Package 'dynamite'

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Title Bayesian Modeling and Causal Inference for Multivariate Longitudinal Data

Version 1.5.2

Description Easy-to-use and efficient interface for Bayesian inference of complex panel (time series) data using dynamic multivariate panel models by Helske and Tikka (2024) <doi:10.1016/j.alcr.2024.100617>. The package supports joint modeling of multiple measurements per individual, time-varying and time-invariant effects, and a wide range of discrete and continuous distributions. Estimation of these dynamic multivariate panel models is carried out via 'Stan'. For an in-depth tutorial of the package, see (Tikka and Helske, 2024) <doi:10.48550/arXiv.2302.01607>.

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URL https://docs.ropensci.org/dynamite/, https://github.com/ropensci/dynamite/

BugReports https://github.com/ropensci/dynamite/issues/

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`dynamite-package` *The* `dynamite` *package.*

Description

Easy-to-use and efficient interface for Bayesian inference of complex panel data consisting of multiple individuals with multiple measurements over time. Supports several observational distributions, time-varying effects and realistic counterfactual predictions which take into account the dynamic structure of the model.

See Also

- The package vignettes
- `dynamiteformula()` for information on defining models.
- `dynamite()` for information on fitting models.
- `https://github.com/ropensci/dynamite/issues/` to submit a bug report or a feature request.

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See Also

Useful links:

- https://docs.ropensci.org/dynamite/
- https://github.com/ropensci/dynamite/
- Report bugs at https://github.com/ropensci/dynamite/issues/

`as.data.frame.dynamitefit` *Extract Samples From a* `dynamitefit` *Object as a Data Frame*

Description

Provides a `data.frame` representation of the posterior samples of the model parameters.

Usage

```
## S3 method for class 'dynamitefit'
as.data.frame(
  x,
  row.names = NULL,
  optional = FALSE,
  types = NULL,
  parameters = NULL,
  responses = NULL,
  times = NULL,
  groups = NULL,
  summary = FALSE,
  probs = c(0.05, 0.95),
  include_fixed = TRUE,
  ...
)
```

Arguments

`x`	[`dynamitefit`] The model fit object.
`row.names`	Ignored.
`optional`	Ignored.
`types`	[`character()`] Type(s) of the parameters for which the samples should be extracted. See details of possible values. Default is all values listed in details except spline coefficients `omega`. This argument is mutually exclusive with `parameters`.
`parameters`	[`character()`] Parameter(s) for which the samples should be extracted. Possible options can be found with function `get_parameter_names()`. Default is all parameters of specific type for all responses. This argument is mutually exclusive with `types`.

`responses`	[`character()`] Response(s) for which the samples should be extracted. Possible options are elements of `unique(x$priors$response)`, and the default is this entire vector. Ignored if the argument `parameters` is supplied. `omega_alpha`, and `omega_psi`. See also `get_parameter_types()`.
`times`	[`double()`] Time point(s) to keep. If `NULL` (the default), all time points are kept.
`groups`	[`character()`] Group name(s) to keep. If `NULL` (the default), all groups are kept.
`summary`	[`logical(1)`] If `TRUE`, returns posterior mean, standard deviation, and posterior quantiles (as defined by the `probs` argument) for all parameters. If `FALSE` (default), returns the posterior samples instead.
`probs`	[`numeric()`] Quantiles of interest. Default is `c(0.05, 0.95)`.
`include_fixed`	[`logical(1)`] If `TRUE` (default), time-varying parameters for `1:fixed` time points are included in the output as `NA` values. If `FALSE`, fixed time points are omitted completely from the output.
`...`	Ignored.

Details

The arguments `responses` and `types` can be used to extract only a subset of the model parameters (i.e., only certain types of parameters related to a certain response variable).

Potential values for the `types` argument are:

- `alpha`
  Intercept terms (time-invariant or time-varying).
- `beta`
  Time-invariant regression coefficients.
- `cutpoint`
  Cutpoints for ordinal regression.
- `delta`
  Time-varying regression coefficients.
- `nu`
  Group-level random effects.
- `lambda`
  Factor loadings.
- `psi`
  Latent factors.
- `tau`
  Standard deviations of the spline coefficients of `delta`.
- `tau_alpha`
  Standard deviations of the spline coefficients of time-varying `alpha`.

- `sigma_nu`
  Standard deviations of the random effects `nu`.
- `corr_nu`
  Pairwise within-group correlations of random effects `nu`. Samples of the full correlation matrix can be extracted manually as `rstan::extract(fit$stanfit, pars = "corr_matrix_nu")` if necessary.
- `sigma_lambda`
  Standard deviations of the latent factor loadings `lambda`.
- `corr_psi`
  Pairwise correlations of the noise terms of the latent factors. Samples of the full correlation matrix can be extracted manually as `rstan::extract(fit$stanfit, pars = "corr_matrix_psi")` if necessary.
- `sigma`
  Standard deviations of gaussian responses.
- `corr`
  Pairwise correlations of multivariate gaussian responses.
- `phi`
  Describes various distributional parameters, such as:
  - Dispersion parameter of the Negative Binomial distribution.
  - Shape parameter of the Gamma distribution.
  - Precision parameter of the Beta distribution.
  - Degrees of freedom of the Student t-distribution.
- `omega`
  Spline coefficients of the regression coefficients `delta`.
- `omega_alpha`
  Spline coefficients of time-varying `alpha`.
- `omega_psi`
  Spline coefficients of the latent factors `psi`. Note that in case of `nonzero_lambda = FALSE`, mean of these are used to flip the sign of `psi` to avoid multimodality due to sign-switching, but `omega_psi` variables are not modified.

Value

A `tibble` containing either samples or summary statistics of the model parameters in a long format. For a wide format, see `as_draws()`.

See Also

Model outputs `as.data.table.dynamitefit()`, `as_draws_df.dynamitefit()`, `coef.dynamitefit()`, `confint.dynamitefit()`, `dynamite()`, `get_code()`, `get_data()`, `get_parameter_dims()`, `get_parameter_names()`, `get_parameter_types()`, `ndraws.dynamitefit()`, `nobs.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
as.data.frame(
  gaussian_example_fit,
  responses = "y",
  types = "beta"
)

# Basic summaries can be obtained automatically with summary = TRUE
as.data.frame(
  gaussian_example_fit,
  responses = "y",
  types = "beta",
  summary = TRUE
)

# Time-varying coefficients "delta"
as.data.frame(
  gaussian_example_fit,
  responses = "y",
  types = "delta",
  summary = TRUE
)

# Obtain summaries for a specific parameters
as.data.frame(
  gaussian_example_fit,
  parameters = c("tau_y_x", "sigma_y"),
  summary = TRUE
)
```

---

as.data.table.dynamitefit

Extract Samples From a `dynamitefit` *Object as a Data Table*

Description

Provides a `data.table` representation of the posterior samples of the model parameters. See `as.data.frame.dynamitefit()` for details.

Usage

```
## S3 method for class 'dynamitefit'
as.data.table(
  x,
  keep.rownames = FALSE,
  row.names = NULL,
  optional = FALSE,
```

```
  types = NULL,
  parameters = NULL,
  responses = NULL,
  times = NULL,
  groups = NULL,
  summary = FALSE,
  probs = c(0.05, 0.95),
  include_fixed = TRUE,
  ...
)
```

Arguments

x	[dynamitefit] The model fit object.
keep.rownames	[logical(1)] Not used.
row.names	Ignored.
optional	Ignored.
types	[character()] Type(s) of the parameters for which the samples should be extracted. See details of possible values. Default is all values listed in details except spline coefficients omega. This argument is mutually exclusive with parameters.
parameters	[character()] Parameter(s) for which the samples should be extracted. Possible options can be found with function get_parameter_names(). Default is all parameters of specific type for all responses. This argument is mutually exclusive with types.
responses	[character()] Response(s) for which the samples should be extracted. Possible options are elements of unique(x$priors$response), and the default is this entire vector. Ignored if the argument parameters is supplied. omega_alpha, and omega_psi. See also get_parameter_types().
times	[double()] Time point(s) to keep. If NULL (the default), all time points are kept.
groups	[character()] Group name(s) to keep. If NULL (the default), all groups are kept.
summary	[logical(1)] If TRUE, returns posterior mean, standard deviation, and posterior quantiles (as defined by the probs argument) for all parameters. If FALSE (default), returns the posterior samples instead.
probs	[numeric()] Quantiles of interest. Default is c(0.05, 0.95).
include_fixed	[logical(1)] If TRUE (default), time-varying parameters for 1:fixed time points are included in the output as NA values. If FALSE, fixed time points are omitted completely from the output.
...	Ignored.

Value

A `data.table` containing either samples or summary statistics of the model parameters.

See Also

Model outputs `as.data.frame.dynamitefit()`, `as_draws_df.dynamitefit()`, `coef.dynamitefit()`, `confint.dynamitefit()`, `dynamite()`, `get_code()`, `get_data()`, `get_parameter_dims()`, `get_parameter_names()`, `get_parameter_types()`, `ndraws.dynamitefit()`, `nobs.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
as.data.table(
  gaussian_example_fit,
  responses = "y",
  types = "beta",
  summary = FALSE
)
```

---

as_draws_df.dynamitefit

Convert `dynamite` *Output to* `draws_df` *Format*

Description

Converts the output from a `dynamite()` call to a `draws_df` format of the **posterior** package, enabling the use of diagnostics and plotting methods of **posterior** and **bayesplot** packages. Note that this function returns variables in a wide format, whereas `as.data.frame()` uses the long format.

Usage

```
## S3 method for class 'dynamitefit'
as_draws_df(
  x,
  parameters = NULL,
  responses = NULL,
  types = NULL,
  times = NULL,
  groups = NULL,
  ...
)

## S3 method for class 'dynamitefit'
as_draws(x, parameters = NULL, responses = NULL, types = NULL, ...)
```

Arguments

x	[dynamitefit] The model fit object.
parameters	[character()] Parameter(s) for which the samples should be extracted. Possible options can be found with function get_parameter_names(). Default is all parameters of specific type for all responses. This argument is mutually exclusive with types.
responses	[character()] Response(s) for which the samples should be extracted. Possible options are elements of unique(x$priors$response), and the default is this entire vector. Ignored if the argument parameters is supplied. omega_alpha, and omega_psi. See also get_parameter_types().
types	[character()] Type(s) of the parameters for which the samples should be extracted. See details of possible values. Default is all values listed in details except spline coefficients omega. This argument is mutually exclusive with parameters.
times	[double()] Time point(s) to keep. If NULL (the default), all time points are kept.
groups	[character()] Group name(s) to keep. If NULL (the default), all groups are kept.
...	Ignored.

Details

You can use the arguments parameters, responses and types to extract only a subset of the model parameters (i.e., only certain types of parameters related to a certain response variable).

See potential values for the types argument in as.data.frame.dynamitefit() and get_parameter_names() for potential values for parameters argument.

Value

A draws_df object.

A draws_df object.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
as_draws(gaussian_example_fit, types = c("sigma", "beta"))

# Compute MCMC diagnostics using the posterior package
posterior::summarise_draws(as_draws(gaussian_example_fit))
```

categorical_example *Simulated Categorical Multivariate Panel Data*

Description

A simulated data containing multiple individuals with two categorical response variables.

Usage

```
categorical_example
```

Format

A data frame with 2000 rows and 5 variables:

id Variable defining individuals (1 to 100).

time Variable defining the time point of the measurement (1 to 20).

x Categorical variable with three levels, A, B, and C.

y Categorical variable with three levels, a, b, and c.

z A continuous covariate.

Source

The data was generated according to a script in https://github.com/ropensci/dynamite/blob/main/data-raw/categorical_example.R

See Also

Example models categorical_example_fit, gaussian_example, gaussian_example_fit, gaussian_simulation_fit, multichannel_example, multichannel_example_fit

categorical_example_fit *Model Fit for the Simulated Categorical Multivariate Panel Data*

Description

A dynamitefit object obtained by running dynamite on the categorical_example dataset as

```
set.seed(1)
library(dynamite)
f <- obs(x ~ z + lag(x) + lag(y), family = "categorical") +
  obs(y ~ z + lag(x) + lag(y), family = "categorical")
categorical_example_fit <- dynamite(
  f,
```

```
  data = categorical_example,
  time = "time",
  group = "id",
  chains = 1,
  refresh = 0,
  thin = 5,
  save_warmup = FALSE
)
```

Note the small number of samples due to size restrictions on CRAN.

Usage

```
categorical_example_fit
```

Format

A `dynamitefit` object.

Source

Script in https://github.com/ropensci/dynamite/blob/main/data-raw/categorical_example_fit.R

See Also

Example models `categorical_example`, `gaussian_example`, `gaussian_example_fit`, `gaussian_simulation_fit`, `multichannel_example`, `multichannel_example_fit`

---

coef.dynamitefit *Extract Regression Coefficients of a Dynamite Model*

Description

Extracts either time-varying or time-invariant parameters of the model.

Usage

```
## S3 method for class 'dynamitefit'
coef(
  object,
  types = c("alpha", "beta", "delta"),
  parameters = NULL,
  responses = NULL,
  times = NULL,
  groups = NULL,
  summary = TRUE,
  probs = c(0.05, 0.95),
  ...
)
```

Arguments

object	[dynamitefit] The model fit object.
types	[character()] Type(s) of the parameters for which the samples should be extracted. See details of possible values. Default is all values listed in details except spline coefficients omega. This argument is mutually exclusive with parameters.
parameters	[character()] Parameter(s) for which the samples should be extracted. Possible options can be found with function get_parameter_names(). Default is all parameters of specific type for all responses. This argument is mutually exclusive with types.
responses	[character()] Response(s) for which the samples should be extracted. Possible options are elements of unique(x$priors$response), and the default is this entire vector. Ignored if the argument parameters is supplied. omega_alpha, and omega_psi. See also get_parameter_types().
times	[double()] Time point(s) to keep. If NULL (the default), all time points are kept.
groups	[character()] Group name(s) to keep. If NULL (the default), all groups are kept.
summary	[logical(1)] If TRUE (default), returns posterior mean, standard deviation, and posterior quantiles (as defined by the probs argument) for all parameters. If FALSE, returns the posterior samples instead.
probs	[numeric()] Quantiles of interest. Default is c(0.05, 0.95).
...	Ignored.

Value

A tibble containing either samples or summary statistics of the model parameters in a long format.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
betas <- coef(gaussian_example_fit, type = "beta")
deltas <- coef(gaussian_example_fit, type = "delta")
```

`confint.dynamitefit` *Credible Intervals for Dynamite Model Parameters*

Description

Extracts credible intervals from `dynamitefit` object.

Usage

```
## S3 method for class 'dynamitefit'
confint(object, parm, level = 0.95, ...)
```

Arguments

`object`	[`dynamitefit`] The model fit object.
`parm`	Ignored.
`level`	[`numeric(1)`] Credible interval width.
`...`	Ignored.

Value

The rows of the resulting `matrix` will be named using the following logic: `{parameter}_{time}_{category}_{group}` where `parameter` is the name of the parameter, `time` is the time index of the parameter, `category` specifies the level of the response the parameter is related to if the response is categorical, and `group` determines which group of observations the parameter is related to in the case of random effects and loadings. Non-applicable fields in the this syntax are set to `NA`.

See Also

Model outputs `as.data.frame.dynamitefit()`, `as.data.table.dynamitefit()`, `as_draws_df.dynamitefit()`, `coef.dynamitefit()`, `dynamite()`, `get_code()`, `get_data()`, `get_parameter_dims()`, `get_parameter_names()`, `get_parameter_types()`, `ndraws.dynamitefit()`, `nobs.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
confint(gaussian_example_fit, level = 0.9)
```

dynamice *Estimate a Bayesian Dynamic Multivariate Panel Model With Multiple Imputation*

Description

Applies multiple imputation using `mice::mice()` to the supplied `data` and fits a dynamic multivariate panel model to each imputed data set using `dynamite()`. Posterior samples from each imputation run are combined. When using wide format imputation, the long format `data` is automatically converted to a wide format before imputation to preserve the longitudinal structure, and then converted back to long format for estimation.

Usage

```
dynamice(
  dformula,
  data,
  time,
  group = NULL,
  priors = NULL,
  backend = "rstan",
  verbose = TRUE,
  verbose_stan = FALSE,
  stanc_options = list("O0"),
  threads_per_chain = 1L,
  grainsize = NULL,
  custom_stan_model = NULL,
  debug = NULL,
  mice_args = list(),
  impute_format = "wide",
  keep_imputed = FALSE,
  stan_csv_dir = tempdir(),
  ...
)
```

Arguments

`dformula`	[`dynamiteformula`] The model formula. See `dynamiteformula()` and 'Details'.
`data`	[`data.frame`, `tibble::tibble`, or `data.table::data.table`] The data that contains the variables in the model in long format. Supported column types are `integer`, `logical`, `double`, and `factor`. Columns of type `character` will be converted to factors. Unused factor levels will be dropped. The `data` can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input `data` is converted to channel specific matrix representations via `stats::model.matrix.lm()`.

time [character(1)]
A column name of data that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.

group [character(1)]
A column name of data that denotes the unique groups or NULL corresponding to a scenario without any groups. If group is NULL, a new column .group is created with constant value 1L is created indicating that all observations belong to the same group. In case of name conflicts with data, see the group_var element of the return object to get the column name of the new variable.

priors [data.frame]
An optional data frame with prior definitions. See get_priors() and 'Details'.

backend [character(1)]
Defines the backend interface to Stan, should be either "rstan" (the default) or "cmdstanr". Note that cmdstanr needs to be installed separately as it is not on CRAN. It also needs the actual CmdStan software. See https://mc-stan.org/cmdstanr/ for details.

verbose [logical(1)]
All warnings and messages are suppressed if set to FALSE. Defaults to TRUE. Setting this to FALSE will also disable checks for perfect collinearity in the model matrix.

verbose_stan [logical(1)]
This is the verbose argument for rstan::sampling(). Defaults to FALSE.

stanc_options [list()]
This is the stanc_options argument passed to the compile method of a CmdStanModel object via cmdstanr::cmdstan_model() when backend = "cmdstanr". Defaults to list("O0"). To enable level one compiler optimizations, use list("O1").

threads_per_chain
[integer(1)]
A Positive integer defining the number of parallel threads to use within each chain. Default is 1. See rstan::rstan_options() and cmdstanr::sample() for details.

grainsize [integer(1)]
A positive integer defining the suggested size of the partial sums when using within-chain parallelization. Default is number of time points divided by threads_per_chain. Setting this to 1 leads the workload division entirely to the internal scheduler. The performance of the within-chain parallelization can be sensitive to the choice of grainsize, see Stan manual on reduce-sum for details.

custom_stan_model
[character(1)]
An optional character string that either contains a customized Stan model code or a path to a .stan file that contains the code. Using this will override the generated model code. For expert users only.

debug [list()]
A named list of form name = TRUE indicating additional objects in the environ-

ment of the dynamite function which are added to the return object. Additionally, values no_compile = TRUE and no_sampling = TRUE can be used to skip the compilation of the Stan code and sampling steps respectively. This can be useful for debugging when combined with model_code = TRUE, which adds the Stan model code to the return object.

mice_args [list()]
Arguments passed to mice::mice() excluding data.

impute_format [character(1)]
Format of the data that will be passed to the imputation method. Should be either "wide" (the default) or "long" corresponding to wide format and long format imputation.

keep_imputed [logical(1)]
Should the imputed datasets be kept in the return object? The default is FALSE. If TRUE, the imputations will be included in the imputed field in the return object that is otherwise NULL.

stan_csv_dir [character(1)] A directory path to output the Stan .csv files when backend is "cmdstanr". The files are saved here via $save_output_files() to avoid garbage collection between sampling runs with different imputed datasets.

... For dynamite(), additional arguments to rstan::sampling() or cmdstanr::sample(), such as chains and cores (chains and parallel_chains in cmdstanr). For summary(), additional arguments to as.data.frame.dynamitefit(). For print(), further arguments to the print method for tibbles (see tibble::formatting). Not used for formula().

See Also

Model fitting dynamite(), get_priors(), update.dynamitefit()

---

dynamite *Estimate a Bayesian Dynamic Multivariate Panel Model*

Description

Fit a Bayesian dynamic multivariate panel model (DMPM) using Stan for Bayesian inference. The **dynamite** package supports a wide range of distributions and allows the user to flexibly customize the priors for the model parameters. The dynamite model is specified using standard R formula syntax via dynamiteformula(). For more information and examples, see 'Details' and the package vignettes.

The formula method returns the model definition as a quoted expression.

Information on the estimated dynamite model can be obtained via print including the following: The model formula, the data, the smallest effective sample sizes, largest Rhat and summary statistics of the time- and group-invariant model parameters.

The summary() method provides statistics of the posterior samples of the model; this is an alias of as.data.frame.dynamitefit() with summary = TRUE.

Usage

```
dynamite(
  dformula,
  data,
  time,
  group = NULL,
  priors = NULL,
  backend = "rstan",
  verbose = TRUE,
  verbose_stan = FALSE,
  stanc_options = list("O0"),
  threads_per_chain = 1L,
  grainsize = NULL,
  custom_stan_model = NULL,
  debug = NULL,
  ...
)

## S3 method for class 'dynamitefit'
formula(x, ...)

## S3 method for class 'dynamitefit'
print(x, full_diagnostics = FALSE, ...)

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

Arguments

dformula	[dynamiteformula] The model formula. See dynamiteformula() and 'Details'.
data	[data.frame, tibble::tibble, or data.table::data.table] The data that contains the variables in the model in long format. Supported column types are integer, logical, double, and factor. Columns of type character will be converted to factors. Unused factor levels will be dropped. The data can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input data is converted to channel specific matrix representations via stats::model.matrix.lm().
time	[character(1)] A column name of data that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.
group	[character(1)] A column name of data that denotes the unique groups or NULL corresponding to a scenario without any groups. If group is NULL, a new column .group is created with constant value 1L is created indicating that all observations belong to the same group. In case of name conflicts with data, see the group_var element of the return object to get the column name of the new variable.

priors [data.frame]
An optional data frame with prior definitions. See get_priors() and 'Details'.

backend [character(1)]
Defines the backend interface to Stan, should be either "rstan" (the default) or "cmdstanr". Note that cmdstanr needs to be installed separately as it is not on CRAN. It also needs the actual CmdStan software. See https://mc-stan.org/cmdstanr/ for details.

verbose [logical(1)]
All warnings and messages are suppressed if set to FALSE. Defaults to TRUE. Setting this to FALSE will also disable checks for perfect collinearity in the model matrix.

verbose_stan [logical(1)]
This is the verbose argument for rstan::sampling(). Defaults to FALSE.

stanc_options [list()]
This is the stanc_options argument passed to the compile method of a CmdStanModel object via cmdstanr::cmdstan_model() when backend = "cmdstanr". Defaults to list("O0"). To enable level one compiler optimizations, use list("O1").

threads_per_chain
[integer(1)]
A Positive integer defining the number of parallel threads to use within each chain. Default is 1. See rstan::rstan_options() and cmdstanr::sample() for details.

grainsize [integer(1)]
A positive integer defining the suggested size of the partial sums when using within-chain parallelization. Default is number of time points divided by threads_per_chain. Setting this to 1 leads the workload division entirely to the internal scheduler. The performance of the within-chain parallelization can be sensitive to the choice of grainsize, see Stan manual on reduce-sum for details.

custom_stan_model
[character(1)]
An optional character string that either contains a customized Stan model code or a path to a .stan file that contains the code. Using this will override the generated model code. For expert users only.

debug [list()]
A named list of form name = TRUE indicating additional objects in the environment of the dynamite function which are added to the return object. Additionally, values no_compile = TRUE and no_sampling = TRUE can be used to skip the compilation of the Stan code and sampling steps respectively. This can be useful for debugging when combined with model_code = TRUE, which adds the Stan model code to the return object.

... For dynamite(), additional arguments to rstan::sampling() or cmdstanr::sample(), such as chains and cores (chains and parallel_chains in cmdstanr). For summary(), additional arguments to as.data.frame.dynamitefit(). For print(), further arguments to the print method for tibbles (see tibble::formatting). Not used for formula().

`x` [dynamitefit]
The model fit object.

`full_diagnostics`
By default, the effective sample size (ESS) and Rhat are computed only for the time- and group-invariant parameters (`full_diagnostics = FALSE`). Setting this to `TRUE` computes ESS and Rhat values for all model parameters, which can take some time for complex models.

`object` [dynamitefit]
The model fit object.

Details

The best-case scalability of `dynamite` in terms of data size should be approximately linear in terms of number of time points and and number of groups, but as wall-clock time of the MCMC algorithms provided by Stan can depend on the discrepancy of the data and the model (and the subsequent shape of the posterior), this can vary greatly.

Value

`dynamite` returns a `dynamitefit` object which is a list containing the following components:

- `stanfit`
  A `stanfit` object, see `rstan::sampling()` for details.
- `dformulas`
  A list of `dynamiteformula` objects for internal use.
- `data`
  A processed version of the input `data`.
- `data_name`
  Name of the input data object.
- `stan`
  A `list` containing various elements related to Stan model construction and sampling.
- `group_var`
  Name of the variable defining the groups.
- `time_var`
  Name of the variable defining the time index.
- `priors`
  Data frame containing the used priors.
- `backend`
  Either `"rstan"` or `"cmdstanr"` indicating which package was used in sampling.
- `call`
  Original function call as an object of class `call`.

`formula` returns a quoted expression.

`print` returns `x` invisibly.

`summary` returns a `data.frame`.

References

Santtu Tikka and Jouni Helske (2023). dynamite: An R Package for Dynamic Multivariate Panel Models. arXiv preprint, https://arxiv.org/abs/2302.01607.

Jouni Helske and Santtu Tikka (2022). Estimating Causal Effects from Panel Data with Dynamic Multivariate Panel Models. SocArxiv preprint, https://osf.io/preprints/socarxiv/mdwu5/.

See Also

Model fitting dynamice(), get_priors(), update.dynamitefit()

Model formula construction dynamiteformula(), lags(), lfactor(), random_spec(), splines()

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN

# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  fit <- dynamite(
    dformula = obs(y ~ -1 + varying(~x), family = "gaussian") +
      lags(type = "varying") +
      splines(df = 20),
    gaussian_example,
    "time",
    "id",
    chains = 1,
    refresh = 0
  )
}


data.table::setDTthreads(1) # For CRAN
formula(gaussian_example_fit)

data.table::setDTthreads(1) # For CRAN
print(gaussian_example_fit)

data.table::setDTthreads(1) # For CRAN
summary(gaussian_example_fit,
  types = "beta",
  probs = c(0.05, 0.1, 0.9, 0.95)
)
```

dynamite-deprecated *Deprecated Functions in the dynamite Package*

Description

These functions are provided for compatibility with older versions of the package. They will eventually be completely removed.

Usage

```
plot_betas(x, ...)
plot_deltas(x,  ...)
plot_nus(x, ...)
plot_lambdas(x,  ...)
plot_psis(x, ...)
```

Arguments

x	[dynamitefit] The model fit object.
...	Not used.

Value

A ggplot object.

Details

- plot_betas is now called via plot(., types = "beta")
- plot_deltas is now called via plot(., types = "delta")
- plot_nus is now called via plot(., types = "nu")
- plot_lambdas is now called via plot(., types = "lambda")
- plot_psis is now called via plot(., types = "psi")

See Also

See plot.dynamitefit() for documentation of the parameters of these functions

dynamiteformula *Model formula for* **dynamite**

Description

Defines a new observational or a new auxiliary channel for the model using standard R formula syntax. Formulas of individual response variables can be joined together via +. See 'Details' and the package vignettes for more information. The function obs is a shorthand alias for dynamiteformula, and aux is a shorthand alias for dynamiteformula(formula, family = "deterministic").

Usage

```
dynamiteformula(formula, family, link = NULL)

obs(formula, family, link = NULL)

aux(formula)

## S3 method for class 'dynamiteformula'
e1 + e2

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

Arguments

formula	[formula] An R formula describing the model.
family	[character(1)] The family name. See 'Details' for the supported families.
link	[character(1)] The name of the link function to use or NULL. See details for supported link functions and default values of specific families.
e1	[dynamiteformula] A model formula specification.
e2	[dynamiteformula] A model formula specification.
x	[dynamiteformula] The model formula.
...	Ignored.

Details

Currently the **dynamite** package supports the following distributions for the observations:

- Categorical: `categorical` (with a softmax link using the first category as reference). See the documentation of the `categorical_logit_glm` in the Stan function reference manual (https://mc-stan.org/users/documentation/).
- Multinomial: `multinomial` (softmax link, first category is reference).
- Gaussian: `gaussian` (identity link, parameterized using mean and standard deviation).
- Multivariate Gaussian: `mvgaussian` (identity link, parameterized using mean vector, standard deviation vector and the Cholesky decomposition of the correlation matrix).
- Poisson: `poisson` (log-link, with an optional known offset variable).
- Negative-binomial: `negbin` (log-link, using mean and dispersion parameterization, with an optional known offset variable). See the documentation on `NegBinomial2` in the Stan function reference manual.
- Bernoulli: `bernoulli` (logit-link).
- Binomial: `binomial` (logit-link).
- Exponential: `exponential` (log-link).
- Gamma: `gamma` (log-link, using mean and shape parameterization).
- Beta: `beta` (logit-link, using mean and precision parameterization).
- Student t: `student` (identity link, parameterized using degrees of freedom, location and scale)

The models in the **dynamite** package are defined by combining the channel-specific formulas defined via R formula syntax. Each channel is defined via the `obs` function, and the channels are combined with `+`. For example a formula `obs(y ~ lag(x), family = "gaussian") + obs(x ~ z, family = "poisson")` defines a model with two channels; first we declare that `y` is a gaussian variable depending on a previous value of `x` (`lag(x)`), and then we add a second channel declaring `x` as Poisson distributed depending on some exogenous variable `z` (for which we do not define any distribution).

Number of trials for binomial channels should be defined via a `trials` model component, e.g., `obs(y ~ x + trials(n), family = "binomial")`, where `n` is a data variable defining the number of trials. For multinomial channels, the number of trials is automatically defined to be the sum of the observations over the categories, but can also be defined using the `trials` component, for example for prediction.

Multivariate channels are defined by providing a single formula for all components or by providing component-specific formulas separated by a `|`. The response variables that correspond to the components should be joined by `c()`. For instance, the following would define `c(y1, y2)` as multivariate gaussian with `x` as a predictor for the mean of the first component and `x` and `z` as predictors for the mean of the second component: `obs(c(y1, y2) ~ x | x + z, family = "mvgaussian")`. A multinomial channel should only have a single formula.

In addition to declaring response variables via `obs`, we can also use the function `aux` to define auxiliary channels which are deterministic functions of other variables. The values of auxiliary variables are computed dynamically during prediction, making the use of lagged values and other transformations possible. The function `aux` also does not use the `family` argument, which is automatically set to `deterministic` and is a special channel type of `obs`. Note that lagged values of deterministic `aux` channels do not imply fixed time points. Instead they must be given starting values using a special function `init` that directly initializes the lags to specified values, or by `past` which computes the initial values based on an R expression. Both `init` and `past` should appear on the right hand side of the model formula, separated from the primary defining expression via `|`.

The formula within obs can also contain an additional special function varying, which defines the time-varying part of the model equation, in which case we could write for example obs(x ~ z + varying(~ -1 + w), family = "poisson"), which defines a model equation with a constant intercept and time-invariant effect of z, and a time-varying effect of w. We also remove the duplicate intercept with -1 in order to avoid identifiability issues in the model estimation (we could also define a time varying intercept, in which case we would write obs(x ~ -1 + z + varying(~ w), family = "poisson")). The part of the formula not wrapped with varying is assumed to correspond to the fixed part of the model, so obs(x ~ z + varying(~ -1 + w), family = "poisson") is actually identical to obs(x ~ -1 + fixed(~ z) + varying(~ -1 + w), family = "poisson") and obs(x ~ fixed(~ z) + varying(~ -1 + w), family = "poisson").

When defining varying effects, we also need to define how the these time-varying regression coefficient behave. For this, a splines component should be added to the model, e.g., obs(x ~ varying(~ -1 + w), family = "po defines a cubic B-spline with 10 degrees of freedom for the time-varying coefficient corresponding to the w. If the model contains multiple time-varying coefficients, same spline basis is used for all coefficients, with unique spline coefficients and their standard deviation.

If the desired model contains lagged predictors of each response in each channel, these can be quickly added to the model as either time-invariant or time-varying predictors via lags() instead of writing them manually for each channel.

It is also possible to define group-specific (random) effects term using the special syntax random() similarly as varying(). For example, random(~1) leads to a model where in addition to the common intercept, each individual/group has their own intercept with zero-mean normal prior and unknown standard deviation analogously with the typical mixed models. An additional model component random_spec() can be used to define whether the random effects are allowed to correlate within and across channels and whether to use centered or noncentered parameterization for the random effects.

Value

A dynamiteformula object.

See Also

Model formula construction dynamite(), lags(), lfactor(), random_spec(), splines()

Examples

```
data.table::setDTthreads(1) # For CRAN
# A single gaussian response channel with a time-varying effect of 'x',
# and a time-varying effect of the lag of 'y' using B-splines with
# 20 degrees of freedom for the coefficients of the time-varying terms.
obs(y ~ -1 + varying(~x), family = "gaussian") +
  lags(type = "varying") +
  splines(df = 20)

# A two-channel categorical model with time-invariant predictors
# here, lag terms are specified manually
obs(x ~ z + lag(x) + lag(y), family = "categorical") +
  obs(y ~ z + lag(x) + lag(y), family = "categorical")
```

```
# The same categorical model as above, but with the lag terms
# added using 'lags'
obs(x ~ z, family = "categorical") +
  obs(y ~ z, family = "categorical") +
  lags(type = "fixed")

# A multichannel model with a gaussian, Poisson and a Bernoulli response and
# an auxiliary channel for the logarithm of 'p' plus one
obs(g ~ lag(g) + lag(logp), family = "gaussian") +
  obs(p ~ lag(g) + lag(logp) + lag(b), family = "poisson") +
  obs(b ~ lag(b) * lag(logp) + lag(b) * lag(g), family = "bernoulli") +
  aux(numeric(logp) ~ log(p + 1))

data.table::setDTthreads(1) # For CRAN
obs(y ~ x, family = "gaussian") + obs(z ~ w, family = "exponential")

data.table::setDTthreads(1) # For CRAN
x <- obs(y ~ x + random(~ 1 + lag(d)), family = "gaussian") +
  obs(z ~ varying(~w), family = "exponential") +
  aux(numeric(d) ~ log(y) | init(c(0, 1))) +
  lags(k = 2) +
  splines(df = 5) +
  random_spec(correlated = FALSE)
print(x)
```

`fitted.dynamitefit` *Extract Fitted Values of a Dynamite Model*

Description

Fitted values for a `dynamitefit` object, i.e., $E(y_t|newdata, \theta)$ where θ contains all the model parameters. See also `predict.dynamitefit()` for multi-step predictions.

Usage

```
## S3 method for class 'dynamitefit'
fitted(
  object,
  newdata = NULL,
  n_draws = NULL,
  thin = 1,
  expand = TRUE,
  df = TRUE,
  ...
)
```

Arguments

object	[dynamitefit] The model fit object.
newdata	[data.frame] Data used in predictions. If NULL (default), the data used in model estimation is used for predictions as well. There should be no new time points that were not present in the data that were used to fit the model, and no new group levels can be included.
n_draws	[integer(1)] Number of posterior samples to use, default is NULL which uses all samples without permuting (with chains concatenated). If n_drawsis smaller than ndraws(object), a random subset of n_draws posterior samples are used.
thin	[integer(1)] Use only every thin posterior sample. This can be beneficial with when the model object contains large number of samples. Default is 1 meaning that all samples are used.
expand	[logical(1)] If TRUE (the default), the output is a single data.frame containing the original newdata and the predicted values. Otherwise, a list is returned with two components, simulated and observed, where the first contains only the predicted values, and the second contains the original newdata. Setting expand to FALSE can help conserve memory because newdata is not replicated n_draws times in the output. This argument is ignored if funs are provided.
df	[logical(1)] If TRUE (default) the output consists of data.frame objects, and data.table objects otherwise.
...	Ignored.

Value

A data.frame containing the fitted values.

See Also

Obtaining predictions predict.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
fitted(gaussian_example_fit, n_draws = 2L)

set.seed(1)
# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  fit <- dynamite(
    dformula = obs(LakeHuron ~ 1, "gaussian") + lags(),
    data = data.frame(LakeHuron, time = seq_len(length(LakeHuron)), id = 1),
```

```
  time = "time",
  group = "id",
  chains = 1,
  refresh = 0
)

if (requireNamespace("dplyr") &&
  requireNamespace("tidyr") &&
  base::getRversion() >= "4.1.0") {

  # One-step ahead samples (fitted values) from the posterior
  # (first time point is fixed due to lag in the model):
  fitted(fit) |>
    dplyr::filter(time > 2) |>
    ggplot2::ggplot(ggplot2::aes(time, LakeHuron_fitted, group = .draw)) +
    ggplot2::geom_line(alpha = 0.5) +
    # observed values
    ggplot2::geom_line(ggplot2::aes(y = LakeHuron), colour = "tomato") +
    ggplot2::theme_bw()

  # Posterior predictive distribution given the first time point:
  predict(fit, type = "mean") |>
    dplyr::filter(time > 2) |>
    ggplot2::ggplot(ggplot2::aes(time, LakeHuron_mean, group = .draw)) +
    ggplot2::geom_line(alpha = 0.5) +
    # observed values
    ggplot2::geom_line(ggplot2::aes(y = LakeHuron), colour = "tomato") +
    ggplot2::theme_bw()
}
}
```

`gaussian_example` *Simulated Data of Gaussian Responses*

Description

Simulated data containing gaussian response variables with two covariates. The dataset was generated from a model with time-varying effects of covariate x and the lagged value of the response variable, time-varying intercept, and time-invariant effect of covariate z. The time-varying coefficients vary according to a spline with 20 degrees of freedom.

Usage

```
gaussian_example
```

Format

A data frame with 3000 rows and 5 variables:

y The response variable.

x A continuous covariate.

z A binary covariate.

id Variable defining individuals (1 to 50).

time Variable defining the time point of the measurement (1 to 30).

Source

The data was generated according to a script in https://github.com/ropensci/dynamite/blob/main/data-raw/gaussian_example.R

See Also

Example models categorical_example, categorical_example_fit, gaussian_example_fit, gaussian_simulation_fit, multichannel_example, multichannel_example_fit

---

gaussian_example_fit *Model Fit for the Simulated Data of Gaussian Responses*

Description

A dynamitefit object obtained by running dynamite on the gaussian_example dataset as

```
set.seed(1)
library(dynamite)
gaussian_example_fit <- dynamite(
  obs(y ~ -1 + z + varying(~ x + lag(y)) + random(~1), family = "gaussian") +
    random_spec() + splines(df = 20),
  data = gaussian_example,
  time = "time",
  group = "id",
  iter = 2000,
  warmup = 1000,
  thin = 10,
  chains = 2,
  cores = 2,
  refresh = 0,
  save_warmup = FALSE,
  pars = c("omega_alpha_1_y", "omega_raw_alpha_y", "nu_raw", "nu", "L",
    "sigma_nu", "a_y"),
  include = FALSE
)
```

Note the very small number of samples due to size restrictions on CRAN.

Usage

```
gaussian_example_fit
```

Format

A dynamitefit object.

Source

The data was generated according to a script in https://github.com/ropensci/dynamite/blob/main/data-raw/gaussian_example_fit.R

See Also

Example models categorical_example, categorical_example_fit, gaussian_example, gaussian_simulation_fit, multichannel_example, multichannel_example_fit

---

gaussian_simulation_fit

Model Fit for the time-varying example in the dynamite_simulation *Vignette*

Description

A dynamitefit object obtained by running dynamite with the "Fixed_param" algorithm on the specified inits in the example.

```
set.seed(1)
library(dynamite)
gaussian_simulation_fit <- dynamite(
  dformula = f,
  data = d,
  time = "time",
  group = "id",
  chains = 1,
  iter = 1,
  algorithm = "Fixed_param",
  init = list(init),
)
```

Usage

```
gaussian_simulation_fit
```

Format

A dynamitefit object.

Source

The data was generated according to a script in https://github.com/ropensci/dynamite/blob/main/data-raw/gaussian_simulation_fit.R

See Also

Example models categorical_example, categorical_example_fit, gaussian_example, gaussian_example_fit, multichannel_example, multichannel_example_fit

---

`get_code` *Extract the Stan Code of the Dynamite Model*

Description

Returns the Stan code of the model. Mostly useful for debugging or for building a customized version of the model.

Usage

```
get_code(x, ...)

## S3 method for class 'dynamiteformula'
get_code(x, data, time, group = NULL, blocks = NULL, ...)

## S3 method for class 'dynamitefit'
get_code(x, blocks = NULL, ...)
```

Arguments

`x`	[`dynamiteformula` or `dynamitefit`] The model formula or an existing `dynamitefit` object. See `dynamiteformula()` and `dynamite()`.
`...`	Ignored.
`data`	[`data.frame`, `tibble::tibble`, or `data.table::data.table`] The data that contains the variables in the model in long format. Supported column types are `integer`, `logical`, `double`, and `factor`. Columns of type `character` will be converted to factors. Unused factor levels will be dropped. The `data` can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input `data` is converted to channel specific matrix representations via `stats::model.matrix.lm()`.
`time`	[`character(1)`] A column name of `data` that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.

group [character(1)]
A column name of data that denotes the unique groups or NULL corresponding to a scenario without any groups. If group is NULL, a new column .group is created with constant value 1L is created indicating that all observations belong to the same group. In case of name conflicts with data, see the group_var element of the return object to get the column name of the new variable.

blocks [character()]
Stan block names to extract. If NULL, extracts the full model code.

Value

The Stan model blocks as a character string.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
d <- data.frame(y = rnorm(10), x = 1:10, time = 1:10, id = 1)
cat(get_code(obs(y ~ x, family = "gaussian"),
  data = d, time = "time", group = "id"
))
# same as
cat(dynamite(obs(y ~ x, family = "gaussian"),
  data = d, time = "time", group = "id",
  debug = list(model_code = TRUE, no_compile = TRUE)
)$model_code)
```

---

get_data *Extract the Model Data of the Dynamite Model*

Description

Returns the input data to the Stan model. Mostly useful for debugging.

Usage

```
get_data(x, ...)

## S3 method for class 'dynamiteformula'
get_data(x, data, time, group = NULL, ...)

## S3 method for class 'dynamitefit'
get_data(x, ...)
```

Arguments

x	[dynamiteformula or dynamitefit] The model formula or an existing dynamitefit object. See dynamiteformula() and dynamite().
...	Ignored.
data	[data.frame, tibble::tibble, or data.table::data.table] The data that contains the variables in the model in long format. Supported column types are integer, logical, double, and factor. Columns of type character will be converted to factors. Unused factor levels will be dropped. The data can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input data is converted to channel specific matrix representations via stats::model.matrix.lm().
time	[character(1)] A column name of data that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.
group	[character(1)] A column name of data that denotes the unique groups or NULL corresponding to a scenario without any groups. If group is NULL, a new column .group is created with constant value 1L is created indicating that all observations belong to the same group. In case of name conflicts with data, see the group_var element of the return object to get the column name of the new variable.

Value

A list containing the input data to Stan.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
d <- data.frame(y = rnorm(10), x = 1:10, time = 1:10, id = 1)
str(get_data(obs(y ~ x, family = "gaussian"),
  data = d, time = "time", group = "id"
))
```

get_parameter_dims *Get Parameter Dimensions of the Dynamite Model*

Description

Extracts the names and dimensions of all parameters used in the dynamite model. See also get_parameter_types() and get_parameter_names(). The returned dimensions match those of the stanfit element of the dynamitefit object. When applied to dynamiteformula objects, the model is compiled and sampled for 1 iteration to get the parameter dimensions.

Usage

```
get_parameter_dims(x, ...)

## S3 method for class 'dynamiteformula'
get_parameter_dims(x, data, time, group = NULL, ...)

## S3 method for class 'dynamitefit'
get_parameter_dims(x, ...)
```

Arguments

x	[dynamiteformula or dynamitefit] The model formula or an existing dynamitefit object. See dynamiteformula() and dynamite().
...	Ignored.
data	[data.frame, tibble::tibble, or data.table::data.table] The data that contains the variables in the model in long format. Supported column types are integer, logical, double, and factor. Columns of type character will be converted to factors. Unused factor levels will be dropped. The data can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input data is converted to channel specific matrix representations via stats::model.matrix.lm().
time	[character(1)] A column name of data that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.
group	[character(1)] A column name of data that denotes the unique groups or NULL corresponding to a scenario without any groups. If group is NULL, a new column .group is created with constant value 1L is created indicating that all observations belong to the same group. In case of name conflicts with data, see the group_var element of the return object to get the column name of the new variable.

Value

A named list with all parameter dimensions of the input model.

See Also

Model outputs `as.data.frame.dynamitefit()`, `as.data.table.dynamitefit()`, `as_draws_df.dynamitefit()`, `coef.dynamitefit()`, `confint.dynamitefit()`, `dynamite()`, `get_code()`, `get_data()`, `get_parameter_names()`, `get_parameter_types()`, `ndraws.dynamitefit()`, `nobs.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
get_parameter_dims(multichannel_example_fit)
```

---

get_parameter_names *Get Parameter Names of the Dynamite Model*

Description

Extracts all parameter names of used in the `dynamitefit` object.

Usage

```
get_parameter_names(x, types = NULL, ...)

## S3 method for class 'dynamitefit'
get_parameter_names(x, types = NULL, ...)
```

Arguments

`x`	[`dynamitefit`] The model fit object.
`types`	[`character()`] Extract only names of parameter of a certain type. See `get_parameter_types()`.
`...`	Ignored.

Details

The naming of parameters generally follows style where the name starts with the parameter type (e.g. beta for time-invariant regression coefficient), followed by underscore and the name of the response variable, and in case of time-invariant, time-varying or random effect, the name of the predictor. An exception to this is spline coefficients omega, which also contain the number denoting the knot number.

Value

A `character` vector with parameter names of the input model.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_types(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
get_parameter_names(multichannel_example_fit)
```

---

get_parameter_types *Get Parameter Types of the Dynamite Model*

Description

Extracts all parameter types of used in the dynamitefit object. See as.data.frame.dynamitefit() for explanations of different types.

Usage

```
get_parameter_types(x, ...)

## S3 method for class 'dynamitefit'
get_parameter_types(x, ...)
```

Arguments

x	[dynamitefit] The model fit object.
...	Ignored.

Value

A character vector with all parameter types of the input model.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), ndraws.dynamitefit(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
get_parameter_types(multichannel_example_fit)
```

get_priors *Get Prior Definitions of a Dynamite Model*

Description

Extracts the priors used in the dynamite model as a data frame. You can then alter the priors by changing the contents of the `prior` column and supplying this data frame to `dynamite` function using the argument `priors`. See vignettes for details.

Usage

```
get_priors(x, ...)

## S3 method for class 'dynamiteformula'
get_priors(x, data, time, group = NULL, ...)

## S3 method for class 'dynamitefit'
get_priors(x, ...)
```

Arguments

`x`	[`dynamiteformula` or `dynamitefit`] The model formula or an existing `dynamitefit` object. See `dynamiteformula()` and `dynamite()`.
`...`	Ignored.
`data`	[`data.frame`, `tibble::tibble`, or `data.table::data.table`] The data that contains the variables in the model in long format. Supported column types are `integer`, `logical`, `double`, and `factor`. Columns of type `character` will be converted to factors. Unused factor levels will be dropped. The `data` can contain missing values which will simply be ignored in the estimation in a case-wise fashion (per time-point and per channel). Input `data` is converted to channel specific matrix representations via `stats::model.matrix.lm()`.
`time`	[`character(1)`] A column name of `data` that denotes the time index of observations. If this variable is a factor, the integer representation of its levels are used internally for defining the time indexing.
`group`	[`character(1)`] A column name of `data` that denotes the unique groups or `NULL` corresponding to a scenario without any groups. If `group` is `NULL`, a new column `.group` is created with constant value `1L` is created indicating that all observations belong to the same group. In case of name conflicts with `data`, see the `group_var` element of the return object to get the column name of the new variable.

Value

A `data.frame` containing the prior definitions.

Note

Only the `prior` column of the output should be altered when defining the user-defined priors for the `dynamite`.

See Also

Model fitting `dynamice()`, `dynamite()`, `update.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
d <- data.frame(y = rnorm(10), x = 1:10, time = 1:10, id = 1)
get_priors(obs(y ~ x, family = "gaussian"),
  data = d, time = "time", group = "id"
)
```

`hmc_diagnostics` *HMC Diagnostics for a Dynamite Model*

Description

Prints the divergences, saturated treedepths, and low E-BFMI warnings.

Usage

```
hmc_diagnostics(x, ...)

## S3 method for class 'dynamitefit'
hmc_diagnostics(x, ...)
```

Arguments

`x`	[`dynamitefit`] The model fit object.
`...`	Ignored.

Value

Returns x (invisibly). data.table::setDTthreads(1) # For CRAN hmc_diagnostics(gaussian_example_fit)

See Also

Model diagnostics `lfo()`, `loo.dynamitefit()`, `mcmc_diagnostics()`

`lags` *Add Lagged Responses as Predictors to Each Channel of a Dynamite Model*

Description

Adds the lagged value of the response of each channel specified via `dynamiteformula()` as a predictor to each channel. The added predictors can be either time-varying or time-invariant.

Usage

```
lags(k = 1L, type = c("fixed", "varying", "random"))
```

Arguments

`k`	[`integer()`] Values lagged by `k` units of time of each observed response variable will be added as a predictor for each channel. Should be a positive (unrestricted) integer.
`type`	[`integer(1)`] Either `"fixed"` or `"varying"` which indicates whether the coefficients of the added lag terms should vary in time or not.

Value

An object of class `lags`.

See Also

Model formula construction `dynamite()`, `dynamiteformula()`, `lfactor()`, `random_spec()`, `splines()`

Examples

```
data.table::setDTthreads(1) # For CRAN
obs(y ~ -1 + varying(~x), family = "gaussian") +
  lags(type = "varying") + splines(df = 20)

# A two-channel categorical model with time-invariant predictors
# here, lag terms are specified manually
obs(x ~ z + lag(x) + lag(y), family = "categorical") +
  obs(y ~ z + lag(x) + lag(y), family = "categorical")

# The same categorical model as above, but with the lag terms
# added using 'lags'
obs(x ~ z, family = "categorical") +
  obs(y ~ z, family = "categorical") +
  lags(type = "fixed")
```

`lfactor` *Define a Common Latent Factor for the Dynamite Model.*

Description

This function can be used as part of `dynamiteformula()` to define a common latent factor component. The latent factor is modeled as a spline similarly as a time-varying intercept, but instead of having equal effect on each group, there is an additional loading variable for each group so that in the linear predictor we have a term $\lambda_i \psi_t$ for each group i.

Usage

```
lfactor(
  responses = NULL,
  nonzero_lambda = TRUE,
  correlated = TRUE,
  noncentered_psi = FALSE,
  flip_sign = TRUE
)
```

Arguments

`responses` [`character()`]
Names of the responses that the factor should affect. Default is all responses defined with `obs` except categorical responses, which do not (yet) support the factor component.

`nonzero_lambda` [`logical()`]
If `TRUE` (the default), assumes that the mean of factor loadings is nonzero or not. Should be a logical vector matching the length of `responses` or a single logical value in case `responses` is `NULL`. See details.

`correlated` [`logical()`]
If `TRUE` (the default), the latent factors are assumed to be correlated between channels.

`noncentered_psi` [`logical(1)`]
If `TRUE`, uses a noncentered parametrization for spline coefficients of all the factors. The number of knots is based `splines()` call. Default is `FALSE`.

`flip_sign` [`logical(1)`]
If `TRUE` (default), try to avoid multimodality due to sign-switching by defining the sign of λ and ψ based on the mean of $\omega_1, \ldots, \omega_D$ coefficients. This only affects channels with `nonzero_lambda = FALSE`. If the true mean of ωs is close to zero, this might not help, in which case it is better to set `flip_sign = FALSE` and post-process the samples in other ways (or use only one chain and/or suitable initial values). This argument is common to all factors.

Value

An object of class `latent_factor`.

See Also

Model formula construction `dynamite()`, `dynamiteformula()`, `lags()`, `random_spec()`, `splines()`

Examples

```
data.table::setDTthreads(1) # For CRAN
# three channel model with common factor affecting for responses x and y
obs(y ~ 1, family = "gaussian") +
  obs(x ~ 1, family = "poisson") +
  obs(z ~ 1, family = "gaussian") +
  lfactor(
    responses = c("y", "x"), nonzero_lambda = c(TRUE, FALSE),
    correlated = TRUE, noncentered_psi = FALSE
  )
```

---

lfo *Approximate Leave-Future-Out (LFO) Cross-validation*

Description

Estimates the leave-future-out (LFO) information criterion for `dynamite` models using Pareto smoothed importance sampling.

Usage

```
lfo(x, ...)

## S3 method for class 'dynamitefit'
lfo(x, L, verbose = TRUE, k_threshold = 0.7, ...)
```

Arguments

`x`	[`dynamitefit`] The model fit object.
`...`	Additional arguments passed to `rstan::sampling()` or `cmdstanr::sample()`, such as `chains` and `cores` (`parallel_chains` in `cmdstanr`).
`L`	[`integer(1)`] Positive integer defining how many time points should be used for the initial fit.
`verbose`	[`logical(1)`] If `TRUE` (default), print the progress of the LFO computations to the console.
`k_threshold`	[`numeric(1)`] Threshold for the Pareto k estimate triggering refit. Default is 0.7.

Details

For multichannel models, the log-likelihoods of all channels are combined. For models with groups, expected log predictive densities (ELPDs) are computed independently for each group, but the re-estimation of the model is triggered if pareto k values of any group exceeds the threshold.

Value

An `lfo` object which is a `list` with the following components:

- `ELPD`
  Expected log predictive density estimate.
- `ELPD_SE`
  Standard error of ELPD. This is a crude approximation which does not take into account potential serial correlations.
- `pareto_k`
  Pareto k values.
- `refits`
  Time points where model was re-estimated.
- `L`
  L value used in the LFO estimation.
- `k_threshold`
  Threshold used in the LFO estimation.

References

Paul-Christian Bürkner, Jonah Gabry, and Aki Vehtari (2020). Approximate leave-future-out cross-validation for Bayesian time series models, Journal of Statistical Computation and Simulation, 90:14, 2499-2523.

See Also

Model diagnostics `hmc_diagnostics()`, `loo.dynamitefit()`, `mcmc_diagnostics()`

Examples

```
data.table::setDTthreads(1) # For CRAN

# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  # this gives warnings due to the small number of iterations
  out <- suppressWarnings(
    lfo(gaussian_example_fit, L = 20, chains = 1, cores = 1)
  )
  out$ELPD
  out$ELPD_SE
  plot(out)
}
```

loo.dynamitefit *Approximate Leave-One-Out (LOO) Cross-validation*

Description

Estimates the leave-one-out (LOO) information criterion for dynamite models using Pareto smoothed importance sampling with the loo package.

Usage

```
## S3 method for class 'dynamitefit'
loo(x, separate_channels = FALSE, thin = 1L, ...)
```

Arguments

x	[dynamitefit] The model fit object.
separate_channels	[logical(1)] If TRUE, computes LOO separately for each channel. This can be useful in diagnosing where the model fails. Default is FALSE, in which case the likelihoods of different channels are combined, i.e., all channels of are left out.
thin	[integer(1)] Use only every thin posterior sample when computing LOO. This can be beneficial with when the model object contains large number of samples. Default is 1 meaning that all samples are used.
...	Ignored.

Value

An output from loo::loo() or a list of such outputs (if separate_channels was TRUE).

References

Aki Vehtari, Andrew, Gelman, and Johah Gabry (2017). Practical Bayesian model evaluation using leave-one-out cross-validation and WAIC. Statistics and Computing. 27(5), 1413–1432.

See Also

Model diagnostics hmc_diagnostics(), lfo(), mcmc_diagnostics()

Examples

```
data.table::setDTthreads(1) # For CRAN

# Please update your rstan and StanHeaders installation before running
# on Windows
```

```
if (!identical(.Platform$OS.type, "windows")) {
  # this gives warnings due to the small number of iterations
  suppressWarnings(loo(gaussian_example_fit))
  suppressWarnings(loo(gaussian_example_fit, separate_channels = TRUE))
}
```

`mcmc_diagnostics` *Diagnostic Values of a Dynamite Model*

Description

Prints HMC diagnostics and lists parameters with smallest effective sample sizes and largest Rhat values. See `hmc_diagnostics()` and `posterior::default_convergence_measures()` for details.

Usage

```
mcmc_diagnostics(x, ...)

## S3 method for class 'dynamitefit'
mcmc_diagnostics(x, n = 3L, ...)
```

Arguments

`x`	[`dynamitefit`] The model fit object.
`...`	Ignored.
`n`	[`integer(1)`] How many rows to print in parameter-specific convergence measures. The default is 3. Should be a positive (unrestricted) integer.

Value

Returns `x` (invisibly).

See Also

Model diagnostics `hmc_diagnostics()`, `lfo()`, `loo.dynamitefit()`

Examples

```
data.table::setDTthreads(1) # For CRAN
mcmc_diagnostics(gaussian_example_fit)
```

multichannel_example *Simulated Multivariate Panel Data*

Description

A simulated multichannel data containing multiple individuals with multiple response variables of different distributions.

Usage

```
multichannel_example
```

Format

A data frame with 3000 rows and 5 variables:

id Variable defining individuals (1 to 50).

time Variable defining the time point of the measurement (1 to 20).

g Response variable following gaussian distribution.

p Response variable following Poisson distribution.

b Response variable following Bernoulli distribution.

Source

The data was generated according to a script in https://github.com/ropensci/dynamite/blob/main/data-raw/multichannel_example.R

See Also

Example models categorical_example, categorical_example_fit, gaussian_example, gaussian_example_fit, gaussian_simulation_fit, multichannel_example_fit

multichannel_example_fit *Model Fit for the Simulated Multivariate Panel Data*

Description

A dynamitefit object obtained by running dynamite on the multichannel_example dataset as

```
set.seed(1)
library(dynamite)
f <- obs(g ~ lag(g) + lag(logp), family = "gaussian") +
  obs(p ~ lag(g) + lag(logp) + lag(b), family = "poisson") +
  obs(b ~ lag(b) * lag(logp) + lag(b) * lag(g), family = "bernoulli") +
  aux(numeric(logp) ~ log(p + 1))
multichannel_example_fit <- dynamite(
  f,
  data = multichannel_example,
  time = "time",
  group = "id",
  chains = 1,
  cores = 1,
  iter = 2000,
  warmup = 1000,
  init = 0,
  refresh = 0,
  thin = 5,
  save_warmup = FALSE
)
```

Note the small number of samples due to size restrictions on CRAN.

Usage

```
multichannel_example_fit
```

Format

A dynamitefit object.

Source

Script in https://github.com/ropensci/dynamite/blob/main/data-raw/multichannel_example_fit.R

See Also

Example models categorical_example, categorical_example_fit, gaussian_example, gaussian_example_fit, gaussian_simulation_fit, multichannel_example

ndraws.dynamitefit *Return the Number of Posterior Draws of a* dynamitefit *Object*

Description

Return the Number of Posterior Draws of a dynamitefit Object

Usage

```
## S3 method for class 'dynamitefit'
ndraws(x)
```

Arguments

x	[dynamitefit] The model fit object.

Value

Number of posterior draws as a single integer value.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), nobs.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
ndraws(gaussian_example_fit)
```

nobs.dynamitefit *Extract the Number of Observations Used to Fit a Dynamite Model*

Description

Extract the Number of Observations Used to Fit a Dynamite Model

Usage

```
## S3 method for class 'dynamitefit'
nobs(object, ...)
```

Arguments

object	[dynamitefit] The model fit object.
...	Not used.

Value

Total number of non-missing observations as an integer.

See Also

Model outputs as.data.frame.dynamitefit(), as.data.table.dynamitefit(), as_draws_df.dynamitefit(), coef.dynamitefit(), confint.dynamitefit(), dynamite(), get_code(), get_data(), get_parameter_dims(), get_parameter_names(), get_parameter_types(), ndraws.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
nobs(gaussian_example_fit)
```

---

plot.dynamitefit *Plots for* dynamitefit *Objects*

Description

Produces the traceplots and the density plots of the model parameters. Can also be used to plot the time-varying and time-invariant parameters of the model along with their posterior intervals. See the plot_type argument for details on available plots.

Usage

```
## S3 method for class 'dynamitefit'
plot(
  x,
  plot_type = c("default", "trace", "dag"),
  types = NULL,
  parameters = NULL,
  responses = NULL,
  groups = NULL,
  times = NULL,
  level = 0.05,
  alpha = 0.5,
  facet = TRUE,
  scales = c("fixed", "free"),
  n_params = NULL,
  ...
)
```

Arguments

x	[dynamitefit] The model fit object.
plot_type	[character(1)] What type of plot to draw? The default is "default" which draws posterior means and intervals of the parameters selected by types or parameters. If both "types" and parameters are NULL, all parameters are drawn up to the maximum specified by n_params. Option "trace" instead draws posterior densities and traceplots of the parameters. Option "dag" instead plots the directed acyclic graph of the model formula, see plot.dynamiteformula() for the arguments available for this option.
types	[character(1)] Types of the parameter for which the plots should be drawn. Possible options can be found with the function get_parameter_types(). Ignored if the argument parameters is supplied.
parameters	[character()] Parameter name(s) for which the plots should be drawn. Possible options can be found with the function get_parameter_names(). The default is all parameters, limited by n_params.
responses	[character()] Response(s) for which the plots should be drawn. Possible options are unique(x$priors$response). Default is all responses. Ignored if the argument parameters is supplied.
groups	[character(1)] Group name(s) for which the plots should be drawn for group-specific parameters.
times	[double()] Time point(s) for which the plots should be drawn for time-varying parameters. By default, all time points are included, up to the maximum number of parameters specified by n_params starting from the first non-fixed time point.
level	[numeric(1)] Level for posterior intervals. Default is 0.05, leading to 90% intervals.
alpha	[numeric(1)] Opacity level for geom_ribbon. Default is 0.5.
facet	[logical(1)] Should the time-invariant parameters be plotted separately (TRUE) or in a single plot (FALSE)?
scales	[character(1)] Should y-axis of the panels be "fixed" (the default) or "free"? See ggplot2::facet_wrap().
n_params	[integer()] A single value or a vector of length 2 specifying the maximum number of parameters to plot. If a single value is provided, the same limit is used for all parameters. If a vector is supplied, the first element defines the maximum number of time-invariant parameters to plot and the second the maximum number of time-varying parameters to plot. The defaults values are 20 for time-invariant parameters and 3 for time-varying parameters. The default value is 5 for plot_type == "trace".

... Arguments passed to plot.dynamiteformula() when using plot_type = "dag".

Value

A ggplot object.

See Also

Drawing plots plot.dynamiteformula()

Examples

```
data.table::setDTthreads(1) # For CRAN
plot(gaussian_example_fit, type = "beta")
```

---

plot.dynamiteformula *Plot the Model Structure as a Directed Acyclic Graph (DAG)*

Description

Plot a snapshot of the model structure at a specific time point with a window of the highest-order lag dependency both into the past and the future as a directed acyclic graph (DAG). Only response variables are shown in the plot. This function can also produce a TikZ code of the DAG to be used in reports and publications.

Usage

```
## S3 method for class 'dynamiteformula'
plot(
  x,
  show_auxiliary = TRUE,
  show_covariates = FALSE,
  tikz = FALSE,
  vertex_size = 0.25,
  label_size = 18,
  ...
)
```

Arguments

x	[dynamiteformula] The model formula.
show_auxiliary	[logical(1)] Should deterministic auxiliary responses be shown in the plot? If FALSE, the vertices corresponding to such responses will be projected out. The default is TRUE.

show_covariates
: [logical(1)]
Should unmodeled covariates be shown in the plot? The defaults is FALSE.

tikz
: [logical(1)]
Should the DAG be returned in TikZ format? The default is FALSE returning a ggplot object instead.

vertex_size
: [double(1)]
The size (radius) of the vertex circles used in the ggplot DAG. (The vertical and horizontal distances between vertices in the grid are 1, for reference.)

label_size
: [double(1)]
Font size (in points) to use for the vertex labels in the ggplot DAG.

...
: Not used..

Value

A ggplot object, or a character string if tikz = TRUE.

See Also

Drawing plots plot.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
multichannel_formula <- obs(g ~ lag(g) + lag(logp), family = "gaussian") +
  obs(p ~ lag(g) + lag(logp) + lag(b), family = "poisson") +
  obs(b ~ lag(b) * lag(logp) + lag(b) * lag(g), family = "bernoulli") +
  aux(numeric(logp) ~ log(p + 1))
# A ggplot
plot(multichannel_formula)
# TikZ format
plot(multichannel_formula, tikz = TRUE)
```

---

plot.lfo *Diagnostic Plot for Pareto k Values from LFO*

Description

Plots Pareto k values per each time point (with one point per group), together with a horizontal line representing the used threshold.

Usage

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

Arguments

x	[lfo] Output of the lfo method.
...	Ignored.

Value

A ggplot object.

Examples

```
data.table::setDTthreads(1) # For CRAN

# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  # This gives warnings due to the small number of iterations
  plot(suppressWarnings(
    lfo(gaussian_example_fit, L = 20, chains = 1, cores = 1)
  ))
}
```

---

predict.dynamitefit *Predict Method for a Dynamite Model*

Description

Obtain counterfactual predictions for a dynamitefit object.

Usage

```
## S3 method for class 'dynamitefit'
predict(
  object,
  newdata = NULL,
  type = c("response", "mean", "link"),
  funs = list(),
  impute = c("none", "locf", "nocb"),
  new_levels = c("none", "bootstrap", "gaussian", "original"),
  global_fixed = FALSE,
  n_draws = NULL,
  thin = 1,
  expand = TRUE,
  df = TRUE,
  ...
)
```

Arguments

object	[dynamitefit] The model fit object.
newdata	[data.frame] Data used in predictions. Predictions are computed for missing (NA) values in the response variable columns, and non-missing values are assumed fixed. If NULL (default), the data used in model estimation is used for predictions as well, after all values in the response variable columns after the first fixed time point are converted to NA values. Missing values in predictor columns can be imputed (argument impute). There should be no new time points that were not present in the data that were used to fit the model. New group levels can be included, but if the model contains random effects, an option for the random effects for the new levels must be chosen (argument new_levels). If the grouping variable of the original data is missing, it is assumed that all observations in newdata belong to the first group in the original data. New group levels are not allowed for models using latent factors.
type	[character(1)] Type of prediction, "response" (default), "mean", or "link".
funs	[list()] A named list whose names should correspond to the response variables of the model. Each element of funs should be a a named list of functions that will be applied to the corresponding predicted type of the channel over the individuals for each combination of the posterior draws and time points. In other words, the resulting predictions will be averages over the individuals. The functions should take the corresponding type variable values as their only argument. If funs is empty, the full individual level values are returned instead. Note that this argument can only be used if there are multiple individuals (i.e., group was not NULL in the dynamite call).
impute	[character(1)] Which imputation scheme to use for missing exogenous predictor values. Currently supported options are no imputation: "none" (default), last observation carried forward: "locf", and next observation carried backward: "nocb".
new_levels	[character(1)] Defines if and how to sample the random effects for observations whose group level was not present in the original data. The options are: • "none" (the default) which will signal an error if new levels are encountered. • "bootstrap" which will randomly draw from the posterior samples of the random effects across all original levels. • "gaussian" which will randomly draw from a gaussian distribution using the posterior samples of the random effects standard deviation (and correlation matrix if applicable). • "original" which will randomly match each new level to one of the original levels. The posterior samples of the random effects of the matched levels will then be used for the new levels. This argument is ignored if the model does not contain random effects.

`global_fixed` [logical(1)]
If FALSE (the default), the first non-fixed time point is counted from the the first non-NA observation for each group member separately. Otherwise, the first non-fixed time point is counted from the first time point globally. If there are no groups, then the options are equivalent.

`n_draws` [integer(1)]
Number of posterior samples to use, default is NULL which uses all samples without permuting (with chains concatenated). If n_drawsis smaller than ndraws(object), a random subset of n_draws posterior samples are used.

`thin` [integer(1)]
Use only every thin posterior sample. This can be beneficial with when the model object contains large number of samples. Default is 1 meaning that all samples are used.

`expand` [logical(1)]
If TRUE (the default), the output is a single data.frame containing the original newdata and the predicted values. Otherwise, a list is returned with two components, simulated and observed, where the first contains only the predicted values, and the second contains the original newdata. Setting expand to FALSE can help conserve memory because newdata is not replicated n_draws times in the output. This argument is ignored if funs are provided.

`df` [logical(1)]
If TRUE (default) the output consists of data.frame objects, and data.table objects otherwise.

`...` Ignored.

Details

Note that forecasting (i.e., predictions for time indices beyond the last time index in the original data) is not supported by the **dynamite** package. However, such predictions can be obtained by augmenting the original data with NA values before model estimation.

Value

A data.frame containing the predicted values or a list of two data.frames. See the expand argument for details. Note that the .draw column is not the same as .draw from as.data.frame and as_draws methods as predict uses permuted samples. A mapping between these variables can be done using information in object$stanfit@sim$permutation.

See Also

Obtaining predictions fitted.dynamitefit()

Examples

```
data.table::setDTthreads(1) # For CRAN
out <- predict(gaussian_example_fit, type = "response", n_draws = 2L)
head(out)
```

```
# using summary functions
sumr <- predict(multichannel_example_fit, type = "mean",
  funs = list(g = list(m = mean, s = sd), b = list(sum = sum)),
  n_draws = 2L)
head(sumr$simulated)

# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  # Simulate from the prior predictive distribution

  f <- obs(y ~ lag(y) + varying(~ -1 + x), "gaussian") +
    splines(df = 10, noncentered = TRUE)

  # Create data with missing observations
  # Note that due to the lagged term in the model,
  # we need to fix the first time point
  d <- data.frame(y = c(0, rep(NA, 49)), x = rnorm(50), time = 1:50)

  # Suppress warnings due to the lack of data
  suppressWarnings(
    priors <- get_priors(f, data = d, time = "time")
  )

  # Modify default priors which can produce exploding behavior when used
  # without data
  priors$prior <- c(
    "normal(0, 1)",
    "normal(0.6, 0.1)",
    "normal(-0.2, 0.5)",
    "normal(0.2, 0.1)",
    "normal(0.5, 0.1)"
  )

  # Samples from the prior conditional on the first time point and x
  fit <- dynamite(
    dformula = f,
    data = d,
    time = "time",
    verbose = FALSE,
    priors = priors,
    chains = 1
  )

  # Simulate new data
  pp <- predict(fit)

  ggplot2::ggplot(pp, ggplot2::aes(time, y_new, group = .draw)) +
    ggplot2::geom_line(alpha = 0.1) +
    ggplot2::theme_bw()
}
```

print.lfo *Print the results from the LFO*

Description

Prints the summary of the leave-future-out cross-validation.

Usage

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

Arguments

x	[lfo] Output of the lfo method.
...	Ignored.

Value

Returns x invisibly.

Examples

```
data.table::setDTthreads(1) # For CRAN

# Please update your rstan and StanHeaders installation before running
# on Windows
if (!identical(.Platform$OS.type, "windows")) {
  # This gives warnings due to the small number of iterations
  suppressWarnings(lfo(gaussian_example_fit, L = 20))
}
```

random_spec *Additional Specifications for the Group-level Random Effects of the DMPM*

Description

This function can be used as part of dynamiteformula() to define whether the group-level random effects should be modeled as correlated or not.

Usage

```
random_spec(correlated = TRUE, noncentered = TRUE)
```

Arguments

correlated	[logical(1)] If TRUE (the default), correlations of random effects are modeled as multivariate normal.
noncentered	[logical(1)] If TRUE (the default), use a noncentered parameterization for random effects. Try changing this if you encounter divergences or other problems in sampling.

Details

With a large number of time points random intercepts can become challenging sample with default priors. This is because with large group sizes the group-level intercepts tend to be behave similarly to fixed group-factor variable so the model becomes overparameterized given these and the common intercept term. Another potential cause for sampling problems is relatively large variation in the intercepts (large sigma_nu) compared to the sampling variation (sigma) in the Gaussian case.

Value

An object of class random_spec.

See Also

Model formula construction dynamite(), dynamiteformula(), lags(), lfactor(), splines()

Examples

```
data.table::setDTthreads(1) # For CRAN
# two channel model with correlated random effects for responses x and y
obs(y ~ 1 + random(~1), family = "gaussian") +
  obs(x ~ 1 + random(~1 + z), family = "poisson") +
  random_spec(correlated = TRUE)
```

---

splines *Define the B-splines Used for the Time-varying Coefficients of the Model.*

Description

This function can be used as part of dynamiteformula() to define the splines used for the time-varying coefficients δ.

Usage

```
splines(
  df = NULL,
  degree = 3L,
  lb_tau = 0,
  noncentered = FALSE,
  override = FALSE
)
```

Arguments

df	[integer(1)] Degrees of freedom, i.e., the total number of spline coefficients. See splines::bs(). Note that the knots are always defined as an equidistant sequence on the interval starting from the first non-fixed time point to the last time point in the data. See dynamiteformula() for more information on fixed time points. Should be an (unrestricted) positive integer.
degree	[integer(1)] See splines::bs(). Should be an (unrestricted) positive integer.
lb_tau	[numeric()] Hard constraint(s) on the lower bound of the standard deviation parameters τ of the random walk priors. Can be useful in avoiding divergences in some cases. See also the noncentered argument. Can be a single positive value, or vector defining the lower bound separately for each channel, even for channels without varying effects. The ordering is based on the order of channel definitions in the dynamiteformula object.
noncentered	[logical()] If TRUE, use a noncentered parameterization for the spline coefficients. Default is FALSE. Try changing this if you encounter divergences or other problems in sampling for example when simulating from prior predictive distribution. Can be a single logical value, or vector of logical values, defining the parameterization separately for each channel, even for channels without varying effects.
override	[logical(1)] If FALSE (the default), an existing definition for the splines will not be overridden by another call to splines(). If TRUE, any existing definitions will be replaced.

Value

An object of class splines.

See Also

Model formula construction dynamite(), dynamiteformula(), lags(), lfactor(), random_spec()

Examples

```
data.table::setDTthreads(1) # For CRAN
# Two channel model with varying effects, with explicit lower bounds for the
```

```
# random walk prior standard deviations, with noncentered parameterization
# for the first channel and centered for the second channel.
obs(y ~ 1, family = "gaussian") + obs(x ~ 1, family = "gaussian") +
  lags(type = "varying") +
  splines(
    df = 20, degree = 3, lb_tau = c(0, 0.1),
    noncentered = c(TRUE, FALSE)
  )
```

`update.dynamitefit` *Update a Dynamite Model*

Description

Note that using a different backend for the original model fit and when updating can lead to an error due to different naming in `cmdstanr` and `rstan` sampling arguments.

Usage

```
## S3 method for class 'dynamitefit'
update(
  object,
  dformula = NULL,
  data = NULL,
  priors = NULL,
  recompile = NULL,
  ...
)
```

Arguments

`object`	[`dynamitefit`] The model fit object.
`dformula`	[`dynamiteformula`] Updated model formula. By default the original formula is used.
`data`	[`data.frame`, `tibble::tibble`, or `data.table::data.table`] Data for the updated model. By default original data is used.
`priors`	[`data.frame`] Updated priors. By default the priors of the original model are used.
`recompile`	[`logical(1)`] Should the model be recompiled? If `NULL` (default), tries to avoid recompilation. Recompilation is forced when the model formula or the priors are changed, or if the new data contains missing values in a channel which did not contain missing values in the original data. Recompilation is also forced in case the backend previous or new backend is `cmdstanr`.
`...`	Additional parameters to `dynamite`.

Value

An updated dynamitefit object.

See Also

Model fitting dynamice(), dynamite(), get_priors()

Examples

```
data.table::setDTthreads(1) # For CRAN
## Not run:
# re-estimate the example fit without thinning:
# As the model is compiled on Windows, this will fail on other platforms
if (identical(.Platform$OS.type, "windows")) {
  fit <- update(gaussian_example_fit, thin = 1)
}

## End(Not run)
```

Index