IT 542: Pattern Recognition and Machine Learning

Assignment 3

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1. Check suitability of naïve-bayes classifier on IRIS data from UCI Machine Learning Repository. Consider 40 samples from each class as training data, use the remaining 10 from each class as testing data. Repeat the experiment 10 times and calculate the average accuracy.

Code:

```
from sklearn import datasets
from sklearn.model_selection import KFold
iris = datasets.load_iris()
from sklearn.naive_bayes import GaussianNB
gnb = GaussianNB()
y_pred = gnb.fit(iris.data, iris.target).predict(iris.data)
print("Number of mislabeled points out of a total %d points : %d" %(iris.data.shape[0],(iris.target
!= y_pred).sum()))
```

OUTPUT:

```
Number of mislabeled points out of a total 150 points : 6
print(iris.data)[1:5,1:5]
```

OUTPUT:

```
[[5.1 3.5 1.4 0.2]
 [4.9 3.  1.4 0.2]
 [4.7 3.2 1.3 0.2]
 [4.6 3.1 1.5 0.2]
 [5.  3.6 1.4 0.2]
 [5.4 3.9 1.7 0.4]
 [4.6 3.4 1.4 0.3]
 [5.  3.4 1.5 0.2]
 [4.4 2.9 1.4 0.2]
 [4.9 3.1 1.5 0.1]
 [5.4 3.7 1.5 0.2]
 [4.8 3.4 1.6 0.2]
 [4.8 3.  1.4 0.1]
 [4.3 3.  1.1 0.1]
 [5.8 4.  1.2 0.2]
 [5.7 4.4 1.5 0.4]
```

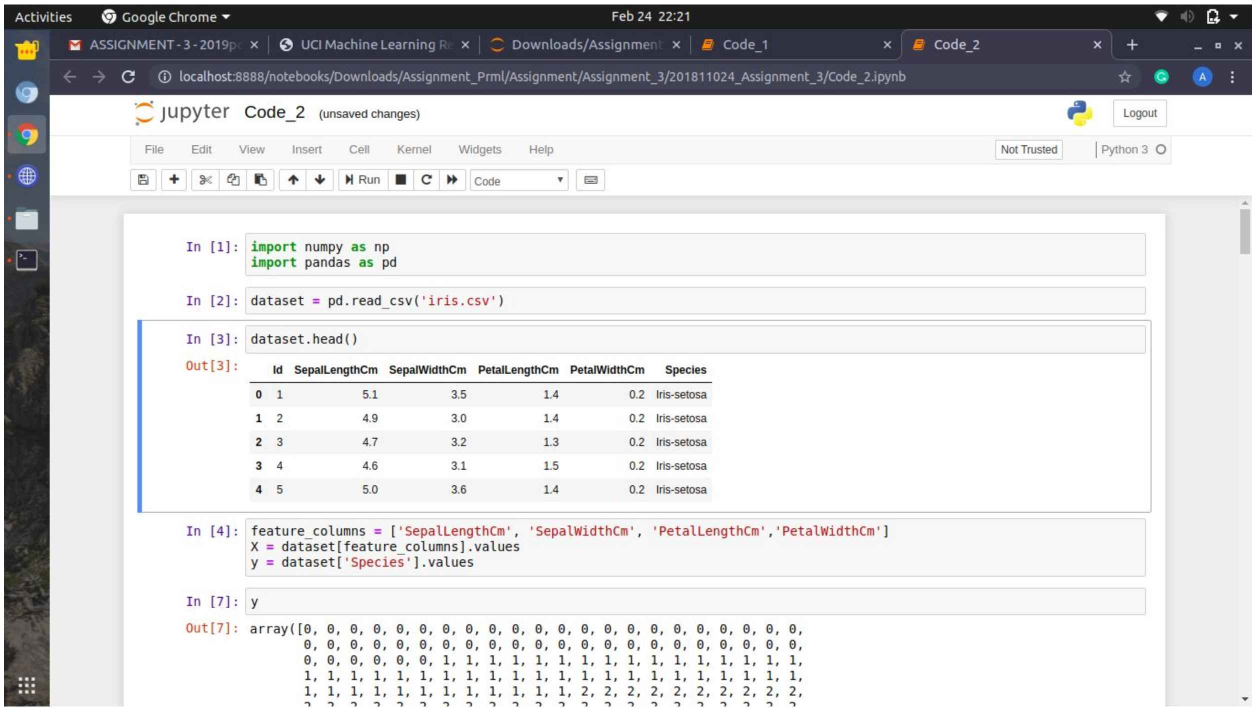
```
print(iris.target)
```
OUTPUT:
```
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 2 2
 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2
 2 2]
```
```
print(len(iris.data))
print(iris.data.shape[0])
```
OUTPUT:
```
150
150
```
```
from sklearn.model_selection import KFold # import KFold
X =iris.data # create an array
Y = iris.target # Create another array
kf = KFold(n_splits=3,shuffle=True) # Define the split - into 2 folds
kf.get_n_splits(X) # returns the number of splitting iterations in the cross-validator
print(kf)
for train_index, test_index in kf.split(X):
 X_train=X[train_index]
 X_test=X[test_index]
 Y_train=Y[train_index]
 Y_test=Y[test_index]
 y_pred = gnb.fit(X_train,Y_train).predict(X_test)
 print("Number of mislabeled points out of a total %d points : %d" %(X_test.shape[0],(Y_test !=
y_pred).sum()))
 num=(Y_test == y_pred).sum()
 denom=X_test.shape[0]
 print('Accuracy:',(num/denom)*100, '%')
```
OUTPUT:
```
Number of mislabeled points out of a total 50 points : 3
Accuracy: 94.0 %
Number of mislabeled points out of a total 50 points : 2
Accuracy: 96.0 %
Number of mislabeled points out of a total 50 points : 1
Accuracy: 98.0 %
```
```
print(len(X_train))
print(len(X_test))
```
OUTPUT:
```
100
50
```

2. Implement k-NN classifier and use it for IRIS data with k = 1, 3, 5 and 11. Repeat the experiment 10 times and calculate the average accuracy.

CODE:

```
import numpy as np
import pandas as pd
dataset = pd.read_csv('iris.csv')
dataset.head()
```

OUTPUT:



```
In [1]: import numpy as np
        import pandas as pd

In [2]: dataset = pd.read_csv('iris.csv')

In [3]: dataset.head()
Out[3]:
```

	Id	SepalLengthCm	SepalWidthCm	PetalLengthCm	PetalWidthCm	Species
0	1	5.1	3.5	1.4	0.2	Iris-setosa
1	2	4.9	3.0	1.4	0.2	Iris-setosa
2	3	4.7	3.2	1.3	0.2	Iris-setosa
3	4	4.6	3.1	1.5	0.2	Iris-setosa
4	5	5.0	3.6	1.4	0.2	Iris-setosa

```
In [4]: feature_columns = ['SepalLengthCm', 'SepalWidthCm', 'PetalLengthCm','PetalWidthCm']
        X = dataset[feature_columns].values
        y = dataset['Species'].values

In [7]: y
Out[7]: array([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, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
               1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
               1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
```

```
feature_columns = ['SepalLengthCm', 'SepalWidthCm',
'PetalLengthCm','PetalWidthCm']
X = dataset[feature_columns].values
y = dataset['Species'].values
Y
```

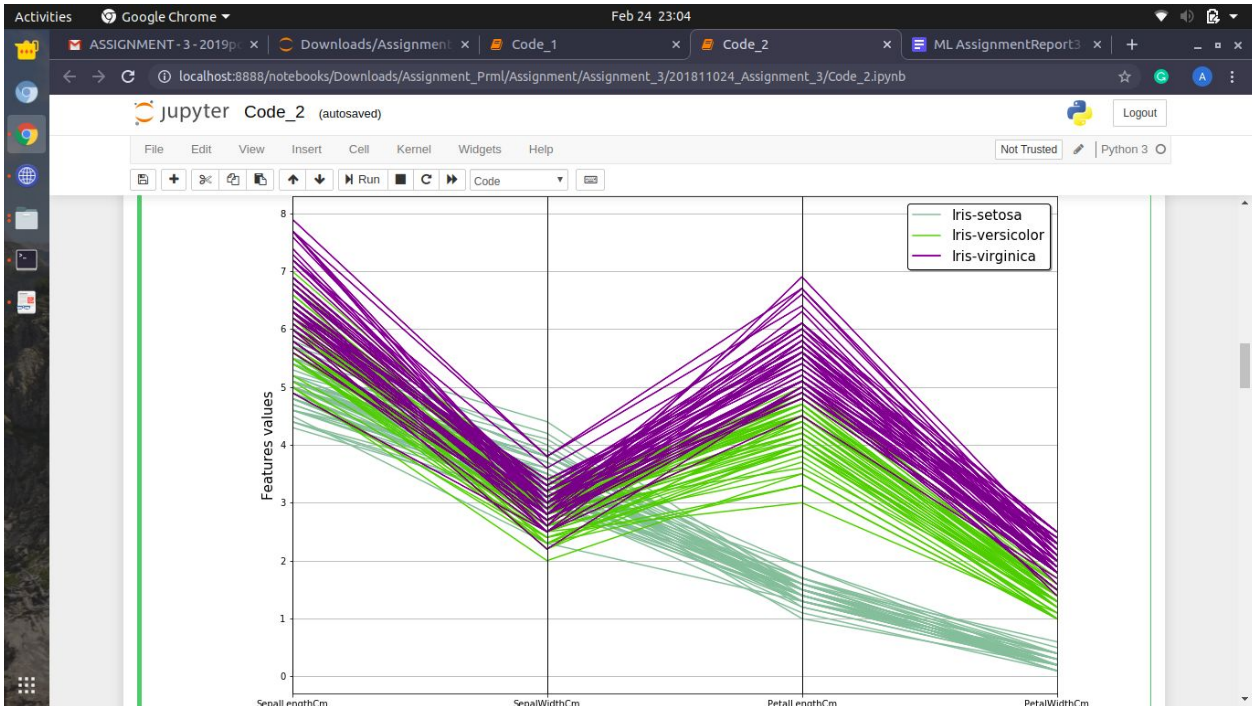
OUTPUT:

```
[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, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
  2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
  2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2]
from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()
y = le.fit_transform(y)
```

```
Y
array([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, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2,
       2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2, 2], dtype=int64)
from sklearn.cross_validation import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.2, random_state = 0)
print(X_train)
print(y_train)
print(X_test)
print(y_test)
[[6.4 3.1 5.5 1.8]
 [5.4 3.  4.5 1.5]
 [5.2 3.5 1.5 0.2]
 [6.1 3.  4.9 1.8]
 [6.4 2.8 5.6 2.2]
 [5.2 2.7 3.9 1.4]
 [5.7 3.8 1.7 0.3]
 [6.  2.7 5.1 1.6]
 [5.9 3.  4.2 1.5]
 [5.8 2.6 4.  1.2]
 [6.8 3.  5.5 2.1]
 [4.7 3.2 1.3 0.2]
 [6.9 3.1 5.1 2.3]
 [5.  3.5 1.6 0.6]
 [5.4 3.7 1.5 0.2]
 [5.  2.  3.5 1. ]
 [6.5 3.  5.5 1.8]
 [6.7 3.3 5.7 2.5]
 [6.  2.2 5.  1.5]
 [6.7 2.5 5.8 1.8]
 [5.6 2.5 3.9 1.1]
 [7.7 3.  6.1 2.3]
 [6.3 3.3 4.7 1.6]]
import matplotlib.pyplot as plt
import seaborn as sns
%matplotlib inline
from pandas.plotting import parallel_coordinates
plt.figure(figsize=(15,10))
parallel_coordinates(dataset.drop("Id", axis=1), "Species")
plt.title('Parallel Coordinates Plot', fontsize=20, fontweight='bold')
plt.xlabel('Features', fontsize=15)
```

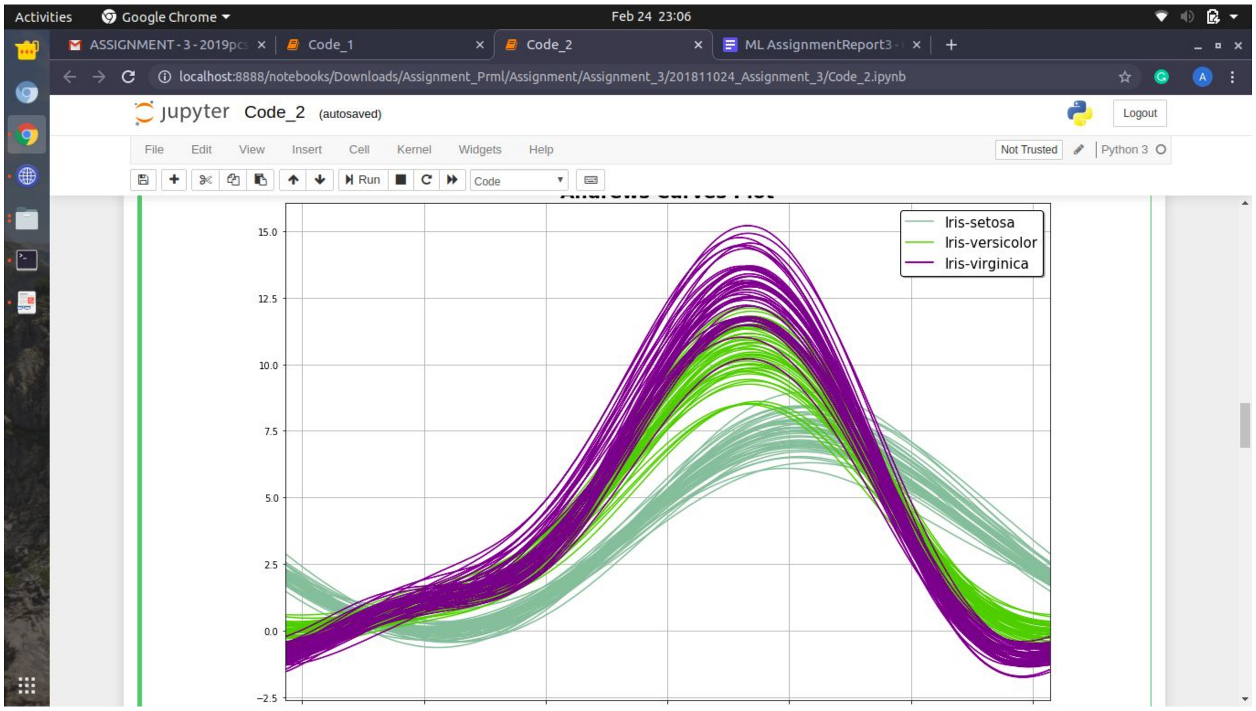
plt.ylabel('Features values', fontsize=15)
plt.legend(loc=1, prop={'size': 15}, frameon=True,shadow=True, facecolor="white", edgecolor="black")
plt.show()

OUTPUT:



from pandas.plotting import andrews_curves
plt.figure(figsize=(15,10))
andrews_curves(dataset.drop("Id", axis=1), "Species")
plt.title('Andrews Curves Plot', fontsize=20, fontweight='bold')
plt.legend(loc=1, prop={'size': 15}, frameon=True,shadow=True, facecolor="white", edgecolor="black")
plt.show()

OUTPUT:



```
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import confusion_matrix, accuracy_score
from sklearn.model_selection import cross_val_score
classifier = KNeighborsClassifier(n_neighbors=3)
classifier.fit(X_train, y_train)
y_pred = classifier.predict(X_test)
cm = confusion_matrix(y_test, y_pred)
Cm
```

OUTPUT:

```
array([[11,  0,  0],
       [ 0, 12,  1],
       [ 0,  0,  6]], dtype=int64)
```

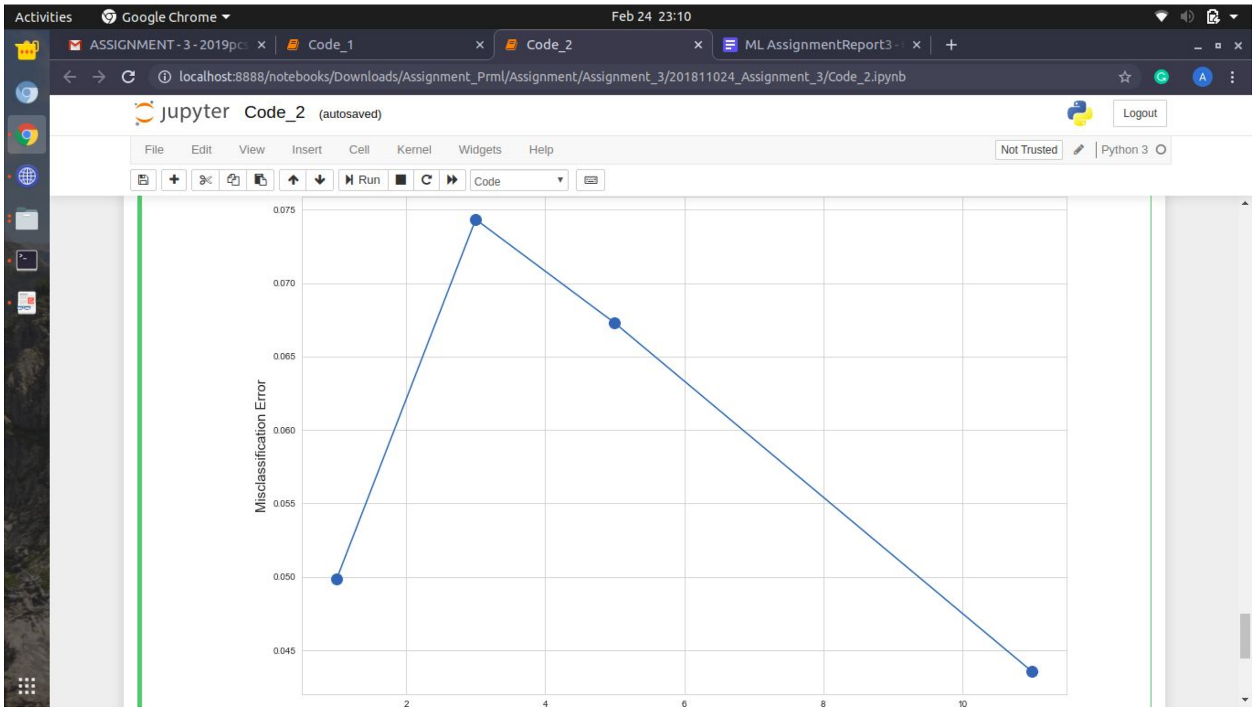
```
accuracy = accuracy_score(y_test, y_pred)*100
print('Accuracy of our model is equal ' + str(round(accuracy, 2)) + ' %.')
```

OUTPUT:

```
Accuracy of our model is equal 96.67 %.
```

```
k_list = list([1,3,5,11])
cv_scores = []
for k in k_list:
    knn = KNeighborsClassifier(n_neighbors=k)
    scores = cross_val_score(knn, X_train, y_train, cv=3, scoring='accuracy')
    cv_scores.append(scores.mean())
MSE = [1 - x for x in cv_scores]
plt.figure()
plt.figure(figsize=(15,10))
plt.title('The optimal number of neighbors', fontsize=20, fontweight='bold')
plt.xlabel('Number of Neighbors K', fontsize=15)
plt.ylabel('Misclassification Error', fontsize=15)
sns.set_style("whitegrid")
plt.plot(k_list, MSE,marker='o',markersize=12)
plt.show()
```

OUTPUT:



```
best_k = k_list[MSE.index(min(MSE))]
print("The optimal number of neighbors is %d." % best_k)
```

OUTPUT:

```
The optimal number of neighbors is 11.
```

```
MSE
```

OUTPUT:

```
[0.04986013986013982,
 0.0743356643356643,
 0.06728438228438216,
 0.043566433566433416]
```