

# Package ‘ggdmc’

July 22, 2025

**Type** Package

**Title** Cognitive Models

**Version** 0.2.6.2

**Date** 2025-04-13

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**Description** Hierarchical Bayesian models. The package provides tools to fit two response time models, using the population-based Markov Chain Monte Carlo.

**License** GPL-2

**URL** <https://github.com/yxlin/ggdmc>

**BugReports** <https://github.com/yxlin/ggdmc/issues>

**Imports** Rcpp (>= 1.0.7), coda, stats, utils, ggplot2, matrixStats, data.table (>= 1.10.4)

**Depends** R (>= 3.3.0)

**LinkingTo** Rcpp (>= 1.0.7), RcppArmadillo (>= 0.7.100.3.0)

**Suggests** testthat

**RoxygenNote** 7.3.2

**Encoding** UTF-8

**NeedsCompilation** yes

**Repository** CRAN

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**Date/Publication** 2025-04-13 11:50:02 UTC

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---

 BuildDMI

*Bind data and models*


---

### Description

Binding a data set with a model object. The function also checks whether they are compatible and adds attributes on a data model instance.

**Usage**

```
BuildDMI(x, model)
```

**Arguments**

x	data as in data frame
model	a model object

**Value**

a data model instance

---

BuildModel	<i>Create a model object</i>
------------	------------------------------

---

**Description**

A model object consists of arrays with model attributes.

**Usage**

```
BuildModel(
  p.map,
  responses,
  factors = list(A = "1"),
  match.map = NULL,
  constants = numeric(0),
  type = "norm",
  posdrift = TRUE,
  verbose = TRUE
)

## S3 method for class 'model'
print(x, p.vector = NULL, ...)

## S3 method for class 'dmi'
print(x, ...)
```

**Arguments**

p.map	parameter map. This option maps a particular factorial design to model parameters
responses	specifying the response names and levels
factors	specifying a list of factors and their levels
match.map	match map. This option matches stimuli and responses

constants	specifying the parameters with fixed values
type	specifying model type, either "rd" or "norm".
posdrift	a Boolean, switching between enforcing strict positive drift rates by using truncated normal distribution. This option is only useful in "norm" model type.
verbose	Print p.vector, constants and model type
x	a model object
p.vector	parameter vector
...	other arguments

### Examples

```
model <- BuildModel(
  p.map      = list(a = "1", v = "1", z = "1", d = "1", t0 = "1",
                  sv = "1", sz = "1", st0 = "1"),
  constants  = c(st0 = 0, d = 0, sz = 0, sv = 0),
  match.map  = list(M = list(s1 = "r1", s2 = "r2")),
  factors    = list(S = c("s1", "s2")),
  responses  = c("r1", "r2"),
  type       = "rd")
```

---

 BuildPrior

*Specifying Parameter Prior Distributions*


---

### Description

BuildPrior sets up parameter prior distributions for each model parameter. p1 and p2 refer to the first and second parameters a prior distribution.

### Usage

```
BuildPrior(
  p1,
  p2,
  lower = rep(NA, length(p1)),
  upper = rep(NA, length(p1)),
  dists = rep("tnorm", length(p1)),
  untrans = rep("identity", length(p1)),
  types = c("tnorm", "beta", "gamma", "lnorm", "unif", "constant", "tnorm2", NA)
)
```

### Arguments

p1	the first parameter of a distribution
p2	the second parameter of a distribution
lower	lower support (boundary)

upper	upper support (boundary)
dists	a vector of character string specifying a distribution.
untrans	whether to do log transformation. Default is not
types	available distribution types

### Details

Four distribution types are implemented:

1. Normal and truncated normal, where:  $p1 = \text{mean}$ ,  $p2 = \text{sd}$ . It specifies a normal distribution when bounds are set  $-\text{Inf}$  and  $\text{Inf}$ ,
2. Beta, where:  $p1 = \text{shape1}$  and  $p2 = \text{shape2}$  (see [pbeta](#)). Note the uniform distribution is a special case of the beta with  $p1$  and  $p2 = 1$ ),
3. Gamma, where  $p1 = \text{shape}$  and  $p2 = \text{scale}$  (see [pgamma](#)). Note  $p2$  is scale, not rate,
4. Lognormal, where  $p1 = \text{meanlog}$  and  $p2 = \text{sdlog}$  (see [plnorm](#)).

### Value

a list of list

---

check_pvec	<i>Does a model object specify a correct p.vector</i>
------------	---

---

### Description

Check a parameter vector

### Usage

```
check_pvec(p.vector, model)
```

### Arguments

p.vector	parameter vector
model	a model object

---

ConvertChains	<i>Prepare posterior samples for plotting functions version 1</i>
---------------	---

---

**Description**

Convert MCMC chains to a data frame for plotting functions

**Usage**

```
ConvertChains(x, start = 1, end = NA, pll = TRUE)
```

**Arguments**

x	posterior samples
start	which iteration to start
end	end at which iteration
pll	a Boolean switch to make posterior log likelihood

---

dbeta_lu	<i>A modified dbeta function</i>
----------	----------------------------------

---

**Description**

A modified dbeta function

**Usage**

```
dbeta_lu(x, p1, p2, lower, upper, lg = FALSE)
```

**Arguments**

x	quantile
p1	shape1 parameter
p2	shape2 parameter
lower	lower bound
upper	upper bound
lg	logical; if TRUE, return log density.

---

dcauchy_1	<i>A modified dcauchy functions</i>
-----------	-------------------------------------

---

**Description**

A modified dcauchy functions

**Usage**

```
dcauchy_1(x, p1, p2, lg = FALSE)
```

**Arguments**

x	quantile
p1	location parameter
p2	scale parameter
lg	log density?

---

dconstant	<i>A pseudo constant function to get constant densities</i>
-----------	---

---

**Description**

Used with constant prior

**Usage**

```
dconstant(x, p1, p2, lower, upper, lg = FALSE)
```

**Arguments**

x	quantile
p1	constant value
p2	unused argument
lower	dummy varlable
upper	dummy varlable
lg	log density?

---

deviance.model	<i>Calculate the statistics of model complexity</i>
----------------	---

---

**Description**

Calculate deviance for a model object for which a log-likelihood value can be obtained, according to the formula  $-2 \times \log\text{-likelihood}$ .

**Usage**

```
## S3 method for class 'model'
deviance(object, ...)
```

**Arguments**

object	posterior samples
...	other plotting arguments passing through dot dot dot.

---

dgamma_1	<i>A modified dgamma function</i>
----------	-----------------------------------

---

**Description**

A modified dgamma function

**Usage**

```
dgamma_1(x, p1, p2, lower, upper, lg = FALSE)
```

**Arguments**

x	quantile
p1	shape parameter
p2	scale parameter
lower	lower bound
upper	upper bound
lg	log density?



---

DIC *Deviance information criteria*

---

**Description**

Calculate DIC and BPIC.

**Usage**

DIC(object, ...)

BPIC(object, ...)

**Arguments**

object           posterior samples  
 ...              other plotting arguments passing through dot dot dot.

---

dlnorm\_1 *A modified dlnorm functions*

---

**Description**

A modified dlnorm functions

**Usage**

dlnorm\_1(x, p1, p2, lower, upper, lg = FALSE)

**Arguments**

x                quantile  
 p1               meanlog parameter  
 p2               sdlog parameter  
 lower            lower bound  
 upper            upper bound  
 lg               log density?

dtnorm

*Truncated Normal Distribution***Description**

Random number generation, probability density and cumulative density functions for truncated normal distribution.

**Usage**

```
dtnorm(x, p1, p2, lower, upper, lg = FALSE)
```

```
rtnorm(n, p1, p2, lower, upper)
```

```
ptnorm(q, p1, p2, lower, upper, lt = TRUE, lg = FALSE)
```

**Arguments**

x, q	vector of quantiles;
p1	mean (must be scalar).
p2	standard deviation (must be scalar).
lower	lower truncation value (must be scalar).
upper	upper truncation value (must be scalar).
lg	log probability. If TRUE (default is FALSE) probabilities p are given as log(p).
n	number of observations. n must be a scalar.
lt	lower tail. If TRUE (default) probabilities are $P[X \leq x]$ , otherwise, $P[X > x]$ .

**Value**

a column vector.

**Examples**

```
## rtn example
dat1 <- rtnorm(1e5, 0, 1, 0, Inf)
hist(dat1, breaks = "fd", freq = FALSE, xlab = "",
     main = "Truncated normal distributions")

## dtn example
x <- seq(-5, 5, length.out = 1e3)
dat1 <- dtnorm(x, 0, 1, -2, 2, 0)
plot(x, dat1, type = "l", lwd = 2, xlab = "", ylab = "Density",
     main = "Truncated normal distributions")

## ptn example
x <- seq(-10, 10, length.out = 1e2)
```

```

mean <- 0
sd <- 1
lower <- 0
upper <- 5
dat1 <- ptnorm(x, 0, 1, 0, 5, lg = TRUE)

```

---

effectiveSize\_hyper     *Calculate effective sample sizes*

---

### Description

effectiveSize calls effectiveSize in **coda** package to calculate sample sizes.

### Usage

```
effectiveSize_hyper(x, start, end, digits, verbose)
```

```
effectiveSize_many(x, start, end, verbose)
```

```
effectiveSize_one(x, start, end, digits, verbose)
```

```

effectiveSize(
  x,
  hyper = FALSE,
  start = 1,
  end = NA,
  digits = 0,
  verbose = FALSE
)

```

### Arguments

x	posterior samples
start	starting iteration
end	ending iteraton
digits	printing how many digits
verbose	printing more information
hyper	a Boolean switch to extract hyper attribute

### Examples

```

#####40
## effectiveSize example
#####40
## Not run:
es1 <- effectiveSize_one(hsam[[1]], 1, 100, 2, TRUE)
es2 <- effectiveSize_one(hsam[[1]], 1, 100, 2, FALSE)

```

```
es3 <- effectiveSize_many(hsam, 1, 100, TRUE)
es4 <- effectiveSize_many(hsam, 1, 100, FALSE)
es5 <- effectiveSize_hyper(hsam, 1, 100, 2, TRUE)
es6 <- effectiveSize(hsam, TRUE, 1, 100, 2, TRUE)
es7 <- effectiveSize(hsam, TRUE, 1, 100, 2, FALSE)
es8 <- effectiveSize(hsam, FALSE, 1, 100, 2, TRUE)
es9 <- effectiveSize(hsam, FALSE, 1, 100, 2, FALSE)
es10 <- effectiveSize(hsam[[1]], FALSE, 1, 100, 2, TRUE)

## End(Not run)
```

---

gelman

*Potential scale reduction factor*

---

### Description

gelman function calls the function, `gelman.diag` in the **coda** package to calculates PSRF.

### Usage

```
gelman(
  x,
  hyper = FALSE,
  start = 1,
  end = NA,
  confidence = 0.95,
  transform = TRUE,
  autoburnin = FALSE,
  multivariate = TRUE,
  split = TRUE,
  subchain = FALSE,
  nsubchain = 3,
  digits = 2,
  verbose = FALSE,
  ...
)
```

```
hgelman(
  x,
  start = 1,
  end = NA,
  confidence = 0.95,
  transform = TRUE,
  autoburnin = FALSE,
  split = TRUE,
  subchain = FALSE,
  nsubchain = 3,
  digits = 2,
```

```

    verbose = FALSE,
    ...
)

```

### Arguments

x	posterior samples
hyper	a Boolean switch, indicating posterior samples are from hierarchical modeling
start	start iteration
end	end iteration
confidence	confident interval
transform	turn on transform
autoburnin	turn on auto burnin
multivariate	multivariate Boolean switch
split	split whether split mcmc chains; When split is TRUE, the function doubles the number of chains by splitting into 1st and 2nd halves.
subchain	whether only calculate a subset of chains
nsubchain	indicate how many chains in a subset
digits	print out how many digits
verbose	print more information
...	arguments passing to coda gelman.diag.

### Examples

```

## Not run:
rhat1 <- hgelman(hsam); rhat1
rhat2 <- hgelman(hsam, end = 51); rhat2
rhat3 <- hgelman(hsam, confidence = .90); rhat3
rhat4 <- hgelman(hsam, transform = FALSE); rhat4
rhat5 <- hgelman(hsam, autoburnin = TRUE); rhat5
rhat6 <- hgelman(hsam, split = FALSE); rhat6
rhat7 <- hgelman(hsam, subchain = TRUE); rhat7
rhat8 <- hgelman(hsam, subchain = TRUE, nsubchain = 4);
rhat9 <- hgelman(hsam, subchain = TRUE, nsubchain = 4,
digits = 1, verbose = TRUE);

hat1 <- gelman(hsam[[1]], multivariate = FALSE); hat1
hat2 <- gelman(hsam[[1]], hyper = TRUE, verbose = TRUE); hat2
hat3 <- gelman(hsam, hyper = TRUE, verbose = TRUE); hat3
hat4 <- gelman(hsam, multivariate = TRUE, verbose = FALSE);
hat5 <- gelman(hsam, multivariate = FALSE, verbose = FALSE);
hat6 <- gelman(hsam, multivariate = FALSE, verbose = TRUE);
hat7 <- gelman(hsam, multivariate = T, verbose = TRUE);

## End(Not run)

```

GetNsim

*Get a n-cell matrix***Description**

Constructs a matrix, showing how many responses to in each cell. The function checks whether the format of n and ns conform.

**Usage**

```
GetNsim(model, n, ns)
```

**Arguments**

model	a model object.
n	number of trials.
ns	number of subjects.

**Details**

n can be:

1. an integer for a balanced design,
2. a matrix for an unbalanced design, where rows are subjects and columns are cells. If the matrix is a row vector, all subjects have the same n in each cell. If it is a column vector, all cells have the same n. Otherwise each entry specifies the n for a particular subject x cell combination. See below for concrete examples.

**Examples**

```
model <- BuildModel(
  p.map      = list(A = "1", B = "R", t0 = "1", mean_v = "M", sd_v = "M",
                   st0 = "1"),
  match.map  = list(M = list(s1 = 1, s2 = 2)),
  constants  = c(sd_v.false = 1, st0 = 0),
  factors    = list(S = c("s1", "s2")),
  responses  = c("r1", "r2"),
  type      = "norm")

#####30
## Example 1
#####30
GetNsim(model, ns = 2, n = 1)
#      [,1] [,2]
# [1,]   1   1
# [2,]   1   1

#####30
```

```

## Example 2
#####30
n <- matrix(c(1:2), ncol = 1)
#      [,1]
# [1,]  1  ## subject 1 has 1 response for each cell
# [2,]  2  ## subject 2 has 2 responses for each cell

GetNsim(model, ns = 2, n = n)
#      [,1] [,2]
# [1,]  1   1
# [2,]  2   2

#####30
## Example 3
#####30
n <- matrix(c(1:2), nrow = 1)
#      [,1] [,2]
# [1,]  1   2
GetNsim(model, ns = 2, n = n)
#      [,1] [,2]
# [1,]  1   2 ## subject 1 has 1 response for cell 1 and 2 responses for cell 2
# [2,]  1   2 ## subject 2 has 1 response for cell 1 and 2 responses for cell 2

#####30
## Example 4
#####30
n <- matrix(c(1:4), nrow=2)
#      [,1] [,2]
# [1,]  1   3
# [2,]  2   4
ggdmc::GetNsim(model, ns = 2, n = n)
#      [,1] [,2]
# [1,]  1   3 ## subject 1 has 1 response for cell 1 and 3 responses for cell 2
# [2,]  2   4 ## subject 2 has 2 responses for cell 1 and 4 responses for cell 2

```

---

GetParameterMatrix      *Constructs a ns x npar matrix,*

---

### Description

The matrix is used to simulate data. Each row represents one set of parameters for a participant.

### Usage

```
GetParameterMatrix(x, nsub, prior = NA, ps = NA, seed = NULL)
```

### Arguments

x	a model object
nsub	number of subjects.

prior            a prior object  
 ps              a vector or a matrix.  
 seed            an integer specifying a random seed.

### Details

One must enter either a vector or a matrix as true parameters to the argument, ps, when presuming to simulate data based on a fixed-effect model. When the assumption is to simulate data based on a random-effect model, one must enter a prior object to the argument, prior to first randomly generate a true parameter matrix.

### Value

a ns x npar matrix

### Examples

```
model <- BuildModel(
  p.map      = list(a = "1", v = "1", z = "1", d = "1", sz = "1", sv = "1",
                  t0 = "1", st0 = "1"),
  match.map = list(M = list(s1 = "r1", s2 = "r2")),
  factors    = list(S = c("s1", "s2")),
  constants  = c(st0 = 0, d = 0),
  responses  = c("r1", "r2"),
  type       = "rd")

p.prior <- BuildPrior(
  dists = c("tnorm", "tnorm", "beta", "beta", "tnorm", "beta"),
  p1     = c(a = 1, v = 0, z = 1, sz = 1, sv = 1, t0 = 1),
  p2     = c(a = 1, v = 2, z = 1, sz = 1, sv = 1, t0 = 1),
  lower  = c(0, -5, NA, NA, 0, NA),
  upper  = c(2, 5, NA, NA, 2, NA))

## Example 1: Randomly generate 2 sets of true parameters from
## parameter priors (p.prior)
GetParameterMatrix(model, 2, p.prior)
##           a           v           z           sz           sv           t0
## [1,] 1.963067  1.472940  0.9509158  0.5145047  1.344705  0.0850591
## [2,] 1.512276 -1.995631  0.6981290  0.2626882  1.867853  0.1552828

## Example 2: Use a user-selected true parameters
true.vector <- c(a=1, v=1, z=0.5, sz=0.2, sv=1, t0=.15)
GetParameterMatrix(model, 2, NA, true.vector)
##           a v z sz sv t0
## [1,] 1 1 0.5 0.2 1 0.15
## [2,] 1 1 0.5 0.2 1 0.15
GetParameterMatrix(model, 2, ps = true.vector)

## Example 3: When a user enter arbitrary sequence of parameters.
## Note sv is before sz. It should be sz before sv
## See correct sequence, by entering "attr(model, 'p.vector')"
```



```
## GetParameterMatrix will rearrange the sequence.
true.vector <- c(a=1, v=1, z=0.5, sv=1, sz = .2, t0=.15)
GetParameterMatrix(model, 2, NA, true.vector)
##      a v  z  sz sv  t0
## [1,] 1 1 0.5 0.2  1 0.15
## [2,] 1 1 0.5 0.2  1 0.15
```

---

GetPNames	<i>Extract parameter names from a model object</i>
-----------	--

---

### Description

Extract parameter names from a model object

### Usage

```
GetPNames(x)
```

### Arguments

x                    a model object

---

get_os	<i>Retrieve information of operating system</i>
--------	---

---

### Description

A wrapper function to extract system information from Sys.info and .Platform

### Usage

```
get_os()
```

### Examples

```
get_os()
## sysname
## "linux"
```

---

 ggdmc

*Bayesian computation of response time models*


---

### Description

**ggdmc** uses the population-based Markov chain Monte Carlo to conduct Bayesian computation on cognitive models.

### Author(s)

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### References

Heathcote, A., Lin, Y.-S., Reynolds, A., Strickland, L., Gretton, M. & Matzke, D., (2018). Dynamic model of choice. *Behavior Research Methods*. <https://doi.org/10.3758/s13428-018-1067-y>.

Turner, B. M., & Sederberg P. B. (2012). Approximate Bayesian computation with differential evolution, *Journal of Mathematical Psychology*, 56, 375–385.

Ter Braak (2006). A Markov Chain Monte Carlo version of the genetic algorithm Differential Evolution: easy Bayesian computing for real parameter spaces. *Statistics and Computing*, 16, 239-249.

---

 iseffective

*Model checking functions*


---

### Description

The function tests whether we have drawn enough samples.

### Usage

```
iseffective(x, minN, nfun, verbose = FALSE)
```

### Arguments

x	posterior samples
minN	specify the size of minimal effective samples
nfun	specify to use the mean or median function to calculate effective samples
verbose	print more information

---

isflat *Model checking functions*

---

### Description

The function tests whether Markov chains converge prematurely:

### Usage

```
isflat(
  x,
  p1 = 1/3,
  p2 = 1/3,
  cut_location = 0.25,
  cut_scale = Inf,
  verbose = FALSE
)
```

### Arguments

x	posterior samples
p1	the range of the head of MCMC chains
p2	the range of the tail of the MCMC chains
cut_location	how far away a location chains been considered as stuck
cut_scale	how far away a scale chains been considered as stuck
verbose	print more information

---

ismixed *Model checking functions*

---

### Description

The function tests whether Markov chains are mixed well.

### Usage

```
ismixed(x, cut = 1.01, split = TRUE, verbose = FALSE)
```

### Arguments

x	posterior samples
cut	psrf criterion for well mixed
split	whether to split MCMC chains. This is an argument passing to gelman function
verbose	print more information

**See Also**

[gelman](#))

---

isstuck	<i>Model checking functions</i>
---------	---------------------------------

---

**Description**

The function tests whether Markov chains encounter a parameter region that is difficult to search. CheckConverged is a wrapper function running the four checking functions, isstuck, isflat, ismixed and iseffective.

**Usage**

```
isstuck(x, hyper = FALSE, cut = 10, start = 1, end = NA, verbose = FALSE)
```

```
CheckConverged(x)
```

**Arguments**

x	posterior samples
hyper	a Boolean switch, extracting hyper attribute.
cut	the criteria for suggesting abnormal chains found
start	start iteration
end	end iteration
verbose	print more information

---

likelihood	<i>Calculate likelihoods</i>
------------	------------------------------

---

**Description**

These function calculate likelihoods. likelihood\_rd implements the equations in Voss, Rothermund, and Voss (2004). These equations calculate diffusion decision model (Ratcliff & Mckoon, 2008). Specifically, this function implements Voss, Rothermund, and Voss's (2004) equations A1 to A4 (page 1217) in C++.

**Usage**

```
likelihood(p_vector_r, data, min_lik = 1e-10)
```

**Arguments**

p_vector_r	a parameter vector
data	data model instance
min_lik	minimal likelihood.

**Value**

a vector

**References**

Voss, A., Rothermund, K., & Voss, J. (2004). Interpreting the parameters of the diffusion model: An empirical validation. *Memory & Cognition*, **32**(7), 1206-1220.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review*, **85**, 238-255.

**Examples**

```

model <- BuildModel(
  p.map      = list(A = "1", B = "1", t0 = "1", mean_v = "M", sd_v = "1",
                   st0 = "1"),
  match.map = list(M = list(s1 = 1, s2 = 2)),
  factors    = list(S = c("s1", "s2")),
  constants  = c(st0 = 0, sd_v = 1),
  responses  = c("r1", "r2"),
  type       = "norm")

p.vector <- c(A = .25, B = .35, t0 = .2, mean_v.true = 1,
             mean_v.false = .25)
dat <- simulate(model, 1e3, ps = p.vector)
dmi <- BuildDMI(dat, model)
den <- likelihood(p.vector, dmi)

model <- BuildModel(
  p.map      = list(a = "1", v = "1", z = "1", d = "1", t0 = "1", sv = "1",
                   sz = "1", st0 = "1"),
  constants  = c(st0 = 0, d = 0),
  match.map = list(M = list(s1 = "r1", s2 = "r2")),
  factors    = list(S = c("s1", "s2")),
  responses  = c("r1", "r2"),
  type       = "rd")

p.vector <- c(a = 1, v = 1, z = 0.5, sz = 0.25, sv = 0.2, t0 = .15)
dat <- simulate(model, 1e2, ps = p.vector)
dmi <- BuildDMI(dat, model)
den <- likelihood(p.vector, dmi)

```

---

mcmc_list.model	<i>Create a MCMC list</i>
-----------------	---------------------------

---

**Description**

Create a MCMC list

**Usage**

```
mcmc_list.model(x, start = 1, end = NA, pll = TRUE)
```

**Arguments**

x	posterior samples
start	start from which iteration
end	end at which iteration
pll	a Boolean switch for calculating posterior log-likelihood

---

PickStuck	<i>Which chains get stuck</i>
-----------	-------------------------------

---

**Description**

Calculate each chain separately for the mean (across many MCMC iterations) of posterior log-likelihood. If the difference of the means and the median (across chains) of the mean of posterior is greater than the cut, chains are considered stuck. The default value for cut is 10. `unstuck` manually removes stuck chains from posterior samples.

**Usage**

```
PickStuck(  
  x,  
  hyper = FALSE,  
  cut = 10,  
  start = 1,  
  end = NA,  
  verbose = FALSE,  
  digits = 2  
)
```

**Arguments**

x	posterior samples
hyper	whether x are hierarhcial samples
cut	a criterion deciding if a chain is stuck.
start	start to evaluate from which iteration.
end	end at which iteration for evaeuation.
verbose	a boolean switch to print more information
digits	print how many digits. Default is 2

**Value**

PickStuck gives an index vector; unstick gives a DMC sample.

**Examples**

```

model <- BuildModel(
  p.map      = list(A = "1", B = "1", t0 = "1", mean_v = "M", sd_v = "1", st0 = "1"),
  match.map  = list(M = list(s1 = 1, s2 = 2)),
  factors    = list(S = c("s1", "s2")),
  constants  = c(st0 = 0, sd_v = 1),
  responses  = c("r1", "r2"),
  type       = "norm")
p.vector <- c(A = .75, B = .25, t0 = .2, mean_v.true = 2.5, mean_v.false = 1.5)

p.prior <- BuildPrior(
  dists = c("tnorm", "tnorm", "beta", "tnorm", "tnorm"),
  p1     = c(A = .3, B = .3, t0 = 1, mean_v.true = 1, mean_v.false = 0),
  p2     = c(1, 1, 1, 3, 3),
  lower  = c(0, 0, 0, NA, NA),
  upper  = c(NA, NA, 1, NA, NA))

## Not run:
dat <- simulate(model, 30, ps = p.vector)
dmi <- BuildDMI(dat, model)
sam <- run(StartNewsamples(dmi, p.prior))
bad <- PickStuck(sam)

## End(Not run)

```

---

plot\_prior

*Plot prior distributions*


---

**Description**

plot\_prior plots one member in a prior object. plot.prior plots all members in a prior object.

**Usage**

```
plot_prior(
  i,
  prior,
  xlim = NA,
  natural = TRUE,
  npoint = 100,
  trans = NA,
  save = FALSE,
  ...
)

## S3 method for class 'prior'
plot(x, save = FALSE, ps = NULL, ...)
```

**Arguments**

<code>i</code>	an integer or a character string indicating which parameter to plot
<code>prior</code>	a prior object
<code>xlim</code>	set the range of on x axis. This is usually the range for each parameter.
<code>natural</code>	default TRUE.
<code>npoint</code>	default to plot 100
<code>trans</code>	default NA. trans can be a scalar or vector.
<code>save</code>	whether to save the data out
<code>...</code>	other plotting arguments passing through dot dot dot.
<code>x</code>	a prior object
<code>ps</code>	true parameter vectors or matrix in the case of many observation units

**Examples**

```
p.prior <- BuildPrior(
  dists = rep("tnorm", 7),
  p1 = c(a = 2, v.f1 = 4, v.f2 = 3, z = 0.5, sv = 1,
        sz = 0.3, t0 = 0.3),
  p2 = c(a = 0.5, v.f1 = .5, v.f2 = .5, z = 0.1, sv = .3,
        sz = 0.1, t0 = 0.05),
  lower = c(0, -5, -5, 0, 0, 0, 0),
  upper = c(5, 7, 7, 1, 2, 1, 1))

plot_prior("a", p.prior)
plot_prior(2, p.prior)
plot(p.prior)
```



---

print.prior	<i>Print Prior Distribution</i>
-------------	---------------------------------

---

**Description**

a convenient function to rearrange p.prior or an element in a pp.prior as a data frame for inspection.

**Usage**

```
## S3 method for class 'prior'
print(x, ...)
```

**Arguments**

x                    a list of prior distributions list, usually created by BuildPrior  
 ...                   other arguments

**Value**

a data frame listing prior distributions and their settings

**Examples**

```
pop.mean <- c(a=1, v.f1=1, v.f2=.2, z=.5, sz=.3, sv.f1=.25, sv.f2=.23,
             t0=.3)
pop.scale <- c(a=.2, v.f1=.2, v.f2=.2, z=.1, sz=.05, sv.f1=.05, sv.f2=.05,
             t0=.05)

p.prior <- BuildPrior(
  dists = rep("tnorm", 8),
  p1    = pop.mean,
  p2    = pop.scale,
  lower = c(0, -5, -5, 0, 0, 0, 0, 0),
  upper = c(2, 5, 5, 1, 2, 2, 1, 1))

print(p.prior)
```

---

random	<i>Generate random numbers</i>
--------	--------------------------------

---

**Description**

A wrapper function for generating random numbers of either the model type, rd, or norm.

**Usage**

```
random(type, pmat, n, seed = NULL)
```

**Arguments**

type	a character string of the model type
pmat	a matrix of response x parameter
n	number of observations
seed	an integer specifying a random seed

---

rlba\_norm

*Generate Random Responses of the LBA Distribution*


---

**Description**

rlba\_norm used the LBA process to generate response times and responses.

**Usage**

```
rlba_norm(n, A, b, mean_v, sd_v, t0, st0, posdrift)
```

**Arguments**

n	is the numbers of observation.
A	start point upper bound, a vector of a scalar.
b	decision threshold, a vector or a scalar.
mean_v	mean drift rate vector
sd_v	standard deviation of drift rate vector
t0	non-decision time, a vector.
st0	non-decision time variation, a vector.
posdrift	if exclude negative drift rates

**Value**

a n x 2 matrix of response time (first column) and responses (second column).

rprior

*Parameter Prior Distributions***Description**

Probability density functions and random generation for parameter prior distributions.

**Usage**

```
rprior(prior, n = 1)
```

**Arguments**

**prior** a list of list usually created by BuildPrior to store the information about parameter prior distributions.

**n** number of observations/random draws

**Examples**

```
p.prior <- BuildPrior(
  dists = c("tnorm", "tnorm", "beta", "tnorm", "beta", "beta"),
  p1 = c(a = 1, v = 0, z = 1, sz = 1, sv = 1, t0 = 1),
  p2 = c(a = 1, v = 2, z = 1, sz = 1, sv = 1, t0 = 1),
  lower = c(0,-5, NA, NA, 0, NA),
  upper = c(2, 5, NA, NA, 2, NA))

rprior(p.prior, 9)
##           a           v           z           sz           sv           t0
## [1,] 0.97413686 0.78446178 0.9975199 -0.5264946 0.5364492 0.55415052
## [2,] 0.72870190 0.97151662 0.8516604 1.6008591 0.3399731 0.96520848
## [3,] 1.63153685 1.96586939 0.9260939 0.7041254 0.4138329 0.78367440
## [4,] 1.55866180 1.43657110 0.6152371 0.1290078 0.2957604 0.23027759
## [5,] 1.32520281 -0.07328408 0.2051155 2.4040387 0.9663111 0.06127237
## [6,] 0.49628528 -0.19374770 0.5142829 2.1452972 0.4335482 0.38410626
## [7,] 0.03655549 0.77223432 0.1739831 1.4431507 0.6257398 0.63228368
## [8,] 0.71197612 -1.15798082 0.8265523 0.3813370 0.4465184 0.23955415
## [9,] 0.38049166 3.32132034 0.9888108 0.9684292 0.8437480 0.13502154

pvec <- c(a=1, v=1, z=0.5, sz=0.25, sv=0.2,t0=.15)
p.prior <- BuildPrior(
  dists = rep("tnorm", 6),
  p1 = c(a=2, v=2.5, z=0.5, sz=0.3, sv=1, t0=0.3),
  p2 = c(a=0.5, v=.5, z=0.1, sz=0.1, sv=.3, t0=0.05) * 5,
  lower = c(0,-5, 0, 0, 0, 0),
  upper = c(5, 7, 2, 2, 2, 2))
```

---

simulate.model	<i>Simulate response time data</i>
----------------	------------------------------------

---

### Description

Simulate response time data either for one subject or multiple subjects. The simulation is based on a model object. For one subject, one must supply a true parameter vector to the ps argument.

### Usage

```
## S3 method for class 'model'
simulate(object, nsim = NA, seed = NULL, nsub = NA, prior = NA, ps = NA, ...)
```

### Arguments

object	a model object.
nsim	number of trials / responses. n can be a single number for a balanced design or a matrix for an unbalanced design, where rows are subjects and columns are design cells. If the matrix has one row then all subjects have the same n in each cell, if it has one column then all cells have the same n; Otherwise each entry specifies the n for a particular subject x design cell combination.
seed	a user specified random seed.
nsub	number of subjects
prior	a prior object
ps	a true parameter vector or matrix.
...	additional optional arguments.

### Details

For multiple subjects, one can enter a matrix (or a row vector) as true parameters. Each row is to generate data separately for a subject. This is the fixed-effect model. To generate data based on a random-effect model, one must supply a prior object. In this case, ps argument is unused. Note in some cases, a random-effect model may fail to draw data from the model, because true parameters are randomly drawn from a prior object. This would happen sometimes in diffusion model, because certain parameter combinations are considered invalid.

ps can be a row vector, in which case each subject has identical parameters. It can also be a matrix with one row per subject, in which case it must have ns rows. The true values will be saved as parameters attribute in the output object.

### Value

a data frame

---

StartNewsamples	<i>Start new model fits</i>
-----------------	-----------------------------

---

### Description

Fit a hierarchical or a fixed-effect model, using Bayesian optimisation. We use a specific type of pMCMC algorithm, the DE-MCMC. This particular sampling method includes crossover and two different migration operators. The migration operators are similar to random-walk algorithm. They would be less efficient to find the target parameter space, if been used alone.

### Usage

```
StartNewsamples(  
  data,  
  prior = NULL,  
  nmc = 200,  
  thin = 1,  
  nchain = NULL,  
  report = 100,  
  rp = 0.001,  
  gammamult = 2.38,  
  pm_Hu = 0.05,  
  pm_BT = 0.05,  
  block = TRUE,  
  ncore = 1,  
  add = FALSE,  
  is_old = FALSE  
)
```

```
run(  
  samples,  
  nmc = 500,  
  thin = 1,  
  report = 100,  
  rp = 0.001,  
  gammamult = 2.38,  
  pm_Hu = 0,  
  pm_BT = 0,  
  block = TRUE,  
  ncore = 1,  
  add = FALSE,  
  is_old = TRUE  
)
```

### Arguments

data	data model instance(s)
------	------------------------

prior	prior objects. For hierarchical model, this must be a list with three sets of prior distributions. Each is respectively named, "pprior", "location", and "scale".
nmc	number of Monte Carlo samples
thin	thinning length
nchain	number of chains
report	progress report interval
rp	tuning parameter 1
gammult	tuning parameter 2. This is the step size.
pm_Hu	probability of migration type 0 (Hu & Tsui, 2010)
pm_BT	probability of migration type 1 (Turner et al., 2013)
block	Only for hierarchical modeling. A Boolean switch for update one parameter at a time
ncore	Only for non-hierarchical, fixed-effect models with many subjects.
add	Boolean whether to add new samples
is_old	start sampling from a DMI or fit samples
samples	posterior samples.

---

summary.model

*Summarise posterior samples*


---

## Description

This calls seven different variants of summary function to summarise posterior samples

## Usage

```
## S3 method for class 'model'
summary(
  object,
  hyper = FALSE,
  start = 1,
  end = NA,
  hmeans = FALSE,
  hci = FALSE,
  prob = c(0.025, 0.25, 0.5, 0.75, 0.975),
  recovery = FALSE,
  ps = NA,
  type = 1,
  verbose = FALSE,
  digits = 2,
  ...
)
```

**Arguments**

object	posterior samples
hyper	whether to summarise hyper parameters
start	start from which iteration.
end	end at which iteration. For example, set start = 101 and end = 1000, instructs the function to calculate from 101 to 1000 iteration.
hmeans	a boolean switch indicating to calculate mean of hyper parameters
hci	boolean switch; whether to calculate credible intervals of hyper parameters
prob	a numeric vector, indicating the quantiles to calculate
recovery	a boolean switch indicating if samples are from a recovery study
ps	true parameter values. This is only for recovery studies
type	calculate type 1 or 2 hyper parameters
verbose	print more information
digits	printing digits
...	other arguments

**Examples**

```
## Not run:
est1 <- summary(hsam[[1]], FALSE)
est2 <- summary(hsam[[1]], FALSE, 1, 100)

est3 <- summary(hsam)
est4 <- summary(hsam, verbose = TRUE)
est5 <- summary(hsam, verbose = FALSE)

hest1 <- summary(hsam, TRUE)

## End(Not run)
```

---

summary\_mcmc\_list      *Summary statistic for posterior samples*

---

**Description**

Calculate summary statistics for posterior samples

**Usage**

```
summary_mcmc_list(object, prob = c(0.025, 0.25, 0.5, 0.75, 0.975), ...)
```

**Arguments**

object	posterior samples
prob	summary quantile summary
...	other arguments passing in

---

TableParameters	<i>Table response and parameter</i>
-----------------	-------------------------------------

---

### Description

TableParameters arranges the values in a parameter vector and creates a response x parameter matrix. The matrix is used by the likelihood function, assigning a trial to a cell for calculating probability densities.

### Usage

```
TableParameters(p.vector, cell, model, n1order)
```

### Arguments

p.vector	a parameter vector
cell	a string or an integer indicating a design cell, e.g., s1.f1.r1 or 1. Note the integer cannot exceed the number of cell. One can check this by entering <code>length(dimnames(model))</code> .
model	a model object
n1order	a Boolean switch, indicating using node 1 ordering. This is only for LBA-like models and its n1PDF likelihood function.

### Value

each row corresponding to the model parameter for a response. When `n1.order` is FALSE, TableParameters returns a matrix without rearranging into node 1 order. For example, this is used in the `simulate` function. By default `n1.order` is TRUE.

### Examples

```
m1 <- BuildModel(
  p.map      = list(a = "1", v = "F", z = "1", d = "1", sz = "1", sv = "F",
                  t0 = "1", st0 = "1"),
  match.map = list(M = list(s1 = "r1", s2 = "r2")),
  factors    = list(S = c("s1", "s2"), F = c("f1", "f2")),
  constants  = c(st0 = 0, d = 0),
  responses  = c("r1", "r2"),
  type      = "rd")

m2 <- BuildModel(
  p.map = list(A = "1", B = "1", mean_v = "M", sd_v = "1",
              t0 = "1", st0 = "1"),
  constants = c(st0 = 0, sd_v = 1),
  match.map = list(M = list(s1 = 1, s2 = 2)),
  factors    = list(S = c("s1", "s2")),
  responses  = c("r1", "r2"),
  type      = "norm")
```



```

pvec1 <- c(a = 1.15, v.f1 = -0.10, v.f2 = 3, z = 0.74, sz = 1.23,
          sv.f1 = 0.11, sv.f2 = 0.21, t0 = 0.87)
pvec2 <- c(A = .75, B = .25, mean_v.true = 2.5, mean_v.false = 1.5,
          t0 = .2)

print(m1, pvec1)
print(m2, pvec2)

accMat1 <- TableParameters(pvec1, "s1.f1.r1", m1, FALSE)
accMat2 <- TableParameters(pvec2, "s1.r1", m2, FALSE)

##   a    v  t0   z d  sz  sv st0
## 1.15 -0.1 0.87 0.26 0 1.23 0.11  0
## 1.15 -0.1 0.87 0.26 0 1.23 0.11  0

##   A b  t0 mean_v sd_v st0
## 0.75 1 0.2   2.5   1   0
## 0.75 1 0.2   1.5   1   0

```

---

theta2mcmclist

*Convert theta to a mcmc List*


---

## Description

Extracts the parameter array (ie theta) from posterior samples of a participant and convert it to a **cod** mcmc.list.

## Usage

```

theta2mcmclist(
  x,
  start = 1,
  end = NA,
  split = FALSE,
  subchain = FALSE,
  nsubchain = 3,
  thin = NA
)

phi2mcmclist(
  x,
  start = 1,
  end = NA,
  split = FALSE,
  subchain = FALSE,
  nsubchain = 3
)

```

**Arguments**

x	posterior samples
start	start iteration
end	end iteraton
split	whether to divide one MCMC sequence into two sequences.
subchain	boolean swith convert only a subset of chains
nsubchain	indicate the number of chains in the subset
thin	thinning lenght of the posterior samples

**Details**

phi2mcmclic extracts the phi parameter array, which stores the location and scale parameters at the hyper level.

**Examples**

```
## Not run:
model <- BuildModel(
  p.map = list(a = "RACE", v = c("S", "RACE"), z = "RACE", d = "1",
    sz = "1", sv = "1", t0 = c("S", "RACE"), st0 = "1"),
  match.map = list(M = list(gun = "shoot", non = "not")),
  factors = list(S = c("gun", "non"), RACE = c("black", "white")),
  constants = c(st0 = 0, d = 0, sz = 0, sv = 0),
  responses = c("shoot", "not"),
  type = "rd")

pnames <- GetPNames(model)
npar <- length(pnames)
pop.mean <- c(1, 1, 2.5, 2.5, 2.5, 2.5, .50, .50, .4, .4, .4, .4)
pop.scale <- c(.15, .15, 1, 1, 1, 1, .05, .05, .05, .05, .05, .05)
names(pop.mean) <- pnames
names(pop.scale) <- pnames
pop.prior <- BuildPrior(
  dists = rep("tnorm", npar),
  p1 = pop.mean,
  p2 = pop.scale,
  lower = c(rep(0, 2), rep(-5, 4), rep(0, 6)),
  upper = c(rep(5, 2), rep(7, 4), rep(2, 6)))
p.prior <- BuildPrior(
  dists = rep("tnorm", npar),
  p1 = pop.mean,
  p2 = pop.scale*10,
  lower = c(rep(0, 2), rep(-5, 4), rep(0, 6)),
  upper = c(rep(10, 2), rep(NA, 4), rep(5, 6)))
mu.prior <- BuildPrior(
  dists = rep("tnorm", npar),
  p1 = pop.mean,
  p2 = pop.scale*10,
  lower = c(rep(0, 2), rep(-5, 4), rep(0, 6)),
```

```

upper = c(rep(10, 2), rep(NA, 4), rep(5, 6))
sigma.prior <- BuildPrior(
  dists = rep("beta", npar),
  p1     = rep(1, npar),
  p2     = rep(1, npar),
  upper = rep(2, npar))
names(sigma.prior) <- GetPNames(model)
priors <- list(pprior=p.prior, location=mu.prior, scale=sigma.prior)
dat    <- simulate(model, nsim = 10, nsub = 10, prior = pop.prior)
dmi    <- BuildDMI(dat, model)
ps     <- attr(dat, "parameters")

fit0 <- StartNewsamples(dmi, priors)
fit  <- run(fit0)

tmp1 <- theta2mcmclist(fit[[1]])
tmp2 <- theta2mcmclist(fit[[2]], start = 10, end = 90)
tmp3 <- theta2mcmclist(fit[[3]], split = TRUE)
tmp4 <- theta2mcmclist(fit[[4]], subchain = TRUE)
tmp5 <- theta2mcmclist(fit[[5]], subchain = TRUE, nsubchain = 4)
tmp6 <- theta2mcmclist(fit[[6]], thin = 2)

## End(Not run)

```

---

unstick\_one

*Unstick posterios samples (One subject)*


---

### Description

Unstick posterios samples (One subject)

### Usage

```
unstick_one(x, bad)
```

### Arguments

x	posterior samples
bad	a numeric vector, indicating which chains to remove

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