

# Package ‘boa’

May 7, 2026

**Version** 1.1.8-2

**Date** 2016-06-22

**Title** Bayesian Output Analysis Program (BOA) for MCMC

**Maintainer** Brian J. Smith <brian-j-smith@uiowa.edu>

**Depends** R (>= 2.7)

**Imports** graphics, grDevices, stats, utils

**Description** A menu-driven program and library of functions for carrying out convergence diagnostics and statistical and graphical analysis of Markov chain Monte Carlo sampling output.

**License** GPL-2

**URL** <http://www.jstatsoft.org/v21/i11>

**NeedsCompilation** no

**Author** Brian J. Smith [aut, cre]

**Repository** CRAN

**Date/Publication** 2016-06-23 01:29:05

## Contents

boa.acf . . . . .	2
boa.chain . . . . .	3
boa.chain.add . . . . .	4
boa.chain.collapse . . . . .	5
boa.chain.del . . . . .	6
boa.chain.eval . . . . .	6
boa.chain.gandr . . . . .	7
boa.chain.import . . . . .	8
boa.chain.info . . . . .	9
boa.chain.reset . . . . .	10
boa.chain.subset . . . . .	10
boa.chain.support . . . . .	11
boa.geweke . . . . .	12

boa.handw . . . . .	13
boa.hpd . . . . .	14
boa.importASCII . . . . .	14
boa.importBUGS . . . . .	15
boa.importMatrix . . . . .	16
boa.init . . . . .	17
boa.load . . . . .	17
boa.menu . . . . .	18
boa.par . . . . .	19
boa.plot . . . . .	21
boa.plot.acf . . . . .	22
boa.plot.bandg . . . . .	23
boa.plot.density . . . . .	24
boa.plot.gandr . . . . .	25
boa.plot.geweke . . . . .	26
boa.plot.history . . . . .	27
boa.plot.par . . . . .	27
boa.plot.title . . . . .	28
boa.plot.trace . . . . .	28
boa.print.acf . . . . .	29
boa.print.cor . . . . .	29
boa.print.gandr . . . . .	30
boa.print.geweke . . . . .	30
boa.print.handw . . . . .	31
boa.print.hpd . . . . .	31
boa.print.info . . . . .	32
boa.print.par . . . . .	33
boa.print.randl . . . . .	33
boa.print.stats . . . . .	34
boa.quit . . . . .	35
boa.randl . . . . .	35
boa.save . . . . .	36
boa.stats . . . . .	37
line . . . . .	38
<b>Index</b>	<b>39</b>

---

boa.acf	<i>Autocorrelation Function</i>
---------	---------------------------------

---

### Description

Computes lag autocorrelations for the parameters in an MCMC sequence.

### Usage

```
boa.acf(link, lags)
```

**Arguments**

link	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code>
lags	Vector of lags at which to estimate the autocorrelation function.

**Value**

A matrix whose columns and rows contain the estimated autocorrelation functions at the specified lags and the monitored parameters, respectively.

**Author(s)**

Brian J. Smith

**See Also**

[boa.plot](#), [boa.plot.acf](#), [boa.print.acf](#)

---

 boa.chain

*Session Lists of MCMC Sequences*


---

**Description**

Extracts and sets the MCMC sequence(s) stored internally for use during a BOA session. Users can safely use this function to extract data. However, it should not be called directly to modify the stored MCMC sequence(s). Instead, data management should be accomplished with the `libboa.chain` functions.

**Usage**

```
boa.chain(...)
```

**Arguments**

... A list may be given as the only argument, or a character string given as the only argument, or any number of arguments may be in the `<name> = <value>` form, or no argument at all may be given. See the Value and Side Effects sections for further details.

**Value**

If no arguments are supplied, a list of the current values is returned. If a character string is given, the current value of the named variable is returned. Otherwise, no values are returned.

### Parameter Names and Default Values

**master = list()** Master list containing all added MCMC sequences. Sequences may only be added to or deleted from the master list. The sequences in this list are never modified or used in any of the analyses. It serves as a template for the working list described below. The parameters and iterations may differ between the sequences. Each element in the list is a matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names are stored in the dimnames.

**master.support = list()** List containing the support for each of the parameters in 'master'. Each element in the list is a matrix whose columns and rows contain the monitored parameters and the support (lower and upper limits), respectively. The default for each parameter is c(-Inf, Inf).

**work = master** Working list used in all analyses. This list is essentially a modifiable copy of 'master'. All data management functions operate on the working list.

**work.support = master.support** List containing the support for each of the parameters in 'work'.

**work.sync = TRUE** Logical value indicating that the working list is an identical copy of the master list. This variable is automatically set to F after a successful call to [boa.chain.subset](#) or [boa.chain.collapse](#). While `work.sync = F`, only the master list will be updated if MCMC sequences are added or deleted. A call to [boa.chain.reset](#) will reset this variable to T and copy the master list to the working list.

### Side Effects

When variables are set, `boa.chain()` modifies the internal list `.boa.chain`. If `boa.chain()` is called with either a list as the single argument, or with one or more arguments in the `<name> = <value>` form, the variables specified by the names in the arguments are modified.

### Author(s)

Brian J. Smith

---

<code>boa.chain.add</code>	<i>Add MCMC Sequence</i>
----------------------------	--------------------------

---

### Description

Adds an MCMC sequence to the session lists of sequences. Most users should not call this function directly. Passing improperly formatted data to this function will most likely break the functions in this library. The preferred method of adding a new sequence is to call the function [boa.chain.import](#).

### Usage

```
boa.chain.add(link, lname)
```

**Arguments**

link	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code> .
lname	Character string giving the list name to use for the newly added MCMC sequence.

**Value**

A logical value indicating that 'link' has been successfully added.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.import](#)

---

boa.chain.collapse      *Concatenate MCMC Sequences*

---

**Description**

Concatenates together all of the MCMC sequences in the working session list of sequences. Only those parameters common to all sequences are kept.

**Usage**

```
boa.chain.collapse()
```

**Value**

A logical value indicating that the MCMC sequences have been collapsed. If the sequences share no common parameters, no modifications are made to the working list and FALSE is returned.

**Author(s)**

Brian J. Smith

**See Also**

[codeboa.chain.reset](#), [codeboa.chain.subset](#)

---

boa.chain.del      *Delete MCMC Sequences*

---

**Description**

Delete MCMC sequences from the session list of sequences.

**Usage**

```
boa.chain.del(lnames, pnames)
```

**Arguments**

lnames	Character vector giving the names of the MCMC sequences in the session list of sequences to be deleted. If omitted, no sequences are deleted.
pnames	Character vector giving the names of the parameters in the MCMC sequences to be deleted. If omitted, no parameters are deleted.

**Side Effects**

The specified MCMC sequences are deleted from the session lists of sequences.

**Author(s)**

Brian J. Smith

---

boa.chain.eval      *Formulate New Parameter*

---

**Description**

Evaluates a user-specified expression to formulate a new parameter in each of the system lists of MCMC sequences.

**Usage**

```
boa.chain.eval(expr, pname)
```

**Arguments**

expr	S expression object used to formulate the new parameter. Typically, the new parameter is a function of the existing parameters.
pname	Name given to the new parameter.

**Side Effects**

The specified parameter is added to the session lists of MCMC sequences.

**Author(s)**

Brian J. Smith

---

 boa.chain.gandr

*Gelman and Rubin Convergence Diagnostics*


---

**Description**

Computes the Gelman and Rubin convergence diagnostics for a list of MCMC sequences. Estimates are calculated from the second half of each sequence.

**Usage**

```
boa.chain.gandr(chain, chain.support, alpha, pnames, window, to)
```

**Arguments**

chain	List of matrices whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to the dimnames.
chain.support	List of matrices whose columns and rows contain the monitored parameters and the support (lower and upper limits), respectively.
alpha	Quantile $(1 - \alpha / 2)$ at which to estimate the upper limit of the shrink factor.
pnames	Character vector giving the names of the parameters to use in the analysis. If omitted, all parameters are used.
window	Proportion of iterations to include in the analysis. If omitted, 50% are included.
to	Largest iteration to include in the analysis. If omitted, no upper bound is set.

**Value**

psrf	A vector containing the Gelman and Rubin (uncorrected) potential scale reduction factors for the monitored parameters.
csrf	A matrix whose columns and rows are the Gelman and Rubin corrected scale reduction factors (i.e. shrink factor estimates at the median and specified quantile of the sampling distribution) and the monitored parameters, respectively. A correction of $(df + 3) / (df + 1)$ is applied to the scale reduction factors.
mpsr	A numeric value giving the multivariate potential scale reduction factor proposed by Brooks and Gelman.
window	A numeric vector with two elements giving the range of the iterations used in the analysis.

**Author(s)**

Brian J. Smith, Nicky Best, Kate Cowles

**References**

1. Brooks, S. and Gelman, A. (1998). General methods for monitoring convergence of iterative simulations. *Journal of Computational and Graphical Statistics*, 7(4), 434-55.
2. Gelman, A. and Rubin, D. B. (1992). Inference from iterative simulation using multiple sequences. *Statistical Science*, 7, 457-72.

**See Also**

[boa.plot](#), [boa.plot.bandg](#), [boa.plot.gandr](#), [boa.print.gandr](#)

---

boa.chain.import      *Import MCMC Sequence*

---

**Description**

Reads an MCMC sequence from an external file and adds it to the session lists of sequences.

**Usage**

```
boa.chain.import(prefix, path = boa.par("path"), type = "ASCII")
```

**Arguments**

prefix	Character string giving the prefix for the file(s) in which the MCMC sequence is stored.
path	Character string giving the directory path in which the file(s) subsides.
type	Character string specifying the type of data to be imported. Currently, the supported types are: <ul style="list-style-type: none"><li>• "ASCII" : ASCII text file. Calls <a href="#">boa.importASCII</a> to import data from "prefix.txt".</li><li>• "BUGS" : BUGS output files. Calls <a href="#">boa.importBUGS</a> to import data from "prefix.ind" and "prefix.out".</li><li>• "S" : S data frame or matrix.</li></ul>

**Value**

A logical value indicating that the specified file(s) has been successfully imported.

**Side Effects**

The imported MCMC sequence is automatically added to the session lists of sequences via a call to [boa.chain.add](#).

**Author(s)**

Brian J. Smith

**See Also**[boa.chain.add](#), [boa.importASCII](#), [boa.importBUGS](#)

---

`boa.chain.info`*Information about MCMC Sequences*

---

**Description**

Returns summary information from a list of MCMC sequences.

**Usage**`boa.chain.info(chain, chain.support)`**Arguments**

<code>chain</code>	List of matrices whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to the <code>dimnames</code> .
<code>chain.support</code>	List of matrices whose columns and rows contain the monitored parameters and the support (lower and upper limits), respectively.

**Value**

<code>lnames</code>	Character vector giving the names of the MCMC sequences in the session list of sequences.
<code>pnames</code>	List of character vectors giving the parameter names in each of the MCMC sequences.
<code>iter</code>	List of numeric vectors giving the iterations from each MCMC sequence.
<code>iter.range</code>	Matrix whose columns give the range of the iterations for the MCMC sequences named in the rows.
<code>support</code>	List of numeric vectors giving the support for the parameters in each of the MCMC sequences.

**Author(s)**

Brian J. Smith

**See Also**[boa.print.info](#)

---

boa.chain.reset	<i>Reset MCMC Sequences</i>
-----------------	-----------------------------

---

**Description**

Returns the data in the working list of MCMC sequences to the state it was in when originally imported. This function undoes any subsetting or collapsing that was done via the [boa.chain.collapse](#) or [boa.chain.subset](#) functions.

**Usage**

```
boa.chain.reset()
```

**Side Effects**

Returns the data in the working list of MCMC sequences to the state it was in when originally imported. This function undoes any subsetting or collapsing that was done via the [boa.chain.collapse](#) or [boa.chain.subset](#) functions.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.collapse](#), [boa.chain.subset](#)

---

boa.chain.subset	<i>Subset MCMC Sequences</i>
------------------	------------------------------

---

**Description**

Selects a subset of the MCMC sequences stored in the working session list of sequences.

**Usage**

```
boa.chain.subset(lnames, pnames, iter)
```

**Arguments**

lnames	Character vector giving the names of the MCMC sequences to include in the subset. If omitted, all sequences are included.
pnames	Character vector giving the names of the parameters to include in the subset. If omitted, all parameters are included.
iter	Character vector giving the names of the parameters to include in the subset. If omitted, all parameters are included.

**Value**

A logical value indicating that the data has been successfully subsetted. If the requested subset contains no data, the working session list is not modified and FALSE is returned.

**Side Effects**

The subsetted data, if not an empty set, is copied to the working session list of MCMC sequences used in all analyses.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.collapse](#), [boa.chain.reset](#)

---

boa.chain.support      *Set Support for Parameters*

---

**Description**

Modifies the support (range of possible values) for the parameters in the session lists of MCMC sequences.

**Usage**

```
boa.chain.support(lnames, pnames, limits)
```

**Arguments**

lnames	Character vector giving the names of the MCMC sequences over which to apply the changes. If omitted, changes are applied to all sequences.
pnames	Character vector giving the names of the parameters whose support is to be modified.
limits	Numeric vector with two elements giving the lower and upper limits, respectively, of the support for the specified parameters. Unbounded lower or upper limits should be specified as -Inf or Inf, respectively.

**Value**

A logical vector with two elements indicating that the support has been changed for variables in the master list and working list of MCMC sequences, respectively.

**Side Effects**

The support for each of the specified parameters is changed in the session lists of MCMC sequences.

**Author(s)**

Brian J. Smith

---

`boa.geweke`*Geweke Convergence Diagnostics*

---

**Description**

Computes the Geweke convergence diagnostics for the parameters in an MCMC sequence.

**Usage**

```
boa.geweke(link, p.first, p.last)
```

**Arguments**

<code>link</code>	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code> .
<code>p.first</code>	Proportion of iterations to include in the first window.
<code>p.last</code>	Proportion of iterations to include in the last window.

**Value**

A matrix whose columns contain the Z-Scores and associated p-values and whose rows contain the monitored parameters.

**Author(s)**

Brian J. Smith

**References**

Geweke, J. (1992). Evaluating the accuracy of sampling-based approaches to calculating posterior moments. In Bayesian Statistics 4, (ed. J. M. Bernardo, J. O. Berger, A. P. Dawid, and A. F. M. Smith). Clarendon Press, Oxford, UK.

**See Also**

[boa.plot](#), [boa.plot.geweke](#), [boa.print.geweke](#)

---

`boa.handw`*Heidelberger and Welch Convergence Diagnostics*

---

**Description**

Computes the Heidelberger and Welch convergence diagnostics for the parameters in an MCMC sequence.

**Usage**

```
boa.handw(link, error, alpha)
```

**Arguments**

<code>link</code>	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code> .
<code>error</code>	Accuracy of the posterior estimates for the parameters.
<code>alpha</code>	Alpha level for the confidence in the sample mean of the retained iterations.

**Value**

A matrix whose columns and rows are the Heidelberger and Welch convergence diagnostics (i.e. stationarity test, number of iterations to keep and to drop, Cramer-von-Mises statistic, halfwidth test, mean, and halfwidth) and the monitored parameters, respectively.

**Author(s)**

Brian J. Smith, Nicky Best, Kate Cowles

**References**

Heidelberger, P. and Welch, P. (1983). Simulation run length control in the presence of an initial transient. *Operations Research*, 31, 1109-44.

**See Also**

[boa.print.handw](#)

---

boa.hpd	<i>Highest Probability Density Interval</i>
---------	---

---

**Description**

Estimates the highest probability density (HPD) interval for the given parameter draws. Uses the Chen and Shao algorithm assuming a unimodal marginal posterior distribution.

**Usage**

```
boa.hpd(x, alpha)
```

**Arguments**

x	MCMC draws from the marginal posterior to use in computing the HPD.
alpha	Specifies the 100*(1 - alpha)% interval to compute.

**Value**

A vector containing the lower and upper bound of the HPD interval, labeled "Lower Bound" and "Upper Bound", respectively.

**Author(s)**

Brian J. Smith

**References**

Chen, M-H. and Shao, Q-M. (1999). Monte Carlo estimation of Bayesian credible and HPD intervals. *Journal of Computational and Graphical Statistics*, 8(1), 69-92.

---

boa.importASCII	<i>Import ASCII Data</i>
-----------------	--------------------------

---

**Description**

Import data from an ASCII text file. The variables and iterations should appear in the columns and rows, respectively, of the file. The variable names must be given in the first row. The iteration numbers are taken from the the column entitled "iter" (case-sensitive), if it exists; otherwise, the numbers 1..n are used, where n is the number of rows. The columns may be separated by white space or tabs.

**Usage**

```
boa.importASCII(prefix, path = NULL)
```

**Arguments**

prefix	Character string giving the prefix for the files in which the ASCII data is stored. <code>boa.importASCII()</code> looks for the file "prefix.txt".
path	Character string giving the directory path in which the file subsides. This argument may be omitted if the file is located in the current working directory. The specified path should not end with a slash(es).

**Value**

If the data is successfully imported, a matrix is returned whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names are stored in the `dimnames` of the returned matrix. Otherwise, `NULL` is returned.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.import](#), [boa.importBUGS](#), [boa.importMatrix](#)

---

<code>boa.importBUGS</code>	<i>Import BUGS Data</i>
-----------------------------	-------------------------

---

**Description**

Import data from BUGS output files.

**Usage**

```
boa.importBUGS(prefix, path = NULL)
```

**Arguments**

prefix	Character string giving the prefix for the files in which the BUGS output is stored. <code>boa.importBUGS()</code> looks for the two files "prefix.ind" and "prefix.out".
path	Character string giving the directory path in which the file subsides. This argument may be omitted if the file is located in the current working directory. The specified path should not end with a slash(es).

**Value**

If the data is successfully imported, a matrix is returned whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names are stored in the `dimnames` of the returned matrix. Otherwise, `NULL` is returned.

**Author(s)**

Brian J. Smith

**See Also**[boa.chain.import](#), [boa.importASCII](#), [boa.importMatrix](#)

---

boa.importMatrix	<i>Import ASCII Data</i>
------------------	--------------------------

---

**Description**

Import data from an S numeric matrix object. The variables and iterations should appear in the columns and rows, respectively, of the matrix. The variable names and iteration numbers may be optionally specified in the dimnames of the matrix object. Otherwise, the iterations will be numbered 1..n, where n is the number of rows.

**Usage**

```
boa.importMatrix(prefix)
```

**Arguments**

prefix            Character string giving the name of the S object.

**Value**

If the data is successfully imported, a matrix is returned whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names are stored in the dimnames of the returned matrix. Otherwise, NULL is returned.

**Author(s)**

Brian J. Smith

**See Also**[boa.chain.import](#), [boa.importASCII](#), [boa.importBUGS](#)

---

boa.init	<i>Start Session</i>
----------	----------------------

---

**Description**

boa.init() is the first function called to start a BOA session when using the command-line. It sets up the internal data structures and initializes them with the appropriate default values.

**Usage**

```
boa.init(recover = FALSE)
```

**Arguments**

recover	a logical value for use if the previous BOA menu session terminated unexpectedly. It may be possible to crash the menu system by supplying the wrong type of data. In the event of a crash, recover = TRUE may be used to ensure that no data is lost.
---------	--

**Author(s)**

Brian J. Smith

**See Also**

[boa.load](#), [boa.quit](#)

---

boa.load	<i>Load Session</i>
----------	---------------------

---

**Description**

Loads the data and global parameter settings from a previously saved BOA session.

**Usage**

```
boa.load(name, envir = globalenv())
```

**Arguments**

name	Character string giving the name of the object containing the session to be loaded.
envir	The 'environment' from which the object should come. For more information, consult the help documentation in R on the get function.

**Value**

A logical value indicating that the object was successfully loaded.

**Author(s)**

Brian J. Smith

---

boa.menu

*Interactive BOA Menu*

---

**Description**

Starts the interactive menu for BOA. Provides a menu-driven interface to all of the convergence diagnostics and statistical and graphical analysis tools.

**Usage**

```
boa.menu(recover = FALSE)
```

**Arguments**

recover	a logical value for use if the previous BOA menu session terminated unexpectedly. It may be possible to crash the menu system by supplying the wrong type of data. In the event of a crash, recover = TRUE may be used to ensure that no data is lost.
---------	--

**Warning**

Do not use the recover argument unless starting the menu immediately after a crash.

**Note**

boa.menu is the only function in the BOA library that need be called in order to use the menu-driven interface.

**Author(s)**

Brian J. Smith

**Examples**

```
## Not run:  
## Start the menu system  
boa.menu()  
  
## End(Not run)
```

---

 boa.par

*Global Parameters*


---

### Description

Displays and sets the global parameters stored internally for use during a BOA session.

### Usage

```
boa.par(...)
```

### Arguments

... A list may be given as the only argument, or a character string given as the only argument, or any number of arguments may be in the <name> = <value> form, or no argument at all may be given.

### Value

If no arguments are supplied, a list of the current values is returned. If a character string is given, the current value of the named variable is returned. Otherwise, a list of the named variables and their old values is returned, but not printed.

### Parameter Names and Default Values

**acf.lags = c(1, 5, 10, 50)** Numeric vector of lags at which to estimate the autocorrelation function.

**alpha = 0.05** Type I error rate used for all statistical tests and confidence intervals.

**ASCIIext = ".txt"** Character string giving the filename extension used when importing ASCII files.

**bandwidth = function(x) 0.5 \* diff(range(x)) / (log(length(x)) + 1)** Function for computing the bandwidth used in estimating the density functions for parameters. This should take one argument which is a numeric vector of data on which density estimation is to be performed. A constant bandwidth may be specified by having this function return the desired constant.

**batch.size = 50** Number of iterations to include in each batch when computing batch means and lag-1 batch autocorrelations. The batch size has the single largest impact on the time required to compute summary statistics. The computation time is decreased dramatically as the batch size increases. Consequently, users may want to increase the value of this variable for long MCMC sequences.

**dev = «see below»** Character string giving the name of the function that creates graphics windows on the current platform. For Unix systems this is either "motif", "openlook", or "X11". The default is "motif" for the UNIX S-PLUS, "win.graph" for Windows S-PLUS, "X11" for UNIX R, and "windows" for Windows R.

**dev.list = numeric(0)** Numeric vector containing the active graphics windows in use by the program. This is automatically maintained by the program, user should not directly modify this variable.

- gandr.bins = 20** Number of line segments within the MCMC sequence at which to plot the Gelman and Rubin shrink factors.
- gandr.win = 0.50** Proportion of iterations to include in the Brooks, Gelman, and Rubin Statistics.
- geweke.bins = 10** Number of line segments within the MCMC sequence at which to plot the Geweke convergence diagnostics.
- geweke.first = 0.1** Proportion of iterations to include in the first window when computing the Geweke convergence diagnostics.
- geweke.last = 0.5** Proportion of iterations to include in the last window when computing the Geweke convergence diagnostics.
- handw.error = 0.1** Accuracy of the posterior estimates when computing the Heidelberger and Welch convergence diagnostics.
- kernel = "gaussian"** Character string giving the type of window used in estimating the density functions for parameters. Other choices are "cosine", "rectangular", or "triangular".
- legend = TRUE** Logical value indicating that a legend be included in the plots.
- path = ""** Character string giving the directory path in which the raw data files are stored. The default may be used if the files are located in the current working directory. The specified path should not end with a slash(es).
- par = list()** List specifying graphics parameters passed to the par function for the construction of new plots.
- plot.mfdim = c(3, 2)** Numeric vector giving the maximum number of rows and columns, respectively, of plots to include in a single graphics window.
- plot.new = F** Logical value indicating that a new graphics window be automatically opened upon successive calls to boa.plot(). Otherwise, previous graphics windows will be closed.
- plot.onelink = FALSE** Logical value indicating that each plot should include only one MCMC sequence. Otherwise, all sequences are displayed on the same plot.
- quantiles = c(0.025, 0.5, 0.975)** Vector of probabilities at which to compute the quantiles. Values must be between 0 and 1.
- randl.error = 0.005** Desired amount of error in estimating the quantile specified in the Raftery and Lewis convergence diagnostics.
- randl.delta = 0.001** Delta valued used in computing the Raftery and Lewis convergence diagnostics.
- randl.q = 0.025** Quantile to be estimated in computing the Raftery and Lewis convergence diagnostics.
- title = TRUE** Logical value indicating that a title be added to the plots.

### Side Effects

When variables are set, boa.par() modifies the internal list .boa.par. If boa.par() is called with either a list as the single argument, or with one or more arguments in the <name> = <value> form, the variables specified by the names in the arguments are modified.

### Author(s)

Brian J. Smith

**Description**

Automatically generates the specified plot type for all parameters in the working session list of MCMC sequences. This function takes care of all the plotting tasks - opening windows, setting the number of plots per page, and adding titles.

**Usage**

```
boa.plot(type, dev = boa.par("dev"), mfdim = boa.par("plot.mfdim"),
newplot = boa.par("plot.new"), onelink = boa.par("plot.onelink"),
title = boa.par("title"))
```

**Arguments**

type	The type of plots to generate. The supported types are: <ul style="list-style-type: none"> <li>• "acf" = autocorrelation functions</li> <li>• "bandg" = Brooks and Gelman multivariate shrink factors</li> <li>• "density" = density functions</li> <li>• "gandr" = Gelman and Rubin shrink factors</li> <li>• "geweke" = Geweke convergence diagnostics</li> <li>• "history" = running means</li> <li>• "trace" = trace histories</li> </ul>
dev	Character string giving the name of the function that creates graphics windows on the current platform. For Unix systems this is either "motif", "openlook", or "X11". For windows, this should be set to "win.graph"
mfdim	Numeric vector giving the maximum number of rows and columns, respectively, of plots to include in a single graphics window. If only one graphics window is opened, 'mfdim' is proportionately scaled down so as to minimize the number of empty frames within that window.
newplot	Logical value indicating that a new graphics window be automatically opened. Otherwise, previous graphics windows will be closed.
onelink	Logical value indicating that each plot should include only one MCMC sequence. Otherwise, all sequences are displayed on the same plot.
title	Logical value indicating that a title be added to the plot.

**Value**

A logical value indicating that the plots were successfully created.

**Author(s)**

Brian J. Smith

**See Also**

[boa.plot.acf](#), [boa.plot.bandg](#), [boa.plot.density](#), [boa.plot.gandr](#), [boa.plot.geweke](#), [boa.plot.history](#), [boa.plot.trace](#)

---

boa.plot.acf

*Plot Autocorrelation Function*

---

**Description**

Creates a single plot of the lag autocorrelations for a specified parameter.

**Usage**

```
boa.plot.acf(lname, pname, annotate = boa.par("legend"))
```

**Arguments**

lname	Character string giving the name of the desired MCMC sequence in the working session list of sequences.
pname	Character string giving the name of the parameter to be plotted.
annotate	Logical value indicating that a legend be included in the plot.

**Value**

A logical value indicating that the plot was successfully created.

**Author(s)**

Brian J. Smith

**See Also**

[boa.acf](#), [boa.print.acf](#)

---

boa.plot.bandg      *Plot Brooks and Gelman Multivariate Shrink Factors*

---

## Description

Plots the Brooks and Gelman multivariate shrink factors within different line segments across the MCMC sequences. This diagnostic is a multivariate extension to the Gelman and Rubin shrink factors.

## Usage

```
boa.plot.bandg(bins = boa.par("gandr.bins"), win = boa.par("gandr.win"),  
annotate = boa.par("legend"))
```

## Arguments

bins	Number of line segments within the MCMC sequence at which to plot the Gelman and Rubin shrink factors. The first segment contains the first 50 iterations; the remaining iterations are partitioned into equal bins and added incrementally to construct the remaining line segments. The shrink factors are plotted against the maximum iteration number for the segment. Cubic splines are used to interpolate through the point estimates for each segment.
win	Proportion of iterations to include in the Brooks, Gelman, and Rubin Statistics.
annotate	Logical value indicating that a legend be included in the plot.

## Value

A logical value indicating that the plot was successfully created.

## Author(s)

Brian J. Smith

## See Also

[boa.chain.gandr](#), [boa.plot](#), [boa.plot.gandr](#), [boa.print.gandr](#)

---

boa.plot.density      *Plot Density Functions*

---

### Description

Estimates and displays, in a single plot, the density function(s) for the specified parameter(s).

### Usage

```
boa.plot.density(lnames, pname, bandwidth = boa.par("bandwidth"),  
window = boa.par("kernel"), annotate = boa.par("legend"))
```

### Arguments

lnames	Character vector giving the names of the desired MCMC sequence in the working session list of sequences.
pname	Character string giving the name of the parameter to be plotted.
bandwidth	Function for computing the bandwidth used in estimating the density functions for parameters. This should take one argument which is a numeric vector of data on which density estimation is to be performed. A constant bandwidth may be specified by having this function return the desired constant.
window	Character string giving the type of window used in estimating the density functions for the parameters. Available choices are "cosine", "gaussian", "rectangular", or "triangular".
annotate	Logical value indicating that a legend be included in the plot.

### Value

A logical value indicating that the plot was successfully created.

### Author(s)

Brian J. Smith

### See Also

[boa.plot](#)

**Description**

Creates a single plot of the Gelman and Rubin shrink factors within different line segments for a parameter in an MCMC sequence.

**Usage**

```
boa.plot.gandr(pname, bins = boa.par("gandr.bins"), alpha = boa.par("alpha"),  
win = boa.par("gandr.win"), annotate = boa.par("legend"))
```

**Arguments**

pname	Character string giving the name of the parameter in the working session list of MCMC sequences to be plotted.
bins	Number of line segments within the MCMC sequence at which to plot the Gelman and Rubin shrink factors. The first segment contains the first 50 iterations; the remaining iterations are partitioned into equal bins and added incrementally to construct the remaining line segments. The shrink factors are plotted against the maximum iteration number for the segment. Cubic splines are used to interpolate through the point estimates for each segment.
alpha	Quantile $(1 - \alpha / 2)$ at which to estimate the upper limit of the shrink factor.
win	Proportion of iterations to include in the Brooks, Gelman, and Rubin Statistics.
annotate	Logical value indicating that a legend be included in the plot.

**Value**

A logical value indicating that the plot was successfully created.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.gandr](#), [boa.plot](#), [boa.plot.bandg](#), [boa.print.gandr](#)

---

`boa.plot.geweke`*Plot Geweke Convergence Diagnostics*

---

**Description**

Creates a single plot of the Geweke convergence diagnostics within different line segments for a parameter in an MCMC sequence.

**Usage**

```
boa.plot.geweke(lname, pname, bins = boa.par("geweke.bins"),
                p.first = boa.par("geweke.first"), p.last = boa.par("geweke.last"),
                alpha = boa.par("alpha"), annotate = boa.par("legend"))
```

**Arguments**

<code>lname</code>	Character string giving the name of the desired MCMC sequence in the working session list of sequences.
<code>pname</code>	Character string giving the name of the parameter to be plotted.
<code>bins</code>	Number of line segments within the MCMC sequence at which to plot the Geweke convergence diagnostics. The <i>i</i> th line segment contains the last $((bins - i + 1) / bins) * 100$ bins. This may lead to segments in which there are too few iterations to compute the convergence diagnostics. Such segments, if they exist, are automatically omitted from the calculations.
<code>p.first</code>	Proportion of iterations to include in the first window.
<code>p.last</code>	Proportion of iterations to include in the last window.
<code>alpha</code>	Alpha level for the rejection region lines drawn on the graph.
<code>annotate</code>	Logical value indicating that a legend be included in the plot.

**Value**

A logical value indicating that the plot was successfully created.

**Author(s)**

Brian J. Smith, Nicky Best, Kate Cowles

**See Also**

[boa.geweke](#), [boa.plot](#), [boa.print.geweke](#)

---

boa.plot.history	<i>Plot Parameter Estimation Histories</i>
------------------	--

---

**Description**

Computes and displays, in a single plot, the running mean(s) for the specified parameter(s).

**Usage**

```
boa.plot.history(lnames, pname, annotate = boa.par("legend"))
```

**Arguments**

lnames	Character vector giving the name of the desired MCMC sequence in the working session list of sequences.
pname	Character vector giving the names of the parameters to be plotted.
annotate	Logical value indicating that a legend be included in the plot.

**Value**

A logical value indicating that the plot was successfully created.

**Author(s)**

Brian J. Smith

**See Also**

[boa.plot](#)

---

boa.plot.par	<i>Set Plotting Parameters</i>
--------------	--------------------------------

---

**Description**

Set Plotting Parameters

**Usage**

```
boa.plot.par(mfdim = c(1, 1), title = TRUE)
```

**Arguments**

mfdim	Numeric vector with two elements giving the number of rows and column, respectively, of plots to display on the page. Plots will be drawn row-by-row.
title	Logical value indicating that a title be added to the plot.

**Author(s)**

Brian J. Smith

---

boa.plot.title      *Add Plot Title*

---

**Description**

Adds a title to the graphics window. This function should be called after all plots have been added to the target graphics window.

**Usage**

```
boa.plot.title(text)
```

**Arguments**

text	Character string giving the title to be centered and displayed across the top of the graphics window.
------	---

**Author(s)**

Brian J. Smith

---

boa.plot.trace      *Plot Trace Histories*

---

**Description**

Displays, in a single plot, the trace histories for the specified parameter(s).

**Usage**

```
boa.plot.trace(lnames, pname, annotate = boa.par("legend"))
```

**Arguments**

lnames	Character vector giving the name of the desired MCMC sequence in the working session list of sequences.
pname	Character string giving the name of the parameters to be plotted.
annotate	Logical value indicating that a legend be included in the plot.

**Value**

A logical value indicating that the plot was successfully created.

**Author(s)**

Brian J. Smith

**See Also**

[boa.plot](#)

---

*boa.print.acf*                      *Print Autocorrelation Functions*

---

**Description**

Iteratively calls `boa.acf()` to display the lag autocorrelations for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.acf(lags = boa.par("acf.lags"))
```

**Arguments**

`lags`                      Numeric vector of lags at which to estimate the autocorrelation functions.

**Author(s)**

Brian J. Smith

**See Also**

[boa.acf](#), [boa.plot](#), [boa.plot.acf](#)

---

*boa.print.cor*                      *Print Correlation Matrices*

---

**Description**

Iteratively computes and displays the correlation matrices for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.cor()
```

**Author(s)**

Brian J. Smith

---

boa.print.gandr      *Print Gelman and Rubin Convergence Diagnostics*

---

**Description**

Calls `boa.chain.gandr()` and displays the Gelman and Rubin convergence diagnostics for the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.gandr(alpha = boa.par("alpha"), win = boa.par("gandr.win"))
```

**Arguments**

alpha	Quantile $(1 - \alpha / 2)$ at which to estimate the upper limit of the corrected shrink factor.
win	Proportion of iterations to include in the Brooks, Gelman, and Rubin Statistics.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.gandr](#), [boa.plot](#), [boa.plot.bandg](#), [boa.plot.gandr](#)

---

boa.print.geweke      *Print Geweke Convergence Diagnostics*

---

**Description**

Iteratively calls `boa.geweke()` to display the Geweke convergence diagnostics for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.geweke(p.first = boa.par("geweke.first"), p.last = boa.par("geweke.last"))
```

**Arguments**

p.first	Proportion of iterations to include in the first window.
p.last	Proportion of iterations to include in the last window.

**Author(s)**

Brian J. Smith

**See Also**

[boa.geweke](#), [boa.plot](#), [boa.plot.geweke](#)

---

boa.print.handw      *Print Heidelberger and Welch Convergence Diagnostics*

---

**Description**

Iteratively calls `boa.handw()` to display the Heidelberger and Welch convergence diagnostics for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.handw(error = boa.par("handw.error"), alpha = boa.par("alpha"))
```

**Arguments**

error	Accuracy of the posterior estimates for the monitored parameters.
alpha	Alpha level for the confidence in the sample mean of the retained iterations.

**Author(s)**

Brian J. Smith

**See Also**

[boa.handw](#)

---

boa.print.hpd      *Print Highest Probability Density Intervals*

---

**Description**

Iteratively calls `boa.hpd()` to display the highest probability density (HPD) intervals for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.hpd(alpha = boa.par("alpha"))
```

**Arguments**

alpha	Specifies the $100 \cdot (1 - \alpha)\%$ HPD intervals to be computed.
-------	--

**Author(s)**

Brian J. Smith

**See Also**

[boa.hpd](#)

---

boa.print.info

*Print Information about MCMC Sequences*

---

**Description**

Iteratively calls `boa.chain.info()` to display information from the MCMC sequences in the specified session list of sequences.

**Usage**

```
boa.print.info(which = "work")
```

**Arguments**

which	Character string specifying which session list of MCMC sequences for which to print information. The two choices are "work" (used in all analyses) or "data" (the template for "work").
-------	---

**Value**

The full list obtained from `boa.chain.info()` is returned, but not printed.

**Author(s)**

Brian J. Smith

**See Also**

[boa.chain.info](#)

---

`boa.print.par`*Print Global Parameters' Descriptions and Current Values*

---

**Description**

Displays a description of and the current value for all global parameters.

**Usage**

```
boa.print.par(group)
```

**Arguments**

<code>group</code>	Character string specifying which parameter group to display. The groups are "Analysis", "Data", and "Plot". If omitted, information on all global parameters is displayed.
--------------------	---

**Value**

The character matrix obtained from `boa.pardesc()` is returned, but not printed.

**Author(s)**

Brian J. Smith

**See Also**

[boa.pardesc](#)

---

`boa.print.randl`*Print Raftery and Lewis Convergence Diagnostics*

---

**Description**

Iteratively calls `boa.randl()` to display the Raftery and Lewis convergence diagnostics for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.randl(q = boa.par("randl.q"), error = boa.par("randl.error"),  
               prob = 1 - boa.par("alpha"), delta = boa.par("randl.delta"))
```

**Arguments**

q	Quantile to be estimated.
error	Desired amount of error in estimating the specified quantile 'q'.
prob	Probability of attaining the desired degree of 'error'.
delta	Delta value used in computing the convergence diagnostic.

**Author(s)**

Brian J. Smith

**See Also**

[boa.randl](#)

---

boa.print.stats      *Print Summary Statistics*

---

**Description**

Iteratively calls `boa.stats()` to display summary statistics for the parameters in each of the MCMC sequences in the working session list of sequences.

**Usage**

```
boa.print.stats(probs = boa.par("quantiles"), batch.size = boa.par("batch.size"))
```

**Arguments**

probs	Vector of probabilities at which to compute the quantiles. Values must be between 0 and 1.
batch.size	Number of iterations to include in each batch when computing batch means and lag-1 batch autocorrelation function.

**Author(s)**

Brian J. Smith

**See Also**

[boa.stats](#)

---

boa.quit	<i>Quit Session</i>
----------	---------------------

---

**Description**

boa.quit() is called to end a BOA session. It removes the objects used to store the session lists of MCMC sequences and the global parameters. Failure to do this may result in lost or lingering data.

**Usage**

```
boa.quit()
```

**Author(s)**

Brian J. Smith

**See Also**

[boa.save](#), [boa.init](#)

---

boa.randl	<i>Raftery and Lewis Convergence Diagnostics</i>
-----------	--

---

**Description**

Computes the Raftery and Lewis convergence diagnostics for the parameters in an MCMC sequence.

**Usage**

```
boa.randl(link, q, error, prob, delta)
```

**Arguments**

link	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code> .
q	Quantile to be estimated.
error	Desired amount of error in estimating the specified quantile 'q'.
prob	Probability of attaining the desired degree of error - 'error'.
delta	Delta value used in computing the convergence diagnostics.

**Value**

A matrix whose columns and rows are the Raftery and Lewis convergence diagnostics (i.e. thin, burn-in, total, lower bound, and dependence factor) and the monitored parameters, respectively.

**Author(s)**

Brian J. Smith, Nicky Best, Kate Cowles

**References**

1. Raftery, A. L. and Lewis, S. (1992a). Comment: One long run with diagnostics: Implementation strategies for Markov chain Monte Carlo. *Statistical Science*, 7, 493-7.
2. Raftery, A. L. and Lewis, S. (1992b). How many iterations in the Gibbs sampler? In *Bayesian Statistics 4*, (ed. J. M. Bernardo, J. O. Berger, A. P. Dawid, and A. F. M. Smith), pp. 763-74. Oxford University Press.

**See Also**

[boa.print.randl](#)

---

boa.save

*Save Session*

---

**Description**

Save the current state of the session lists of MCMC sequences and the global parameters to a database object.

**Usage**

```
boa.save(name, envir = globalenv(), replace = FALSE)
```

**Arguments**

name	Character string giving the name of the object to which the current session should be saved.
envir	The 'environment' to which the object should be saved. For more information, consult the help documentation in R on the <code>assign()</code> function.
replace	Logical value indicating whether object name should be replaced if it already exists.

**Value**

A logical value indicating that the session was successfully saved to the specified object.

**Author(s)**

Brian J. Smith

---

boa.stats	<i>Summary Statistics</i>
-----------	---------------------------

---

**Description**

Computes summary statistics for the parameters in an MCMC sequence.

**Usage**

```
boa.stats(link, probs, batch.size)
```

**Arguments**

link	Matrix whose columns and rows contain the monitored parameters and the MCMC iterations, respectively. The iteration numbers and parameter names must be assigned to <code>dimnames(link)</code> .
probs	Vector of probabilities at which to compute the quantiles. Values must be between 0 and 1.
batch.size	Number of iterations to include in each batch when computing batch means and lag-1 batch autocorrelations.

**Value**

A matrix whose columns and rows contain the summary statistics (i.e. sample mean, standard deviation, naive standard error, MC error, batch standard error, lag-1 batch autocorrelation, specified quantiles, minimum and maximum iteration numbers, and total iterations in the sample) and the monitored parameters, respectively.

**Author(s)**

Brian J. Smith

**See Also**

[boa.print.stats](#)

---

line

*BUGS Line Example*

---

### Description

The Line example involves a linear regression analysis of the data points (1,1), (2,3), (3,3), (4,3), and (5,5). The proposed Bayesian model is

$$y[i] \sim N(\mu[i], \tau)$$

$$\mu[i] = \alpha + \beta * (x[i] - \text{mean}(x[]))$$

with the following priors:

$$\alpha \sim N(0, 0.0001)$$

$$\beta \sim N(0, 0.0001)$$

$$\tau \sim \text{Gamma}(0.001, 0.001)$$

Two parallel chains from the MCMC sampler were generated and the output saved in the S data frames line1 and line2.

### Usage

data(line)

### Format

The data frames line1 and line2 each containing 200 observations.

### References

Spiegelhalter, D., Thomas, A. and Best, N., (2000). WinBugs Version 1.4 User Manual.

# Index

- \* **datasets**
  - line, 38
- \* **hplot**
  - boa.plot, 21
  - boa.plot.acf, 22
  - boa.plot.bandg, 23
  - boa.plot.density, 24
  - boa.plot.gandr, 25
  - boa.plot.geweke, 26
  - boa.plot.history, 27
  - boa.plot.trace, 28
- \* **interface**
  - boa.menu, 18
- \* **print**
  - boa.print.acf, 29
  - boa.print.cor, 29
  - boa.print.gandr, 30
  - boa.print.geweke, 30
  - boa.print.handw, 31
  - boa.print.hpd, 31
  - boa.print.info, 32
  - boa.print.par, 33
  - boa.print.randl, 33
  - boa.print.stats, 34
- \* **univar**
  - boa.acf, 2
  - boa.chain.gandr, 7
  - boa.geweke, 12
  - boa.handw, 13
  - boa.hpd, 14
  - boa.randl, 35
  - boa.stats, 37
- \* **utilities**
  - boa.chain, 3
  - boa.chain.add, 4
  - boa.chain.collapse, 5
  - boa.chain.del, 6
  - boa.chain.eval, 6
  - boa.chain.import, 8
  - boa.chain.info, 9
  - boa.chain.reset, 10
  - boa.chain.subset, 10
  - boa.chain.support, 11
  - boa.importASCII, 14
  - boa.importBUGS, 15
  - boa.importMatrix, 16
  - boa.init, 17
  - boa.load, 17
  - boa.par, 19
  - boa.plot.par, 27
  - boa.plot.title, 28
  - boa.quit, 35
  - boa.save, 36
- boa.acf, 2, 22, 29
- boa.chain, 3
- boa.chain.add, 4, 8, 9
- boa.chain.collapse, 4, 5, 10, 11
- boa.chain.del, 6
- boa.chain.eval, 6
- boa.chain.gandr, 7, 23, 25, 30
- boa.chain.import, 4, 5, 8, 15, 16
- boa.chain.info, 9, 32
- boa.chain.reset, 4, 5, 10, 11
- boa.chain.subset, 4, 5, 10, 10
- boa.chain.support, 11
- boa.geweke, 12, 26, 31
- boa.handw, 13, 31
- boa.hpd, 14, 32
- boa.importASCII, 8, 9, 14, 16
- boa.importBUGS, 8, 9, 15, 15, 16
- boa.importMatrix, 15, 16, 16
- boa.init, 17, 35
- boa.load, 17, 17
- boa.menu, 18
- boa.par, 19
- boa.pardesc, 33
- boa.plot, 3, 8, 12, 21, 23–27, 29–31
- boa.plot.acf, 3, 22, 22, 29

boa.plot.bandg, [8](#), [22](#), [23](#), [25](#), [30](#)  
boa.plot.density, [22](#), [24](#)  
boa.plot.gandr, [8](#), [22](#), [23](#), [25](#), [30](#)  
boa.plot.geweke, [12](#), [22](#), [26](#), [31](#)  
boa.plot.history, [22](#), [27](#)  
boa.plot.par, [27](#)  
boa.plot.title, [28](#)  
boa.plot.trace, [22](#), [28](#)  
boa.print.acf, [3](#), [22](#), [29](#)  
boa.print.cor, [29](#)  
boa.print.gandr, [8](#), [23](#), [25](#), [30](#)  
boa.print.geweke, [12](#), [26](#), [30](#)  
boa.print.handw, [13](#), [31](#)  
boa.print.hpd, [31](#)  
boa.print.info, [9](#), [32](#)  
boa.print.par, [33](#)  
boa.print.randl, [33](#), [36](#)  
boa.print.stats, [34](#), [37](#)  
boa.quit, [17](#), [35](#)  
boa.randl, [34](#), [35](#)  
boa.save, [35](#), [36](#)  
boa.stats, [34](#), [37](#)

line, [38](#)  
line1(line), [38](#)  
line2(line), [38](#)