

Package ‘FBMS’

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Description Implements the Mode Jumping Markov Chain Monte Carlo algorithm described in <[doi:10.1016/j.csda.2018.05.020](https://doi.org/10.1016/j.csda.2018.05.020)> and its Genetically Modified counterpart described in <[doi:10.1613/jair.1.13047](https://doi.org/10.1613/jair.1.13047)> as well as the sub-sampling versions described in <[doi:10.1016/j.ijar.2022.08.018](https://doi.org/10.1016/j.ijar.2022.08.018)> for flexible Bayesian model selection and model averaging.

URL <https://github.com/jonlachmann/FBMS>

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 FBMS-package

Flexible Bayesian Model Selection and Model Averaging

Description

Implements the Mode Jumping Markov Chain Monte Carlo algorithm described in <doi:10.1016/j.csda.2018.05.020> and its Genetically Modified counterpart described in <doi:10.1613/jair.1.13047> as well as the sub-sampling versions described in <doi:10.1016/j.ijar.2022.08.018> for flexible Bayesian model selection and model averaging.

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References

- Lachmann, J., Storvik, G., Frommlet, F., & Hubin, A. (2022). A subsampling approach for Bayesian model selection. *International Journal of Approximate Reasoning*, 151, 33-63. Elsevier.
- Hubin, A., Storvik, G., & Frommlet, F. (2021). Flexible Bayesian Nonlinear Model Configuration. *Journal of Artificial Intelligence Research*, 72, 901-942.
- Hubin, A., Frommlet, F., & Storvik, G. (2021). Reversible Genetically Modified MJMCMC. Under review in EYSM 2021.
- Hubin, A., & Storvik, G. (2018). Mode jumping MCMC for Bayesian variable selection in GLMM. *Computational Statistics & Data Analysis*, 127, 281-297. Elsevier.

abalone*Physical Measurements of 4177 Abalones, a Species of Sea Snail.*

Description

%% ~~ A concise (1-5 lines) description of the dataset. ~~

Format

A data frame with 4177 observations on the following 9 variables.

Diameter Diameter Perpendicular to length, continuous

Height Height with with meat in shell, continuous.

Length Longest shell measurement, continuous

Rings +1.5 gives the age in years, integer

Sex Sex of the abalone, F is female, M male, and I infant, categorical.

Weight_S Grams after being dried, continuous.

Weight_Sh Grams weight of meat, continuous.

Weight_V Grams gut weight (after bleeding), continuous.

Weight_W Grams whole abalone, continuous.

Details

See the web page <https://archive.ics.uci.edu/ml/datasets/Abalone> for more information about the data set.

Source

Dua, D. and Graff, C. (2019). UCI Machine Learning Repository <https://archive.ics.uci.edu/ml/>. Irvine, CA: University of California, School of Information and Computer Science.

Examples

```
data(abalone)
## maybe str(abalone) ; plot(abalone) ...
```

aggr	<i>Generic for Accessing Aggregated Predictions</i>
------	---

Description

Dispatches to methods for extracting aggregated predictions from objects.

Usage

```
aggr(object, ...)
```

Arguments

object	An object.
...	Additional arguments passed to methods.

Value

Aggregated predictions (format depends on the object class).

aggr.fbms_predict	<i>Access Aggregated Predictions</i>
-------------------	--------------------------------------

Description

Extracts the aggregated predictions (mean and quantiles) from an FBMS prediction object.

Usage

```
## S3 method for class 'fbms_predict'
aggr(object, ...)
```

Arguments

object	Object of class "fbms_predict".
...	Additional arguments (ignored).

Value

List containing aggregated mean and quantiles.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
pred <- predict(model, exoplanet[51:60, -1])
aggr(pred)
```

arcsinh	<i>Arcsinh Transform</i>
---------	--------------------------

Description

Arcsinh Transform

Usage

```
arcsinh(x)
```

Arguments

x	The vector of values
---	----------------------

Value

```
arcsinh(x)
```

Examples

```
arcsinh(2)
```

breastcancer	<i>Breast Cancer Wisconsin (Diagnostic) Data Set</i>
--------------	--

Description

Features are computed from a digitized image of a fine needle aspirate (FNA) of a breast mass. They describe characteristics of the cell nuclei present in the image.

Usage

```
data(breastcancer)
```

Format

A data frame with 569 rows and 32 variables

Details

Separating plane described above was obtained using Multisurface Method-Tree (MSM-T) (K. P. Bennett, "Decision Tree Construction Via Linear Programming." Proceedings of the 4th Midwest Artificial Intelligence and Cognitive Science Society, pp. 97-101, 1992), a classification method which uses linear programming to construct a decision tree. Relevant features were selected using an exhaustive search in the space of 1-4 features and 1-3 separating planes.

The actual linear program used to obtain the separating plane in the 3-dimensional space is that described in: (K. P. Bennett and O. L. Mangasarian: "Robust Linear Programming Discrimination of Two Linearly Inseparable Sets", Optimization Methods and Software 1, 1992, 23-34).

The variables are as follows:

- ID number
- Diagnosis (1 = malignant, 0 = benign)
- Ten real-valued features are computed for each cell nucleus

Source

Dataset downloaded from the UCI Machine Learning Repository. [http://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+\(Diagnostic\)](http://archive.ics.uci.edu/ml/datasets/Breast+Cancer+Wisconsin+(Diagnostic))

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References

W.N. Street, W.H. Wolberg and O.L. Mangasarian. Nuclear feature extraction for breast tumor diagnosis. IS&T/SPIE 1993 International Symposium on Electronic Imaging: Science and Technology, volume 1905, pages 861-870, San Jose, CA, 1993.

Lichman, M. (2013). UCI Machine Learning Repository <http://archive.ics.uci.edu/ml>. Irvine, CA: University of California, School of Information and Computer Science.

coef.bgnlm_model	<i>Coefficients for BGNLM Model</i>
------------------	-------------------------------------

Description

Extracts coefficients from a BGNLM model.

Usage

```
## S3 method for class 'bgnlm_model'
coef(object, ...)
```

Arguments

object	Object of class "bgnlm_model".
...	Additional arguments (ignored).

Value

Vector of coefficients.

Examples

```
data(exoplanet)
model <- get.best.model(fbms(semimajoraxis ~ ., data = exoplanet, family = "gaussian"))
coef(model)
```

coef.gmjcmc	<i>Coefficients for GMJMCMC Model</i>
-------------	---------------------------------------

Description

Extracts coefficients from the best GMJMCMC model found.

Usage

```
## S3 method for class 'gmjcmc'
coef(object, ...)
```

Arguments

object	Object of class "gmjcmc".
...	Additional arguments (ignored).

Value

Vector of coefficients from the best model found.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "gmjcmc", transforms = c("sigmoid"))
coef(model)
```

coef.gmjcmc_merged	<i>Coefficients for GMJMCMC Merged Model</i>
--------------------	--

Description

Extracts coefficients from the best GMJMCMC merged model.

Usage

```
## S3 method for class 'gmjcmc_merged'
coef(object, ...)
```

Arguments

object	Object of class "gmjcmc_merged".
...	Additional arguments (ignored).

Value

Vector of coefficients from the best model found.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet,
method = "gmjcmc.parallel", transforms = c("sigmoid"),
runs = 2, cores = 1)
coef(model)
```

coef.mjcmc	<i>Coefficients for MJCMC Model</i>
------------	-------------------------------------

Description

Extracts coefficients from the best MJCMC model.

Usage

```
## S3 method for class 'mjcmc'
coef(object, ...)
```

Arguments

object	Object of class "mjcmc".
...	Additional arguments (ignored).

Value

Vector of coefficients from the best model found.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjcmc")
coef(model)
```

coef.mjcmc_parallel	<i>Coefficients for MJCMC Parallel Model</i>
---------------------	--

Description

Extracts coefficients from the best MJCMC parallel model.

Usage

```
## S3 method for class 'mjcmc_parallel'
coef(object, ...)
```

Arguments

object	Object of class "mjcmc_parallel".
...	Additional arguments (ignored).

Value

Vector of coefficients from the best model found.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjcmc.parallel", cores = 1, runs = 2)
coef(model)
```

compute_effects

Compute Effects for Specified Covariates Using a Fitted Model

Description

This function computes model averaged effects for specified covariates using a fitted model object. The effects are expected change in the BMA linear predictor having an increase of the corresponding covariate by one unit, while other covariates are fixed to 0. Users can provide custom labels and specify quantiles for the computation of effects.

Usage

```
compute_effects(object, labels, quantiles = c(0.025, 0.5, 0.975))
```

Arguments

object	A fitted model object, typically the result of a regression or predictive modeling.
labels	A vector of labels for which effects are to be computed.
quantiles	A numeric vector specifying the quantiles to be calculated. Default is c(0.025, 0.5, 0.975).

Value

A matrix of treatment effects for the specified labels, with rows corresponding to labels and columns to quantiles.

See Also

[predict](#)

Examples

```
data <- data.frame(matrix(rnorm(600), 100))
result <- mjcmc.parallel(
  runs = 2,
  cores = 1,
  y = matrix(rnorm(100), 100),
  x = data,
  loglik.pi = gaussian.loglik)
```

```
)  
compute_effects(result, labels = names(data))
```

cos_deg	<i>Cosine Function for Degrees</i>
---------	------------------------------------

Description

Cosine Function for Degrees

Usage

```
cos_deg(x)
```

Arguments

x The vector of values in degrees

Value

The cosine of x

Examples

```
cos_deg(0)
```

diagn_plot	<i>Plot Convergence Diagnostics for GMJMCMC or GMJMCMC Merged Results</i>
------------	---

Description

Plots the convergence of summary statistics (e.g., median, mean) of log posteriors or marginal likelihoods over populations for a GMJMCMC or GMJMCMC merged result object, with support for various plot types.

Usage

```

diagn_plot(
  res,
  FUN = median,
  conf = 0.95,
  burnin = 0,
  window = 5,
  ylim = NULL,
  type = "convergence",
  per_thread = FALSE,
  pool = FALSE,
  mass = FALSE,
  ...
)

```

Arguments

<code>res</code>	Object of class <code>gmjcmc</code> or <code>gmjcmc_merged</code> containing results from a GMJM-CMC run or merged runs.
<code>FUN</code>	Function to compute summary statistics (e.g., median, mean). Default is median.
<code>conf</code>	Numeric; confidence level for intervals (e.g., 0.95 for 95%). Default is 0.95.
<code>burnin</code>	Integer; number of initial populations to skip. Default is 0.
<code>window</code>	Integer; size of the sliding window for computing standard deviation. Default is 5.
<code>ylim</code>	Numeric vector; y-axis limits for the plot. If <code>NULL</code> , computed from the data being plotted.
<code>type</code>	String; type of plot to produce. Options are: • "convergence": (Default) Summary statistic with confidence intervals based on sliding window SD. • "min-mean-max": Min, mean, and max log-posteriors per population across threads. • "all-threads": Each thread's summary statistic (defined by <code>FUN</code>) as a separate time series. • "total-mass": Total log-posterior (sum of log-posteriors of all unique models) per population.
<code>per_thread</code>	Logical; if <code>TRUE</code> and <code>type = "total-mass"</code> , plots mass for each thread individually.
<code>pool</code>	Logical; if <code>TRUE</code> , statistics are calculated across all models pooled from all threads for each population.
<code>mass</code>	Logical; if <code>TRUE</code> , total statistics are calculated for each thread under "min-mean-max" settings.
<code>...</code>	Additional graphical parameters passed to <code>plot</code> and <code>lines</code> (e.g., <code>col</code> , <code>lwd</code> , <code>lty</code> , <code>main</code> , <code>xlab</code> , <code>ylab</code>).

Value

Returns a list of summary statistics used for the plot.

Examples

```
data(exoplanet)
result <- fbms(semimajoraxis ~ ., data = exoplanet, method = "gmjcmc", transforms = c("sin"))
diagm_plot(result, FUN = median, conf = 0.95, main = "Convergence Plot")
```

erf	<i>Erf Function</i>
-----	---------------------

Description

Erf Function

Usage

```
erf(x)
```

Arguments

x The vector of values

Value

```
2 * pnorm(x * sqrt(2)) - 1
```

Examples

```
erf(2)
```

exoplanet	<i>Excerpt from the Open Exoplanet Catalogue Data Set</i>
-----------	---

Description

Data fields include planet and host star attributes.

Usage

```
data(exoplanet)
```

Format

A data frame with 223 rows and 11 variables

Details

The variables are as follows:

- semimajoraxis: Semi-major axis of the planetary object's orbit in astronomical units
- mass: Mass of the planetary object in Jupiter masses
- radius: Radius of the planetary object in Jupiter radii
- period: Orbital period of the planetary object in days
- eccentricity: Eccentricity of the planetary object's orbit
- hoststar_mass: Mass of the host star in solar masses
- hoststar_radius: Radius of the host star in solar radii
- hoststar_metallicity: Metallicity of the host star
- hoststar_temperature: Effective temperature of the host star in Kelvin
- binaryflag: Flag indicating the type of planetary system

Source

Dataset downloaded from the Open Exoplanet Catalogue Repository. https://github.com/OpenExoplanetCatalogue/oec_tables/

Creators:

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exp_dbl

Double Exponential Function

Description

Double Exponential Function

Usage

exp_dbl(x)

Arguments

x The vector of values

Value

$e^{(-\text{abs}(x))}$

Examples

```
exp_dbl(2)
```

fbms

Fit a BGNLM Model Using MJMCMC or GMJMCMC Sampling.

Description

This function fits a model using the relevant MCMC sampling. The user can specify the formula, family, data, transforms, and other parameters to customize the model.

Usage

```
fbms(
  formula = NULL,
  family = "gaussian",
  beta_prior = list(type = "g-prior"),
  model_prior = NULL,
  extra_params = NULL,
  data = NULL,
  impute = FALSE,
  loglik.pi = NULL,
  method = "mjmcmc",
  verbose = TRUE,
  ...
)
```

Arguments

formula	A formula object specifying the model structure. Default is NULL.
family	The distribution family of the response variable. Currently supports "gaussian", "binomial", "poisson", "gamma", and "custom". Default is "gaussian".
beta_prior	Type of prior as a string (default: "g-prior" with $a = \max(n, p^2)$). Possible values include: - "beta.prime": Beta-prime prior (GLM/Gaussian, no additional args) - "CH": Compound Hypergeometric prior (GLM/Gaussian, requires a, b, optionally s) - "EB-local": Empirical Bayes local prior (GLM/Gaussian, requires a for Gaussian) - "EB-global": Empirical Bayes local prior (Gaussian, requires a for Gaussian) - "g-prior": Zellner's g-prior (GLM/Gaussian, requires g) - "hyper-g": Hyper-g prior (GLM/Gaussian, requires a) - "hyper-g-n": Hyper-g/n prior (GLM/Gaussian, requires a) - "tCCH": Truncated Compound Hypergeometric prior (GLM/Gaussian, requires a, b, s, rho, v, k) - "intrinsic": Intrinsic prior (GLM/Gaussian, no additional args) - "TG": Truncated Gamma prior (GLM/Gamma, requires a, s) - "Jeffreys": Jeffreys prior (GLM/Gaussian, no additional args) - "uniform": Uniform prior (GLM/Gaussian, no additional args) - "benchmark": Benchmark prior (Gaussian/GLM, no additional args) -

	"ZS-adapted": Zellner-Siow adapted prior (Gaussian TCCH, no additional args) - "robust": Robust prior (Gaussian/GLM, no additional args) - "Jeffreys-BIC": Jeffreys prior with BIC approximation of marginal likelihood (Gaussian/GLM) - "ZS-null": Zellner-Siow null prior (Gaussian, requires a) - "ZS-full": Zellner-Siow full prior (Gaussian, requires a) - "hyper-g-laplace": Hyper-g Laplace prior (Gaussian, requires a) - "AIC": AIC prior from BAS (Gaussian, requires penalty a) - "BIC": BIC prior from BAS (Gaussian/GLM) - "JZS": Jeffreys-Zellner-Siow prior (Gaussian, requires a) • r: Model complexity penalty (default: 1/n) • g: Tuning parameter for g-prior (default: $\max(n, p^2)$) • a, b, s, v, rho, k: Hyperparameters for various priors • n: Sample size for some priors (default: $\text{length}(y)$) • var: Variance assumption for Gaussian models ("known" or "unknown", default: "unknown") • laplace: Logical for Laplace approximation in GLM only (default: FALSE)
model_prior	a list with parameters of model priors, by default r should be provided
extra_params	extra parameters to be passed to the loglik.pi function
data	A data frame or matrix containing the data to be used for model fitting. If the outcome variable is in the first column of the data frame, the formula argument in fbms can be omitted, provided that all other columns are intended to serve as input covariates.
impute	TRUE means imputation combined with adding a dummy column with indicators of imputed values, FALSE (default) means only full data is used.
loglik.pi	Custom function to compute the logarithm of the posterior mode based on logarithm of marginal likelihood and logarithm of prior functions (needs specification only used if family = "custom")
method	Which fitting algorithm should be used, currently implemented options include "gmjcmc", "gmjcmc.parallel", "mjmcmc" and "mjmcmc.parallel" with "mjmcmc" being the default and 'mjmcmc' means that only linear models will be estimated
verbose	If TRUE, print detailed progress information during the fitting process. Default is TRUE.
...	Additional parameters to be passed to the underlying method.

Value

An object containing the results of the fitted model and MCMC sampling.

See Also

[mjmcmc](#), [gmjcmc](#), [gmjcmc.parallel](#)

Examples

```
# Fit a Gaussian multivariate time series model
fbms_result <- fbms(
  X1 ~ .,
  family = "gaussian",
  method = "gmjcmc.parallel",
  data = data.frame(matrix(rnorm(600), 100)),
  transforms = c("sin", "cos"),
  P = 10,
  runs = 1,
  cores = 1
)
summary(fbms_result)
```

fbms.mlik.master

Master Log Marginal Likelihood Function

Description

This function serves as a unified interface to compute the log marginal likelihood for different regression models and priors by calling specific log likelihood functions.

Usage

```
fbms.mlik.master(
  y,
  x,
  model,
  complex,
  mlpost_params = list(family = "gaussian", beta_prior = list(type = "g-prior"), r =
    NULL)
)
```

Arguments

- | | |
|---------------|---|
| y | A numeric vector containing the dependent variable. |
| x | A matrix containing the precalculated features (independent variables). |
| model | A logical vector indicating which variables to include in the model. |
| complex | A list of complexity measures for the features. |
| mlpost_params | A list of parameters controlling the model family, prior, and tuning parameters. Key elements include: <ul style="list-style-type: none"> family: "binomial", "poisson", "gamma" (all three referred to as GLM below), or "gaussian" (default: "gaussian") |

- `prior_beta`: Type of prior as a string (default: "g-prior"). Possible values include:
 - "beta.prime": Beta-prime prior (GLM/Gaussian, no additional args)
 - "CH": Compound Hypergeometric prior (GLM/Gaussian, requires a, b, optionally s)
 - "EB-local": Empirical Bayes local prior (GLM/Gaussian, requires a for Gaussian)
 - "EB-global": Empirical Bayes local prior (Gaussian, requires a for Gaussian)
 - "g-prior": Zellner's g-prior (GLM/Gaussian, requires g)
 - "hyper-g": Hyper-g prior (GLM/Gaussian, requires a)
 - "hyper-g-n": Hyper-g/n prior (GLM/Gaussian, requires a)
 - "tCCH": Truncated Compound Hypergeometric prior (GLM/Gaussian, requires a, b, s, rho, v, k)
 - "intrinsic": Intrinsic prior (GLM/Gaussian, no additional args)
 - "TG": Truncated Gamma prior (GLM/Gamma, requires a, s)
 - "Jeffreys": Jeffreys prior (GLM/Gaussian, no additional args)
 - "uniform": Uniform prior (GLM/Gaussian, no additional args)
 - "benchmark": Benchmark prior (Gaussian/GLM, no additional args)
 - "ZS-adapted": Zellner-Siow adapted prior (Gaussian TCCH, no additional args)
 - "robust": Robust prior (Gaussian/GLM, no additional args)
 - "Jeffreys-BIC": Jeffreys prior with BIC approximation of marginal likelihood (Gaussian/GLM)
 - "ZS-null": Zellner-Siow null prior (Gaussian, requires a)
 - "ZS-full": Zellner-Siow full prior (Gaussian, requires a)
 - "hyper-g-laplace": Hyper-g Laplace prior (Gaussian, requires a)
 - "AIC": AIC prior from BAS (Gaussian, requires penalty a)
 - "BIC": BIC prior from BAS (Gaussian/GLM)
 - "JZS": Jeffreys-Zellner-Siow prior (Gaussian, requires a)
- `r`: Model complexity penalty (default: $1/n$)
- `a`: Tuning parameter for g-prior (default: $\max(n, p^2)$)
- `a, b, s, v, rho, k`: Hyperparameters for various priors
- `n`: Sample size for some priors (default: $\text{length}(y)$)
- `var`: Variance assumption for Gaussian models ("known" or "unknown", default: "unknown")
- `laplace`: Logical for Laplace approximation in GLM only (default: FALSE)

Value

A list with elements:

<code>crit</code>	Log marginal likelihood combined with the log prior.
<code>coefs</code>	Posterior mode of the coefficients.

Examples

```
fbms.mlik.master(y = rnorm(100),
x = matrix(rnorm(100)),
c(TRUE,TRUE),
list(oc = 1),
mlpost_params = list(family = "gaussian", beta_prior = list(type = "g-prior", a = 2),
r = exp(-0.5)))
```

fitted.fbms_predict	<i>Access Fitted Values</i>
---------------------	-----------------------------

Description

Extracts the mean predictions from an FBMS prediction object (alias for mean).

Usage

```
fitted.fbms_predict(object, ...)
```

Arguments

object	Object of class "fbms_predict".
...	Additional arguments (ignored).

Value

Vector of mean predictions.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
pred <- predict(model, exoplanet[51:60, -1])
fitted(pred)
```

gaussian.loglik	<i>Log Likelihood Function for Gaussian Regression with a Jeffreys Prior and BIC Approximation</i>
-----------------	--

Description

Log Likelihood Function for Gaussian Regression with a Jeffreys Prior and BIC Approximation

Usage

```
gaussian.loglik(y, x, model, complex, mlpost_params)
```

Arguments

y	A vector containing the dependent variable
x	The matrix containing the precalculated features
model	The model to estimate as a logical vector
complex	A list of complexity measures for the features
mlpost_params	A list of parameters for the log likelihood, supplied by the user

Value

A list with the log marginal likelihood combined with the log prior (crit) and the posterior mode of the coefficients (coefs).

Examples

```
gaussian.loglik(rnorm(100), matrix(rnorm(100)), TRUE, list(oc = 1), NULL)
```

gelu	<i>GELU Function</i>
------	----------------------

Description

GELU Function

Usage

```
gelu(x)
```

Arguments

x	The vector of values
---	----------------------

Value

$x * \text{pnorm}(x)$

Examples

```
gelu(2)
```

gen.params.gmjcmc	<i>Generate a Parameter List for GMJCMC (Genetically Modified MJCMC)</i>
-------------------	--

Description

This function generates the full list of parameters required for the Generalized Mode Jumping Markov Chain Monte Carlo (GMJCMC) algorithm, building upon the parameters from `gen.params.mjcmc`. The generated parameter list includes feature generation settings, population control parameters, and optimization controls for the search process.

Usage

```
gen.params.gmjcmc(ncov)
```

Arguments

`ncov` The number of covariates in the dataset that will be used in the algorithm

Value

A list of parameters for controlling GMJCMC behavior:

Feature Generation Parameters (feat)

`feat$D` Maximum feature depth, default 5. Limits the number of recursive feature transformations. For fractional polynomials, it is recommended to set $D = 1$.

`feat$L` Maximum number of features per model, default 15. Increase for complex models.

`feat$alpha` Strategy for generating `$alpha$` parameters in non-linear projections:

 "unit" (Default) Sets all components to 1.

 "deep" Optimizes `$alpha$` across all feature layers.

 "random" Samples `$alpha$` from the prior for a fully Bayesian approach.

`feat$pop.max` Maximum feature population size per iteration. Defaults to $\min(100, \text{as.integer}(1.5 * p))$, where p is the number of covariates.

`feat$keep.org` Logical flag; if TRUE, original covariates remain in every population (default FALSE).

`feat$prel.filter` Threshold for pre-filtering covariates before the first population generation. Default 0 disables filtering.

`feat$prel.select` Indices of covariates to include initially. Default NULL includes all.

`feat$keep.min` Minimum proportion of features to retain during population updates. Default 0.8.

`feat$eps` Threshold for feature inclusion probability during generation. Default 0.05.

`feat$check.col` Logical; if TRUE (default), checks for collinearity during feature generation.

`feat$max.proj.size` Maximum number of existing features used to construct a new one. Default 15.

Scaling Option

`rescale.large` Logical flag for rescaling large data values for numerical stability. Default FALSE.

MJMCMC Parameters

`burn_in` The burn-in period for the MJMCMC algorithm, which is set to 100 iterations by default.

`mh` A list containing parameters for the regular Metropolis-Hastings (MH) kernel:

`neigh.size` The size of the neighborhood for MH proposals with fixed proposal size, default set to 1.

`neigh.min` The minimum neighborhood size for random proposal size, default set to 1.

`neigh.max` The maximum neighborhood size for random proposal size, default set to 2.

`large` A list containing parameters for the large jump kernel:

`neigh.size` The size of the neighborhood for large jump proposals with fixed neighborhood size, default set to the smaller of $0.35 * p$ and 35, where p is the number of covariates.

`neigh.min` The minimum neighborhood size for large jumps with random size of the neighborhood, default set to the smaller of $0.25 * p$ and 25.

`neigh.max` The maximum neighborhood size for large jumps with random size of the neighborhood, default set to the smaller of $0.45 * p$ and 45.

`random` A list containing a parameter for the randomization kernel:

`prob` The small probability of changing the component around the mode, default set to 0.01.

`sa` A list containing parameters for the simulated annealing kernel:

`probs` A numeric vector of length 6 specifying the probabilities for different types of proposals in the simulated annealing algorithm.

`neigh.size` The size of the neighborhood for the simulated annealing proposals, default set to 1.

`neigh.min` The minimum neighborhood size, default set to 1.

`neigh.max` The maximum neighborhood size, default set to 2.

`t.init` The initial temperature for simulated annealing, default set to 10.

`t.min` The minimum temperature for simulated annealing, default set to 0.0001.

`dt` The temperature decrement factor, default set to 3.

`M` The number of iterations in the simulated annealing process, default set to 12.

`greedy` A list containing parameters for the greedy algorithm:

`probs` A numeric vector of length 6 specifying the probabilities for different types of proposals in the greedy algorithm.

`neigh.size` The size of the neighborhood for greedy algorithm proposals, set to 1.

neigh.min The minimum neighborhood size for greedy proposals, set to 1.
 neigh.max The maximum neighborhood size for greedy proposals, set to 2.
 steps The number of steps for the greedy algorithm, set to 20.
 tries The number of tries for the greedy algorithm, set to 3.
 loglik A list to store log-likelihood values, which is by default empty.

See Also

[gen.params.mjcmc](#), [gmjcmc](#)

Examples

```
data <- data.frame(y = rnorm(100), x1 = rnorm(100), x2 = rnorm(100))
params <- gen.params.gmjcmc(ncol(data) - 1)
str(params)
```

gen.params.mjcmc	<i>Generate a Parameter List for MJMCMC (Mode Jumping MCMC)</i>
------------------	---

Description

Generate a Parameter List for MJMCMC (Mode Jumping MCMC)

Usage

```
gen.params.mjcmc(ncov)
```

Arguments

ncov The number of covariates in the dataset that will be used in the algorithm

Value

A list of parameters to use when running the mjcmc function.

The list contains the following elements:

burn_in The burn-in period for the MJMCMC algorithm, which is set to 100 iterations by default.

mh A list containing parameters for the regular Metropolis-Hastings (MH) kernel:

 neigh.size The size of the neighborhood for MH proposals with fixed proposal size, default set to 1.

 neigh.min The minimum neighborhood size for random proposal size, default set to 1.

 neigh.max The maximum neighborhood size for random proposal size, default set to 2.

large A list containing parameters for the large jump kernel:

 neigh.size The size of the neighborhood for large jump proposals with fixed neighborhood size, default set to the smaller of $0.35 \times p$ and 35, where p is the number of covariates.

`neigh.min` The minimum neighborhood size for large jumps with random size of the neighborhood, default set to the smaller of $0.25 \times p$ and 25.
`neigh.max` The maximum neighborhood size for large jumps with random size of the neighborhood, default set to the smaller of $0.45 \times p$ and 45.
`random` A list containing a parameter for the randomization kernel:
`prob` The small probability of changing the component around the mode, default set to 0.01.
`sa` A list containing parameters for the simulated annealing kernel:
`probs` A numeric vector of length 6 specifying the probabilities for different types of proposals in the simulated annealing algorithm.
`neigh.size` The size of the neighborhood for the simulated annealing proposals, default set to 1.
`neigh.min` The minimum neighborhood size, default set to 1.
`neigh.max` The maximum neighborhood size, default set to 2.
`t.init` The initial temperature for simulated annealing, default set to 10.
`t.min` The minimum temperature for simulated annealing, default set to 0.0001.
`dt` The temperature decrement factor, default set to 3.
`M` The number of iterations in the simulated annealing process, default set to 12.
`greedy` A list containing parameters for the greedy algorithm:
`probs` A numeric vector of length 6 specifying the probabilities for different types of proposals in the greedy algorithm.
`neigh.size` The size of the neighborhood for greedy algorithm proposals, set to 1.
`neigh.min` The minimum neighborhood size for greedy proposals, set to 1.
`neigh.max` The maximum neighborhood size for greedy proposals, set to 2.
`steps` The number of steps for the greedy algorithm, set to 20.
`tries` The number of tries for the greedy algorithm, set to 3.
`loglik` A list to store log-likelihood values, which is by default empty.

Note that the `$loglik` item is an empty list, which is passed to the log likelihood function of the model, intended to store parameters that the estimator function should use.

Examples

```
gen.params.mjmmc(matrix(rnorm(600), 100))
```

<code>gen.probs.gmjmmc</code>	<i>Generate a Probability List for GMJMMC (Genetically Modified MJMMC)</i>
-------------------------------	--

Description

Generate a Probability List for GMJMMC (Genetically Modified MJMMC)

Usage

```
gen.probs.gmjmcmc(transforms)
```

Arguments

`transforms` A list of the transformations used (to get the count).

Value

A named list with eight elements:

`large` The probability of a large jump kernel in the MJMCMC algorithm. With this probability, a large jump proposal will be made; otherwise, a local Metropolis-Hastings proposal will be used. One needs to consider good mixing around and between modes when specifying this parameter.

`large.kern` A numeric vector of length 4 specifying the probabilities for different types of large jump kernels. The four components correspond to:

1. Random change with random neighborhood size
2. Random change with fixed neighborhood size
3. Swap with random neighborhood size
4. Swap with fixed neighborhood size

These probabilities will be automatically normalized if they do not sum to 1.

`localopt.kern` A numeric vector of length 2 specifying the probabilities for different local optimization methods during large jumps. The first value represents the probability of using simulated annealing, while the second corresponds to the greedy optimizer. These probabilities will be normalized if needed.

`random.kern` A numeric vector of length 2 specifying the probabilities of first two randomization kernels applied after local optimization. These correspond to the same kernel types as in `large.kern` but are used for local proposals where type and 2 only are allowed.

`mh` A numeric vector specifying the probabilities of different standard Metropolis-Hastings kernels, where the first four are the same as for other kernels, while fifth and sixth components are uniform addition/deletion of a covariate.

`filter` A numeric value controlling the filtering of features with low posterior probabilities in the current population. Features with posterior probabilities below this threshold will be removed with a probability proportional to $1 - P(\text{feature} \mid \text{population})$.

`gen` A numeric vector of length 4 specifying the probabilities of different feature generation operators. These determine how new nonlinear features are introduced. The first entry gives the probability for an interaction, followed by modification, nonlinear projection, and a mutation operator, which reintroduces discarded features. If these probabilities do not sum to 1, they are automatically normalized.

`trans` A numeric vector of length equal to the number of elements in `transforms`, specifying the probabilities of selecting each nonlinear transformation from $\mathcal{G}$. By default, a uniform distribution is assigned, but this can be modified by providing a specific `transforms` argument.

Examples

```
gen.probs.gmjmc(c("p0", "exp_dbl"))
```

gen.probs.mjmcmc	<i>Generate a Probability List for MJMCMC (Mode Jumping MCMC)</i>
------------------	---

Description

Generate a Probability List for MJMCMC (Mode Jumping MCMC)

Usage

```
gen.probs.mjmcmc()
```

Value

A named list with five elements:

large A numeric value representing the probability of making a large jump. If a large jump is not made, a local MH (Metropolis-Hastings) proposal is used instead.

large.kern A numeric vector of length 4 specifying the probabilities for different types of large jump kernels. The four components correspond to:

1. Random change with random neighborhood size
2. Random change with fixed neighborhood size
3. Swap with random neighborhood size
4. Swap with fixed neighborhood size

These probabilities will be automatically normalized if they do not sum to 1.

localopt.kern A numeric vector of length 2 specifying the probabilities for different local optimization methods during large jumps. The first value represents the probability of using simulated annealing, while the second corresponds to the greedy optimizer. These probabilities will be normalized if needed.

random.kern A numeric vector of length 2 specifying the probabilities of different randomization kernels applied after local optimization of type one or two. These correspond to the first two kernel types as in **large.kern** but are used for local proposals with different neighborhood sizes.

mh A numeric vector specifying the probabilities of different standard Metropolis-Hastings kernels, where the first four are the same as for other kernels, while fifth and sixth components are uniform addition/deletion of a covariate.

Examples

```
gen.probs.mjmcmc()
```

get.best.model

*Extract the Best Model from MJMCMC or GMJMCMC Results***Description**

Retrieves the best model from the results of MJMCMC, MJMCMC parallel, GMJMCMC, or GMJMCMC merged runs based on the maximum criterion value (`crit`). The returned list includes the model probability, selected features, criterion value, intercept parameter, and named coefficients.

Usage

```
get.best.model(result, labels = FALSE, ...)
```

Arguments

<code>result</code>	An object of class <code>mjcmc</code> , <code>mjcmc_parallel</code> , <code>gmjcmc</code> , or <code>gmjcmc_merged</code> , containing the results from the corresponding model search algorithms.
<code>labels</code>	Logical; if <code>TRUE</code> , uses labeled feature names when naming the model coefficients. Alternatively, a character vector of feature names. Default is <code>FALSE</code> .
<code>...</code>	Additional arguments passed to methods.

Details

The function identifies the best model by selecting the one with the highest `crit` value. Selection logic depends on the class of the `result` object:

`mjcmc` Selects the top model from a single MJMCMC run.

`mjcmc_parallel` Identifies the best chain, then selects the best model from that chain.

`gmjcmc` Selects the best population and model within that population.

`gmjcmc_merged` Finds the best chain and population before extracting the top model.

Value

A list containing the details of the best model:

`prob` A numeric value representing the model's probability.

`model` A logical vector indicating which features are included in the best model.

`crit` The criterion value used for model selection (e.g., marginal likelihood or posterior probability).

`alpha` The intercept parameter of the best model.

`coefs` A named numeric vector of model coefficients, including the intercept and selected features.

Examples

```
data(exoplanet)
result <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjcmc")
get.best.model(result)
```

get.mpm.model

*Retrieve the Median Probability Model (MPM)***Description**

This function extracts the Median Probability Model (MPM) from a fitted model object. The MPM includes features with marginal posterior inclusion probabilities greater than 0.5. It constructs the corresponding model matrix and computes the model fit using the specified likelihood.

Usage

```
get.mpm.model(
  result,
  y,
  x,
  labels = F,
  family = "gaussian",
  loglik.pi = gaussian.loglik,
  params = NULL
)
```

Arguments

result	A fitted model object (e.g., from mjmcmc, gmjmcmc, or related classes) containing the summary statistics and marginal probabilities.
y	A numeric vector of response values. For family = "binomial", it should contain binary (0/1) responses.
x	A data.frame of predictor variables. Columns must correspond to features considered during model fitting.
labels	If specified, custom labels of covariates can be used. Default is FALSE.
family	Character string specifying the model family. Supported options are: • "gaussian" (default) - for continuous outcomes. • "binomial" - for binary outcomes. • "custom" - for user-defined likelihood functions. If an unsupported family is provided, a warning is issued and the Gaussian likelihood is used by default.
loglik.pi	A function that computes the log-likelihood. Defaults to gaussian.loglik unless family = "binomial", in which case logistic.loglik is used. for custom family the user must specify the same likelihood that was used in the inference.
params	Parameters of loglik.pi, if not specified NULL will be used by default

Value

A bgnlm_model object containing:

- prob The log marginal likelihood of the MPM.
- model A logical vector indicating included features.
- crit Criterion label set to "MPM".
- coefs A named numeric vector of model coefficients, including the intercept.

Examples

```
## Not run:
# Simulate data
set.seed(42)
x <- data.frame(
  PlanetaryMassJpt = rnorm(100),
  RadiusJpt = rnorm(100),
  PeriodDays = rnorm(100)
)
y <- 1 + 0.5 * x$PlanetaryMassJpt - 0.3 * x$RadiusJpt + rnorm(100)

# Assume 'result' is a fitted object from gmjcmc or mjmcmc
result <- mjmcmc(cbind(y, x))

# Get the MPM
mpm_model <- get.mpm.model(result, y, x, family = "gaussian")

# Access coefficients
mpm_model$coefs

## End(Not run)
```

gmjcmc

*Main Algorithm for GMJMCMC (Genetically Modified MJMCMC)***Description**

Main Algorithm for GMJMCMC (Genetically Modified MJMCMC)

Usage

```
gmjcmc(
  x,
  y,
  transforms,
  P = 10,
  N = 100,
  N.final = NULL,
```

```

probs = NULL,
params = NULL,
loglik.pi = NULL,
loglik.alpha = gaussian.loglik.alpha,
mlpost_params = list(family = "gaussian", beta_prior = list(type = "g-prior")),
intercept = TRUE,
fixed = 0,
sub = FALSE,
verbose = TRUE
)

```

Arguments

<code>x</code>	matrix containing the design matrix with data to use in the algorithm
<code>y</code>	response variable
<code>transforms</code>	A character vector including the names of the non-linear functions to be used by the modification and the projection operator.
<code>P</code>	The number of population iterations for GMJMC. The default value is $P = 10$, which was used in our initial example for illustrative purposes. However, a larger value, such as $P = 50$, is typically more appropriate for most practical applications.
<code>N</code>	The number of MJMC iterations per population. The default value is $N = 100$; however, for real applications, a larger value such as $N = 1000$ or higher is often preferable.
<code>N.final</code>	The number of MJMC iterations performed for the final population. Per default one has $N.final = N$, but for practical applications, a much larger value (e.g., $N.final = 1000$) is recommended. Increasing $N.final$ is particularly important if predictions and inferences are based solely on the last population.
<code>probs</code>	A list of various probability vectors used by GMJMC, generated by <code>gen.probs.gmjmc</code> . The key component <code>probs.gen</code> defines probabilities of different operators in the feature generation process. Defaults typically favor interactions and modifications (0.4 each) over projections and mutations (0.1 each) to encourage interpretable nonlinear features.
<code>params</code>	A list of various parameter vectors used by GMJMC, generated by <code>gen.params.gmjmc</code> .
<code>loglik.pi</code>	A function specifying the marginal log-posterior of the model up to a constant, including the logarithm of the model prior: $\log p(M Y) = \text{const} + \log p(Y M) + \log p(M)$. Typically assumes a Gaussian model with Zellner's with $g = \max(n, p^2)$ by default.
<code>loglik.alpha</code>	Relevant only if the non-linear projection features depend on parameters α . If α is estimated, this argument specifies the corresponding marginal log-likelihood. The default method sets all α to 1 (fastest, but sometimes suboptimal). Alternative estimation strategies ("deep" and "random") are implemented in FBMS .
<code>mlpost_params</code>	All parameters for the estimator function <code>loglik.pi</code>
<code>intercept</code>	Logical. Whether to include an intercept in the design matrix. Default is TRUE. No variable selection is performed on the intercept.

fixed	Integer specifying the number of leading columns in the design matrix to always include in the model. Default is 0.
sub	Logical. If TRUE, uses subsampling or a stochastic approximation approach to the likelihood rather than the full likelihood. Default is FALSE.
verbose	Logical. Whether to print messages during execution. Default is TRUE for gmjcmc and FALSE for the parallel version.

Value

A list containing the following elements:

models	All models per population.
mc.models	All models accepted by mjcmc per population.
populations	All features per population.
marg.probs	Marginal feature probabilities per population.
model.probs	Marginal feature probabilities per population.
model.probs.idx	Marginal feature probabilities per population.
best.margs	Best marginal model probability per population.
accept	Acceptance rate per population.
accept.tot	Overall acceptance rate.
best	Best marginal model probability throughout the run, represented as the maximum value in <code>unlist(best.margs)</code> .

Examples

```
result <- gmjcmc(y = matrix(rnorm(100), 100),
x = matrix(rnorm(600), 100),
P = 2,
transform = c("p0", "exp_dbl"))
summary(result)
plot(result)
```

gmjcmc.parallel	<i>Run Multiple GMJMCMC (Genetically Modified MJMCMC) Runs in Parallel.</i>
-----------------	---

Description

Run Multiple GMJMCMC (Genetically Modified MJMCMC) Runs in Parallel.

Usage

```
gmjmcmmc.parallel(
  x,
  y,
  loglik.pi = NULL,
  mlpost_params = list(family = "gaussian", beta_prior = list(type = "g-prior")),
  loglik.alpha = gaussian.loglik.alpha,
  transforms,
  runs = 2,
  cores = getOption("mc.cores", 2L),
  verbose = FALSE,
  merge.options = list(populations = "best", complex.measure = 2, tol = 1e-07),
  ...
)
```

Arguments

x	matrix containing the design matrix with data to use in the algorithm
y	response variable
loglik.pi	The (log) density to explore
mlpost_params	parameters for the estimator function loglik.pi
loglik.alpha	The likelihood function to use for alpha calculation
transforms	A Character vector including the names of the non-linear functions to be used by the modification
runs	The number of runs to run
cores	The number of cores to run on
verbose	A logical denoting if messages should be printed
merge.options	A list of options to pass to the merge_results() function run after the run
...	Further parameters passed to mjmcmc.

Value

Results from multiple gmjmcmmc runs

Examples

```
result <- gmjmcmmc.parallel(
  runs = 1,
  cores = 1,
  loglik.pi = NULL,
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  transforms = c("p0", "exp_dbl")
)

summary(result)
```

```
plot(result)
```

hs	<i>Heavy Side Function</i>
----	----------------------------

Description

Heavy Side Function

Usage

```
hs(x)
```

Arguments

x The vector of values

Value

```
as.integer(x>0)
```

Examples

```
hs(2)
```

impute_x	<i>Impute Missing Values in the Data</i>
----------	--

Description

Imputes missing values in the data using median imputation based on the data set.

Usage

```
impute_x(object, x)
```

Arguments

object A fitted model object with an "imputed" attribute indicating columns to impute.
x A matrix or data frame

Value

A matrix with imputed values and additional columns for missingness indicators.

Examples

```

set.seed(123)
x <- matrix(rnorm(60), 10, 6)
colnames(x) <- paste0("X", 1:6)
x[1:2, 1] <- NA # Introduce missing values
model <- list(imputed = c(1))
attr(model, "imputed") <- c(1)
x_imputed <- impute_x(model, x)
dim(x_imputed) # 10 rows, 7 columns (6 original + 1 missingness indicator)
any(is.na(x_imputed)) # FALSE, no missing values

```

impute_x_pred

Impute Missing Values in Test Data Using Training Data

Description

Imputes missing values in the test data using median imputation based on the training set.

Usage

```
impute_x_pred(object, x_test, x_train)
```

Arguments

object	A fitted model object with an "imputed" attribute indicating columns to impute.
x_test	A matrix or data frame containing the test data.
x_train	A matrix or data frame containing the training data.

Value

A matrix with imputed values and additional columns for missingness indicators.

Examples

```

set.seed(123)
x_test <- matrix(rnorm(60), 10, 6)
colnames(x_test) <- paste0("X", 1:6)
x_test[1:2, 1] <- NA # Introduce missing values
x_train <- matrix(rnorm(300), 50, 6)
colnames(x_train) <- paste0("X", 1:6)
model <- list(imputed = c(1))
attr(model, "imputed") <- c(1)
x_imputed <- impute_x_pred(model, x_test, x_train)
dim(x_imputed) # 10 rows, 7 columns (6 original + 1 missingness indicator)
any(is.na(x_imputed)) # FALSE, no missing values

```

logistic.loglik	<i>Log Likelihood Function for Logistic Regression with a Jeffreys Parameter Prior and BIC Approximations of the Posterior.</i>
-----------------	---

Description

This function is created as an example of how to create an estimator that is used to calculate the marginal likelihood of a model.

Usage

```
logistic.loglik(y, x, model, complex, mlpost_params = list(r = exp(-0.5)))
```

Arguments

y	A vector containing the dependent variable
x	The matrix containing the precalculated features
model	The model to estimate as a logical vector
complex	A list of complexity measures for the features
mlpost_params	A list of parameters for the log likelihood, supplied by the user

Value

A list with the log marginal likelihood combined with the log prior (crit) and the posterior mode of the coefficients (coefs).

Examples

```
logistic.loglik(as.integer(rnorm(100) > 0), matrix(rnorm(100)), TRUE, list(oc = 1))
```

log_prior	<i>Log Model Prior Function</i>
-----------	---------------------------------

Description

Log Model Prior Function

Usage

```
log_prior(mlpost_params, complex)
```

Arguments

mlpost_params list of passed parameters of the likelihood in GMJMCMC
 complex list of complexity measures of the features included into the model

Value

A numeric with the log model prior.

Examples

```
log_prior(mlpost_params = list(r=2), complex = list(oc = 2))
```

marginal.probs	<i>Function for Calculating Marginal Inclusion Probabilities of Features Given a List of Models</i>
----------------	---

Description

Function for Calculating Marginal Inclusion Probabilities of Features Given a List of Models

Usage

```
marginal.probs(models)
```

Arguments

models The list of models to use.

Value

A numeric vector of marginal model probabilities based on relative frequencies of model visits in MCMC.

Examples

```
result <- gmjmc(x = matrix(rnorm(600), 100),
y = matrix(rnorm(100), 100),
P = 2,
transforms = c("p0", "exp_dbl"))
marginal.probs(result$models[[1]])
```

merge_results

*Merge a List of Multiple Results from Many Runs***Description**

This function will weight the features based on the best marginal posterior in that population and merge the results together, simplifying by merging equivalent features (having high correlation).

Usage

```
merge_results(
  results,
  populations = NULL,
  complex.measure = NULL,
  tol = NULL,
  data = NULL
)
```

Arguments

results	A list containing multiple results from GMJMCMC (Genetically Modified MJMCMC).
populations	Which populations should be merged from the results, can be "all", "last", "best" (default) or "highest_mass".
complex.measure	The complex measure to use when finding the simplest equivalent feature, 1=total width, 2=operation count and 3=depth.
tol	The tolerance to use for the correlation when finding equivalent features, default is 0.0000001
data	Data to use when comparing features, default is NULL meaning that mock data will be generated, if data is supplied it should be of the same form as is required by gmjmc, i.e. with both x, y and an intercept.

Value

An object of class "gmjmc_merged" containing the following elements:

features	The features where equivalent features are represented in their simplest form.
marg.probs	Importance of features.
counts	Counts of how many versions that were present of each feature.
results	Results as they were passed to the function.
pop.best	The population in the results which contained the model with the highest log marginal posterior.
thread.best	The thread in the results which contained the model with the highest log marginal posterior.

<code>crit.best</code>	The highest log marginal posterior for any model in the results.
<code>reported</code>	The highest log marginal likelihood for the reported populations as defined in the <code>populations</code> argument.
<code>rep.pop</code>	The index of the population which contains reported.
<code>best.log.posterior</code>	A matrix where the first column contains the population indices and the second column contains the model with the highest log marginal posterior within that population.
<code>rep.thread</code>	The index of the thread which contains reported.

Examples

```
result <- fbms(semimajoraxis ~ .,
  data = exoplanet,
  method = "gmjmcmc.parallel", transforms = c("sigmoid"),
  runs = 2, cores = 1
)

summary(result)

plot(result)

merge_results(result$results.raw)
```

mjmcmc

Main Algorithm for MJMCMC (Genetically Modified MJMCMC)

Description

Main Algorithm for MJMCMC (Genetically Modified MJMCMC)

Usage

```
mjmcmc(
  x,
  y,
  N = 1000,
  probs = NULL,
  params = NULL,
  loglik.pi = NULL,
  mlpost_params = list(family = "gaussian", beta_prior = list(type = "g-prior")),
  intercept = TRUE,
  fixed = 0,
  sub = FALSE,
  verbose = TRUE
)
```

Arguments

<code>x</code>	matrix containing the design matrix with data to use in the algorithm,
<code>y</code>	response variable
<code>N</code>	The number of MJMCMC iterations to run for (default 100)
<code>probs</code>	A list of various probability vectors used by GMJMCMC, generated by <code>gen.probs.mjmcmc</code> .
<code>params</code>	A list of various parameter vectors used by MJMCMC, generated by <code>gen.params.mjmcmc</code> .
<code>loglik.pi</code>	A function specifying the marginal log-posterior of the model up to a constant, including the logarithm of the model prior: $\log p(M Y) = \text{const} + \log p(Y M) + \log p(M)$. Typically assumes a Gaussian model with Zellner's g prior with $g = \max(n, p^2)$ by default.
<code>mlpost_params</code>	All parameters for the estimator function <code>loglik.pi</code>
<code>intercept</code>	Logical. Whether to include an intercept in the design matrix. Default is TRUE. No variable selection is performed on the intercept.
<code>fixed</code>	Integer specifying the number of leading columns in the design matrix to always include in the model. Default is 0.
<code>sub</code>	Logical. If TRUE, uses subsampling or a stochastic approximation approach to the likelihood rather than the full likelihood. Default is FALSE.
<code>verbose</code>	Logical. Whether to print messages during execution. Default is TRUE for <code>gmjmcmc</code> and FALSE for the parallel version.

Value

A list containing the following elements:

<code>models</code>	All visited models in both <code>mjmcmc</code> and local optimization.
<code>accept</code>	Average acceptance rate of the chain.
<code>mc.models</code>	All models visited during <code>mjmcmc</code> iterations.
<code>best.crit</code>	The highest log marginal probability of the visited models.
<code>marg.probs</code>	Marginal probabilities of the features.
<code>model.probs</code>	Marginal probabilities of all of the visited models.
<code>model.probs.idx</code>	Indices of unique visited models.
<code>populations</code>	The covariates represented as a list of features.

Examples

```
result <- mjmcmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  loglik.pi = gaussian.loglik)
summary(result)
plot(result)
```

mjcmc.parallel	<i>Run Multiple MJMCMC Runs in Parallel, Merging the Results Before Returning.</i>
----------------	--

Description

Run Multiple MJMCMC Runs in Parallel, Merging the Results Before Returning.

Usage

```
mjcmc.parallel(runs = 2, cores = getOption("mc.cores", 2L), ...)
```

Arguments

runs	The number of runs to run
cores	The number of cores to run on
...	Further parameters passed to mjcmc.

Value

Merged results from multiple mjcmc runs

Examples

```
result <- mjcmc.parallel(runs = 1,
  cores = 1,
  loglik.pi = FBMS::gaussian.loglik,
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100))
summary(result)
plot(result)
```

model.string	<i>Function to Generate a Function String for a Model Consisting of Features</i>
--------------	--

Description

Function to Generate a Function String for a Model Consisting of Features

Usage

```
model.string(model, features, link = "I", round = 2)
```

Arguments

model	A logical vector indicating which features to include
features	The population of features
link	The link function to use, as a string
round	Rounding error for the features in the printed format

Value

A character representation of a model

Examples

```
result <- gmjmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2, transforms = c("p0", "exp_dbl")
)
summary(result)
plot(result)
model.string(c(TRUE, FALSE, TRUE, FALSE, TRUE), result$populations[[1]])
model.string(result$models[[1]][1][1]$model, result$populations[[1]])
```

ngelu

Negative GELU Function

Description

Negative GELU Function

Usage

```
ngelu(x)
```

Arguments

x	The vector of values
---	----------------------

Value

$-x \cdot \text{pnorm}(-x)$

Examples

```
ngelu(2)
```

nhs	<i>Negative Heavy Side Function</i>
-----	-------------------------------------

Description

Negative Heavy Side Function

Usage

nhs(x)

Arguments

x The vector of values

Value

as.integer(x<0)

Examples

nhs(2)

not	<i>Not x</i>
-----	--------------

Description

Not x

Usage

not(x)

Arguments

x The vector of binary values

Value

1-x

Examples

not(TRUE)

nrelu	Negative ReLU Function
-------	------------------------

Description

Negative ReLU Function

Usage

nrelu(x)

Arguments

x The vector of values

Value

max(-x,0)

Examples

nrelu(2)

p0	p0 Polynomial Term
----	--------------------

Description

p0 Polynomial Term

Usage

p0(x)

Arguments

x The vector of values

Value

log(abs(x) + .Machine\$double.eps)

Examples

p0(2)

p05	<i>p05 Polynomial Term</i>
-----	----------------------------

Description

p05 Polynomial Term

Usage

p05(x)

Arguments

x The vector of values

Value

(abs(x)+.Machine\$double.eps)^(0.5)

Examples

p05(2)

p0p0	<i>p0p0 Polynomial Term</i>
------	-----------------------------

Description

p0p0 Polynomial Term

Usage

p0p0(x)

Arguments

x The vector of values

Value

p0(x)*p0(x)

Examples

p0p0(2)

p0p05	<i>p0p05 Polynomial Term</i>
-------	------------------------------

Description

p0p05 Polynomial Term

Usage

p0p05(x)

Arguments

x The vector of values

Value

p0(x)*(abs(x)+.Machine\$double.eps)^(0.5)

Examples

p0p05(2)

p0p1	<i>p0p1 Polynomial Term</i>
------	-----------------------------

Description

p0p1 Polynomial Term

Usage

p0p1(x)

Arguments

x The vector of values

Value

p0(x)*x

Examples

p0p1(2)

<i>p0p2</i>	<i>p0p2 Polynomial Term</i>
-------------	-----------------------------

Description

p0p2 Polynomial Term

Usage

p0p2(*x*)

Arguments

x The vector of values

Value

p0(*x*)**x*^(2)

Examples

p0p2(2)

<i>p0p3</i>	<i>p0p3 Polynomial Term</i>
-------------	-----------------------------

Description

p0p3 Polynomial Term

Usage

p0p3(*x*)

Arguments

x The vector of values

Value

p0(*x*)**x*^(3)

Examples

p0p3(2)

p0pm05

p0pm05 Polynomial Term

Description

p0pm05 Polynomial Term

Usage

p0pm05(x)

Arguments

x The vector of values

Value

$p0(x)sign(x)(abs(x)+.Machine$double.eps)^{-0.5}$

Examples

p0pm05(2)

p0pm1

p0pm1 Polynomial Terms

Description

p0pm1 Polynomial Terms

Usage

p0pm1(x)

Arguments

x The vector of values

Value

$p0(x)*(x+.Machine$double.eps)^{-1}$

Examples

p0pm1(2)

p0pm2	<i>p0pm2 Polynomial Term</i>
-------	------------------------------

Description

p0pm2 Polynomial Term

Usage

p0pm2(x)

Arguments

x The vector of values

Value

p0(x)*sign(x)*(abs(x)+.Machine\$double.eps)^(-2)

Examples

p0pm2(2)

p2	<i>p2 Polynomial Term</i>
----	---------------------------

Description

p2 Polynomial Term

Usage

p2(x)

Arguments

x The vector of values

Value

x^(2)

Examples

p2(2)

p3	<i>p3 Polynomial Term</i>
----	---------------------------

Description

p3 Polynomial Term

Usage

p3(x)

Arguments

x The vector of values

Value

x^3

Examples

p3(2)

plot.bgnlm_model	<i>Plot BGNLM Model</i>
------------------	-------------------------

Description

Plots the coefficients of a BGNLM model.

Usage

```
## S3 method for class 'bgnlm_model'
plot(x, ...)
```

Arguments

x Object of class "bgnlm_model".
 ... Additional arguments passed to barplot.

Value

The input object (invisibly).

Examples

```
data(exoplanet)
model <- get.best.model(fbms(semimajoraxis ~ ., data = exoplanet, family = "gaussian"))
plot(model)
```

plot.fbms_predict	<i>Plot FBMS Prediction Object</i>
-------------------	------------------------------------

Description

Plots the mean predictions and quantile intervals from an FBMS prediction object, with quantiles in varying shades of grey.

Usage

```
## S3 method for class 'fbms_predict'
plot(x, ...)
```

Arguments

x	Object of class "fbms_predict".
...	Additional arguments passed to plot.

Value

Plots the predictions and returns NULL.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
pred <- predict(model, exoplanet[51:60, -1],
  quantiles = c(0.025, 0.1, 0.5, 0.9, 0.975))
plot(pred)
```

plot.gmjcmc	<i>Function to Plot GMJMCMC Results and Merged Results from merge.results</i>
-------------	---

Description

Function to Plot GMJMCMC Results and Merged Results from merge.results

Usage

```
## S3 method for class 'gmjcmc'
plot(x, count = "all", pop = "best", tol = 1e-07, data = NULL, ...)
```

Arguments

x	The results to use
count	The number of features to plot, defaults to all
pop	The population to plot, can be "last", "best" or "highest_mass". Defaults to "best".
tol	The tolerance to use for the correlation when finding equivalent features, default is 0.0000001
data	Data to merge on, important if pre-filtering was used
...	Not used.

Value

No return value, just creates a plot

Examples

```
result <- gmjcmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
plot(result)
```

plot.gmjmc_merged *Plot a gmjmc_merged Run*

Description

Plot a gmjmc_merged Run

Usage

```
## S3 method for class 'gmjmc_merged'
plot(x, count = "all", pop = NULL, tol = 1e-07, data = NULL, ...)
```

Arguments

x	The results to use
count	The number of features to plot, defaults to all
pop	The population to plot, can be "last", "best" or "highest_mass". Defaults to "best".
tol	The tolerance to use for the correlation when finding equivalent features, default is 0.0000001
data	Data to merge on, important if pre-filtering was used
...	Not used.

Value

No return value, just creates a plot

Examples

```
result <- gmjmc.parallel(
  runs = 1,
  cores = 1,
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
plot(result)
```

plot.mjmcmc	<i>Function to Plot GMJMCMC Results and Merged Results from merge.results</i>
-------------	---

Description

Function to Plot GMJMCMC Results and Merged Results from merge.results

Usage

```
## S3 method for class 'mjmcmc'
plot(x, count = "all", ...)
```

Arguments

x	The results to use
count	The number of features to plot, defaults to all
...	Not used.

Value

No return value, just creates a plot

Examples

```
result <- mjmcmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  loglik.pi = gaussian.loglik
)
plot(result)
```

plot.mjmcmc_parallel	<i>Plot an mjmcmc_parallel Run</i>
----------------------	------------------------------------

Description

Plot an mjmcmc_parallel Run

Usage

```
## S3 method for class 'mjmcmc_parallel'
plot(x, count = "all", ...)
```

Arguments

x	The results to use
count	The number of features to plot, defaults to all
...	Not used.

Value

No return value, just creates a plot

Examples

```
result <- mjmcmc.parallel(  
  runs = 1,  
  cores = 1,  
  y = matrix(rnorm(100), 100),  
  x = matrix(rnorm(600), 100),  
  loglik.pi = gaussian.loglik  
)  
plot(result)
```

pm05	<i>pm05 Polynomial Term</i>
------	-----------------------------

Description

pm05 Polynomial Term

Usage

```
pm05(x)
```

Arguments

x	The vector of values
---	----------------------

Value

```
(abs(x)+.Machine$double.eps)^(-0.5)
```

Examples

```
pm05(2)
```

pm1	<i>pm1 Polynomial Term</i>
-----	----------------------------

Description

pm1 Polynomial Term

Usage

pm1(x)

Arguments

x The vector of values

Value

$\text{sign}(x) * (\text{abs}(x) + .\text{Machine\$double.eps})^{-1}$

Examples

pm1(2)

pm2	<i>pm2 Polynomial Term</i>
-----	----------------------------

Description

pm2 Polynomial Term

Usage

pm2(x)

Arguments

x The vector of values

Value

$\text{sign}(x) * (\text{abs}(x) + .\text{Machine\$double.eps})^{-2}$

Examples

pm2(2)

predict.bgnlm_model *Predict Responses from a BGNLM Model*

Description

This function generates predictions from a fitted bgnlm_model object given a new dataset.

Usage

```
## S3 method for class 'bgnlm_model'
predict(
  object,
  x,
  link = function(x) {
    x
  },
  x_train = NULL,
  ...
)
```

Arguments

object	A fitted bgnlm_model object obtained from the BGNLM fitting procedure. It should contain the estimated coefficients in model\$coefs.
x	A data.frame containing the new data for which predictions are to be made. The variables in x must match the features used in the model.
link	A link function to apply to the linear predictor. By default, it is the identity function function(x){x}, but it can be any function such as plogis for logistic regression models.
x_train	Training design matrix to be provided when imputations are to be made from them
...	Additional arguments to pass to prediction function.

Value

A numeric vector of predicted values for the given data x. These predictions are calculated as $\hat{y} = \text{link}(X\beta)$, where X is the design matrix and β are the model coefficients.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
preds <- predict(get.best.model(model), exoplanet[, -1])
```

predict.gmjcmc	<i>Predict Using a GMJMCMC Result Object</i>
----------------	--

Description

Predict Using a GMJMCMC Result Object

Usage

```
## S3 method for class 'gmjcmc'
predict(
  object,
  x,
  link = function(x) x,
  quantiles = c(0.025, 0.5, 0.975),
  pop = "best",
  tol = 1e-07,
  x_train = NULL,
  ...
)
```

Arguments

object	The model to use.
x	The new data to use for the prediction, a matrix where each row is an observation.
link	The link function to use
quantiles	The quantiles to calculate credible intervals for the posterior modes (in model space).
pop	The population to use, can be "last", "best" or "highest_mass". Defaults to "best".
tol	The tolerance to use for the correlation when finding equivalent features, default is 0.0000001
x_train	Training design matrix to be provided when imputations are to be made from them
...	Not used.

Value

A list containing aggregated predictions and per model predictions.

aggr	Aggregated predictions with mean and quantiles.
preds	A list of lists containing individual predictions per model per population in object.

Examples

```

result <- gmjmcmc(
  x = matrix(rnorm(600), 100),
  y = matrix(rnorm(100), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
preds <- predict(result, matrix(rnorm(600), 100))

```

predict.gmjmcmc_merged

Predict Using a Merged GMJMCMC Result Object

Description

Predict Using a Merged GMJMCMC Result Object

Usage

```

## S3 method for class 'gmjmcmc_merged'
predict(
  object,
  x,
  link = function(x) x,
  quantiles = c(0.025, 0.5, 0.975),
  pop = NULL,
  tol = 1e-07,
  x_train = NULL,
  ...
)

```

Arguments

object	The model to use.
x	The new data to use for the prediction, a matrix where each row is an observation.
link	The link function to use
quantiles	The quantiles to calculate credible intervals for the posterior modes (in model space).
pop	The population to use, can be "last", "best" or "highest_mass". Defaults to "best".
tol	The tolerance to use for the correlation when finding equivalent features, default is 0.0000001

x_train	Training design matrix to be provided when imputations are to be made from them
...	Not used.

Value

A list containing aggregated predictions and per model predictions.

aggr	Aggregated predictions with mean and quantiles.
preds	A list of lists containing individual predictions per model per population in object.

Examples

```
result <- gmjmcmc.parallel(
  runs = 1,
  cores = 1,
  x = matrix(rnorm(600), 100),
  y = matrix(rnorm(100), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
preds <- predict(result, matrix(rnorm(600), 100))
```

predict.gmjmcmc_parallel

Predict Using a GMJMCMC Result Object from a Parallel Run

Description

Predict Using a GMJMCMC Result Object from a Parallel Run

Usage

```
## S3 method for class 'gmjmcmc_parallel'
predict(
  object,
  x,
  link = function(x) x,
  quantiles = c(0.025, 0.5, 0.975),
  x_train = NULL,
  ...
)
```

Arguments

object	The model to use.
x	The new data to use for the prediction, a matrix where each row is an observation.
link	The link function to use
quantiles	The quantiles to calculate credible intervals for the posterior modes (in model space).
x_train	Training design matrix to be provided when imputations are to be made from them
...	Additional arguments to pass to merge_results.

Value

A list containing aggregated predictions and per model predictions.

aggr	Aggregated predictions with mean and quantiles.
preds	A list of lists containing individual predictions per model per population in object.

Examples

```
result <- gmjmc.parallel(
  runs = 1,
  cores = 1,
  x = matrix(rnorm(600), 100),
  y = matrix(rnorm(100), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
preds <- predict(result, matrix(rnorm(600), 100))
```

predict.mjmc

Predict Using an MJMCMC Result Object

Description

Predict Using an MJMCMC Result Object

Usage

```
## S3 method for class 'mjmc'
predict(
  object,
  x,
  link = function(x) x,
```

```

    quantiles = c(0.025, 0.5, 0.975),
    x_train = NULL,
    ...
  )

```

Arguments

object	The model to use.
x	The new data to use for the prediction, a matrix where each row is an observation.
link	The link function to use
quantiles	The quantiles to calculate credible intervals for the posterior modes (in model space).
x_train	Training design matrix to be provided when imputations are to be made from them
...	Not used.

Value

A list containing aggregated predictions.

mean	Mean of aggregated predictions.
quantiles	Quantiles of aggregated predictions.

Examples

```

result <- mjmc(
  x = matrix(rnorm(600), 100),
  y = matrix(rnorm(100), 100),
  loglik.pi = gaussian.loglik)
preds <- predict(result, matrix(rnorm(600), 100))

```

predict.mjmc_parallel

Predict Using an MJMCMC Result Object from a Parallel Run

Description

Predict Using an MJMCMC Result Object from a Parallel Run

Usage

```
## S3 method for class 'mjmc_parallel'
predict(
  object,
  x,
  link = function(x) x,
  quantiles = c(0.025, 0.5, 0.975),
  x_train = NULL,
  ...
)
```

Arguments

<code>object</code>	The model to use.
<code>x</code>	The new data to use for the prediction, a matrix where each row is an observation.
<code>link</code>	The link function to use
<code>quantiles</code>	The quantiles to calculate credible intervals for the posterior modes (in model space).
<code>x_train</code>	Training design matrix to be provided when imputations are to be made from them
<code>...</code>	Not used.

Value

A list containing aggregated predictions.

<code>mean</code>	Mean of aggregated predictions.
<code>quantiles</code>	Quantiles of aggregated predictions.

Examples

```
result <- mjmc_parallel(runs = 1,
  cores = 1,
  x = matrix(rnorm(600), 100),
  y = matrix(rnorm(100), 100),
  loglik.pi = gaussian.loglik)
preds <- predict(result, matrix(rnorm(600), 100))
```

predmean	<i>Generic for Accessing Mean Predictions</i>
----------	---

Description

Dispatches to methods for extracting quantile predictions from objects.

Usage

```
predmean(object, ...)
```

Arguments

object	An object.
...	Additional arguments passed to methods.

Value

Posterior mean predictions (format depends on the object class).

predmean.fbms_predict	<i>Access Mean Predictions</i>
-----------------------	--------------------------------

Description

Extracts the mean predictions from an FBMS prediction object.

Usage

```
## S3 method for class 'fbms_predict'
predmean(object, ...)
```

Arguments

object	Object of class "fbms_predict".
...	Additional arguments (ignored).

Value

Vector of mean predictions.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjmcmc")
pred <- predict(model, exoplanet[51:60, -1])
predmean(pred)
```

predquantiles

Generic for Accessing Quantile Predictions

Description

Dispatches to methods for extracting quantile predictions from objects.

Usage

```
predquantiles(object, ...)
```

Arguments

object	An object.
...	Additional arguments passed to methods.

Value

Quantile predictions (format depends on the object class).

predquantiles.fbms_predict

Access Quantile Predictions

Description

Extracts the quantile predictions from an FBMS prediction object.

Usage

```
## S3 method for class 'fbms_predict'
predquantiles(object, ...)
```

Arguments

object	Object of class "fbms_predict".
...	Additional arguments (ignored).

Value

Matrix of quantile predictions, or NULL if not available.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjmcmc")
pred <- predict(model, exoplanet[51:60, -1])
predquantiles(pred)
```

print.bgnlm_model	<i>Print BGNLM Model Object</i>
-------------------	---------------------------------

Description

Displays the coefficients of a BGNLM model object.

Usage

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

Arguments

x	Object of class "bgnlm_model".
...	Additional arguments (ignored).

Value

Prints a summary of the model and returns NULL

Examples

```
data(exoplanet)
model <- get.best.model(fbms(semimajoraxis ~ ., data = exoplanet,
family = "gaussian"))
print(model)
model <- get.mpm.model(fbms(semimajoraxis ~ ., data = exoplanet,
family = "gaussian"), y = exoplanet[,1], x = exoplanet[, -1])
print(model)
```

```
print.fbms_predict      Print FBMS Prediction Object
```

Description

Displays a summary of an FBMS prediction object, including mean predictions and quantiles.

Usage

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

Arguments

```
x          Object of class "fbms_predict".
...        Additional arguments (ignored).
```

Value

Prints a summary and returns NULL.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
pred <- predict(model, exoplanet[51:60, -1])
print(pred)
```

```
print.feature          Print Method for \"feature\" Class
```

Description

Print Method for \"feature\" Class

Usage

```
## S3 method for class 'feature'
print(
  x,
  dataset = FALSE,
  fixed = 0,
  alphas = FALSE,
  labels = FALSE,
  round = FALSE,
  ...
)
```

Arguments

x	An object of class "feature"
dataset	Set the regular covariates as columns in a dataset
fixed	How many of the first columns in dataset are fixed and do not contribute to variable selection
alphas	Print a "?" instead of actual alphas to prepare the output for alpha estimation
labels	Should the covariates be named, or just referred to as their place in the data.frame.
round	Should numbers be rounded when printing? Default is FALSE, otherwise it can be set to the number of decimal places.
...	Not used.

Value

String representation of a feature

Examples

```
result <- gmjcmc(x = matrix(rnorm(600), 100),
y = matrix(rnorm(100), 100),
P = 2,
transforms = c("p0", "exp_dbl"))
print(result$populations[[1]][1])
```

print.gmjcmc

Print GMJMCMC Model Object

Description

Displays a concise summary of a GMJMCMC model object.

Usage

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

Arguments

x	Object of class "gmjcmc".
...	Additional arguments passed to summary method.

Value

Prints a summary of the model and returns NULL

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "gmjcmc", transforms = c("sigmoid"))
print(model)
```

```
print.gmjcmc_merged    Print GMJMCMC Merged Model Object
```

Description

Displays a concise summary of a GMJMCMC merged model object.

Usage

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

Arguments

x Object of class "gmjcmc_merged".
... Additional arguments passed to summary method.

Value

Prints a summary of the model and returns NULL

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet,
method = "gmjcmc.parallel", cores = 1, runs = 2,
transforms = c("sigmoid"))

print(model)
```

```
print.mjmcmc            Print MJMCMC Model Object
```

Description

Displays a concise summary of an MJMCMC model object.

Usage

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

Arguments

<code>x</code>	Object of class "mjcmc".
<code>...</code>	Additional arguments passed to summary method.

Value

Prints a summary of the model and returns NULL

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjcmc")
print(model)
```

`print.mjcmc_parallel` *Print MJMCMC Parallel Model Object*

Description

Displays a concise summary of an MJMCMC parallel model object.

Usage

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

Arguments

<code>x</code>	Object of class "mjcmc_parallel".
<code>...</code>	Additional arguments passed to summary method.

Value

Prints a summary of the model and returns NULL

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjcmc.parallel", cores = 1, runs = 2)
print(model)
```

relu	<i>ReLU Function</i>
------	----------------------

Description

ReLU Function

Usage

relu(x)

Arguments

x The vector of values

Value

max(x,0)

Examples

relu(2)

residuals.bgnlm_model	<i>Residuals for BGNLM Model</i>
-----------------------	----------------------------------

Description

Computes residuals as the difference between observed and predicted values.

Usage

```
## S3 method for class 'bgnlm_model'
residuals(object, y, x, ...)
```

Arguments

object Object of class "bgnlm_model".
y Respnse.
x Covariates.
... Additional arguments (ignored).

Value

Vector of residuals.

Examples

```
library(FBMS)
data(exoplanet)
model <- get.best.model(fbms(semimajoraxis ~ ., data = exoplanet, family = "gaussian"))
hist(residuals(model, exoplanet[,1], exoplanet[,-1]))
```

residuals.gmjcmc	<i>Residuals for GMJMCMC Model</i>
------------------	------------------------------------

Description

Computes residuals as the difference between observed and predicted values.

Usage

```
## S3 method for class 'gmjcmc'
residuals(object, y, x, ...)
```

Arguments

object	Object of class "gmjcmc".
y	Response.
x	Covariates.
...	Additional arguments (ignored).

Value

Vector of residuals.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "gmjcmc", transforms = c("sigmoid"))
hist(residuals(model, exoplanet[,1], exoplanet[,-1]))
```

residuals.gmjmcmc_merged

Residuals for GMJMCMC Merged Model

Description

Computes residuals as the difference between observed and predicted values.

Usage

```
## S3 method for class 'gmjmcmc_merged'
residuals(object, y, x, ...)
```

Arguments

object	Object of class "gmjmcmc_merged".
y	Response.
x	Covariates.
...	Additional arguments (ignored).

Value

Vector of residuals.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet,
method = "gmjmcmc.parallel", transforms = c("sigmoid"),
runs = 2, cores = 1)
hist(residuals(model, exoplanet[,1], exoplanet[,-1]))
```

residuals.mjmcmc

Residuals for MJMCMC Model

Description

Computes residuals as the difference between observed and predicted values.

Usage

```
## S3 method for class 'mjmcmc'
residuals(object, y, x, ...)
```

Arguments

object	Object of class "mjmcmc".
y	Response.
x	Covariates.
...	Additional arguments (ignored).

Value

Vector of residuals.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjmcmc")
hist(residuals(model, exoplanet[,1], exoplanet[,-1]))
```

residuals.mjmcmc_parallel

Residuals for MJMCMC Parallel Model

Description

Computes residuals as the difference between observed and predicted values.

Usage

```
## S3 method for class 'mjmcmc_parallel'
residuals(object, y, x, ...)
```

Arguments

object	Object of class "mjmcmc_parallel".
y	Response.
x	Covariates.
...	Additional arguments (ignored).

Value

Vector of residuals.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet, method = "mjmcmc.parallel", runs = 2, cores = 1)
hist(residuals(model, exoplanet[,1], exoplanet[,-1]))
```

 rmclapply

rmclapply: Cross-Platform mclapply/Forking Hack for Windows

Description

This function applies a function in parallel to a list or vector (X) using multiple cores. On Linux/macOS, it uses mclapply, while on Windows it uses a hackish version of parallelism. The Windows version is based on parLapply to mimic forking following Nathan VanHoudnos.

Usage

```
rmclapply(runs, args, fun, mc.cores = NULL)
```

Arguments

runs	The runs to run
args	The arguments to pass to fun
fun	The function to run
mc.cores	Number of cores to use for parallel processing. Defaults to detectCores().

Value

A list of results, with one element for each element of X.

 SangerData2

Gene Expression Data for Lymphoblastoid Cell Lines of 210 Unrelated HapMap individuals from four populations

Description

A 210 times 3221 matrix with individuals along the rows and expression data along the columns

Usage

```
data(SangerData2)
```

Format

A data frame with 210 rows and 3221 variables

Details

The first column corresponds to column number 24266 (with name GI_6005726-S) in the original data. Column names give the name of the variables, row names the "name" of the individuals. This is a subset of SangerData where the 3220 last rows are select among all original rows following the same pre-processing procedure as in (section 1.6.1). See also the file Read_sanger_data.R

Source

Dataset downloaded from <https://ftp.sanger.ac.uk/pub/genevar/>

References:

Stranger, BE et al (2007): Relative impact of nucleotide and copy number variation on gene expression phenotypes Science, 2007•science.org

Bogdan et al (2020): Handbook of Multiple Comparisons, <https://arxiv.org/pdf/2011.12154>

set.transforms	<i>Set the Transformations Option for GMJMCMC (Genetically Modified MJMCMC).</i>
----------------	--

Description

This is also done when running the algorithm, but this function allows for it to be done manually.

Usage

```
set.transforms(transforms)
```

Arguments

transforms The vector of non-linear transformations

Value

No return value, just sets the gmjmc-m-transformations option

Examples

```
set.transforms(c("p0", "p1"))
```

sigmoid	<i>Sigmoid Function</i>
---------	-------------------------

Description

Sigmoid Function

Usage

```
sigmoid(x)
```

Arguments

x The vector of values

Value

The sigmoid of x

Examples

```
sigmoid(2)
```

sin_deg

Sine Function for Degrees

Description

Sine Function for Degrees

Usage

```
sin_deg(x)
```

Arguments

x The vector of values in degrees

Value

The sine of x

Examples

```
sin_deg(0)
```

sqrt	<i>Square Root Function</i>
------	-----------------------------

Description

Square Root Function

Usage

```
sqrt(x)
```

Arguments

x	The vector of values
---	----------------------

Value

The square root of the absolute value of x

Examples

```
sqrt(4)
```

string.population	<i>Function to Get a Character Representation of a List of Features</i>
-------------------	---

Description

Function to Get a Character Representation of a List of Features

Usage

```
string.population(x, round = 2)
```

Arguments

x	A list of feature objects
round	Rounding precision for parameters of the features

Value

A matrix of character representations of the features of a model.

Examples

```

result <- gmjmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
string.population(result$populations[[1]])

```

string.population.models

Function to Get a Character Representation of a List of Models

Description

Function to Get a Character Representation of a List of Models

Usage

```
string.population.models(features, models, round = 2, link = "I")
```

Arguments

features	A list of feature objects on which the models are build
models	A list of model objects
round	Rounding precision for parameters of the features
link	The link function to use, as a string

Value

A matrix of character representations of a list of models.

Examples

```

result <- gmjmc(
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
string.population.models(result$populations[[2]], result$models[[2]])

```

summary.fbms_predict *Summary of FBMS Prediction Object*

Description

Provides a detailed summary of an FBMS prediction object, including prediction ranges.

Usage

```
## S3 method for class 'fbms_predict'
summary(object, ...)
```

Arguments

object Object of class "fbms_predict".
 ... Additional arguments (ignored).

Value

Prints a summary and returns NULL.

Examples

```
data(exoplanet)
model <- fbms(semimajoraxis ~ ., data = exoplanet)
pred <- predict(model, exoplanet[51:60, -1])
summary(pred)
```

summary.gmjcmc *Function to Print a Quick Summary of the Results*

Description

Function to Print a Quick Summary of the Results

Usage

```
## S3 method for class 'gmjcmc'
summary(
  object,
  pop = "best",
  tol = 1e-04,
  labels = FALSE,
  effects = NULL,
  data = NULL,
```

```

    verbose = TRUE,
    ...
  )

```

Arguments

object	The results to use
pop	The population to print for, can be "last", "best" (default), "all" or "highest_mass".
tol	The tolerance to use as a threshold when reporting the results.
labels	Should the covariates be named, or just referred to as their place in the data.frame.
effects	Quantiles for posterior modes of the effects across models to be reported, if either effects are NULL or if labels are NULL, no effects are reported.
data	Data to merge on, important if pre-filtering was used
verbose	If the summary should be printed to the console or just returned, defaults to TRUE
...	Not used.

Value

A data frame containing the following columns:

feats.strings	Character representation of the features ordered by marginal probabilities.
marg.probs	Marginal probabilities corresponding to the ordered feature strings.

Examples

```

result <- gmjcmc(y = matrix(rnorm(100), 100),
x = matrix(rnorm(600), 100),
P = 2,
transforms = c("p0", "exp_dbl"))
summary(result, pop = "best")

```

summary.gmjcmc_merged

Function to Print a Quick Summary of the Results

Description

Function to Print a Quick Summary of the Results

Usage

```
## S3 method for class 'gmjmc_merged'
summary(
  object,
  tol = 1e-04,
  labels = FALSE,
  effects = NULL,
  pop = NULL,
  data = NULL,
  verbose = TRUE,
  ...
)
```

Arguments

object	The results to use
tol	The tolerance to use as a threshold when reporting the results.
labels	Should the covariates be named, or just referred to as their place in the data.frame.
effects	Quantiles for posterior modes of the effects across models to be reported, if either effects are NULL or if labels are NULL, no effects are reported.
pop	If null same as in merge.options for running parallel gmjmc otherwise results will be re-merged according to pop that can be "all", "last", "best" or "highest_mass"
data	Data to merge on, important if pre-filtering was used
verbose	If the summary should be printed to the console or just returned, defaults to TRUE
...	Not used.

Value

A data frame containing the following columns:

feats.strings	Character representation of the features ordered by marginal probabilities.
marg.probs	Marginal probabilities corresponding to the ordered feature strings.

Examples

```
result <- gmjmc.parallel(
  runs = 1,
  cores = 1,
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  P = 2,
  transforms = c("p0", "exp_dbl")
)
summary(result)
```

summary.mjcmc

*Function to Print a Quick Summary of the Results***Description**

Function to Print a Quick Summary of the Results

Usage

```
## S3 method for class 'mjcmc'
summary(
  object,
  tol = 1e-04,
  labels = FALSE,
  effects = NULL,
  verbose = TRUE,
  ...
)
```

Arguments

object	The results to use
tol	The tolerance to use as a threshold when reporting the results.
labels	Should the covariates be named, or just referred to as their place in the data.frame.
effects	Quantiles for posterior modes of the effects across models to be reported, if either effects are NULL or if labels are NULL, no effects are reported.
verbose	If the summary should be printed to the console or just returned, defaults to TRUE
...	Not used.

Value

A data frame containing the following columns:

feats.strings	Character representation of the covariates ordered by marginal probabilities.
marg.probs	Marginal probabilities corresponding to the ordered feature strings.

Examples

```
result <- mjcmc(y = matrix(rnorm(100), 100),
x = matrix(rnorm(600), 100),
loglik.pi = gaussian.loglik)
summary(result)
```

summary.mjcmc_parallel

Function to Print a Quick Summary of the Results

Description

Function to Print a Quick Summary of the Results

Usage

```
## S3 method for class 'mjcmc_parallel'
summary(
  object,
  tol = 1e-04,
  labels = FALSE,
  effects = NULL,
  verbose = TRUE,
  ...
)
```

Arguments

object	The results to use
tol	The tolerance to use as a threshold when reporting the results.
labels	Should the covariates be named, or just referred to as their place in the data.frame.
effects	Quantiles for posterior modes of the effects across models to be reported, if either effects are NULL or if labels are NULL, no effects are reported.
verbose	If the summary should be printed to the console or just returned, defaults to TRUE
...	Not used.

Value

A data frame containing the following columns:

feats.strings	Character representation of the covariates ordered by marginal probabilities.
marg.probs	Marginal probabilities corresponding to the ordered feature strings.

Examples

```
result <- mjcmc.parallel(runs = 1,
  cores = 1,
  y = matrix(rnorm(100), 100),
  x = matrix(rnorm(600), 100),
  loglik.pi = gaussian.loglik)
summary(result)
```

troot	<i>Cube Root Function</i>
-------	---------------------------

Description

Cube Root Function

Usage

troot(x)

Arguments

x The vector of values

Value

The cube root of x

Examples

troot(27)

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