Package 'MIRT4FC'

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Type Package
Title Fit FC-Model by *i*StEM Algorithm
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Description The objective of MIRT4FC is to efficiently implement various forced-choice models using the istem algorithm.Currently, it includes Two Parameter Logistic Model (Morillo et al., 2016; Zheng et al., 2024). 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, 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
URL https://github.com/SAL-Lab-ECNU/MIRT4FC

R topics documented:

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*i*StEM *Improved Stochastic EM algorithm for solving FC model item parameter*

Description

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

Usage

```
iStEM(Y, BID ,positive=rep(TRUE,nrow(BID)), blocksize=3, res='rank', M=10, B=20,
  model='2PL', SE='Louis', 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=NULL,
  h=NULL)
```

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.
model	A string; FC model('2PL').
SE	A string; Standard error method ('XPD'/ 'Louis'/ 'complete'/ 'REM'/ 'FDM'/ 'CDM'/ 'MCMC'/ 'Sandwich').
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.
h	A number; The perturbation constant of the differential method (Suggested values are 1e-5).

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 <- iStEM (Y, BID, maxitr = 100, blocksize = 3, res = 'rank', fix.sigma = TRUE)
print(fit)
```

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

Description

Simulated dataset for multivariate FC item response theory model.

Usage

data.sim (item.par, theta, BID, blocksize = 3, res = 'rank', model='2pl')

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.
model	A string; model('2pl')

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)
print(Y)
```

MAP_data *A Triple Empirical Data for Dominance Model.*

Description

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

This is an empirical example for the paper "A 2PLM-RANK Multidimensional Forced-choice Model and its Fast Estimation"

```
######################an empirical example for the 2PL-RANK model#####################
######## Read dataset
library (MIRT4FC)
Y <- data("MAP_data")
BID <- data.frame(                          # Block-item-demension correspondence table
  Block = rep(1:88,each=3),
  Item = rep(1:3,times=88),
  Dim = c(11, 1,   14,  15,  13,  18,  6,   2,   7,   1,   21,  24,  23,  9,   22, 5,   3,   8,
    6,   18,  20,  9,   7,   5,   19,  1,   9,   14,   22, 10,  23,  21,  8,   3,   20,  10,  22,
    3,   17,  4,   23,  24,
         8,   4,   24,  21,  12,  10,  9,   11,  8,   17,  12,  2,   15,  11,  14,  24,  22,
    15,  13,  16,  14,  22,  4,   14,  10,  7,   6,   14,  19,  6,   4,   13,  3,   14,  15,  2,
    8,   3,   11,  18,  23,  20,  24,  15,
         22,  3,   20,  1,   14,  21,  16,  18,  4,   13,  16,  18,  5,   1,   8,   23,  2,
    24,  11,  19,  23,  15,  12,  11,  10,  20,  9,   21,  10,  4,   16,  7,   2,   3,   12,  16,
    10,  6,   13,  16,  21,  16,  17,  20,
         10,  19,  13,  7,   5,   15,  11,  23,  24,  8,   6,   11,  2,   19,  15,  17,  20,
    18,  9,   7,   12,  5,   9,   7,   22,  17,  24,  16,  6,   17, 13,  23,  7,   15,  17,  5,
    8,   19,  14,  18,  3,   12,  22,  4,   5,
         21,  13,  1,   23,  9,   13,  11,  22,  9,   19,  21,  8,   21,  12,  6,   16,  1,
    23,  9,   1,   19,  2,   6,   11,  18,  24,  10,  7,   18,  17,  5,   7,   3,   22,  4,   2,
```

```
8,  20,  17,  15,  8,  3,  24,  12,  10,  22,
        2,  11,  23,  19,  19,  13,  17,  6,  20,  24,  9,  17,  5,  20,  12,  6,  19,
18,  16,  15,  21,  7,  5,  1,  18,  2,  4,  14,  1,  13,  12,  16, 12,  2,  20,  4,
5,  10,  4,  1,  21,  14,  3))

######## Item parameter estimation
fit <- iStEM (Y, BID, maxitr = 150, blocksize = 3, res = 'rank', fix.sigma = TRUE)
print(fit)
```

---

theta.est *Provide the function of estimating latent traits.*

Description

Estimating latent traits for multivariate FC item response theory model.

Usage

```
theta.est (Y,a,d,BID,sigma,prior=TRUE,blocksize=3,res='rank',model='2PL')
```

Arguments

Y	A # of subjects * # of blocks matrix; item responses.
a	A vector; length = # of statements, initial alpha parameters.
d	A vector; length = # of statements, initial beta parameters.
BID	A # of statements * 3 matrix; item information, columns are "Block", "Item" and "Dimensions".
sigma	A # of dimensions * # of dimensions matrix; initial sigma parameters.
prior	Logical; TRUE if prior is added
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.
model	A string; FC model('2PL').

Value

A # of subjects x # of block number matrix.

Examples

```
###################### A simulation example based on the 2PL model#####################
########Set simulation information
library (MIRT4FC)
  D <- 6
nitem.per.dim <- 10
nblock <- D * nitem.per.dim / 3
```

```
set.seed(123456)

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
})
a=matrix(item.par$a,nrow=3,ncol = 20)
d=matrix(item.par$d,nrow=3,ncol = 20)

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)]))
item.par$d <- c(t(aggregate(item.par$d,by=list(BID$Block),function(x)x-mean(x))[,-1]))
N <- 1000

v <- matrix(0,D,D)
diag(v) <- 1
eigen(v)$values
theta <- mvnfast::rmvn(N,rep(0,each = D),sigma = v)
Y <- data.sim(item.par,theta,BID,blocksize = 3,res = "rank")

theta_est <- theta.est(Y,a,d,BID=BID,sigma=v,prior=TRUE,blocksize=3,res='rank',model='2PL')
```