```r
# Assignment: ASSIGNMENT 11.2.1
# Name: Anjale, Jiteshwar
# Date: 2021-05-29
#Introduction to Machine Learning

## Load the foreign package
library(caTools)
```

```
## Warning: package 'caTools' was built under R version 4.0.5
```

```r
library(ggplot2)
setwd('C:/Users/anjal/OneDrive/Desktop/MS/DSC520/dsc520')

# Load the `data/binary-classifier-data.csv` to
binary_df <- read.csv("C:/Users/anjal/OneDrive/Desktop/MS/DSC520/dsc520/data/binary-classifier-data.csv")

# Examine the structure of `binary-classifier-data.csv` using `str()`
str(binary_df)
```

```
## 'data.frame':    1498 obs. of  3 variables:
##  $ label: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ x    : num  70.9 75 73.8 66.4 69.1 ...
##  $ y    : num  83.2 87.9 92.2 81.1 84.5 ...
```

```r
# Show the top rows of binary-classifier-data.csv
head(binary_df)
```

```
##   label        x        y
## 1     0 70.88469 83.17702
## 2     0 74.97176 87.92922
## 3     0 73.78333 92.20325
## 4     0 66.40747 81.10617
## 5     0 69.07399 84.53739
## 6     0 72.23616 86.38403
```

```r
# Load the `data/trinary-classifier-data.csv` to
trinary_df <- read.csv("C:/Users/anjal/OneDrive/Desktop/MS/DSC520/dsc520/data/trinary-classifier-data.csv")

# Examine the structure of `trinary-classifier-data.csv` using `str()`
str(trinary_df)
```

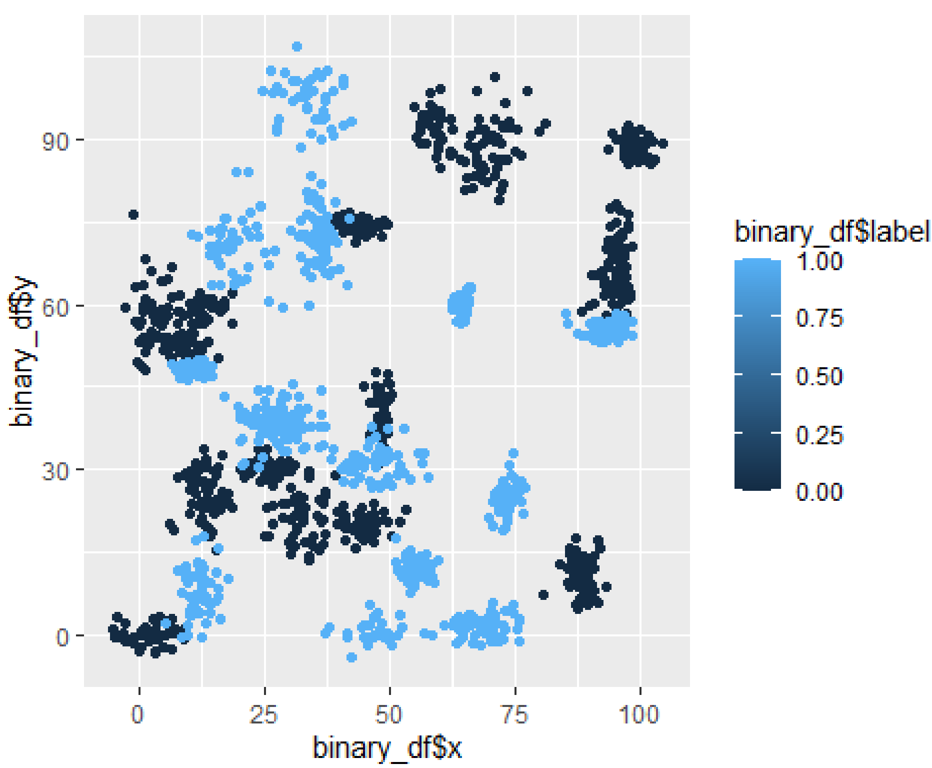
```
## 'data.frame':    1568 obs. of  3 variables:
##  $ label: int  0 0 0 0 0 0 0 0 0 0 ...
##  $ x    : num  30.1 31.3 34.1 32.6 34.7 ...
##  $ y    : num  39.6 51.8 49.3 41.2 45.5 ...
```

```r
# Show the top rows of trinary-classifier-data.csv
head(trinary_df)
```

```
##   label        x        y
## 1     0 30.08387 39.63094
## 2     0 31.27613 51.77511
## 3     0 34.12138 49.27575
## 4     0 32.58222 41.23300
## 5     0 34.65069 45.47956
## 6     0 33.80513 44.24656
```

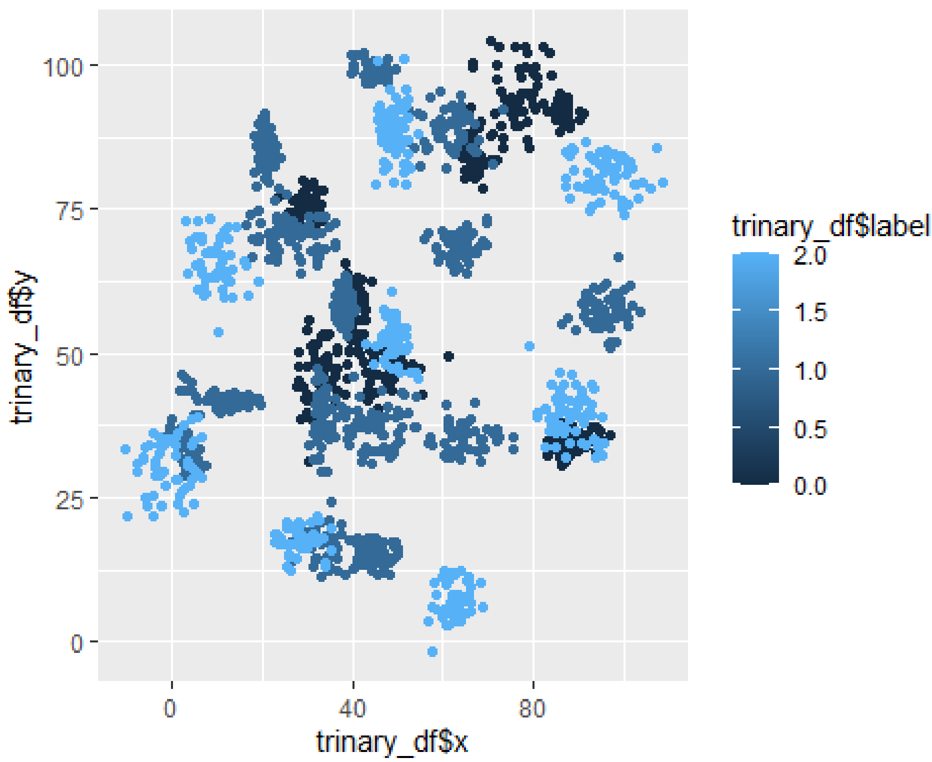
```r
  # i.Plot the data from each dataset using a scatter plot.
  #scatter plot - binary_df
  ggplot(binary_df, aes(x=binary_df$x, y=binary_df$y)) + geom_point(aes(color
=binary_df$label))
```

```
## Warning: Use of `binary_df$label` is discouraged. Use `label` instead.

## Warning: Use of `binary_df$x` is discouraged. Use `x` instead.

## Warning: Use of `binary_df$y` is discouraged. Use `y` instead.
```




```r
  #scatter plot - trinary_df
  ggplot(trinary_df, aes(x=trinary_df$x, y=trinary_df$y)) + geom_point(aes(co
lor=trinary_df$label))
```

```
## Warning: Use of `trinary_df$label` is discouraged. Use `label` instead.

## Warning: Use of `trinary_df$x` is discouraged. Use `x` instead.

## Warning: Use of `trinary_df$y` is discouraged. Use `y` instead.
```




```
  #Normalization of binary_df
  normalize <- function(x) {
    return ((x - min(x)) / (max(x) - min(x))) }

  binary_df.n=as.data.frame(lapply(binary_df[,2:3], normalize))

  trinary_df.n=as.data.frame(lapply(trinary_df[,2:3], normalize))


  set.seed(123)
  dat.d <- sample(1:nrow(binary_df.n),size=nrow(binary_df.n)*0.7,replace = FA
LSE) #random selection of 70% data.

  train.binary_df <- binary_df[dat.d,] # 70% training data
  test.binary_df <- binary_df[-dat.d,] # remaining 30% test data


  #Creating seperate dataframe for 'label' feature which is our target.
  train.binary_df_label <- binary_df[dat.d,1]
  test.binary_df_label <-binary_df[-dat.d,1]


  #Find the number of observation
  NROW(train.binary_df)

## [1] 1048
```

```r
  #So, we have 700 observations in our training data set. The square root of 700 is around 26.45, therefore we'll create two models. One with 'K' value as 26 and the other model with a 'K' value as 27.

  library(class)

## Warning: package 'class' was built under R version 4.0.5

  knn.binary_df.1 <- knn(train=train.binary_df, test=test.binary_df, cl=train
.binary_df_label, k=1)

  #After building the model, it is time to calculate the accuracy of the crea
ted models:
  #Calculate the proportion of correct classification for k = 32, 33
  ACC.binary_df.1 <- 100 * sum(test.binary_df_label == knn.binary_df.1)/NROW(
test.binary_df_label)

  ACC.binary_df.1 #Accuracy is 98.22

## [1] 98.22222

  # Check prediction against actual value in tabular form for k=32
  table(knn.binary_df.1 ,test.binary_df_label)

##                test.binary_df_label
## knn.binary_df.1   0   1
##               0 227   4
##               1   4 215

  #use the confusion matrix to calculate the accuracy
  library(caret)

## Warning: package 'caret' was built under R version 4.0.5

## Loading required package: lattice

  confusionMatrix(table(knn.binary_df.1 ,test.binary_df_label))

## Confusion Matrix and Statistics
##
##                test.binary_df_label
## knn.binary_df.1   0   1
##               0 227   4
##               1   4 215
##
##                Accuracy : 0.9822
##                  95% CI : (0.9653, 0.9923)
##     No Information Rate : 0.5133
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9644
##
```

```
##  Mcnemar's Test P-Value : 1
##
##             Sensitivity : 0.9827
##             Specificity : 0.9817
##          Pos Pred Value : 0.9827
##          Neg Pred Value : 0.9817
##              Prevalence : 0.5133
##          Detection Rate : 0.5044
##    Detection Prevalence : 0.5133
##       Balanced Accuracy : 0.9822
##
##        'Positive' Class : 0
##
```

```
  #Normalization of trinary_df
  normalize <- function(x) {
    return ((x - min(x)) / (max(x) - min(x))) }

  trinary_df.n=as.data.frame(lapply(trinary_df[,2:3], normalize))

  trinary_df.n=as.data.frame(lapply(trinary_df[,2:3], normalize))


  set.seed(123)
  dat.d <- sample(1:nrow(trinary_df.n),size=nrow(trinary_df.n)*0.7,replace =
FALSE) #random selection of 70% data.

  train.trinary_df <- trinary_df[dat.d,] # 70% training data
  test.trinary_df <- trinary_df[-dat.d,] # remaining 30% test data


  #Creating seperate dataframe for 'label' feature which is our target.
  train.trinary_df_label <- trinary_df[dat.d,1]
  test.trinary_df_label <-trinary_df[-dat.d,1]


  #Find the number of observation
  NROW(train.trinary_df)
```

```
## [1] 1097
```

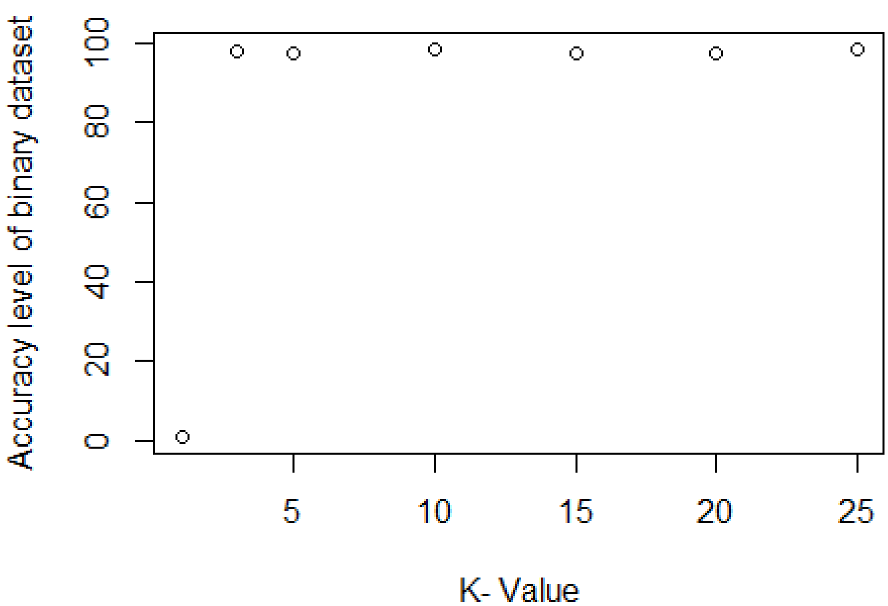
```
  library(class)

  knn.trinary_df.1 <- knn(train=train.trinary_df, test=test.trinary_df, cl=tr
ain.trinary_df_label, k=1)

  #After building the model, it is time to calculate the accuracy of the crea
ted models:
  #Calculate the proportion of correct classification for k = 32, 33
```

```r
  ACC.trinary_df.1 <- 100 * sum(test.trinary_df_label == knn.trinary_df.1)/NR
OW(test.trinary_df_label)

  ACC.trinary_df.1 #Accuracy is 95.75

## [1] 95.75372

  # Check prediction against actual value in tabular form for k=32
  table(knn.trinary_df.1 ,test.trinary_df_label)

##                   test.trinary_df_label
## knn.trinary_df.1   0   1   2
##                  0 131   7   1
##                  1   3 185   7
##                  2   0   2 135

  #use the confusion matrix to calculate the accuracy
  library(caret)

  confusionMatrix(table(knn.trinary_df.1 ,test.trinary_df_label))

## Confusion Matrix and Statistics
##
##                   test.trinary_df_label
## knn.trinary_df.1   0   1   2
##                  0 131   7   1
##                  1   3 185   7
##                  2   0   2 135
##
## Overall Statistics
##
##                Accuracy : 0.9575
##                  95% CI : (0.9352, 0.9739)
##     No Information Rate : 0.4119
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.9354
##
##  Mcnemar's Test P-Value : 0.1461
##
## Statistics by Class:
##
##                      Class: 0 Class: 1 Class: 2
## Sensitivity            0.9776   0.9536   0.9441
## Specificity            0.9763   0.9639   0.9939
## Pos Pred Value         0.9424   0.9487   0.9854
## Neg Pred Value         0.9910   0.9674   0.9760
## Prevalence             0.2845   0.4119   0.3036
## Detection Rate         0.2781   0.3928   0.2866
## Detection Prevalence   0.2951   0.4140   0.2909
## Balanced Accuracy      0.9769   0.9588   0.9690
```

```r
  #ii.Fit a k nearest neighbors’ model for each dataset for k=3, k=5, k=10, k
=15, k=20, and k=25. Compute the accuracy of the resulting models for each va
lue of k. Plot the results in a graph where the x-axis is the different value
s of k and the y-axis is the accuracy of the model.

  #Accuracy level of binary dataset
  j<-1
  k.optm<-1
  for (i in c(3,5,10,15,20,25)){
     knn.mod <- knn(train=train.binary_df, test=test.binary_df, cl=train.bina
ry_df_label, k=i)
     k.optm[i] <- 100 * sum(test.binary_df_label == knn.mod)/NROW(test.binary
_df_label)
     k<-i
     j <-j+1
     cat(k,'=',k.optm[i],'')}
```

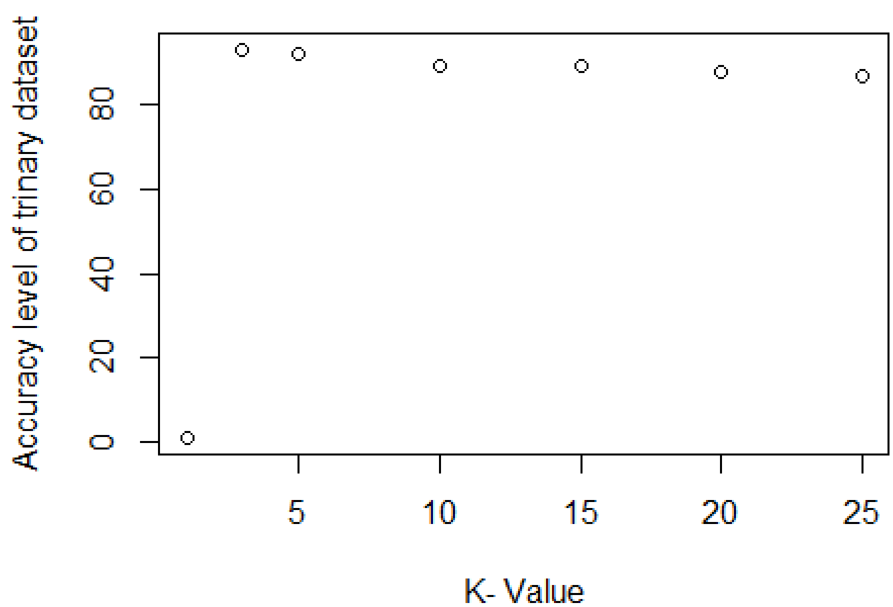
```
## 3 = 98 5 = 97.55556 10 = 98.22222 15 = 97.55556 20 = 97.55556 25 = 98.4444
4
```

```r
  #Accuracy plot
  plot(k.optm, type="b", xlab="K- Value",ylab="Accuracy level of binary datas
et")
```




```r
  #Accuracy level of trinary dataset
  j<-1
  k.optm<-1
```

```
  for (i in c(3,5,10,15,20,25)){
    knn.mod <- knn(train=train.trinary_df, test=test.trinary_df, cl=train.tri
nary_df_label, k=i)
    k.optm[i] <- 100 * sum(test.trinary_df_label == knn.mod)/NROW(test.trinar
y_df_label)
    k<-i
    j <-j+1
    cat(k,'=',k.optm[i],'')}

## 3 = 93.20594 5 = 92.14437 10 = 89.38429 15 = 89.17197 20 = 87.89809 25 = 8
6.83652

  #Accuracy plot
  plot(k.optm, type="b", xlab="K- Value",ylab="Accuracy level of trinary data
set")
```

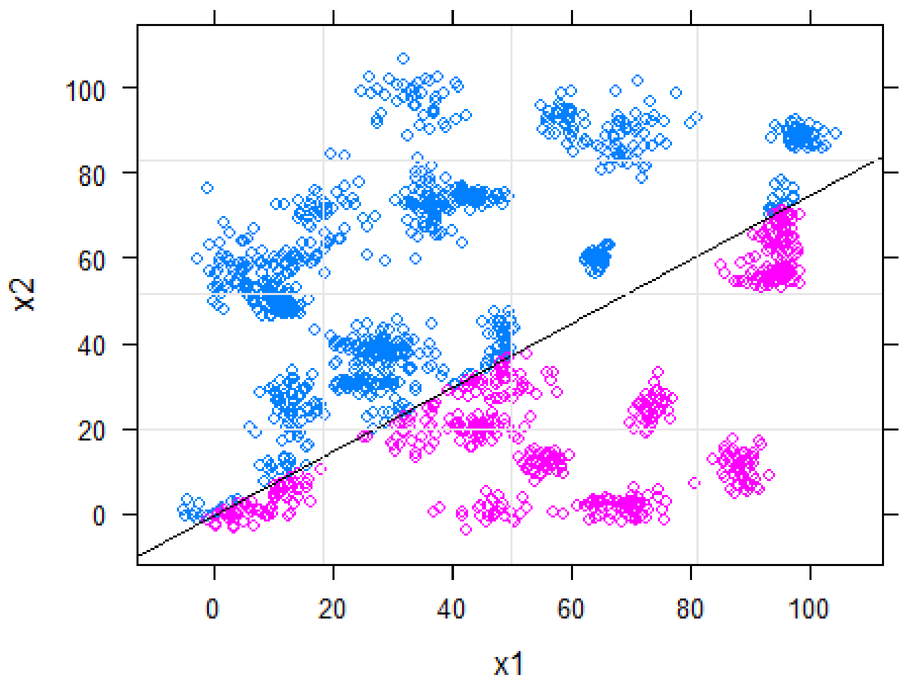



```
  #i.Looking back at the plots of the data, do you think a linear classifier
would work well on these datasets?

  x1=binary_df[2]
  x2=binary_df[3]

  y <- sign(3 * x1 - 4 * x2 - 1)

  y[ y == -1] <- 0

  df <- cbind.data.frame( y, x1, x2)
```

```r
names(df)[1] <- 'y'
names(df)[2]<-'x1'
names(df)[3]<-'x2'
mdl <- glm( y ~ . , data = df , family=binomial)
```

```
## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
slope <- coef(mdl)[2]/(-coef(mdl)[3])
intercept <- coef(mdl)[1]/(-coef(mdl)[3])

library(lattice)
xyplot( x2 ~ x1 , data = df, groups = y,
        panel=function(...){
          panel.xyplot(...)
          panel.abline(intercept , slope)
          panel.grid(...)
        })
```

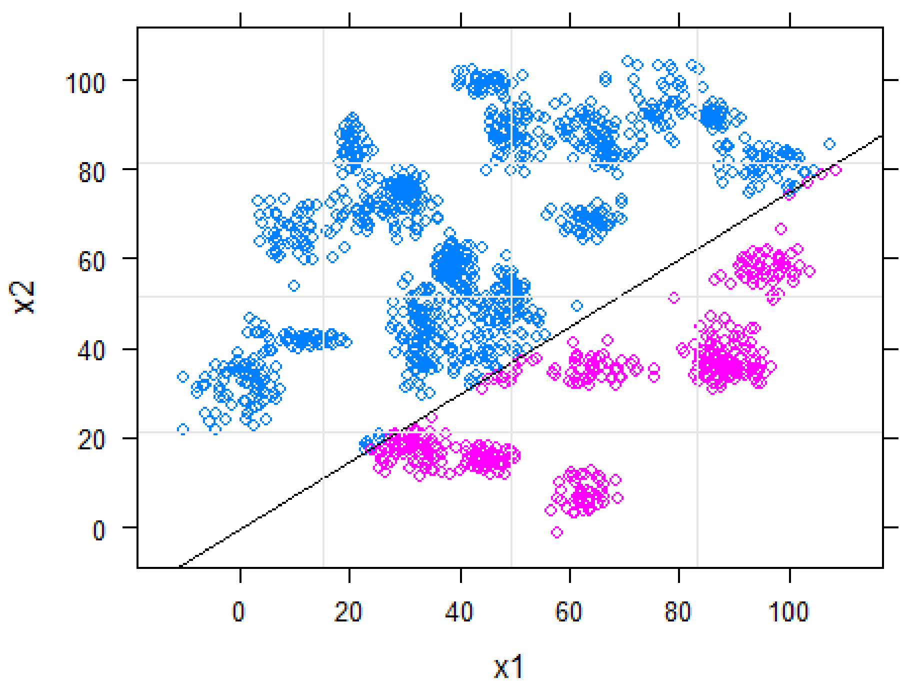



```r
x1=trinary_df[2]
x2=trinary_df[3]

y <- sign(3 * x1 - 4 * x2 - 1)

y[ y == -1] <- 0
```

```r
df <- cbind.data.frame( y, x1, x2)
names(df)[1] <- 'y'
names(df)[2]<-'x1'
names(df)[3]<-'x2'
mdl <- glm( y ~ . , data = df , family=binomial)
```

```
## Warning: glm.fit: algorithm did not converge

## Warning: glm.fit: fitted probabilities numerically 0 or 1 occurred
```

```r
slope <- coef(mdl)[2]/(-coef(mdl)[3])
intercept <- coef(mdl)[1]/(-coef(mdl)[3])

library(lattice)
xyplot( x2 ~ x1 , data = df, groups = y,
        panel=function(...){
          panel.xyplot(...)
          panel.abline(intercept , slope)
          panel.grid(...)
        })
```




```r
# By looking at the plots I think that the linear classfier would work well on binary dataset but not on trinary dataset.


# ii.How does the accuracy of your logistic regression classifier from last week compare?  Why is the accuracy different between these two methods?
```

```
  # The accuracy of logistic regression model was 67% but the accuracy of knn
model is 98% for binary dataset
  # The difference in accuracy is due to the non-linearness of the data in th
e input datasets.
  # KNN fits good for the non-linear dataset and hence is more suitable model
in our case.
```