Data Science II: Homework 5

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Question 1: In this problem, we will apply support vector machines to predict whether a given car gets high or low gas mileage based on the dataset "auto.csv" (used in Homework 3; see Homework 3 for more details of the dataset). The response variable is mpg cat. The predictors are cylinders, displacement, horsepower, weight, acceleration, year, and origin. Split the dataset into two parts: training data (70%) and test data (30%).

```
auto = read.csv("auto.csv")
head(auto)
```

```
##   cylinders displacement horsepower weight acceleration year origin mpg_cat
## 1         8          307        130   3504         12.0   70      1     low
## 2         8          350        165   3693         11.5   70      1     low
## 3         8          318        150   3436         11.0   70      1     low
## 4         8          304        150   3433         12.0   70      1     low
## 5         8          302        140   3449         10.5   70      1     low
## 6         8          429        198   4341         10.0   70      1     low
```

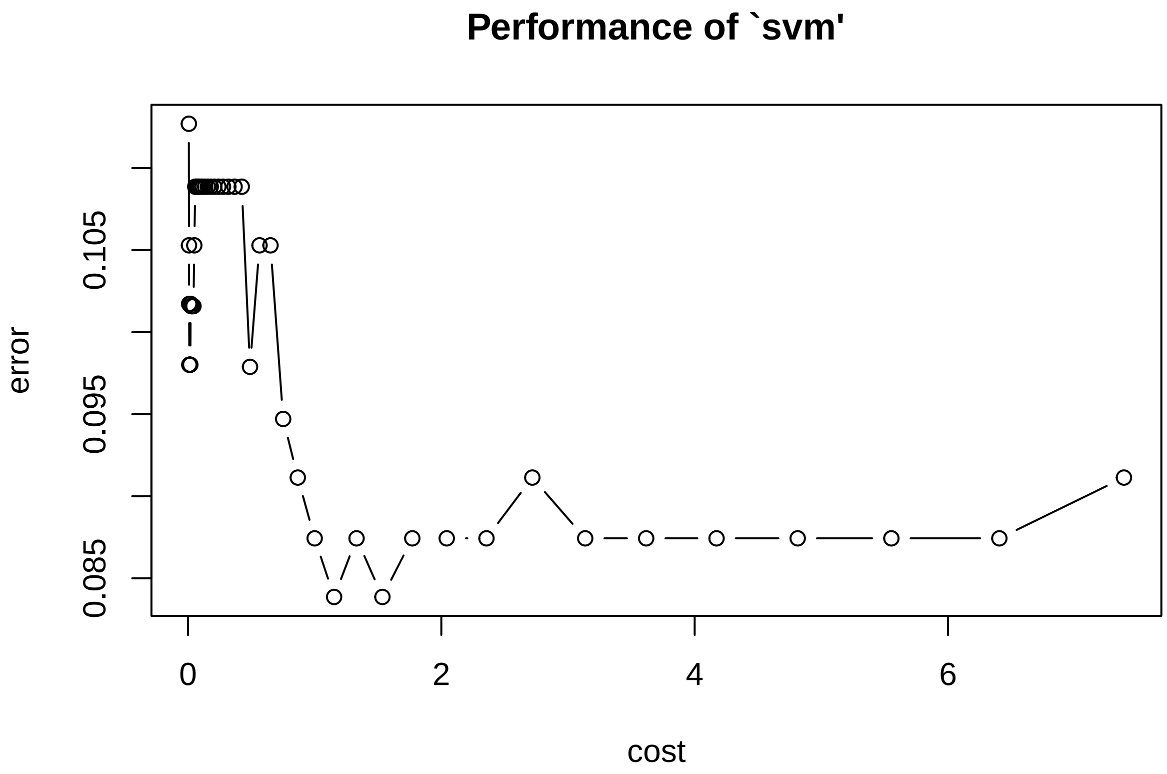
```
set.seed(111111)
datSplit = initial_split(data = auto, prop = 0.7)
trainData = training(datSplit)
testData = testing(datSplit)
head(trainData)
```

```
##   cylinders displacement horsepower weight acceleration year origin mpg_cat
## 1         4          134         95   2515         14.8   78      3     low
## 2         4          156         92   2585         14.5   82      1    high
## 3         6          168        120   3820         16.7   76      2     low
## 4         4          151         90   2670         16.0   79      1    high
## 5         6          258        110   3632         18.0   74      1     low
## 6         4           98         68   2135         16.6   78      3    high
```

```
trainData$mpg_cat = as.factor(trainData$mpg_cat)
testData$mpg_cat = as.factor(testData$mpg_cat)
```

(a): Fit a support vector classifier to the training data. What are the training and test error rates?

```
set.seed(1)
linear.tune <- tune.svm(mpg_cat ~ .,
                        data = trainData,
                        kernel = "linear",
                        cost = exp(seq(-5,2, len = 50)),
                        scale = TRUE)
plot(linear.tune)
```



```
best.linear = linear.tune$best.model

train.pred = predict(best.linear, trainData)
train.error = mean(train.pred != trainData$mpg_cat)

test.pred <- predict(best.linear, testData)
test.error <- mean(test.pred != testData$mpg_cat)

print(train.error)
```

```
## [1] 0.08029197
```

```
print(test.error)
```

```
## [1] 0.07627119
```

(b): Fit a support vector machine with a radial kernel to the training data. What are the training and test error rates?

Question 2: In this problem, we perform hierarchical clustering on the states using the USArrests data in the ISLR package. For each of the 50 states in the United States, the dataset contains the number of arrests per 100,000 residents for each of three crimes: Assault, Murder, and Rape. The dataset also contains the percent of the population in each state living in urban areas, UrbanPop. The four variables will be used as features for clustering.

(a): Using hierarchical clustering with complete linkage and Euclidean distance, cluster the states. Cut the dendrogram at a height that results in three distinct clusters. Which states belong to which clusters?

(b): Hierarchically cluster the states using complete linkage and Euclidean distance, after scaling the variables to have standard deviation one. Does scaling the variables change the clustering results? In your opinion, should the variables be scaled before the inter-observation dissimilarities are computed?