Package 'DFIT'

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Title Differential Functioning of Items and Tests

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Imports msm, mirt, simex, mvtnorm, ggplot2

Description A set of functions to perform Raju, van der Linden and Fleer's (1995, <doi:10.1177/014662169501900405>) Differential Functioning of Items and Tests (DFIT) analyses. It includes functions to use the Monte Carlo Item Parameter Replication approach (Oshima, Raju, & Nanda, 2006, <doi:10.1111/j.1745-3984.2006.00001.x>) for obtaining the associated statistical significance tests cut-off points. They may also be used for a priori and post-hoc power calculations (Cervantes, 2017, <doi:10.18637/jss.v076.i05>).

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`Ase1pl` *Calculates the asymptotic variance for difficulty parameter estimates under the 1pl model*

Description

Calculates the asymptotic variance for difficulty parameter estimates under the 1pl model

Usage

```
Ase1pl(
  itemParameters,
  distribution = "norm",
  distributionParameters = list(mean = 0, sd = 1),
  logistic = TRUE,
  sampleSize = 1,
  subdivisions = 5000
)
```

Arguments

itemParameters	A matrix or vector containing the item difficulties.
distribution	A string character indicating the generic name for the assumed distribution.
distributionParameters	A list of extra parameters for the distribution function.
logistic	A logical indicating whether the logistic or the normal metric should be used.
sampleSize	A value indicating the sample size.
subdivisions	A numeric value stating the maximum number of subdivisions for adaptive quadrature.

Value

ase A list containing the asymptotic variances for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Li, Y. & Lissitz, R. (2004). Applications of the analytically derived standard errors of Item Response Theory item parameter estimates. Journal of educational measurement, 41(2), 85–117. doi:10.1111/j.1745-3984.2004.tb01109.x

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Ase2pl *Calculates the asymptotic covariance matrix of item parameter estimates under the 2pl model*

Description

Calculates the asymptotic covariance matrix of item parameter estimates under the 2pl model

Usage

```
Ase2pl(
  itemParameters,
  distribution = "norm",
  distributionParameters = list(mean = 0, sd = 1),
  logistic = TRUE,
  sampleSize = 1,
  subdivisions = 5000
)
```

Arguments

itemParameters	A matrix or vector containing the item difficulties.
distribution	A string character indicating the generic name for the assumed distribution.
distributionParameters	A list of extra parameters for the distribution function.
logistic	A logical indicating whether the logistic or the normal metric should be used.
sampleSize	A value indicating the sample size.
subdivisions	A numeric value stating the maximum number of subdivisions for adaptive quadrature.

Value

ase A list containing the asymptotic matrices for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Li, Y. & Lissitz, R. (2004). Applications of the analytically derived standard errors of Item Response Theory item parameter estimates. Journal of educational measurement, 41(2), 85–117. doi:10.1111/j.1745-3984.2004.tb01109.x

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Ase3pl *Calculates the asymptotic covariance matrix of item parameter estimates under the 3pl model*

Description

Calculates the asymptotic covariance matrix of item parameter estimates under the 3pl model

Usage

```
Ase3pl(
  itemParameters,
  distribution = "norm",
  distributionParameters = list(mean = 0, sd = 1),
  logistic = TRUE,
  sampleSize = 1,
  subdivisions = 5000
)
```

Arguments

itemParameters	A matrix or vector containing the item difficulties.
distribution	A string character indicating the generic name for the assumed distribution.
distributionParameters	A list of extra parameters for the distribution function.
logistic	A logical indicating whether the logistic or the normal metric should be used.
sampleSize	A value indicating the sample size.
subdivisions	A numeric value stating the maximum number of subdivisions for adaptive quadrature.

Value

ase A list containing the asymptotic matrices for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Li, Y. & Lissitz, R. (2004). Applications of the analytically derived standard errors of Item Response Theory item parameter estimates. Journal of educational measurement, 41(2), 85–117. doi:10.1111/j.1745-3984.2004.tb01109.x

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AseIrt *Calculates the asymptotic covariance matrices for item parameters according with the IRT model.*

Description

Calculates the asymptotic covariance matrices for item parameters according with the IRT model.

Usage

```
AseIrt(
  itemParameters,
  distribution = "norm",
  distributionParameters = list(mean = 0, sd = 1),
  logistic = TRUE,
  sampleSize = 1,
  irtModel = "3pl",
  subdivisions = 5000
)
```

Arguments

itemParameters	A matrix or vector containing the item difficulties.
distribution	A string character indicating the generic name for the assumed distribution. Defaults to 'norm' for normal distribution.
distributionParameters	A list of extra parameters for the distribution function.
logistic	A logical indicating whether the logistic or the normal metric should be used.
sampleSize	A value indicating the sample size.
irtModel	A string stating the IRT model for all items.
subdivisions	A numeric value stating the maximum number of subdivisions for adaptive quadrature.

Value

ase A list containing the asymptotic matrices for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Li, Y. & Lissitz, R. (2004). Applications of the analytically derived standard errors of Item Response Theory item parameter estimates. Journal of educational measurement, 41(2), 85–117. doi:10.1111/j.1745-3984.2004.tb01109.x

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]         <- threePlParameters[['focal']][!isNot3Pl, ]
```

```
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 15000,
# #                                     irtModel = "3pl")
```

`Bound3PlIpr` *Takes item parameters from Ipr and forces guessing to lie between 0 and 1*

Description

Makes all simulated guessing values from a 3PL model that are outside the [0, 1] interval to be 0 or 1.

Usage

```
Bound3PlIpr(itemParameterList)
```

Arguments

`itemParameterList`
: A list where each element is a list containing "focal" and "reference" item Parameters from a 3PL model. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items

Value

itemParameterList A list where each element is a list containing "focal" and "reference" item Parameters where guessing parameters outside the [0, 1] interval are changed by 0 and 1.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 15000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# # threePlIpr <- Bound3PlIpr(threePlIpr)
```

`Bound4PlIpr` *Takes item parameters from Ipr and forces guessing to lie between 0 and 1*

Description

Makes all simulated guessing values from a 3PL model that are outside the [0, 1] interval to be 0 or 1.

Usage

```
Bound4PlIpr(itemParameterList)
```

Arguments

itemParameterList
: A list where each element is a list containing "focal" and "reference" item Parameters from a 3PL model. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items

Value

itemParameterList A list where each element is a list containing "focal" and "reference" item Parameters where guessing parameters outside the [0, 1] interval are changed by 0 and 1.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 15000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# # threePlIpr <- Bound3PlIpr(threePlIpr)
```

Calculate1plProb *Calculates the item success probability under the 1PL model.*

Description

Calculates the item success probability under the 1PL model.

Usage

```
Calculate1plProb(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

thetaValue	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
itemParameters	A vector or column matrix containing the numeric values of item difficulties
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

probabilities A numeric matrix with the probabilities on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

Calculate2plProb *Calculates the item success probability under the 2PL model.*

Description

Calculates the item success probability under the 2PL model.

Usage

```
Calculate2plProb(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

thetaValue	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
itemParameters	A matrix containing the numeric values of item discriminations on the first column and item difficulties on the second
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

probabilities A numeric matrix with the probabilities on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

---

Calculate3plProb *Calculates the item success probability under the 3PL model.*

Description

Calculates the item success probability under the 3PL model.

Usage

```
Calculate3plProb(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

thetaValue	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
itemParameters	A matrix containing the numeric values of item discriminations on the first column, item difficulties on the second and item guessing parameters on the third
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

probabilities A numeric matrix with the probabilities on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

---

`Calculate4plProb` *Calculates the item success probability under the 4PL model.*

Description

Calculates the item success probability under the 4PL model.

Usage

```
Calculate4plProb(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

`thetaValue`	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
`itemParameters`	A matrix containing the numeric values of item discriminations on the first column, item difficulties on the second, item guessing parameters on the third, and item upper asymptote on the fourth
`logistic`	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

probabilities A numeric matrix with the probabilities on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

`CalculateGrmExp` *Calculates the expected item score under the GRM model.*

Description

Calculates the expected item score under the GRM model.

Usage

```
CalculateGrmExp(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

`thetaValue`	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
`itemParameters`	A matrix containing the numeric values of item discriminations on the first column and category thresholds on the rest columns where the (column position - 1) indicates the category score or weight.
`logistic`	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

expectedScore A numeric matrix with the expected score on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

Oshima, T. & Morris, S. (2008). Raju's Differential Functioning of Items and Tests (DFIT). Educational Measurement: Issues and Practice, 27(3), 43–50. doi:10.1111/j.1745-3992.2008.00127.x

`CalculateItemDifferences`

Calculates the differences between two item option characteristic curves for all options (minus one).

Description

Calculates the differences between two item option characteristic curves for all options (minus one).

Usage

```
CalculateItemDifferences(
  thetaValue,
  itemParameters,
  irtModel = "2pl",
  logistic = TRUE
)
```

Arguments

thetaValue	A numeric value or array for the theta (ability) value(s) for which the difference will be calculated
itemParameters	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

difference A numeric matrix with the differences on probabilities or on expected score for each item between focal and reference groups.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

CalculatePcmExp *Calculates the expected item score under the (G)PCM model.*

Description

Calculates the expected item score under the (G)PCM model.

Usage

```
CalculatePcmExp(thetaValue, itemParameters, logistic = TRUE)
```

Arguments

thetaValue	A numeric value or array for the theta (ability) value(s) where the difference will be calculated
itemParameters	A matrix containing the numeric values of item discriminations on the first column and category thresholds on the rest columns where the (column position - 1) indicates the category score or weight.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.

Value

expectedScore A numeric matrix with the expected score on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

Oshima, T. & Morris, S. (2008). Raju's Differential Functioning of Items and Tests (DFIT). Educational Measurement: Issues and Practice, 27(3), 43–50. doi:10.1111/j.1745-3992.2008.00127.x

---

`Cdif` *Calculates CDIF index for an item with given item parameters of focal and reference groups.*

Description

Calculates CDIF index for an item with given item parameters of focal and reference groups.

Usage

```
Cdif(
  itemParameters,
  irtModel = "2pl",
  focalAbilities = NULL,
  focalDistribution = "norm",
  subdivisions = 5000,
  logistic = TRUE,
  focalDistrExtra = list(mean = 0, sd = 1)
)
```

Arguments

`itemParameters`	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
`irtModel`	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
`focalAbilities`	If NULL, NCDIF is calculated by numerical integration of focal distribution. If not NULL, it must be a numerical vector containing the abilities for the individuals in the focal group.

`focalDistribution`
: A string stating the distribution name to be used for integrating. Only used if focalAbilities is NULL.

`subdivisions`
: A numeric value indicating the number of subdivisions for numerical integration. Only used if focalAbilities is NULL.

`logistic`
: A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

`focalDistrExtra`
: Extra parameters for the focal group distribution function if needed.

Value

cdif Numeric vector with the CDIF index value for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Raju, N. S., van der Linden, W. J., & Fleer, P. F. (1995). IRT-based internal measures of differential functioning of items and tests. Applied Psychological Measurement, 19, 353–368. doi:10.1177/014662169501900405

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# #
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlCdif <- Cdif(itemParameters = dichotomousItemParameters, irtModel = '3pl',
# #                     focalAbilities = NULL, focalDistribution = "norm",
# #                     subdivisions = 5000, logistic = TRUE)
```

CheckDiscriminations *Identifies items with nonpositive discrimination*

Description

Identifies items with nonpositive discrimination

Usage

```
CheckDiscriminations(itemParameters)
```

Arguments

itemParameters	A vector or column matrix containing the numeric values of item difficulties

Value

message A character string used to signal items with nonpsitive discriminations

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

CheckGuessings *Identifies items with guessing outside [0, 1]*

Description

Identifies items with guessing outside [0, 1]

Usage

```
CheckGuessings(itemParameters)
```

Arguments

itemParameters	A vector or column matrix containing the numeric values of item difficulties

Value

message A character string used to signal items iadmissible guessing parameters

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

`CheckUpper` *Identifies items with upper asymptote outside [0, 1]*

Description

Identifies items with upper asymptote outside [0, 1]

Usage

```
CheckUpper(itemParameters)
```

Arguments

`itemParameters`	A vector or column matrix containing the numeric values of item difficulties

Value

message A character string used to signal items iadmissible guessing parameters

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

`CrossedProbabilities` *Calculates the crossed probabilities associated with the numerator and denominator of the odds-ratio under dichotomous IRT models*

Description

Calculates the crossed probabilities associated with the numerator and denominator of the odds-ratio under dichotomous IRT models

Usage

```
CrossedProbabilities(thetaValue, itemParameters, logistic, irtModel = "3pl")
```

Arguments

`thetaValue`	A numeric value or array for the theta (ability) value(s) for which the odds will be calculated
`itemParameters`	A list containing the "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale.
`logistic`	A logical indicating whether the logistic or the normal metric should be used.
`irtModel`	A string stating the irtModel used. May be one of "1pl", "2pl", or "3pl".

Value

out A list containing the crossed products for the 'num' the numerator, 'den' the denominator for the odds-ratio, and 'or' the odds-ratio

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Roussos, L., Schnipke, D. & Pashley, P. (1999). A generalized formula for the Mantel-Haenszel Differential Item Functioning parameter. Journal of educational and behavioral statistics, 24(3), 293–322. doi:10.3102/10769986024003293

`CutoffIpr` *Cut-off points for Ipr generated estimates*

Description

Calculates a given quantile cut-off point for each item on the IPR estimated items statistics. This function may produce the cut-off points for the NCDIF index, Signed and Unsigned Area Measures and the Mantel-Haenszel statistic based on the Monte Carlo Item parameter replication approach. The quantiles may be calculated directly on the output from the IprNcdif, IprSam, IprUam, and IprMh functions; the may be calculated by obtaining the corresponding statistics for the item parameters simulated under the IPR approach; or by obatining both the simulated item parameters and the statistics based on the item parameter values and their corresponging covariance matrices for the parameter estimates. In the latter case, the user may choose to obtain the IPR simulated item parameters based only on the focal group's covariance matrix as proposed by Oshima et al. (2006), or both focal and reference groups' matrices as proposed by Cervantes (2012).

Usage

```
CutoffIpr(
  iprStatistics = NULL,
  quantiles,
  statistic = "ncdif",
  itemParameterList = NULL,
  irtModel = "2pl",
  focalAbilities = NULL,
  focalDistribution = "norm",
  focalDistrExtra = list(mean = 0, sd = 1),
  referenceDistribution = "norm",
  referenceDistrExtra = list(mean = 0, sd = 1),
  groupRatio = 1,
  subdivisions = 5000,
  logistic = TRUE,
  itemParameters = NULL,
```

```
  itemCovariances = NULL,
  nullGroup = NULL,
  focalSampleSize = NULL,
  referenceSampleSize = NULL,
  nReplicates = 5000
)
```

Arguments

iprStatistics	A numeric matrix with the statistics obtained for the simulated IPR item parameters or a list containing all the elements of the output of this function. If not NULL they will be used for calculating the cut-off points.
quantiles	A numeric vector with the quantiles to be calculated.
statistic	A character indicating which statistic will the cut-off point will be obtained for. If iprStatistics are provided, it is up to the user to correctly especify this string for it will only be informative; otherwise, it will be used to identify the statistic to be calculated. Should be one of "ncdif", "sam", "uam" or "mh".
itemParameterList	A list where each element is a list containing "focal" and "reference" item Parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items. Not used if iprStatistics are not NULL. If itemParameterList is not NULL, the statistic indicated with the argument "statistic" will be obtained for the set of itemParameterList, the corresponding arguments may be provided.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm". Not used if iprStatistics are not NULL.
focalAbilities	Only used if statistic is "ncdif". If NULL, NCDIF is calculated by numerical integration of focal distribution. If not NULL, must be a numerical vector containing the abilities for the individuals in the focal group.
focalDistribution	A string stating the distribution assumed for the focal group. Not used if iprStatistics are not NULL.
focalDistrExtra	A list stating the extra parameters needed by the focal distribution function. Not used if iprStatistics are not NULL.
referenceDistribution	A string stating the distribution assumed for the reference group. Not used if iprStatistics are not NULL.
referenceDistrExtra	A list stating the extra parameters needed by the reference distribution function. Not used if iprStatistics are not NULL.
groupRatio	A positive value indicating how many members of the reference group are expected for each member of the focal group. Only used if iprStatistics are NULL and statistic is "mh".
subdivisions	A numeric value indicating the number of subdivisions for numerical integration. Only used if focalAbilities and iprStatistics are NULL.

`logistic` A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

`itemParameters` A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items. Only used if both iprStatistics and itemParameterList are NULL. If used an itemParameterList from applying the IPR procedure will be simulated and the "statistic" will be calculated.

`itemCovariances`
Either a list containing "focal" and "reference" lists of matrices of covariance for item estimates or the string "asymptotic". Defaults to NULL. Only used if iprStatistics and itemParameterList are NULL, in all other cases the itemCovariances element of the returned list is equal to what is provided as value for these arguments.

`nullGroup` If different from NULL and itemParameterList is NULL, a string equal to 'focal' or 'reference' to indicate which set of item parameters from itemParameters should be taken for the null hypothesis. If equal to NULL, itemParameterList will be generated using the given itemParameters for both groups.

`focalSampleSize`
A positive integer indicating the size of the focal group. Only used if itemCovariances is 'asymptotic'. Defaults to NULL.

`referenceSampleSize`
A positive integer indicating the size of the reference group. Only used if itemCovariances is 'asymptotic'. Defaults to NULL.

`nReplicates` A numeric value indicating the number of replications to perform. Only used if iprStatistics and itemParameterList are NULL.

Value

cutoff A list containing: 'itemParameters', NULL if not provided as argument, 'itemCovariances', NULL if not provided as argument, 'itemParameterList', NULL unless calculated from 'itemParameters' or provided as argument, 'iprStatistics' the matrix of 'statistics' provided as argument or calculated from 'itemParameterList', 'statistic' for which the IPR approach is used according to the provided argument, 'quantiles' the vector or matrix of calculated quantiles for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Cervantes, V. H. (2012). On using the Item Parameter Replication (IPR) approach for power calculation of the noncompensatory differential item functioning (NCDIF) index (pp. 206-207). Proceedings of the V European Congress of Methodology. Santiago de Compostela, Spain: Universidade de Santiago de Compostela.

Cervantes, V. H. (2017). DFIT: An R Package for Raju's Differential Functioning of Items and Tests Framework. Journal of Statistical Software, 76(5), 1-24. doi:10.18637/jss.v076.i05

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Roussos, L., Schnipke, D. & Pashley, P. (1999). A generalized formula for the Mantel-Haenszel Differential Item Functioning parameter. Journal of educational and behavioral statistics, 24(3), 293–322. doi:10.3102/10769986024003293

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 15000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# #
# # threePlIprCutoff <- CutoffIpr(itemParameters = threePlParameters,
# #                               itemCovariances = threePlAse, nullGroup = 'focal',
# #                            nReplicates = 1000, statistic = 'ncdif', irtModel = '3pl')
```

`DeltaMhIrt` *Obtains the ETS Delta measure for Mantel-Haneszel DIF statistic effect size.*

Description

Obtains the ETS Delta measure for Mantel-Haneszel DIF statistic effect size.

Usage

```
DeltaMhIrt(mh, logistic = FALSE)
```

Arguments

mh	A numeric vector containing the MH statistic values
logistic	A logical indicating whether the logistic or the normal metric should be used.

Value

delta A numeric vector containing the delta values

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Holland, P.W., and Thayer, D.T. (1988). Differential Item Performance and the Mantel-Haenszel Procedure. In H. Wainer and H.I. Braun (Eds.), Test Validity. Hillsdale, NJ: Erlbaum.

Examples

```
data(dichotomousItemParameters)
threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

threePlMh <- IrtMh(itemParameters = threePlParameters,  irtModel = "3pl",
                   focalDistribution = "norm", referenceDistribution = "norm",
                   focalDistrExtra = list(mean = 0, sd = 1),
                   referenceDistrExtra = list(mean = 0, sd = 1), groupRatio = 1,
                   logistic = FALSE)

delta3pl <- DeltaMhIrt(threePlMh)
```

DFIT *Differential Functioning of Items and Tests framework*

Description

DFIT provides functions for calculating the differential item and test functioning proposed by Raju et al. (1995).

Details

DFIT provides a set of functions to calculate the noncompensatory (NCDIF), compensatory (CDIF) and test level (DTF) differential functioning indices for items and tests under Raju's (Raju, et al. 1995) DFIT framework. It also provides functions for obtaining cut-off points for identifying differential functioning for these indices following the Monte Carlo Item Parameter Replication approach proposed by Oshima et al. (2006).

This package also improves upon available DFIT software by allowing the covariance matrices for both focal and reference groups to be used. This improves the obtained cut-off points, which result in type I error rates at the nominal level, and increased power, when compared to the cut-off points obtained when using only the focal group item parameter estimates and their estimate covariances (Cervantes, 2012). Furthermore, this package includes functions for obtaining the asymptotic covariance matrices of item parameter estimates (currently only for dichotomous IRT models) and for calculating the DFIT indices base on the focal group distribution as well as ability estimates for a sample from the focal population are included; these enable ad hoc and a priori power calculations for given item parameters and sample sizes to be possible with this package.

References

de Ayala, R. J., (2009). The theory and practice of item response theory. New York: The Guildford Press

Cervantes, V. H. (2012). On using the Item Parameter Replication (IPR) approach for power calculation of the noncompensatory differential item functioning (NCDIF) index (pp. 206-207). Proceedings of the V European Congress of Methodology. Santiago de Compostela, Spain: Universidade de Santiago de Compostela.

Cervantes, V. H. (2017). DFIT: An R Package for Raju's Differential Functioning of Items and Tests Framework. Journal of Statistical Software, 76(5), 1-24. doi:10.18637/jss.v076.i05

Cohen, A., Kim, S-H and Baker, F. (1993). Detection of differential item functioning in the Graded Response Moodel. Applied psychological measurement, 17(4), 335-350. doi:10.1177/014662169301700402

Holland, P.W., and Thayer, D.T. (1988). Differential Item Performance and the Mantel-Haenszel Procedure. In H. Wainer and H.I. Braun (Eds.), Test Validity. Hillsdale, NJ: Erlbaum.

Li, Y. & Lissitz, R. (2004). Applications of the analytically derived standard errors of Item Response Theory item parameter estimates. Journal of educational measurement, 41(2), 85–117. doi:10.1111/j.1745-3984.2004.tb01109.x

Oshima, T. & Morris, S. (2008). Raju's Differential Functioning of Items and Tests (DFIT). Educational Measurement: Issues and Practice, 27(3), 43–50. doi:10.1111/j.1745-3992.2008.00127.x

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Raju, N., Fortmann-Johnson, K., Kim, W., Morris, S., Nering, M. & Oshima, T. (2009). The item parameter replication method for detecting differential functioning in the polytomous DFIT framework. Applied psychological measurement, 33(2), 133–147. doi:10.1177/0146621608319514

Raju, N. S., van der Linden, W. J., & Fleer, P. F. (1995). IRT-based internal measures of differential functioning of items and tests. Applied Psychological Measurement, 19, 353–368. doi:10.1177/014662169501900405

Roussos, L., Schnipke, D. & Pashley, P. (1999). A generalized formula for the Mantel-Haenszel Differential Item Functioning parameter. Journal of educational and behavioral statistics, 24(3), 293–322. doi:10.3102/10769986024003293

Wright, K. (2011). Improvements for Differential Funtioning of Items and Tests (DFIT): Investigating the addition of reporting an effect size measure and power (Unpublished doctoral dissertation). Georgia State University, USA.

`dichotomousItemParameters` *Sets of focal and reference item parameters from Wright (2011).*

Description

This data set contains the item parameters found in Wright, K. (2011). Improvements for Differential Funtioning of Items and Tests (DFIT): Investigating the addition of reporting an effect size measure and power Unpublished doctoral dissertation). Georgia State University, USA.

Usage

```
data(dichotomousItemParameters)
```

Format

a list with 'focal' and 'reference' elements. Each is a `matrix` 1 row per item by 3 columns: item discrimination, difficulty and guessing parameters.

Source

This data set contains the item parameters based on those found in Wright, K. (2011).

References

Wright, K. (2011). Improvements for Differential Funtioning of Items and Tests (DFIT): Investigating the addition of reporting an effect size measure and power (Unpublished doctoral dissertation). Georgia State University, USA.

`Dtf` *Calculates DTF index for a set of items with given item parameters of focal and reference groups.*

Description

Calculates DTF index for a set of items with given item parameters of focal and reference groups.

Usage

```
Dtf(
  cdif = NULL,
  itemParameters = NULL,
  irtModel = "2pl",
  focalAbilities = NULL,
  focalDistribution = "norm",
  subdivisions = 5000,
  logistic = TRUE,
  focalDistrExtra = list(mean = 0, sd = 1)
)
```

Arguments

`cdif`	A numeric vector of CDIF values for the test items. If NULL it is calculated using itemParameters and the other arguments.
`itemParameters`	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Only used if cdif is NULL. Item parameters for each group should me a matrix with nrow equal to the number of items.
`irtModel`	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm". Only used if cdif is NULL.
`focalAbilities`	If NULL, CDIF is calculated by numerical integration of focal distribution. If not NULL, it must be a numerical vector containing the abilities for the individuals in the focal group. Only used if cdif is NULL.
`focalDistribution`	A string stating the distribution name to be used for integrating. Only used if focalAbilities and cdif are NULL.
`subdivisions`	A numeric value indicating the number of subdivisions for numerical integration. Only used if focalAbilities and cdif are NULL.
`logistic`	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used. Only used if cdif is NULL.
`focalDistrExtra`	Extra parameters for the focal group distribution function if needed.

Value

dtf Numeric vector with the CDIF index value for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Raju, N. S., van der Linden, W. J., & Fleer, P. F. (1995). IRT-based internal measures of differential functioning of items and tests. Applied Psychological Measurement, 19, 353–368. doi:10.1177/014662169501900405

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# #
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlCdif <- Cdif(itemParameters = threePlParameters, irtModel = '3pl',
# #                     focalAbilities = NULL, focalDistribution = "norm",
# #                     subdivisions = 5000, logistic = TRUE)
# # threePlDtf  <- Dtf(cdif = threePlCdif)
```

`Extract2PLMirt` *Extract item discrimination and difficulties and estimate covariance estimates for 2PL items from a fitted mirt object for one or two groups*

Description

Extract item discrimination and difficulties and estimate covariance estimates for 2PL items from a fitted mirt object for one or two groups

Usage

```
Extract2PLMirt(mod, focal = NULL, reference = NULL)
```

Arguments

mod	A mirt object containing the fit of unidimensional model.
focal	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
reference	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "2PL", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
data <- expand.table(LSAT7)
(mod1 <- mirt(data, model = 1, itemtype = "2PL", SE = TRUE))
(DFIT:::Extract2PLMirt(mod1))
```

Extract3PLMirt *Extract item discrimination, difficulties, and guessing parameters and estimate covariance estimates for 3PL items from a fitted mirt object for one or two groups*

Description

Extract item discrimination, difficulties, and guessing parameters and estimate covariance estimates for 3PL items from a fitted mirt object for one or two groups

Usage

```
Extract3PLMirt(mod, focal = NULL, reference = NULL)
```

Arguments

mod	A mirt object containing the fit of unidimensional model.
focal	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
reference	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "3PL", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
data <- expand.table(LSAT7)
(mod1 <- mirt(data, model = 1, itemtype = "3PL", SE = TRUE))
(DFIT:::Extract3PLMirt(mod1))
```

Extract4PLMirt *Extract item discrimination, difficulties, guessing, and upper asymptote parameters and estimate covariance estimates for 4PL items from a fitted mirt object for one or two groups*

Description

Extract item discrimination, difficulties, guessing, and upper asymptote parameters and estimate covariance estimates for 4PL items from a fitted mirt object for one or two groups

Usage

```
Extract4PLMirt(mod, focal = NULL, reference = NULL)
```

Arguments

mod	A mirt object containing the fit of unidimensional model.
focal	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
reference	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "4PL", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
data <- expand.table(LSAT7)
(mod1 <- mirt(data, model = 1, itemtype = "4PL", SE = TRUE))
(DFIT:::Extract4PLMirt(mod1))
```

`ExtractGPCMMirt` *Extract item discrimination and difficulties and estimate covariance estimates for GPCM items from a fitted mirt object for one or two groups*

Description

Extract item discrimination and difficulties and estimate covariance estimates for GPCM items from a fitted mirt object for one or two groups

Usage

```
ExtractGPCMMirt(mod, focal = NULL, reference = NULL)
```

Arguments

`mod`	A mirt object containing the fit of unidimensional model.
`focal`	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
`reference`	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "gpcm", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
(mod1 <- mirt(Science, model = 1, itemtype = "gpcm", SE = TRUE))
(DFIT:::ExtractGPCMMirt(mod1))
```

`ExtractGRMMirt` *Extract item discrimination and difficulties and estimate covariance estimates for GRM items from a fitted mirt object for one or two groups*

Description

Extract item discrimination and difficulties and estimate covariance estimates for GRM items from a fitted mirt object for one or two groups

Usage

```
ExtractGRMMirt(mod, focal = NULL, reference = NULL)
```

Arguments

`mod`	A mirt object containing the fit of unidimensional model.
`focal`	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
`reference`	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "graded", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
(mod1 <- mirt(Science, model = 1, itemtype = "graded", SE = TRUE))
(DFIT:::ExtractGRMMirt(mod1))
```

`ExtractMirtPars` *Extracts the item parameters from a unidimensional mirt model*

Description

Extracts the item parameters from a unidimensional mirt model

Usage

```
ExtractMirtPars(mod, focal = NULL, reference = NULL)
```

Arguments

mod	A mirt object containing the fit of unidimensional model.
focal	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
reference	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "gpcm", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
(mod1 <- mirt(Science, model = 1, itemtype = c("graded", "graded", "gpcm", "gpcm"), SE = TRUE))
(ExtractMirtPars(mod1))
```

ExtractRaschMirt — *Extract item difficulties and item difficulty variance estimates for Rasch items from a fitted mirt object for one or two groups*

Description

Extract item difficulties and item difficulty variance estimates for Rasch items from a fitted mirt object for one or two groups

Usage

```
ExtractRaschMirt(mod, focal = NULL, reference = NULL)
```

Arguments

mod	A mirt object containing the fit of unidimensional model.
focal	Character. Required if mod is MultipleGroupClass, focal should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.
reference	Character. Required if mod is MultipleGroupClass, reference should coincide with the label for the focal group. If mod is SingleGroupClass, it is ignored.

Value

If mod contains any itemtype == "Rasch", a list with the item parameters and the estimate covariances (if available). If mod is SingleGroupClass, the list contains the item parameters as a matrix and the covariances as a list. If mod is MultipleGroupClass, the list contains the item parameters and covariances for the focal and reference groups only.

Examples

```
library(mirt)
data <- expand.table(LSAT7)
(mod1 <- mirt(data, model = 1, itemtype = "Rasch", SE = TRUE))
(DFIT:::ExtractRaschMirt(mod1))
```

Ipr *Item parameter replication*

Description

Generates a sample of item parameters assuming multivariate normality of estimates

Usage

```
Ipr(itemParameters, itemCovariances, nReplicates = 5000)
```

Arguments

itemParameters	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
itemCovariances	A list containing "focal" and "reference" matrices of covariance for item estimates. Each (focal and reference) may be either a list of covariance matrices for each item or a single matrix of covariance of all parameters.
nReplicates	A numeric value indicating the number of replications to perform

Value

itemParameters A list with item parameters for focal and reference groups

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 15000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
```

IprMh *Mantel Haenszel for Item parameter replication*

Description

Calculates the Mantel-Haenszel theoretical parameter under IRT assumptions on a list of item parameters such as those produced by the Ipr function

Usage

```
IprMh(
  itemParameterList,
  irtModel = "2pl",
  focalDistribution = "norm",
  focalDistrExtra = list(mean = 0, sd = 1),
  referenceDistribution = "norm",
  referenceDistrExtra = list(mean = 0, sd = 1),
```

```
  groupRatio = 1,
  subdivisions = 5000,
  logistic = TRUE
)
```

Arguments

itemParameterList	A list where each element is a list containing "focal" and "reference" item Parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
focalDistribution	A string stating the distribution assumed for the focal group.
focalDistrExtra	A list stating the extra parameters needed by the focal distribution function.
referenceDistribution	A string stating the distribution assumed for the reference group.
referenceDistrExtra	A list stating the extra parameters needed by the reference distribution function.
groupRatio	A positive value indicating how many members of the reference group are expected for each member of the focal group.
subdivisions	A numeric value indicating the number of subdivisions for numerical integration.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

Value

mh A numeric matrix with the Mantel Haenszel values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Roussos, L., Schnipke, D. & Pashley, P. (1999). A generalized formula for the Mantel-Haenszel Differential Item Functioning parameter. Journal of educational and behavioral statistics, 24(3), 293–322. doi:10.3102/10769986024003293

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# #
# # threePlMhIpr <- IprMh(itemParameterList = threePlIpr, irtModel = '3pl', logistic = TRUE)
```

`IprNcdif` *NCDIF for Item parameter replication*

Description

Calculates the NCDIF index on a list of item parameters such as those produced by the Ipr function

Usage

```
IprNcdif(
  itemParameterList,
  irtModel = "2pl",
  focalAbilities = NULL,
  focalDistribution = "norm",
  subdivisions = 5000,
```

```
  logistic = TRUE,
  focalDistrExtra = list(mean = 0, sd = 1)
)
```

Arguments

itemParameterList	A list where each element is a list containing "focal" and "reference" item Parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
focalAbilities	If NULL, NCDIF is calculated by numerical integration of focal distribution. If not NULL, must be a numerical vector containing the abilities for the individuals in the focal group.
focalDistribution	A string stating the distribution name to be used for integrating. Only used if focalAbilities is NULL.
subdivisions	A numeric value indicating the number of subdivisions for numerical integration. Only used if focalAbilities is NULL.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.
focalDistrExtra	A list stating the extra parameters needed by the focal distribution function.

Value

ncdif A numeric matrix with the NCDIF values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
```

```
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# #
# # threePlNcdifIpr <- IprNcdif(itemParameterList = threePlIpr, irtModel = '3pl', logistic = TRUE)
```

IprSam *Signed Area Measure for Item parameter replication*

Description

Calculates Raju's Signed Area Measure index on a list of item parameters such as those produced by the Ipr function

Usage

```
IprSam(
  itemParameterList,
  irtModel = "2pl",
  subdivisions = 5000,
  logistic = TRUE
)
```

Arguments

itemParameterList
: A list where each element is a list containing "focal" and "reference" item Parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items.

irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
subdivisions	A numeric value indicating the number of subdivisions for numerical integration.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

Value

sam A numeric matrix with the Signed Area Measure values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
```

```
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# #
# # threePlSamIpr <- IprSam(itemParameterList = threePlIpr, irtModel = '3pl', logistic = TRUE)
```

IprUam *Unsigned Area Measure for Item parameter replication*

Description

Calculates Raju's Unsigned Area Measure index on a list of item parameters such as those produced by the Ipr function

Usage

```
IprUam(
  itemParameterList,
  irtModel = "2pl",
  subdivisions = 5000,
  logistic = TRUE
)
```

Arguments

itemParameterList	A list where each element is a list containing "focal" and "reference" item Parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should be a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
subdivisions	A numeric value indicating the number of subdivisions for numerical integration.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

Value

uam A numeric matrix with the Unsigned Area Measure values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Oshima, T., Raju, N. & Nanda, A. (2006). A new method for assessing the statistical significance in the Differential Functioning of Items and Tests (DFIT) framework. Journal of educational measurement, 43(1), 1–17. doi:10.1111/j.1745-3984.2006.00001.x

Examples

```
# # Not run
# #
# # data(dichotomousItemParameters)
# # threePlParameters <- dichotomousItemParameters
# # isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
# #                       (dichotomousItemParameters[['reference']][, 3] == 0))
# #
# # threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
# # threePlParameters[['reference']]     <- threePlParameters[['reference']][!isNot3Pl, ]
# # threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
# # threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
# # threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
# # threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
# # threePlParameters[['focal']]        <- threePlParameters[['focal']][-c(12, 16, 28), ]
# # threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]
# #
# # threePlAse <- list()
# # threePlAse[["focal"]]     <- AseIrt(itemParameters = threePlParameters[["focal"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# # threePlAse[["reference"]] <- AseIrt(itemParameters = threePlParameters[["reference"]],
# #                                     logistic = TRUE,
# #                                     sampleSize = 10000,
# #                                     irtModel = "3pl")
# #
# # set.seed(41568)
# # threePlIpr <- Ipr(itemParameters = threePlParameters, itemCovariances = threePlAse,
# #                   nReplicates = 100)
# #
# # threePlUamIpr <- IprUam(itemParameterList = threePlIpr, irtModel = '3pl', logistic = TRUE)
```

IrtMh *Calculates the Mantel-Haenszel theoretical parameter when a dichotomous IRT model holds*

Description

Calculates the Mantel-Haenszel theoretical parameter when a dichotomous IRT model holds

Usage

```
IrtMh(
  itemParameters,
  irtModel = "2pl",
  focalDistribution = "norm",
  referenceDistribution = "norm",
  focalDistrExtra = list(mean = 0, sd = 1),
  referenceDistrExtra = list(mean = 0, sd = 1),
  groupRatio = 1,
  logistic = TRUE,
  subdivisions = 5000
)
```

Arguments

itemParameters	A list containing the "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale.
irtModel	A string stating the irtModel used. May be one of "1pl", "2pl", or "3pl".
focalDistribution	A string stating the distribution assumed for the focal group.
referenceDistribution	A string stating the distribution assumed for the reference group.
focalDistrExtra	A list of extra parameters for the focal distribution function.
referenceDistrExtra	A list of extra parameters for the reference distribution function.
groupRatio	A positive value indicating how many members of the reference group are expected for each member of the focal group.
logistic	A logical indicating whether the logistic or the normal metric should be used.
subdivisions	A numeric value stating the maximum number of subdivisions for adaptive quadrature.

Value

mh A list containing the asymptotic matrices for each item

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Roussos, L., Schnipke, D. & Pashley, P. (1999). A generalized formula for the Mantel-Haenszel Differential Item Functioning parameter. Journal of educational and behavioral statistics, 24(3), 293–322. doi:10.3102/10769986024003293

Examples

```
data(dichotomousItemParameters)
threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

threePlMh <- IrtMh(itemParameters = threePlParameters,  irtModel = "3pl",
                   focalDistribution = "norm", referenceDistribution = "norm",
                   focalDistrExtra = list(mean = 0, sd = 1),
                   referenceDistrExtra = list(mean = 0, sd = 1), groupRatio = 1,
                   logistic = FALSE)
```

`Ncdif` *Calculates NCDIF index for an item with given item parameters of focal and reference groups.*

Description

Calculates NCDIF index for an item with given item parameters of focal and reference groups.

Usage

```
Ncdif(
  itemParameters,
  irtModel = "2pl",
  focalAbilities = NULL,
  focalDistribution = "norm",
```

```
  subdivisions = 5000,
  logistic = TRUE,
  focalDistrExtra = list(mean = 0, sd = 1)
)
```

Arguments

itemParameters	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
focalAbilities	If NULL, NCDIF is calculated by numerical integration of focal distribution. If not NULL, it must be a numerical vector containing the abilities for the individuals in the focal group.
focalDistribution	A string stating the distribution name to be used for integrating. Only used if focalAbilities is NULL.
subdivisions	A numeric value indicating the number of subdivisions for numerical integration. Only used if focalAbilities is NULL.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.
focalDistrExtra	Extra parameters for the focal group distribution function if needed.

Value

ncdif Numeric vector with the NCDIF index value for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Raju, N. S., van der Linden, W. J., & Fleer, P. F. (1995). IRT-based internal measures of differential functioning of items and tests. Applied Psychological Measurement, 19, 353–368. doi:10.1177/014662169501900405

Examples

```
data(dichotomousItemParameters)

threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]         <- threePlParameters[['focal']][!isNot3Pl, ]
```

```
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

threePlNcdif <- Ncdif(itemParameters = threePlParameters, irtModel = '3pl',
                      focalAbilities = NULL, focalDistribution = "norm",
                      subdivisions = 5000, logistic = TRUE)
```

PlotNcdif *Plot the item characteristic (expected score) curve for focal and reference groups for the iiItem along with a representation of the focal group density.*

Description

Plot the item characteristic (expected score) curve for focal and reference groups for the iiItem along with a representation of the focal group density.

Usage

```
PlotNcdif(
  iiItem,
  itemParameters,
  irtModel = "2pl",
  logistic = TRUE,
  plotDensity = FALSE,
  focalAbilities = NULL,
  focalDistribution = "norm",
  focalDistrExtra = list(mean = 0, sd = 1),
  from = -5,
  to = 5,
  thetaInt = 0.01,
  colour = TRUE,
  highColour = "blue",
  main = "",
  xlab = "Ability",
  ylab = "Probability",
  iccText = "Group ICCs",
  focalIccText = "Focal group ICC",
  referenceIccText = "Reference group ICC",
  focalDensityText = "Focal group density"
)
```

Arguments

iiItem	Item (row) number for the item in each of the itemParameter matrices to plot.
itemParameters	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
logistic	A logical value stating if the IRT model will use the logistic or the normal metric.
plotDensity	logical indicating if the focal distribution density should be plotted as a density curve (TRUE) or if it should be represented as an area gradient (FALSE). Defaults to gradient.
focalAbilities	If NULL, density is calculated theoretically from focal distribution. If not NULL, it must be a numerical vector containing the abilities for the individuals in the focal group.
focalDistribution	A string stating the distribution name to be used for density calculation. Only used if focalAbilities is NULL.
focalDistrExtra	Extra parameters for the focal group distribution function if needed.
from	value on the x-axis to serve as minimum for the plot
to	value on the x-axis to serve as maximum for the plot
thetaInt	value for the x-axis step for probabilities and density evaluation. Only used if focalAbilities is NULL.
colour	logical value indicating if the area gradient should be presented in colour when plotDensity is FALSE, or if the different lines should be presented in colour when plotDensity is TRUE.
highColour	character indicating the colour text name that should be used for high density regions.
main	text for plot main title.
xlab	text for x-axis label.
ylab	text for y-axis label.
iccText	text for legend title related to ICC curves.
focalIccText	legend for focal group ICC curve.
referenceIccText	legend for reference group ICC curve.
focalDensityText	legend for focal group density curve when plotDensity is TRUE. Text for legend title related to the colour gradient when plotDensity is FALSE.

Value

plotNCDIF A ggplot object for the plot

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

Examples

```
data(dichotomousItemParameters)

threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

# # Non Uniform - != guess DIF item
PlotNcdif(iiItem = 22, itemParameters = threePlParameters, irtModel = "3pl",
        plotDensity = FALSE, main = "Item 22 Non uniform and different guessing DIF. 3PL")

# # Uniform - != guess DIF item
PlotNcdif(iiItem = 15, itemParameters = threePlParameters, irtModel = "3pl",
          plotDensity = FALSE, main = "Item 15 Uniform and different guessing DIF. 3PL")
```

---

polytomousItemParameters

Sets of focal and reference item parameters from Raju et al. (2009)

Description

This data set contains the item parameters found in Raju, N., Fortmann-Johnson, K., Kim, W., Morris, S., Nering, M. & Oshima, T. (2009). The item parameter replication method for detecting differential functioning in the polytomous DFIT framework. Applied psychological measurement, 33(2), 133–147.

Usage

```
data(polytomousItemParameters)
```

Format

a list with 'focal' and 'reference' elements. Each is a `matrix` 1 row per item by 5 columns: item discrimination, four item step parameters.

Source

This data set contains the item parameters based on those found in Raju et al. (2009).

References

Raju, N., Fortmann-Johnson, K., Kim, W., Morris, S., Nering, M. & Oshima, T. (2009). The item parameter replication method for detecting differential functioning in the polytomous DFIT framework. Applied psychological measurement, 33(2), 133–147. doi: 10.1177/01466216083319514

`ProductProbabilities` *Calculates the product of item response probabilities for dichotomous IRT models*

Description

Calculates the product of item response probabilities for dichotomous IRT models

Usage

```
ProductProbabilities(thetaValue, itemParameters, logistic, irtModel = "3pl")
```

Arguments

`thetaValue`	A numeric value or array for the theta (ability) value(s) for which the product will be calculated
`itemParameters`	A matrix containing the item parameters.
`logistic`	A logical indicating whether the logistic or the normal metric should be used.
`irtModel`	A string stating the irtModel used. May be one of "1pl", "2pl", or "3pl".

Value

pq A numeric matrix containing the crossed product on each thetaValue for each item.

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

SignedArea *Calculates Raju's Signed Area Measure index for an item with given item parameters of focal and reference groups.*

Description

Calculates Raju's Signed Area Measure index for an item with given item parameters of focal and reference groups.

Usage

```
SignedArea(
  itemParameters,
  irtModel = "2pl",
  subdivisions = 5000,
  logistic = TRUE
)
```

Arguments

itemParameters	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
irtModel	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
subdivisions	A numeric value indicating the number of subdivisions for numerical integration.
logistic	A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

Value

sam A numeric matrix with the Signed Area Measure values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Cohen, A., Kim, S-H and Baker , F. (1993). Detection of differential item functioning in the Graded Response Moodel. Applied psychological measurement, 17(4), 335-350. doi:10.1177/014662169301700402

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Examples

```
data(dichotomousItemParameters)

threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

sam3pl <- SignedArea(itemParameters = threePlParameters, irtModel = "3pl",
                     subdivisions = 5000, logistic = TRUE)
```

`UnsignedArea` *Calculates Raju's Unsigned Area Measure index for an item with given item parameters of focal and reference groups.*

Description

Calculates Raju's Unsigned Area Measure index for an item with given item parameters of focal and reference groups.

Usage

```
UnsignedArea(
  itemParameters,
  irtModel = "2pl",
  subdivisions = 5000,
  logistic = TRUE
)
```

Arguments

`itemParameters`	A list containing "focal" and "reference" item parameters. Item parameters are assumed to be on the same scale. Item parameters for each group should me a matrix with nrow equal to the number of items.
`irtModel`	A string stating the irtModel to be used. Should be one of "1pl", "2pl", "3pl", "grm" or "pcm".
`subdivisions`	A numeric value indicating the number of subdivisions for numerical integration.

`logistic` A logical value stating if the IRT model will use the logistic or the normal metric. Defaults to using the logistic metric by fixing the D constant to 1. If FALSE the constant is set to 1.702 so that the normal metric is used.

Value

uam A numeric matrix with the Unsigned Area Measure values for all the item parameter in each set of itemParameterList

Author(s)

Victor H. Cervantes <vhcervantesb at unal.edu.co>

References

Cohen, A., Kim, S-H and Baker , F. (1993). Detection of differential item functioning in the Graded Response Moodel. Applied psychological measurement, 17(4), 335-350. doi:10.1177/014662169301700402

Raju, N. (1988). The area between two item characteristic cureves. Psychometricka, 53(4), 495–502. doi:10.1007/bf02294403

Examples

```
data(dichotomousItemParameters)

threePlParameters <- dichotomousItemParameters
isNot3Pl          <- ((dichotomousItemParameters[['focal']][, 3] == 0) |
                      (dichotomousItemParameters[['reference']][, 3] == 0))

threePlParameters[['focal']]          <- threePlParameters[['focal']][!isNot3Pl, ]
threePlParameters[['reference']]      <- threePlParameters[['reference']][!isNot3Pl, ]
threePlParameters[['focal']][, 3]     <- threePlParameters[['focal']][, 3] + 0.1
threePlParameters[['reference']][, 3] <- threePlParameters[['reference']][, 3] + 0.1
threePlParameters[['focal']][, 2]     <- threePlParameters[['focal']][, 2] + 1.5
threePlParameters[['reference']][, 2] <- threePlParameters[['reference']][, 2] + 1.5
threePlParameters[['focal']]          <- threePlParameters[['focal']][-c(12, 16, 28), ]
threePlParameters[['reference']]    <- threePlParameters[['reference']][-c(12, 16, 28), ]

uam3pl <- UnsignedArea(itemParameters = threePlParameters, irtModel = "3pl",
                       subdivisions = 5000, logistic = TRUE)
```

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