Package ‘rFerns’

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Title Random Ferns Classifier
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Description An R implementation of the random ferns classifier by Ozuysal et al., modified for generic and multi-label classification and featuring OOB error approximation and importance measure.

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merge.rFerns

Merge two random ferns models

Description

This function combines two compatible (same decision, same training data structure and same depth) models into a single ensemble. It can be used to distribute model training, perform it on batches of data, save checkouts or precisely investigate its course.

Usage

```r
## S3 method for class 'rFerns'
merge(x, y, dropModel = FALSE,
     ignoreObjectConsistency = FALSE, trueY = NULL, ...)
```

Arguments

- **x**
  - Object of a class rFerns; a first model to be merged.

- **y**
  - Object of a class rFerns; a second model to be merged. Can also be NULL, x is immediately returned in that case. Has to have been built on the same kind of training data as x, with the same depth.

- **dropModel**
  - If TRUE, model structure will be dropped to save size. This disallows prediction using the merged model, but retains importance and OOB approximations.

- **ignoreObjectConsistency**
  - If TRUE, merge will be done even if both models were built on a different sets of objects. This drops OOB approximations.

- **trueY**
  - Copy of the training decision, used to re-construct OOB error and confusion matrix. Can be omitted, OOB error and confusion matrix will disappear in that case; ignored when ignoreObjectConsistency is TRUE.

- **...**
  - Ignored, for S3 generic/method consistency.

Value

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

- **model**
  - The merged model in case both x and y had model structures included and dropModel was FALSE. Otherwise NULL.

- **oobErr**
  - OOB approximation of accuracy, if can be computed. Namely, when oobScores could be and trueY is provided.

- **importance**
  - The merged importance scores in case both x and y had importance calculated. Shadow importance appears only if both models had it enabled.

- **oobScores**
  - OOB scores, if can be computed; namely if both models had it calculated and ignoreObjectConsistency was not used.

- **oobPreds**
  - A vector of OOB predictions of class for each object in training set, if can be computed.
**naiveWrapper**

*Naive feature selection method utilising the rFerns shadow importance*

**Description**

Proof-of-concept ensemble of rFerns models, built to stabilise and improve selection based on shadow importance. It employs a super-ensemble of iterations small rFerns forests, each built on a subspace of size attributes, which is selected randomly, but with a higher selection probability for attributes claimed important by previous sub-models. Final selection is a group of attributes which hold a substantial weight at the end of the procedure.

**oobConfusionMatrix**

OOB confusion matrix, if can be computed. Namely, when oobScores could be and trueY is provided.

**timeTaken**

Time used to train the model, calculated as a sum of training times of x and y.

**parameters**

Numerical vector of three elements: classes, depth and ferns.

**classLabels**

Copy of levels(Y) after purging unused levels.

**isStruct**

Copy of the train set structure.

**merged**

Set to TRUE to mark that merging was done.

**Note**

In case of different training object sets were used to build the merged models, merged importance is calculated but mileage may vary; for substantially different sets it may become biased. Your have been warned.

Shadow importance is only merged when both models have shadow importance and the same consistentSeed value; otherwise shadow importance would be biased down.

The order of objects in x and y is not important; the only exception is merging with NULL, in which case x must be an rFerns object for R to use proper merge method.

**Author(s)**

Miron B. Kursa

**Examples**

```r
set.seed(77)
#Fetch Iris data
data(iris)
#Build models
rFerns(Species ~ ., data=iris) -> modelA
rFerns(Species ~ ., data=iris) -> modelB
modelAB = merge(modelA, modelB);
print(modelA);
print(modelAB);
```
Usage

naiveWrapper(x, y, iterations = 1000, depth = 5, ferns = 100, size = 30)

Arguments

x  Data frame containing attributes; must have unique names and contain only numeric, integer or (ordered) factor columns. Factors must have less than 31 levels. No NA values are permitted.

y  A decision vector. Must a factor of the same length as nrow(x) for ordinary many-label classification, or a logical matrix with each column corresponding to a class for multi-label classification.

iterations  Number of iterations i.e., the number of sub-models built.

depth  The depth of the ferns; must be in 1–16 range. Note that time and memory requirements scale with $2^\text{depth}$.

ferns  Number of ferns to be build in each sub-model. This should be a small number, around 3-5 times size.

size  Number of attributes considered by each sub-model.

Value

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

found  Names of all selected attributes.

weights  Vector of weights indicating the confidence that certain feature is relevant.

timeTaken  Time of computation.

params  Copies of algorithm parameters, iterations, depth, ferns and size, as a named vector.

Author(s)

Miron B. Kursa

Examples

set.seed(77);
#Fetch Iris data
data(iris)
#Extend with random noise
noisyIris<-cbind(iris[,-5],apply(iris[,-5],2,sample));
names(noisyIris)[5:8]<-sprintf("Nonsense%d",1:4)
#Execute selection
naiveWrapper(noisyIris,iris$Species,iterations=50,ferns=20,size=8)
**predict.rFerns**  
*Prediction with random ferns model*

**Description**

This function predicts classes of new objects with given rFerns object.

**Usage**

```r
## S3 method for class 'rFerns'
predict(object, x, scores = FALSE, ...)
```

**Arguments**

- `object` Object of a class rFerns; a model that will be used for prediction.
- `x` Data frame containing attributes; must have corresponding names to training set (although order is not important) and do not introduce new factor levels. If this argument is not given, OOB predictions on the training set will be returned.
- `scores` If TRUE, the result will contain score matrix instead of simple predictions.
- `...` Additional parameters.

**Value**

Predictions. If `scores` is TRUE, a factor vector (for many-class classification) or a logical data.frame (for multi-class classification) with predictions, else a data.frame with class’ scores.

**Author(s)**

Miron B. Kursa

**Examples**

```r
set.seed(77)
# Fetch Iris data
data(iris)
# Split into tRain and tEst set
iris[c(TRUE, FALSE), ] -> irisR
iris[c(FALSE, TRUE), ] -> irisE
# Build model
rFerns(Species ~ ., data = irisR) -> model
print(model)

# Test
predict(model, irisE) -> p
print(table(
  Predictions = p,
  True = irisE[['Species']]))
err <- mean(p != irisE[['Species']])
```
print(paste("Test error",err,sep=" "))

# Show first OOB scores
head(predict(model,scores=TRUE))

---

**rFerns**  
*Classification with random ferns*

**Description**  
This function builds a random ferns model on the given training data.

**Usage**  
```r
rFerns(x, ...)  
```

```
## S3 method for class 'formula'
rFerns(formula, data = .GlobalEnv, ...)

## S3 method for class 'matrix'
rFerns(x, y, ...)

## Default S3 method:
rFerns(x, y, depth = 5, ferns = 1000,
    importance = "none", reportErrorEvery = 0, saveErrorPropagation = FALSE,
    saveForest = TRUE, consistentSeed = NULL, ...)
```

**Arguments**

- **x**  
  Data frame containing attributes; must have unique names and contain only numeric, integer or (ordered) factor columns. Factors must have less than 31 levels. No NA values are permitted.

- **...**  
  For formula and matrix methods, a place to state parameters to be passed to default method. For the print method, arguments to be passed to `print`.

- **formula**  
  Alternatively, formula describing model to be analysed.

- **data**  
  In which to interpret formula.

- **y**  
  A decision vector. Must a factor of the same length as `nrow(X)` for ordinary many-label classification, or a logical matrix with each column corresponding to a class for multi-label classification.

- **depth**  
  The depth of the ferns; must be in 1–16 range. Note that time and memory requirements scale with 2^depth.

- **ferns**  
  Number of ferns to be build.
importance  Set to calculate attribute importance measure (VIM); "simple" will calculate the default mean decrease of true class score (MDTS, something similar to Random Forest's MDA/MeanDecreaseAccuracy), "shadow" will calculate MDTS and additionally MDTS of this attribute shadow, an implicit feature build by shuffling values within it, thus stripping it from information (which is slightly slower). Shadow importance is useful as a reference to judge significance of a regular importance. "none" turns importance calculation off, for a slightly faster execution. For compatibility with pre-1.2 rFerns, TRUE will resolve to "simple" and FALSE to "none". Abbreviation can be used instead of a full value.

reportErrorEvery  If set to a number larger than 0, current OOB error approximation will be printed every time a chunk of reportErrorEvery ferns is finished.

saveErrorPropagation  Should the OOB error approximation be calculated after each ferns was created and saved? Setting to FALSE may improve performance.

saveForest  Should the model be saved? It must be TRUE if you want to use the model for prediction; however, if you are interested in importance or OOB error only, setting it to FALSE significantly improves memory requirements, especially for large depth and ferns.

consistentSeed  PRNG seed used for shadow importance only. Must be either a 2-element integer vector or NULL, which corresponds to seeding from the default PRNG. It should be set to the same value in two merged models to make shadow importance meaningful.

Value

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

model  The built model; NULL if saveForest was FALSE.

oobErr  OOB approximation of accuracy. Ignores never-OOB-test objects (see oobScores element).

importance  The importance scores or NULL if importance was set to "none". In a first case it is a data.frame with two or three columns: MeanScoreLoss which is a mean decrease of a score of a correct class when a certain attribute is permuted, Tries which is number of ferns which utilised certain attribute, and, only when importance was set to "shadow", Shadow, which is a mean decrease of accuracy for the correct class for a permuted copy of an attribute (useful as a baseline for normal importance). The rownames are set and equal to the names(x).

oobScores  A matrix of OOB scores of each class for each object in training set. Rows correspond to classes in the same order as in levels(y). If the ferns is too small, some columns may contain NAs, what means that certain objects were never in test set.

oobPreds  A vector of OOB predictions of class for each object in training set. Never-OOB-tested objects (see above) have predictions equal to NA.

oobConfusionMatrix  Confusion matrix build from oobPreds and y.
**timeTaken**

Time used to train the model (smaller than wall time because data preparation and model final touches are excluded; however it includes the time needed to compute importance, if it applies). An object of `difftime` class.

**parameters**

Numerical vector of three elements: `classes`, `depth` and `ferns`, containing respectively the number of classes in decision and copies of `depth` and `ferns` parameters.

**classLabels**

Copy of `levels(Y)` after purging unused levels.

**consistentSeed**

Consistent seed used; only present for `importance="shadow"`. Can be used to seed a new model via `consistentSeed` argument.

**isStruct**

Copy of the train set structure, required internally by predict method.

**Note**

The unused levels of the decision will be removed; on the other hand unused levels of categorical attributes will be preserved, so that they could be present in the data later predicted with the model. The levels of ordered factors in training and predicted data must be identical.

Do not use formula interface for a data with large number of attributes; the overhead from handling the formula may be significant.

**Author(s)**

Miron B. Kursa

**References**


**Examples**

```r
set.seed(77);
#Fetch Iris data
data(iris)
#Build model
rFerns(Species~.,data=iris)
#Importance
rFerns(Species~.,data=iris,importance="shadow")->model
print(model$imp)
```
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