Package ‘SwarmSVM’

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Title Ensemble Learning Algorithms Based on Support Vector Machines
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Description Three ensemble learning algorithms based on support vector machines. They all train support vector machines on subset of data and combine the result.
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alphasvm is used to train a support vector machine. It can be used to carry out general regression and classification (of nu and epsilon-type), as well as density-estimation. A formula interface is provided.

Usage

alphasvm(x, ...)

## S3 method for class 'formula'
alphasvm(
  formula,
  data = NULL,
  ..., 
  subset,
  na.action = stats::na.omit,
  scale = FALSE
)

## Default S3 method:
alphasvm(
  x,
  y = NULL,
  scale = FALSE,
  type = NULL,
  kernel = "radial",
  degree = 3,
  gamma = if (is.vector(x)) 1 else 1/ncol(x),
  coef0 = 0,
  cost = 1,
  nu = 0.5,
class.weights = NULL,
cachesize = 40,
tolerance = 0.001,
epsilon = 0.1,
shrinking = TRUE,
cross = 0,
probability = FALSE,
fitted = TRUE,
alpha = NULL,
mute = TRUE,
nclass = NULL,
..., 
subset,
na.action = stats::na.omit
)

## S3 method for class 'alphasvm'
print(x, ...)

## S3 method for class 'alphasvm'
summary(object, ...)

## S3 method for class 'summary.alphasvm'
print(x, ...)

Arguments

x  
a data matrix, a vector, or a sparse matrix (object of class Matrix provided by the Matrix package, or of class matrix.csr provided by the SparseM package, or of class simple_triplet_matrix provided by the slam package).

...  
additional parameters for the low level fitting function svm. default

formula  
a symbolic description of the model to be fit.

data  
an optional data frame containing the variables in the model. By default the variables are taken from the environment which 'svm' is called from.

subset  
An index vector specifying the cases to be used in the training sample. (NOTE: If given, this argument must be named.)

na.action  
A function to specify the action to be taken if NAs are found. The default action is stats::na.omit, which leads to rejection of cases with missing values on any required variable. An alternative is stats::na.fail, which causes an error if NA cases are found. (NOTE: If given, this argument must be named.)

scale  
A logical vector indicating the variables to be scaled. If scale is of length 1, the value is recycled as many times as needed. Per default, data are scaled internally (both x and y variables) to zero mean and unit variance. The center and scale values are returned and used for later predictions.

y  
a response vector with one label for each row/component of x. Can be either a factor (for classification tasks) or a numeric vector (for regression).
type

svm can be used as a classification machine. The default setting for type is C-classification, but may be set to nu-classification as well.

kernel

the kernel used in training and predicting. You might consider changing some of the following parameters, depending on the kernel type.

linear: \( u'v \)

polynomial: \( (\gamma u'v + \text{coef}0)^\text{degree} \)

radial basis: \( e^{(-\gamma |u - v|^2)} \)

sigmoid: \( \text{tanh}(\gamma u'v + \text{coef}0) \)

degree

parameter needed for kernel of type polynomial (default: 3)

gamma

parameter needed for all kernels except linear (default: 1/(data dimension))

coef0

parameter needed for kernels of type polynomial and sigmoid (default: 0)

cost

cost of constraints violation (default: 1)—it is the ‘C’-constant of the regularization term in the Lagrange formulation.

nu

parameter needed for nu-classification

class.weights

a named vector of weights for the different classes, used for asymmetric class sizes. Not all factor levels have to be supplied (default weight: 1). All components have to be named.

cachesize

cache memory in MB (default 40)

tolerance

tolerance of termination criterion (default: 0.001)

epsilon

epsilon in the insensitive-loss function (default: 0.1)

shrinking

option whether to use the shrinking-heuristics (default: TRUE)

cross

if a integer value k>0 is specified, a k-fold cross validation on the training data is performed to assess the quality of the model: the accuracy rate for classification and the Mean Squared Error for regression

probability

logical indicating whether the model should allow for probability predictions.

fitted

logical indicating whether the fitted values should be computed and included in the model or not (default: TRUE)

alpha

Initial values for the coefficients (default: NULL). A numerical vector for binary classification or a nx(k-1) matrix for a k-class-classification problem.

mute

a logical value indicating whether to print training information from svm.

nclass

the number of classes in total.

object

An object of class alphavm

Details

For multiclass-classification with k levels, k>2, libsvm uses the ‘one-against-one’-approach, in which k(k-1)/2 binary classifiers are trained; the appropriate class is found by a voting scheme.

libsvm internally uses a sparse data representation, which is also high-level supported by the package SparseM.

If the predictor variables include factors, the formula interface must be used to get a correct model matrix.
plot.svm allows a simple graphical visualization of classification models.

The probability model for classification fits a logistic distribution using maximum likelihood to the decision values of all binary classifiers, and computes the a-posteriori class probabilities for the multi-class problem using quadratic optimization. The probabilistic regression model assumes (zero-mean) laplace-distributed errors for the predictions, and estimates the scale parameter using maximum likelihood.

Author(s)

Tong He (based on package e1071 by David Meyer and C/C++ code by Cho-Jui Hsieh in Divide-and-Conquer kernel SVM (DC-SVM))

References

- Chang, Chih-Chung and Lin, Chih-Jen: LIBSVM: a library for Support Vector Machines
  http://www.csie.ntu.edu.tw/~cjlin/libsvm
- Exact formulations of models, algorithms, etc. can be found in the document: Chang, Chih-Chung and Lin, Chih-Jen: LIBSVM: a library for Support Vector Machines
  http://www.csie.ntu.edu.tw/~cjlin/papers/libsvm.ps.gz
- More implementation details and speed benchmarks can be found on: Rong-En Fan and Pai-Hsune Chen and Chih-Jen Lin:
  Working Set Selection Using the Second Order Information for Training SVM

Examples

data(svmguide1)
svmguide1.t = svmguide1[[2]]
svmguide1 = svmguide1[[1]]

model = alphasvm(x = svmguide1[,1], y = svmguide1[,2], scale = TRUE)
preds = predict(model, svmguide1.t[,1])
table(preds, svmguide1.t[,1])

data(iris)
attach(iris)

# default with factor response:
model = alphasvm(Species ~ ., data = iris)

# get new alpha
new.alpha = matrix(0, nrow(iris),2)
new.alpha[model$index,] = model$coefs

model2 = alphasvm(Species ~ ., data = iris, alpha = new.alpha)
preds = predict(model2, as.matrix(iris[,5]))
table(preds, iris[,5])
cluster.fun.kkmeans  Wrapper function for kernal kmeans

Description

Wrapper function for kernal kmeans

Usage

cluster.fun.kkmeans(x, centers, ...)

Arguments

x  the input data
centers  the number of centers
...  other parameters passing to kernlab::kkmeans

cluster.fun.mlpack.old  Kmeans Clustering from RcppMLPACK

Description

The Kmeans algorithm from RcppMLPACK.

Usage

cluster.fun.mlpack.old(x, centers, ...)

Arguments

x  The input data for the clustering algorithm.
centers  A number indicating the number of clustering centers.
...  arguments for future use.
cluster.predict.kkmeans

*Predict function for kernel kmeans*

**Description**

Predict function for kernel kmeans

**Usage**

```r
cluster.predict.kkmeans(x, cluster.object)
```

**Arguments**

- `x` The data to make prediction
- `cluster.object` The result object from `kernlab::kkmeans`

---

clusterSVM

*Clustered Support Vector Machine*

**Description**

Implementation of Gu, Quanquan, and Jiawei Han. "Clustered support vector machines."

**Usage**

```r
clusterSVM(
  x,
  y,
  centers = NULL,
  cluster.object = NULL,
  lambda = 1,
  sparse = TRUE,
  valid.x = NULL,
  valid.y = NULL,
  valid.metric = NULL,
  type = 1,
  cost = 1,
  epsilon = NULL,
  bias = TRUE,
  wi = NULL,
  verbose = 1,
  seed = NULL,
  cluster.method = "kmeans",
  cluster.fun = NULL,
)```
cluster.predict = NULL,
...
)

Arguments

x      the nxp training data matrix. Could be a matrix or a sparse matrix object.
y      a response vector for prediction tasks with one value for each of the n rows of x. For classification, the values correspond to class labels and can be a 1xn matrix, a simple vector or a factor.
centers an integer indicating the number of centers in clustering.
cluster.object an object generated from cluster.fun, and can be passed to cluster.predict
lambda the weight for the global l2-norm
sparse indicating whether the transformation results in a sparse matrix or not
valid.x the mxp validation data matrix.
valid.y if provided, it will be used to calculate the validation score with valid.metric
valid.metric the metric function for the validation result. By default it is the accuracy for classification. Customized metric is acceptable.
type the type of the mission for LiblineaR.
cost cost of constraints violation (default: 1). Rules the trade-off between regularization and correct classification on data. It can be seen as the inverse of a regularization constant. See details in LiblineaR.
epsilon set tolerance of termination criterion for optimization. If NULL, the LIBLINEAR defaults are used, which are:
bias if bias is TRUE (default), instances of data becomes [data; 1].
wi a named vector of weights for the different classes, used for asymmetric class sizes. Not all factor levels have to be supplied (default weight: 1). All components have to be named according to the corresponding class label.
verbose if set to 0, no information is printed. If set to 1 (default), the running time and validation score (if applicable) will be printed. If set to 2, the running time, validation score (if applicable) and the LiblineaR information will be printed.
seed the random seed. Set it to NULL to randomize the model.
cluster.method The clustering algorithm to use. Possible choices are
  • "kmeans" Algorithm from stats::kmeans
  • "mlKmeans" Algorithm from RcppMLPACK::mlKmeans
  • "kernkmeans" Algorithm from kernLab::kkmeans
If cluster.fun and cluster.predict are provided, cluster.method doesn't work anymore.
cluster.fun The function to train cluster labels for the data based on given number of centers. Customized function is acceptable, as long as the resulting list contains two fields named as cluster and centers.
The function to predict cluster labels for the data based on trained object. Customized function is acceptable, as long as the resulting list contains two fields named as `cluster` and `centers`.

Additional parameters passing to `cluster.fun`.

**Value**

- `svm` the svm object from LiblineaR
- `lambda` the parameter used.
- `sparse` whether the data is sparsely transformed
- `label` the clustering label for training data
- `centers` the clustering centers from the training dataset
- `cluster.fun` the function used for clustering
- `cluster.object` the object either
- `cluster.predict` the function used for prediction on new data based on the object
- `valid.pred` the validation prediction
- `valid.score` the validation score
- `valid.metric` the validation metric
- `time` a list object recording the time consumption for each steps.

**Examples**

```r
data(svmguide1)
svmguide1.t = svmguide1[[2]]
svmguide1 = svmguide1[[1]]

csvm.obj = clusterSVM(x = svmguide1[, -1], y = svmguide1[, 1], lambda = 1,
                      centers = 8, seed = 512, verbose = 0,
                      valid.x = svmguide1.t[, -1], valid.y = svmguide1.t[, 1])
csvm.pred = csvm.obj$valid.pred

# Or predict from the data
pred = predict(csvm.obj, svmguide1.t[, -1])
```

---

**Description**

Transform a data matrix according to the kmeans clustering result based on Gu, Quanquan, and Jiawei Han. "Clustered support vector machines."
Usage

csvmTransform(x, lambda, cluster.label, sparse = TRUE)

Arguments

- **x**: The data matrix, could be a matrix or dgCMatrix object.
- **lambda**: The parameter from the algorithm.
- **cluster.label**: The clustering label starting from 1. Its length must equal to the number of rows in `x`.
- **sparse**: Logical argument indicating whether the output should be a sparse matrix or not.

dcSVM

*Divide-and-Conquer kernel SVM (DC-SVM)*

Description

Implementation of Divide-and-Conquer kernel SVM (DC-SVM) by Cho-Jui Hsieh, Si Si, and Inderjit S. Dhillon

Usage

dcSVM(
  x, y, k = 4, m, kernel = 3, max.levels, early = 0, final.training = FALSE, pre.scale = FALSE, seed = NULL, verbose = TRUE, valid.x = NULL, valid.y = NULL, valid.metric = NULL, cluster.method = "kmeans", cluster.fun = NULL, cluster.predict = NULL,
  ...
)

)
dcSVM

Arguments

x  
the n x p training data matrix. Could be a matrix or a sparse matrix object.

y  
a response vector for prediction tasks with one value for each of the n rows of x. 
For classification, the values correspond to class labels and can be a 1 x n matrix, 
a simple vector or a factor.

k  
the number of sub-problems divided

m  
the number of sample for kernel kmeans

kernel  
the kernel type: 1 for linear, 2 for polynomial, 3 for gaussian

max.levels  
the maximum number of level

early  
whether use early prediction

final.training  
whether train the svm over the entire data again. usually not needed.

pre.scale  
either a logical value indicating whether to scale the data or not, or an integer 
vector specifying the columns. We don’t scale data in SVM seperately.

seed  
the random seed. Set it to NULL to randomize the model.

verbose  
a logical value indicating whether to print information of training.

valid.x  
the m x p validation data matrix.

valid.y  
if provided, it will be used to calculate the validation score with valid.metric

valid.metric  
the metric function for the validation result. By default it is the accuracy for 
classification. Customized metric is acceptable.

cluster.method  
The clustering algorithm to use. Possible choices are

- "kmeans" Algorithm from stats::kmeans
- "mlKmeans" Algorithm from RcppMLPACK::mlKmeans
- "kernkmeans" Algorithm from kernlab::kkmeans

If cluster.fun and cluster.predict are provided, cluster.method doesn’t 
work anymore.

cluster.fun  
The function to train cluster labels for the data based on given number of centers. 
Customized function is acceptable, as long as the resulting list contains two 
fields named as cluster and centers.

cluster.predict  
The function to predict cluster labels for the data based on trained object. Custom- 
ized function is acceptable, as long as the resulting list contains two fields 
named as cluster and centers.

...  
other parameters passed to e1071::svm

Value

- svm a list of svm models if using early prediction, or an svm object otherwise.
- early whether using the early prediction strategy or not
- cluster.tree a matrix containing clustering labels in each level
- cluster.fun the clustering training function
- cluster.predict the clustering predicting function
**eucliDist**

Euclidean Distance calculation

**Description**

Euclidean Distance calculation

**Usage**

`eucliDist(x, centers)`

**Arguments**

- `x` : the data matrix
- `centers` : the matrix of centers

---

- scale a list containing scaling information
- `valid.pred` the validation prediction
- `valid.score` the validation score
- `valid.metric` the validation metric
- `time` a list object recording the time consumption for each steps.

**Examples**

```r
data(svmguide1)
svmguide1.t = as.matrix(svmguide1[[2]])
svmguide1 = as.matrix(svmguide1[[1]])
dcsvm.model = dcSVM(x = svmguide1[-1], y = svmguide1[,1],
                    k = 4, max.levels = 4, seed = 0, cost = 32, gamma = 2,
                    kernel = 3, early = 0, m = 800,
                    valid.x = svmguide1.t[-1], valid.y = svmguide1.t[,1])
preds = dcsvm.model$valid.pred
table(preds, svmguide1.t[,1])
dcsvm.model$valid.score
```
gater

Gater function for mixture SVMs

Description

Gater function for mixture SVMs

Usage

gater(
  x,
  y,
  S,
  hidden,
  learningrate = 0.01,
  threshold = 0.01,
  stepmax = 100,
  verbose = verbose,
  ...
)

Arguments

x the nxp training data matrix. Could be a matrix or a sparse matrix object.
y a response vector for prediction tasks with one value for each of the n rows of x. For classification, the values correspond to class labels and can be a 1xn matrix, a simple vector or a factor. For regression, the values correspond to the values to predict, and can be a 1xn matrix or a simple vector.
S the prediction matrix from experts
hidden the number of neurons in the hidden layer
learningrate the learningrate for the back propagation
threshold neural network stops training once all gradient is below the threshold
stepmax the maximum iteration of the neural network training process
verbose a logical value indicating whether to print information of training.
... other parameters passing to neuralnet
gaterSVM

*Mixture SVMs with gater function*

**Description**

Implementation of Collobert, R., Bengio, S., and Bengio, Y. "A parallel mixture of SVMs for very large scale problems. Neural computation".

**Usage**

```r
gaterSVM(
  x,
  y,
  m,
  c = 1,
  max.iter,
  hidden = 5,
  learningrate = 0.01,
  threshold = 0.01,
  stepmax = 100,
  seed = NULL,
  valid.x = NULL,
  valid.y = NULL,
  valid.metric = NULL,
  verbose = FALSE,
  ...
)
```

**Arguments**

- **x**: the n x p training data matrix. Could be a matrix or an object that can be transformed into a matrix object.
- **y**: a response vector for prediction tasks with one value for each of the n rows of x. For classification, the values correspond to class labels and can be a 1 x n matrix, a simple vector or a factor. For regression, the values correspond to the values to predict, and can be a 1 x n matrix or a simple vector.
- **m**: the number of experts
- **c**: a positive constant controlling the upper bound of the number of samples in each subset.
- **max.iter**: the number of iterations
- **hidden**: the number of neurons on the hidden layer
- **learningrate**: the learning rate for the back propagation
- **threshold**: neural network stops training once all gradient is below the threshold
- **stepmax**: the maximum iteration of the neural network training process
**kmeans.predict**

*Euclidean Distance based clustering prediction*

**Description**

Euclidean Distance based clustering prediction

**Usage**

```r
kmeans.predict(x, cluster.object)
```

**Arguments**

- `x` the data matrix
- `cluster.object` the matrix of centers

---

**seed**

the random seed. Set it to `NULL` to randomize the model.

**valid.x**

the mxp validation data matrix.

**valid.y**

if provided, it will be used to calculate the validation score with `valid.metric`

**valid.metric**

the metric function for the validation result. By default it is the accuracy for classification. Customized metric is acceptable.

**verbose**

a logical value indicating whether to print information of training.

... other parameters passing to `neuralnet`

**Value**

- expert a list of svm experts
- gater the trained neural network model
- valid.pred the validation prediction
- valid.score the validation score
- valid.metric the validation metric
- time a list object recording the time consumption for each steps.

**Examples**

```r
data(svmguide1)
svmguide1.t = as.matrix(svmguide1[[2]])
svmguide1 = as.matrix(svmguide1[[1]])
gaterSVM.model = gaterSVM(x = svmguide1[,-1], y = svmguide1[,1], hidden = 10, seed = 0,
                          m = 10, max.iter = 1, learningrate = 0.01, threshold = 1, stepmax = 100,
                          valid.x = svmguide1.t[,-1], valid.y = svmguide1.t[,1], verbose = FALSE)
table(gaterSVM.model$valid.pred,svmguide1.t[,1])
gaterSVM.model$valid.score
```
plot.alphasvm

---

Plot alphasvm object

Description

Plot alphasvm object

Usage

```r
## S3 method for class 'alphasvm'
plot(
x, 
data, 
formula = NULL, 
fill = TRUE, 
grid = 50, 
slice = list(), 
symbolPalette = grDevices::palette(), 
svSymbol = "x", 
dataSymbol = "o", 
...
)
```

Arguments

- **x**: An object of class alphasvm
- **data**: data to visualize. Should be the same used for fitting.
- **formula**: formula selecting the visualized two dimensions. Only needed if more than two input variables are used.
- **fill**: switch indicating whether a contour plot for the class regions should be added.
- **grid**: granularity for the contour plot.
- **slice**: a list of named values for the dimensions held constant (only needed if more than two variables are used). The defaults for unspecified dimensions are 0 (for numeric variables) and the first level (for factors). Factor levels can either be specified as factors or character vectors of length 1.
- **symbolPalette**: Color palette used for the class the data points and support vectors belong to.
- **svSymbol**: Symbol used for support vectors.
- **dataSymbol**: Symbol used for data points (other than support vectors).
- **...**: additional graphics parameters passed to `graphics::filled.contour` and `plot`.
predict.alphasvm

Prediction function for an alphasvm object

Description
Prediction function for an alphasvm object

Usage
## S3 method for class 'alphasvm'
predict(
  object,
  newdata,
  decision.values = FALSE,
  probability = FALSE,
  ..., 
  na.action = stats::na.omit
)

Arguments
- object: the object trained from alphasvm
- newdata: the test data set
- decision.values: a logical variable indicating whether to output the decision values
- probability: a logical variable indicating whether to output the classification probability
- ...: currently not used
- na.action: A function to specify the action to be taken if 'NA's are found. The default action is stats::na.omit, which leads to rejection of cases with missing values on any required variable. An alternative is stats::na.fail, which causes an error if NA cases are found. (NOTE: If given, this argument must be named.)

predict.clusterSVM

Predictions with Clustered Support Vector Machines

Description
The function applies a model (classification) produced by the clusterSVM function to every row of a data matrix and returns the model predictions.

Usage
## S3 method for class 'clusterSVM'
predict(object, newdata = NULL, cluster.predict = NULL, ...)

predict.gater

Arguments

object Object of class "clusterSVM", created by clusterSVM.
newdata An n x p matrix containing the new input data. Could be a matrix or a sparse matrix object.
cluster.predict a function predict new labels on newdata.
... other parameters passing to predict.LiblineaR

predict.dcSVM Predictions with Divide-Conquer Support Vector Machines

Description

The function applies a model produced by the dcSVM function to every row of a data matrix and returns the model predictions.

Usage

## S3 method for class 'dcSVM'
predict(object, newdata, ...)

Arguments

object Object of class "dcSVM", created by dcSVM.
newdata An n x p matrix containing the new input data. Could be a matrix or a sparse matrix object.
... other parameters passing to predict.svm

predict.gater Predictions for Gater function

Description

The function applies a model produced by the gaterSVM function to every row of a data matrix and returns the model predictions.

Usage

## S3 method for class 'gater'
predict(object, newdata, ...)

predict.gaterSVM

Arguments

object Object of class "gater", created by gater.
newdata An n x p matrix containing the new input data. Could be a matrix or a sparse matrix object.
... parameters for future usage.

Description

The function applies a model produced by the gaterSVM function to every row of a data matrix and returns the model predictions.

Usage

## S3 method for class 'gaterSVM'
predict(object, newdata, ...)

Arguments

object An object of class gaterSVM
newdata newdata An n x p matrix containing the new input data. Could be a matrix or a sparse matrix object.
... parameters for future usage.

svmguide1

Description

An astroparticle application from Jan Conrad of Uppsala University, Sweden.

Usage

data(svmguide1)

Format

A list of two data objects svmguide1 and svmguide1.t. The first column is the target variable.
**SwarmSVM**

*SwarmSVM: A Package for several Ensemble Support Vector Machine Models*

**Description**

The SwarmSVM package contains three different Ensemble SVM models, they all train SVM models on subset of data and combine the results together. The three models are from the following three papers:

**Details**


**SwarmSVM functions**

- clusterSVM
dcSVM
gaterSVM

---

**write.alphasvm**

*Write alphasvm object*

**Description**

Write alphasvm object

**Usage**

```r
## S3 method for class 'alphasvm'
write(
  object,
  svm.file = "Rdata.svm",
  scale.file = "Rdata.scale",
  yscale.file = "Rdata.yscale"
)
```

**Arguments**

- `object` Object of class "alphasvm", created by alphasvm.
- `svm.file` filename to export the alphasvm object to.
- `scale.file` filename to export the scaling data of the explanatory variables to.
- `yscale.file` filename to export the scaling data of the dependent variable to, if any.
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