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ELC Activity – Handwritten Digit Recognition

Case1: K=2, and split=60:40

Accuracy=0.7693452380952381

& Confusion Matrix=

```
[[1664    0    1    0    0    1    1    0    5    0]
 [  40 1724   25   33    1    0    8    8   64    0]
 [ 264    0 1294   14    2    6   15    5   29    3]
 [ 267    3   57 1237    1   46    1    6  131    7]
 [ 420    3   15    0 1013    0   14    9  116   80]
 [ 321    5   11   69    3  899   43    5  182    5]
 [ 209    1    7    3    1    6 1419    0    3    0]
 [  70    1   38   21   19    3    0 1438   84   42]
 [ 380   26   16    9    9   39    2    0 1148    0]
 [ 138    0    2    6   14    5    1   79  296 1089]]
```

Case2: K=2, and split=70:30

Accuracy= 0.7984126984126985

& Confusion Matrix=

```
[[1219    0    0    0    0    0    1    0    2    0]
 [  38 1265   13   21    0    0    3    4   42    0]
 [ 175    0 1041    9    0    2    4    3   17    2]
 [ 173    2   31  969    0   23    0    5   73    3]
 [ 286    4   17    1  774    0    5    5   80   45]
 [ 209    0    7   49    2  772   19    1  101    3]
 [ 131    3    5    1    0    5 1095    0    6    0]
 [  43    1   19   10   10    1    1 1148   68   30]
 [ 246   15   10   10    2   15    3    1  922    0]
 [ 105    1    1    3    8    5    0   57  244  855]]
```

Case3: K=2, and split=75:25

Accuracy= 0.9572380952380952

& Confusion Matrix=

```
[[1041    0    1    0    0    0    0    1    0    0]
 [   0 1169    2    0    1    0    0    1    0    0]
 [   3   13  990    1    0    0    1   14    1    0]
 [   2    5   21 1056    1    3    0    2    5    1]
 [   1   11    0    0  983    0    3    0    0    9]
 [   1    0    0   44    3  887   11    1    1    1]
 [  15    3    1    0    3    4 1007    0    0    0]
 [   0   17    7    1    8    0    0 1108    0    4]
 [   5   15    5   34    5   32    6    8  853    8]
 [   6    4    2   12   37    5    1   35    1  957]]
```

Case4: K=2, and split=80:20

Accuracy= 0.7008333333333333

& Confusion Matrix=

```
[[817   0   0   0   0   0   1   0   3   0]
 [ 28 793   8  13   2   0   4   1  43   0]
 [303   0 525   5   0   0   2   3  14   1]
 [247   3  21 552   0   6   0   5  50   2]
 [337   0   0   0 371   0   6  16  49  33]
 [225   1   0  24   2 421  15   3  64   2]
 [143   0   0   0   1   5 669   0   1   0]
 [ 43   0  14  13   0   0   0 761  31  18]
 [270  14   0   1   2   6   2   2 519   0]
 [113   0   2   2   8   1   0 124 155 459]]
```

Case5: K=2, and split=90:10

Accuracy= 0.7111904761904762

& Confusion Matrix=

```
[[433   0   0   0   0   0   1   0   0   0]
 [ 13 436   6  10   0   0   2   1   7   0]
 [151   0 237   5   0   0   1   0   9   0]
 [119   1   9 259   0  12   0   0  14   2]
 [162   0   3   1 176   0   4   6  17  16]
 [118   0   3  20   0 218   8   1  19   1]
 [ 64   0   0   0   0   1 341   0   1   0]
 [ 28   0   4   4   3   0   0 412  17   6]
 [156   4   4   1   1   3   3   1 219   0]
 [ 48   0   0   0   3   1   0  51  67 256]]
```

Case6: K=2, and split=95:5

Accuracy= 0.721

& Confusion Matrix=

```
[[2031    0    0    1    0    2    3    0    2    1]
 [  93 2104   36   46    0    0    9    7   53    1]
 [ 445    2 1612   10    1    8    7    4   27    1]
 [ 434    6   62 1494    0   62    1   17  101    5]
 [ 867    4   18    2  861    4   13   77  127   80]
 [ 487    2   13   90    2 1111   15    3  124    5]
 [ 367    3    6    1    0    4 1659    0   14    0]
 [ 124    2   65   25    8    3    0 1840   45   63]
 [ 643   43   21   15    4   67    3    2 1252    0]
 [ 263    3    4    9   15   14    0  340  303 1177]]
```

Case7: K=4, and split=60:40

Accuracy= 0.8164285714285714

& Confusion Matrix=

```
[[1659    0    0    0    0    0    1    0   12    0]
 [  11 1731   20    5    1    0   14    4  117    0]
 [ 115    0 1387   11    2    1   24    4   84    4]
 [ 112    2   26 1341    0   30    1    4  232    8]
 [ 228    0    3    1 1028    0   44    7  211  148]
 [ 229    1    6   49    0  878   35    4  336    5]
 [ 102    0    0    0    1    4 1524    0   18    0]
 [  49    1   27    7   12    1    0 1443  111   65]
 [  71    3    3    4    6   13    4    0 1525    0]
 [  87    0    0    8    4    6    1   37  287 1200]]
```

Case8: K=4, and split=70:30

Accuracy= 0.8211111111111111

& Confusion Matrix=

```
[[1212    0    0    0    0    0    1    0    8    1]
 [   9 1290   19   10    0    0    8    2   45    3]
 [ 114    0 1064    9    0    0    6    2   55    3]
 [  68    2   20 1014    0   24    3    4  139    5]
 [ 213    2    4    0  673    0   23    7  187  108]
 [ 155    0    6   51    1  710   20    2  212    6]
 [  81    0    1    0    0    2 1139    0   23    0]
 [  38    1   25    6    2    1    1 1124   69   64]
 [  35    2    2   13    1    9    2    1 1159    0]
 [  63    0    0    5    4    4    0   36  206  961]]
```

Case9: K=4, and split=75:25

Accuracy= 0.7452380952380953

& Confusion Matrix=

```
[[1039    0    0    0    0    0    1    0    2    1]
 [  25 1013   12    0    0    0   10    2  110    1]
 [ 173    0  785    8    0    0   12    6   38    1]
 [ 158    2   14  758    0   13    0    2  148    1]
 [ 330    0    0    0  481    0    5    6  104   81]
 [ 253    0    2   19    2  464   11    0  192    6]
 [ 165    0    0    0    0    1  859    0    8    0]
 [  52    0   13    4    3    0    0  959   69   45]
 [ 206    0    2    1    1    3    4    1  753    0]
 [ 109    0    0    2    4    1    0   38  192  714]]
```

Case10: K=4, and split=80:20

Accuracy= 0.7585714285714286

& Confusion Matrix=

```
[[816   0   0   0   0   0   1   0   4   0]
 [ 22 777   8   1   0   0   4   1  79   0]
 [163   0 645   9   0   0   4   5  27   0]
 [111   1  12 669   0   4   0   0  85   4]
 [265   0   1   0 386   0  11   9  85  55]
 [156   0   0  11   2 433  13   1 138   3]
 [114   0   0   0   1   3 695   0   6   0]
 [ 37   0   9   5   0   0   0 764  38  27]
 [180   0   0   3   0   1   3   1 627   1]
 [ 94   0   1   1   5   0   0  41 162 560]]
```

Case11: K=4, and split=90:10

Accuracy= 0.784047619047619

& Confusion Matrix=

```
[[432   0   0   0   0   0   1   0   1   0]
 [  8 438   6   0   0   0   4   2  17   0]
 [ 71   0 305   8   0   0   3   0  16   0]
 [ 54   0   2 315   0   6   2   0  35   2]
 [119   1   0   0 205   0   5   0  21  34]
 [ 94   0   0  10   1 229   7   0  45   2]
 [ 49   0   0   0   0   0 353   0   5   0]
 [ 25   0   6   1   1   0   0 410  19  12]
 [ 86   0   0   1   0   1   1   1 302   0]
 [ 46   0   0   0   0   1   0  13  62 304]]
```

Case12: K=4, and split=95:5

Accuracy= 0.7965238095238095

& Confusion Matrix=

```
[[2022    0    0    1    0    0    4    0   12    1]
 [  38 2129   26    7    0    0   10    3  133    3]
 [ 245    1 1772   18    1    4    8    3   63    2]
 [ 199    3   44 1701    1   32    1    6  185   10]
 [ 638    2    3    2  923    0   15   13  230  227]
 [ 287    0    3   66    1 1186   23    3  270   13]
 [ 205    1    0    1    1    3 1805    0   38    0]
 [ 104    2   44    7    3    3    0 1832   80  100]
 [ 168    6    6   13    1   30    1    2 1822    1]
 [ 195    0    1    3    3    6    1   91  293 1535]]
```

Case13: K=5, and split=60:40

Accuracy= 0.8211309523809524

& Confusion Matrix=

```
[[1660    0    0    0    0    0    1    0   11    0]
 [   5 1738   22    3    1    0   14    3  117    0]
 [ 113    1 1398   10    1    0   23    5   78    3]
 [ 103    3   28 1351    0   31    2    3  228    7]
 [ 183    1    3    0 1023    0   48    8  246  158]
 [ 206    0    2   58    0  866   43    3  360    5]
 [  86    0    0    0    1    5 1546    0   11    0]
 [  49    1   30    9   11    3    0 1414  117   82]
 [  56    4    5    6    6    9    3    0 1539    1]
 [  63    0    0    8    3    5    2   36  253 1260]]
```

Case14: K=5, and split=70:30

Accuracy= 0.8256349206349206

& Confusion Matrix=

```
[[1204    0    0    0    0    0    1    0   16    1]
 [   7 1288   20    6    0    0    8    3   53    1]
 [  97    0 1071    9    0    0   10    4   59    3]
 [  57    2   17 1015    0   26    3    4  150    5]
 [ 190    1    3    0  686    1   18    6  189  123]
 [ 152    0    3   58    1  686   21    2  236    4]
 [  58    0    1    0    0    2 1160    0   25    0]
 [  33    1   24    9    2    0    1 1109   80   72]
 [  31    1    2    9    0    5    0    0 1175    1]
 [  55    0    0    5    2    4    0   29  175 1009]]
```

Case15: K=5, and split=75:25

Accuracy= 0.7743809523809524

& Confusion Matrix=

```
[[1035    0    0    0    0    0    1    0    6    1]
 [  30 1000   14    0    0    0    9    3  117    0]
 [ 145    1  814   11    0    0   12    6   33    1]
 [ 123    1   15  790    0   17    1    2  145    2]
 [ 280    0    2    0  517    0    9    4  112   83]
 [ 247    0    1   25    1  450   14    0  206    5]
 [ 115    0    0    0    0    1  908    0    9    0]
 [  42    0   20    5    3    0    0  959   62   54]
 [  56    0    2    2    1    1    4    1  904    0]
 [  94    0    0    2    3    1    0   31  175  754]]
```

Case16: K=5, and split=80:20

Accuracy= 0.7867857142857143

& Confusion Matrix=

```
[[817   0   0   0   0   0   0   0   4   0]
 [ 22 777  11   0   0   0   3   0  78   1]
 [131   0 675  10   0   0   4   4  29   0]
 [ 90   1  11 687   0   6   0   0  87   4]
 [245   0   0   0 398   1  13   9  91  55]
 [150   0   0  18   2 430  12   2 140   3]
 [ 75   0   0   0   0   2 733   0   9   0]
 [ 30   0   9   8   0   0   0 750  46  37]
 [ 59   0   0   4   0   1   2   0 749   1]
 [ 85   0   1   2   3   0   0  37 143 593]]
```

Case17: K=5, and split=90:10

Accuracy= 0.8095238095238095

& Confusion Matrix=

```
[[432   0   0   0   0   0   1   0   1   0]
 [ 10 434   4   0   0   0   5   2  20   0]
 [ 62   0 314   5   0   0   5   0  17   0]
 [ 47   1   2 323   0   7   2   0  33   1]
 [106   1   1   0 214   0   6   0  23  34]
 [ 82   0   0  13   1 229   9   0  52   2]
 [ 34   0   0   0   0   0 368   0   5   0]
 [ 23   0   6   1   0   0   0 408  21  15]
 [ 34   0   0   2   0   2   2   0 352   0]
 [ 28   0   0   0   0   0   0  13  59 326]]
```

Case18: K=5, and split=95:5

Accuracy= 0.815047619047619

& Confusion Matrix=

```
[[2021    1    0    1    0    0    4    0   13    0]
 [  27 2135   24    3    0    0   12    7  139    2]
 [ 201    0 1818   14    1    0   10    3   67    3]
 [ 162    3   43 1746    0   31    2   11  173   11]
 [ 536    2    5    0 1003    1   20   13  259  214]
 [ 257    0    2   90    1 1174   24    3  293    8]
 [ 128    1    0    2    0    2 1890    0   31    0]
 [  88    2   47   12    2    2    0 1836   80  106]
 [ 101    7   12   18    1   14    4    4 1886    3]
 [ 141    0    0    7    3    7    1   87  275 1607]]
```

Case19: K=6, and split=60:40

Accuracy= 0.8235119047619047

& Confusion Matrix=

```
[[1662    0    0    0    0    0    1    0    9    0]
 [   5 1748   19    0    1    0   14    4  112    0]
 [ 113    1 1401    8    0    0   30    2   73    4]
 [ 107    3   30 1362    0   23    2    3  220    6]
 [ 169    0    3    1 1041    0   60    3  245  148]
 [ 199    0    2   70    0  876   38    2  350    6]
 [  90    0    0    0    1    4 1536    0   18    0]
 [  52    1   29   11   12    1    0 1416  121   73]
 [  45    4    6    4    5   12    3    0 1550    0]
 [  62    0    0    8    3    4    2   44  264 1243]]
```

Case20: K=6, and split=70:30

Accuracy= 0.8280952380952381

& Confusion Matrix=

```
[[1213    0    0    0    0    0    1    0    7    1]
 [   9 1293   16    3    1    0    7    3   53    1]
 [  94    0 1078   11    0    0    9    4   54    3]
 [  60    2   16 1026    0   20    3    3  145    4]
 [ 184    1    6    0  691    1   18    8  189  119]
 [ 158    0    3   62    0  690   21    1  223    5]
 [  71    0    1    0    0    2 1152    0   20    0]
 [  31    1   26    7    2    0    1 1121   75   67]
 [  32    2    2    8    0    4    0    1 1174    1]
 [  53    0    0    4    2    3    0   36  185  996]]
```

Case21: K=6, and split=75:25

Accuracy= 0.7916666666666666

& Confusion Matrix=

```
[[818   0   0   0   0   0   0   0   3   0]
 [ 13 796   9   0   0   0   5   0  69   0]
 [125   0 679  11   0   0   3   6  29   0]
 [ 71   1  14 705   0   2   0   0  90   3]
 [234   0   1   0 398   0   9   7 102  61]
 [152   0   0  20   1 426   8   2 145   3]
 [ 79   0   0   0   0   2 729   0   9   0]
 [ 31   0  12   4   0   1   0 764  40  28]
 [ 55   0   0   5   0   1   2   0 752   1]
 [ 88   0   1   1   3   0   0  42 146 583]]
```

Case22: K=6, and split=90:10

Accuracy= 0.8192857142857143

& Confusion Matrix=

```
[[432   0   0   0   0   0   1   0   1   0]
 [  6 441   5   1   0   0   5   1  16   0]
 [ 57   0 319   6   0   0   5   0  16   0]
 [ 33   1   4 337   0   6   1   1  31   2]
 [ 95   1   1   0 220   0   5   0  28  35]
 [ 76   0   0  16   2 233   9   1  49   2]
 [ 38   0   0   0   0   0 363   0   6   0]
 [ 25   0   6   1   1   0   0 412  18  11]
 [ 30   0   0   1   0   1   1   0 359   0]
 [ 30   0   0   0   0   1   0  15  55 325]]
```

Case23: K=6, and split=80:20

Accuracy= 0.7916666666666666

& Confusion Matrix=

```
[[818   0   0   0   0   0   0   0   3   0]
 [ 13 796   9   0   0   0   5   0  69   0]
 [125   0 679  11   0   0   3   6  29   0]
 [ 71   1  14 705   0   2   0   0  90   3]
 [234   0   1   0 398   0   9   7 102  61]
 [152   0   0  20   1 426   8   2 145   3]
 [ 79   0   0   0   0   2 729   0   9   0]
 [ 31   0  12   4   0   1   0 764  40  28]
 [ 55   0   0   5   0   1   2   0 752   1]
 [ 88   0   1   1   3   0   0  42 146 583]]
```

Case24: K=6, and split=95:5

Accuracy= 0.8225238095238095

& Confusion Matrix=

```
[[2021    1    0    1    0    0    3    0   14    0]
 [  21 2147   22    3    0    0   13    9  133    1]
 [ 173    0 1843   16    0    0   10    3   70    2]
 [ 146    3   45 1748    0   27    2    9  195    7]
 [ 471    2    4    0 1052    1   28   17  245  233]
 [ 257    0    3   77    0 1175   24    3  299   14]
 [ 114    1    0    1    0    3 1903    0   32    0]
 [  86    3   51   11    5    2    0 1848   76   93]
 [  79    5    9   19    0   15    3    4 1914    2]
 [ 134    0    0    9    1    4    1   94  263 1622]]
```

Case25: K=7, and split=60:40

Accuracy= 0.8245238095238095

& Confusion Matrix=

```
[[1659    0    0    0    0    0    1    0   12    0]
 [   5 1753   21    0    1    0   13    5  105    0]
 [  99    0 1408   11    1    0   26    2   82    3]
 [  93    3   25 1381    0   17    5    3  222    7]
 [ 153    0    3    1 1029    0   55    5  267  157]
 [ 197    0    1   56    0  846   41    3  392    7]
 [  74    0    0    1    1    5 1548    0   20    0]
 [  52    1   28   10    9    1    1 1403  114   97]
 [  47    3    3    3    5   10    3    0 1555    0]
 [  59    0    0    8    4    5    2   41  241 1270]]
```

Case26: K=7, and split=70:30

Accuracy= 0.8288888888888889

& Confusion Matrix=

```
[[1210    0    0    0    0    0    1    0   10    1]
 [   5 1290   15    4    1    0    9    2   59    1]
 [  84    0 1081   11    1    0   10    5   58    3]
 [  58    2   17 1020    0   18    3    2  153    6]
 [ 151    1    4    1  708    1   21    5  191  134]
 [ 151    0    3   61    0  664   21    1  255    7]
 [  65    0    1    0    0    1 1156    0   23    0]
 [  29    1   25    9    2    0    2 1115   78   70]
 [  31    2    2    7    0    3    0    1 1177    1]
 [  50    0    0    5    2    3    0   33  163 1023]]
```

Case27: K=7, and split=75:25

Accuracy= 0.7856190476190477

& Confusion Matrix=

```
[[1035    0    0    0    0    0    1    0    6    1]
 [   7 1018   13    1    0    0    8    2  124    0]
 [  97    1  845   11    0    0    9    6   53    1]
 [  89    0   20  797    0   15    0    2  172    1]
 [ 230    0    3    0  539    0    9    7  126   93]
 [ 195    0    1   26    0  453   16    1  253    4]
 [  91    0    0    0    0    1  925    0   16    0]
 [  38    0   19    7    1    0    0  960   73   47]
 [  37    0    4    3    1    3    3    1  918    1]
 [  89    0    0    1    2    0    0   31  178  759]]
```

Case28: K=7, and split=80:20

Accuracy= 0.799404761904762

& Confusion Matrix=

```
[[818   0   0   0   0   0   0   0   3   0]
 [  7 796   9   0   0   0   5   0  75   0]
 [108   0 689  11   0   0   3   4  38   0]
 [ 61   1  13 716   0   3   0   0  88   4]
 [213   0   1   0 409   0  10   7 111  61]
 [137   0   0  17   0 425   9   2 164   3]
 [ 70   0   0   0   0   1 737   0  11   0]
 [ 29   0  14   7   0   0   0 751  45  34]
 [ 32   1   0   7   0   0   2   0 773   1]
 [ 79   0   0   1   2   0   0  34 147 601]]
```

Case29: K=7, and split=90:10

Accuracy= 0.8330952380952381

& Confusion Matrix=

```
[[432   0   0   0   0   0   1   0   1   0]
 [  3 442   4   1   0   0   5   1  19   0]
 [ 48   0 330   4   0   0   5   0  16   0]
 [ 25   1   5 339   0   5   0   1  38   2]
 [ 85   1   0   0 226   0   7   0  30  36]
 [ 61   0   0  19   2 233   9   1  61   2]
 [ 29   0   0   0   0   0 374   0   4   0]
 [ 19   0   6   0   0   0   0 410  25  14]
 [ 18   1   0   2   0   2   0   0 369   0]
 [ 22   0   0   0   0   1   0  12  47 344]]
```

Case30: K=7, and split=95:5

Accuracy= 0.8266666666666667

& Confusion Matrix=

```
[[2022    0    0    0    0    0    3    0   15    0]
 [  18 2155   21    5    0    0   14    3  132    1]
 [ 165    0 1848   15    0    0   13    5   67    4]
 [ 131    2   44 1764    0   21    2    7  203    8]
 [ 389    2    7    0 1067    0   41   12  270  265]
 [ 228    0    3   79    0 1157   29    3  338   15]
 [ 116    0    0    1    0    6 1914    0   17    0]
 [  77    1   51   15    4    2    1 1844   74  106]
 [  71    2    7   17    1   11    3    4 1931    3]
 [ 112    0    0    9    2    3    1   78  265 1658]]
```

Case31: K=10, and split=60:40

Accuracy= 0.8299404761904762

& Confusion Matrix=

```
[[1664    0    0    0    0    0    1    0    7    0]
 [   1 1754   18    1    1    0   12    2  114    0]
 [  98    1 1422   10    0    0   29    4   65    3]
 [ 101    2   25 1372    0   17    4    3  224    8]
 [ 114    0    2    0 1045    0   65    3  275  166]
 [ 205    0    1   53    0  880   37    2  357    8]
 [  77    0    0    1    2    6 1545    0   18    0]
 [  53    0   25   11    5    1    1 1415  119   86]
 [  49    1    4    2    4   11    2    0 1556    0]
 [  57    0    0    5    1    3    4   33  237 1290]]
```

Case32: K=10, and split=70:30

Accuracy= 0.832936507936508

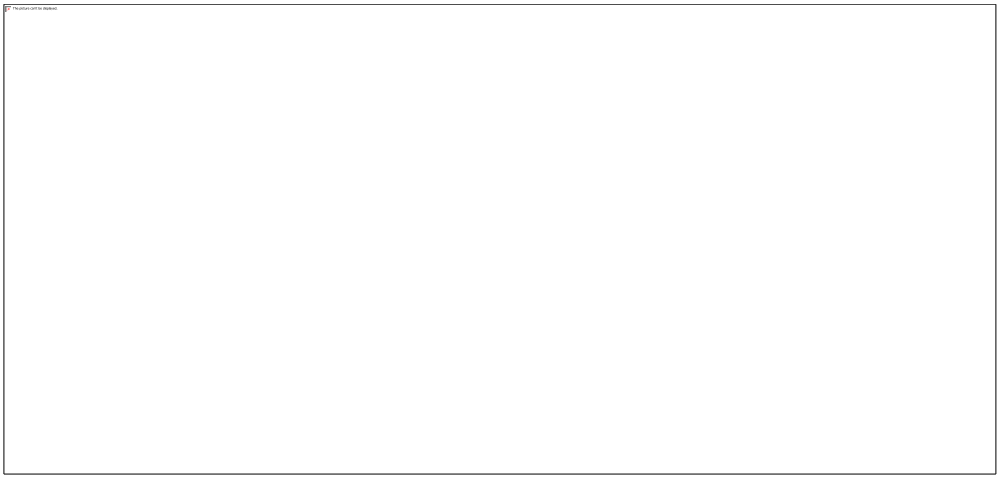
& Confusion Matrix=

```
[[1210    0    0    0    0    0    1    0   11    0]
 [   1 1302   13    3    0    0    8    2   56    1]
 [  86    0 1083   10    1    0   10    3   58    2]
 [  52    1   19 1036    0   12    2    3  149    5]
 [ 131    1    6    0  719    0   17    4  208  131]
 [ 155    0    4   60    0  666   22    2  250    4]
 [  76    0    1    0    0    3 1145    0   21    0]
 [  31    1   26    6    1    0    2 1117   73   74]
 [  25    1    2    9    0    1    0    1 1184    1]
 [  43    0    1    4    1    2    0   31  164 1033]]
```

Case33: K=10, and split=75:25

Accuracy= 0.7973333333333333

& Confusion Matrix=



Case34: K=10, and split=80:20

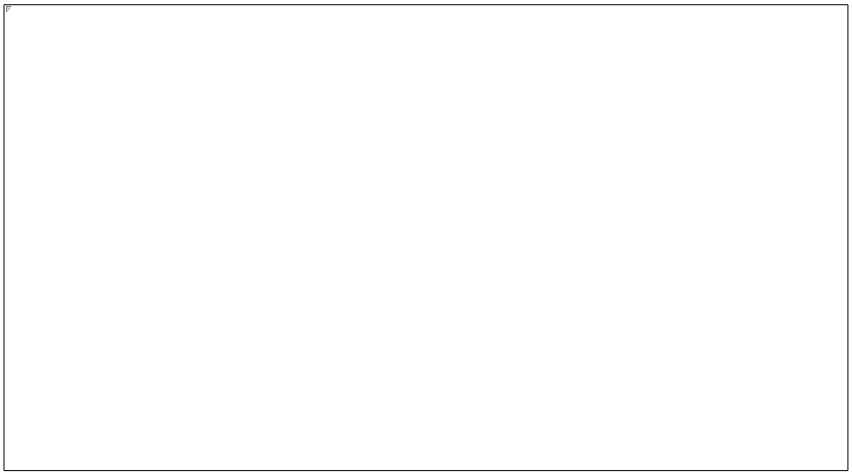
Accuracy= 0.8082142857142857

& Confusion Matrix=

Case35: K=10, and split=90:10

Accuracy= 0.8452380952380952

& Confusion Matrix=



Case36: K=10, and split=95:5

Accuracy= 0.8346190476190476

& Confusion Matrix=