# Package 'MIRT4FC'

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**Type** Package

**Title** Fit FC-Model by *i*StEM Algorithm

**Version** 0.1.0

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**Description** The objective of MIRT4FC is to efficiently implement various forced-choice models using the *i*stem algorithm.Currently, it includes Thurstone's Item Response Theory (TIRT, Brown et al., 2011) Model, Multi-Unidimensional Pairwise Preference Two Parameter Logistic Model (MUPP-2PLM, Morillo et al., 2016), Multi-Unidimensional Pairwise Preference Generalized Graded Unfolding Model (MUPP-GGUM ,Stark et al., 2005) and Generalized Graded Unfolding-RANK Model (GGUM-RANK, Lee et al., 2018), and we plan to continue updating and adding new models in the future. In addition to item parameter estimation capabilities, our R package also offers the ability to estimate ability parameters using MAP, EAP, and MLE methods. It can generate simulated response matrices, calculate standard errors (SE) for both ability and item parameters, and include a set of empirical data.

**License** GPL-3

**Encoding** UTF-8

**Data** inst/data/MAP_data.rda

**LazyData** true

**RoxygenNote** 7.2.3

**Imports** armspp, doParallel, foreach, coda, mvnfast, stats, utils, Matrix

**Depends** parallel

# R topics documented:



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StEM *Improved Stochastic EM algorithm for solving FC: MUPP-2PL model*

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**Description**

Improved Stochastic EM algorithm for solving Force Choice: Multi-Unidimensional Pairwise-Preference Two-Parameter Logistic (FC: MUPP-2PL) model.

**Usage**

StEM (Y, BID, positive = rep (TRUE, nrow (BID)), blocksize = 3, res = "rank", M = 10, B = 20, a = NULL, d = NULL, item.par = NULL, sigma = NULL, theta = NULL, fix.sigma = FALSE, burnin. maxitr = 40, maxitr = 500, eps1 = 1.5, eps2 = 0.4, frac1 = 0.2, frac2 = 0.5, cores = 1)

**Arguments**

| | |
|---|---|
| Y | A # of subjects * # of blocks matrix; item responses. |
| BID | A # of statements * 3 matrix; item information, columns are "Block", "Item" and "Dimensions". |
| positive | A logical vector; indicating whether each statement is positive directional or not. |
| blocksize | A number; block size of FC (2/3/4). |
| res | A string; response format('pick'/'rank'/'mole'), pick-2/rank-2/mole-2 are equivalent, rank-3/mole-3 are equivalent. |
| M | A number; # of batch. |
| B | A number; # of iterations in each batch. |
| a | A vector; length = # of statements, initial alpha parameters. |
| d | A vector; length = # of statements, initial beta parameters. |
| item.par | A data frame; initial parameters for a and d. |
| sigma | A # of dimensions * # of dimensions matrix; initial sigma parameters. |
| theta | A # of subjects * # of dimensions matrix; initial theta parameters. |
| fix.sigma | Logical; TRUE if sigma is estimated. |
| burnin.maxitr | A number; max burn-in allowed. |
| maxitr | A number; max iterations allowed. |
| eps1 | A number; stability criteria. |

| | |
|---|---|
| eps2 | A number; convergence criterion. |
| frac1 | A number; cutoffs for calculating Geweke z. |
| frac2 | A number; cutoffs for calculating Geweke z. |
| cores | A number; number of parallel cores. |

**Value**

The function returns a list with the following components:

| | |
|---|---|
| a | A vector; length = # of statements, alpha parameters |
| d | A vector; length = # of statements, beta parameters. |
| sigm | A # of dimensions x # of dimensions matrix; sigma parameters. |
| total batch number | A number; total batch number. |
| final chain size | A number; final chain size. |
| burn-in size | A number; burn-in size. |
| time | A number; time. |

**Examples**

```
##################### A simulation example based on the MUPP-2PL model###############
########Set simulation information
library (MIRT4FC)
D <- 6                                  # Dimension
nitem.per.dim <- 10                     # Iems number per dimension
nblock <- D * nitem.per.dim / 3         # Blocks number
set.seed(123456)                        # Set random seed
# Simulate block-item-demension correspondence table
BID <- data.frame (Block = rep (1:nblock,each=3),
                   Item=rep (1:3, nblock),
                   Dim=c(combn(D,3) [, sample(choose(D,3), nblock,replace = TRUE)]))
# Simulate item parameter truth value
item.par <- data.frame (a = seq_len (D * nitem.per.dim))
item.par <- within (item.par, {
   a <- runif (D*nitem.per.dim,0.7,3)
   b <- rnorm (D*nitem.per.dim)
   d <- a*b
})
item.par$d <- c (t (aggregate (item.par$d, by=list (BID$Block), function(x)x-mean(x)) [, -1]))
N <- 1000                               # Sample number
v <- matrix (0.5, D, D)                 # Intertrait correlation
diag (v) <- 1
# Simulate latent trait parameter truth value
theta <- mvnfast::rmvn (N, seq(-1, 1, length.out = D),sigma = v)
######## Generate a simulated dataset
Y <- data.sim (item.par, theta, BID, blocksize = 3, res = 'rank')
```

```
######## Item parameter estimation
fit <- StEM (Y, BID, maxitr = 100, blocksize = 3, res = 'rank', fix.sigma = TRUE, cores = 1)
```

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data.sim *Simulated dataset for multivariate FC item response theory model.*

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**Description**

Simulated dataset for multivariate FC item response theory model.

**Usage**

```
data.sim (item.par, theta, BID, blocksize = 3, res = 'rank')
```

**Arguments**

| | |
|---|---|
| BID | A # of statements * 3 matrix; item information, columns are "Block", "Item" and "Dimensions". |
| blocksize | A number; block size of FC (2/3/4). |
| res | A string; response format('pick'/'rank'/'mole'), pick-2 (blocksize = 2)/rank-2/mole-2 are equivalent, rank-3/mole-3 are equivalent. |
| item.par | A data frame; parameters for a and d. |
| theta | A # of subjects * # of dimensions matrix; theta parameters. |

**Value**

A # of subjects x # of block number matrix.

**Examples**

```
##################### A simulation example based on the MUPP-2PL model###############
########Set simulation information
library (MIRT4FC)
D <- 6                                  # Dimension
nitem.per.dim <- 10                     # Iems number per dimension
nblock <- D * nitem.per.dim / 3         # Blocks number
set.seed(123456)                        # Set random seed
# Simulate block-item-demension correspondence table
BID <- data.frame (Block = rep (1:nblock,each=3),
                   Item=rep (1:3, nblock),
                   Dim=c(combn(D,3) [, sample(choose(D,3), nblock,replace = TRUE)]))
# Simulate item parameter truth value
item.par <- data.frame (a = seq_len (D * nitem.per.dim))
item.par <- within (item.par, {
  a <- runif (D*nitem.per.dim,0.7,3)
  b <- rnorm (D*nitem.per.dim)
```

```
  d <- a*b
})
item.par$d <- c (t (aggregate (item.par$d, by=list (BID$Block), function(x)x-mean(x)) [, -1]))
N <- 1000                                  # Sample number
v <- matrix (0.5, D, D)                    # Intertrait correlation
diag (v) <- 1
# Simulate latent trait parameter truth value
theta <- mvnfast::rmvn (N, seq(-1, 1, length.out = D),sigma = v)
######## Generate a simulated dataset
Y <- data.sim (item.par, theta, BID, blocksize = 3, res = 'rank')
```

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MAP_data *A Triple Empirical Data for Dominance Modell.*

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**Description**

Simulated dataset for multivariate FC item response theory model. This data set contains a real data set of 1391 participants on 88 triplets. In each triplet, participants had to rank the three alternative items according to their preference.

**Usage**

```
MAP_data
```

**Format**

A large matrix of 1391 observations containing information on 6 variables. In each block, 3 items (e.g., A/B/C) measure 3 different traits.

A>B>C=1; A>C>B=2; B>A>C=3; B>C>A=4; C>A>B=5; C>B>A=6

**Examples**

```
####################an empirical example based on the MUPP-2PL model################
######## Read dataset
library (MIRT4FC)
Y <- data("MAP_data")
######## Item parameter estimation
fit <- StEM (Y, BID, maxitr = 150, blocksize = 3, res = 'rank', fix.sigma = TRUE, cores = 1)
```