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Description A Gibbs sampler corresponding to a Group Inverse-Gamma Gamma (GIGG) regression model with adjustment covariates. Hyperparameters in the GIGG prior specification can either be fixed by the user or can be estimated via Marginal Maximum Likelihood Estimation. Jonathan Boss, Jyotishka Datta, Xin Wang, Sung Kyun Park, Jian Kang, Bhramar Mukherjee (2021) <doi:10.48550/arXiv.2102.10670>.

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`chol_solve` *Solve function with Cholesky decomposition.*

Description

An Rcpp function that solves M*U = V.

Usage

```
chol_solve(M, V)
```

Arguments

`M`	A (M x M) symmetric positive definite matrix.
`V`	A (M x 1) vector.

Value

The solution to M*U = V.

`concentrated` *Example data set*

Description

Contains a list with data and parameters to run the package examples. Please see `?gigg_fixed` and `?grouped_igg_mmle` pages for use.

Usage

```
concentrated
```

Format

An object of class `list` of length 15.

Examples

```
concentrated
names(concentrated)
```

---

digamma_inv *Inverse digamma function.*

Description

Evaluate the inverse digamma function.

Usage

```
digamma_inv(y, precision = 1e-08)
```

Arguments

`y`	value to evaluate the inverse digamma function at.
`precision`	default = 1e-08.

Value

Numeric inverse digamma value.

---

distributed *Example data set*

Description

Contains a list with data and parameters to run the package examples. Please see `?gigg_fixed` and `?grouped_igg_mmle` pages for use.

Usage

```
distributed
```

Format

An object of class `list` of length 15.

Examples

```
distributed
names(distributed)
```

gigg *GIGG regression*

Description

Perform GIGG (Group Inverse-Gamma Gamma) regression. This package implements a Gibbs sampler corresponding to a Group Inverse-Gamma Gamma (GIGG) regression model with adjustment covariates. Hyperparameters in the GIGG prior specification can either be fixed by the user or can be estimated via Marginal Maximum Likelihood Estimation.

Usage

```
gigg(
  X,
  C,
  Y,
  method = "mmle",
  grp_idx,
  alpha_inits = rep(0, ncol(C)),
  beta_inits = rep(0, ncol(X)),
  a = rep(0.5, length(unique(grp_idx))),
  b = rep(0.5, length(unique(grp_idx))),
  sigma_sq_init = 1,
  tau_sq_init = 1,
  n_burn_in = 500,
  n_samples = 1000,
  n_thin = 1,
  verbose = TRUE,
  btrick = FALSE,
  stable_solve = TRUE
)
```

Arguments

X	A (n x p) matrix of covariates that to apply GIGG shrinkage on.
C	A (n x k) matrix of covariates that to apply no shrinkage on (typically intercept + adjustment covariates).
Y	A length n vector of responses.
method	Either `fixed` for GIGG regression with fixed hyperparameters or `mmle` for GIGG regression with MMLE. Defaults to method = "mmle".
grp_idx	A length p integer vector indicating which group of the G groups the p covariates in X belong to. The `grp_idx` vector must be a sequence from 1 to G with no skips. A valid example is 1,1,1,2,2,3,3,3,4,5,5.
alpha_inits	A length k vector containing initial values for the regression coefficients corresponding to C.

beta_inits	A length p vector containing initial values for the regression coefficients corresponding to X.
a	A length G vector of shape parameters for the prior on the group shrinkage parameters. The a parameter is only used if the user selects method = 'fixed'. If method = 'mmle', then a = rep(1/n, length(unique(grp_idx))).
b	A length G vector of shape parameters for the prior on the individual shrinkage parameters. If method = 'mmle', then the b is used as an inital value for the MMLE procedure.
sigma_sq_init	Initial value for the residual error variance (double).
tau_sq_init	Initial value for the global shrinkage parameter (double).
n_burn_in	The number of burn-in samples (integer).
n_samples	The number of posterior draws (integer).
n_thin	The thinning interval (integer).
verbose	Boolean value which indicates whether or not to print the progress of the Gibbs sampler.
btrick	Boolean value which indicates whether or not to use the computational trick in Bhattacharya et al. (2016). Only recommended if number of covariates is much larger than the number of observations.
stable_solve	Boolean value which indicates whether or not to use Cholesky decomposition during the update of the regression coefficients corresponding to X. In our experience, stable_solve = TRUE is slightly slower, but more stable.

Value

A list containing

- "draws" - A list containing the posterior draws of
  (1) the regression coefficients (alphas and betas)
  (2) the individual shrinkage parameters (lambda_sqs)
  (3) the group shrinkage parameters (gamma_sqs)
  (4) the global shrinkage parameter (tau_sqs) and
  (5) the residual error variance (sigma_sqs).
  The list also contains details regarding the dataset (X, C, Y, grp_idx) and Gibbs sampler details (n_burn_in, n_samples, and n_thin).
- "beta.hat" - Posterior mean of betas
- "beta.lcl.95" - 95% credible interval lower bound of betas
- "beta.ucl.95" - 95% credible interval upper bound of betas
- "alpha.hat" - Posterior mean of alpha
- "alpha.lcl.95" - 95% credible interval lower bound of alphas
- "alpha.ucl.95" - 95% credible interval upper bound of alphas
- "sigma_sq.hat" - Posterior mean of sigma squared
- "sigma_sq.lcl.95" - 95% credible interval lower bound of sigma sq.
- "sigma_sq.ucl.95" - 95% credible interval upper bound of sigma sq.

References

Boss, J., Datta, J., Wang, X., Park, S.K., Kang, J., & Mukherjee, B. (2021). Group Inverse-Gamma Gamma Shrinkage for Sparse Regression with Block-Correlated Predictors. arXiv

Examples

```
X = concentrated$X
C = concentrated$C
Y = as.vector(concentrated$Y)
grp_idx = concentrated$grps
alpha_inits = concentrated$alpha
beta_inits = concentrated$beta

gf = gigg(X, C, Y, method = "fixed", grp_idx, alpha_inits, beta_inits,
          n_burn_in = 200, n_samples = 500, n_thin = 1,
          verbose = TRUE, btrick = FALSE, stable_solve = FALSE)

gf_mmle = gigg(X, C, Y, method = "mmle", grp_idx, alpha_inits, beta_inits,
                n_burn_in = 200, n_samples = 500, n_thin = 1,
                verbose = TRUE, btrick = FALSE,
                stable_solve = FALSE)
```

---

gigg_fixed_gibbs_sampler

Gibbs sampler for GIGG regression with fixed hyperparameters.

Description

An Rcpp function that implements a Gibbs sampler for GIGG regression with fixed hyperparameters.

Usage

```
gigg_fixed_gibbs_sampler(
  X,
  C,
  Y,
  grp_idx,
  grp_size,
  grp_size_cs,
  alpha_inits,
  beta_inits,
  lambda_sq_inits,
  gamma_sq_inits,
  eta_inits,
  p,
```

```
  q,
  tau_sq_init = 1,
  sigma_sq_init = 1,
  nu_init = 1,
  n_burn_in = 500L,
  n_samples = 1000L,
  n_thin = 1L,
  stable_const = 1e-07,
  verbose = TRUE,
  btrick = FALSE,
  stable_solve = FALSE
)
```

Arguments

X	A (n x M) matrix of covariates that we want to apply GIGG shrinkage on.
C	A (n x K) matrix of covariates that we want to apply no shrinkage on (typically intercept + adjustment covariates).
Y	A (n x 1) column vector of responses.
grp_idx	A (1 x M) row vector indicating which group of the J groups the M covariates in X belong to.
grp_size	A (1 x J) row vector indicating the number of covariates in each group.
grp_size_cs	A (1 x J) row vector that is the cumulative sum of grp_size (indicating the indicies where each group ends).
alpha_inits	A (K x 1) column vector containing initial values for the regression coefficients corresponding to C.
beta_inits	A (M x 1) column vector containing initial values for the regression coefficients corresponding to X.
lambda_sq_inits	A (M x 1) column vector containing initial values for the local shrinkage parameters.
gamma_sq_inits	A (J x 1) column vector containing initial values for the group shrinkage parameters.
eta_inits	A (J x 1) column vector containing initial values for the mixing parameters.
p	A (J x 1) column vector of shape parameter for the prior on the group shrinkage parameters.
q	A (J x 1) column vector of shape parameter for the prior on the individual shrinkage parameters.
tau_sq_init	Initial value for the global shrinkage parameter (double).
sigma_sq_init	Initial value for the residual variance (double).
nu_init	Initial value for the augmentation variable (double).
n_burn_in	The number of burn-in samples (integer).
n_samples	The number of posterior draws (integer).

n_thin	The thinning interval (integer).
stable_const	Parameter that controls numerical stability of the algorithm (double).
verbose	Boolean value which indicates whether or not to print the progress of the Gibbs sampler.
btrick	Boolean value which indicates whether or not to use the computational trick in Bhattacharya et al. (2016). Only recommended if number of covariates is much larger than the number of observations.
stable_solve	default to FALSE

Value

A list containing the posterior draws of (1) the regression coefficients (alphas and betas) (2) the individual shrinkage parameters (lambda_sqs) (3) the group shrinkage parameters (gamma_sqs) (4) the global shrinkage parameter (tau_sqs) and (5) the residual error variance (sigma_sqs). The list also contains details regarding the dataset (X, C, Y, grp_idx) and Gibbs sampler details (n_burn_in, n_samples, and n_thin).

---

gigg_mmle_gibbs_sampler

Gibbs sampler for GIGG regression with hyperparameters estimated via MMLE.

Description

An Rcpp function that implements a Gibbs sampler for GIGG regression with hyperparameters estimated via MMLE.

Usage

```
gigg_mmle_gibbs_sampler(
  X,
  C,
  Y,
  grp_idx,
  grp_size,
  grp_size_cs,
  alpha_inits,
  beta_inits,
  lambda_sq_inits,
  gamma_sq_inits,
  eta_inits,
  p_inits,
  q_inits,
  tau_sq_init = 1,
  sigma_sq_init = 1,
  nu_init = 1,
```

```
  n_burn_in = 500L,
  n_samples = 1000L,
  n_thin = 1L,
  stable_const = 1e-07,
  verbose = TRUE,
  btrick = FALSE,
  stable_solve = FALSE
)
```

Arguments

X	A (n x M) matrix of covariates that we want to apply GIGG shrinkage on.
C	A (n x K) matrix of covariates that we want to apply no shrinkage on (typically intercept + adjustment covariates).
Y	A (n x 1) column vector of responses.
grp_idx	A (1 x M) row vector indicating which group of the J groups the M covariates in X belong to.
grp_size	A (1 x J) row vector indicating the number of covariates in each group.
grp_size_cs	A (1 x J) row vector that is the cumulative sum of grp_size (indicating the indicies where each group ends).
alpha_inits	A (K x 1) column vector containing initial values for the regression coefficients corresponding to C.
beta_inits	A (M x 1) column vector containing initial values for the regression coefficients corresponding to X.
lambda_sq_inits	A (M x 1) column vector containing initial values for the local shrinkage parameters.
gamma_sq_inits	A (J x 1) column vector containing initial values for the group shrinkage parameters.
eta_inits	A (J x 1) column vector containing initial values for the mixing parameters.
p_inits	A (J x 1) column vector of initial shape parameter for the prior on the group shrinkage parameters.
q_inits	A (J x 1) column vector of inital shape parameter for the prior on the individual shrinkage parameters.
tau_sq_init	Initial value for the global shrinkage parameter (double).
sigma_sq_init	Initial value for the residual variance (double).
nu_init	Initial value for the augmentation variable (double).
n_burn_in	The number of burn-in samples (integer).
n_samples	The number of posterior draws (integer).
n_thin	The thinning interval (integer).
stable_const	Parameter that controls numerical stability of the algorithm (double).
verbose	Boolean value which indicates whether or not to print the progress of the Gibbs sampler.

btrick	Boolean value which indicates whether or not to use the computational trick in Bhattacharya et al. (2016). Only recommended if number of covariates is much larger than the number of observations.
stable_solve	default to FALSE

Value

A list containing the posterior draws of (1) the regression coefficients (alphas and betas) (2) the individual shrinkage parameters (lambda_sqs) (3) the group shrinkage parameters (gamma_sqs) (4) the global shrinkage parameter (tau_sqs) and (5) the residual error variance (sigma_sqs). The list also contains details regarding the dataset (X, C, Y, grp_idx) and Gibbs sampler details (n_burn_in, n_samples, and n_thin).

---

quick_solve *Iterative one rank update for matrix inverse.*

Description

An Rcpp function that computes the matrix inverse of XtX + D_pos.

Usage

```
quick_solve(XtX_inv, D_pos, vec_draw)
```

Arguments

XtX_inv	A precomputed (M x M) matrix inverse.
D_pos	A (M x 1) vector of the square root of the diagonal entries in the D matrix.
vec_draw	A (M x 1) vector drawn from a multivariate normal distribution.

Value

The solution to (XtX + D)*U = vec_draw.

---

rgig_cpp *Randomly generate a generalized inverse gaussian random variable.*

Description

Randomly generates one draw from a generalized inverse gaussian distribution.

Usage

```
rgig_cpp(chi, psi, lambda)
```

Arguments

`chi`	A positive double.
`psi`	A positive double.
`lambda`	A non-negative double.

Value

A random draw from the generalized inverse gaussian distribution with parameters chi, psi, and lambda (double).

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