Package ‘equateMultiple’

April 6, 2021

**Type** Package

**Title** Equating of Multiple Forms

**Version** 0.1.0

**Author** Michela Battauz

**Maintainer** Michela Battauz <michela.battauz@uniud.it>


**License** GPL-3

**Imports** stats, graphics, numDeriv, statmod, Rcpp (>= 0.12.11)

**Depends** equateIRT(>= 2.0-4)

**LinkingTo** Rcpp, RcppArmadillo

**Suggests** knitr, rmarkdown, ltm

**VignetteBuilder** knitr

**NeedsCompilation** yes

**Repository** CRAN

**Date/Publication** 2021-04-06 15:30:03 UTC

**R topics documented:**

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>EquateMultiple-package</td>
<td>2</td>
</tr>
<tr>
<td>eqc.mlteqc</td>
<td>3</td>
</tr>
<tr>
<td>itm.mlteqc</td>
<td>4</td>
</tr>
<tr>
<td>multieqc</td>
<td>5</td>
</tr>
<tr>
<td>score.mlteqc</td>
<td>7</td>
</tr>
<tr>
<td>summary.mlteqc</td>
<td>9</td>
</tr>
</tbody>
</table>

**Index** 10
EquateMultiple-package

Equating of Multiple Forms

Description

The EquateMultiple package implements IRT-based methods to equate simultaneously many forms calibrated separately. This package estimates the equating coefficients to convert the item parameters and the ability values to the scale of the base form. It can be applied to a large number of test forms, as well as to 2 forms. The computation of the equated scores is also implemented.

Details

This package implements the methods proposed in Haberman (2009) and Battauz (2017). Function multiec computes the equating coefficients to convert the item parameters and the ability values to the scale of the base form. The methods implemented are: multiple mean-geometric mean (Haberman, 2009), multiple mean-mean, multiple item response function, and multiple test response function (Battauz, 2017). The function provides the equating coefficients, the synthetic item parameters and the standard errors of the equating coefficients and the synthetic item parameters. Equated scores can be computed using true score equating and observed score equating methods. Standard errors of equated scores are also provided.

Author(s)

Michela Battauz

Maintainer: Michela Battauz <michela.battauz@uniud.it>

References


See Also
equateIRT

Examples

data(est2pl)
# prepare the data
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)
# Estimation of the equating coefficients with the multiple mean-mean method
eqMM <- multiec(mods = mods, base = 1, method = "mean-mean")
summary(eqMM)
# Estimation of the equating coefficients with the multiple mean-geometric mean method (Haberman, 2009)
eqMGM <- multiec(mods = mods, base = 1, method = "mean-gmean")
summary(eqMGM)

# Estimation of the equating coefficients with the multiple item response function method
eqIRF <- multiec(mods = mods, base = 1, method = "irf")
summary(eqIRF)

# Estimation of the equating coefficients with the multiple item response function method
# using as initial values the estimates obtained with the multiple mean-geometric mean method
# eqMGM <- multiec(mods = mods, base = 1, method = "mean-gmean", se = FALSE)
eqIRF <- multiec(mods = mods, base = 1, method = "irf", start = eqMGM)
summary(eqIRF)

# Estimation of the equating coefficients with the multiple test response function method
eqTRF <- multiec(mods = mods, base = 1, method = "trf")
summary(eqTRF)

# scoring using the true score equating method and equating coefficients
# obtained with the multiple item response function method
score(eqIRF)

---

eqc.mlteqc

**Extract Equating Coefficients of Multiple Forms**

**Description**

eqc is a generic function which extracts the equating coefficients.

**Usage**

```r
## S3 method for class 'mlteqc'
eqc(x, ...)
```

**Arguments**

- `x` object of the class mlteqc returned by function `multiec`
- `...` further arguments passed to or from other methods.

**Value**

A data frame containing the equating coefficients.

**Author(s)**

Michela Battauz
See Also

`multieic`

Examples

data(est2pl)
# prepare the data
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)
# Estimation of the equating coefficients with the multiple item response function method
eqIRF <- multiec(mods = mods, base = 1, method = "irf")

# extract equating coefficients
eqc(eqIRF)

itm.mlteqc

Extract Item Parameters

Description

`itm` is a generic function which extracts a data frame containing the item parameters of multiple forms being equated in the original scale and the item parameters converted to the scale of the base form.

Usage

```r
## S3 method for class 'mlteqc'
itm(x, ...)
```

Arguments

- `x` object of the class `mlteqc` returned by function `multieic`
- `...` further arguments passed to or from other methods.

Value

A data frame containing item names (Item), item parameters of all the forms (e.g. T1, ..., T3), and item parameters of all the forms converted in the scale of the base form (e.g. T3.as.T1).

Author(s)

Michela Battauz

See Also

`multieic`
Examples

data(est2pl)
# prepare the data
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)
# Estimation of the equating coefficients with the multiple item response function method
eqIRF <- multiec(mods, base = 1, method = "irf")

# extract item parameters
itm(eqIRF)

multiec  Multiple Equating Coefficients

Description
Calculates the equating coefficients between multiple forms.

Usage
multiec(mods, base = 1, method = "mean-mean", se = TRUE, nq = 30, start = NULL, eval.max = 100000)

Arguments
mods an object of the class modIRT containing item parameter coefficients and their covariance matrix of the forms to be equated.
base integer value indicating the base form.
method the method used to compute the equating coefficients. This should be one of "mean-mean", "mean-gmean", "irf" or "trf" (see details).
se logical; if TRUE the standard errors of the equating coefficients and the synthetic item parameters are computed.
nq number of quadrature points used for the Gauss-Hermite quadrature for methods "irf" or "trf".
start initial values. This can be a vector containing the A and B equating coefficients excluding the base form, or an object of class mlteqc returned by function multiec. Used only with methods "irf" and "trf".
eval.max maximum number of evaluations of the objective function allowed. Used only with methods "irf" and "trf".

Details
The methods implemented for the computation of the multiple equating coefficients are the multiple mean-mean method ("mean-mean"), the multiple mean-geometric mean method ("mean-gmean"), the multiple item response function method ("irf") and the multiple test response function method ("trf").
Value

An object of class `mlteqc` with components

- `A`: A equating coefficients.
- `B`: B equating coefficients.
- `se.B`: standard errors of B equating coefficients.
- `varAB`: covariance matrix of equating coefficients.
- `as`: synthetic discrimination parameters $\hat{a}_j^*$. 
- `bs`: synthetic difficulty parameters $\hat{b}_j^*$. 
- `se.as`: standard errors of synthetic discrimination parameters.
- `se.bs`: standard errors of synthetic difficulty parameters.
- `tab`: data frame containing item names (Item), item parameters of all the forms (e.g. T1, ..., T3), and item parameters of all the forms converted in the scale of the base form (e.g. T3.as.T1).
- `varFull`: list of covariance matrices of the item parameters of every form.
- `partial`: partial derivatives of equating coefficients with respect to the item parameters.
- `itmp`: number of item parameters of the IRT model.
- `method`: the equating method used.
- `basename`: the name of the base form.
- `convergence`: An integer code. 0 indicates successful convergence. Returned only with methods "irf" and "trf".

Author(s)

Michela Battauz

References


See Also

`modIRT`, `score.mlteqc`

Examples

```r
data(est2pl)
# prepare the data
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)
# Estimation of the equating coefficients with the multiple mean-mean method
eqMM <- multiec(mods = mods, base = 1, method = "mean-mean")
```
summary(eqMGM)

# Estimation of the equating coefficients with the multiple mean-geometric mean method (Haberman, 2009)
eqMGM <- multiec(mods = mods, base = 1, method = "mean-gmean")
summary(eqMGM)

# Estimation of the equating coefficients with the multiple item response function method
eqIRF <- multiec(mods = mods, base = 1, method = "irf")
summary(eqIRF)

# Estimation of the equating coefficients with the multiple item response function method
# using as initial values the estimates obtained with the multiple mean-geometric mean method
eqMGM <- multiec(mods = mods, base = 1, method = "mean-gmean", se = FALSE)
eqIRF <- multiec(mods = mods, base = 1, method = "irf", start = eqMGM)
summary(eqIRF)

# Estimation of the equating coefficients with the multiple test response function method
eqTRF <- multiec(mods = mods, base = 1, method = "trf")
summary(eqTRF)

---

score.mlteqc  Scoring of multiple forms

### Description

Relates number-correct scores on multiple forms.

### Usage

```r
## S3 method for class 'mlteqc'
score(obj, method="TSE", D=1, scores=NULL, se=TRUE, nq=30,
w=0.5, theta=NULL, weights=NULL, ...)
```

### Arguments

- `obj`: object of the class mlteqc returned by function `multiec`.
- `method`: the scoring method to be used. This should be one of "TSE" (the default) for true score equating or "OSE" for observed score equating.
- `D`: constant D of the IRT model used to estimate item parameters.
- `scores`: integer values to be converted.
- `se`: logical; is TRUE standard errors of equated scores are computed.
- `nq`: number of quadrature points used to approximate integrals with observed score equating. Used only if arguments `theta` and `weights` are NULL.
- `w`: synthetic weight for population 1. It should be a number between 0 and 1.
- `theta`: vector of ability values used to approximate integrals with observed score equating.
- `weights`: vector of weights used to approximate integrals with observed score equating.
- `...`: further arguments passed to or from other methods.
Details

In this function common items are internal, i.e. they are used for scoring the test.

Value

A data frame containing theta values (only for true score equating), scores of the form chosen as base, equated scores of all other forms, and standard errors of equated scores.

Author(s)

Michela Battauz

References


See Also

*multieic*

Examples

data(est2pl)
# prepare the data
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)

# Estimation of the equating coefficients with the multiple item response function method
eqIRF <- multieic(mods = mods, base = 1, method = "irf")
summary(eqIRF)

# scoring using the true score equating method
score(eqIRF)

# scoring using observed score equating method, without standard errors
score(eqIRF, method = "OSE", se = FALSE)
Summary for class \texttt{mlteqc}.

Usage

\begin{verbatim}
## S3 method for class 'mlteqc'
summary(object, ...)  
\end{verbatim}

Arguments

- \texttt{object} \hspace{1cm} an object of the class \texttt{mlteqc} returned by function \texttt{multiec}.
- \texttt{...} \hspace{1cm} further arguments passed to or from other methods.

Author(s)

Michela Battauz

See Also

\texttt{multiec}

Examples

\begin{verbatim}
data(est2pl)  
# prepare the data  
mods <- modIRT(coef = est2pl$coef, var = est2pl$var, display = FALSE)  
# Estimation of the equating coefficients with the multiple mean-mean method  
eqMM <- multiec(mods = mods, base = 1, method = "mean-mean")  
summary(eqMM)
\end{verbatim}
Index

* package
  EquateMultiple-package, 2

eqc.mlteqc, 3
equateIRT, 2
EquateMultiple
  (EquateMultiple-package), 2
EquateMultiple-package, 2
itm.mlteqc, 4
modIRT, 5, 6
multiec, 2–4, 5, 7–9
print.mlteqc(multiec), 5
score.mlteqc, 6, 7
summary.mlteqc, 9