Package ‘rstantools’

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Description

Stan Development Team

The rstantools package provides various tools for developers of R packages interfacing with Stan (https://mc-stan.org), including functions to set up the required package structure, S3 generic methods to unify function naming across Stan-based R packages, and vignettes with guidelines for developers. To get started building a package see rstan_create_package().

See Also

- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

- After reading the guidelines for developers, if you have trouble setting up your package let us know on the the Stan Forums or at the rstantools GitHub issue tracker.

- The useR2016 presentation How to Use (R)Stan to Estimate Models in External R Packages.
Generic function and default method for Bayesian R-squared

Description

Generic function and default method for Bayesian version of R-squared for regression models. A generic for LOO-adjusted R-squared is also provided. See the \texttt{bayes.R2.stanreg()} method in the \texttt{rstanarm} package for an example of defining a method.

Usage

\begin{verbatim}
bayes.R2(object, ...)  
## Default S3 method:  
bayes.R2(object, y, ...)  
loo.R2(object, ...)  
\end{verbatim}

Arguments

- \texttt{object} The object to use.
- \texttt{...} Arguments passed to methods. See the methods in the \texttt{rstanarm} package for examples.
- \texttt{y} For the default method, a vector of y values the same length as the number of columns in the matrix used as object.

Value

\texttt{bayes.R2()} and \texttt{loo.R2()} methods should return a vector of length equal to the posterior sample size.

The default \texttt{bayes.R2()} method just takes \texttt{object} to be a matrix of y-hat values (one column per observation, one row per posterior draw) and \texttt{y} to be a vector with length equal to \texttt{ncol(object)}.

References


See Also

- The \texttt{rstanarm} package (mc.stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of \texttt{R} packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with \texttt{rstantools} and at mc.stan.org/rstantools/articles.
init_cpp

Register functions implemented in C++

Description
If you set up your package using `rstan_package_skeleton()` before version 1.2.1 of `rstantools` it may be necessary for you to call this function yourself in order to pass `R CMD check` in R >= 3.4. If you used `rstan_package_skeleton()` in `rstantools` version 1.2.1 or later then this has already been done automatically.

Usage
`init_cpp(name, path)`

Arguments
- **name**: The name of your package as a string.
- **path**: The path to the root directory for your package as a string. If not specified it is assumed that this is already the current working directory.

Value
This function is only called for its side effect of writing the necessary `init.cpp` file to the package’s `src/` directory.

log_lik

Generic function for pointwise log-likelihood

Description
We define a new function `log_lik()` rather than a `stats::logLik()` method because (in addition to the conceptual difference) the documentation for `logLik()` states that the return value will be a single number, whereas `log_lik()` returns a matrix. See the `log_lik.stanreg()` method in the `rstanarm` package for an example of defining a method.

Usage
`log_lik(object, ...)`

Arguments
- **object**: The object to use.
- **...**: Arguments passed to methods. See the methods in the `rstanarm` package for examples.
Value

log_lik() methods should return a \( S \) by \( N \) matrix, where \( S \) is the size of the posterior sample (the number of draws from the posterior distribution) and \( N \) is the number of data points.

See Also

- The \texttt{rstanarm} package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of \texttt{R} packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with \texttt{rstantools} and at mc-stan.org/rstantools/articles.

Examples

\# See help("log_lik", package = "rstanarm")

---

\textbf{loo-prediction} \hspace{1cm} \textit{Generic functions for LOO predictions}

Description

See the methods in the \texttt{rstanarm} package for examples.

Usage

\begin{verbatim}
loo_linpred(object, ...)
loo_predict(object, ...)
loo_predictive_interval(object, ...)
loo_pit(object, ...)
## Default S3 method:
loo_pit(object, y, lw, ...)
\end{verbatim}

Arguments

- \textbf{object} \hspace{0.5cm} The object to use.
- \textbf{...} \hspace{1cm} Arguments passed to methods. See the methods in the \texttt{rstanarm} package for examples.
- \textbf{y} \hspace{1cm} For the default method of \texttt{loo_pit()}, a vector of \texttt{y} values the same length as the number of columns in the matrix used as \texttt{object}.
- \textbf{lw} \hspace{1cm} For the default method of \texttt{loo_pit()}, a matrix of log-weights of the same length as the number of columns in the matrix used as \texttt{object}.
Value

`loo_predict()`, `loo_linpred()`, and `loo_pit()` (probability integral transform) methods should return a vector with length equal to the number of observations in the data. `loo_predictive_interval()` methods should return a two-column matrix formatted in the same way as for `predictive_interval()`.

See Also

- The `rstanarm` package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with `rstantools` and at mc-stan.org/rstantools/articles.

---

### nsamples

*Generic function for extracting the number of posterior samples*

**Description**

Extract the number of posterior samples stored in a fitted Bayesian model.

**Usage**

```r
nsamples(object, ...)
```

**Arguments**

- `object`: The object to use.
- `...`: Arguments passed to methods. See the methods in the `rstanarm` package for examples.

---

### posterior_interval

*Generic function and default method for posterior uncertainty intervals*

**Description**

These intervals are often referred to as credible intervals, but we use the term uncertainty intervals to highlight the fact that wider intervals correspond to greater uncertainty. See `posterior_interval.stanreg()` in the `rstanarm` package for an example.

**Usage**

```r
posterior_interval(object, ...)
```

### Examples

```r
## Default S3 method:
posterior_interval(object, prob = 0.9, ...)
```
**Arguments**

- **object**: The object to use.
- **...**: Arguments passed to methods. See the methods in the rstanarm package for examples.
- **prob**: A number $p \in (0, 1)$ indicating the desired probability mass to include in the intervals.

**Value**

posterior_interval() methods should return a matrix with two columns and as many rows as model parameters (or a subset of parameters specified by the user). For a given value of prob, $p$, the columns correspond to the lower and upper $100p\%$ interval limits and have the names $100\alpha/2\%$ and $100(1 - \alpha/2)\%$, where $\alpha = 1 - p$. For example, if prob=0.9 is specified (a 90\% interval), then the column names would be "95\%" and "95\%", respectively.

The default method just takes object to be a matrix (one column per parameter) and computes quantiles, with prob defaulting to 0.9.

**See Also**

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

**Examples**

```r
# Default method takes a numeric matrix (of posterior draws)
draws <- matrix(rnorm(100 * 5), 100, 5) # fake draws
colnames(draws) <- paste0("theta_", 1:5)
p = posterior_interval(draws)

# Also see help("posterior_interval", package = "rstanarm")
```

---

**posterior_linpred**

Generic function for accessing the posterior distribution of the linear predictor

**Description**

Extract the posterior draws of the linear predictor, possibly transformed by the inverse-link function. See posterior_linpred.stanreg() in the rstanarm package for an example.

**Usage**

```r
posterior_linpred(object, transform = FALSE, ...)
```
Arguments

- **object**: The object to use.
- **transform**: Should the linear predictor be transformed using the inverse-link function? The default is `FALSE`, in which case the untransformed linear predictor is returned.
- **...**: Arguments passed to methods. See the methods in the `rstanarm` package for examples.

Value

`posterior_linpred()` methods should return a $D$ by $N$ matrix, where $D$ is the number of draws from the posterior distribution distribution and $N$ is the number of data points.

See Also

- The `rstanarm` package ([mc-stan.org/rstanarm](mc-stan.org/rstanarm)) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with `rstantools` and at mc-stan.org/rstantools/articles.

Examples

```r
# See help("posterior_linpred", package = "rstanarm")
```

---

### posterior_predict

*Generic function for drawing from the posterior predictive distribution*

**Description**

Draw from the posterior predictive distribution of the outcome. See `posterior_predict.stanreg()` in the `rstanarm` package for an example.

**Usage**

```r
posterior_predict(object, ...)
```

**Arguments**

- **object**: The object to use.
- **...**: Arguments passed to methods. See the methods in the `rstanarm` package for examples.

**Value**

`posterior_predict()` methods should return a $D$ by $N$ matrix, where $D$ is the number of draws from the posterior predictive distribution and $N$ is the number of data points being predicted per draw.
See Also

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

Examples

```r
# See help("posterior_predict", package = "rstanarm")
```

---

**predictive_error**  
*Generic function and default method for predictive errors*

**Description**

Generic function and default method for computing predictive errors $y - \tilde{y}$ (in-sample, for observed $y$) or $y - \tilde{y}$ (out-of-sample, for new or held-out $y$). See `predictive_error.stanreg()` in the rstanarm package for an example.

**Usage**

```r
predictive_error(object, ...)  
## Default S3 method:  
predictive_error(object, y, ...)
```

**Arguments**

- `object`  
The object to use.
- `...`  
Arguments passed to methods. See the methods in the rstanarm package for examples.
- `y`  
For the default method, a vector of $y$ values the same length as the number of columns in the matrix used as object.

**Value**

`predictive_error()` methods should return a $D$ by $N$ matrix, where $D$ is the number of draws from the posterior predictive distribution and $N$ is the number of data points being predicted per draw.

The default method just takes `object` to be a matrix and `y` to be a vector.
See Also

- The `rstanarm` package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).

- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with `rstantools` and at mc-stan.org/rstantools/articles.

Examples

```r
# default method
y <- rnorm(10)
ypred <- matrix(rnorm(500), 50, 10)
pred_errors <- predictive_error(ypred, y)
dim(pred_errors)
head(pred_errors)

# Also see help("predictive_error", package = "rstanarm")
```

---

`predictive_interval`  
*Generic function for predictive intervals*

Description

See `predictive_interval.stanreg()` in the `rstanarm` package for an example.

Usage

```r
predictive_interval(object, ...)
```

## Default S3 method:
`predictive_interval(object, prob = 0.9, ...)`

Arguments

- `object` The object to use.
- `...` Arguments passed to methods. See the methods in the `rstanarm` package for examples.
- `prob` A number \( p \in (0, 1) \) indicating the desired probability mass to include in the intervals.
Value

predictive_interval() methods should return a matrix with two columns and as many rows as data points being predicted. For a given value of prob, $p$, the columns correspond to the lower and upper $100\alpha/2\%$ interval limits and have the names $100\alpha/2\%$ and $100(1 - \alpha/2)\%$, where $\alpha = 1 - p$. For example, if prob=0.9 is specified (a 90% interval), then the column names would be "5%" and "95%", respectively.

The default method just takes object to be a matrix and computes quantiles, with prob defaulting to 0.9.

See Also

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

Examples

```r
# Default method takes a numeric matrix (of draws from posterior
# predictive distribution)
ytilde <- matrix(rnorm(100 * 5, sd = 2), 100, 5)  # fake draws
predictive_interval(ytilde, prob = 0.8)
```

See Also

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

Examples

```r
# Default method takes a numeric matrix (of draws from posterior
# predictive distribution)
ytilde <- matrix(rnorm(100 * 5, sd = 2), 100, 5)  # fake draws
predictive_interval(ytilde, prob = 0.8)
```

See Also

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

Examples

```r
# Default method takes a numeric matrix (of draws from posterior
# predictive distribution)
ytilde <- matrix(rnorm(100 * 5, sd = 2), 100, 5)  # fake draws
predictive_interval(ytilde, prob = 0.8)
```

See Also

- The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.
Value

prior_summary() methods should return an object containing information about the prior distribution(s) used for the given model. The structure of this object will depend on the method.

The default method just returns object$prior.info, which is NULL if there is no 'prior.info' element.

See Also

• The rstanarm package (mc-stan.org/rstanarm) for example methods (CRAN, GitHub).

• Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.

Examples

# See help("prior_summary", package = "rstanarm")

rstan_config

Configure system files for compiling Stan source code

Description

Creates or update package-specific system files to compile .stan model files found in inst/stan.

Usage

rstan_config(pkgdir = ".")

Arguments

pkgdir Path to package root folder.

Details

The Stan source files for the package should be stored in:

• inst/stan for .stan files containing instructions to build a stanmodel object.

• inst/stan/any_subfolder for files to be included via the #include "/my_subfolder/mylib.stan" directive.

• inst/stan/any_subfolder for a license.stan file.

• inst/include for the stan_meta_header.hpp file, to be used for directly interacting with the Stan C++ libraries.

Value

Invisibly, whether or not any files were added/removed/modified by the function.
rstan_create_package  

Create a new \texttt{R} package with compiled Stan programs

Description

The \texttt{rstan_create_package()} function helps you started developing a new \texttt{R} package that interfaces with Stan via the \texttt{rstan} package. First the basic package structure is set up via \texttt{usethis::create_package()}. Then several adjustments are made so the package can include Stan programs that can be built into binary versions (i.e., pre-compiled Stan C++ code).

The Details section below describes the process and the See Also section provides links to recommendations for developers and a step-by-step walk-through.

As of version 2.0.0 of \texttt{rstantools} the \texttt{rstan_package_skeleton()} function is defunct and only \texttt{rstan_create_package()} is supported.

Usage

\begin{verbatim}
  rstan_create_package(path, fields = NULL, rstudio = TRUE, 
                       open = TRUE, stan_files = character(), roxygen = TRUE, 
                       travis = TRUE, license = TRUE, auto_config = TRUE)
\end{verbatim}

Arguments

\begin{itemize}
\item \texttt{path} \hspace{5em} The path to the new package to be created (terminating in the package name).
\item \texttt{fields, rstudio, open} \hspace{5em} Same as \texttt{usethis::create_package()}. See the documentation for that function, especially the note in the Description section about the side effect of changing the active project.
\item \texttt{stan_files} \hspace{5em} A character vector with paths to .stan files to include in the package.
\item \texttt{roxygen} \hspace{5em} Should \texttt{roxygen2} be used for documentation? Defaults to \texttt{TRUE}. If so, a file \texttt{R/pkgnames-package.R} is added to the package with roxygen tags for the required import lines. See the Note section below for advice specific to the latest versions of \texttt{roxygen2}.
\item \texttt{travis} \hspace{5em} Should a .travis.yml file be added to the package directory? Defaults to \texttt{TRUE}. While the file contains some presets to help with compilation issues, at present it is not guaranteed to work on \texttt{travis-ci} without manual adjustments.
\item \texttt{license} \hspace{5em} Logical or character; whether or not to paste the contents of a license.stan file at the top of all Stan code, or path to such a file. If \texttt{TRUE} (the default) adds the GPL (\texttt{>= 3}) license (see Details).
\item \texttt{auto_config} \hspace{5em} Whether to automatically configure Stan functionality whenever the package gets installed (see Details). Defaults to \texttt{TRUE}.
\end{itemize}
Details

This function first creates a regular R package using `usethis::create_package()`, then adds the infrastructure required to compile and export `stanmodel` objects. In the package root directory, the user's Stan source code is located in:

```
inst/
   |_stan/
      | |_include/
      |__include/
```

All `.stan` files containing instructions to build a `stanmodel` object must be placed in `inst/stan`. Other `.stan` files go in any `stan/` subdirectory, to be invoked by Stan’s `#include` mechanism, e.g.,

```r
#include "include/mylib.stan"
#include "data/preprocess.stan"
```

See `rstanarm` for many examples.

The folder `inst/include` is for all user C++ files associated with the Stan programs. In this folder, the only file to directly interact with the Stan C++ library is `stan_meta_header.hpp`; all other `#include` directives must be channeled through here.

The final step of the package creation is to invoke `rstan_config()`, which creates the following files for interfacing with Stan objects from R:

- `src` contains the `stan_ModelName{.cc/.hpp}` pairs associated with all `ModelName.stan` files in `inst/stan` which define `stanmodel` objects.
- `src/Makevars[.win]` which link to the StanHeaders and Boost (BH) libraries.
- `R/stanmodels.R` loads the C++ modules containing the `stanmodel` class definitions, and assigns an R instance of each `stanmodel` object to a `stanmodels` list (with names corresponding to the names of the Stan files).

When `auto_config = TRUE`, a `configure[.win]` file is added to the package, calling `rstan_config()` whenever the package is installed. Consequently, the package must list `rstantools` in the DESCRIPTION Imports field for this mechanism to work. Setting `auto_config = FALSE` removes the package’s dependency on `rstantools`, but the package then must be manually configured by running `rstan_config()` whenever `stanmodel` files in `inst/stan` are added, removed, or modified.

In order to enable Stan functionality, `rstantools` copies some files to your package. Since these files are licensed as GPL

= 3, the same license applies to your package should you choose to distribute it. Even if you don’t use `rstantools` to create your package, it is likely that you will be linking to `Repp` to export the Stan C++ `stanmodel` objects to R. Since `Repp` is released under GPL >= 2, the same license would apply to your package upon distribution.

Authors willing to license their Stan programs of general interest under the GPL are invited to contribute their `.stan` files and supporting R code to the `rstanarm` package.
Using the pre-compiled Stan programs in your package

The stanmodel objects corresponding to the Stan programs included with your package are stored in a list called stanmodels. To run one of the Stan programs from within an R function in your package just pass the appropriate element of the stanmodels list to one of the rstan functions for model fitting (e.g., sampling()). For example, for a Stan program "foo.stan" you would use rstan::sampling(stanmodels$foo,...).

Note

For devtools users, because of changes in the latest versions of roxygen2 it may be necessary to run pkgbuild::compile_dll() once before devtools::document() will work.

See Also

- use_rstan() for adding Stan functionality to an existing R package and rstan_config() for updating an existing package when its Stan files are changed.
- The rstanarm package repository on GitHub.
- Guidelines and recommendations for developers of R packages interfacing with Stan and a demonstration getting a simple package working can be found in the vignettes included with rstantools and at mc-stan.org/rstantools/articles.
- After reading the guidelines for developers, if you have trouble setting up your package let us know on the the Stan Forums or at the rstantools GitHub issue tracker.
- The useR2016 presentation How to Use (R)Stan to Estimate Models in External R Packages.

use_rstan

Add Stan infrastructure to an existing package

Description

Add Stan infrastructure to an existing R package. To create a new package containing Stan programs use rstan_create_package() instead.

Usage

use_rstan(pkgdir = ".", license = TRUE, auto_config = TRUE)

Arguments

pkgdir Path to package root folder.
license Logical or character; whether or not to paste the contents of a license.stan file at the top of all Stan code, or path to such a file. If TRUE (the default) adds the GPL (>= 3) license (see Details).
auto_config Whether to automatically configure Stan functionality whenever the package gets installed (see Details). Defaults to TRUE.
Details

Prepares a package to compile and use Stan code by performing the following steps:

1. Create inst/stan folder where all .stan files defining Stan models should be stored.
2. Create inst/stan/include where optional license.stan file is stored.
3. Create inst/include/stan_meta_header.hpp to include optional header files used by Stan code.
4. Create src folder (if it doesn’t exist) to contain the Stan C++ code.
5. Create R folder (if it doesn’t exist) to contain wrapper code to expose Stan C++ classes to R.
6. Update DESCRIPTION file to contain all needed dependencies to compile Stan C++ code.
7. If NAMESPACE file is generic (i.e., created by rstan_create_package()), append import(Rcpp,methods), importFrom(rstan,sampling), and useDynLib directives. If NAMESPACE is not generic, display message telling user what to add to NAMESPACE for themselves.

When auto_config = TRUE, a configure[.win] file is added to the package, calling rstan_config() whenever the package is installed. Consequently, the package must list rstantools in the DESCRIPTION Imports field for this mechanism to work. Setting auto_config = FALSE removes the package’s dependency on rstantools, but the package then must be manually configured by running rstan_config() whenever stanmodel files in inst/stan are added, removed, or modified.

Value

Invisibly, TRUE or FALSE indicating whether or not any files or folders where created or modified.

Using the pre-compiled Stan programs in your package

The stanmodel objects corresponding to the Stan programs included with your package are stored in a list called stanmodels. To run one of the Stan programs from within an R function in your package just pass the appropriate element of the stanmodels list to one of the rstan functions for model fitting (e.g., sampling()). For example, for a Stan program "foo.stan" you would use rstan::sampling(stanmodels$foo,...).
Index

bayes_R2, 3
init_cpp, 4
log_lik, 4
loo-prediction, 5
loo_linpred (loo-prediction), 5
loo_pit (loo-prediction), 5
loo_predict (loo-prediction), 5
loo_predictive_interval (loo-prediction), 5
loo_R2 (bayes_R2), 3
nsamples, 6
posterior_interval, 6
posterior_linpred, 7
posterior_predict, 8
predictive_error, 9
predictive_interval, 10
predictive_interval(), 6
prior_summary, 11
Rcpp, 14
rstan_config, 12
rstan_config(), 14–16
rstan_create_package, 13
rstan_create_package(), 2, 15, 16
rstan_package_skeleton (rstan_create_package), 13
rstantools, 14
rstantools (rstantools-package), 2
rstantools-package, 2
stats::logLik(), 4
use_rstan, 15
use_rstan(), 15
usethis::create_package(), 13