P8106 HW5 yz4184

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Contents


```
library(tidyverse)
library(caret)
library(e1071)
library(kernlab)
library(ISLR)
```

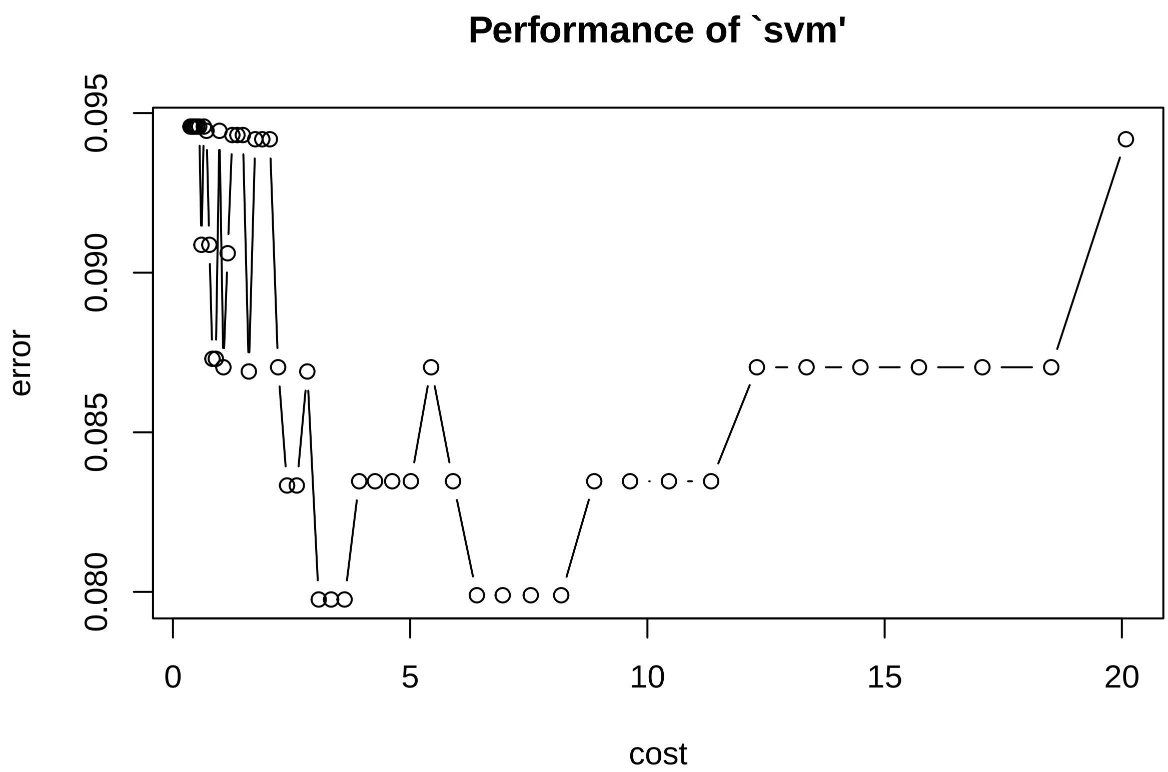
Problem 1

```
# import data
dat = read.csv("./auto.csv")%>%
  na.omit() %>%
  mutate(
    cylinders = as.factor(cylinders),
         year = as.factor(year),
         origin = as.factor(origin),
    mpg_cat = factor(mpg_cat, levels = c("low", "high")))

# divide data into two parts (training and test)
set.seed(1)
rowTrain <- createDataPartition(y = dat$mpg_cat,
                                p = 0.7,
                                list = FALSE)

train_df = dat[rowTrain,]
test_df = dat[-rowTrain,]
```

Part a

Fit a support vector classifier (linear kernel) to the training data.

```
set.seed(1)
linear.tune <- tune.svm( mpg_cat ~ . ,
data = train_df,
kernel = "linear",
cost = exp(seq(-1,3,len=50)),
scale = TRUE)
plot(linear.tune)
```




```
best.linear <- linear.tune$best.model
summary(best.linear)
```

```
##
## Call:
## best.svm(x = mpg_cat ~ ., data = train_df, cost = exp(seq(-1, 3,
##     len = 50)), kernel = "linear", scale = TRUE)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  linear
```

```
##        cost:  3.072369
##
## Number of Support Vectors:  50
##
##  ( 27 23 )
##
##
## Number of Classes:  2
##
## Levels:
##  low high
```

According to the cost-error plot and best model summary above, we can conclude that the best tuning parameter c is 3.072369.

There are 50 support vectors in the optimal support vector classifier with a linear kernel.

Training error rate

```
#train error
pred.linear.train <- predict(best.linear, newdata = train_df)
confusionMatrix(data = pred.linear.train,
                reference = train_df$mpg_cat)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction low high
##       low  134    7
##       high   4  131
##
##                Accuracy : 0.9601
##                  95% CI : (0.9298, 0.9799)
##     No Information Rate : 0.5
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9203
##
##  Mcnemar's Test P-Value : 0.5465
##
##             Sensitivity : 0.9710
##             Specificity : 0.9493
##          Pos Pred Value : 0.9504
##          Neg Pred Value : 0.9704
##              Prevalence : 0.5000
##          Detection Rate : 0.4855
##    Detection Prevalence : 0.5109
##       Balanced Accuracy : 0.9601
##
##        'Positive' Class : low
##
```

According to the confusion Matrix above, the accuracy is 0.9601, so the training error rate is (1-0.9601)*100% = 3.99% .

Test error rate

```r
#test error
pred.linear.test <- predict(best.linear, newdata = test_df)
confusionMatrix(data = pred.linear.test,
                reference = test_df$mpg_cat)
```

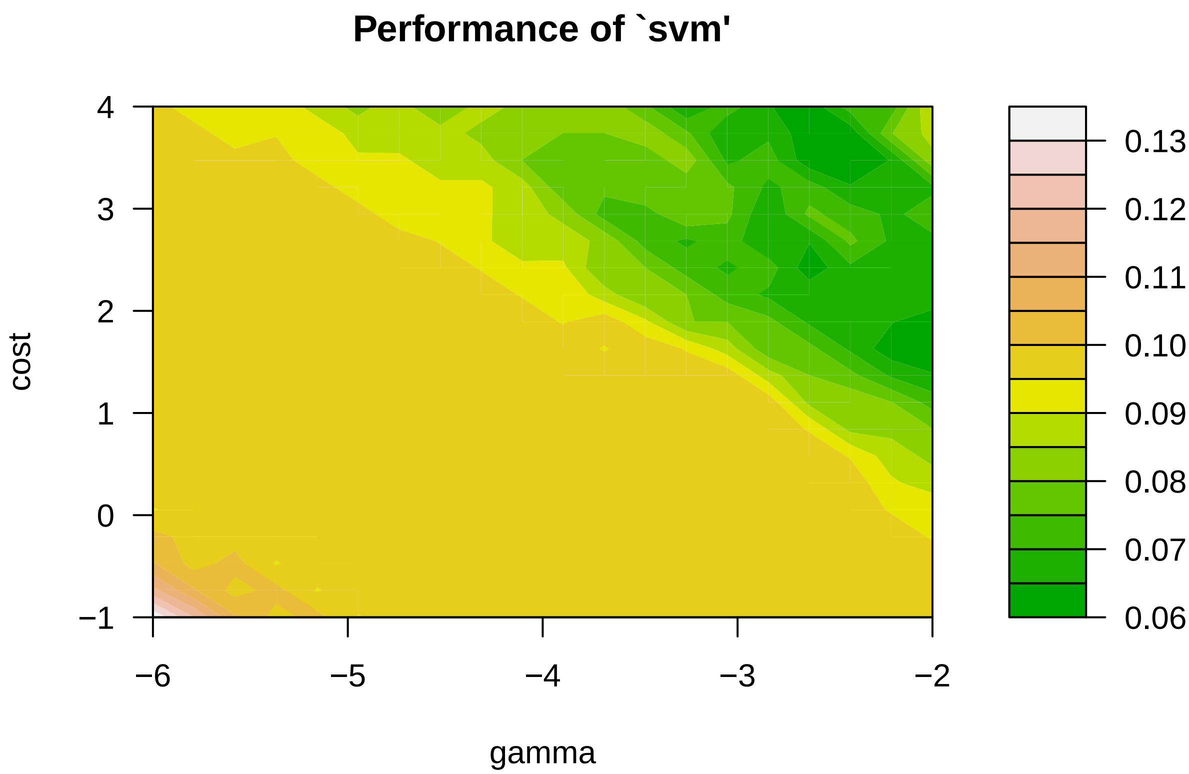
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction low high
##       low   50    4
##       high   8   54
##
##                Accuracy : 0.8966
##                  95% CI : (0.8263, 0.9454)
##     No Information Rate : 0.5
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.7931
##
##  Mcnemar's Test P-Value : 0.3865
##
##             Sensitivity : 0.8621
##             Specificity : 0.9310
##          Pos Pred Value : 0.9259
##          Neg Pred Value : 0.8710
##              Prevalence : 0.5000
##          Detection Rate : 0.4310
##    Detection Prevalence : 0.4655
##       Balanced Accuracy : 0.8966
##
##        'Positive' Class : low
##
```

According to the confusion Matrix above, the accuracy is 0.8966, so the test error rate is (1-0.8966)*100% = 10.34% .

Part b

Fit a support vector machine with a radial kernel to the training data.

```
set.seed(1)
radial.tune <- tune.svm( mpg_cat ~ . ,
                         data = train_df,
                        kernel = "radial",
                        cost = exp(seq(-1,4,len=20)),
                        gamma = exp(seq(-6,-2,len=20)))

plot(radial.tune, transform.y = log, transform.x = log,
     color.palette = terrain.colors)
```




```
radial.tune$best.parameters
```

```
##          gamma     cost
## 357 0.07196474 32.25536
```

```
best.radial <- radial.tune$best.model
summary(best.radial)
```

```
##
```

```
## Call:
## best.svm(x = mpg_cat ~ ., data = train_df, gamma = exp(seq(-6, -2,
##     len = 20)), cost = exp(seq(-1, 4, len = 20)), kernel = "radial")
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  32.25536
##
## Number of Support Vectors:  54
##
##  ( 29 25 )
##
##
## Number of Classes:  2
##
## Levels:
##  low high
```

According to the gamma-cost plot and best parameters summary above, we can conclude that the best tuning parameters, gamma and cost, of the support vector machine are 0.07196474 and 32.25536.

There are 54 support vectors in the optimal support vector classifier with a linear kernel.

Training error rate

```r
#train error
pred.radial <- predict(best.radial, newdata = train_df)

confusionMatrix(data = pred.radial,
                reference = train_df$mpg_cat)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction low high
##       low  137    2
##       high   1  136
##
##                Accuracy : 0.9891
##                  95% CI : (0.9686, 0.9978)
##     No Information Rate : 0.5
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9783
##
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9928
##             Specificity : 0.9855
##          Pos Pred Value : 0.9856
```

```
##          Neg Pred Value : 0.9927
##              Prevalence : 0.5000
##          Detection Rate : 0.4964
##    Detection Prevalence : 0.5036
##       Balanced Accuracy : 0.9891
##
##        'Positive' Class : low
##
```

According to the confusion Matrix above, the accuracy is 0.9891, so the training error rate is (1-0.9891)*100% = 1.09% .

Test error rate

```r
#test error
pred.radial <- predict(best.radial, newdata = test_df)

confusionMatrix(data = pred.radial,
                reference = test_df$mpg_cat)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction low high
##       low   49    4
##       high   9   54
##
##                Accuracy : 0.8879
##                  95% CI : (0.816, 0.939)
##     No Information Rate : 0.5
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.7759
##
##  Mcnemar's Test P-Value : 0.2673
##
##             Sensitivity : 0.8448
##             Specificity : 0.9310
##          Pos Pred Value : 0.9245
##          Neg Pred Value : 0.8571
##              Prevalence : 0.5000
##          Detection Rate : 0.4224
##    Detection Prevalence : 0.4569
##       Balanced Accuracy : 0.8879
##
##        'Positive' Class : low
##
```

According to the confusion Matrix above, the accuracy is 0.8879, so the test error rate is (1-0.8879)*100% = 11.21% .

Problem 2

```
# import data
data(USArrests)
arrests_df = USArrests %>%
  as.data.frame() %>%
  janitor::clean_names()
```