Program 25

October 25, 2022

1 PROGRAM 25

Aim : Program to implement k-NN classification using the datasets (Breastcancer.csv,Telco-Customer-Churn.csv) and find the accuracy of the algorithm

Date : 28/09/2022

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[718]:

```
import numpy as np
import pandas as pd
!pip install scikit-learn
```

```
Defaulting to user installation because normal site-packages is not writeable
Requirement already satisfied: scikit-learn in
/opt/anaconda3/lib/python3.9/site-packages (1.0.2)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/opt/anaconda3/lib/python3.9/site-packages (from scikit-learn) (2.2.0)
Requirement already satisfied: numpy>=1.14.6 in
/opt/anaconda3/lib/python3.9/site-packages (from scikit-learn) (1.21.5)
Requirement already satisfied: scipy>=1.1.0 in
/opt/anaconda3/lib/python3.9/site-packages (from scikit-learn) (1.7.3)
Requirement already satisfied: joblib>=0.11 in
/opt/anaconda3/lib/python3.9/site-packages (from scikit-learn) (1.1.0)
```

[719]:

```
import pandas as pd
df=pd.read_csv('Telco-Customer-Churn.csv')
#print(df)
```

[720]:

```
cols=df.columns
print(cols)
```

```
Index(['customerID', 'gender', 'SeniorCitizen', 'Partner', 'Dependents',
       'tenure', 'PhoneService', 'MultipleLines', 'InternetService',
       'OnlineSecurity', 'OnlineBackup', 'DeviceProtection', 'TechSupport',
       'StreamingTV', 'StreamingMovies', 'Contract', 'PaperlessBilling',
       'PaymentMethod', 'MonthlyCharges', 'TotalCharges', 'Churn'],
      dtype='object')
```

[721]:

```
df.describe()
```

[721]:

```
       SeniorCitizen       tenure  MonthlyCharges
count    7043.000000  7043.000000     7043.000000
mean        0.162147    32.371149       64.761692
std         0.368612    24.559481       30.090047
min         0.000000     0.000000       18.250000
25%         0.000000     9.000000       35.500000
50%         0.000000    29.000000       70.350000
75%         0.000000    55.000000       89.850000
max         1.000000    72.000000      118.750000
```

[722]:

```
df.isnull().sum()
```

[722]:

```
customerID          0
gender              0
SeniorCitizen       0
Partner             0
Dependents          0
tenure              0
PhoneService        0
MultipleLines       0
InternetService     0
OnlineSecurity      0
OnlineBackup        0
DeviceProtection    0
TechSupport         0
StreamingTV         0
StreamingMovies     0
Contract            0
PaperlessBilling    0
PaymentMethod       0
MonthlyCharges      0
TotalCharges        0
Churn               0
dtype: int64
```

[723]:

```
df.value_counts("Churn")
```

[723]:

```
Churn
No     5174
Yes    1869
dtype: int64
```

[724]:

```
df["TotalCharges"]=pd.to_numeric(df["TotalCharges"],errors='coerce')
df=df.dropna()
```

[725]:

```
y=df['Churn'] ##Dependent variable
df.drop('Churn',axis=1,inplace=True)
print(y)
```

```
0         No
1         No
2        Yes
3         No
4        Yes
       …
7038      No
7039      No
7040      No
7041     Yes
7042      No
Name: Churn, Length: 7032, dtype: object
```

[726]:

```
df.drop('customerID', axis = 1,inplace=True)
cols=df.columns
print(cols)
x=df
print(x)
```

```
Index(['gender', 'SeniorCitizen', 'Partner', 'Dependents', 'tenure',
       'PhoneService', 'MultipleLines', 'InternetService', 'OnlineSecurity',
       'OnlineBackup', 'DeviceProtection', 'TechSupport', 'StreamingTV',
       'StreamingMovies', 'Contract', 'PaperlessBilling', 'PaymentMethod',
       'MonthlyCharges', 'TotalCharges'],
      dtype='object')
      gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0     Female              0     Yes         No       1           No
1       Male              0      No         No      34          Yes
2       Male              0      No         No       2          Yes
3       Male              0      No         No      45           No
4     Female              0      No         No       2          Yes
…      …            …     …        …     …          …
7038    Male              0     Yes        Yes      24          Yes
7039  Female              0     Yes        Yes      72          Yes
7040  Female              0     Yes        Yes      11           No
7041    Male              1     Yes         No       4          Yes
7042    Male              0      No         No      66          Yes

         MultipleLines InternetService OnlineSecurity OnlineBackup  \
0     No phone service             DSL             No          Yes
1                   No             DSL            Yes           No
2                   No             DSL            Yes          Yes
3     No phone service             DSL            Yes           No
4                   No     Fiber optic             No           No
```

```
…                …             …            …          …
7038               Yes             DSL            Yes           No
7039               Yes     Fiber optic             No          Yes
7040  No phone service             DSL            Yes           No
7041               Yes     Fiber optic             No           No
7042                No     Fiber optic            Yes           No

     DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0                  No          No          No              No  Month-to-month
1                 Yes          No          No              No        One year
2                  No          No          No              No  Month-to-month
3                 Yes         Yes          No              No        One year
4                  No          No          No              No  Month-to-month
…                …         …         …             …             …
7038              Yes         Yes         Yes             Yes        One year
7039              Yes          No         Yes             Yes        One year
7040               No          No          No              No  Month-to-month
7041               No          No          No              No  Month-to-month
7042              Yes         Yes         Yes             Yes        Two year

     PaperlessBilling              PaymentMethod  MonthlyCharges  TotalCharges
0                 Yes           Electronic check           29.85         29.85
1                  No               Mailed check           56.95       1889.50
2                 Yes               Mailed check           53.85        108.15
3                  No  Bank transfer (automatic)           42.30       1840.75
4                 Yes           Electronic check           70.70        151.65
…                …                        …             …           …
7038              Yes               Mailed check           84.80       1990.50
7039              Yes    Credit card (automatic)          103.20       7362.90
7040              Yes           Electronic check           29.60        346.45
7041              Yes               Mailed check           74.40        306.60
7042              Yes  Bank transfer (automatic)          105.65       6844.50

[7032 rows x 19 columns]
```

[727]:

```
from sklearn.preprocessing import LabelEncoder
label_encoder_y=LabelEncoder()
y=label_encoder_y.fit_transform(y)
print("After labeling :\n",y)
```

```
After labeling :
 [0 0 1 … 0 1 0]
```

[728]:

```
label_encoder_x=LabelEncoder()
x.iloc[:,0]=label_encoder_x.fit_transform(x.iloc[:,0])  #gender
print("After labeling :\n",x)
```

```
After labeling :
       gender  SeniorCitizen Partner Dependents  tenure PhoneService  \
0          0              0     Yes         No        1           No
1          1              0      No         No       34          Yes
2          1              0      No         No        2          Yes
3          1              0      No         No       45           No
4          0              0      No         No        2          Yes
…      …            …     …        …     …          …
7038       1              0     Yes        Yes       24          Yes
7039       0              0     Yes        Yes       72          Yes
7040       0              0     Yes        Yes       11           No
7041       1              1     Yes         No        4          Yes
7042       1              0      No         No       66          Yes

         MultipleLines InternetService OnlineSecurity OnlineBackup  \
0     No phone service             DSL             No          Yes
1                   No             DSL            Yes           No
2                   No             DSL            Yes          Yes
3     No phone service             DSL            Yes           No
4                   No     Fiber optic             No           No
…                …             …            …          …
7038               Yes             DSL            Yes           No
7039               Yes     Fiber optic             No          Yes
7040  No phone service             DSL            Yes           No
7041               Yes     Fiber optic             No           No
7042                No     Fiber optic            Yes           No

     DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0                  No          No          No              No  Month-to-month
1                 Yes          No          No              No        One year
2                  No          No          No              No  Month-to-month
3                 Yes         Yes          No              No        One year
4                  No          No          No              No  Month-to-month
…               …         …         …             …             …
7038              Yes         Yes         Yes             Yes        One year
7039              Yes          No         Yes             Yes        One year
7040               No          No          No              No  Month-to-month
7041               No          No          No              No  Month-to-month
7042              Yes         Yes         Yes             Yes        Two year

     PaperlessBilling              PaymentMethod  MonthlyCharges  TotalCharges
0                 Yes           Electronic check           29.85         29.85
1                  No               Mailed check           56.95       1889.50
2                 Yes               Mailed check           53.85        108.15
3                  No  Bank transfer (automatic)           42.30       1840.75
4                 Yes           Electronic check           70.70        151.65
…               …                        …             …           …
7038              Yes               Mailed check           84.80       1990.50
7039              Yes    Credit card (automatic)          103.20       7362.90
```

```
7040              Yes           Electronic check           29.60        346.45
7041              Yes               Mailed check           74.40        306.60
7042              Yes  Bank transfer (automatic)          105.65       6844.50

[7032 rows x 19 columns]
```

[729]:

```
x.iloc[:,2]=label_encoder_x.fit_transform(x.iloc[:,2]) #partner
print("After labeling :\n",x)
```

```
After labeling :
       gender  SeniorCitizen  Partner Dependents  tenure PhoneService  \
0          0              0        1         No       1           No
1          1              0        0         No      34          Yes
2          1              0        0         No       2          Yes
3          1              0        0         No      45           No
4          0              0        0         No       2          Yes
…      …            …      …        …     …          …
7038       1              0        1        Yes      24          Yes
7039       0              0        1        Yes      72          Yes
7040       0              0        1        Yes      11           No
7041       1              1        1         No       4          Yes
7042       1              0        0         No      66          Yes

         MultipleLines InternetService OnlineSecurity OnlineBackup  \
0     No phone service             DSL             No          Yes
1                   No             DSL            Yes           No
2                   No             DSL            Yes          Yes
3     No phone service             DSL            Yes           No
4                   No     Fiber optic             No           No
…                …             …            …          …
7038               Yes             DSL            Yes           No
7039               Yes     Fiber optic             No          Yes
7040  No phone service             DSL            Yes           No
7041               Yes     Fiber optic             No           No
7042                No     Fiber optic            Yes           No

     DeviceProtection TechSupport StreamingTV StreamingMovies        Contract  \
0                  No          No          No              No  Month-to-month
1                 Yes          No          No              No        One year
2                  No          No          No              No  Month-to-month
3                 Yes         Yes          No              No        One year
4                  No          No          No              No  Month-to-month
…               …         …         …             …             …
7038              Yes         Yes         Yes             Yes        One year
7039              Yes          No         Yes             Yes        One year
7040               No          No          No              No  Month-to-month
7041               No          No          No              No  Month-to-month
7042              Yes         Yes         Yes             Yes        Two year
```

```
     PaperlessBilling              PaymentMethod  MonthlyCharges  TotalCharges
0                 Yes           Electronic check           29.85         29.85
1                  No               Mailed check           56.95       1889.50
2                 Yes               Mailed check           53.85        108.15
3                  No  Bank transfer (automatic)           42.30       1840.75
4                 Yes           Electronic check           70.70        151.65
…               …                        …             …           …
7038              Yes               Mailed check           84.80       1990.50
7039              Yes    Credit card (automatic)          103.20       7362.90
7040              Yes           Electronic check           29.60        346.45
7041              Yes               Mailed check           74.40        306.60
7042              Yes  Bank transfer (automatic)          105.65       6844.50

[7032 rows x 19 columns]
```

[730]:

```
x.iloc[:,3]=label_encoder_x.fit_transform(x.iloc[:,3]) #Dependents
x.iloc[:,5]=label_encoder_x.fit_transform(x.iloc[:,5]) #PhoneService
x.iloc[:,6]=label_encoder_x.fit_transform(x.iloc[:,6]) #multiplelines
x.iloc[:,7]=label_encoder_x.fit_transform(x.iloc[:,7]) #internet service
x.iloc[:,8]=label_encoder_x.fit_transform(x.iloc[:,8]) #Online Security
x.iloc[:,9]=label_encoder_x.fit_transform(x.iloc[:,9]) #Online Backup
x.iloc[:,10]=label_encoder_x.fit_transform(x.iloc[:,10]) #DeviceProtection
x.iloc[:,11]=label_encoder_x.fit_transform(x.iloc[:,11]) #TechSupport
x.iloc[:,12]=label_encoder_x.fit_transform(x.iloc[:,12]) #StreamingTV
x.iloc[:,13]=label_encoder_x.fit_transform(x.iloc[:,13]) #StreamingMovies
x.iloc[:,14]=label_encoder_x.fit_transform(x.iloc[:,14]) #Contract
x.iloc[:,15]=label_encoder_x.fit_transform(x.iloc[:,15]) #PaperlessBilling
x.iloc[:,16]=label_encoder_x.fit_transform(x.iloc[:,16]) #PaymentMethod
print("After labeling :\n",x)
```

```
After labeling :
       gender  SeniorCitizen  Partner  Dependents  tenure  PhoneService  \
0           0              0        1           0       1             0
1           1              0        0           0      34             1
2           1              0        0           0       2             1
3           1              0        0           0      45             0
4           0              0        0           0       2             1
…      …            …      …         …     …          …
7038        1              0        1           1      24             1
7039        0              0        1           1      72             1
7040        0              0        1           1      11             0
7041        1              1        1           0       4             1
7042        1              0        0           0      66             1

      MultipleLines  InternetService  OnlineSecurity  OnlineBackup  \
0                  1                0               0             2
1                  0                0               2             0
```

```
2                  0                 0                2              2
3                  1                 0                2              0
4                  0                 1                0              0
…              …              …              …            …
7038               2                 0                2              0
7039               2                 1                0              2
7040               1                 0                2              0
7041               2                 1                0              0
7042               0                 1                2              0

      DeviceProtection  TechSupport  StreamingTV  StreamingMovies  Contract  \
0                    0            0            0                0         0
1                    2            0            0                0         1
2                    0            0            0                0         0
3                    2            2            0                0         1
4                    0            0            0                0         0
…                  …          …          …              …       …
7038                 2            2            2                2         1
7039                 2            0            2                2         1
7040                 0            0            0                0         0
7041                 0            0            0                0         0
7042                 2            2            2                2         2

      PaperlessBilling  PaymentMethod  MonthlyCharges  TotalCharges
0                    1              2           29.85         29.85
1                    0              3           56.95       1889.50
2                    1              3           53.85        108.15
3                    0              0           42.30       1840.75
4                    1              2           70.70        151.65
…                  …            …             …           …
7038                 1              3           84.80       1990.50
7039                 1              1          103.20       7362.90
7040                 1              2           29.60        346.45
7041                 1              3           74.40        306.60
7042                 1              0          105.65       6844.50

[7032 rows x 19 columns]
```

[731]:
```
x.shape
```

[731]:
```
(7032, 19)
```

[732]:
```
x=df
one_hot_encoding_columns=["MultipleLines","InternetService","OnlineSecurity","OnlineBackup","D
x=pd.get_dummies(x,columns=one_hot_encoding_columns)
print(x)
```

```
      gender  SeniorCitizen  Partner  Dependents  tenure  PhoneService  \
0          0              0        1           0       1             0
1          1              0        0           0      34             1
2          1              0        0           0       2             1
3          1              0        0           0      45             0
4          0              0        0           0       2             1
…      …            …      …         …     …           …
7038       1              0        1           1      24             1
7039       0              0        1           1      72             1
7040       0              0        1           1      11             0
7041       1              1        1           0       4             1
7042       1              0        0           0      66             1

      PaperlessBilling  MonthlyCharges  TotalCharges  MultipleLines_0  …  \
0                    1           29.85         29.85                0  …
1                    0           56.95       1889.50                1  …
2                    1           53.85        108.15                1  …
3                    0           42.30       1840.75                0  …
4                    1           70.70        151.65                1  …
…                …             …           …              …  …
7038                 1           84.80       1990.50                0  …
7039                 1          103.20       7362.90                0  …
7040                 1           29.60        346.45                0  …
7041                 1           74.40        306.60                0  …
7042                 1          105.65       6844.50                1  …

      StreamingMovies_0  StreamingMovies_1  StreamingMovies_2  Contract_0  \
0                     1                  0                  0           1
1                     1                  0                  0           0
2                     1                  0                  0           1
3                     1                  0                  0           0
4                     1                  0                  0           1
…                 …                …                …         …
7038                  0                  0                  1           0
7039                  0                  0                  1           0
7040                  1                  0                  0           1
7041                  1                  0                  0           1
7042                  0                  0                  1           0

      Contract_1  Contract_2  PaymentMethod_0  PaymentMethod_1  \
0              0           0                0                0
1              1           0                0                0
2              0           0                0                0
3              1           0                1                0
4              0           0                0                0
…          …         …              …              …
7038           1           0                0                0
7039           1           0                0                1
7040           0           0                0                0
```

```
7041           0           0                0                0
7042           0           1                1                0

      PaymentMethod_2  PaymentMethod_3
0                   1                0
1                   0                1
2                   0                1
3                   0                0
4                   1                0
…               …              …
7038                0                1
7039                0                0
7040                1                0
7041                0                1
7042                0                0

[7032 rows x 40 columns]
```

[734]:
```
x.isnull().sum()
```

[734]:
```
gender                0
SeniorCitizen         0
Partner               0
Dependents            0
tenure                0
PhoneService          0
PaperlessBilling      0
MonthlyCharges        0
TotalCharges          0
MultipleLines_0       0
MultipleLines_1       0
MultipleLines_2       0
InternetService_0     0
InternetService_1     0
InternetService_2     0
OnlineSecurity_0      0
OnlineSecurity_1      0
OnlineSecurity_2      0
OnlineBackup_0        0
OnlineBackup_1        0
OnlineBackup_2        0
DeviceProtection_0    0
DeviceProtection_1    0
DeviceProtection_2    0
TechSupport_0         0
TechSupport_1         0
TechSupport_2         0
```

```
StreamingTV_0         0
StreamingTV_1         0
StreamingTV_2         0
StreamingMovies_0     0
StreamingMovies_1     0
StreamingMovies_2     0
Contract_0            0
Contract_1            0
Contract_2            0
PaymentMethod_0       0
PaymentMethod_1       0
PaymentMethod_2       0
PaymentMethod_3       0
dtype: int64
```

[735]:

```
#convert total charge into numeric
x["TotalCharges"]=pd.to_numeric(x["TotalCharges"],errors='coerce')
print(x)
```

```
      gender  SeniorCitizen  Partner  Dependents  tenure  PhoneService  \
0          0              0        1           0       1             0
1          1              0        0           0      34             1
2          1              0        0           0       2             1
3          1              0        0           0      45             0
4          0              0        0           0       2             1
…       …            …      …         …     …           …
7038       1              0        1           1      24             1
7039       0              0        1           1      72             1
7040       0              0        1           1      11             0
7041       1              1        1           0       4             1
7042       1              0        0           0      66             1

      PaperlessBilling  MonthlyCharges  TotalCharges  MultipleLines_0  …  \
0                    1           29.85         29.85                0  …
1                    0           56.95       1889.50                1  …
2                    1           53.85        108.15                1  …
3                    0           42.30       1840.75                0  …
4                    1           70.70        151.65                1  …
…                …              …            …               …  …
7038                 1           84.80       1990.50                0  …
7039                 1          103.20       7362.90                0  …
7040                 1           29.60        346.45                0  …
7041                 1           74.40        306.60                0  …
7042                 1          105.65       6844.50                1  …

      StreamingMovies_0  StreamingMovies_1  StreamingMovies_2  Contract_0  \
0                     1                  0                  0           1
```

```
1                     1                  0                  0           0
2                     1                  0                  0           1
3                     1                  0                  0           0
4                     1                  0                  0           1
...                 ...                ...                ...         ...
7038                  0                  0                  1           0
7039                  0                  0                  1           0
7040                  1                  0                  0           1
7041                  1                  0                  0           1
7042                  0                  0                  1           0

      Contract_1  Contract_2  PaymentMethod_0  PaymentMethod_1  \
0              0           0                0                0
1              1           0                0                0
2              0           0                0                0
3              1           0                1                0
4              0           0                0                0
...          ...         ...              ...              ...
7038           1           0                0                0
7039           1           0                0                1
7040           0           0                0                0
7041           0           0                0                0
7042           0           1                1                0

      PaymentMethod_2  PaymentMethod_3
0                   1                0
1                   0                1
2                   0                1
3                   0                0
4                   1                0
...               ...              ...
7038                0                1
7039                0                0
7040                1                0
7041                0                1
7042                0                0

[7032 rows x 40 columns]
```

```
[736]: x.dtypes
```

```
[736]: gender                  int64
       SeniorCitizen           int64
       Partner                 int64
       Dependents              int64
       tenure                  int64
       PhoneService            int64
```

```
PaperlessBilling        int64
MonthlyCharges        float64
TotalCharges          float64
MultipleLines_0         uint8
MultipleLines_1         uint8
MultipleLines_2         uint8
InternetService_0       uint8
InternetService_1       uint8
InternetService_2       uint8
OnlineSecurity_0        uint8
OnlineSecurity_1        uint8
OnlineSecurity_2        uint8
OnlineBackup_0          uint8
OnlineBackup_1          uint8
OnlineBackup_2          uint8
DeviceProtection_0      uint8
DeviceProtection_1      uint8
DeviceProtection_2      uint8
TechSupport_0           uint8
TechSupport_1           uint8
TechSupport_2           uint8
StreamingTV_0           uint8
StreamingTV_1           uint8
StreamingTV_2           uint8
StreamingMovies_0       uint8
StreamingMovies_1       uint8
StreamingMovies_2       uint8
Contract_0              uint8
Contract_1              uint8
Contract_2              uint8
PaymentMethod_0         uint8
PaymentMethod_1         uint8
PaymentMethod_2         uint8
PaymentMethod_3         uint8
dtype: object
```

from sklearn.preprocessing import MinMaxScaler st_x=MinMaxScaler() x=st_x.fit_transform(x) print(x)

[737]:

```
x.isnull().sum()
```

[737]:

```
gender              0
SeniorCitizen       0
Partner             0
Dependents          0
tenure              0
PhoneService        0
```

```
PaperlessBilling       0
MonthlyCharges         0
TotalCharges           0
MultipleLines_0        0
MultipleLines_1        0
MultipleLines_2        0
InternetService_0      0
InternetService_1      0
InternetService_2      0
OnlineSecurity_0       0
OnlineSecurity_1       0
OnlineSecurity_2       0
OnlineBackup_0         0
OnlineBackup_1         0
OnlineBackup_2         0
DeviceProtection_0     0
DeviceProtection_1     0
DeviceProtection_2     0
TechSupport_0          0
TechSupport_1          0
TechSupport_2          0
StreamingTV_0          0
StreamingTV_1          0
StreamingTV_2          0
StreamingMovies_0      0
StreamingMovies_1      0
StreamingMovies_2      0
Contract_0             0
Contract_1             0
Contract_2             0
PaymentMethod_0        0
PaymentMethod_1        0
PaymentMethod_2        0
PaymentMethod_3        0
dtype: int64
```

[738]:

```
x=x.dropna()
```

[739]:

```
from sklearn.model_selection import train_test_split
x_train,x_test,y_train,y_test=train_test_split(x, y,test_size= 0.
 ↪25,random_state=0)
```

[740]:

```
from sklearn.preprocessing import MinMaxScaler
st_x=MinMaxScaler()
x_train=st_x.fit_transform(x_train)
x_test=st_x.fit_transform(x_test)
print("Taining data \n",x_train)
print("Testing data \n",x_test)
```

```
Taining data
 [[0. 0. 1. … 0. 0. 0.]
 [1. 0. 1. … 0. 0. 0.]
 [0. 0. 0. … 0. 1. 0.]
 …
 [1. 0. 1. … 1. 0. 0.]
 [0. 0. 1. … 1. 0. 0.]
 [1. 0. 0. … 1. 0. 0.]]
Testing data
 [[1. 0. 0. … 0. 1. 0.]
 [1. 0. 0. … 1. 0. 0.]
 [0. 0. 0. … 1. 0. 0.]
 …
 [1. 0. 0. … 0. 1. 0.]
 [1. 1. 0. … 0. 0. 0.]
 [0. 0. 1. … 0. 0. 1.]]
```

[741]:

```
from sklearn.neighbors import KNeighborsClassifier
classifier=KNeighborsClassifier(n_neighbors=5)
classifier.fit(x_train,y_train)
```

[741]:

```
KNeighborsClassifier()
```

[742]:

```
y_pred=classifier.predict(x_test)
print(y_pred)
```

```
[0 0 0 … 1 0 0]
```

[743]:

```
from sklearn.metrics import confusion_matrix
cm=confusion_matrix (y_test,y_pred,labels=classifier.classes_)
print(cm)
```

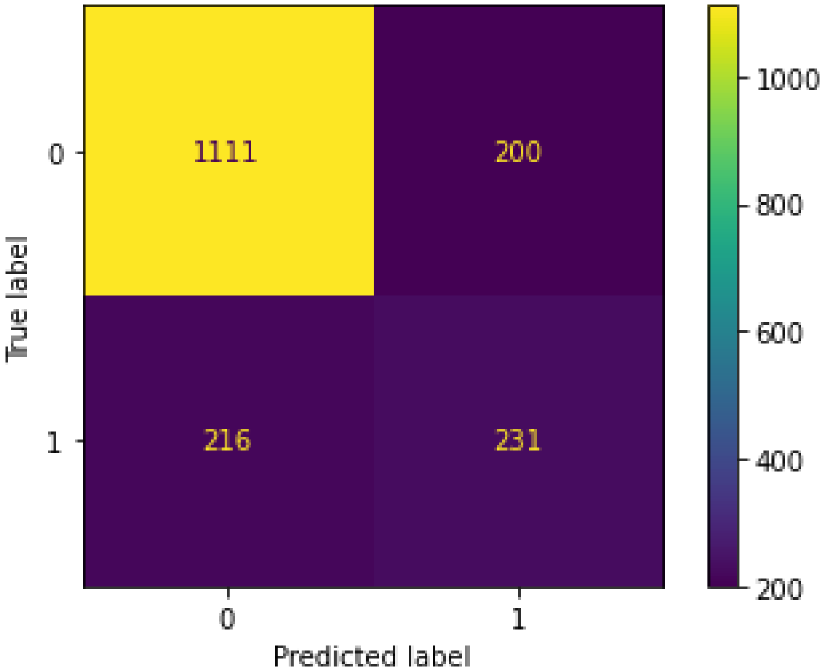
```
[[1111  200]
 [ 216  231]]
```

[744]:

```
from sklearn.metrics import ConfusionMatrixDisplay
disp=ConfusionMatrixDisplay(confusion_matrix=cm,display_labels=classifier.
 ↪classes_)
disp.plot()
```

[744]:

```
<sklearn.metrics._plot.confusion_matrix.ConfusionMatrixDisplay at
0x7f15f1363eb0>
```



[745]:

```
training_score=classifier.score(x_train, y_train)
test_score=classifier.score(x_test, y_test)
print("Training Accuracy :",training_score)
print("Testing Accuracy :",test_score)
```

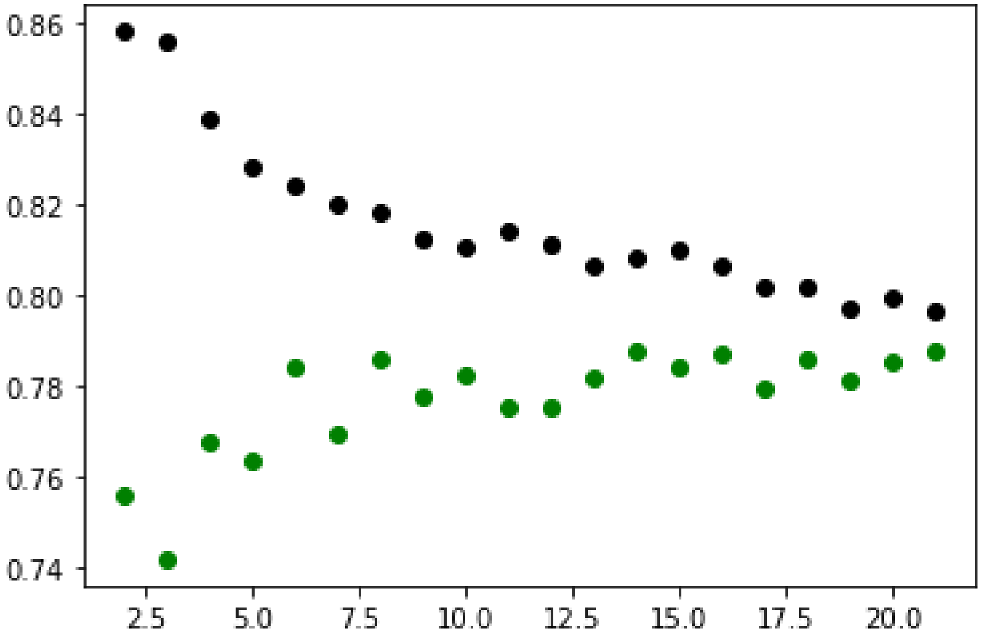
```
Training Accuracy : 0.8282138794084186
Testing Accuracy : 0.7633674630261661
```

[748]:

```
K=[]
training=[]
test=[]
scores={}
for k in range(2, 22):
    clf=KNeighborsClassifier(n_neighbors=k)
    clf.fit(x_train,y_train)
    training_score=clf.score(x_train, y_train)
    test_score=clf.score(x_test, y_test)
    K.append(k)
    training.append(training_score)
    test.append(test_score)
    scores[k]=[training_score, test_score]
for keys, values in scores.items():
    print(keys,':',values)
# visualization
import matplotlib.pyplot as plt
```

```
plt.scatter(K,training,color='k')
plt.scatter(K,test,color='g')
plt.show()
```

```
2 : [0.8581721653394009, 0.7559726962457338]
3 : [0.8558968524838833, 0.7417519908987485]
4 : [0.8386423966628744, 0.767349260523322]
5 : [0.8282138794084186, 0.7633674630261661]
6 : [0.8244216913158893, 0.7838452787258248]
7 : [0.820250284414107, 0.7696245733788396]
8 : [0.8179749715585893, 0.7861205915813424]
9 : [0.8122866894197952, 0.7775881683731513]
10 : [0.810580204778157, 0.7821387940841866]
11 : [0.8141827834660599, 0.7753128555176336]
12 : [0.8109594235874099, 0.7753128555176336]
13 : [0.8064087978763747, 0.7815699658703071]
14 : [0.8081152825180129, 0.7878270762229806]
15 : [0.8102009859689041, 0.7838452787258248]
16 : [0.8064087978763747, 0.7872582480091013]
17 : [0.8020477815699659, 0.7792946530147895]
18 : [0.801668562760713, 0.7861205915813424]
19 : [0.7973075464543041, 0.7810011376564278]
20 : [0.7992036405005688, 0.785551763367463]
21 : [0.7963594994311718, 0.7878270762229806]
```



[ ]: