

CSE 151: Programming Assignment #2

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Homework Code

```
import random
import csv
import math
import operator
5 from decimal import *
import numpy as np
import matplotlib.pyplot as plt

10 #method for generating hits
#@param:x => our data
#      :testSize => hit rate
#      :genList => list of # of hits per index
#@return:genList => updated list with hits per index
15 def count (x, testSize, genList):
    size = len(x)
    expectedDraws = int(round(size*testSize))
    x1 = Decimal(expectedDraws)/Decimal(size)

20     j = 0

    for i in range(0, size):
        x2 = random.uniform(0,1)
        if x2 < x1:
25             genList[i] = genList[i] + 1
            j = j+1
        x1 = Decimal(expectedDraws-j)/Decimal(size-i)
    return genList

30 # Performs z-scaling on matrix
# @param: matrix - The matrix/array to scale
# @return: matrix - The matrix that has been scaled by the mean of each
#           column and the standard deviation of each column
def zscale(matrix, means,stdev):
35     offset = len(means)-2
    matrix[:,0:offset] = (matrix[:,0:offset] - means[0:offset])/(stdev[0:offset])
    return matrix

# Calculate the distance between two instances of data
40 # @param: data1 - First data to compare to
# @param: data2 - Second data to compare to
# @param: length - Size of data
def calculateDistance(data1, data2, length):
    distance = 0
45     for x in range(length):
        distance+=pow((data1[x] - data2[x]),2)
    return math.sqrt(distance)

# Find the nearest neighbor
50 # @param: trainingSet - The set to be trained
# @param: testInstance - The test item to be categorized
```

```

# @param: k - the k-nearest neighbors
def findNeighbor(training, testI, k):
    d = []
55     length = len(testI)-1

    for x in range(len(training)):
        dist = calculateDistance(testI, training[x], length)
        d.append((training[x], dist))

60     d.sort(key=operator.itemgetter(1))
    k_neighbors = []

    for x in range(k):
65         k_neighbors.append(d[x][0])
    return k_neighbors

# Voting process
# @param: neighbors - neighbors already chosen
70 # @return: sortedVotes - the nearest neighbor
def getResponse(k_neighbors):
    votes = {}
    for x in range(len(k_neighbors)):
        est = k_neighbors[x][-1]

75         if est in votes:
            votes[est] += 1
        else:
            votes[est] = 1

80     sVotes = sorted(votes.items(), key=operator.itemgetter(1), reverse=True)
    return sVotes[0][0]

85 # Create a confusion matrix
# @param: predicted - Predictions in array
# @param: actual - Actual values
# @param: size - Number of classes
def confuseMe(predicted, actual, size):
90     # Initialize confusion matrix
    confusionMatrix = [[0 for x in range(size)] for x in range(size)]
    confusionMatrix = np.array(confusionMatrix).astype(np.float)
    # Count true positives and false positives
    for i in range(len(predicted)):
95         # If actual is equal to predicted, increase the diagonal by 1
        if actual[i] == predicted[i]:
            confusionMatrix[int(actual[i])][int(actual[i])] = confusionMatrix[int(actual[i])][int(actual[i])] + 1

        # If actual does not equal predicted, increase that respective spot by 1
100        elif actual[i] is not predicted[i]:
            confusionMatrix[int(actual[i])][int(predicted[i])] = confusionMatrix[int(actual[i])][int(predicted[i])] + 1

    return confusionMatrix

```

```
105 # Change a confusion matrix into a series of ratios
# @param: confusionMatrix - The Confusion Matrix to change
def decimateConfusionMatrix(confusionMatrix):
    for k in range(len(confusionMatrix)):
        weight = np.sum(confusionMatrix[k,:])
110         if (weight > 0):
            confusionMatrix[k,:] = confusionMatrix[k,:]/weight
    return confusionMatrix

115 ##### BEGIN MAIN METHOD HERE #####

# Read CSV Files
inputFile = open('abalone.data')
inputReader = csv.reader(inputFile)
120 inputData = list(inputReader)    #inputData = list of our data (which is in lists)

# Initiaize test Size
trainingSize = 0.9
125
# Length of the data
size = len(inputData)

# Set a random seed
130 random.seed(123451)

# Initialize counter
counter = [] #stores hit rates on index

135 # initialize counter array
for x in range(size):
    counter.append(0)

# Find test size
140 for i in range(1,2):
    counter = count(inputData, trainingSize, counter)

for i in range(size):
    if inputData[i][0] == 'M':
145         inputData[i][0] = 0
    elif inputData[i][0] == 'F':
        inputData[i][0] = 1
    elif inputData[i][0] == 'I':
        inputData[i][0] = 2
150

# Add 3 columns for classification of sex
proxiedData = np.zeros((size,len(inputData[0])+3))
proxiedData[:, :-3] = inputData
# Fix data for Euclidean distance
155 for i in range(size):
    if proxiedData[i][0] == 0:
        proxiedData[i][9] = 1
```

```
    elif proxiedData[i][0] == 1:
        proxiedData[i][10] = 1
160    elif proxiedData[i][0] == 2:
        proxiedData[i][11] = 1

    # Remove first column
    proxiedData = proxiedData[:,1:12]
165
    # Swap the actual to the predictions
    proxiedData[:,[7,8,9,10]] = proxiedData[:,[8,9,10,7]]

    # Keep track of counter and create training and testing sets
170    trainIndex = []
    testIndex = []
    trainingSet = []
    testSet = []

175    # Create training and testing sets
    for i in range(size):
        if counter[i] == 1:
            trainIndex.append(i)
            trainingSet.append(proxiedData[i])
180        else:
            testIndex.append(i)
            testSet.append(proxiedData[i])

185    # Change to numeric arrays
    trainingSet = np.array(trainingSet)
    testSet = np.array(testSet)

    # Calculate mean and standard deviation of the training set
190    means = trainingSet.mean(axis=0)
    stdevs = trainingSet.std(axis=0)

    # Standard normalization
    proxiedData = zscale(proxiedData,means,stdevs)
195
    predictions1 = []
    predictions2 = []
    predictions3 = []
    predictions4 = []
200    predictions5 = []
    ##### Start k-NN clustering
    ### K=1 Testing ###
    k=1
    for x in range(len(testSet)):
205        neighbors = findNeighbor(trainingSet, testSet[x],k)
        result = getResponse(neighbors)
        predictions1.append(result)

    # Get minimum and maximum of age to create confusion matrix
210    ages = set(proxiedData[:,10])
```

```
sizeOfAges = len(ages)
actualAges = testSet[:,10]
predictions1 = np.array(predictions1)

215 # Calculate confusion matrix
confusionMatrix1 = []
confusionMatrix1 = confuseMe(predictions1, actualAges, sizeOfAges)

# Print accuracy
220 accuracy1 = sum(confusionMatrix1.diagonal())/len(actualAges)
print('Accuracy for Abalone Dataset for k = ',k,":", accuracy1)

### K=3 Testing ###
k=3
225 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions2.append(result)

230 predictions2 = np.array(predictions2)

# Calculate confusion matrix
confusionMatrix2 = []
confusionMatrix2 = confuseMe(predictions2, actualAges, sizeOfAges)

235 # Print accuracy
accuracy2 = sum(confusionMatrix2.diagonal())/len(actualAges)
print('Accuracy for Abalone Dataset for k = ',k,":", accuracy2)

240 ### K=5 Testing ###
k=5
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
245 predictions3.append(result)

predictions3 = np.array(predictions3)

# Calculate confusion matrix
250 confusionMatrix3 = []
confusionMatrix3 = confuseMe(predictions3, actualAges, sizeOfAges)

# Print accuracy
accuracy3 = sum(confusionMatrix3.diagonal())/len(actualAges)
255 print('Accuracy for Abalone Dataset for k = ',k,":", accuracy3)

### K=7 Testing ###
k=7
260 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions4.append(result)
```

```
predictions4 = np.array(predictions4)
265
# Calculate confusion matrix
confusionMatrix4 = []
confusionMatrix4 = confuseMe(predictions4, actualAges, sizeOfAges)

270
# Print accuracy
accuracy4 = sum(confusionMatrix4.diagonal())/len(actualAges)
print('Accuracy for Abalone Dataset for k = ',k,":", accuracy4)

### K=9 Testing ###
275
k=9
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions5.append(result)

280
predictions5 = np.array(predictions5)

# Calculate confusion matrix
confusionMatrix5 = []
285
confusionMatrix5 = confuseMe(predictions5, actualAges, sizeOfAges)

# Print accuracy
accuracy5 = sum(confusionMatrix5.diagonal())/len(actualAges)
print('Accuracy for Abalone Dataset for k = ',k,":", accuracy5)

290
# We observe that we will have k=9 be the best choice
print(confusionMatrix4)

295
##### Testing 10% Categorization
from numpy import genfromtxt
inputData2 = genfromtxt(r'C:\Users\Kyle Lee\Google Drive\School Doc. 2015-2016\CSE 151\Programming H
inputData2 = np.array(inputData2)
# Length of the data
300
size = len(inputData2)

# Initialize counter
counter = [] #stores hit rates on index
305
# initialize counter array
for x in range(size):
    counter.append(0)

310
# Find test size
for i in range(1,2):
    counter = count(inputData2, trainingSize, counter)

# Keep track of counter and create training and testing sets
315
trainingSet = []
testSet = []
```

```
# Create training and testing sets
for i in range(size):
    if counter[i] == 1:
        trainingSet.append(inputData2[i])
    else:
        testSet.append(inputData2[i])

# Change to numeric arrays
trainingSet = np.array(trainingSet)
testSet = np.array(testSet)

# Calculate mean and standard deviation of the training set
means = trainingSet.mean(axis=0)
stdevs = trainingSet.std(axis=0)

# Standard normalization
inputData2 = zscale(inputData2, means, stdevs)

predictions1 = []
predictions2 = []
predictions3 = []
predictions4 = []
predictions5 = []

##### Start k-NN clustering
### K=1 Testing ###
k=1
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
    predictions1.append(result)

# Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions1 = np.array(predictions1)

# Calculate confusion matrix
confusionMatrix1 = []
confusionMatrix1 = confuseMe(predictions1, actualAges, n)

# Print accuracy
accuracy1 = sum(confusionMatrix1.diagonal())/len(actualAges)
print('Accuracy for 10% Dataset for k = ', k, ":", accuracy1)

### K=3 Testing ###
k=3
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
```



```
370     predictions2.append(result)

    # Get predictions
    predictions2 = np.array(predictions2)

375 # Calculate confusion matrix
    confusionMatrix2 = []
    confusionMatrix2 = confuseMe(predictions2, actualAges, n)

    # Print accuracy
380 accuracy2 = sum(confusionMatrix2.diagonal())/len(actualAges)
    print('Accuracy for 10% Dataset for k = ',k,"", accuracy2)

    ### K=5 Testing ###
    k=5
385 for x in range(len(testSet)):
        neighbors = findNeighbor(trainingSet, testSet[x],k)
        result = getResponse(neighbors)
        predictions3.append(result)

390 # Get minimum and maximum of age to create confusion matrix
    ages = set(inputData2[:,9])
    n = len(ages)
    actualAges = testSet[:,9]
    predictions3 = np.array(predictions3)

395 # Calculate confusion matrix
    confusionMatrix3 = []
    confusionMatrix3 = confuseMe(predictions3, actualAges, n)

400 # Print accuracy
    accuracy3 = sum(confusionMatrix3.diagonal())/len(actualAges)
    print('Accuracy for 10% Dataset for k = ',k,"", accuracy3)

405 ### K=7 Testing ###
    k=7
    inputData2 = np.array(inputData2)
    for x in range(len(testSet)):
        neighbors = findNeighbor(trainingSet, testSet[x],k)
410     result = getResponse(neighbors)
        predictions4.append(result)

    # Get minimum and maximum of age to create confusion matrix
    ages = set(inputData2[:,9])
415 n = len(ages)
    actualAges = testSet[:,9]
    predictions4 = np.array(predictions4)

    # Calculate confusion matrix
420 confusionMatrix4 = []
    confusionMatrix4 = confuseMe(predictions4, actualAges, n)
```

```

# Print accuracy
accuracy4 = sum(confusionMatrix4.diagonal())/len(actualAges)
425 print('Accuracy for 10% Dataset for k = ',k,":", accuracy4)

### K=9 Testing ###
k=9
inputData2 = np.array(inputData2)
430 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions5.append(result)

435 # Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions5 = np.array(predictions5)

440 # Calculate confusion matrix
confusionMatrix5 =[]
confusionMatrix5 = confuseMe(predictions5, actualAges, n)

445 # Print accuracy
accuracy5 = sum(confusionMatrix5.diagonal())/len(actualAges)
print('Accuracy for 10% Dataset for k = ',k,":", accuracy5)

# Print k=9 confusion matrix since we know the best confusion matrix
450 print(confusionMatrix5)

##### Testing 3% Categorization
from numpy import genfromtxt
inputData2 = genfromtxt(r'C:\Users\Kyle Lee\Google Drive\School Doc. 2015-2016\CSE 151\Programming H
455 inputData2 = np.array(inputData2)
# Length of the data

size = len(inputData2)

460 # Initialize counter
counter = [] #stores hit rates on index

# initialize counter array
for x in range(size):
465     counter.append(0)

# Find test size
for i in range(1,2):
    counter = count(inputData2, trainingSize, counter)

470 # Keep track of counter and create training and testing sets
trainingSet = []
testSet = []

475 # Create training and testing sets

```

```
for i in range(size):
    if counter[i] == 1:
        trainingSet.append(inputData2[i])
    else:
480         testSet.append(inputData2[i])

# Change to numeric arrays
trainingSet = np.array(trainingSet)
testSet = np.array(testSet)
485

# Calculate mean and standard deviation of the training set
means = trainingSet.mean(axis=0)
stdevs = trainingSet.std(axis=0)

490 # Standard normalization
inputData2 = zscale(inputData2, means, stdevs)

predictions1 = []
predictions2 = []
495 predictions3 = []
predictions4 = []
predictions5 = []
##### Start k-NN clustering
### K=1 Testing ###
500 k=1
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
505 predictions1.append(result)

# Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
510 actualAges = testSet[:,9]
predictions1 = np.array(predictions1)

# Calculate confusion matrix
confusionMatrix1 = []
515 confusionMatrix1 = confuseMe(predictions1, actualAges, n)

# Print accuracy
accuracy1 = sum(confusionMatrix1.diagonal())/len(actualAges)
print('Accuracy for 3% Dataset for k = ', k, ":", accuracy1)
520

### K=3 Testing ###
k=3
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
525     neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
    predictions2.append(result)
```

```
# Get predictions
530 predictions2 = np.array(predictions2)

# Calculate confusion matrix
confusionMatrix2 = []
confusionMatrix2 = confuseMe(predictions2, actualAges, n)
535

# Print accuracy
accuracy2 = sum(confusionMatrix2.diagonal())/len(actualAges)
print('Accuracy for 3% Dataset for k = ',k,":", accuracy2)

540 ### K=5 Testing ###
k=5
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
545 predictions3.append(result)

# Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
550 actualAges = testSet[:,9]
predictions3 = np.array(predictions3)

# Calculate confusion matrix
confusionMatrix3 = []
555 confusionMatrix3 = confuseMe(predictions3, actualAges, n)

# Print accuracy
accuracy3 = sum(confusionMatrix3.diagonal())/len(actualAges)
print('Accuracy for 3% Dataset for k = ',k,":", accuracy3)
560

### K=7 Testing ###
k=7
inputData2 = np.array(inputData2)
565 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions4.append(result)

570 # Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions4 = np.array(predictions4)
575

# Calculate confusion matrix
confusionMatrix4 = []
confusionMatrix4 = confuseMe(predictions4, actualAges, n)

580 # Print accuracy
accuracy4 = sum(confusionMatrix4.diagonal())/len(actualAges)
```

```
print('Accuracy for 3% Dataset for k = ',k,":", accuracy4)

### K=9 Testing ###
585 k=9
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
590 predictions5.append(result)

# Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
595 actualAges = testSet[:,9]
predictions5 = np.array(predictions5)

# Calculate confusion matrix
confusionMatrix5 = []
600 confusionMatrix5 = confuseMe(predictions5, actualAges, n)

# Print accuracy
accuracy5 = sum(confusionMatrix5.diagonal())/len(actualAges)
print('Accuracy for 3% Dataset for k = ',k,":", accuracy5)
605

# Print k=9 confusion matrix
print(confusionMatrix5)

610 ##### Testing separable Categorization
from numpy import genfromtxt
inputData2 = genfromtxt(r'C:\Users\Kyle Lee\Google Drive\School Doc. 2015-2016\CSE 151\Programming H
inputData2 = np.array(inputData2)
# Length of the data
615 size = len(inputData2)

# Initialize counter
counter = [] #stores hit rates on index
620

# initialize counter array
for x in range(size):
    counter.append(0)

625 # Find test size
for i in range(1,2):
    counter = count(inputData2, trainingSize, counter)

# Keep track of counter and create training and testing sets
630 trainingSet = []
testSet = []

# Create training and testing sets
for i in range(size):
```

```
635     if counter[i] == 1:
        trainingSet.append(inputData2[i])
    else:
        testSet.append(inputData2[i])

640 # Change to numeric arrays
trainingSet = np.array(trainingSet)
testSet = np.array(testSet)

# Calculate mean and standard deviation of the training set
645 means = trainingSet.mean(axis=0)
stdevs = trainingSet.std(axis=0)

# Standard normalization
inputData2 = zscale(inputData2, means, stdevs)

650 predictions1 = []
predictions2 = []
predictions3 = []
predictions4 = []
655 predictions5 = []
##### Start k-NN clustering
### K=1 Testing ###
k=1
inputData2 = np.array(inputData2)
660 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
    predictions1.append(result)

665 # Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions1 = np.array(predictions1)

670 # Calculate confusion matrix
confusionMatrix1 = []
confusionMatrix1 = confuseMe(predictions1, actualAges, n)

675 # Print accuracy
accuracy1 = sum(confusionMatrix1.diagonal())/len(actualAges)
print('Accuracy for separable Dataset for k = ', k, ":", accuracy1)

### K=3 Testing ###
680 k=3
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x], k)
    result = getResponse(neighbors)
685 predictions2.append(result)

# Get predictions
```

```
predictions2 = np.array(predictions2)

690 # Calculate confusion matrix
confusionMatrix2 = []
confusionMatrix2 = confuseMe(predictions2, actualAges, n)

# Print accuracy
695 accuracy2 = sum(confusionMatrix2.diagonal())/len(actualAges)
print('Accuracy for separable Dataset for k = ',k,":", accuracy2)

### K=5 Testing ###
k=5
700 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions3.append(result)

705 # Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions3 = np.array(predictions3)

710 # Calculate confusion matrix
confusionMatrix3 = []
confusionMatrix3 = confuseMe(predictions3, actualAges, n)

715 # Print accuracy
accuracy3 = sum(confusionMatrix3.diagonal())/len(actualAges)
print('Accuracy for separable Dataset for k = ',k,":", accuracy3)

720 ### K=7 Testing ###
k=7
inputData2 = np.array(inputData2)
for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
725     result = getResponse(neighbors)
    predictions4.append(result)

# Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
730 n = len(ages)
actualAges = testSet[:,9]
predictions4 = np.array(predictions4)

# Calculate confusion matrix
735 confusionMatrix4 = []
confusionMatrix4 = confuseMe(predictions4, actualAges, n)

# Print accuracy
accuracy4 = sum(confusionMatrix4.diagonal())/len(actualAges)
740 print('Accuracy for separable Dataset for k = ',k,":", accuracy4)
```

```

### K=9 Testing ###
k=9
inputData2 = np.array(inputData2)
745 for x in range(len(testSet)):
    neighbors = findNeighbor(trainingSet, testSet[x],k)
    result = getResponse(neighbors)
    predictions5.append(result)

750 # Get minimum and maximum of age to create confusion matrix
ages = set(inputData2[:,9])
n = len(ages)
actualAges = testSet[:,9]
predictions5 = np.array(predictions5)

755 # Calculate confusion matrix
confusionMatrix5 = []
confusionMatrix5 = confuseMe(predictions5, actualAges, n)

760 # Print accuracy
accuracy5 = sum(confusionMatrix5.diagonal())/len(actualAges)
print('Accuracy for separable Dataset for k = ',k,":", accuracy5)

# Print k=9 confusion matrix
765 print(confusionMatrix5)

```

Console Output

```

Accuracy for Abalone Dataset for k = 1 : 0.1861575179
Accuracy for Abalone Dataset for k = 3 : 0.219570405728
Accuracy for Abalone Dataset for k = 5 : 0.233890214797
Accuracy for Abalone Dataset for k = 7 : 0.252983293556
5 Accuracy for Abalone Dataset for k = 9 : 0.26968973747
[[ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
10 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  3.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
15 [ 0.  0.  0.  2.  0.  4.  0.  1.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  1.  3.  3.  4.  1.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
20 [ 0.  0.  0.  0.  0.  0.  2. 10.  7.  2.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  1.  6. 12. 13.  4.  1.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  0.  3.  7. 17. 14.  7.  1.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  1.]
 [ 0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.
   0.  0.  0.  0.  0.  0.  0.  0.  0.  0.  0.]
 [ 0.  0.  0.  0.  0.  0.  1.  1.  3. 16. 25. 17. 10.  1.
   0.

```



```

25     0.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   2.  13.  22.  26.   9.   1.   2.
      0.   0.   1.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   1.   2.  14.  16.   9.   2.   1.
      1.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
30     [  0.   0.   0.   0.   0.   0.   0.   1.   3.   4.   7.   5.   3.   0.
      1.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   2.   4.   4.   4.   0.   0.
      0.   0.   1.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   2.   3.   3.   1.   2.   2.
      0.   0.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
35     [  0.   0.   0.   0.   0.   0.   0.   1.   1.   0.   2.   3.   0.   1.
      0.   1.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   1.   2.   1.   1.   1.
      1.   0.   0.   2.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
40     [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   1.   1.   0.   1.
      0.   0.   0.   0.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   1.   0.   0.   1.   1.   1.   0.
      0.   0.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   2.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
45     [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   2.   0.   0.   0.
      0.   0.   1.   1.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
50     [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   1.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
55     [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
60     [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.
      0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]
    [  0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.   0.]

Accuracy for 10% Dataset for k = 1 : 0.593406593407
Accuracy for 10% Dataset for k = 3 : 0.597402597403
65 Accuracy for 10% Dataset for k = 5 : 0.614385614386
Accuracy for 10% Dataset for k = 7 : 0.63036963037
Accuracy for 10% Dataset for k = 9 : 0.637362637363
[[ 255.  182.]
 [ 181.  383.]]

70
Accuracy for 3% Dataset for k = 1 : 0.596403596404
Accuracy for 3% Dataset for k = 3 : 0.628371628372
Accuracy for 3% Dataset for k = 5 : 0.636363636364
Accuracy for 3% Dataset for k = 7 : 0.637362637363
75 Accuracy for 3% Dataset for k = 9 : 0.629370629371
[[ 262.  204.]
 [ 167.  368.]]

```

```
Accuracy for separable Dataset for k = 1 : 0.713286713287
80 Accuracy for separable Dataset for k = 3 : 0.741258741259
Accuracy for separable Dataset for k = 5 : 0.754245754246
Accuracy for separable Dataset for k = 7 : 0.756243756244
Accuracy for separable Dataset for k = 9 : 0.755244755245
[[ 337.  115.]
85 [ 130.  419.]]
```