Machine Learning with R

Unsupervised Learning

Clustering: task of grouping a set of objects in such a way that objects in the same group are more similar to each other than to those in other groups

K-Means

- Randomly choose k
- Group observations by minimizing distance to centroid
- Shift centroids for every classified observation until there are no more shift

R BASE Package

kmeans(df, k)
arguments:
-df: dataset used to run the algorithm
-k: Number of clusters
-kmeans(df, k)$cluster returns the clusters each row of data belongs to

```
> kmeans(df,3)$cluster
 [1] 1 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3
```

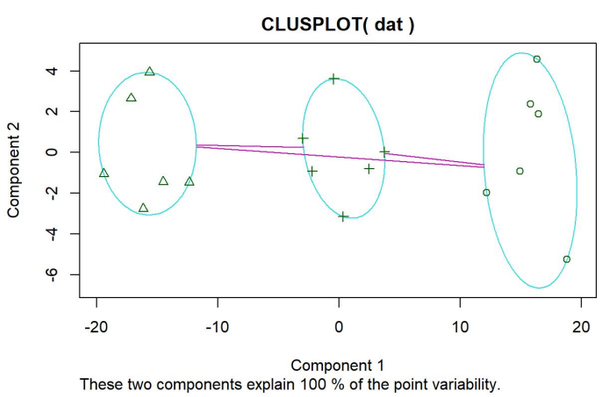
Visualization

cluster Package

- clusplot draws a 2-dimensional plot of clusters using PCA to summarize the variability in two dimensions
- ellipses summarize the covariance within each group

clusplot(df,cluster)
-cluster: the cluster vector; often obtained by kmeans(df,k)$cluster
-create the cluster plot

```
> clusplot(df, kmeans(dat,3)$cluster)
```



Ward's Method

- Hierarchical clustering
- Merge pair of clusters at each step based on minimizing the sum of squares error

stats Package

d_mat=dist(df,method="euclidean")
-df: dataset used to run the algorithm
-returns a euclidean distance matrix

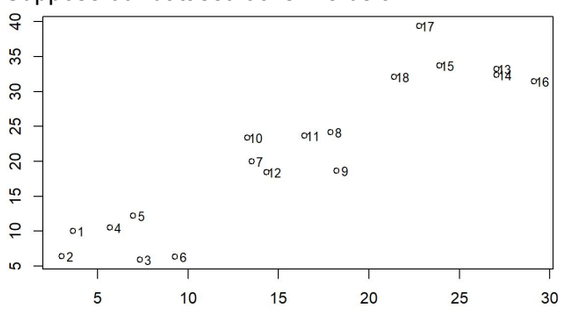
tree=hcluster(d_mat,method="ward")
-returns a tree by fitting Ward's method on the previous distance matrix

cutree(tree,k)
-tree: object returned by *hcluster*
-k: number of expected clusters
-returns the clusters each row of data belongs to

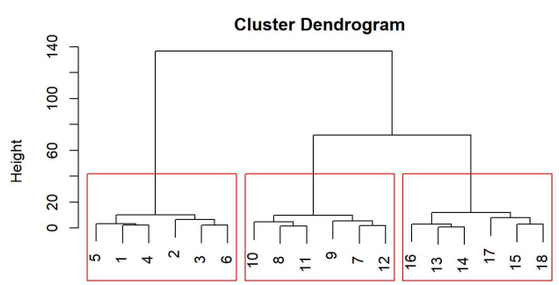
Visualization:
plot(tree)
-plot the cluster dendrogram

rect.hclust(tree,k,border)
-first 2 arguments are the same as in *cutree*
-border: border color (e.g. "red")
-draw the rectangular borders around the clusters

Suppose our dataset looks like below



```
> cutree(tree,k=3)
 [1] 1 1 1 1 1 1 2 2 2 2 2 2 3 3 3 3 3 3
> plot(tree)
> rect.hclust(tree,k=3,border="red")
```



Supervised Learning

Linear Regression: linear approach for modelling the relationship between a scalar response and one or more explanatory variables

stats Package

lm(formula, data)
arguments:
-formula: symbolic description of the model to be fit (ex. height~age)
-data: data points in the form of a dataframe

Ridge Regression: method of estimating the coefficients of multiple-regression models in scenarios where the independent variables are highly correlated.

glmnet Package

glmnet(x,y,alpha)
arguments:
-x: input matrix of explanatory variables
-y: response variable
-alpha: 1 → Lasso Regression, 0-1 → elastic net

Random Forests: ensemble learning method for classification, regression and other tasks that operates by constructing a multitude of decision trees

randomForest Package

randomForest(formula,data,proximity)

arguments:
-formula: symbolic description of the model to be fit (ex. height~age)
-data: training data
-proximity: True/False, used in replacing missing data, locating outliers, and producing illuminating low-dimensional views of the data.

Evaluating Random Forest -Confusion Matrix

predict(model, data)
arguments:
-model: randomForest model object
-data: test dataset to predict on

confusionMatrix(model_predictions,data)
-model_predictions: output from predict function
-data: ground truth test dataset

	setosa	versicolor	virginica	class.error
setosa	35	0	0	0.00000000
versicolor	0	35	1	0.02777778
virginica	0	2	33	0.05714286

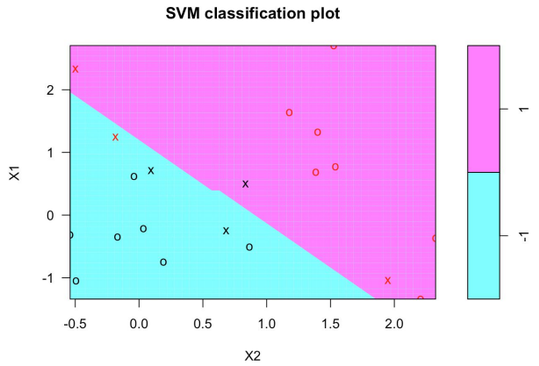
Support Vector Machines: performs supervised learning for classification or regression of data groups

e1071 Package

svm(formula, data , kernel, cost, scale)
-formula: symbolic description of the model to be fit
-data: data frame containing the variables in the mode
-kernel: kernel used in training and predicting (linear, polynomial, radial basis or sigmoid)
-cost: 'C'-constant of the regularization term in the Lagrange formulation
-scale: whether to scale the variables

Visualizing your Support Vector Machine

plot(model, data)
arguments:
-model: SVMmodel object
-data: data frame containing the variables in the mode



Here you can visualize the support vectors ('x' points) and the the decision boundary. However, there's no control over the colors and breaks with convention since it puts x2 on the horizontal axis and x1 on the vertical axis.

K-Nearest Neighbors: classification algorithm that uses proximity to make classifications or predictions about the grouping of an individual data point

class Package

knn(train,test,cl,k)
arguments:
- train: data frame of training set cases
- test: data frame of test set cases
- cl: factor of true classifications of training set
- k: number of neighbours considered

Evaluating KNN-Confusion Matrix

table(model,data)
arguments:
-model: KNN model object
-data: test dataset to predict on