Package 'DIFtree'

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Title Item Focussed Trees for the Identification of Items in Differential Item Functioning

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Description Item focussed recursive partitioning for simultaneous selection of items and variables that induce Differential Item Functioning (DIF) in dichotomous or polytomous items.

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`data_sim_PCM` *Simulated Data Set with Polytomous Items*

Description

The data set is simulated from a Partial Credit Model where some items exhibit differential item functioning. Existing differences in item difficulties are simulated by step-functions. The true, simulated DIF structure is described in Bollmann et al. (2017), Section 4.3.

Usage

```
data(data_sim_PCM)
```

Format

A data frame containing 500 observations on 4 variables:

Y matrix with categorical responses (3-point scale)

x1 binary covariate

x2 ordinal covariate

x3 numeric covariate

References

Bollmann, Stella, Berger, Moritz & Tutz, Gerhard (2018): Item-Focussed Trees for the Detection of Differential Item Functioning in Partial Credit Models, Educational and Psychological Measurement 78(5), 781-804.

Examples

```
data(data_sim_PCM)

Y <- data_sim_PCM[,1]
X <- data_sim_PCM[,-1]

apply(Y,2,table)
summary(X)
```

`data_sim_Rasch` *Simulated Data Set with Dichotomous Items*

Description

The data set is simulated from a Rasch model where some items exhibit differential item functioning. Existing differences in item difficulties are simulated by step-functions. The true, simulated DIF structure is described in Tutz and Berger (2015), Section 4.2.

Usage

```
data(data_sim_Rasch)
```

Format

A data frame containing 500 observations on 5 variables:

Y matrix with binary 0/1 response for 20 items

x1 binary covariate 1

x2 metric covariate 1

x3 binary covariate 2

x4 metric covariate 2

References

Berger, Moritz and Tutz, Gerhard (2016): Detection of Uniform and Non-Uniform Differential Item Functioning by Item Focussed TreesJournal of Educational and Behavioral Statistics 41(6), 559-592.

Tutz, Gerhard and Berger, Moritz (2016): Item focussed Trees for the Identification of Items in Differential Item Functioning, Psychometrika 81(3), 727-750.

Examples

```
data(data_sim_Rasch)

Y <- data_sim_Rasch[,1]
X <- data_sim_Rasch[,-1]

hist(rowSums(Y), breaks = 0:19 + 0.5)
summary(X)
```

DIFtree *Item focussed Trees for the Identification of Items in Differential Item Functioning*

Description

A function to estimate item focussed trees for simultaneous selection of items and variables that induce DIF (Differential Item Functioning) in dichotomous or polytomous items. DIF detection can be based on the Rasch Model (dichotomous case), the Logistic Regression Approach (dichotomous case) or the Partial Credit Model (polytomous case). The basic method of item focussed recursive partitioning in Rasch Models is described in Tutz and Berger (2015).

Usage

```
DIFtree(Y, X, model = c("Rasch", "Logistic", "PCM"), type = c("udif", "dif",
  "nudif"), alpha = 0.05, nperm = 1000, trace = FALSE, penalize = FALSE,
  ...)

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

Arguments

Y	Matrix or Data.frame of binary 0/1 or categorical response (rows correspond to persons, columns correspond to items)
X	Data.frame of (not scaled) covariates (rows correspond to persons, columns correspond to covariates)
model	Type of model to be fitted; can be "Rasch", "Logistic" or "PCM".
type	Type of DIF to be modelled; one out of "udif", "dif" and "nudif". For "Rasch" and "PCM" only uniform DIF can be modelled and therefore type will be ignored.
alpha	Global significance level for the permutation tests
nperm	Number of permutations used for the permutation tests
trace	If true, information about the estimation progress is printed
penalize	If true, a small ridge penalty is added to ensure existence of model parameters; only for "Rasch".
...	Further arguments passed to or from other methods
x	Object of class "DIFtree"

Details

The methods require 0/1 coded answers on binary items ("Rasch" and "Logistic") or categorical answers on polytomous items ("PCM"). Items with DIF are gradually identified by recursive partitioning.

For "Rasch" one yields a model with linear predictors

$$eta_{pi} = theta_p - tr_i(x_p),$$

where $theta_p$ correspond to the ability and x_p correspond to the covariate vector of person p.

For "Logistic" one yields a model with linear predictors

- Uniform DIF, type="udif"

$$eta_{pi} = S_p beta_i + tr_i(x_p),$$

  where S_p corresponds to the test score and x_p corresponds to the covariate vector of person p.
- DIF and Non-Uniform DIF, type="dif", "nudif"

$$eta_{pi} = tr_i(x_p) + tr_i(S_p, x_p),$$

  where S_p corresponds to the test score and x_p corresponds to the covariate vector of person p.

For "PCM" one yields a model with linear predictors

$$eta_{pir} = theta_p - tr_{ir}(x_p),$$

where $theta_p$ correspond to the ability and x_p correspond to the covariate vector of person p.

Significance of each split is verified by permutation tests. The result of the permutation tests can strongly depend on the number of permutations nperm. In the case of pure terminal nodes estimates of the model do not exist. If penalize=TRUE a small ridge penalty is added during estimation to ensure existence of all parameters.

Value

Object of class "DIFtree". An object of class "DIFtree" is a list containing the following components:

splits	Matrix with detailed information about all executed splits during the estimation process
coefficients	List of estimated coefficients for items with and without DIF. Structure of coefficients depends on model and type.
pvalues	P-values of each permutation test during the estimation process
devs	Maximal value statistics T_j of the selected variables in each iteration during the estimation process
crit	Critical values of each permutation test during the estimation process
Y	Response matrix used in the estimation process
X	Model matrix used in the estimation process
persons	Number of persons
items	Number of items

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References

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Bollmann, Stella, Berger, Moritz & Tutz, Gerhard (2018): Item-Focussed Trees for the Detection of Differential Item Functioning in Partial Credit Models, Educational and Psychological Measurement 78(5), 781-804.

Swaminathan, Hariharan and Rogers, H Jane (1990): Detecting differential item functioning using logistic regression procedures, Journal of Educational Measurements 27(4), 361-370.

Tutz, Gerhard and Berger, Moritz (2016): Item focussed Trees for the Identification of Items in Differential Item Functioning, Psychometrika 81(3), 727-750.

See Also

plot.DIFtree, predict.DIFtree, summary.DIFtree

Examples

```
data(data_sim_Rasch)
data(data_sim_PCM)

Y1 <- data_sim_Rasch[,1]
X1 <- data_sim_Rasch[,-1]

Y2 <- data_sim_PCM[,1]
X2 <- data_sim_PCM[,-1]

## Not run:

mod1 <- DIFtree(Y=Y1,X=X1,model="Logistic",type="udif",alpha=0.05,nperm=1000,trace=TRUE)
print(mod1)

mod2 <- DIFtree(Y=Y2,X=X2,model="PCM",alpha=0.05,nperm=100,trace=TRUE)
print(mod2)

## End(Not run)
```

---

plot.DIFtree *Plotting of Item focussed Trees*

Description

Visualization of trees for items with DIF identified by item focussed recursive partitioning in dichotomous or polytomous items.

Usage

```
## S3 method for class 'DIFtree'
plot(x, item, component = "intercept", cex.lines = 2,
  cex.branches = 1, cex.coefs = 1, cex.main = 1, title = NULL, ...)
```

Arguments

x	Object of class DIFtree
item	Number of the item, for which the tree shall be plotted
component	Component of the model for which the tree shall be plotted; can be "intercept" or "slope". For "Rasch" and "PCM" only one tree of item parameters is available for each DIF item and therefore component will be ignored.
cex.lines	Width of branches of the tree
cex.branches	Size of the labels of branches of the tree
cex.coefs	Size of coefficients in the terminal nodes of the tree
cex.main	Size of the title of the tree
title	Optional title, which is added to the tree; if title=NULL the title is the number of the plotted item.
...	Further arguments passed to or from other methods

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Bollmann, Stella, Berger, Moritz & Tutz, Gerhard (2018): Item-Focussed Trees for the Detection of Differential Item Functioning in Partial Credit Models, Educational and Psychological Measurement 78(5), 781-804.

Tutz, Gerhard and Berger, Moritz (2016): Item focussed Trees for the Identification of Items in Differential Item Functioning, Psychometrika 81(3), 727-750.

See Also

DIFtree, predict.DIFtree, summary.DIFtree

Examples

```
data(data_sim_Rasch)

Y <- data_sim_Rasch[,1]
X <- data_sim_Rasch[,-1]
```

```
## Not run:

mod <- DIFtree(Y=Y,X=X,model="Logistic",type="udif",alpha=0.05,nperm=1000,trace=TRUE)

plot(mod,item=1)

## End(Not run)
```

`predict.DIFtree` *Prediction from fitted Item focussed Trees*

Description

The function returns predictions of item parameters obtained by item focussed recursive partitioning in dichotomous or polytomous items.

Usage

```
## S3 method for class 'DIFtree'
predict(object, item, newdata, ...)
```

Arguments

`object`	Object of class `DIFtree`
`item`	Number of the item, for which the prediction shall be returned
`newdata`	New data.frame, for which the prediction shall be returned
`...`	Further arguments passed to or from other methods

Details

For `"Rasch"` model the function returns the predicted item difficulty. For `"Logistic"` models the function returns the predicted intercept and/or slope. For `"PCM"` the function returns the predicted threshold parameters.

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References

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Bollmann, Stella, Berger, Moritz & Tutz, Gerhard (2018): Item-Focussed Trees for the Detection of Differential Item Functioning in Partial Credit Models, Educational and Psychological Measurement 78(5), 781-804.

Tutz, Gerhard and Berger, Moritz (2016): Item focussed Trees for the Identification of Items in Differential Item Functioning, Psychometrika 81(3), 727-750.

See Also

DIFtree, plot.DIFtree, summary.DIFtree

Examples

```
data(data_sim_Rasch)

Y <- data_sim_Rasch[,1]
X <- data_sim_Rasch[,-1]

Xnew <- data.frame("x1"=c(0,1),"x2"=c(-1.1,2.5),"x3"=c(1,0),"x4"=c(-0.2,0.7))

## Not run:

mod <- DIFtree(Y=Y,X=X,model="Logistic",type="udif",alpha=0.05,nperm=1000,trace=TRUE)

predict(mod,item=1,Xnew)

## End(Not run)
```

---

summary.DIFtree *Summary for fitted Item focussed Trees*

Description

The function takes an object of class "DIFtree" and returns an useful summary with an overiew of all executed splits during the estimation procedure.

Usage

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

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

Arguments

object	Object of class DIFtree
...	Further arguments passed to or from other methods
x	Object of class summary.DIFtree

Value

Object of class "summary.DIFtree". An object of class "summary.DIFtree" is a list containing the following components:

stats	Useful overview of detected DIF items, responsible variables and executed splits
nosplits	Total number of executed splits during the estimation procedure

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References

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Bollmann, Stella, Berger, Moritz & Tutz, Gerhard (2018): Item-Focussed Trees for the Detection of Differential Item Functioning in Partial Credit Models, Educational and Psychological Measurement 78(5), 781-804.

Tutz, Gerhard and Berger, Moritz (2016): Item focussed Trees for the Identification of Items in Differential Item Functioning, Psychometrika 81(3), 727-750.

See Also

DIFtree, plot.DIFtree, predict.DIFtree

Examples

```
data(data_sim_Rasch)

Y <- data_sim_Rasch[,1]
X <- data_sim_Rasch[,-1]

## Not run:

mod <- DIFtree(Y=Y,X=X,model="Logistic",type="udif",alpha=0.05,nperm=1000,trace=TRUE)

summary(mod)

## End(Not run)
```

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