Package ‘abcrf’

June 14, 2019

Type Package

Title Approximate Bayesian Computation via Random Forests

Version 1.8

Date 2019-05-16

Description Performs Approximate Bayesian Computation (ABC) model choice and parameter inference via random forests.


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Encoding UTF-8

LazyData TRUE

Imports readr, MASS, matrixStats, ranger, doParallel, parallel, foreach, stringr, Rcpp (>= 0.11.2)

LinkingTo Rcpp, RcppArmadillo

Depends R(>= 3.1)

NeedsCompilation yes

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Date/Publication 2019-06-14 12:40:08 UTC
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**abcrf** Create an ABC-RF object: a classification random forest from a reference table towards performing an ABC model choice

Description

abcrf constructs a random forest from a reference table towards performing an ABC model choice. Basically, the reference table (i.e. the dataset that will be treated with the present package) includes a column with the index of the models to be compared and additional columns corresponding to the values of the simulated summary statistics.

Usage

```r
## S3 method for class 'formula'
abcrf(formula, data, group=list(), lda=TRUE, ntree=500, sampsize=min(1e5, nrow(data)),
     paral=FALSE, ncores= if(paral) max(detectCores()-1,1) else 1, ...)
```

Arguments

- `formula`: a formula: left of ~, variable representing the model index; right of ~, summary statistics of the reference table.
- `data`: a data frame containing the reference table.
- `group`: a list containing groups (at least 2) of model(s) on which the model choice will be performed. This is not necessarily a partition, one or more models can be excluded from the elements of the list and by default no grouping is done.
- `lda`: should LDA scores be added to the list of summary statistics?
- `ntree`: number of trees to grow in the forest, by default 500 trees.
sampsize: size of the sample from the reference table to grow a tree of the classification forest, by default the minimum between the number of elements of the reference table and 100,000.

paral: a boolean that indicates if the calculations of the classification random forest (forest used to assign a model to the observed dataset) should be parallelized.

ncores: the number of CPU cores to use. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

... additional arguments to be passed on to ranger used to construct the classification random forest that predicts the selected model.

Value

An object of class abcrf, which is a list with the following components:

call: the original call to abcrf,

lda: a boolean indicating if LDA scores have been added to the list of summary statistics,

formula: the formula used to construct the classification random forest,

group: a list containing the groups of model(s) used. This list is empty if no grouping has been performed,

model.rf: an object of class randomforest containing the trained forest with the reference table,

model.lda: an object of class lda containing the Linear Discriminant Analysis based on the reference table,

prior.err: prior error rates of model selection on the reference table, estimated with the "out-of-bag" error of the forest.

References


See Also

plot.abcrf, predict.abcrf, err.abcrf, ranger
Examples

data(snp)
modindex <- snp$modindex[1:500]
sumsta <- snp$sumsta[1:500,]
data1 <- data.frame(modindex, sumsta)
model.rf1 <- abcfrf(modindex = ., data = data1, ntree = 100)
model.rf1
model.rf2 <- abcfrf(modindex = ., data = data1, group = list(c("1","2","3"), ntree = 100)
model.rf2

covRegAbcrf  Predict posterior covariance between two parameters for new data using two reg-ABC-RF objects

Description

Using two reg-ABC-RF objects constructed on the same reference table for two different response variables, this function predicts the posterior covariance between those two response variables, given a new dataset of summaries.

Usage

# S3 method for class 'regAbcrf'
covRegAbcrf(regForest1, regForest2, obs, training1, training2, ntree = 500, mtry = max(floor((dim(training1)[2] - 1)/3), 1), sampsize = min(1e5, dim(training1)[1]), paral = FALSE, ncores = if(paral) max(detectCores()-1,1) else 1, paral.predict = FALSE, ncores.predict = if(paral.predict) max(detectCores()-1,1) else 1, ... )

Arguments

regForest1, regForest2
  regAbcrf objects.
obs
  a data frame containing the summary statistics of the observed data sets.
training1, training2
  data frames containing the reference table respectively used to train the regAbcrf objects regForest1 and regForest2.
ntree
  number of trees to grow in the forest, by default equal to 500 trees.
mtry
  Number of variables to possibly split at in each node for the regression random forest. Default is the minimum between 1 and the number of variables divided by 3.
sampsize
  size of the sample from the reference table used to grow a tree of the regression forest, by default the minimum between the number of elements of the reference table and 100,000.
covRegAbcrf

paral
a boolean that indicates whether or not the calculations of the regression random forest (forest used to predict a response from the observed dataset) should be parallelized.

ncores
the number of CPU cores to use. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

paral.predict
a boolean that indicates if random forests predictions should be parallelized.

ncores.predict
the number of CPU cores to use for the regression random forest predictions. If paral.predict=TRUE, it is used the number of CPU cores minus 1. If ncores.predict is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

... additional arguments to be passed on to ranger used to construct the regression random forest that predicts posterior covariance.

Value
covRegAbcrf returns predicted posterior covariances between response variables of two reg-ABC-RF objects, for a new data set.

References

See Also
regAbcrf, predict.regAbcrf, err.regAbcrf, plot.regAbcrf, ranger, densityPlot

Examples
```r
data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
N1 <- snp$param$N1[modindex == "3"]
N1 <- N1[1:500]
data3 <- data.frame(N1, sumsta)
model.rf.N1 <- regAbcrf(N1~., data3, ntree=100)
data(snp.obs)
covRegAbcrf(model.rf.r, model.rf.N1, snp.obs, data2, data3, ntree=100)
```
**densityPlot**

Plot the posterior density given a new summary statistic

**Description**

Given a reg-ABC-RF object and a new value of the summary statistics, `densityPlot` gives the corresponding posterior density plot of the parameter, as well as the prior (in grey).

**Usage**

```r
## S3 method for class 'regAbcrf'
densityPlot(object, obs, training, add=TRUE, main="Posterior density", log="", xlim=NULL, ylim=NULL, xlab=NULL, ylab=NULL, paral=FALSE, ncores= if(paral) max(detectCores()-1,1) else 1, ...)
```

**Arguments**

- `object`: a `regAbcrf` object.
- `obs`: a data frame containing the summary statistics of the observed data sets.
- `training`: the data frame containing the reference table used to train the `regAbcrf` object.
- `add`: a boolean that indicates if the posterior distributions should be plotted on the same graph or not, when more than one observed summary statistics is given.
- `main`: main title to be used for the posterior density plot.
- `log`: a character string which contains "x" if the x axis is to be logarithmic, "y" if the y axis is to be logarithmic and "xy" or "yx" if both axes are to be logarithmic. The default value "" implies no logarithmic transformation.
- `xlim`: range of the abscissa.
- `ylim`: range of the ordinate.
- `xlab`: label of the abscissa.
- `ylab`: label of the ordinate.
- `paral`: a boolean that indicates if random forests predictions should be parallelized.
- `ncores`: the number of CPU cores to use for the regression random forest predictions. If `paral=TRUE`, it is used the number of CPU cores minus 1. If `ncores` is not specified and `detectCores` does not detect the number of CPU cores with success then 1 core is used.
- `...`: additional arguments to be passed on to `density`, as for example the smoothing bandwidth `bw` to be used.

**References**

See Also

regAbcrf, predict.regAbcrf, err.regAbcrf, covRegAbcrf, ranger, plot.regAbcrf

Examples

data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r ~., data2, ntree=100)
data(snp.obs)
densityPlot(model.rf.r, snp.obs, data2, ylab="density", main = "Posterior density of r")

err.abcrf

Calculate and plot for different numbers of tree, the out-of-bag errors associated with an ABC-RF object

Description

err.abcrf returns out-of-bag errors and plot them.

Usage

err.abcrf(object, training, paral=FALSE, ncores= if(paral) max(detectCores())-1,1) else 1)

Arguments

object an abcrf object.
training the data frame containing the reference table used to train the abcrf object.
paral a boolean that indicates if random forests predictions should be parallelized.
ncores the number of CPU cores to use for the random forest predictions. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

Value

a matrix with 2 columns: the number of trees and the out-of-bag errors. Errors are computed from 40 trees to the total number.
References


See Also

abcrf, predict.abcrf, plot.abcrf

Examples

data(snp)
modindex <- snp$modindex[1:500]
sumsta <- snp$sumsta[1:500]
data1 <- data.frame(modindex, sumsta)
model.rf <- abcrf(modindex~., data1, ntree=100)
err.rf <- err.abcrf(model.rf, data1)

err_regAbcrf Calculate and plot for different numbers of tree, the out-of-bag mean squared errors associated with a REG-ABC-RF object

Description

err_regAbcrf returns out-of-bag mean squared errors and plot them.

Usage

err_regAbcrf(object, training, paral=FALSE,
ncores= if(paral) max(detectCores()-1,1) else 1, what="mean")

Arguments

object a regAbcrf object.
training the data frame containing the reference table used to train the regAbcrf object.
paral a boolean that indicates if random forests predictions should be parallelized.
ncores the number of CPU cores to use for the random forest predictions. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.
what a string carater "mean" or "median" indicating if the predictions are computed with mean or median of the response variable.

Value

a matrix with 2 columns: the number of trees and the out-of-bag mean squared errors. NAs might be returned if the number of trees is too low. Errors are computed from 40 trees to the total number.
References


See Also

regAbcrf, predict.regAbcrf, plot.regAbcrf, densityPlot, covRegAbcrf, ranger

Examples

data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
err.regAbcrf(model.rf.r, data2)

plot.abcrf

Plot of an ABC-RF object

Description

plot.abcrf provides both a variable importance plot of a model choice ABC-RF object and the projection of the reference table on the LDA axes.

Usage

## S3 method for class 'abcrf'
plot(x, training, obs=NULL, n.var=20, pdf=FALSE, xlim=NULL, ...)

Arguments

x an abcrf object.
training the data frame containing the reference table used to train the abcrf object.
obs a vector containing the summary statistics of an observed dataset that will be added to the graph of the projected reference table (black star or vertical line).
n.var number of variables in the variable importance representation.
pdf a boolean that indicates if a pdf version of the graph(s) should be saved in the current directory.
xlim range of the abscissa for the variable importance plot.
... not used.
Note

The graph of the reference table projected on the LD axes is shown only if LD axes has been added to the set of summary statistics in the call of abcrf.

References


See Also

abcrf, predict.abcrf, err.abcrf, variableImportPlot

Examples

data(snp)
modindex <- snp$modindex[1:500]
sumsta <- snp$sumsta[1:500]
data1 <- data.frame(modindex, sumsta)
model.rf <- abcrf(modindex~., data1, ntree=100)
plot(model.rf, data1)
data(snp.obs)
plot(model.rf, data1, obs=snp.obs[1,])
predict.abcrf

References

See Also
regAbcrf, predict.regAbcrf, err.regAbcrf, covRegAbcrf, ranger, densityPlot

Examples

data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
plot(model.rf.r)

Arguments

object an abcrf object.
obs a data frame containing the summary statistics of the observed data sets.
training the data frame containing the reference table used to train the abcrf object.
ntree number of trees to grow in the regression forest, by default 1,000 trees.
sampsize size of the sample from the reference table used to grow a tree of the forest, by default the minimum between the number of elements of the reference table and 100,000.
paral  a boolean that indicates if the calculations of the regression random forest (forest that returns the posterior probability of the selected model) should be parallelized.

cores  the number of CPU cores to use for the regression random forest construction. If paral=TRUE, it is used the number of CPU cores minus 1. If cores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

paral.predict  a boolean that indicates if random forests predictions should be parallelized.

cores.predict  the number of CPU cores to use for random forest predictions (classification and regression). If paral.predict=TRUE, it is used the number of CPU cores minus 1. If cores.predict is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.

...  additional arguments to be passed on to ranger used to construct the regression random forest that estimates the posterior probability of the selected model.

Value

An object of class abcrfpredict, which is a list with the following components:

allocation  indices of the selected models for each observed data set,

vote  votes for each observed dataset,

post.prob  ABC-RF approximations of the posterior probability of the selected model for each observed dataset.

References


See Also

abcrf, plot.abcrf, err.abcrf

Examples

data(snp)
modindex <- snp$modindex[1:500]
sumsta <- snp$sumsta[1:500,]
data1 <- data.frame(modindex, sumsta)
model.rf <- abcrf(modindex..., data1, ntree=100)
data(snp.obs)
predict(model.rf, snp.obs, data1, ntree=100)
predict.regAbcrf

Predict posterior expectation, median, variance and quantiles given a new dataset using a reg-ABC-RF object

Description

Based on a reg-ABC-RF object this function predicts the posterior expectation, median, variance, quantiles for the corresponding parameter given new dataset. Somes posterior errors can be computed at an higher computational price.

Usage

```r
## S3 method for class 'regAbcrf'
predict(object, obs, training, quantiles=\(c(0.025, 0.975)\),
paral = FALSE, ncores = if(paral) max(detectCores()-1,1) else 1, rf.weights = FALSE,
post.err.med = FALSE, ...)  
```

Arguments

- `object`: a `regAbcrf` object.
- `obs`: a data frame containing the summary statistics of the observed data sets.
- `training`: the data frame containing the reference table used to train the `regAbcrf` object.
- `quantiles`: numeric vector of probabilities with values in \([0,1]\). The default value is equal to \(c(0.025, 0.975)\).
- `paral`: a boolean that indicates if random forests predictions should be parallelized.
- `ncores`: the number of CPU cores to use for the regression random forest predictions. If `paral=TRUE`, it is used the number of CPU cores minus 1. If `ncores` is not specified and `detectCores` does not detect the number of CPU cores with success then 1 core is used.
- `rf.weights`: a boolean that indicates if the random forest weights used to predict quantities of interest should we returned. The default value is FALSE.
- `post.err.med`: a boolean that indicates if posterior errors based on posterior medians should be computed. The default value is FALSE. If computed, this function might take a much more time.
- `...`: optional arguments to be passed on to the function `predict.ranger`.

Value

An object of class `regAbcrfpredict`, which is a list with the following components:

- `expectation`: predicted posterior expectation for each oberved data set,
- `med`: predicted posterior median for each oberved data set,
- `variance`: predicted posterior variance for each observed data set, computed by reusing weights, this quantity is also the posterior mean squared error,
variance.cdf  predicted posterior variance for each observed data set, computed by approximation of the cumulative distribution function,
quantiles  predicted posterior quantiles for each observed data set,
weights  a matrix composed of the weights used to predict quantities of interest. Returned if rf.weights is TRUE,
post.NMAE.mean  posterior normalized mean absolute error obtained using the out-of-bag posterior expectation (mean) and previously computed random forest weights, for each observed data set,
post.MSE.med  posterior mean squared error obtained using the out-of-bag posterior median and previously computed random forest weights, for each observed data set,
post.NMAE.med  posterior normalized mean absolute error obtained using the out-of-bag posterior expectation (mean) and previously computed random forest weights, for each observed data set,
prior.MSE  prior mean squared error computed with training out-of-bag prediction based on mean of response variable,
prior.NMAE  prior normalized mean absolute error computed with training out-of-bag predictions based on mean of response variable,
prior.MSE.med  prior mean squared error computed with training out-of-bag predictions based on median of response variable,
prior.NMAE.med  prior normalized mean absolute error with training out-of-bag predictions based on median of response variable,
prior.coverage  prior credible interval coverage computed for training instances, if only two quantiles are of interest, NULL otherwise.

References

See Also
regAbcrf, predictOOB, plot.regAbcrf, err.regAbcrf, covRegAbcrf, ranger, densityPlot

Examples
data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
data(snp.obs)
predict(model.rf.r, snp.obs, data2)
Predict out-of-bag posterior expectation, median, variance, quantiles and error measures using a reg-ABC-RF object

Description

Based on a reg-ABC-RF object this function predicts the out-of-bag posterior expectation, median, variance, quantiles, mean squared errors, normalized mean absolute errors, credible interval and coverage, for the corresponding parameter using the out-of-bag observations of the training data set.

Mean squared errors and normalized mean absolute errors are computed both with mean and median of the response variable.

Memory allocation issues might be encountered when the size of the training data set is large.

Usage

```r
## S3 method for class 'regAbcrf'
predictOOB(object, training, quantiles = c(0.025, 0.975), paral = FALSE, ncores = if(paral) max(detectCores()-1,1) else 1,...)
```

Arguments

- `object`: a `regAbcrf` object.
- `training`: the data frame containing the reference table used to train the `regAbcrf` object.
- `quantiles`: numeric vector of probabilities with values in [0,1]. The default value is equal to c(0.025, 0.975).
- `paral`: a boolean that indicates if training data predictions should be parallelized or not.
- `ncores`: the number of CPU cores to use for the regression random forest predictions. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and `detectCores` does not detect the number of CPU cores with success then 1 core is used.
- `...`: optional arguments to be passed on to the function `predict.ranger`.

Value

An object of class `regAbcrfOOBpredict`, which is a list with the following components:

- `expectation`: predicted posterior expectation for each observed data set,
- `med`: predicted posterior median for each observed data set,
- `variance`: predicted posterior variance for each observed data set, computed by reusing weights,
- `variance.cdf`: predicted posterior variance for each observed data set, computed by approximation of the cumulative distribution function,
- `quantiles`: predicted posterior quantiles for each observed data set,
**MSE**
mean squared error computed with prediction based on mean of response variable,

**NMAE**
normalized mean absolute error computed with predictions based on mean of response variable,

**MSE.med**
mean squared error computed with predictions based on median of response variable,

**NMAE.med**
normalized mean absolute error with predictions based on median of response variable,

**coverage**
credible interval coverage if only two quantiles are of interest, NULL otherwise.

### References

### See Also
- `regAbcrf`, `predict.regAbcrf`, `plot.regAbcrf`, `err.regAbcrf`, `covRegAbcrf`, `ranger`, `densityPlot`

### Examples
```r
data(snp)
modindex <- snp$modindex
sumsta <- snp$sumsta[modindex == "3",]
r <- snp$param$r[modindex == "3"]
r <- r[1:500]
sumsta <- sumsta[1:500,]
data2 <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
res <- predict0OB(model.rf.r, data2)
```

---

**readRefTable**

*Read a reference table simulated from DIYABC*

### Description
readRefTable reads a reference table simulated from DIYABC thanks to a .bin and a .txt file, respectively containing the reference table and its header.

### Usage
```r
readRefTable(filename = "reftable.bin", header = "header.txt", N = 0)
```
regAbcrf

Arguments

filename  a .bin file from DIYABC containing the reference table.
header    a .txt file containing the header of the reference table in filename.
N         an integer indicating the number of observations to extract from the reference table. The default is 0 indicating that the whole reference table is used. Warning: if N is specified, nrecscen returns is obsolete.

Value

A list with the following components:

nrec      number of individuals of the reference table,
nscen     number of scenarios in the reference table,
nrecscen  number of individuals by scenario,
nparam    number of parameters by scenario,
scenarios a vector of factor containing the scenario indices,
params    a matrix with the parameters,
stats     a matrix with the summary statistics.

References


regAbcrf  Create a reg-ABC-RF object: a regression random forest from a reference table aimed out predicting posterior expectation, variance and quantiles for a parameter

Description

regAbcrf constructs a regression random forest from a reference table towards predicting posterior expectations, variances and quantiles of a parameter.

Usage

## S3 method for class 'formula'
regAbcrf(formula, data, ntree=500,
mtry=max(floor((dim(data)[2]-1)/3), 1), sampsize=min(1e5, nrow(data)),
paral=FALSE, ncores=if(paral) max(detectCores()-1,1) else 1, ...)
Arguments

formula  a formula: left of ~, variable representing the response variable; right of ~, summary statistics of the reference table.
data    a data frame containing the reference table, composed of response variable (parameter) and summary statistics.
tree    number of trees to grow in the forest, by default 500 trees.
mtry    Number of variables to possibly split at in each node. Default is the minimum between 1 and the number of variables divided by 3.
sampsize size of the sample from the reference table used to grow a tree of the regression forest, by default the minimum between the number of elements of the reference table and 100,000.
paral    a boolean that indicates if the calculations of the regression random forest should be parallelized.
ncores   the number of CPU cores to use. If paral=TRUE, it is used the number of CPU cores minus 1. If ncores is not specified and detectCores does not detect the number of CPU cores with success then 1 core is used.
...    additional arguments to be passed on to ranger used to construct the regression random forest that predicts the response variable.

Value

An object of class regAbcrf, which is a list with the following components:
call    the original call to regAbcrf,
formula the formula used to construct the regression random forest,
model.rf an object of class ranger containing the trained forest with the reference table.

References


See Also

plot.regAbcrf.err.regAbcrf.predict.regAbcrf, covRegAbcrf, ranger, densityPlot, predictOOB.

Examples

data(snp)
modindex  <- snp$modindex
sumsta    <- snp$sumsta[modindex == "3", ]
r         <- snp$param$r[modindex == "3"]
r         <- r[1:500]
sumsta    <- sumsta[1:500, ]
data2      <- data.frame(r, sumsta)
model.rf.r <- regAbcrf(r~., data2, ntree=100)
model.rf.r
A simulated example in population genetics

Description

The simulated example of population genetics with SNP loci used in Pudlo et al. (2016): `snp` contains the reference table on which to perform ABC model choice, it also contains the simulated parameters to perform regression random forest. `snp.obs` contains two pseudo-observed data sets. The first one (favorable) should be easily allocated to a model, while that is not the case for the second one (unfavorable).

Usage

```r
data(snp)
data(snp.obs)
```

Format

`snp` is a list containing an ABC reference table of 10,000 simulations from a Bayesian prior predictive model (see Pudlo et al., 2016, for a description of the model choice issue). The first element, named `modindex` is a factor containing the model indices, the second element, `param`, is a data frame with seven simulated parameters. The last element of this list, named `sumsta`, contains the reference table on which to perform ABC model choice and parameter estimation.

`snp.obs` is a data frame containing the summary statistics of two pseudo-observed data sets.

Source


Examples

```r
data(snp)
data(snp.obs)
```

variableImpPlot

Variable importance plot from a random forest

Description

`variableImpPlot` provides a dotchart of variable importance as measured by `ranger` with the argument `importance='impurity'`. 

```r
variableImpPlot
```
variableImpPlot

Usage

variableImpPlot(object,
    n.var=min(30, length(object$model.rf$variable.importance)),
    xlim=NULL, main=NULL)

Arguments

object an abcrf or regAbcrf object.
n.var number of variables in the variable importance representation.
xlim range of the abscissa.
main an overall title for the variable importance plot.

Value

Invisibly, the importance of the variables that were plotted.

See Also

abcrf, plot.abcrf, plot.regAbcrf

Examples

data(snp)
modindex <- snp$modindex[1:500]
sumsta <- snp$sumsta[1:500,]
data1 <- data.frame(modindex, sumsta)
model.rf <- abcrf(modindex~, data1, ntree=100)
variableImpPlot(model.rf)
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