Asteroid_KNN

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```
df <- read.csv("~/Documents/Georgetown/Spring23/Statistical Learning & Data Science/Proj
ect/NASA-asteroid-Classification-master/final/nasa.csv")
df <- df[ , !(names(df) %in% c("X"))]

df <- df[-695,]
```

```
library(caret)
```

```
## Loading required package: ggplot2
```

```
## Loading required package: lattice
```

```
# function to normalize data
normalize <- function(x) {
  return ((x - min(x)) / (max(x) - min(x))) }

arr.norm <- apply(df[,-21], 2, normalize)

arr.norm <- data.frame(arr.norm, df$Hazardous)

colnames(arr.norm)[colnames(arr.norm) == "df.Hazardous"] ="Hazardous"
```

(3.b) Fit kNN using 5-fold CV over a grid of values between 1 and 21 for the number of neighbors k,

using set.seed(1). How many neighbors are used in the final model?

```
# 5-fold CV to choose k

set.seed(1)

arr.norm$Hazardous <- as.factor(arr.norm$Hazardous)

fit.knn <- train(Hazardous ~ .,
  method = "knn",
  tuneGrid = expand.grid(k = 1:21),
  trControl = trainControl(method="cv", number=5, savePredictions = TRUE, classProbs = T
RUE),
  metric = "Accuracy",
  data = arr.norm)

fit.knn
```

```
## k-Nearest Neighbors
##
## 3078 samples
##   20 predictor
##    2 classes: 'False', 'True'
##
## No pre-processing
## Resampling: Cross-Validated (5 fold)
## Summary of sample sizes: 2462, 2463, 2463, 2462, 2462
## Resampling results across tuning parameters:
##
##   k   Accuracy   Kappa
##    1  0.8645222  0.4227282
##    2  0.8534785  0.3734312
##    3  0.8804429  0.4254110
##    4  0.8749203  0.3926299
##    5  0.8814180  0.4071912
##    6  0.8778418  0.3926183
##    7  0.8801167  0.3847148
##    8  0.8797931  0.3796854
##    9  0.8775209  0.3589633
##   10  0.8804466  0.3685311
##   11  0.8801193  0.3552413
##   12  0.8804440  0.3575683
##   13  0.8797936  0.3410263
##   14  0.8797936  0.3371958
##   15  0.8801177  0.3317969
##   16  0.8762200  0.3033070
##   17  0.8788180  0.3181018
##   18  0.8781718  0.3167519
##   19  0.8794684  0.3145760
##   20  0.8768699  0.2957819
##   21  0.8791442  0.3117543
##
## Accuracy was used to select the optimal model using the largest value.
## The final value used for the model was k = 5.
```

5 neighbors are used in the final model.

(3.c) Which are the 10 most important variables using kNN? Is there any overlap with the variables you

selected using the lasso penalized logistic regression?

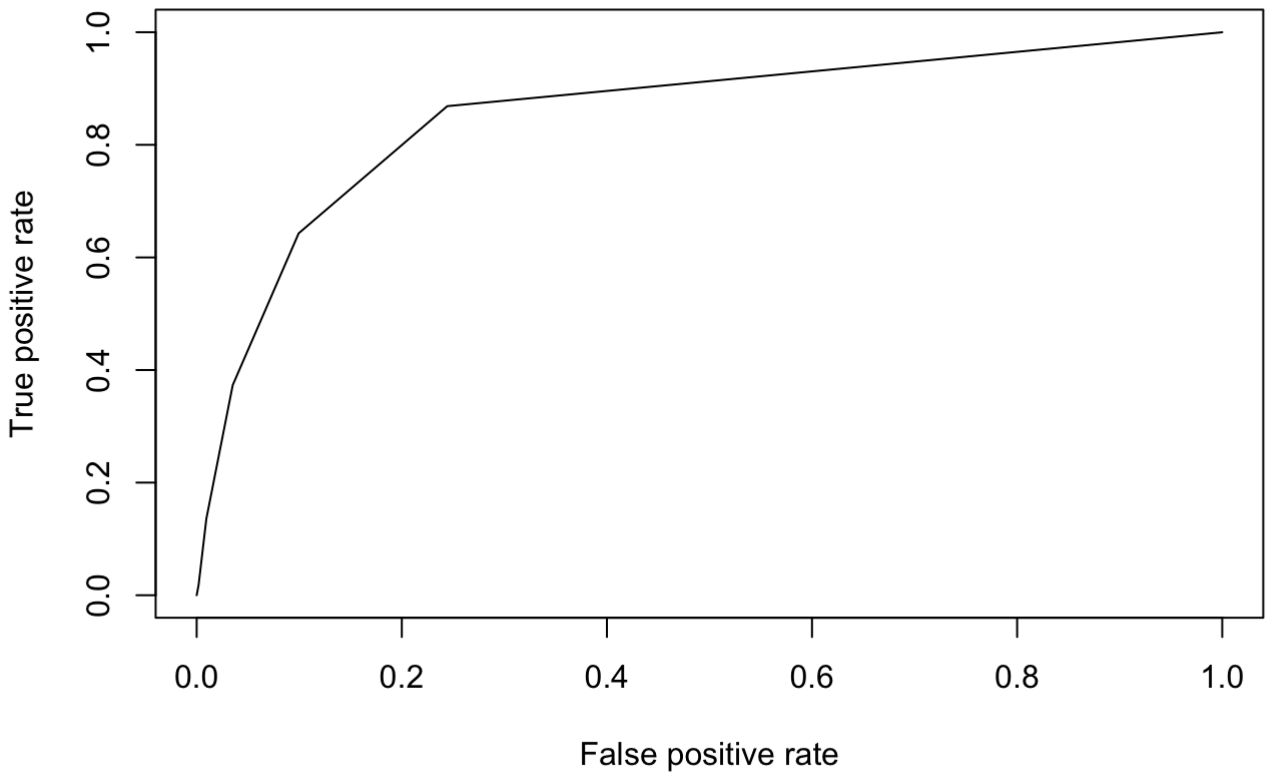
```
imp2 <- varImp(fit.knn)$importance
imp2 <- imp2[order(imp2$True, decreasing=T)[1:10],]
imp2
```

```
##                                     False      True
## Absolute.Magnitude              100.00000 100.00000
## Est.Dia.in.KM.min.              100.00000 100.00000
## Est.Dia.in.KM.max.              100.00000 100.00000
## Est.Dia.in.KM.range             100.00000 100.00000
## Orbit.Uncertainity               93.70653  93.70653
## Minimum.Orbit.Intersection       76.29926  76.29926
## Relative.Velocity.in.KM.per.sec  58.85243  58.85243
## Perihelion.Distance              58.33520  58.33520
## Eccentricity                     53.13038  53.13038
## Close.Approach.Date              26.30449  26.30449
```

```
# colnames(imp2)[1] <- "Importance"
# imp2[-2]
#
# intersect(rownames(imp2), sel.names)
```

(3.d) Provide the cross-validated ROC curve and its AUC.

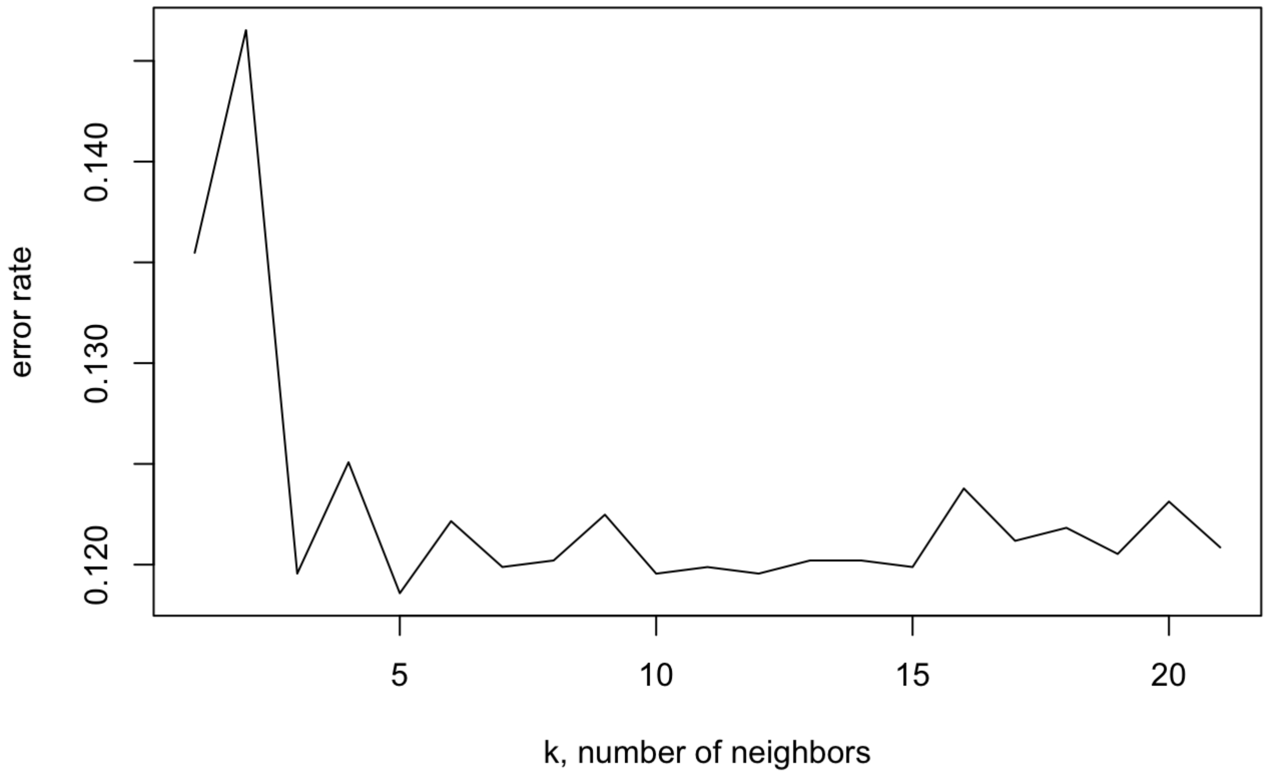
```
library(ROCR)
pihatcv.knn <- fit.knn$pred[fit.knn$pred$k == 5,]
pred <- prediction(pihatcv.knn$True, pihatcv.knn$obs)
perf <- performance(pred, "tpr", "fpr")
plot(perf)
```



```
# Area under ROC curve (AUC) = concordance index
auc.perf = performance(pred, "auc")
knn_auc <- auc.perf@y.values
knn_auc
```

```
## [[1]]
## [1] 0.8553424
```

```
plot(fit.knn$results[,1], 1-fit.knn$results[,2], type="l",
xlab="k, number of neighbors", ylab="error rate")
```



```
#The predictions based on the selected k are:
pihat.fin <- predict(fit.knn, type="prob")
tail(pihat.fin)
```

```
##      False True
## 3073     1    0
## 3074     1    0
## 3075     1    0
## 3076     1    0
## 3077     1    0
## 3078     1    0
```

```
yhat.fin <- predict(fit.knn)
tail(yhat.fin)
```

```
## [1] False False False False False False
## Levels: False True
```

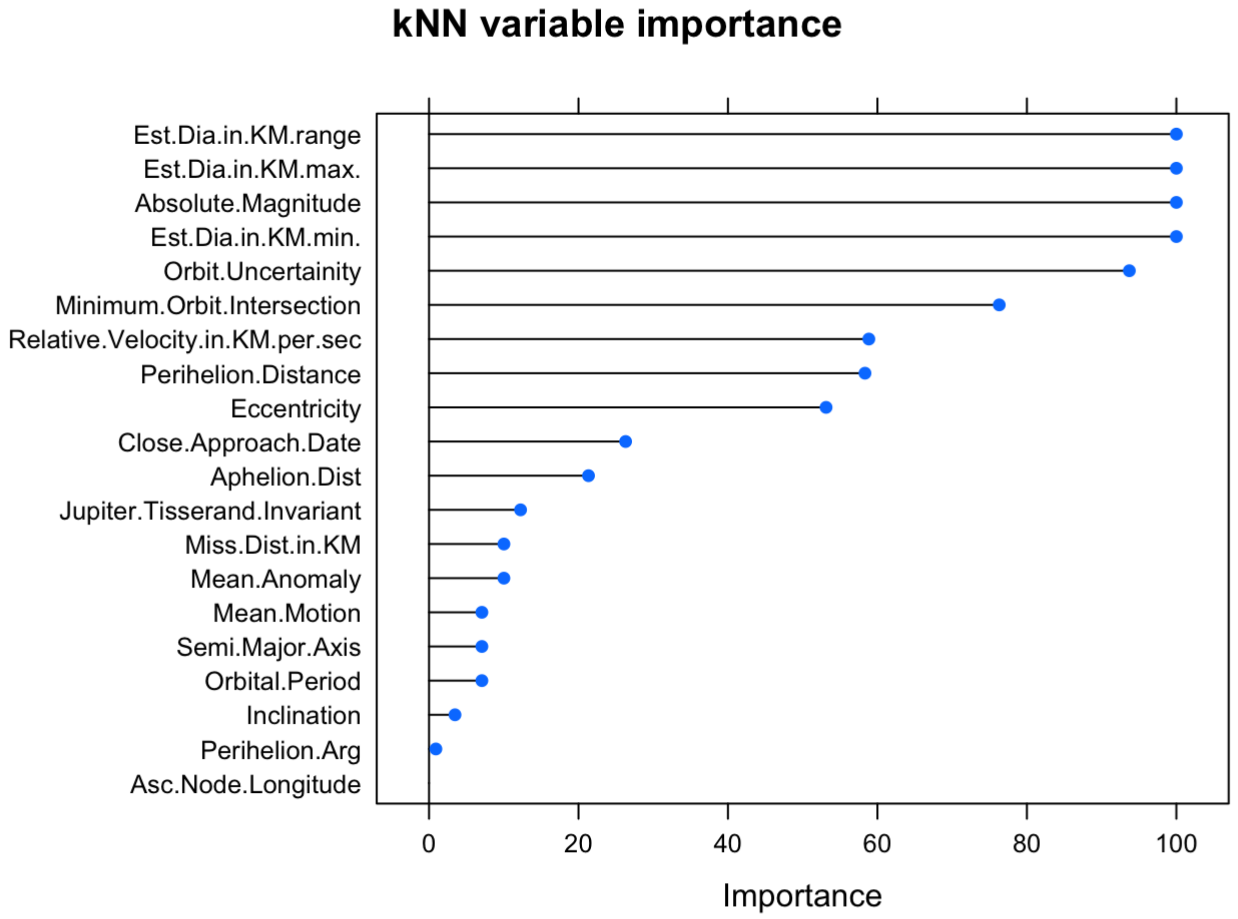
```
table(yhat.fin, df$Hazardous)
```

```
##
## yhat.fin False True
##    False  2591  197
##    True     53  237
```

```
tail(fit.knn$pred)
```

```
##        pred   obs     False       True rowIndex  k Resample
## 64633 False False 1.0000000 0.00000000     3057 21    Fold5
## 64634 False False 0.9047619 0.09523810     3061 21    Fold5
## 64635 False False 1.0000000 0.00000000     3062 21    Fold5
## 64636 False False 0.9523810 0.04761905     3069 21    Fold5
## 64637 False False 1.0000000 0.00000000     3077 21    Fold5
## 64638 False False 1.0000000 0.00000000     3078 21    Fold5
```

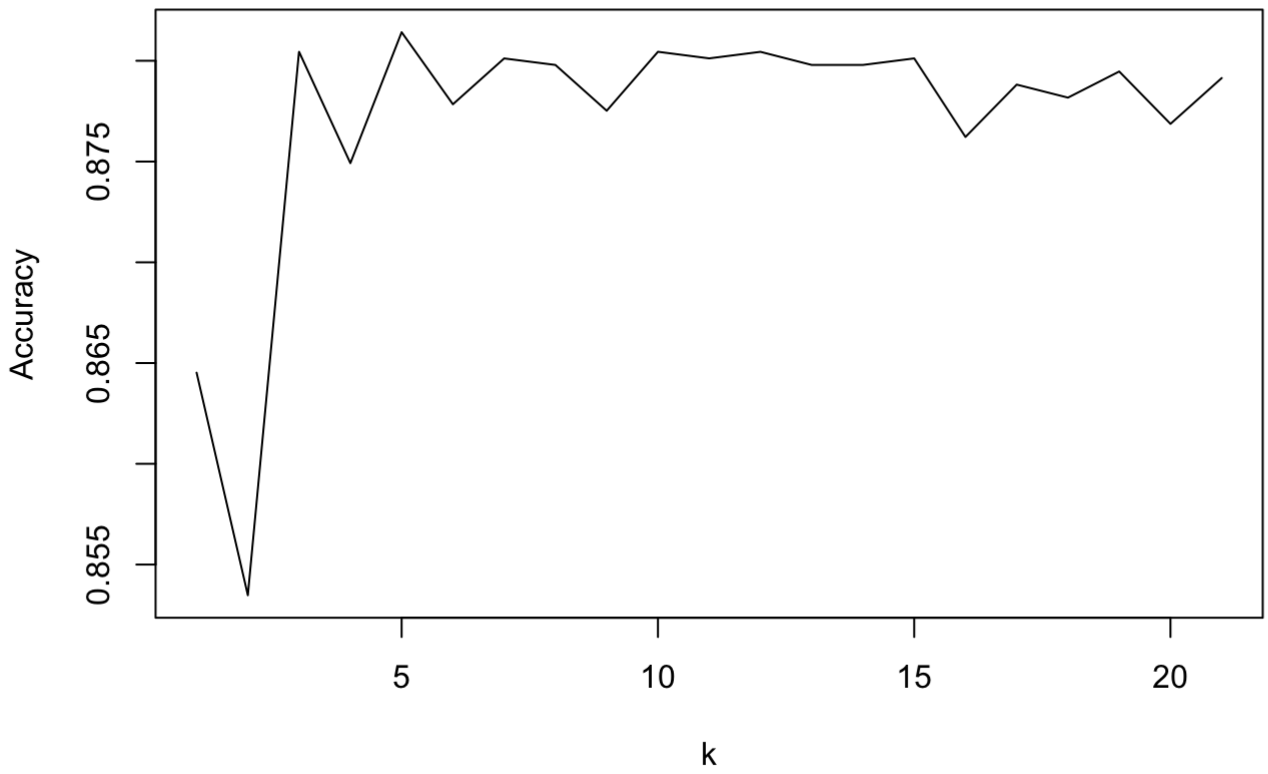
```
plot(varImp(fit.knn), main="kNN variable importance")
```



```
varImp(fit.knn)
```

```
## ROC curve variable importance
## 
##                                 Importance
## Est.Dia.in.KM.range               100.0000
## Est.Dia.in.KM.max.                100.0000
## Est.Dia.in.KM.min.                100.0000
## Absolute.Magnitude                100.0000
## Orbit.Uncertainity                 93.7065
## Minimum.Orbit.Intersection         76.2993
## Relative.Velocity.in.KM.per.sec    58.8524
## Perihelion.Distance                58.3352
## Eccentricity                       53.1304
## Close.Approach.Date                26.3045
## Aphelion.Dist                      21.3395
## Jupiter.Tisserand.Invariant        12.2465
## Miss.Dist.in.KM                    10.0205
## Mean.Anomaly                       10.0178
## Orbital.Period                      7.0710
## Mean.Motion                         7.0710
## Semi.Major.Axis                     7.0710
## Inclination                         3.4734
## Perihelion.Arg                      0.9156
## Asc.Node.Longitude                  0.0000
```

```
plot(fit.knn$results[,1:2], type="l")
```


Accuracy
0.855
0.865
0.875
5
10
15
20
k