

# Package ‘rrum’

September 27, 2025

**Type** Package

**Title** Bayesian Estimation of the Reduced Reparameterized Unified Model  
with Gibbs Sampling

**Version** 0.2.2

**Description** Implementation of Gibbs sampling algorithm for Bayesian Estimation  
of the Reduced Reparameterized Unified Model ('rrum'), described by  
Culpepper and Hudson (2017) <[doi:10.1177/0146621617707511](https://doi.org/10.1177/0146621617707511)>.

**URL** <https://tmsalab.github.io/rrum/>, <https://github.com/tmsalab/rrum>

**BugReports** <https://github.com/tmsalab/rrum/issues>

**License** GPL (>= 2)

**Depends** R (>= 4.3.0), simcdm (>= 0.1.0)

**Imports** Rcpp (>= 1.1.0)

**LinkingTo** Rcpp, RcppArmadillo (>= 15.0.2-2), rgen, simcdm

**Suggests** testthat, covr

**Encoding** UTF-8

**RoxygenNote** 7.3.3

**NeedsCompilation** yes

**Author** Steven Andrew Culpepper [aut, cph] (ORCID:  
<<https://orcid.org/0000-0003-4226-6176>>),  
Aaron Hudson [aut, cph] (ORCID:  
<<https://orcid.org/0000-0002-9731-2224>>),  
James Joseph Balamuta [aut, cph, cre] (ORCID:  
<<https://orcid.org/0000-0003-2826-8458>>)

**Maintainer** James Joseph Balamuta <[balamut2@illinois.edu](mailto:balamut2@illinois.edu)>

**Repository** CRAN

**Date/Publication** 2025-09-27 04:30:02 UTC

## Contents

|                |   |
|----------------|---|
| rrum . . . . . | 2 |
|----------------|---|

rrum

*Gibbs sampler to estimate the rRUM***Description**

Obtains samples from posterior distributon for the reduced Reparametrized Unified Model (rRUM).

**Usage**

```
rrum(
  Y,
  Q,
  chain_length = 10000L,
  as = 1,
  bs = 1,
  ag = 1,
  bg = 1,
  delta0 = rep(1, 2^ncol(Q))
)
```

**Arguments**

|              |                                                                                                                                                                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Y            | A matrix with N rows and J columns, where N repesnts the number of individuals and J the number of items. Y indicates the individuals' responses to each of the items.                                                            |
| Q            | A matrix with J rows and K columns indicating which attributes are required to answer each of the items. An entry of 1 indicates attribute k is required to answer item j. An entry of one indicates attribute k is not required. |
| chain_length | A numeric indicating the number of iterations of Gibbs sampler to be run. Default is set to 10000.                                                                                                                                |
| as           | A numeric, parameter for the prior distribution of pistar. High values as encourage higher values of pistar and lower values of rstar.                                                                                            |
| bs           | A numeric, parameter for the prior distribution of pistar. High values as encourage lower values of pistar and higher values of rstar.                                                                                            |
| ag           | A numeric, parameter for the prior distribution of rstar. High values as encourage higher values of rstar.                                                                                                                        |
| bg           | A numeric, parameter for the prior distribution of pistar. High values as encourage lower values of rstar.                                                                                                                        |
| delta0       | A vector, parameters for the Dirichlet prior on pi.                                                                                                                                                                               |

**Value**

A list that contains

- PISTAR: A matrix where each column represents one draw from the posterior distribution of `pistar`.
- RSTAR: A  $J \times K \times \text{chainlength}$  array where J represents the number of items, and K represents the number of attributes. Each slice represents one draw from the posterior distribution of `rstar`.
- PI: A matrix where each column represents one draw from the posterior distribution of `pi`.
- ALPHA: An  $N \times K \times \text{chainlength}$  array where N represents the number of individuals, and K represents the number of attributes. Each slice represents one draw from the posterior distribution of `alpha`.

**Author(s)**

Steven Andrew Culpepper, Aaron Hudson, and James Joseph Balamuta

**References**

Culpepper, S. A. & Hudson, A. (In Press). An improved strategy for Bayesian estimation of the reduced reparameterized unified model. *Applied Psychological Measurement*.

Hudson, A., Culpepper, S. A., & Douglas, J. (2016, July). Bayesian estimation of the generalized NIDA model with Gibbs sampling. Paper presented at the annual International Meeting of the Psychometric Society, Asheville, North Carolina.

**See Also**

`simcdm::sim_rrum_items()`

**Examples**

```
# Set seed for reproducibility
set.seed(217)

## Define Simulation Parameters

N = 1000 # Number of Individuals
J = 6    # Number of Items
K = 2    # Number of Attributes

# Matrix where rows represent attribute classes
As = attribute_classes(K)

# Latent Class probabilities
pis = c(.1, .2, .3, .4)

# Q Matrix
Q = rbind(c(1, 0),
          c(0, 1),
          c(1, 0),
```

```

        c(0, 1),
        c(1, 1),
        c(1, 1)
    )

# The probabilities of answering each item correctly for individuals
# who do not lack any required attribute
pistar = rep(.9, J)

# Penalties for failing to have each of the required attributes
rstar = .5 * Q

# Randomized alpha profiles
alpha = As[sample(1:(K ^ 2), N, replace = TRUE, pis),]

# Simulate data
rrum_items = simcdm::sim_rrum_items(Q, rstar, pistar, alpha)

## Not run:
# Note: This portion of the code is computationally intensive.

# Recover simulation parameters with Gibbs Sampler
Gibbs.out = rrum(rrum_items, Q)

# Iterations to be discarded from chain as burnin
burnin = 1:5000

# Calculate summarizes of posterior distributions
rstar.mean = with(Gibbs.out, apply(RSTAR[,-burnin], c(1, 2), mean))
pistar.mean = with(Gibbs.out, apply(PISTAR[,-burnin], 1, mean))
pis.mean = with(Gibbs.out, apply(PI[,-burnin], 1, mean))

## End(Not run)

```

# Index

`rrum`, [2](#)

`simcdm::sim_rrum_items()`, [3](#)