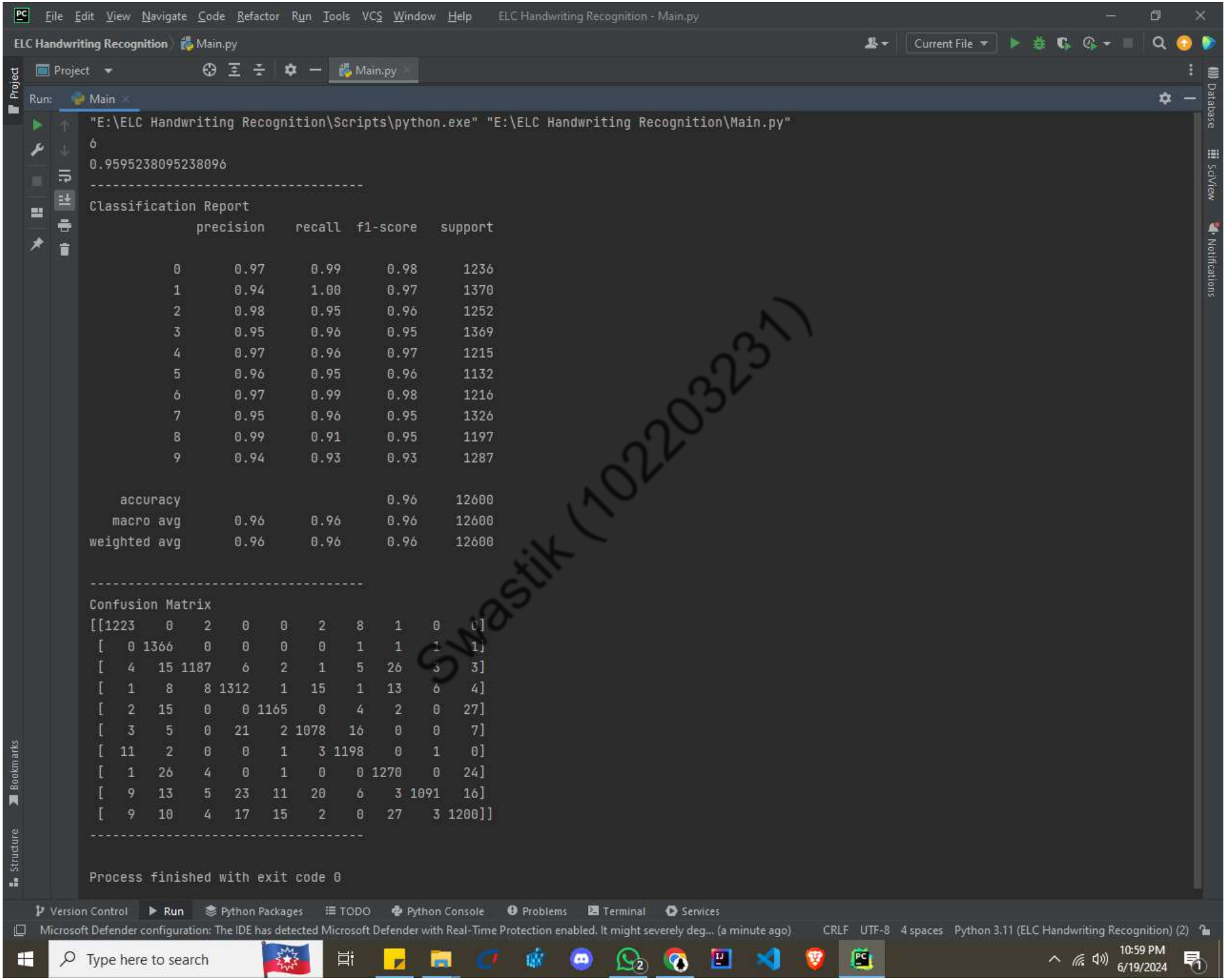
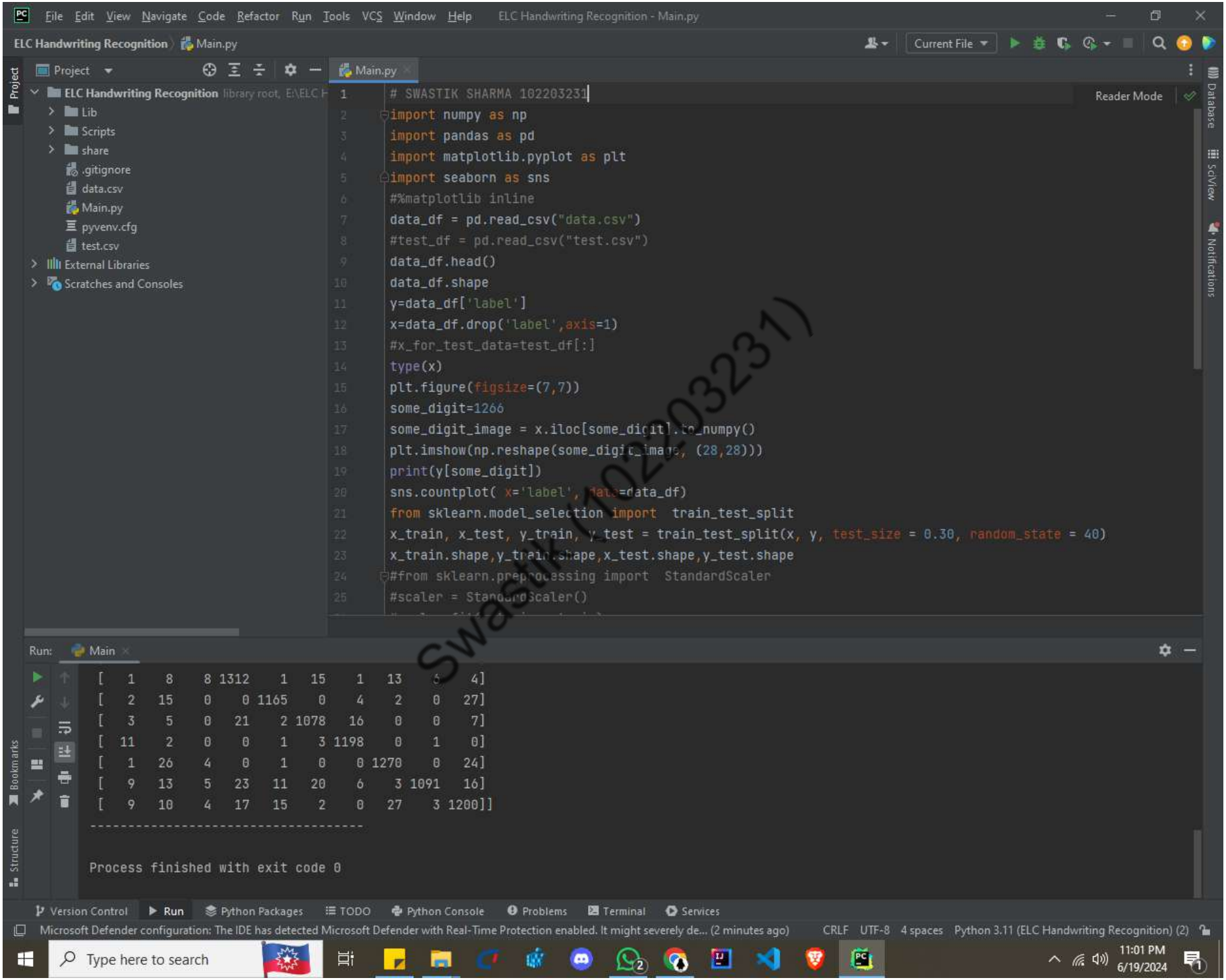

File Edit View Navigate Code Refactor Run Tools VCS Window Help
ELC Handwriting Recognition - Main.py
ELC Handwriting Recognition
Main.py
Current File
Project
Main.py
Run:
Main
"E:\ELC Handwriting Recognition\Scripts\python.exe" "E:\ELC Handwriting Recognition\Main.py"
6
0.9595238095238096
Classification Report
precision recall f1-score support
0 0.97 0.99 0.98 1236
1 0.94 1.00 0.97 1370
2 0.98 0.95 0.96 1252
3 0.95 0.96 0.95 1369
4 0.97 0.96 0.97 1215
5 0.96 0.95 0.96 1132
6 0.97 0.99 0.98 1216
7 0.95 0.96 0.95 1326
8 0.99 0.91 0.95 1197
9 0.94 0.93 0.93 1287
accuracy 0.96 12600
macro avg 0.96 0.96 0.96 12600
weighted avg 0.96 0.96 0.96 12600
Confusion Matrix
[[1223 0 2 0 0 2 8 1 0 0]
[0 1366 0 0 0 0 1 1 1 1]
[4 15 1187 6 2 1 5 26 3 3]
[1 8 8 1312 1 15 1 13 6 4]
[2 15 0 0 1165 0 4 2 0 27]
[3 5 0 21 2 1078 16 0 0 7]
[11 2 0 0 1 3 1198 0 1 0]
[1 26 4 0 1 0 0 1270 0 24]
[9 13 5 23 11 20 6 3 1091 16]
[9 10 4 17 15 2 0 27 3 1200]]
Process finished with exit code 0
Swastik (10220323 1)
Version Control
Run
Python Packages
TODO
Python Console
Problems
Terminal
Services
Microsoft Defender configuration: The IDE has detected Microsoft Defender with Real-Time Protection enabled. It might severely deg... (a minute ago)
CRLF UTF-8 4 spaces Python 3.11 (ELC Handwriting Recognition) (2)
Type here to search
10:59 PM
6/19/2024


File Edit View Navigate Code Refactor Run Tools VCS Window Help ELC Handwriting Recognition - Main.py
ELC Handwriting Recognition Main.py
Current File
Project
ELC Handwriting Recognition library root, E:\ELC H
Lib
Scripts
share
.gitignore
data.csv
Main.py
pyvenv.cfg
test.csv
External Libraries
Scratches and Consoles
Main.py
Reader Mode
1 # SWASTIK SHARMA 102203231
2 import numpy as np
3 import pandas as pd
4 import matplotlib.pyplot as plt
5 import seaborn as sns
6 #%matplotlib inline
7 data_df = pd.read_csv("data.csv")
8 #test_df = pd.read_csv("test.csv")
9 data_df.head()
10 data_df.shape
11 y=data_df['label']
12 x=data_df.drop('label',axis=1)
13 #x_for_test_data=test_df[:]
14 type(x)
15 plt.figure(figsize=(7,7))
16 some_digit=1266
17 some_digit_image = x.iloc[some_digit].to_numpy()
18 plt.imshow(np.reshape(some_digit_image, (28,28)))
19 print(y[some_digit])
20 sns.countplot(x='label', data=data_df)
21 from sklearn.model_selection import train_test_split
22 x_train, x_test, y_train, y_test = train_test_split(x, y, test_size = 0.30, random_state = 40)
23 x_train.shape,y_train.shape,x_test.shape,y_test.shape
24 #from sklearn.preprocessing import StandardScaler
25 #scaler = StandardScaler()
Run: Main
[1 8 8 1312 1 15 1 13 6 4]
[2 15 0 0 1165 0 4 2 0 27]
[3 5 0 21 2 1078 16 0 0 7]
[11 2 0 0 1 3 1198 0 1 0]
[1 26 4 0 1 0 0 1270 0 24]
[9 13 5 23 11 20 6 3 1091 16]
[9 10 4 17 15 2 0 27 3 1200]]
Process finished with exit code 0
Swastik (102203231)
Version Control Run Python Packages TODO Python Console Problems Terminal Services
Microsoft Defender configuration: The IDE has detected Microsoft Defender with Real-Time Protection enabled. It might severely de... (2 minutes ago)
CRLF UTF-8 4 spaces Python 3.11 (ELC Handwriting Recognition) (2)
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6/19/2024

ELC ASSIGNMENT
Handwritten Digit Recognition

Following are the results where K varies as [2,4,5,6,7,10] and test size [60:40, 70:30, 75:25, 80:20, 90:10, 95:5].

ANALYSIS:-

Best Combination:
The combination with the highest validation accuracy is Test Size: 0.2 and K: 5, with a validation accuracy of 0.935. This means that when using 20% of the data for testing and 5 for the number of neighbours in the k-nearest neighbours algorithm, the model achieved the highest accuracy on the validation set.

Worst Combination:
The combination with the lowest validation accuracy is Test Size: 0.25 and K: 2, with a validation accuracy of 0.921. This means that when using 25% of the data for testing and 2 for the number of neighbours in the k-nearest neighbours algorithm, the model achieved the lowest accuracy on the validation set.

Accuracy & Confusion Matrix:-

Test Size: 0.4 K: 2
Validation Accuracy: 0.9167857142857143
Confusion Matrix:
```
[[1596    0    3    3    2    5    7    0    0    1]
 [   1 1863    3    0    0    1    0    0    2    1]
 [  27   28 1596   22    7    2    9   12    7    3]
 [   8   11   56 1679    2   22    1    9   11    4]
 [   2   35   20    3 1535    3    4   12    2   26]
 [  13    5    6  100    9 1340   19    7    5    2]
 [  42    4   16    1    6   24 1518    0    1    0]
 [   3   29   19   17   31    1    0 1616    1   35]
 [  18   25   32   71   29  105    6   11 1275   16]
 [  10   12    9   25   95   13    0  137   11 1384]]
```

Test Size: 0.4 K: 4
Validation Accuracy: 0.9288095238095239
Confusion Matrix:
```
[[1587    0    2    4    0    6   13    2    1    2]
 [   1 1860    3    0    0    1    3    1    1    1]
 [  18   30 1593   21    9    1   12   15    9    5]
 [   5   10   29 1682    1   27    2   18   19   10]
```

```
 [  1  34  14   4 1525   6   4   8   2  44]
 [ 14   6   5  77   7 1351  25   6   7   8]
 [ 29   4  12   3   5  13 1545   0   1   0]
 [  1  29  11   8  27   0   0 1619   1  56]
 [ 14  22  18  41  20  76   4   8 1362  23]
 [ 13   6   8  20  59   6   0  92  12 1480]]
```

Test Size: 0.4 K: 5
Validation Accuracy: 0.9298214285714286
Confusion Matrix:

```
[[1582   2   3   3   0   8  13   2   2   2]
 [   0 1857   3   0   0   1   4   1   2   3]
 [  16  28 1577  32  11   1  13  16  13   6]
 [   5  10  25 1681   2  33   3  18  18   8]
 [   1  32  13   4 1513   5   3   7   4  60]
 [  11   7   4  65   8 1358  31   5   8   9]
 [  24   3  12   2   6  15 1550   0   0   0]
 [   2  28   8   6  30   0   0 1601   1  76]
 [  13  19  18  38  17  64   5   9 1382  23]
 [  11   7   8  19  45   6   0  68  12 1520]]
```

Test Size: 0.4 K: 6
Validation Accuracy: 0.9272619047619047
Confusion Matrix:

```
[[1584   0   3   3   0   8  14   2   1   2]
 [   0 1858   2   0   0   1   4   2   2   2]
 [  22  29 1576  30   8   1  14  15  11   7]
 [   7   9  29 1676   2  30   3  17  22   8]
 [   1  35  15   4 1513   8   4   5   3  54]
 [  12   9   3  70   8 1360  28   4   6   6]
 [  31   3  12   3   5  14 1542   0   2   0]
 [   1  35   7   7  26   0   0 1609   1  66]
 [  16  22  16  43  20  72   7   8 1362  22]
 [  11   9   7  24  50   4   0  83  10 1498]]
```

Test Size: 0.4 K: 7
Validation Accuracy: 0.9273809523809524
Confusion Matrix:

```
[[1580   2   3   4   1   7  14   2   2   2]
 [   0 1856   2   0   0   1   6   1   2   3]
 [  17  32 1567  35  12   1  14  17  13   5]
 [   6  10  18 1683   2  30   3  19  23   9]
 [   1  31  14   5 1504   8   6   6   3  64]
```

```
 [  9  11   3  62   8 1360  31   4   9   9]
 [ 20   3  10   2   6  17 1552   0   2   0]
 [  1  33   7   7  24   0   0 1597   1  82]
 [ 15  22  17  42  17  71   5   9 1366  24]
 [ 12  10   6  23  43   6   0  73   8 1515]]
```

Test Size: 0.4 K: 10
Validation Accuracy: 0.925
Confusion Matrix:

```
[[1585   1   2   3   2   7  13   3   1   0]
 [   0 1856   2   0   0   2   6   1   1   3]
 [  18  39 1563  31  12   0  15  16  12   7]
 [   3  14  24 1669   2  28   3  21  29  10]
 [   1  36  16   3 1498  12   7   5   1  63]
 [  10  11   4  58   8 1360  34   3   7  11]
 [  28   3   8   3   4  18 1545   0   3   0]
 [   1  36   7   4  24   0   0 1600   1  79]
 [  18  26  14  40  18  72   8   9 1360  23]
 [  10  12   7  24  42   5   0  81  11 1504]]
```

Test Size: 0.3 K: 2
Validation Accuracy: 0.921031746031746
Confusion Matrix:

```
[[1217   0   2   4   1   4   7   0   0   1]
 [   0 1363   3   0   0   1   1   1   1   0]
 [  15  20 1171  18   6   2   5   8   5   2]
 [   4   6  37 1283   1  18   1   8   8   3]
 [   1  21  17   4 1132   3   3  10   2  22]
 [   7   4   3  72   6 1016  12   6   3   3]
 [  31   2  11   1   5  15 1151   0   0   0]
 [   3  21  13  10  19   1   0 1229   1  29]
 [  12  14  18  51  19  83   4   6 980  10]
 [   9   7   7  18  66   9   0  99   9 1063]]
```

Test Size: 0.3 K: 4
Validation Accuracy: 0.9315079365079365
Confusion Matrix:

```
[[1214   0   2   1   0   5  10   2   0   2]
 [   0 1361   3   0   0   1   2   1   1   1]
 [  10  17 1165  18   5   1   8  13   8   7]
 [   2   7  23 1280   0  17   2  16  16   6]
 [   0  21  14   4 1128   3   3   7   0  35]
 [   7   3   2  52   7 1026  19   5   5   6]
```

```
 [  25    3    7    3    3    8 1165    0    2    0]
 [   1   19    9    6   17    0    0 1229    1   44]
 [   8   10   13   30   16   60    4    4 1037   15]
 [   9    5    6   14   44    4    0   64    9 1132]]
```

Test Size: 0.3 K: 5
Validation Accuracy: 0.932063492063492
Confusion Matrix:

```
[[1207    0    3    3    0    6   12    2    1    2]
 [   0 1359    3    0    0    1    2    1    2    2]
 [   9   18 1162   21    5    0    9   12    9    7]
 [   2    6   19 1280    0   21    2   17   16    6]
 [   0   20   14    3 1122    2    2    6    2   44]
 [   8    6    2   44    6 1027   22    4    6    7]
 [  19    3    6    2    5   10 1171    0    0    0]
 [   1   20    9    5   17    0    0 1213    1   60]
 [   6    9   12   24   15   54    4    5 1051   17]
 [   9    4    6   15   30    6    0   55   10 1152]]
```

Test Size: 0.3 K: 6
Validation Accuracy: 0.9301587301587302
Confusion Matrix:

```
[[1206    0    3    2    0    8   13    2    0    2]
 [   0 1361    2    0    1    1    2    1    1    1]
 [  10   20 1157   23    5    1   10   13    8    5]
 [   3    5   20 1280    0   22    2   17   15    5]
 [   0   21   14    3 1123    5    2    6    2   39]
 [   8    5    2   47    6 1031   18    4    5    6]
 [  22    3    8    3    4   10 1165    0    1    0]
 [   1   23    8    4   15    0    0 1220    1   54]
 [   9   11   11   27   16   56    4    4 1042   17]
 [  11    7    6   17   40    3    0   61    7 1135]]
```

Test Size: 0.3 K: 7
Validation Accuracy: 0.9288888888888889
Confusion Matrix:

```
[[1206    0    3    2    0    6   13    2    2    2]
 [   0 1357    2    0    1    2    4    1    2    1]
 [  10   21 1148   29    4    1    9   14   10    6]
 [   4    8   15 1276    1   24    2   17   17    5]
 [   0   18   13    4 1114    6    3    7    2   48]
 [   7    8    2   42    5 1029   22    4    4    9]
 [  19    3    7    2    4    9 1170    0    2    0]
```

```
 [   2   23    6    4   17    0    0 1212    1   61]
 [   8   10   12   28   14   61    4    6 1037   17]
 [  11    6    5   17   28    4    0   54    7 1155]]
```

Test Size: 0.3 K: 10
Validation Accuracy: 0.9280952380952381
Confusion Matrix:

```
[[1209    0    2    2    1    6   13    2    0    1]
 [   0 1358    2    0    1    2    4    1    1    1]
 [   7   23 1152   26    7    0   10   12    9    6]
 [   2   10   18 1275    1   17    2   18   19    7]
 [   0   21   11    3 1113    7    5    7    1   47]
 [   7    8    2   48    5 1022   23    3    5    9]
 [  23    2    5    3    4   13 1164    0    2    0]
 [   1   25    9    3   13    0    0 1215    1   59]
 [   9   14   11   24   15   56    5    4 1039   20]
 [   9    8    5   16   29    5    0   61    7 1147]]
```

Test Size: 0.25 K: 2
Validation Accuracy: 0.9214285714285714
Confusion Matrix:

```
[[1006    0    2    4    1    3    5    0    0    1]
 [   0 1124    2    0    0    1    1    1    1    0]
 [  14   20  983   13    7    0    6    4    5    1]
 [   3    5   31 1056    1   17    1    5    6    3]
 [   1   20   15    2  941    2    3    8    2   20]
 [   4    3    2   60    6  835   14    6    2    2]
 [  26    2    8    1    3   12  956    0    0    0]
 [   3   18    7    6   10    1    0 1034    1   23]
 [  12   12   17   35   14   67    3    5  841    7]
 [   7    6    7   14   57   10    0   87    8  899]]
```

Test Size: 0.25 K: 4
Validation Accuracy: 0.931047619047619
Confusion Matrix:

```
[[1003    0    2    1    0    4    8    2    0    2]
 [   0 1123    2    0    0    1    2    0    1    1]
 [  10   14  981   16    5    1    7    8    7    4]
 [   2    6   18 1051    0   17    2   13   13    6]
 [   0   20   11    2  938    3    3    6    1   30]
 [   4    3    1   43    6  840   22    5    4    6]
 [  20    3    3    3    2    8  968    0    1    0]
 [   1   15    6    2   10    0    0 1032    1   36]
```

```
 [   8    7   13   22   17   48    3    4  879   12]
 [   6    4    6   11   33    3    0   61   10  961]]
```

Test Size: 0.25 K: 5
Validation Accuracy: 0.9318095238095238
Confusion Matrix:

```
[[ 998    0    3    2    0    5    9    2    1    2]
 [   0 1123    2    0    0    1    2    1    1    0]
 [   8   15  978   17    5    1    7    9    8    5]
 [   2    7   14 1047    0   19    2   18   13    6]
 [   0   19   12    2  931    2    3    7    2   36]
 [   5    5    1   38    5  843   23    4    3    7]
 [  17    3    3    2    4    7  972    0    0    0]
 [   1   15    4    3   10    0    0 1024    1   45]
 [   6    7   11   19   13   47    4    4  889   13]
 [   8    4    6   13   23    4    0   50    8  979]]
```

Test Size: 0.25 K: 6
Validation Accuracy: 0.9286666666666666
Confusion Matrix:

```
[[ 998    0    3    1    0    6   10    2    0    2]
 [   0 1123    2    0    0    1    2    1    1    0]
 [   7   18  976   19    4    1    9    8    7    4]
 [   3    4   15 1050    0   20    2   17   12    5]
 [   0   19   12    2  931    5    2    6    3   34]
 [   4    4    1   38    5  846   21    4    5    6]
 [  19    3    4    3    3    8  967    0    1    0]
 [   1   19    4    3   12    0    0 1023    1   40]
 [   9    9   10   21   14   49    4    3  879   15]
 [   9    6    6   13   33    4    0   59    7  958]]
```

Test Size: 0.25 K: 7
Validation Accuracy: 0.9282857142857143
Confusion Matrix:

```
[[ 996    0    3    1    0    6   11    2    1    2]
 [   0 1120    2    0    1    2    3    0    1    1]
 [  10   18  970   22    4    0    9    7    9    4]
 [   4    5   13 1051    0   19    2   18   11    5]
 [   0   17   12    2  920    5    3    9    4   42]
 [   4    5    1   35    6  846   22    4    4    7]
 [  17    3    3    2    3    7  972    0    1    0]
 [   1   18    4    3   13    0    0 1017    1   46]
 [   8    9   10   19   13   53    6    4  877   14]
```

```
 [  9   6   6  14  23   3   0  50   6 978]]
```

Test Size: 0.25 K: 10
Validation Accuracy: 0.9261904761904762
Confusion Matrix:

```
[[ 999   1   2   1   0   5  10   2   1   1]
 [   0 1120   2   0   1   2   3   0   1   1]
 [   7  21 968  23   6   0   9   7   9   3]
 [   2   9  16 1050   1  13   2  16  13   6]
 [   0  19  10   3 924   7   2   7   2  40]
 [   5   7   1  39   5 840  23   3   3   8]
 [  16   2   3   3   3  10 970   0   1   0]
 [   1  21   3   3  12   0   0 1016   1  46]
 [  11  12  10  22  14  48   5   4 871  16]
 [   8   8   5  14  27   3   0  55   8 967]]
```

Test Size: 0.2 K: 2
Validation Accuracy: 0.9228571428571428
Confusion Matrix:

```
[[809   0   3   0   0   4   4   0   0   1]
 [  0 894   1   0   0   2   0   1   1   0]
 [ 12  14 803   8   7   0   5   4   4   1]
 [  3   5  25 854   0  14   1   4   5   2]
 [  1  16   9   2 732   2   2   7   1  19]
 [  5   3   1  45   4 684  12   5   2   1]
 [ 21   1   8   1   3   9 765   0   0   0]
 [  1  14   5   4   9   1   0 826   1  19]
 [  9   8  12  26  11  51   2   4 661   5]
 [  6   6   7  14  48   7   0  60   7 724]]
```

Test Size: 0.2 K: 4
Validation Accuracy: 0.9326190476190476
Confusion Matrix:

```
[[808   0   2   0   0   4   6   0   0   1]
 [  0 894   1   0   0   1   1   0   1   1]
 [  9  10 800  12   6   0   6   5   8   2]
 [  2   6  13 855   0  13   2   8  10   4]
 [  0  15   8   2 731   2   3   7   1  22]
 [  4   3   1  36   4 685  16   4   5   4]
 [ 17   1   4   2   2   7 774   0   1   0]
 [  0  11   3   2   8   0   0 825   1  30]
 [  6   5  11  16  11  39   2   3 689   7]
 [  6   3   6  10  30   3   0  42   6 773]]
```

Test Size: 0.2 K: 5
Validation Accuracy: 0.935
Confusion Matrix:
[[808 0 2 0 0 4 6 0 0 1]
[0 894 1 0 0 1 1 1 1 0]
[6 11 798 13 6 0 7 6 8 3]
[2 7 11 851 0 14 2 13 10 3]
[0 15 8 2 725 2 3 8 1 27]
[5 4 1 29 4 692 17 3 3 4]
[15 1 3 2 3 5 779 0 0 0]
[0 11 2 3 10 0 0 819 1 34]
[5 6 10 11 8 34 3 3 701 8]
[8 3 6 12 19 3 0 35 6 787]]

Test Size: 0.2 K: 6
Validation Accuracy: 0.9314285714285714
Confusion Matrix:
[[806 0 4 0 0 4 6 0 0 1]
[0 894 1 0 0 1 1 1 1 0]
[5 14 797 14 4 0 9 5 7 3]
[2 4 12 850 0 15 2 15 10 3]
[0 16 7 2 727 3 2 6 1 27]
[5 3 1 30 3 691 17 4 4 4]
[18 1 4 2 3 5 774 0 1 0]
[0 14 3 3 11 0 0 819 1 29]
[6 7 7 13 11 38 2 2 692 11]
[9 5 6 11 25 4 0 40 5 774]]

Test Size: 0.2 K: 7
Validation Accuracy: 0.9314285714285714
Confusion Matrix:
[[807 0 3 0 0 4 6 0 0 1]
[0 892 1 0 1 1 2 0 1 1]
[8 12 794 14 5 0 9 5 9 2]
[2 5 11 847 1 17 2 14 11 3]
[0 14 7 2 722 3 1 8 3 31]
[4 4 1 27 3 693 18 4 4 4]
[15 1 3 2 3 4 779 0 1 0]
[0 13 1 3 11 0 0 814 1 37]
[6 6 9 12 9 41 4 3 690 9]
[8 5 6 11 20 4 0 33 6 786]]

Test Size: 0.2 K: 10
Validation Accuracy: 0.9263095238095238
Confusion Matrix:
[[806 1 3 0 0 3 7 0 0 1]
[0 891 1 0 1 2 2 0 1 1]
[6 16 788 16 9 0 9 5 7 2]
[2 9 11 844 1 13 2 15 13 3]
[0 14 5 2 723 5 1 8 2 31]
[4 4 1 34 3 687 19 3 2 5]
[15 1 4 1 3 7 776 0 1 0]
[0 17 2 3 10 0 0 809 1 38]
[7 9 8 14 9 40 3 3 685 11]
[8 6 5 12 23 4 0 43 6 772]]

Test Size: 0.1 K: 2
Validation Accuracy: 0.9238095238095239
Confusion Matrix:
[[383 0 0 0 0 2 2 1 0 1]
[0 456 0 0 0 0 0 1 0 0]
[5 7 415 2 5 0 3 2 2 0]
[2 3 14 402 0 7 0 2 3 1]
[0 8 3 0 381 1 1 2 0 11]
[2 2 1 16 3 344 7 3 1 1]
[14 0 3 1 2 4 404 0 0 0]
[0 6 3 2 6 1 0 396 0 7]
[8 2 2 15 7 24 1 3 344 3]
[2 3 2 10 27 3 0 28 4 355]]

Test Size: 0.1 K: 4
Validation Accuracy: 0.9361904761904762
Confusion Matrix:
[[382 0 0 0 0 2 3 0 0 2]
[0 456 0 0 0 0 1 0 0 0]
[3 4 415 5 3 0 4 2 4 1]
[1 3 7 406 0 6 0 3 5 3]
[0 7 2 0 377 1 1 4 0 15]
[2 0 1 14 2 347 8 3 1 2]
[11 0 2 2 1 4 408 0 0 0]
[0 4 1 1 7 0 0 397 0 11]
[4 2 2 6 6 15 1 2 367 4]
[2 2 2 9 15 2 0 22 3 377]]

Test Size: 0.1 K: 5

Validation Accuracy: 0.9378571428571428
Confusion Matrix:
[[383 0 0 0 0 2 3 0 0 1]
[0 456 0 0 0 0 1 0 0 0]
[2 7 410 8 4 0 5 3 1 1]
[1 3 5 404 0 7 0 6 6 2]
[0 7 3 0 376 1 1 5 0 14]
[3 1 1 10 2 349 8 2 1 3]
[9 0 2 2 1 3 411 0 0 0]
[0 4 2 2 7 0 0 394 0 12]
[5 3 3 5 4 14 1 3 368 3]
[2 2 2 9 10 2 0 15 4 388]]

Test Size: 0.1 K: 6
Validation Accuracy: 0.935952380952381
Confusion Matrix:
[[383 0 0 0 0 2 3 0 0 1]
[0 456 0 0 0 0 1 0 0 0]
[2 6 412 7 3 0 5 3 2 1]
[1 3 5 406 0 5 0 7 5 2]
[0 7 3 0 378 1 1 5 0 12]
[3 1 1 13 2 345 9 3 1 2]
[12 0 1 2 1 3 409 0 0 0]
[0 6 2 2 6 0 0 395 0 10]
[7 2 2 5 4 16 2 3 364 4]
[2 2 2 7 12 2 0 20 4 383]]

Test Size: 0.1 K: 7
Validation Accuracy: 0.9354761904761905
Confusion Matrix:
[[383 0 0 0 0 2 3 0 0 1]
[0 455 0 0 0 0 1 0 0 1]
[4 7 407 8 4 0 5 4 2 0]
[1 3 5 405 0 5 0 8 5 2]
[0 6 3 0 375 2 1 6 1 13]
[2 1 1 12 2 347 9 2 1 3]
[10 0 2 1 1 3 411 0 0 0]
[0 5 0 2 7 0 0 397 0 10]
[6 2 2 5 4 18 2 2 362 6]
[2 3 2 8 8 3 0 18 3 387]]

Test Size: 0.1 K: 10
Validation Accuracy: 0.929047619047619

Confusion Matrix:
[[382 0 0 0 0 2 4 0 0 1]
[0 454 0 0 0 1 1 0 0 1]
[3 8 404 10 5 0 6 3 2 0]
[1 5 5 402 0 7 0 7 4 3]
[0 7 2 0 375 3 1 4 1 14]
[2 1 1 14 2 346 10 3 0 1]
[11 0 2 1 1 2 410 0 1 0]
[0 7 1 2 8 0 0 388 0 15]
[6 3 1 6 5 18 2 2 357 9]
[2 3 1 7 11 2 0 19 5 384]]

Test Size: 0.05 K: 2
Validation Accuracy: 0.9214285714285714
Confusion Matrix:
[[208 0 0 0 0 0 1 0 0 1]
[0 215 0 0 0 0 0 0 0 0]
[3 1 200 0 2 0 3 1 1 0]
[1 2 8 199 0 4 0 0 1 0]
[0 2 0 0 181 1 1 1 0 4]
[1 1 1 8 2 179 6 2 1 0]
[7 0 2 1 1 2 199 0 0 0]
[0 4 2 2 4 1 0 207 0 2]
[3 1 2 10 3 13 1 1 188 1]
[1 2 0 7 13 3 0 14 2 159]]

Test Size: 0.05 K: 4
Validation Accuracy: 0.9323809523809524
Confusion Matrix:
[[207 0 0 0 0 0 2 0 0 1]
[0 214 0 0 0 0 1 0 0 0]
[2 2 201 0 1 0 2 1 1 1]
[1 2 5 199 0 4 0 1 1 2]
[0 2 0 0 180 1 1 1 0 5]
[1 1 1 8 1 179 6 2 1 1]
[6 0 0 2 1 1 202 0 0 0]
[0 3 1 1 6 0 0 205 0 6]
[3 0 2 4 2 11 0 1 198 2]
[1 2 0 5 7 1 0 10 2 173]]

Test Size: 0.05 K: 5
Validation Accuracy: 0.9328571428571428
Confusion Matrix:

```
[[207   0   0   0   0   0   2   0   0   1]
 [  0 214   0   0   0   0   1   0   0   0]
 [  1   3 200   2   2   0   2   1   0   0]
 [  1   1   3 201   0   4   0   3   1   1]
 [  0   1   0   0 179   1   1   1   0   7]
 [  2   1   1   5   2 180   6   1   1   2]
 [  6   0   1   2   1   1 201   0   0   0]
 [  0   3   2   2   5   0   0 202   0   8]
 [  2   1   3   3   2  11   0   1 198   2]
 [  1   2   0   5   6   2   0   6   2 177]]
```

Test Size: 0.05 K: 6
Validation Accuracy: 0.9304761904761905
Confusion Matrix:

```
[[207   0   0   0   0   0   2   0   0   1]
 [  0 214   0   0   0   0   1   0   0   0]
 [  2   2 200   0   1   0   3   1   1   1]
 [  1   2   3 199   0   4   0   4   1   1]
 [  0   1   0   0 181   1   1   1   0   5]
 [  2   1   1   7   2 177   7   2   1   1]
 [  6   0   0   2   1   1 202   0   0   0]
 [  0   4   2   2   4   0   0 204   0   6]
 [  3   0   2   3   2  13   1   1 196   2]
 [  1   2   0   5   6   2   0   9   2 174]]
```

Test Size: 0.05 K: 7
Validation Accuracy: 0.9314285714285714
Confusion Matrix:

```
[[207   0   0   0   0   0   2   0   0   1]
 [  0 214   0   0   0   0   1   0   0   0]
 [  3   3 197   1   2   0   3   2   0   0]
 [  1   2   3 198   0   4   0   5   1   1]
 [  0   0   0   0 182   1   1   1   0   5]
 [  1   1   1   7   2 178   7   1   1   2]
 [  6   0   1   1   1   1 202   0   0   0]
 [  0   4   0   2   6   0   0 205   0   5]
 [  3   1   2   3   3  11   0   1 197   2]
 [  1   2   0   6   5   2   0   7   2 176]]
```

Test Size: 0.05 K: 10
Validation Accuracy: 0.9266666666666666
Confusion Matrix:

```
[[207   0   0   0   0   0   2   0   0   1]
```

```
[  0 214   0   0   0   0   1   0   0   0]
[  2   3 199   0   2   0   4   1   0   0]
[  1   2   4 199   0   3   0   4   1   1]
[  0   1   0   0 179   2   1   1   0   6]
[  1   1   1   8   2 177   7   2   0   2]
[  7   0   1   1   1   1 201   0   0   0]
[  0   5   1   2   7   0   0 201   0   6]
[  1   1   1   4   2  15   0   1 194   4]
[  1   2   0   5   5   2   0   8   3 175]]
```
