Package ‘fourPNO’

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four parameter IRT model with lower and upper asymptotes using Bayesian

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Gibbs Implementation of 2PNO

Description
Implement Gibbs 2PNO Sampler

Usage
Gibbs_2PNO(Y, mu_xi, Sigma_xi_inv, mu_theta, Sigma_theta_inv, burnin,  
chain_length = 10000L)

Arguments
- **Y**: A N by J matrix of item responses.
- **mu_xi**: A two dimensional vector of prior item parameter means.
- **Sigma_xi_inv**: A two dimensional identity matrix of prior item parameter VC matrix.
- **mu_theta**: The prior mean for theta.
- **Sigma_theta_inv**: The prior inverse variance for theta.
- **burnin**: The number of MCMC samples to discard.
- **chain_length**: The number of MCMC samples.

Value
Samples from posterior.

Author(s)
Steven Andrew Culpepper

Examples
# simulate small 2PNO dataset to demonstrate function
J = 5
N = 100

# Population item parameters
as_t = rnorm(J,mean=2,sd=.5)
bs_t = rnorm(J,mean=0,sd=.5)

# Sampling gs and ss with truncation
gs_t = rbeta(J,1,8)
ps_g = pbeta(1-gs_t,1,8)
ss_t = qbeta(runif(J)*ps_g,1,8)
theta_t = rnorm(N)
Y_t = Y_4pno_simulate(N,J,as=as_t,bs=bs_t,gs=gs_t,ss=ss_t,theta=theta_t)
# Setting prior parameters
mu_theta = 0
Sigma_theta_inv = 1
mu_xi = c(0,0)
alpha_c = alpha_s = beta_c = beta_s = 1
Sigma_xi_inv = solve(2*matrix(c(1,0,0,1), 2, 2))
burnin = 1000

# Execute Gibbs sampler. This should take about 15.5 minutes
out_t = Gibbs_4PNO(Y_t,mu_xi,Sigma_xi_inv,mu_theta,Sigma_theta_inv,
alpha_c,beta_c,alpha_s, beta_s,burnin,
rep(1,J),rep(1,J),gwg_reps=5,chain_length=burnin*2)

# Summarizing posterior distribution
OUT = cbind(
    apply(out_t$AS[, -c(1:burnin)], 1, mean),
    apply(out_t$BS[, -c(1:burnin)], 1, mean),
    apply(out_t$GS[, -c(1:burnin)], 1, mean),
    apply(out_t$SS[, -c(1:burnin)], 1, mean),
    apply(out_t$AS[, -c(1:burnin)], 1, sd),
    apply(out_t$BS[, -c(1:burnin)], 1, sd),
    apply(out_t$GS[, -c(1:burnin)], 1, sd),
    apply(out_t$SS[, -c(1:burnin)], 1, sd)
)
OUT = cbind(1:J, OUT)
colnames(OUT) = c('Item','as','bs','gs','ss','as_sd','bs_sd','
    'gs_sd','ss_sd')
print(OUT, digits = 3)

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**Gibbs_4PNO**  
*Gibbs Implementation of 4PNO*

**Description**
Internal function to -2LL

**Usage**

Gibbs_4PNO(Y, mu_xi, Sigma_xi_inv, mu_theta, Sigma_theta_inv, alpha_c,
    beta_c, alpha_s, beta_s, burnin, cTF, sTF, gwg_reps,
    chain_length = 10000L)

**Arguments**

- **Y**
  A N by J matrix of item responses.
- **mu_xi**
  A two dimensional vector of prior item parameter means.
- **Sigma_xi_inv**
  A two dimensional identity matrix of prior item parameter VC matrix.
- **mu_theta**
  The prior mean for theta.
Sigma_theta_inv  
The prior inverse variance for theta.
alpha_c  
The lower asymptote prior 'a' parameter.
beta_c  
The lower asymptote prior 'b' parameter.
alpha_s  
The upper asymptote prior 'a' parameter.
beta_s  
The upper asymptote prior 'b' parameter.
burnin  
The number of MCMC samples to discard.
cTF  
A J dimensional vector indicating which lower asymptotes to estimate. 0 = exclude lower asymptote and 1 = include lower asymptote.
sTF  
A J dimensional vector indicating which upper asymptotes to estimate. 0 = exclude upper asymptote and 1 = include upper asymptote.
gwg_reps  
The number of Gibbs within Gibbs MCMC samples for marginal distribution of gamma. Values between 5 to 10 are adequate.
chain_length  
The number of MCMC samples.

Value

Samples from posterior.

Author(s)

Steven Andrew Culpepper

Examples

# Simulate small 4PNO dataset to demonstrate function
J = 5
N = 100

# Population item parameters
as_t = rnorm(J,mean=2,sd=.5)
bs_t = rnorm(J,mean=0,sd=.5)

# Sampling gs and ss with truncation
gs_t = rbeta(J,1,8)
ps_g = pbeta(1-gs_t,1,8)
ss_t = qbeta(runif(J)*ps_g,1,8)
theta_t <- rnorm(N)
Y_t = Y_4pno_simulate(N,J,as=as_t,bs=bs_t,gs=gs_t,ss=ss_t,theta=theta_t)

# Setting prior parameters
mu_theta=0
Sigma_theta_inv=1
mu_xi = c(0,0)
alpha_c=alpha_s=beta_c=beta_s=1
Sigma_xi_inv = solve(2*matrix(c(1,0,0,1),2,2))
burnin = 1000

# Execute Gibbs sampler
**min2LL_4pno**  

Compute 4PNO Deviance

**Description**

Internal function to -2LL.

**Usage**

```
min2LL_4pno(N, J, Y, as, bs, gs, ss, theta)
```

**Arguments**

- **N**
  
  An int, which gives the number of observations. (> 0)

- **J**
  
  An int, which gives the number of items. (> 0)

- **Y**
  
  A N by J matrix of item responses.

- **as**
  
  A vector of item discrimination parameters.

- **bs**
  
  A vector of item threshold parameters.

- **gs**
  
  A vector of item lower asymptote parameters.

- **ss**
  
  A vector of item upper asymptote parameters.

- **theta**
  
  A vector of prior thetas.

**Value**

-2LL.
**Author(s)**

Steven Andrew Culpepper

**See Also**

`Gibbs_4PNO()`

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**Generate Random Multivariate Normal Distribution**

**Description**

Creates a random Multivariate Normal when given number of obs, mean, and sigma.

**Usage**

```r
rmvnorm(n, mu, sigma)
```

**Arguments**

- `n` An int, which gives the number of observations. (> 0)
- `mu` A vector length m that represents the means of the normals.
- `sigma` A matrix with dimensions m x m that provides the covariance matrix.

**Value**

A matrix that is a Multivariate Normal distribution

**Author(s)**

James J Balamuta

**Examples**

```r
# Call with the following data:
rmvnorm(2, c(0,0), diag(2))
```
**Total_Tabulate**

**Calculate Tabulated Total Scores**

**Description**

Internal function to -2LL.

**Usage**

Total_Tabulate(N, J, Y)

**Arguments**

- **N**  
  An int, which gives the number of observations. (> 0)

- **J**  
  An int, which gives the number of items. (> 0)

- **Y**  
  A N by J matrix of item responses.

**Value**

A vector of tabulated total scores.

**Author(s)**

Steven Andrew Culpepper

**See Also**

Gibbs_4PNO()

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**Y_4pno_simulate**

*Simulate from 4PNO Model*

**Description**

Generate item responses under the 4PNO

**Usage**

Y_4pno_simulate(N, J, as, bs, gs, ss, theta)
Arguments

N  An int, which gives the number of observations. (> 0)
J  An int, which gives the number of items. (> 0)
as A vector of item discrimination parameters.
bs A vector of item threshold parameters.
gs A vector of item lower asymptote parameters.
ss A vector of item upper asymptote parameters.
theta A vector of prior thetas.

Value

A N by J matrix of dichotomous item responses.

Author(s)

Steven Andrew Culpepper

See Also

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