Package: StealLikeBayes (via r-universe)

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Type Package

Title A Compendium of Bayesian Statistical Routines Written in 'C++'

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Description This is a compendium of 'C++' routines useful for Bayesian statistics. We steal other people's 'C++' code, repurpose it, and export it so developers of 'R' packages can use it in their 'C++' code. We actually don't steal anything, or claim that Thomas Bayes did, but copy code that is compatible with our GPL 3 licence, fully acknowledging the authorship of the original code.

Imports Rcpp (>= 1.1.0), GIGrvg

LinkingTo Rcpp, RcppArmadillo, RcppEigen, GIGrvg

Suggests tinytest

URL https://bsvars.org/StealLikeBayes/

BugReports https://github.com/bsvars/StealLikeBayes/issues

License GPL (>= 3)

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Contents

`rgennorm` *Samples random draws from a generalised normal distribution using the Gibbs sampler by Waggoner & Zha (2003a)*

Description

Samples random numbers from a generalised normal distribution for a restricted $N \times N$ full rank matrix X. The matrix is drawn row-by-row from their full conditional distributions using the Gibbs sampler by Waggoner & Zha (2003a). The density is proportional to

$$det(X)^{\nu-N}\exp(-\frac{1}{2}\sum_{n=1}^{N}x_nV_nS_nV_n'x_n')$$

specified by the $N \times N$ scale matrices S_n, a positive scalar-valued shape parameter ν, and $r_n \times N$ selection matrices V_n defining the restrictions. Zero restrictions may be imposed on th X matrix row-by-row as

$$X_{n.} = x_nV_n$$

where $1 \times r_n$ vectors x_n collect the unrestricted elements of $X_{n.}$ and the matrices V_n place them in appropriate spots of the $1 \times N$ row $X_{n.}$. The output may be normalised using the method by Waggoner & Zha (2003b) ensuring positive diagonal elements of the output matrices.

This method is useful for sampling the structural matrix of the structural vector autoregressive models identified by exclusion restrictions, sign and exclusion restrictions, heteroskedasticity, and instrumental variables.

Usage

```
rgennorm(n, X, S, nu, V, normalise = TRUE)
```

Arguments

`n`	a positive integer with the number of draws to be sampled. **C++**: a `int` object.
`X`	an $N \times N$ structural matrix with the starting values to initiate the Gibbs sampler. **C++**: an `arma::mat` matrix object.
`S`	an $N \times N \times N$ array with $N \times N$ row-specific precision matrices S_n. **C++**: an `arma::cube` object.
`nu`	a positive integer number with the shape parameter nu. **C++**: an `arma::int` object.
`V`	a list with N elements each including $r_n \times N$ matrices V_n. **C++**: an `arma::field<arma::mat>` object.
`normalise`	a logical value of whether the output should be normalised following the method by Waggoner & Zha (2003b) ensuring positive signs of the diagonal elements of the sampled matrices. **C++**: an `bool` object.

Details

This function is based on C++ code from the R package **bsvars** by Woźniak (2024,2025) and is using objects and commands from the **armadillo** library by Sanderson & Curtin (2025) thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025).

Value

an $N \times N \times n$-array with random draws from the generalised normal distribution. **C++**: an `arma::cube` object.

Author(s)

Tomasz Woźniak <`wozniak.tom@pm.me`>

References

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Waggoner D.F., Zha T., (2003a). A Gibbs Sampler for Structural Vector Autoregressions. Journal of Economic Dynamics and Control, 28(2), 349-366, <doi:10.1016/S0165-1889(02)00168-9>.

Waggoner, D.F., Zha, T. (2003b). Likelihood Preserving Normalization in Multiple Equation Models. Journal of Econometrics, 114(2), 329-347. <doi:10.1016/S0304-4076(03)00087-3>

Woźniak T. (2024). bsvars: Bayesian Estimation of Structural Vector Autoregressive Models, R package version 3.2, <doi:10.32614/CRAN.package.bsvars>.

Woźniak T. (2025). Fast and Efficient Bayesian Analysis of Structural Vector Autoregressions Using the R Package bsvars. University of Melbourne Working Paper, 1–25. <doi:10.48550/arXiv.2410.15090>.

Examples

```
rgennorm(1, diag(2), array(diag(2), c(2,2,2)), 3, list(diag(2), matrix(1,1,2)))
```

`rhaar1` *Sample random matrices from Haar distribution*

Description

This function samples random orthogonal matrices from the Haar distribution, that is, the uniform distribution over the space of orthogonal matrices.

Usage

```
rhaar1(n)
```

Arguments

`n`	a positive integer scalar specifying the dimension of the orthogonal matrix. **C++**: an `int` scalar.

Details

This function is based on C++ code from the R package **bsvarSIGNs** by Wang X., Woźniak T. (2025a,2025b) and is using objects and commands from the **armadillo** library by Sanderson & Curtin (2025) thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025)

Value

An $n \times n$ matrix with a random draw of the orthogonal matrix from the Haar distribution. **C++**: an `arma::mat` object.

Author(s)

Xiaolei Wang <adamwang15@gmail.com>

References

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Stewart, G. W. (1980). The efficient generation of random orthogonal matrices with an application to condition estimators. SIAM Journal on Numerical Analysis, 17(3), 403-409. <doi:10.1137/0717034>

Wang X., Woźniak T. (2025a). bsvarSIGNs: Bayesian SVARs with Sign, Zero, and Narrative Restrictions. R package version 2.0, <doi:0.32614/CRAN.package.bsvarSIGNs>.

Wang X., Woźniak T. (2025b). Bayesian Analyses of Structural Vector Autoregressions with Sign, Zero, and Narrative Restrictions Using the R Package bsvarSIGNs, <doi:10.48550/arXiv.2501.16711>.

Examples

```
rhaar1(3)
```

---

rnorm1_precision_sampler

Samples random draws from a multivariate normal distribution using the precision sampler by Chan & Jeliazkov (2009)

Description

Samples random numbers from an N-variate normal distribution specified by the $N \times N$ precision matrix P and $N \times 1$ location vector L as per:

$$N(P^{-1}L, P^{-1})$$

where the precision matrix P is bi-diagonal with the diagonal elements given in the vector argument `precision_diag` and the off-diagonal element is given in the scalar argument `precision_offdiag`, and the location vector L is provided in the vector argument `location`.

This method is useful for the simulation smoother of the linear Gaussian state-space models with the state variable specified by the autoregressive dynamics with one lag, AR(1). See Woźniak (2021) for more details.

Usage

```
rnorm1_precision_sampler(location, precision_diag, precision_offdiag)
```

Arguments

location — an N-vector with the location parameter L. **C++**: an `arma:vec` vector object.

precision_diag — an N-vector with the diagonal elements of the precision matrix P. **C++**: an `arma:vec` vector object.

precision_offdiag — a numeric scalar with the off-diagonal element of the precision matrix P. **C++**: a `double` scalar.

Details

This function is based on C++ code from the R package **stochvol** by Hosszejni & Kastner (2025) and Kastner G. (2016) and is using objects and commands from the **armadillo** library by Sanderson & Curtin (2025) thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025)

Value

an N-vector with random draws from the multivariate normal distribution. **C++**: an `arma:vec` vector object.

Author(s)

Tomasz Woźniak <wozniak.tom@pm.me>

References

Chan J.C.C., Jeliazkov I. (2009). Efficient simulation and integrated likelihood estimation in state space models. International Journal of Mathematical Modelling and Numerical Optimisation, 1(1/2), <doi:10.1504/IJMMNO.2009.030090>.

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Hosszejni D., Kastner G. (2025). stochvol: Efficient Bayesian Inference for Stochastic Volatility (SV) Models. R package version 3.2.8, <doi:10.32614/CRAN.package.stochvol>

Kastner G. (2016). Dealing with Stochastic Volatility in Time Series Using the R Package stochvol. Journal of Statistical Software, 69(5), 1–30. <doi:10.18637/jss.v069.i05>.

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Woźniak T. (2021). Simulation Smoother using RcppArmadillo, RcppGallery https://gallery.rcpp.org/articles/simulation-smoother-using-rcpparmadillo/

Examples

```
rnorm1_precision_sampler(rep(0, 100), rep(1, 100), -0.5)
```

`rtmvnorm` *Sample Random Draws From the Truncated Multivariate Normal Using the Algorithm Proposed by Yifang Li and Sujit K. Ghosh (2015)*

Description

Samples random numbers from a truncated multivariate normal distribution with parameters mean vector, covariance matrix, and linear inequality constraints of the form $l \leq Bx \leq u$, where B is a constraint matrix and l and u are lower and upper bounds. The function uses a Gibbs sampling algorithm to generate draws from the constrained distribution.

The truncated multivariate normal is important for research in Bayesian statistics, econometrics, and any field requiring parameter estimation subject to inequality constraints. Common applications include censored regression models, portfolio optimization with constraints, and prior distributions with bounded support.

Usage

```
rtmvnorm(mean, sigma, blc, lower, upper, init, burn = 10)
```

Arguments

`mean`	an $n \times p$ matrix of means. n is the number of draws to be sampled. p is the dimension of the draws. **C++**: an `arma::mat` object.
`sigma`	a $p \times p$ covariance matrix for the draws. **C++**: an `arma::mat` object.
`blc`	an $m \times p$ matrix of coefficients for linear inequality constraints. **C++**: an `arma::mat` object.
`lower`	an $n \times m$ matrix of lower truncation bounds. **C++**: an `arma::mat` object.
`upper`	an $n \times m$ matrix of upper truncation bounds. **C++**: an `arma::mat` object.
`init`	an $n \times p$ matrix of initial values for the algorithm. **C++**: an `arma::mat` object.
`burn`	number of iterations used as burn-in. Defaults is 10. **C++**: an `arma::uword` object.

Details

This function is based on C++ code from the R package **tmvtnsim** by Lu (2025) and is using objects and commands from the **armadillo** library by Sanderson & Curtin (2025) thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025).

Value

An $n \times p$ matrix of draws from the specified truncated multivariate normal. **C++**: an `arma::mat` object.

Author(s)

Filip Reierson <filip.reierson@gmail.com>

References

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Li, Y., Ghosh, S.K. Efficient sampling methods for truncated multivariate normal and student-t distributions subject to linear inequality constraints. J Stat Theory Pract 9, 712–732 (2015). <doi:10.1080/15598608.2014.996690>

Lu K. (2025). tmvtnsim: Truncated Multivariate Normal and t Distribution Simulation. R package version 0.1.4, <doi:10.32614/CRAN.package.tmvtnsim>

Examples

```
rtmvnorm(mean = matrix(c(0, 0), nrow = 1), sigma = diag(2),
         blc = diag(2), lower = matrix(c(-Inf, -Inf), nrow = 1),
         upper = matrix(c(1, 1), nrow = 1), init = matrix(c(0, 0),
         nrow = 1), burn = 10)
```

---

rtmvnorm_hmc *Generate Truncated Multivariate Normal Samples via Hamiltonian Monte Carlo*

Description

Generate p-dimensional truncated multivariate normal samples that satisfy an inequality constraint

$$F \times x + g \geq 0,$$

where x is a column vector of the generated sample. The sampler is an exact Hamiltonian Monte Carlo (HMC) sampler as described in Pakman and Paninski (2014).

Usage

```
rtmvnorm_hmc(n, mean, cov, initial, Fmat, g, burn)
```

Arguments

`n`	a positive integer with the number of samples. **C++**: an `int` object.
`mean`	a p-dimensional mean vector. **C++**: an `Eigen::VectorXd` object.
`cov`	a $p \times p$ covariance matrix of the normal distribution. **C++**: an `Eigen::MatrixXd` object.
`initial`	a p-dimensional initial value vector for the Markov chain. **C++**: an `Eigen::VectorXd` object.

Fmat	an $m \times p$ constraint matrix F defining linear inequalities, where m is the number of constraints. **C++**: an `Eigen::MatrixXd` object.
g	an m-dimensional constraint vector defining linear inequalities. **C++**: an `Eigen::VectorXd` object.
burn	a non-negative integer with the number of burn-in iterations before collecting samples. **C++**: an `int` object.

Details

The function generates samples from a truncated multivariate normal distribution with mean `mean` and covariance `cov`, subject to linear constraints defined by `Fmat` and `g`.

The user should supply an initial value that strictly satisfies the inequality constraints, although the generated samples only satisfy them weakly.

No check for symmetry is performed on the covariance matrix.

It is advisable to use a small burn-in period (e.g., 10) to allow the Markov chain to reach stationarity.

This function is a wrapper around a C++ implementation adapted from the 'tnorm' R package by Kenyon Ng.

Value

An $n \times p$ matrix with each row corresponding to a sample. **C++**: an `Eigen::MatrixXd` object.

References

Pakman, A. and Paninski, L. (2014). Exact Hamiltonian Monte Carlo for Truncated Multivariate Gaussians. Journal of Computational and Graphical Statistics, 23(2), 518–542. <doi:10.1080/10618600.2013.788448>

Ng, K. (2024). tnorm: Generate Multivariate Truncated Normal Samples. R package version 0.0.1. <https://github.com/weiyaw/tnorm>

Bates, D. and Eddelbuettel, D. (2013). Fast and Elegant Numerical Linear Algebra Using the RcppEigen Package. Journal of Statistical Software, 52(5), 1–24. <doi:10.18637/jss.v052.i05>

Examples

```
rtmvnorm_hmc(1, c(0, 0), diag(2), c(0, 2), diag(2), c(1, -1), 1)
```

`sample_variances_horseshoe` *Samples variances from the horseshoe prior using Gruber & Kastner (2024)*

Description

Performs one Gibbs sampling iteration for the horseshoe prior variance parameters. The horseshoe prior Carvalho, Polson, Scott (2010) is a continuous shrinkage prior for Bayesian variable selection with the hierarchical structure:

$$\beta_j \sim N(0, \lambda_j^2 \tau^2)$$

$$\lambda_j \sim C^+(0, 1)$$

$$\tau \sim C^+(0, 1)$$

where $C^+(0, 1)$ denotes the half-Cauchy distribution, λ_j^2 are the local shrinkage parameters (argument `theta`), and τ^2 is the global shrinkage parameter (argument `zeta`). The prior variance for coefficient j is $V_{i,j} = \lambda_j^2 \tau^2$.

The half-Cauchy distributions are represented using auxiliary variables ν_j and ϖ to facilitate Gibbs sampling. This implementation allows updating only a subset of coefficients specified by the indices in argument `ind`.

Usage

```
sample_variances_horseshoe(coefs, theta, zeta, nu, varpi)
```

Arguments

`coefs`	a p-vector with the current coefficient values β_j. **C++**: an `arma::vec` vector object.
`theta`	a p-vector with the local variance parameters λ_j^2, updated by reference. **C++**: an `arma::vec` vector object.
`zeta`	a numeric scalar with the global variance parameter τ^2, updated by reference. **C++**: a `double` scalar.
`nu`	a p-vector with auxiliary variables for the local shrinkage, updated by reference. **C++**: an `arma::vec` vector object.
`varpi`	a numeric scalar with the auxiliary variable for the global shrinkage, updated by reference. **C++**: a `double` scalar.

Details

This function is based on C++ code from the R package **bayesianVARs** by Gruber & Kastner (2024) and is using objects and commands from the **armadillo** library. Thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025).

Value

a vector of variances' random draws. **C++**: an `arma::vec` vector object.

Author(s)

Longcan Li <longcando@outlook.com>

References

Carvalho C.M., Polson N.G., Scott J.G. (2010). The horseshoe estimator for sparse signals. Biometrika, 97(2), 465-480. <doi:10.1093/biomet/asq017>

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Gruber L.,Kastner G. (2024). bayesianVARs: MCMC Estimation of Bayesian Vector Autoregressions. R package version 0.1.5, <doi:10.32614/CRAN.package.bayesianVARs>

Makalic E., Schmidt D.F. (2016). A Simple Sampler for the Horseshoe Estimator. IEEE Signal Processing Letters, 23(1), 179-182. <doi:10.1109/LSP.2015.2503725>

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Examples

```
sample_variances_horseshoe( rep(0, 2), rep(0, 2), 1, rep(1, 2), 1)
```

---

sample_variances_normal_gamma

Samples variances of the Normal-Gamma prior distribution by Brown & Griffin (2010).

Description

This function samples variances from a Normal-Gamma prior distribution. The prior distribution has a hierarchical structure where each element x_i of a k-vector X follows:

$$x_i \sim N(0, \vartheta_i \zeta_j), \vartheta_i \sim G(a_j, a_j/2), \text{ and } \zeta_j^{-1} \sim G(b, c)$$

for $i = j = 1, \ldots, k$. The hyperparameter a_j follows an i.i.d. discrete hyperprior with $Pr(a_j = \tilde{a}_r) = p_r$, where $\tilde{a} = (\tilde{a}_1, \ldots, \tilde{a}_R)'$ is the vector of strictly positive support points. See Brown & Griffin (2010) and Gruber & Kastner (2025) for further details.

Usage

```
sample_variances_normal_gamma(
  x,
  theta_tilde,
  zeta,
  a,
  a_vec,
  varrho0,
  varrho1,
  hyper,
  tol = 1e-06
)
```

Arguments

`x`	A starting values vector of the variances. **C++**: an `arma::vec` vector object.
`theta_tilde`	A starting values vector of ϑ_i. **C++**:an `arma::vec` vector object.
`zeta`	A starting value of ζ_j. **C++**: an `double` object.
`a`	Prior shape parameter of the Gamma distribution for ϑ_i. **C++**: an `double` object.
`a_vec`	Multinomial grid for updating shape parameter of the Gamma distribution.**C++**: an `arma::vec` vector object.
`varrho0`	Prior shape parameter of the Gamma distribution for ζ_j. **C++**: an `double` object.
`varrho1`	Prior scale parameter of the Gamma distribution for ζ_j. **C++**: an `double` object.
`hyper`	A logical value. TRUE or FALSE. **C++**: an `bool` object
`tol`	The numerical tolerance, default is '1e-06'. **C++**: an `double` object.

Details

This function is based on C++ code from the R package **bayesianVARs** by Gruber (2025) and is using objects and commands from the **armadillo** library by Sanderson & Curtin (2025) thanks to the **RcppArmadillo** package by Eddelbuettel, Francois, Bates, Ni, & Sanderson (2025).

Value

A vector of variances of the Normal-Gamma prior distribution. **C++**: an `arma::vec` object.

Author(s)

Jianying Shelly Xie <`shellyyinggxie@gmail.com`>

References

Gruber, L. (2025). bayesianVARs: MCMC Estimation of Bayesian Vectorautoregressions. R package version 0.1.5.9000, <doi: 10.32614/CRAN.package.bayesianVARs>.

Gruber, L., & Kastner, G. (2025). Forecasting macroeconomic data with Bayesian VARs: Sparse or dense? It depends!. International Journal of Forecasting, 41(4), 1589-1619, <doi:org/10.1016/j.ijforecast.2025.02.001>.

Philip J. Brown., Jim E. Griffin (2010). Inference with normal-gamma prior distributions in regression problems. Bayesian Analysis, 5(1), 171-188, <doi:org/10.1214/10-BA507>.

Eddelbuettel D., Francois R., Bates D., Ni B., Sanderson C. (2025). RcppArmadillo: 'Rcpp' Integration for the 'Armadillo' Templated Linear Algebra Library. R package version 15.0.2-2. <doi:10.32614/CRAN.package.RcppArmadillo>

Sanderson C., Curtin R. (2025). Armadillo: An Efficient Framework for Numerical Linear Algebra. International Conference on Computer and Automation Engineering, 303-307, <doi:10.1109/ICCAE64891.2025.10980539>

Examples

```
sample_variances_normal_gamma(rep(0,2), rep(1,2), 1, 1, rep(1,2), 1, 1, TRUE, 1e-6)
```

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