CS156 (Introduction to AI), Spring 2021

Homework 2 submission

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Any special notes or anything you would like to communicate to me about this homework submission goes in here.

References and sources

List all your references and sources here. This includes all sites/discussion boards/blogs/posts/etc. where you grabbed some code examples. https://realpython.com/train-test-split-python-data/

Solution

Load libraries and set random number generator seed

In [186…

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import math as math
import sys
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
import collections
from collections import Counter
```

In [187…

```
np.random.seed(42)
```

Beginning with creating our 2D data

In [188…

```
n = 100

X1 = np.random.normal(loc = -2, scale = 2, size = int(n/2))
Y1 = np.random.normal(loc = 0, scale = 1, size = int(n/2))

X2 = np.random.normal(loc = 2, scale = 2, size = int(n/2))
Y2 = np.random.normal(loc = 0, scale = 1, size = int(n/2))

X = np.concatenate((X1, X2), axis=0)
Y = np.concatenate((Y1, Y2), axis=0)

dt = pd.DataFrame({'X': X, 'Y':Y}, columns=['X', 'Y'])
dt.head()
```

Out[188…

	X	Y
0	-1.006572	0.324084
1	-2.276529	-0.385082
2	-0.704623	-0.676922
3	1.046060	0.611676
4	-2.468307	1.031000

Divide dataset into training/test

In [189…

```
l1 = [0]*int(n/2)
l2 = [1]*int(n/2)
labels = l1 + l2
print(labels)
X_train, X_test, Y_train, Y_test = train_test_split(dt, labels, test_size=0.2, random_
print(f"Length of training is {len(X_train)} \nLength of test is {len(X_test)}")
```

```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 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]
Length of training is 80
Length of test is 20
```

Driver code, set up dataframe for reference data, create prediction results and append the result of test dataframe's classification from the training data

In [190…

```
train_df = pd.DataFrame(X_train)
train_df["Output Variable"] = Y_train

test_df = pd.DataFrame(X_test)
pred_results = []

for index in test_df.index:
    pred_results.append(knn(test_df.loc[index], train_df,3))
```

In [191…

```
print(pred_results)
print(Y_test)
```

```
[0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0]
[0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0]
```

ACTUAL FUNCTION - New observation will represent our new data record to be classified as either 0 or 1. Reference data is our dataset and k = 3 will be the nearest neighbor count to the new observation.

In [192…

```
def knn(newObservation, referenceData, k=3):
    if newObservation.size + 1 != referenceData.iloc[0].size:
        raise Exception('newObservation dimensions are not the same as reference Datas


    # Distances will be a dictionary to hold the distances
    # and it's output variable, label counts for how many neighbors are in majority
    distances = {}
    point2 = []

    for x in newObservation:
        point2.append(x)


    #Loop through reference data and find distance between every observation in refere
    # Store the result in distances
    for index in referenceData.index:
        row = referenceData.loc[index]
        point1 = []

        for x in range(row.size-1):
            point1.append(row[x])

        point1 = np.array(point1)
        point2 = np.array(point2)
        distance = np.linalg.norm(point1 - point2)
        distances[distance] = referenceData['Output Variable'][index]

    # Sort the distances dictionary based on key (which is the distance), and then re
    # which are the labels. Count the number of labels and return accordingly
    c = []
    i = 0
    for value in sorted (distances):
        if i == k:
            break
        output_variable = distances[value]
        c.append(output_variable)
        i += 1

    d = Counter(c)
    size = len(d)
    for (key,val) in d.items():
         if (val > (size/2)):
            return key
```

Print Accuracy score between y test and prediction results and then plot

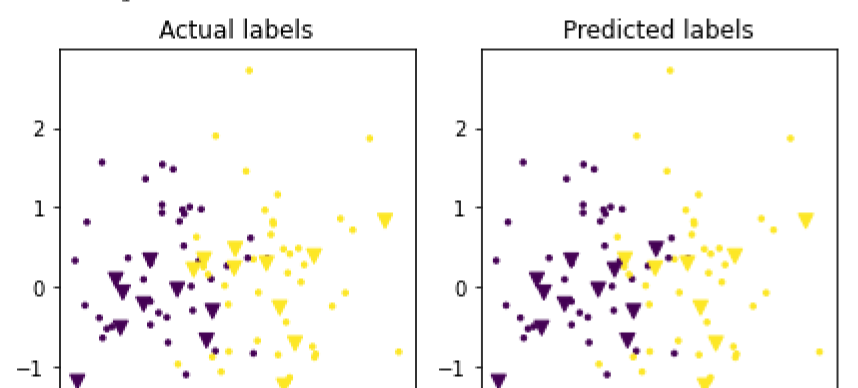
In [193…

```
print(f'Accuracy Score is: {float(accuracy_score(pred_results, Y_test))}')
plt.subplot(1, 2, 1)
plt.scatter(X_train.iloc[:,0],X_train.iloc[:,1], s=25, c=Y_train, marker=".")
plt.scatter(X_test.iloc[:,0],X_test.iloc[:,1], s=50, c=Y_test, marker="v")
plt.title("Actual labels")

plt.subplot(1, 2, 2)
plt.scatter(X_train.iloc[:,0],X_train.iloc[:,1], s=25, c=Y_train, marker=".")
plt.scatter(X_test.iloc[:,0],X_test.iloc[:,1], s=50, c=pred_results, marker="v")
plt.title("Predicted labels")

plt.tight_layout()
plt.show()
```

```
Accuracy Score is: 0.9
```



Now onto 3D data, same process

In [197…

```
n = 1000
X1 = np.random.normal(loc = 0, scale = 3, size = int(n/4))
Y1 = np.random.normal(loc = -3, scale = 1, size = int(n/4))
Z1 = np.random.normal(loc = -1, scale = 1, size = int(n/4))

X2 = np.random.normal(loc = 0, scale = 3, size = int(n/4))
Y2 = np.random.normal(loc = 1, scale = 2, size = int(n/4))
Z2 = np.random.normal(loc = 1, scale = 1, size = int(n/4))

X3 = np.random.normal(loc = 0, scale = 3, size = int(n/4))
Y3 = np.random.normal(loc = 3, scale = 1, size = int(n/4))
Z3 = np.random.normal(loc = 4, scale = 1, size = int(n/4))

X4 = np.random.normal(loc = 0, scale = 3, size = int(n/4))
Y4 = np.random.normal(loc = 5, scale = 3, size = int(n/4))
Z4 = np.random.normal(loc = -3, scale = 1, size = int(n/4))

X = np.concatenate((X1, X2, X3, X4), axis=0)
Y = np.concatenate((Y1, Y2, Y3, Y4), axis=0)
Z = np.concatenate((Z1, Z2, Z3, Z4), axis=0)

three_dt = pd.DataFrame({'X': X, 'Y':Y, 'Z': Z}, columns=['X', 'Y', 'Z'])
```

In [198…

```
l1 = [0]*int(n/4)
l2 = [1]*int(n/4)
l3 = [2] * int(n/4)
l4 = [3] * int(n/4)
labels = l1+l2+l3+l4
X_train, X_test, Y_train, Y_test = train_test_split(three_dt, labels, test_size=0.2, r
train_df = pd.DataFrame(X_train)
train_df["Output Variable"] = Y_train

test_df = pd.DataFrame(X_test)
pred_results = []

for index in test_df.index:
    pred_results.append(knn(test_df.loc[index], train_df,3))

print(pred_results)
print(Y_test)
```

```
[3, 3, 3, 2, 2, 3, 0, 0, 1, 2, 1, 1, 3, 0, 2, 0, 0, 0, 0, 0, 0, 0, 1, 1, 3, 3, 0, 1,
3, 0, 3, 2, 2, 3, 1, 2, 0, 1, 3, 1, 0, 3, 2, 1, 1, 3, 3, 0, 1, 2, 1, 1, 1, 1, 3, 2, 2,
0, 1, 1, 2, 2, 1, 1, 1, 0, 1, 2, 1, 1, 2, 1, 2, 0, 3, 1, 1, 3, 2, 2, 1, 1, 1, 3, 3, 2,
1, 2, 1, 3, 1, 1, 3, 1, 2, 1, 2, 0, 1, 2, 3, 3, 0, 3, 0, 2, 2, 3, 3, 3, 0, 2, 1, 2, 1,
1, 2, 1, 1, 2, 3, 3, 0, 3, 0, 3, 1, 1, 3, 2, 1, 2, 2, 2, 3, 2, 1, 0, 2, 3, 0, 2, 2, 0,
1, 1, 1, 1, 0, 0, 2, 0, 1, 3, 3, 3, 1, 1, 3, 1, 2, 3, 2, 0, 3, 1, 1, 3, 1, 1, 3, 3, 0,
3, 1, 3, 0, 1, 3, 1, 3, 3, 1, 1, 3, 3, 2, 1, 3, 0, 3, 3, 3, 1, 3, 2, 2, 0, 2, 0]
[3, 3, 1, 2, 2, 3, 0, 0, 1, 2, 1, 2, 3, 0, 2, 0, 3, 0, 0, 0, 0, 1, 1, 1, 3, 3, 0, 0,
3, 0, 3, 2, 2, 3, 1, 2, 3, 1, 3, 1, 0, 3, 2, 2, 1, 3, 3, 0, 1, 2, 1, 1, 1, 1, 3, 2, 1,
1, 3, 1, 2, 2, 0, 0, 1, 0, 1, 2, 1, 2, 2, 1, 2, 0, 3, 1, 1, 3, 2, 2, 1, 1, 1, 3, 3, 2,
0, 2, 1, 3, 1, 1, 3, 1, 2, 1, 2, 0, 1, 2, 3, 3, 0, 3, 1, 2, 2, 3, 3, 0, 0, 2, 1, 2, 1,
1, 2, 1, 1, 2, 3, 3, 0, 3, 0, 3, 1, 1, 3, 2, 1, 2, 2, 2, 3, 2, 1, 0, 2, 3, 0, 2, 2, 0,
1, 1, 1, 1, 0, 0, 1, 0, 1, 3, 3, 3, 1, 1, 3, 1, 2, 3, 2, 3, 3, 1, 1, 3, 1, 1, 3, 3, 0,
3, 1, 3, 0, 2, 3, 0, 3, 3, 1, 1, 3, 3, 2, 1, 3, 0, 3, 3, 1, 0, 3, 2, 2, 0, 2, 0]
```

In [199…

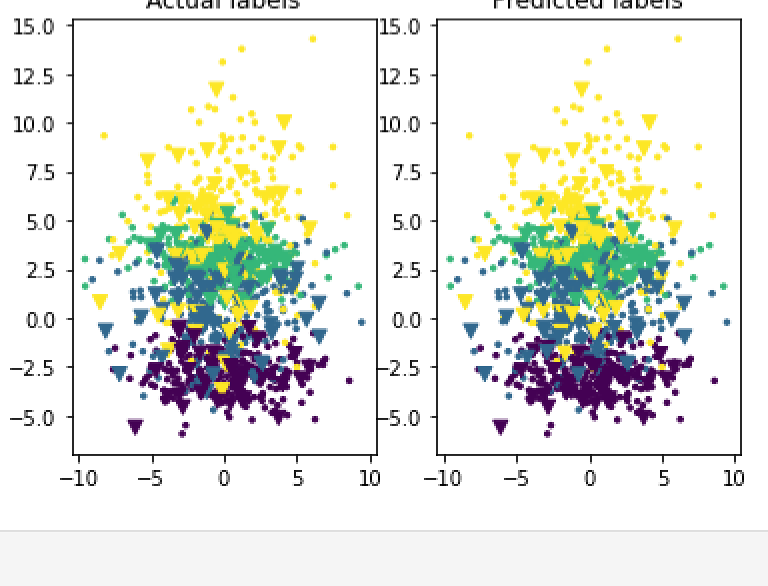
```
print(f'Accuracy Score is: {float(accuracy_score(pred_results, Y_test))}')
plt.subplot(1, 2, 1)
plt.scatter(X_train.iloc[:,0],X_train.iloc[:,1], s=25, c=Y_train, marker=".")
plt.scatter(X_test.iloc[:,0],X_test.iloc[:,1], s=50, c=Y_test, marker="v")
plt.title("Actual labels")

plt.subplot(1, 2, 2)
plt.scatter(X_train.iloc[:,0],X_train.iloc[:,1], s=25, c=Y_train, marker=".")
plt.scatter(X_test.iloc[:,0],X_test.iloc[:,1], s=50, c=pred_results, marker="v")
plt.title("Predicted labels")
```

```
Accuracy Score is: 0.89
```

Out[199…

```
Text(0.5, 1.0, 'Predicted labels')
```



In [ ]: