is a generic function which calls one or several DIF detection methods among multiple groups, and summarize their output. The possible methods are: "GMH" for Generalized Mantel-Haenszel (Penfield, 2001), "genLogistic" for generalized logistic regression (Magis, Raiche Beland and Gerard, 2010) and "genLord" for generalized Lord's chi-square test (Kim, Cohen and Park, 1995).

If method has a single component, the output of genDichoDif is exactly the one provided by the method itself. Otherwise, the main output is a matrix with one row per item and one column per method. For each specified method and related arguments, items detected as DIF and non-DIF are respectively encoded as "DIF" and "NoDIF". When printing the output an additional column is added, counting the number of times each item was detected as functioning differently (Note: this is just an informative summary, since the methods are obviously not independent for the detection of DIF items).

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from either the computation of the sum-scores, the fitting of the logistic models or the IRT models (according to the method).

The vector of group membership must hold at least three different values, either as numeric or character. The focal groups are defined by the values of the argument focal.names.
For the generalized logistic regression method, the argument type permits to test either both uniform and nonuniform effects simultaneously (with type=“both”), only uniform DIF effect (with type=“udif”) or only nonuniform DIF effect (with type=“nudif”). Furthermore, the argument criterion defines which test must be used, either the Wald test (“Wald”) or the likelihood ratio test (“LRT”). Moreover, the matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value “score” and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix. See difGenLord for further details.

For generalized Lord method, one can specify either the IRT model to be fitted (by means of model, c, engine and discr arguments), or the item parameter estimates with arguments irtparam and same.scale. See difGenLord for further details.

The threshold for detecting DIF items depends on the method and is depending on the significance level set by alpha.

Item purification can be requested by specifying purify option to TRUE. Recall that item purification process is slightly different for IRT and for non-IRT based methods. See the corresponding methods for further information.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. See the corresponding methods for further information.

A pre-specified set of anchor items can be provided through the anchor argument. For non-IRT methods, anchor items are used to compute the test score (as matching criterion). For IRT methods, anchor items are used to rescale the item parameters on a common metric. See the corresponding methods for further information.

The output of the genDichoDif function can be stored in a text file by fixing save.output and output appropriately. See the help file of selectGenDif function (or any other DIF method) for further information.

Value

Either the output of one of the DIF detection methods, or a list of class "genDichoDif" with the following arguments:

- **DIF**
  a character matrix with one row per item and whose columns refer to the different specified detection methods. See Details.
- **alpha**
  the significance level alpha.
- **method**
  the value of method argument.
- **match**
  the value of match argument.
- **type**
  the value of type argument.
- **criterion**
  the value of the criterion argument.
- **model**
  the value of model option.
- **c**
  the value of c option.
- **engine**
  The value of the engine argument.
- **discr**
  the value of the discr argument.
irtParam the value of irtParam option.
same.scale the value of same.scale option.
p.adjust.method the value of the p.adjust.method argument.

purification the value of purify option.
nrPur an integer vector (of length equal to the number of methods) with the number of iterations in the purification process. Returned only if purify is TRUE.

convergence a logical vector (of length equal to the number of methods) indicating whether the iterative purification process converged. Returned only if purify is TRUE.

anchor.names the value of the anchor argument.

save.output the value of the save.output argument.

output the value of the output argument.

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References


See Also
difGMM, difGenLogistic, difGenLord
Examples

```r
## Not run:

# Loading of the verbal data
data(vern)  
attach(vern)

# Creating four groups according to gender ("Man" or "Woman") and trait anger score ("Low" or "High")
group <- rep("WomanLow", nrow(vern))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<=20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"

# New data set
Verbal <- cbind(vern[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")

# Comparing the three available methods
# with item purification
genDichoDif(Verbal, group = 25, focal.names = names, method = c("GMM", "genLogistic", "genLord"), purify = TRUE)

# Same analysis, but saving the output into the 'genDicho' file
genDichoDif(Verbal, group = 25, focal.names = names, method = c("GMM", "genLogistic", "genLord"), purify = TRUE, save.output = TRUE, output = c("genDicho", "default"))

## End(Not run)
```

genLogistik  

**Generalized logistic regression DIF statistic**

description

Calculates the "generalized logistic regression" likelihood-ratio or Wald statistics for DIF detection among multiple groups.

Usage

genLogistik(data, member, match = "score", anchor = 1:ncol(data),
type = "both", criterion = "LRT")
Arguments

data numeric: the data matrix (one row per subject, one column per item).
member numeric: the vector of group membership with zero and positive integer entries only. See Details.
match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of data. See Details.
anchor a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.
type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
criterion character: the type of test statistic used to detect DIF items. Possible values are "LRT" (default) and "Wald". See Details.

Details

This command computes the generalized logistic regression statistic (Magis, Raiche, Beland and Gerard, 2010) in the specific framework of differential item functioning among \((J + 1)\) groups and \(J\) is the number of focal groups. It forms the basic command of difGenLogistic and is specifically designed for this call.

The three possible models to be fitted are:

\[
M_0 : \logit(\pi_i) = \alpha + \beta X + \gamma_i + \delta_i X \\
M_1 : \logit(\pi_i) = \alpha + \beta X + \gamma_i \\
M_2 : \logit(\pi_i) = \alpha + \beta X
\]

where \(\pi_i\) is the probability of answering correctly the item in group \(i (i = 0, ..., J)\) and \(X\) is the matching criterion. Parameters \(\alpha\) and \(\beta\) are the common intercept and the slope of the logistic curves, while \(\gamma_i\) and \(\delta_i\) are group-specific parameters. For identification reasons the parameters \(\gamma_0\) and \(\delta_0\) of the reference group are set to zero. The set of parameters \(\{\gamma_i : i = 1, ..., J\}\) of the focal groups \((g = i)\) represents the uniform DIF effect across all groups, and the set of parameters \(\{\delta_i : i = 1, ..., n\}\) is used to model nonuniform DIF effect across all groups. The models are fitted with the \texttt{glm} function.

The matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix.

Two tests are available: the Wald test and the likelihood ratio test. With the likelihood ratio test, two nested models are fitted and compared by means of Wilks’ Lambda (or likelihood ratio) statistic (Wilks, 1938). With the Wald test, the model parameters are statistically tested using an appropriate contrast matrix. Each test is set with the criterion argument, with the values "LRT" and "Wald" respectively.
The argument type determines the type of DIF effect to be tested. The three possible values of type are: type="both" which tests the hypothesis $H_0: \gamma_i = \delta_i = 0$ for all $i$; type="nudif" which tests the hypothesis $H_0: \delta_i = 0$ for all $i$; and type="udif" which tests the hypothesis $H_0: \gamma_i = 0|\delta_i = 0$ for all $i$. In other words, type="both" tests for DIF (without distinction between uniform and nonuniform effects), while type="udif" and type="nudif" test for uniform and nonuniform DIF, respectively. Whatever the tested DIF effects, this is a simultaneous test of the equality of focal group parameters to zero.

The data are passed through the data argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values. They are discarded from the fitting of the logistic models (see glm for further details).

The vector of group membership, specified with member argument, must hold only zeros and positive integers. The value zero corresponds to the reference group, and each positive integer value corresponds to one focal group. At least two different positive integers must be supplied.

Option anchor sets the items which are considered as anchor items for computing the logistic regression DIF statistics. Items other than the anchor items and the tested item are discarded. anchor must hold integer values specifying the column numbers of the corresponding anchor items. It is mainly designed to perform item purification.

In addition to the results of the fitted models (model parameters, covariance matrices, test statistics), Nagelkerke's $R^2$ coefficients (Nagelkerke, 1991) are computed for each model and the output returns the differences in these coefficients. Such differences are used as measures of effect size by the difGenLogistic command; see Gomez-Benito, Dolores Hidalgo and Padilla (2009), Jodoin and Gierl (2001) and Zumbo and Thomas (1997).

### Value

A list with nine components:

- **stat**: the values of the generalized logistic regression DIF statistics (that is, the likelihood ratio test statistics).
- **R2M0**: the values of Nagelkerke's $R^2$ coefficients for the "full" model.
- **R2M1**: the values of Nagelkerke's $R^2$ coefficients for the "simpler" model.
- **deltaR2**: the differences between Nagelkerke's $R^2$ coefficients of the tested models. See Details.
- **parM0**: a matrix with one row per item and 2 + $J \times 2$ columns (where $J$ is the number of focal groups), holding successively the fitted parameters $\hat{\alpha}, \hat{\beta}, \hat{\gamma}_i$ and $\hat{\delta}_i$ ($i = 1, ..., J$) of the "full" model ($M_0$ if type="both" or type="nudif", $M_1$ if type="udif").
- **parM1**: the same matrix as parM0 but with fitted parameters for the "simpler" model ($M_1$ if type="nudif", $M_2$ if type="both" or type="udif").
- **covMat**: a 3-dimensional matrix of size $p \times p \times K$, where $p$ is the number of estimated parameters and $K$ is the number of items, holding the $p \times p$ covariance matrices of the estimated parameters (one matrix for each tested item).
- **criterion**: the value of the criterion argument.
- **match**: a character string, either "score" or "matching variable" depending on the match argument.
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References


See Also
difGenLogistic, genDichoDif

Examples

## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Creating four groups according to gender (0 or 1) and trait anger score
# ("Low" or "High")
# Reference group: women with low trait anger score (<=20)
group <- rep(0,nrow(verbal))
group[Anger>20 & Gender==0] <- 1
group[Anger<=20 & Gender==1] <- 2
group[Anger>20 & Gender==1] <- 3

# Testing both types of DIF simultaneously
# With all items
genLogistik(verb[,1:24], group)
genLogistik(verb[,1:24], group, criterion = "Wald")

# Removing item 6 from the set of anchor items
genLogistik(verb[,1:24], group, anchor = c(1:5, 7:24))
genLogistik(verb[,1:24], group, anchor = c(1:5, 7:24), criterion = "Wald")

# Testing nonuniform DIF effect
genLogistik(verb[,1:24], group, type = "nudif")
genLogistik(verb[,1:24], group, type = "nudif", criterion="Wald")

# Testing uniform DIF effect
genLogistik(verb[,1:24], group, type = "udif")
genLogistik(verb[,1:24], group, type = "udif", criterion="Wald")

# Using trait anger score as matching criterion
genLogistik(verb[,1:24], group, match = verbal[,25])

## End(Not run)

genLordChi2  

---

**Description**

Calculates the generalized Lord’s chi-squared statistics for DIF detection among multiple groups.

**Usage**

genLordChi2(irtParam, nrFocal)

**Arguments**

- **irtParam**: numeric: the matrix of item parameter estimates. See Details.
- **nrFocal**: numeric: the number of focal groups.

**Details**

This command computes the generalized Lord’s chi-squared statistic (Kim, Cohen and Park, 1995), also called the $Q_j$ statistics, in the specific framework of differential item functioning with multiple groups. It forms the basic command of difGenLord and is specifically designed for this call.
The irtparam matrix has a number of rows equal to the number of groups (reference and focal ones) times the number of items \( J \). The first \( J \) rows refer to the item parameter estimates in the reference group, while the next sets of \( J \) rows correspond to the same items in each of the focal groups. The number of columns depends on the selected IRT model: 2 for the 1PL model, 5 for the 2PL model, 6 for the constrained 3PL model and 9 for the unconstrained 3PL model. The columns of irtparam have to follow the same structure as the output of itemParEst command (the latter can actually be used to create the irtparam matrix).

In addition, the item parameters of the reference group and the focal groups must be placed on the same scale. This can be done by using itemRescale command, which performs equal means anchoring between two groups of item estimates (Cook and Eignor, 1991).

The number of focal groups has to be specified with argument nrFocal.

Value

A vector with the values of the generalized Lord’s chi-squared DIF statistics.

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References


See Also

itemParEst, itemRescale, difGenLord
# genMantelHaenszel

### Description

Calculates the generalized Mantel-Haenszel statistics for DIF detection among multiple groups.

### Usage

```
genMantelHaenszel(data, member, anchor = 1:ncol(data))
```
Arguments

data numeric: the data matrix (one row per subject, one column per item).

member numeric: the vector of group membership with zero and positive integer entries only. See Details.

anchor a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.

Details

This command computes the generalized Mantel-Haenszel statistic (Somes, 1986) in the specific framework of differential item functioning. It forms the basic command of difGMH and is specifically designed for this call.

The data are passed through the data argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership, specified with member argument, must hold only zeros and positive integers. The value zero corresponds to the reference group, and each positive integer value corresponds to one focal group. At least two different positive integers must be supplied.

Option anchor sets the items which are considered as anchor items for computing generalized Mantel-Haenszel statistics. Items other than the anchor items and the tested item are discarded. anchor must hold integer values specifying the column numbers of the corresponding anchor items. It is primarily designed to perform item purification.

Value

A vector with the values of the generalized Mantel-Haenszel DIF statistics.

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References


See Also

difGMH

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Creating four groups according to gender (0 or 1) and trait anger # score ("Low" or "High")
# Reference group: women with low trait anger score (<=20)
group <- rep(0, nrow(verbal))
group[Anger<=20 & Gender==0] <- 1
group[Anger<=20 & Gender==1] <- 2
group[Anger>20 & Gender==1] <- 3

# Without continuity correction
genMantelHaenszel(verbal[,1:24], group)

# Removing item 6 from the set of anchor items
genMantelHaenszel(verbal[,1:24], group, anchor = c(1:5, 7:24))

## End(Not run)
```

---

**itemPar1PL**  

*Item parameter estimation for DIF detection using Rasch (1PL) model*

**Description**

Fits the Rasch (1PL) model and returns related item parameter estimates.

**Usage**

```r
itemPar1PL(data, engine = "ltm", discr = 1)
```
Arguments

- **data**: numeric: the data matrix.
- **engine**: character: the engine for estimating the 1PL model, either "1tm" (default) or "1me4".
- **discr**: either NULL or a real positive value for the common discrimination parameter (default is 1). Not used if engine is "1me4". See Details.

Details

ItemPar1PL permits to get item parameter estimates from the Rasch or 1PL model. The output is ordered such that it can be directly used with the general itemParEst command, as well as the methods of Lord (difLord) and Raju (difRaju) and Generalized Lord's (difGenLord) to detect differential item functioning.

The data is a matrix whose rows correspond to the subjects and columns to the items.

Missing values are allowed but must be coded as NA values. They are discarded for item parameter estimation.

The estimation engine is set by the engine argument. By default (engine="1tm"), the Rasch model is fitted using marginal maximum likelihood, by means of the function rasch from the 1tm package (Rizopoulos, 2006). The other option, engine="1me4", permits to fit the Rasch model as a generalized linear mixed model, by means of the glmer function of the lme4 package (Bates and Maechler, 2009).

With the "1tm" engine, the common discrimination parameter is set equal to 1 by default. It is possible to fix another value through the argument discr. Alternatively, this common discrimination parameter can be estimated (though not returned) by fixing discr to NULL. See the functionalities of rasch command for further details.

Value

A matrix with one row per item and two columns, the first one with item parameter estimates and the second one with the related standard errors.

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References


See Also

itemPar2PL, itemPar3PL, itemPar3PLconst, itemParEst, difLord, difRaju, difGenLord

Examples

## Not run:

# Loading of the verbal data
data(verbal)

# Getting item parameter estimates ("ltm" engine)
itemPar1PL(verbal[, 1:24])

# Estimating the common discrimination parameter instead
itemPar1PL(verbal[, 1:24], discr = NULL)

# Getting item parameter estimates ("lme4" engine)
itemPar1PL(verbal[, 1:24], engine = "lme4")

## End(Not run)

---

**itemPar2PL**  
*Item parameter estimation for DIF detection using 2PL model*

Description

Fits the 2PL model and returns related item parameter estimates, standard errors and covariances between item parameters.

Usage

itemPar2PL(data)
Arguments

data numeric: the data matrix.

Details

itemPar2PL permits to get item parameter estimates from the 2PL model. The output is ordered such that it can be directly used with the general itemParEst command, as well as the methods of Lord (difLord) and Raju (difRaju) and Generalized Lord’s (difGenLord) to detect differential item functioning.

The data is a matrix whose rows correspond to the subjects and columns to the items.
Missing values are allowed but must be coded as NA values. They are discarded for item parameter estimation.

The 2PL model is fitted using marginal maximum likelihood by means of the functions from the ltm package (Rizopoulos, 2006).

Value

A matrix with one row per item and five columns: the estimates of item discrimination $a$ and difficulty $b$ parameters, the related standard errors $se(a)$ and $se(b)$, and the covariances $cov(a,b)$, in this order.

Note

The 2PL model is fitted under the linear parametrization in ltm, the covariance matrix is extracted with the vcov() function, and final standard errors and covariances are derived by the Delta method. See Rizopoulos (2006) for further details, and the Note.pdf document in the difR package for mathematical details.

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References


See Also

`itemPar1PL, itemPar3PL, itemPar3PLconst, itemParEst, difLord, difRaju, difGenLord`

Examples

```r
## Not run:

# Loading of the verbal data
data(verb)

# Getting item parameter estimates
itemPar2PL(verb[,1:24])

## End(Not run)
```

---

**itemPar3PL**

*Item parameter estimation for DIF detection using 3PL model*

Description

Fits the 3PL model and returns related item parameter estimates.

Usage

```r
itemPar3PL(data)
```

Arguments

data numeric: the data matrix.

Details

`itemPar3PL` permits to get item parameter estimates from the 3PL model. The output is ordered such that it can be directly used with the general `itemParEst` command, as well as the methods of Lord (`difLord`) and Raju (`difRaju`) and Generalized Lord’s (`difGenLord`) to detect differential item functioning.

The output consists of nine columns which are displayed in the following order. The first three columns hold the estimates of item discrimination $a$, difficulty $b$ and pseudo-guessing $c$ parameters. In the next three columns one can find the related standard errors $se(a)$, $se(b)$ and $se(c)$. Eventually, the last three columns contain the covariances between item parameters, respectively $cov(a,b)$, $cov(a,c)$ and $cov(b,c)$.

The data is a matrix whose rows correspond to the subjects and columns to the items.
Missing values are allowed but must be coded as NA values. They are discarded for item parameter estimation.

The 3PL model is fitted using marginal maximum likelihood by means of the functions from the ltm package (Rizopoulos, 2006).

Value

A matrix with one row per item and nine columns. See Details.

Note

The 3PL model is fitted under the linear parametrization in tpm, the covariance matrix is extracted with the vcov() function, and final standard errors and covariances are derived by the Delta method. See Rizopoulos (2006) for further details, and the Note.pdf document in the difR package for mathematical details.

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References


See Also

itemPar1PL, itemPar2PL, itemPar3PLconst, itemParEst, difLord, difRaju, difGenLord
Examples

```r
## Not run:

# Loading of the verbal data
data(verb)

# Getting item parameter estimates
itemPar3PL(verb[,1:24])

## End(Not run)
```

---

**itemPar3PLconst**  
*Item parameter estimation for DIF detection using constrained 3PL model*

**Description**

Fits the 3PL model with constrained pseudo-guessing values and returns related item parameter estimates.

**Usage**

```r
itemPar3PLconst(data, c=rep(0,ncol(data)))
```

**Arguments**

- `data`: numeric; the data matrix.
- `c`: numeric value or vector of constrained pseudo-guessing parameters. See **Details**.

**Details**

`itemPar3PLconst` permits to get item parameter estimates from the 3PL model for which the pseudo-guessing parameters are constrained to some fixed values. The output is ordered such that it can be directly used with the general `itemParEst` command, as well as the methods of Lord (`difLord`) and Raju (`difRaju`) and Generalized Lord's (`difGenLord`) to detect differential item functioning.

The output is similar to that of `itemPar2PL` method to fit the 2PL model; an additional column is included and holds the fixed pseudo-guessing parameter values.

The data is a matrix whose rows correspond to the subjects and columns to the items.

Missing values are allowed but must be coded as NA values. They are discarded for item parameter estimation.

The argument `c` can be either a single numeric value or a numeric vector of the same length of the number of items. In the former case, the pseudo-guessing parameters are considered to be all identical to the given `c` value; otherwise `c` is directly used to constraint these parameters.

The constrained 3PL model is fitted using marginal maximum likelihood by means of the functions from the `ltm` package (Rizopoulos, 2006).
Value

A matrix with one row per item and six columns: the item discrimination \( a \) and difficulty estimates \( b \), the corresponding standard errors \( se(a) \) and \( se(b) \), the covariances \( cov(a,b) \) and the constrained pseudo-guessing values \( c \).

Note

The constrained 3PL model is fitted under the linear parametrization in \( \text{tpm} \), the covariance matrix is extracted with the \( \text{vcov()} \) function, and final standard errors and covariances are derived by the Delta method. See Rizopoulos (2006) for further details, and the Note.pdf document in the difR package for mathematical details.

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References


See Also

`itemPar1PL, itemPar2PL, itemPar3PL, itemParEst, difLord, difRaju, difGenLord`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)

# Constraining all pseudo-guessing parameters to be equal to 0.05
```
itemPar3PLconst(verbai[,1:24], c = 0.05)

# Constraining pseudo-guessing values to 0.1 for the first 10 items,
# and to 0.05 for the remaining ones
itemPar3PLconst(verbai[,1:24], c = c(rep(0.1, 10), rep(0.05, 14)))

## End(Not run)

---

**itemParEst**

*Item parameter estimation for DIF detection*

**Description**

Fits a specified logistic IRT model and returns related item parameter estimates.

**Usage**

```r
itemParEst(data, model, c = NULL, engine = "ltm", discr = 1)
```

**Arguments**

- **data**
  - numeric: the data matrix.
- **model**
  - character: the IRT model to be fitted (either "1PL", "2PL" or "3PL").
- **c**
  - optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See **Details**.
- **engine**
  - character: the engine for estimating the 1PL model, either "ltm" (default) or "lme4".
- **discr**
  - either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if `model` is "1PL" and `engine` is "ltm". See **Details**.

**Details**

`itemParEst` permits to get item parameter estimates of some pre-specified logistic IRT model, together with estimates of the standard errors and the covariances between item parameters, if any. The output is ordered such that it can be directly used with the methods of Lord (difLord) and Raju (difRaju) and Generalized Lord’s (difGenLord) to detect differential item functioning.

The data is a matrix whose rows correspond to the subjects and columns to the items.

Missing values are allowed but must be coded as `NA` values. They are discarded for item parameter estimation.

If the model is not the 1PL model, or if `engine` is equal to "ltm", the selected IRT model is fitted using marginal maximum likelihood by means of the functions from the `ltm` package (Rizopoulos, 2006). Otherwise, the 1PL model is fitted as a generalized linear mixed model, by means of the `glmer` function of the `lme4` package (Bates and Maechler, 2009). With the "ltm" engine, the common discrimination parameter can be either fixed to a constant value using the `discr` argument,
or it can be estimated (though not returned) by specifying `discr` to `NULL`. The default value of the common discrimination is 1.

The 3PL model can be fitted either unconstrained or by fixing the pseudo-guessing values. In the latter case the argument `c` holds either a numeric vector of same length of the number of items, with one value per item pseudo-guessing parameter, or a single value which is duplicated for all the items. If `c` is different from `NULL` then the 3PL model is always fitted (whatever the value of `model`). Each row of the output matrix corresponds to one item of the data set; the number of columns depends on the fitted model. At most, nine columns are produced, with the unconstrained 3PL model. The order of the columns is the following: first, the estimates of item discrimination `a`, difficulty `b` and pseudo-guessing `c`; second, the corresponding standard errors `se(a)`, `se(b)` and `se(c)`; finally, the covariances between the item parameters, `cov(a,b)`, `cov(a,c)` and `cov(b,c)`.

If the 2PL model is fitted, only five columns are displayed: `a`, `b`, `se(a)`, `se(b)` and `cov(a,b)`. In case of the 1PL model, only `b` and `se(b)` are returned. If the constrained 3PL is considered, the output matrix holds six columns, the first five being identical to those from the 2PL model, and the last one holds the fixed pseudo-guessing parameters.

**Value**

A matrix with one row per item and at most nine columns, with item parameter estimates, standard errors and covariances, if any. See **Details**.

**Note**

Whenever making use of the `ltm` package to fit the IRT models, the linear parametrization is used, the covariance matrix is extracted with the `vcov()` function, and final standard errors and covariances are derived by the Delta method. See Rizopoulos (2006) for further details, and the `note.pdf` document in the `difR` package for mathematical details.

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**References**


See Also

`itempar1pl, itempar2pl, itempar3pl, itempar3pconst, difLord, difRaju, difGenLord`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)

# Estimation of the item parameters (1PL model, "ltm" engine)
items.1PL <- itemParEst(verbatim[,1:24], model = "1PL")

# Estimation of the item parameters (1PL model, "ltm" engine,
# estimated common discrimination parameter)
items.1PL <- itemParEst(verbatim[,1:24], model = "1PL", discr = NULL)

# Estimation of the item parameters (1PL model, "lme4" engine)
items.1PL <- itemParEst(verbatim[,1:24], model = "1PL", engine = "lme4")

# Estimation of the item parameters (2PL model)
items.2PL <- itemParEst(verbatim[,1:24], model = "2PL")

# Estimation of the item parameters (3PL model)
# items.3PL <- itemParEst(verbatim[,1:24], model = "3PL")

# Constraining all pseudo-guessing values to be equal to 0.05
# items.3Plc <- itemParEst(verbatim[,1:24], model = "3PL", c = 0.05)

## End(Not run)
```

itemRescale

Rescaling item parameters by equal means anchoring

Description

Rescale the item parameters from one data set to the scale of the parameters from another data set, using equal means anchoring.
itemRescale

Usage

itemRescale(mR, mF, items = 1:nrow(mR))

Arguments

mR numeric: a matrix of item parameter estimates (one row per item) which constitutes the reference scale. See Details.

mF numeric: a matrix of item parameter estimates (one row per item) which have to be rescaled. See Details.

items a numeric vector of integer values specifying which items are used for equal means anchoring. See Details.

Details

The matrices mR and mF must have the same format as the output of the command itemParEst and one the possible models (1PL, 2PL, 3PL or constrained 3PL). The number of columns therefore equals two, five, nine or six, respectively.

Rescaling is performed by equal means anchoring (Cook and Eignor, 1991). The items involved in the anchoring process are specified by means of their row number in either mR or mF, and are passed through the items argument.

itemRescale primarily serves as a routine for item purification in Lord (difLord) and Raju (difRaju) Generalized Lord’s (difGenLord) methods of DIF identification (Candell and Drasgow, 1988).

Value

A matrix of the same format as mF with the rescaled item parameters.

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References


See Also

`itemPar1PL, itemPar2PL, itemPar3PL, itemPar3PLconst, difLord, difRaju, difGenLord`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)
attach(verbal)

# Splitting the data set into reference and focal groups
nF <- sum(Gender)
nR <- nrow(verbal) - nF
data.ref <- verbal[,1:24][order(Gender),][1:nR,]
data.focal <- verbal[,1:24][order(Gender),][(nR+1):(nR+nF),]

# Estimating item parameters in each data set with 1PL model
mR <- itemPar1PL(data.ref)
mF <- itemPar1PL(data.focal)

# Rescaling focal group item parameters, using all items for anchoring
itemRescale(mR, mF)

# Rescaling focal group item parameters, using the first 10 items for anchoring
itemRescale(mR, mF, items = 1:10)

# Estimating item parameters in each data set with 2PL model
mR <- itemPar2PL(data.ref)
mF <- itemPar2PL(data.focal)

# Rescaling focal group item parameters, using all items for anchoring
itemRescale(mR, mF)

## End(Not run)
```

---

**Logistik**

*Logistic regression DIF statistic*
Description

Calculates the "logistic regression" likelihood-ratio statistics and effect sizes for DIF detection.

Usage

Logistik(data, member, member.type = "group", match = "score",
anchor = 1:ncol(data), type = "both", criterion = "LRT", all.cov = FALSE)

Arguments

data numeric: the data matrix (one row per subject, one column per item).
member numeric or factor: the vector of group membership. Can either take two distinct values (zero for the reference group and one for the focal group) or be a continuous vector. See Details.
member.type character: either "group" (default) to specify that group membership is made of two groups, or "cont" to indicate that group membership is based on a continuous criterion. See Details.
match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of data. See Details.
anchor a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. Ignored if match is not "score". See Details.
type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
criterion a character string specifying which DIF statistic is computed. Possible values are "LRT" (default) or "Wald". See Details.
all.cov logical: should all covariance matrices of model parameter estimates be returned (as lists) for both nested models and all items? (default is FALSE).

Details

This command computes the logistic regression statistic (Swaminathan and Rogers, 1990) in the specific framework of differential item functioning. It forms the basic command of difLogistic and is specifically designed for this call.

If the member.type argument is set to "group", the member argument must be a vector with two distinct (numeric or factor) values, say 0 and 1 (for the reference and focal groups respectively). Those values are internally transformed onto factors to denote group membership. The three possible models to be fitted are then:

\[ M_0 : \text{logit}(\pi_g) = \alpha + \beta X + \gamma_g + \delta_g X \]
\[ M_1 : \text{logit}(\pi_g) = \alpha + \beta X + \gamma_g \]
\[ M_2 : \text{logit}(\pi_g) = \alpha + \beta X \]
where \( \pi_g \) is the probability of answering correctly the item in group \( g \) and \( X \) is the matching variable. Parameters \( \alpha \) and \( \beta \) are the intercept and the slope of the logistic curves (common to all groups), while \( \gamma_g \) and \( \delta_g \) are group-specific parameters. For identification reasons the parameters \( \gamma_0 \) and \( \delta_0 \) for reference group \( (g = 0) \) are set to zero. The parameter \( \gamma_1 \) of the focal group \( (g = 1) \) represents the uniform DIF effect, and the parameter \( \delta_1 \) is used to model nonuniform DIF effect. The models are fitted with the \texttt{glm} function.

If \texttt{member\.type} is set to "cont", then "group membership" is replaced by a continuous or discrete variable, given by the \texttt{member} argument, and the models above are written as

\[
M_0 : \logit(\pi_g) = \alpha + \beta X + \gamma Y + \delta XY \\
M_1 : \logit(\pi_g) = \alpha + \beta X + \gamma Y \\
M_2 : \logit(\pi_g) = \alpha + \beta X
\]

where \( Y \) is the group variable. Parameters \( \gamma \) and \( \delta \) act now as the \( \gamma_1 \) and \( \delta_1 \) DIF parameters.

The matching criterion can be either the test score or any other continuous or discrete variable to be passed in the \texttt{match} function. This is specified by the \texttt{match} argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the \texttt{data} matrix.

Two types of DIF statistics can be computed: the likelihood ratio test statistics, obtained by comparing the fit of two nested models, and the Wald statistics, obtained with an appropriate contrast matrix. If \texttt{type} is set to "both", the contrast matrix has two rows, \((0,0,1,0)\) and \((0,0,0,1)\). If \texttt{type} is set to "udif", the considered model is also model \( M_0 \) but the contrast matrix has only one row, \((0,0,0,1)\). Eventually, if \texttt{type} is set to "nudif", the considered model is model \( M_1 \) and the contrast matrix has one row, \((0,0,1)\).

The data are passed through the \texttt{data} argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values. They are discarded from the fitting of the logistic models (see \texttt{glm} for further details).

The vector of group membership, specified with \texttt{member} argument, must hold only zeros and ones, a value of zero corresponding to the reference group and a value of one to the focal group.

Option \texttt{anchor} sets the items which are considered as anchor items for computing the \texttt{est} scores and related logistic regression DIF statistics. Items other than the anchor items and the tested item are discarded. \texttt{anchor} must hold integer values specifying the column numbers of the corresponding
anchor items. It is mainly designed to perform item purification. Note that this option is discarded
when match is not "score".

The output contains: the selected DIF statistics (either the LRT or the Wald statistic) computed
for each item, two matrices with the parameter estimates of both models (for each item) and two
matrices of related standard error values. In addition, Nagelkerke’s $R^2$ coefficients (Nagelkerke,
1991) are computed for each model and the output returns both, the vectors of $R^2$ coefficients for
each model and the differences in these coefficients. Such differences are used as measures of effect
size by the difLogistic command; see Gomez-Benito, Dolores Hidalgo and Padilla (2009), Jodoin
and Gierl (2001) and Zumbo and Thomas (1997). The criterion and member.type arguments are
also returned, as well as a character argument named match that specifies the type of matching
criterion that was used.

Value

A list with nine components:

- **stat**: the values of the logistic regression DIF statistics.
- **R2M0**: the values of Nagelkerke's $R^2$ coefficients for the "full" model.
- **R2M1**: the values of Nagelkerke's $R^2$ coefficients for the "simpler" model.
- **deltaR2**: the differences between Nagelkerke's $R^2$ coefficients of the tested models. See
  Details.
- **parM0**: a matrix with one row per item and four columns, holding successively the fitted
  parameters $\hat{\alpha}$, $\hat{\beta}$, $\hat{\gamma}_1$ and $\hat{\delta}_1$ of the "full" model ($M_0$ if type="both" or
type="nudif", $M_1$ if type="udif").
- **parM1**: the same matrix as parM0 but with fitted parameters for the "simpler" model
  ($M_1$ if type="nudif", $M_2$ if type="both" or type="udif").
- **seM0**: a matrix with the standard error values of the parameter estimates in matrix
  parM0.
- **seM1**: a matrix with the standard error values of the parameter estimates in matrix
  parM1.
- **cov.M0**: either NULL (if all.cov argument is FALSE) or a list of covariance matrices of
  parameter estimates of the "full" model ($M_0$) for each item (if all.cov argument is TRUE).
- **cov.M1**: either NULL (if all.cov argument is FALSE) or a list of covariance matrices of
  parameter estimates of the "reduced" model ($M_1$) for each item (if all.cov argument is TRUE).
- **criterion**: the value of the criterion argument.
- **member.type**: the value of the member.type argument.
- **match**: a character string, either "score" or "matching variable" depending on the
  match argument.

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References


See Also
difLogistic, dichoDif

Examples

## Not run:

# Loading of the verbal data
data(verbal)

# Testing both types of DIF simultaneously
# With all items, test score as matching criterion
Logistik(verbal[,1:24], verbal[,26])

# Returning all covariance matrices of model parameters
LordChi2

Lord's chi-square DIF statistic

Description

Calculates the Lord’s chi-square statistics for DIF detection.

Usage

LordChi2(mR, mF)

Arguments

mR numeric: the matrix of item parameter estimates (one row per item) for the reference group. See Details.

mF numeric: the matrix of item parameter estimates (one row per item) for the focal group. See Details.

Details

This command computes the Lord’s chi-square statistic (Lord, 1980) in the specific framework of differential item functioning. It forms the basic command of difLord and is specifically designed for this call.
The matrices $mr$ and $mf$ must have the same format as the output of the command `itemParEst` with one of the possible models (1PL, 2PL, 3PL or constrained 3PL). The number of columns therefore equals two, five, nine or six, respectively. Moreover, item parameters of the focal must be on the same scale of that of the reference group. If not, make use of e.g. equal means anchoring (Cook and Eignor, 1991) and `itemRescale` to transform them adequately.

**Value**

A vector with the values of the Lord’s chi-square DIF statistics.

**Note**

WARNING: the previous versions of LordChi2 were holding an error: under the 3PL model, the covariance matrices $\Sigma q_1$ and $\Sigma q_2$ were wrongly computed as the variance of the pseudo-guessing parameters were replaced by the parameter estimates. This has been fixed from version 4.0 of difR. Many thanks to J. Patrick Meyer (Curry School of Education, University of Virginia) for having discovered this mistake.

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**References**


**See Also**

`itemParEst`, `itemRescale`, `difLord`, `dichoDif`
Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Splitting the data into reference and focal groups
nF <- sum(Gender)
nR <- nrow(verbal)-nF
data.ref <- verbal[, 1:24][order(Gender),][1:nR,]
data.focal <- verbal[, 1:24][order(Gender),][(nR+1):(nR+nF),]

# Pre-estimation of the item parameters (1PL model)
mR <- itemParEst(data.ref, model = "1PL")
mF <- itemParEst(data.focal, model = "1PL")
mF <- itemRescale(mR, mF)
LordChi2(mR, mF)

# Pre-estimation of the item parameters (2PL model)
mR <- itemParEst(data.ref, model = "2PL")
mF <- itemParEst(data.focal, model = "2PL")
mF <- itemRescale(mR, mF)
LordChi2(mR, mF)

# Pre-estimation of the item parameters (constrained 3PL model)
mR <- itemParEst(data.ref, model = "3PL", c = 0.05)
mF <- itemParEst(data.focal, model = "3PL", c = 0.05)
mF <- itemRescale(mR, mF)
LordChi2(mR, mF)

## End(Not run)
```

---

**LRT**

*Likelihood-Ratio Test DIF statistic*

**Description**

Calculates Likelihood-Ratio Test (LRT) statistics for DIF detection.

**Usage**

`lrt(data, member)`

**Arguments**

- `data` numeric: the data matrix (one row per subject, one column per item).
- `member` numeric: the vector of group membership with zero and one entries only. See Details.
Details

This command computes the likelihood-ratio test statistic (Thissen, Steinberg and Wainer, 1988) in the specific framework of differential item functioning. It forms the basic command of difLRT and is specifically designed for this call.

The data are passed through the data argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values.

The vector of group membership, specified with member argument, must hold only zeros and ones, a value of zero corresponding to the reference group and a value of one to the focal group.

The LRT DIF statistic is computed for each item separately, using all other items as anchor items.

Value

A vector with the values of the LRT DIF statistics.

Note

Because of the fitting of the modified Rasch model with glmer the process can be very time consuming (see the Details section of difLRT).

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References


mantelHaenszel

See Also
difLRT, dichoDif

Examples

```r
## Not run:

# Loading of the verbal data
data(verbatim)
attach(verbatim)

# Excluding the "Anger" variable
verbatim <- verbatim[colnames(verbatim)!="Anger"]

# Keeping the first 5 items and the first 50 subjects
# (this is an artificial simplification to reduce the computational time)
# Sixth column holds the group membership
verbatim <- verbatim[1:50, c(1:5, 25)]

# Likelihood-ratio statistics
LRT(verbatim[,1:5], verbal[,6])

## End(Not run)
```

mantelHaenszel  Mantel-Haenszel DIF statistic

Description

Calculates Mantel-Haenszel statistics for DIF detection.

Usage

```r
mantelHaenszel(data, member, correct = TRUE, exact = FALSE, anchor = 1:ncol(data))
```

Arguments

data  numeric: the data matrix (one row per subject, one column per item).
member numeric: the vector of group membership with zero and one entries only. See Details.
correct logical: should the continuity correction be used? (default is TRUE).
exact logical: should an exact test be computed? (default is FALSE).
anchor a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.
Details

This command basically computes the Mantel-Haenszel (1959) statistic in the specific framework of differential item functioning. It forms the basic command of `difMH` and is specifically designed for this call.

The data are passed through the `data` argument, with one row per subject and one column per item. Missing values are allowed for item responses (not for group membership) but must be coded as `NA` values. They are discarded from sum-score computation.

The vector of group membership, specified with `member` argument, must hold only zeros and ones, a value of zero corresponding to the reference group and a value of one to the focal group.

By default, the continuity correction factor -0.5 is used (Holland and Thayer, 1988). One can nevertheless remove it by specifying `correct=FALSE`.

By default, the asymptotic Mantel-Haenszel statistic is computed. However, the exact statistics and related P-values can be obtained by specifying the logical argument `exact` to `TRUE`. See Agresti (1990, 1992) for further details about exact inference.

Option `anchor` sets the items which are considered as anchor items for computing Mantel-Haenszel statistics. Items other than the anchor items and the tested item are discarded. `anchor` must hold integer values specifying the column numbers of the corresponding anchor items. It is primarily designed to perform item purification.

In addition to the Mantel-Haenszel statistics to identify DIF items, `mantelHaenszel` computes the estimates of the common odds ratio $\alpha_{MH}$ which are used for measuring the effect size of the items (Holland and Thayer, 1985, 1988). They are returned in the `resAlpha` argument of the output list. Moreover, the logarithm of $\alpha_{MH}$, say $\lambda_{MH}$, is asymptotically distributed and its variance is computed and returned into the `varLambda` argument. Note that this variance is the one proposed by Philips and Holland (1987), since it seems the most accurate expression for the variance of $\lambda_{MH}$ (Penfield and Camilli, 2007).

Value

A list with several arguments:

- `resMH` the vector of the Mantel-Haenszel DIF statistics (either asymptotic or exact).
- `resAlpha` the vector of the (asymptotic) Mantel-Haenszel estimates of the common odds ratios. Returned only if `exact` is `FALSE`.
- `varLambda` the (asymptotic) variance of the $\lambda_{MH}$ statistic. Returned only if `exact` is `FALSE`. See Details.
- `pval` the exact P-values of the MH test. Returned only if `exact` is `TRUE`.

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References


See Also
difMH, dichoDif

Examples

```r
## Not run:

# Loading of the verbal data
data(verb)

# With and without continuity correction
mantelHaenszel(verb[,1:24], verb[,26])
mantelHaenszel(verb[,1:24], verb[,26], correct = FALSE)

# Exact test
mantelHaenszel(verb[,1:24], verb[,26], exact = TRUE)

# Removing item 6 from the set of anchor items
mantelHaenszel(verb[,1:24], verb[,26], anchor = c(1:5,7:24))
```
RajuZ  Raju's area DIF statistic

Description
Calculates the Raju’s statistics for DIF detection.

Usage
RajuZ(mR, mF, signed = FALSE)

Arguments
mR numeric: the matrix of item parameter estimates (one row per item) for the reference group. See Details.
mF numeric: the matrix of item parameter estimates (one row per item) for the focal group. See Details.
signed logical: should the signed area be computed, or the unsigned (i.e. in absolute value) area? Default is FALSE, i.e. the unsigned area. See Details.

Details
This command computes the Raju’s area statistic (Raju, 1988, 1990) in the specific framework of differential item functioning. It forms the basic command of difRaju and is specifically designed for this call.

The matrices mR and mF must have the same format as the output of the command itemParEst and one the possible models (1PL, 2PL or constrained 3PL). The number of columns therefore equals two, five or six, respectively. Note that the unconstrained 3PL model cannot be used in this method: all pseudo-guessing parameters must be equal in both groups of subjects. Moreover, item parameters of the focal must be on the same scale of that of the reference group. If not, make use of e.g. equal means anchoring (Cook and Eignor, 1991) and itemRescale to transform them adequately.

By default, the unsigned area, given by Equation (57) in Raju (1990), is computed. It makes use of Equations (14), (15), (23) and (46) for the numerator, and Equations (17), (33) to (39), and (52) for the denominator of the Z statistic. However, the signed area, given by Equation (56) in Raju (1990), can be used instead. In this case, Equations (14), (21) and (44) are used for the numerator, and Equations (17), (25) and (48) for the denominator. The choice of the type of area is fixed by the logical signed argument, with default value FALSE.
Value

A list with two components:

- `res`: a matrix with one row per item and three columns, holding respectively Raju’s area between the two item characteristic curves, its standard error and the Raju DIF statistic (the latter being the ratio of the first two columns).
- `signed`: the value of the signed argument.

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References


See Also

- `itemParEst`, `itemRescale`, `difRaju`, `dichoDif`

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Splitting the data into reference and focal groups
nF <- sum(Gender)
```
selectDif

Description

This function performs DIF detection for one pre-specified method.

Usage

```
selectDif(Data, group, focal.name, method, anchor = NULL, props = NULL, thrtid = 1.5, alpha = 0.05, MHstat = "MHChisq", correct = TRUE, exact = FALSE, stdWeight = "focal", thrSTD = 0.1, BDstat = "BD", member.type = "group", match = "score", type = "both", criterion = "LRT", model = "2PL", c = NULL, engine = "ltm", discr = 1, irtParam = NULL, same.scale = TRUE, signed = FALSE, purify = FALSE, nIter = 10, p.adjust.method = NULL, save.output = FALSE, output = c("out", "default"))
```
selectDif

Arguments

Data numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.

group numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.

focal.name numeric or character indicating the level of group which corresponds to the focal group.

method character: the name of the selected method. See Details.

anchor either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.

props either NULL (default) or a two-column matrix with proportions of success in the reference group and the focal group. See Details.

thrTID numeric: the threshold for detecting DIF items with TID method (default is 1.5).

alpha numeric: significance level (default is 0.05).

MHstat character: specifies the DIF statistic to be used for DIF identification. Possible values are "MHChisq" (default) and "logOR". See Details.

correct logical: should the continuity correction be used? (default is TRUE).

exact logical: should an exact test be computed? (default is FALSE).

stdWeight character: the type of weights used for the standardized P-DIF statistic. Possible values are "focal" (default), "reference" and "total". See Details.

thrSTD numeric: the threshold (cut-score) for standardized P-DIF statistic (default is 0.10).

BDstat character specifying the DIF statistic to be used. Possible values are "BD" (default) and "trend". See Details.

member.type character: either "group" (default) to specify that group membership is made of two groups, or "cont" to indicate that group membership is based on a continuous criterion. See Details.

match specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of Data. See Details.

type a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.

criterion a character string specifying which DIF statistic is computed. Possible values are "LRT" (default) or "Wald". See Details.

model character: the IRT model to be fitted (either "1PL", "2PL" or "3PL"). Default is "2PL".

c optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See Details.

engine character: the engine for estimating the 1PL model, either "1tm" (default) or "1me4".

discr either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1PL" and engine is "1tm". See Details.
selectDif

irtParam matrix with 2J rows (where J is the number of items) and at most 9 columns containing item parameters estimates. See Details.
same.scale logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See Details.
signed logical: should the Raju’s statistics be computed using the signed (TRUE) or unsigned (FALSE, default) area? See Details.
purify logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
nrIter numeric: the maximal number of iterations in the item purification process (default is 10).
p.adjust.method either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
save.output logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

Details
This is a generic function which calls one of the DIF detection methods and displays its output. It is mainly used as a routine for dichodif command.

The possible methods are: "TID" for Transformed Item Difficulties (TID) method (Angoff and Ford, 1973), "MH" for mantel-Haenszel (Holland and Thayer, 1988), "Std" for standardization (Dorans and Kulick, 1986), "Logistic" for logistic regression (Swaminathan and Rogers, 1990), "BD" for Breslow-Day method (Penfield, 2003), "Lord" for Lord’s chi-square test (Lord, 1980), "Raju" for Raju’s area method (Raju, 1990), and "LRT" for likelihood-ratio test method (Thissen, Steinberg and Wainer, 1988).

The data is a matrix whose rows correspond to the subjects and columns to the items. In addition, the data can hold the vector of group membership. If so, group indicates the column of data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from either the computation of the sum-scores, the fitting of the logistic models or the IRT models (according to the method).

The vector of group membership must hold only two different values, either as numeric or character. The focal group is defined by the argument focal.name.

With the TID method, one can alternatively provide the matrix of proportions of success in for each item in each group. This matrix must have the same format as that provided to the trItemDiff function; see the corresponding help file for further details.

For Lord and Raju methods, one can specify either the IRT model to be fitted (by means of model, c, engine and discr arguments), or the item parameter estimates with arguments irtParam and same.scale. See difLord and difRaju for further details.
The threshold for detecting DIF items depends on the method. For standardization it has to be fully specified (with the thr argument), as well as for the TID method (through the thrTID argument). For the other methods it is depending on the significance level set by alpha.

For Mantel-Haenszel method, the DIF statistic can be either the Mantel-Haenszel chi-square statistic or the log odds-ratio statistic. The method is specified by the argument mhstat, and the default value is "MHchisq" for the chi-square statistic. Moreover, the option correct specifies whether the continuity correction has to be applied to Mantel-Haenszel statistic. See difMH for further details.

By default, the asymptotic Mantel-Haenszel statistic is computed. However, the exact statistics and related P-values can be obtained by specifying the logical argument exact to TRUE. See Agresti (1990, 1992) for further details about exact inference.

The weights for computing the standardized P-DIF statistics are defined through the argument stdweight, with possible values "focal" (default value), "reference" and "total". See stdPDIF for further details.

For Breslow-Day method, two test statistics are available: the usual Breslow-Day statistic for testing homogeneous association (Aguerri, Galibert, Attorresi and Maranon, 2009) and the trend test statistic for assessing some monotonic trend in the odds ratios (Penfield, 2003). The DIF statistic is supplied by the BDstat argument, with values "BD" (default) for the usual statistic and "trend" for the trend test statistic.

For logistic regression, the argument type permits to test either both uniform and nonuniform effects simultaneously (type="both"), only uniform DIF effect (type="udif") or only nonuniform DIF effect (type="nudif"). The criterion argument specifies the DIF statistic to be computed, either the likelihood ratio test statistic (with criterion="LRT") or the Wald test (with criterion="Wald"). Moreover, the group membership can be either a vector of two distinct values, one for the reference group and one for the focal group, or a continuous or discrete variable that acts as the "group" membership variable. In the former case, the member.type argument is set to "group" and the focal.name defines which value in the group variable stands for the focal group. In the latter case, member.type is set to "cont", focal.name is ignored and each value of the group represents one "group" of data (that is, the DIF effects are investigated among participants relying on different values of some discrete or continuous trait). Finally, the matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the data matrix. See Logistik for further details.

For Raju’s method, the type of area (signed or unsigned) is fixed by the logical signed argument, with default value FALSE (i.e. unsigned areas). See RajuZ for further details.

Item purification can be requested by specifying purify option to TRUE. Recall that item purification is slightly different for IRT and for non-IRT based methods. See the corresponding methods for further information.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. See the corresponding methods for further information.

A pre-specified set of anchor items can be provided through the anchor argument. For non-IRT methods, anchor items are used to compute the test score (as matching criterion). For IRT methods, anchor items are used to rescale the item parameters on a common metric. See the corresponding methods for further information. Note that anchor argument is not working with "LRT" method.
The output of the selected method can be stored in a text file by fixing `save.output` and `output` appropriately. See the help file of the corresponding method for further information.

**Value**

The output of the selected DIF detection method.

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**References**


**See Also**

diftID, difMH, difStd, difBD, difLogistic, difLord, difRaju, difLRT, dichoDif

**Examples**

```r
## Not run:

# Loading of the verbal data
data(verbal)
attach(verbal)

# Excluding the "Anger" variable
verbal <- verbal[!tolower(colnames(verbal)) %in% c("Anger")]

# Calling Mantel-Haenszel
selectDif(verbal, group = 25, focal.name = 1, method = "MH")

# Calling Mantel-Haenszel and saving output in 'MH.txt' file
selectDif(verbal, group = 25, focal.name = 1, method = "MH",
           save.output = TRUE, output = c("MH", "default"))

# Calling Lord method
# 2PL model, with item purification
selectDif(verbal, group = 25, focal.name = 1, method = "Lord", model = "2PL",
           purify = TRUE)

## End(Not run)
```

---

**selectGenDif**

Selection of one of the DIF detection methods among multiple groups

**Description**

This function performs DIF detection among multiple groups for one pre-specified method.

**Usage**

```r
selectGenDif(Data, group, focal.names, method, anchor = NULL, match = "score",
type = "both", criterion = "LRT", alpha = 0.05, model = "2PL", c = NULL,
engine = "lrm", discr = 1, irtparam = NULL, nrfocal = 2, same.scale = TRUE,
purify = FALSE, nriter = 10, p.adjust.method = NULL, save.output = FALSE,
```
output = c("out", "default")

Arguments

- **Data** numeric: either the data matrix only, or the data matrix plus the vector of group membership. See Details.
- **group** numeric or character: either the vector of group membership or the column indicator (within data) of group membership. See Details.
- **focal.names** numeric or character vector indicating the levels of group which correspond to the focal groups.
- **method** character: the name of the selected method. See Details.
- **anchor** either NULL (default) or a vector of item names (or identifiers) to specify the anchor items. See Details.
- **match** specifies the type of matching criterion. Can be either "score" (default) to compute the test score, or any continuous or discrete variable with the same length as the number of rows of data. See Details.
- **type** a character string specifying which DIF effects must be tested. Possible values are "both" (default), "udif" and "nudif". See Details.
- **criterion** character: the type of test statistic used to detect DIF items with generalized logistic regression. Possible values are "LRT" (default) and "Wald". See Details.
- **alpha** numeric: significance level (default is 0.05).
- **model** character: the IRT model to be fitted (either "1pl", "2pl" or "3pl"). Default is "2pl".
- **c** optional numeric value or vector giving the values of the constrained pseudo-guessing parameters. See Details.
- **engine** character: the engine for estimating the 1PL model, either "ltm" (default) or "lme4".
- **discr** either NULL or a real positive value for the common discrimination parameter (default is 1). Used only if model is "1pl" and engine is "ltm". See Details.
- **irtParam** matrix with 2J rows (where J is the number of items) and at most 9 columns containing item parameters estimates. See Details.
- **nrFocal** numeric: the number of focal groups (default is 2).
- **same.scale** logical: are the item parameters of the irtParam matrix on the same scale? (default is "TRUE"). See Details.
- **purify** logical: should the method be used iteratively to purify the set of anchor items? (default is FALSE).
- **nrIter** numeric: the maximal number of iterations in the item purification process (default is 10).
- **p.adjust.method** either NULL (default) or the acronym of the method for p-value adjustment for multiple comparisons. See Details.
- **save.output** logical: should the output be saved into a text file? (Default is FALSE).
output character: a vector of two components. The first component is the name of the output file, the second component is either the file path or "default" (default value). See Details.

Details

This is a generic function which calls one of the DIF detection methods for multiple groups, and displays its output. It is mainly used as a routine for genDichoDif command.

There are three possible methods currently implemented: "GMH" for Generalized Mantel-Haenszel (Penfield, 2001), "genLogistic" for generalized logistic regression (Magis, Raiche, Beland and Gerard, 2010) and "genLord" for generalized Lord’s chi-square test (Kim, Cohen and Park, 1995).

The Data is a matrix whose rows correspond to the subjects and columns to the items. In addition, Data can hold the vector of group membership. If so, group indicates the column of Data which corresponds to the group membership, either by specifying its name or by giving the column number. Otherwise, group must be a vector of same length as nrow(Data).

Missing values are allowed for item responses (not for group membership) but must be coded as NA values. They are discarded from either the computation of the sum-scores, the fitting of the logistic models or the IRT models (according to the method).

The vector of group membership must hold at least three different values, either as numeric or character. The focal groups are defined by the values of the argument focal.names.

For the generalized logistic regression method, the argument type permits to test either both uniform and nonuniform effects simultaneously (with type="both"), only uniform DIF effect (with type="udif") or only nonuniform DIF effect (with type="nudif"). Furthermore, the argument criterion defines which test must be used, either the Wald test ("Wald") or the likelihood ratio test ("LRT").

For generalized Lord method, one can specify either the IRT model to be fitted (by means of model, c, engine and discr arguments), or the item parameter estimates with arguments irtParam, nrfocal and same.scale. Moreover, the matching criterion can be either the test score or any other continuous or discrete variable to be passed in the Logistik function. This is specified by the match argument. By default, it takes the value "score" and the test score (i.e. raw score) is computed. The second option is to assign to match a vector of continuous or discrete numeric values, which acts as the matching criterion. Note that for consistency this vector should not belong to the Data matrix. See difGenLord for further details.

The threshold for detecting DIF items depends on the method and is depending on the significance level set by alpha.

Item purification can be requested by specifying purify option to TRUE. Recall that item purification is slightly different for IRT and for non-IRT based methods. See the corresponding methods for further information.

Adjustment for multiple comparisons is possible with the argument p.adjust.method. See the corresponding methods for further information.

A pre-specified set of anchor items can be provided through the anchor argument. For non-IRT methods, anchor items are used to compute the test score (as matching criterion). For IRT methods, anchor items are used to rescale the item parameters on a common metric. See the corresponding methods for further information.

The output of the selected method can be stored in a text file by fixing save.output and output appropriately. See the help file of the corresponding method for further information.
Value

The output of the selected DIF detection method.

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References


See Also
difGMH, difGenLogistic, difGenLord

Examples

```r
## Not run:

# Loading of the verbal data
data(verbald)
attach(verbald)

# Creating four groups according to gender ("Man" or "Woman") and trait anger score ("Low" or "High")
group <- rep("WomanLow", nrow(verbald))
group[Anger>20 & Gender==0] <- "WomanHigh"
group[Anger<20 & Gender==1] <- "ManLow"
group[Anger>20 & Gender==1] <- "ManHigh"
```
# New data set
Verbal <- cbind(verbal[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")

# Calling generalized Mantel-Haenszel
selectGenDif(Verbal, group = 25, focal.names = names, method = "GMH")

# Calling generalized Mantel-Haenszel and saving output in 'GMH.txt' file
selectGenDif(Verbal, group = 25, focal.name = names, method = "GMH",
            save.output = TRUE, output = c("GMH", "default"))

# Calling generalized logistic regression
selectGenDif(Verbal, group = 25, focal.names = names, method = "genLogistic")

# Calling generalized Lord method (2PL model)
selectGenDif(Verbal, group = 25, focal.names = names, method = "genLord",
            model = "2PL")

## End(Not run)

---

**stdPDIF**

*Standardization DIF statistic*

### Description

Calculates standardized P-difference statistics for DIF detection.

### Usage

```
stdPDIF(data, member, anchor = 1:ncol(data), stdWeight = "focal")
```

### Arguments

- **data**
  numeric: the data matrix (one row per subject, one column per item).

- **member**
  numeric: the vector of group membership with zero and one entries only. See Details.

- **anchor**
  a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.

- **stdWeight**
  character: the type of weights used for the standardized P-DIF statistic. Possible values are "focal" (default), "reference" and "total". See Details.
Details

This command computes the standardized P-DIF statistic in the specific framework of differential item functioning (Dorans and Kulick, 1986). It forms the basic command of `difstd` and is specifically designed for this call. In addition, the standardized alpha values (Dorans, 1989) are also computed as a basis for effect size calculation.

The standardized P-DIF statistic is a weighted average of the difference in proportions of successes in the reference group and in the focal group. The average is computed across the test score strata. The weights can be of three kinds (Dorans, 1989; Dorans and Kulick, 1986) and are specified through the `stdWeight` argument: the proportion of focal groups examinees within each stratum (`stdWeight="focal"`), the proportion of reference group examinees within each stratum (`stdWeight="reference"`), and the proportion of examinees (from both groups) within each stratum (`stdWeight="total"`). By default, the weights are built from the focal group.

Similarly to the 'alpha' estimates of the common odds ratio for the Mantel-Haenszel method (see `mantelHaenszel`), the standardized alpha values can be computed as rough measures of effect sizes, after a transformation to the Delta Scale (Holland, 1985). See Dorans (1989, p.228, Eqn.15) for further details.

The data are passed through the `data` argument, with one row per subject and one column per item. Missing values are allowed but must be coded as NA values. They are discarded from sum-score computation.

The vector of group membership, specified with `member` argument, must hold only zeros and ones, a value of zero corresponding to the reference group and a value of one to the focal group.

Option `anchor` sets the items which are considered as anchor items for computing standardized P-DIF statistics. Items other than the anchor items and the tested item are discarded. `anchor` must hold integer values specifying the column numbers of the corresponding anchor items. It is mainly designed to perform item purification.

Value

A list with two arguments:

- `resStd` the vector of the standardized P-DIF statistics.
- `resAlpha` the vector of standardized alpha values.

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References


See Also
difStd, dichoDif, mantelHaenszel

Examples

```r
## Not run:
# Loading of the verbal data
data(verbal)

# All items as anchor items
stdPDIF(verbal[,1:24], verbal[,26])

# All items as anchor items, reference group weights
stdPDIF(verbal[,1:24], verbal[,26], stdWeight = "reference")

# All items as anchor items, both groups' weights
stdPDIF(verbal[,1:24], verbal[,26], stdWeight = "total")

# Removing item 6 from the set of anchor items
stdPDIF(verbal[,1:24], verbal[,26], anchor = c(1:5,7:24))

## End(Not run)
```

subtestLogistic

Testing for DIF among subgroups with generalized logistic regression

Description

Performs the Wald test to identify DIF items among a subset of groups of examinees, using the results of generalized logistic regression for all groups.
Usage

subtestLogistic(x, items, groups, alpha = 0.05)
## S3 method for class 'subLogistic'
print(x, ...)

Arguments

x an object of class "genLogistic", typically the output of the difGenLogistic command.
items numeric or character: a vector of items to be tested. See Details.
groups numeric or character: a vector of groups of examinees to be compared. See Details.
alpha numeric: the significance level (default is 0.05).
... other generic parameters for the print function.

Details

This command makes use of the results from the generalized logistic regression to perform subtests between two or more groups of examinees (Magis, Raiche, Beland and Gerard, 2010). The Wald test is used with an appropriate contrast matrix.

The subtestLogistic command requires a preliminary output of the generalized logistic regression with all groups of examinees, preferable with the difGenLogistic command. The object x is an object of class "genLogistic" from which subtests can be performed. The same DIF effect (either uniform, nonuniform, or both types) is tested among the subset of groups of examinees as the one tested with all groups. It is provided by the argument type argument of x.

The argument items is a vector of the names of the items to be tested, or their number in the data set. A single item can be specified.

The argument groups specifies which groups of examinees are considered in this subtest routine. It is a vector of either group names or integer values. In the latter case, the reference group is specified with the 0 (zero) value, while the focal groups are set up by their rank in the x$focal.names argument. At least two groups must be specified, and all groups can be included (which leads back to the generalized logistic regression with the Wald test).

The output provides, among others, the Wald statistics, the degrees of freedom and related asymptotic p-values for each tested item, as well as the contrast matrix.

Value

A list of class "subLogistic" with the following components:

stats a table with as many rows as tested items, and four columns: the item number, the Wald statistic, the degrees of freedom and the asymptotic p-value.
contrastMatrix the contrast matrix used for testing DIF among the groups set up by groups.
items the value of the items argument.
groups the value of the groups argument.
type the value of the x$type argument.
purification the value of the x$purification argument.
alpha the value of the alpha argument.

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References
differential item functioning among multiple groups. Unpublished manuscript.

See Also
difGenLogistic, genDichoDif

Examples
## Not run:

# Loading of the verbal data
data(verb)  # Loading of the verbal data
attach(verb)

# Creating four groups according to gender (0 or 1) and trait anger score
# ("Low" or "High")
# Reference group: women with low trait anger score (<=20)
group <- rep("WomanLow", nrow(verb))
group[Anger>20 & Gender==0] <- "WomanHigh"  # Reference group: women with low trait anger score (<=20)
group[Anger<=20 & Gender==1] <- "ManLow"  # Reference group: women with low trait anger score (<=20)
group[Anger>20 & Gender==1] <- "ManHigh"  # Reference group: women with low trait anger score (<=20)

# New data set
Verbal <- cbind(verb[,1:24], group)

# Reference group: "WomanLow"
names <- c("WomanHigh", "ManLow", "ManHigh")
# Testing all types of DIF with all items
rdif <- difGenLogistic(Verbal, group = 25, focal.names = names)
rUDIF <- difGenLogistic(Verbal, group = 25, focal.names = names, type = "udif")
rNUdif <- difGenLogistic(Verbal, group = 25, focal.names = names, type = "nudif")

# Subtests between the reference group and the first two focal groups
# for item "S2WantShout" (item 6) and the three types of DIF
subGroups <- c("WomanLow", "WomanHigh", "ManLow")
subtestLogistic(rdif, items = 6, groups = subGroups)
subtestLogistic(rUDIF, items = 6, groups = subGroups)
subtestLogistic(rNUdif, items = 6, groups = subGroups)

# Subtests between the reference group and the first focal group
# for items "S2WantShout" (item 6) and "S3WantCurse" (item 7)
# (only both DIF effects)
subGroups <- c("WomanLow", "WomanHigh")
items1 <- c("S2WantShout", "S3WantCurse")
items2 <- 6:7
subtestLogistic(rdif, items = items1, groups = subGroups)
subtestLogistic(rdif, items = items2, groups = subGroups)

## End(Not run)

---

trItemDiff

Transformed Item Difficulties Perpendicular Distances

**Description**

Computes the perpendicular distances for DIF detection with Transformed Item Difficulties (TID) approach.

**Usage**

trItemDiff(prop, anchor = 1:nrow(prop))

**Arguments**

- **prop** numeric: a matrix with one row per subject and two columns: the first column with proportions of success in the reference group, the second column with proportions of success in the focal group.
- **anchor** a vector of integer values specifying which items (all by default) are currently considered as anchor (DIF free) items. See Details.
Details
This command basically computes the perpendicular distances from each Delta point to the major axis (Angoff, 1982; Angoff and Ford, 1973). It forms the basic command of difTID and is specifically designed for this call.

The data are passed through the prop argument, a matrix with one row per item and two columns. The first column holds the proportions of success (correct responses) for each item in the reference group, and the second column provides the same information but for the focal group. Missing values are not allowed. Moreover, these proportions are internally constrained into the interval [0.001; 0.999] to ensure valid computation of Delta scores.

The computation is made in three steps: (a) the proportions of success are transformed into Delta scores; (b) the major axis of the ellipse made by the Delta points is determined and its intercept and slope parameters are obtained; (c) the perpendicular distances (between each Delta point and the major axis) are computed. See Angoff (1982) and Angoff and Ford (1973) for further details.

Option anchor sets the items which are considered as anchor items for computing the perpendicular distances. Only anchor items are used to compute the intercept and slope parameters of the major axis. anchor must hold integer values specifying the column numbers of the corresponding anchor items. It is primarily designed to perform item purification.

Value
A list with four arguments:

prop  the value of the prop argument.
delta  the matrix of Delta scores, in the same format as prop.
pars  a vector of length two with the intercept and slope parameters of the major axis of Delta points.
dist  a numeric vector of perpendicular distances.

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References


See Also
difTID, dichodif
Verbal Aggression Data Set

Description

The Verbal Aggression data set comes from Vansteelandt (2000) and is made of the responses of 316 subjects (243 women and 73 men) to a questionnaire of 24 items, about verbal aggression. All items describe a frustrating situation together with a verbal aggression response. A correct answer responses is coded as 0 and 1, a value of one meaning that the subject would (want to) respond to the frustrating situation in an aggressive way. In addition, the Trait Anger score (Spielberger, 1988) was computed for each subject.

Format

The verbal matrix consists of 316 rows (one per subject) and 26 columns. The first 24 columns hold the responses to the dichotomously scored items. The 25th column holds the trait anger score for each subject. The 26th column is vector of the group membership; values 0 and 1 refer to women and men, respectively.

Each item name starts with S followed by a value between 1 and 4, referring to one of the situations below:

S1: A bus fails to stop for me.
S2: I miss a train because a clerk gave me faulty information.
S3: The grocery store closes just as I am about to enter.
S4: The operator disconnects me when I had used up my last 10 cents for a call.

The second part of the name is either Want or Do, and indicates whether the subject wanted to respond to the situation or actually did respond.

Examples

```r
## Not run:

# Loading of the verbal data
data(verbal)

# Computing proportions of success
props <- cbind(colMeans(verbal[,26]==0:1:24),
               colMeans(verbal[,26]==1:1:24))

# Perpendicular distances
trItemDiff(props)

# Removing item 6 from the set of anchor items
trItemDiff(props, anchor = c(1,5,7:24))

## End(Not run)
```
The third part of the name is one of the possible aggressive responses, either **Curse**, **Scold** or **Shout**. For example, item $s1\text{WantShout}$ refers to the sentence: "a bus fails to stop for me. I want to shout". The corresponding item response is 1 if the subject agrees with that sentence, and 0 if not.

**Source**

The Verbal aggression data set is taken originally from Vansteelandt (2000) and has been used as an illustrative example in De Boeck (2008), De Boeck and Wilson (2004) and Smits, De Boeck and Vansteelandt (2004), among others. The following URL http://bear.soe.berkely.edu/EIRM/ permits to get access to the full data set.

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