Package ‘fourPNO’

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**Description**


**Author(s)**

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**See Also**

Useful links:

- [https://github.com/tmsalab/fourPNO](https://github.com/tmsalab/fourPNO)
- Report bugs at [https://github.com/tmsalab/fourPNO/issues](https://github.com/tmsalab/fourPNO/issues)

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**Gibbs Implementation of 2PNO**

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

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

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

# Sampling gs and ss with truncation
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(sb_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_Tpno(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$as,-c(1:b burnin)],1,mean),apply(out_t$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.
uTheta 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
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)

---

**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_Tpno()`

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### rmvnorm

**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

# Call with the following data:
rmvnorm(2, c(0,0), diag(2))

Description

Internal function to \texttt{-2LL}.

Usage

\texttt{Total\_Tabulate(N, J, Y)}

Arguments

\begin{itemize}
\item \texttt{N}: An int, which gives the number of observations. (> 0)
\item \texttt{J}: An int, which gives the number of items. (> 0)
\item \texttt{Y}: A N by J matrix of item responses.
\end{itemize}

Value

A vector of tabulated total scores.

Author(s)

Steven Andrew Culpepper

See Also

\texttt{Gibbs\_4PNO()}

Description

Generate item responses under the 4PNO

Usage

\texttt{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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