Package 'tsbridge'

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Type Package

Title Calculate normalising constants for Bayesian time series models.

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Description The tsbridge package contains a collection of R functions that can be used to estimate normalising constants using the bridge sampler of Meng and Wong (1996). The functions can be applied to calculate posterior model probabilities for a variety of time series Bayesian models, where parameters are estimated using BUGS, and models themselves are created using the tsbugs package.

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`tsbridge-package` *Calculated normalising constants for Bayesian time series models*

Description

The tsbridge package contains a collection of R functions that can be used to estimate normalising constants using the bridge sampler of Meng and Wong (1996). The functions can be applied to calculate posterior model probabilities for a variety of time series Bayesian models, where parameters are estimated using BUGS, and models themselves are created using the tsbugs package.

Details

Package:	tsbridge
Type:	Package
Version:	1.0
Date:	2013-10-07
License:	GPL-2

Author(s)

Guy J. Abel and Jackie S. T. Wong

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References

Abel, G.J., Bijak, J., Forster, J.J., Raymer J., Smith P.W.F. and Wong, J.S.T. (2013) Integrating uncertainty in time series population forecasts: An illustration using a simple projection model. *Demographic Research*. 29 43 1187-1226 doi:10.4054/DemRes.2013.29.43

Meng, X.-L., & Wong, W. H. (1996). Simulating Ratios of Normalizing Constants via a Simple Identity: A Theoretical Exploration. *Statistica Sinica*, 6, 831-860.

Blog posts with some additional details of the implementation of functions in the package can be found at: http://gjabel.wordpress.com/category/r/tsbridge/

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

`bridge` *Bridge Function to Obtain Normalising Constant*

Description

Returns the normalising constant, given posterior model densities, q1(.), normalised densities, q2(.) and their ratios, l(.), from both unnormailised (`w1`) and normalised samples (`w2`) of parameter values. All three of these input measures can be obtained from each sample using the `q1q2l` function.

Usage

```
bridge(w1, w2, r0, tol, verbose = FALSE)
```

Arguments

`w1`	A `data.frame` generated from `q1q2l` using simulations from an unnormalised probability density function. Should have three columns with values named `q1` (for the posterior model density function), `q2` (for the normalised probability density function) and `l` (the ratio of `q1` and `q2`).
`w2`	A `data.frame` generated from `q1q2l` using simulations from an normalised probability density function. Should have three columns with values named `q1` (for the posterior model density function), `q2` (for the normalised probability density function) and `l` (the ratio of `q1` and `q2`).
`r0`	Starting value for the calculation of the normalising constant.
`tol`	Tolerance level for convergence.
`verbose`	Print sample sizes of `w1` and `w2` (s_1 and s_2 in Meng and Wong (1996)).

Details

Provides an iterative solution to estimate the normalising constant, following equation (4.1) in Meng and Wong (1996). We adapted their equation slightly to deal with overflow (exponentiating large numbers).

Value

See Details.

Note

Adaption for overflow based on method suggested by Jon Forster.

Author(s)

Guy J. Abel

References

Abel, G.J., Bijak, J., Forster, J.J., Raymer J., Smith P.W.F. and Wong, J.S.T. (2013) Integrating uncertainty in time series population forecasts: An illustration using a simple projection model. *Demographic Research*. 29 43 1187-1226 doi:10.4054/DemRes.2013.29.43

Meng, X.-L., & Wong, W. H. (1996). Simulating Ratios of Normalizing Constants via a Simple Identity: A Theoretical Exploration. *Statistica Sinica*, 6, 831-860.

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

`dcvts` *Posterior Density of Constant Variance, Stochastic Volatility and Random Variance Shift Time Series Model.*

Description

This function is intended for internal use only. It calculates the posterior density of a constant variance, stochastic volatility or random variance shift time series model given a set of sample of parameter values.

Usage

```
dcvts(bug, sims, ymean, hmean = NULL, iter = NULL)
dsvts(bug, sims, ymean, hmean = NULL, iter = NULL)
drvts(bug, sims, ymean, hmean = NULL, iter = NULL)
```

Arguments

bug	A BUGS model created in the tsbugs package.
sims	A data.frame of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
ymean	A data.frame of mean values for response y, the fitted mean process. Columns represent time and rows represent simulations.
hmean	A data.frame of mean values for h, the fitted volatility process. Columns represent time and rows represent simulations. This argument is not used for dcvts.
iter	Prints the contributions of each iteration (simulation) number to the density calculation. By default is set to NULL, hence no values are printed.

Author(s)

Guy J. Abel and Jackie Wong Siaw Tze

See Also

q1q2l

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dmvnb — *Density Function for Multivariate Normal-Binary Distribution for Use With RV-Shift Models*

Description

This function is intended for internal use only. It calculates the density function of a mixed multivariate normal-binary distribution for use in the q1q2l.

Usage

```
dmvnb(bug, sims, MU, COV, P)
```

Arguments

bug	A BUGS model created in the tsbugs package.
sims	A data.frame of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
MU	A vector of the mean parameter values (over a simulated data set)
COV	A matrix of parameter variance-covariances (over a simulated data set)
P	A data.frame of model fits for each binary parameter, used in the simulation of equivalent parameters from a normalised density. Rows represent simulation number, and columns binary parameters.

Note

Function based on method suggested by Jon Forster.

Author(s)

Guy J. Abel and Jackie Wong Siaw Tze

`h.fit` *Fitted Volatility Series from Simulated Parameters*

Description

Returns fitted volatility series for each set of simulated parameter values used in the calculation of the log-likelihood. Will only operate for simulations from BUGS models with either stochastic volatility or a random variance shift created in the tsbugs package.

Usage

```
h.fit(bug, sims, pre.beg = FALSE)
```

Arguments

`bug`	A BUGS model created in the tsbugs package.
`sims`	A `data.frame` of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
`pre.beg`	Logical value to include or exclude `NA` outputs in time periods (columns) before the starting value for which data are considered in the likelihood of the BUGS model. The number of columns will be dependent on the value of the `bug` argument used when setting up the BUGS model using the tsbugs package. By default this argument is `FALSE`, i.e. there are no columns of missing values returned.

Value

A `data.frame` where rows represent simulations and columns time.

Author(s)

Guy J. Abel

See Also

`y.fit`, `tslogl`

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

`q1q2l` *Calculate Posterior Model Density, q1(.), Normalised Density, q2(.), and their Ratio, l(.)*

Description

Calculates the posterior model density, q1(.), normalised density, q2(.), and their ratio, l(.), for a set of simulated parameters.

Usage

```
q1q2l(bug, sims, ymean, hmean = NULL, MU, COV, P = NULL)
```

Arguments

`bug`	A BUGS model created in the tsbugs package.
`sims`	A `data.frame` of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
`ymean`	A `data.frame` of mean values for y, the fitted mean process. Columns represent time and rows represent simulations.
`hmean`	A `data.frame` of mean values for h, the fitted volatility process. Columns represent time and rows represent simulations. This argument is not used.
`MU`	A vector of the mean parameter values (over a simulated data set)
`COV`	A matrix of parameter variance-covariances (over a simulated data set)
`P`	A `data.frame` of model fits for each binary parameter, used in the simulation of equivalent parameters from a normalised density. Rows represent simulation number, and columns binary parameters. Only necessary for random variance shift models.

Details

Returns a `data.frame` with three columns. The first column returns q1(.), the second q2(.) and third l(.) for a given set of simulations. Will only operate for simulations from BUGS models with either constant variance, stochastic volatility or a random variance shift created in the tsbugs package. This function is intended to be run twice in order to obtain 1) q1(w1) and q2(w1) based on a unnormalised MCMC simulation (w1) and 2) q1(w2) and q2(w2) based on a simulations from a normalised density (w2).

Values of q1 are based on posterior model densities calculated in either the dcvts, dsvts or drvts. Values of q2 are based on densities of a multivariate normal distribution (using MU and COV in the dmvnorm function of the mvtnorm package) when the BUGS model (bug) has a constant variance or stochastic volatility component. When BUGS model has a random variance shift component, the q2 density is estimated using the dmvnb function.

The data.frame outputs can be directly used as input into the bridge function to obtain estimates of normalising constants.

Value

A data.frame with columns:

q1	Unnormalised Density.
q2	Normalised Density.
l	Ratio of q1 and q2.

Author(s)

Guy J. Abel

References

Abel, G.J., Bijak, J., Forster, J.J., Raymer J., Smith P.W.F. and Wong, J.S.T. (2013) Integrating uncertainty in time series population forecasts: An illustration using a simple projection model. *Demographic Research*. 29 43 1187-1226 doi:10.4054/DemRes.2013.29.43

Alan Genz, Frank Bretz, Tetsuhisa Miwa, Xuefei Mi, Friedrich Leisch, Fabian Scheipl, Torsten Hothorn (2012). mvtnorm: Multivariate Normal and t Distributions. R package version 0.9-9994. http://CRAN.R-project.org/package=mvtnorm

Meng, X.-L., & Wong, W. H. (1996). Simulating Ratios of Normalizing Constants via a Simple Identity: A Theoretical Exploration. *Statistica Sinica*, 6, 831-860.

See Also

dcvts, dsvts, drvts, dmvnb, dmvnorm, bridge

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

rescale *Rescale Values to and from Whole Real Number Line*

Description

Returns simulated parameters with transformations to or from the real whole number line. Parameters to transform are dependent on their specification of their prior distributions in the BUGS model.

Usage

```
rescale(bug, sims, to.real = NULL)
```

Arguments

bug	A BUGS model created in the tsbugs package.
sims	A data.frame of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
to.real	Set to TRUE or FALSE to indicate if parameters need to be scaled to the real number line or reversed scaled from the real number line back to their original parameter space.

Details

For parameters from a Gamma prior distributions in a BUGS model, a logarithmic transformation is used to convert values onto the real number line to.real=TRUE and the exponential transformation to convert vales back to their original parameter space to.real=FALSE

For parameters from Uniform and Beta prior distributions in a BUGS model, a reverse-logistic transformation is used to convert values onto the real number line to.real=TRUE and a logistic transformation to convert vales back to their original parameter space to.real=FALSE.

This function was written with the intention of reducing code when in calculating the normalising constant, in particular when 1) finding the appropiate summary statistics to simulate a candidate normalised distribution from and 2) transforming simulated values to the same scales as the orginal MCMC simulations for later use.

Value

A data.frame with the same dimensions as the sims argument.

Author(s)

Guy J. Abel

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

`theta.it` *Convert Parameter Data Frame to List*

Description

This function is intended for internal use only. It collates the parameters for a single model into one `list`, given the BUGS model and the paramter simulations in a data frame.

Usage

```
theta.it(bug, sims, max.phi = 8, max.psi = 1)
```

Arguments

`bug`	A BUGS model created in the tsbugs package.
`sims`	A `data.frame` of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
`max.phi`	Maximum number of `phi` autoregressive parameters in the mean structure.
`max.psi`	Maximum number of `psi` autoregressive parameters in the variance structure. Will be ignored if bug is not a stochastic volatility model.

Details

Returns model parameters as a list for easy manipulation in other functions.

Author(s)

Guy J. Abel

tslogl *Log-Likelihood of Time Series Model.*

Description

This function is intended for internal use only. It calculates the log-likelihood function of a time series of normally distributed data for use in the q1q2l (via dcvts, dsvts or drvts)

Usage

```
tslogl(bug, ymean, sigma)
```

Arguments

bug	A BUGS model created in the tsbugs package.
ymean	Mean value of y over time for each set of simulated parameter values.
sigma	Standard deviation of y over time for each set of simulated parameter values.

Author(s)

Guy J. Abel

See Also

q1q2l, dcvts, dsvts,drvts

y.fit *Fitted Time Series from Simulated Parameters*

Description

Returns fitted time series for each set of simulated parameter values used in the calculation of the log-likelihood.

Usage

```
y.fit(bug, sims, ysim = NULL, pre.beg = FALSE)
```

Arguments

bug	A BUGS model created in the tsbugs package.
sims	A data.frame of simulated parameter values with column names labelled according to output from the R2OpenBUGS package.
ysim	A data.frame of simulated y values with column names labelled according to output from the R2OpenBUGS package.
pre.beg	Logical value to include or exclude NA outputs in time periods (columns) before the starting value for which data are considered in the likelihood of the BUGS model. The number of columns will be dependent on the value of the bug argument used when setting up the BUGS model using the tsbugs package. By default this argument is FALSE, i.e. there are no columns of missing values returned.

Details

Returns mean series for each set of simulated parameter values. When y, the observed time series contains missing values, users need to supply a data frame of simulated y values for ysim. This will allow the calculation of mean values for y in the presence of missing data.

Value

A data.frame where rows are simulations and columns are time.

Note

The suggestion of the use of ysim to account for missing values was taken from discussion on Cross Validated: http://stats.stackexchange.com/questions/47877/calculating-the-likelihood-of-time-series-d

Author(s)

Guy J. Abel

See Also

h.fit, tslogl

Examples

```
## Not run:
# demo example with constant variance models for differenced growth rate
# of England and Wales population as used in Abel et. al. (2013)
demo("cv_bma", "tsbridge")

## End(Not run)
```

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