In [ ]:
```
import numpy as np
import matplotlib.pyplot as plt
from scipy.io import loadmat
```

Load Data

In [ ]:
```
data = loadmat('ADA4-digit.mat')
train = data['X']
test = data['T']

print("Train data: {}".format(train.shape))
print("Test data:  {}".format(test.shape))
```

```
Train data: (256, 500, 10)
Test data:  (256, 200, 10)
```

Multi-classifier

In [ ]:
```
mu1 = []
mu2 = []
invS = []

# store mean and variances for each class
for i in range(10):

    train_one = train[:, :, i]
    train_all = np.delete(train,i,axis=2).reshape(256,-1,order="A")

    # Make a classifier for one and all
    mu1.append(np.mean(train_one, axis=1))
    mu2.append(np.mean(train_all, axis=1))
    S = (np.cov(train_one) + np.cov(train_all)) / 2
    invS.append(np.linalg.inv(S + 0.000001 * np.identity(256)))

C = np.zeros((10,10))

# Evaluate test cases using learnt data.
for i in range(10):
    t = test[:, :, i]
    pnet = []
    print(f"Test digit {i+1}")
    for j in range(10):
        p1 = mu1[j][None, :].dot(invS[j]).dot(t) - mu1[j][None, :].dot(invS[j]).do
        p2 = mu2[j][None, :].dot(invS[j]).dot(t) - mu2[j][None, :].dot(invS[j]).do
        pnet.append((p1 - p2)[0])

    pnet = np.dstack(pnet)[0]
    # Select class having highest p1-p2.
    result = np.argmax(pnet, axis=1)

    for d in result: C[i,d]+=1
    print(f"The number of correct prediction: Digit - {i+1} : {np.sum(result == i)
    print(f"The number of false prediction: not Digit - {i+1}: {np.sum(result != i

print("One vs All Prediction")
print(C)
acc = np.trace(C)*100/(test.shape[1]*test.shape[2])
print(f"Accuracy is:{acc}%")
```

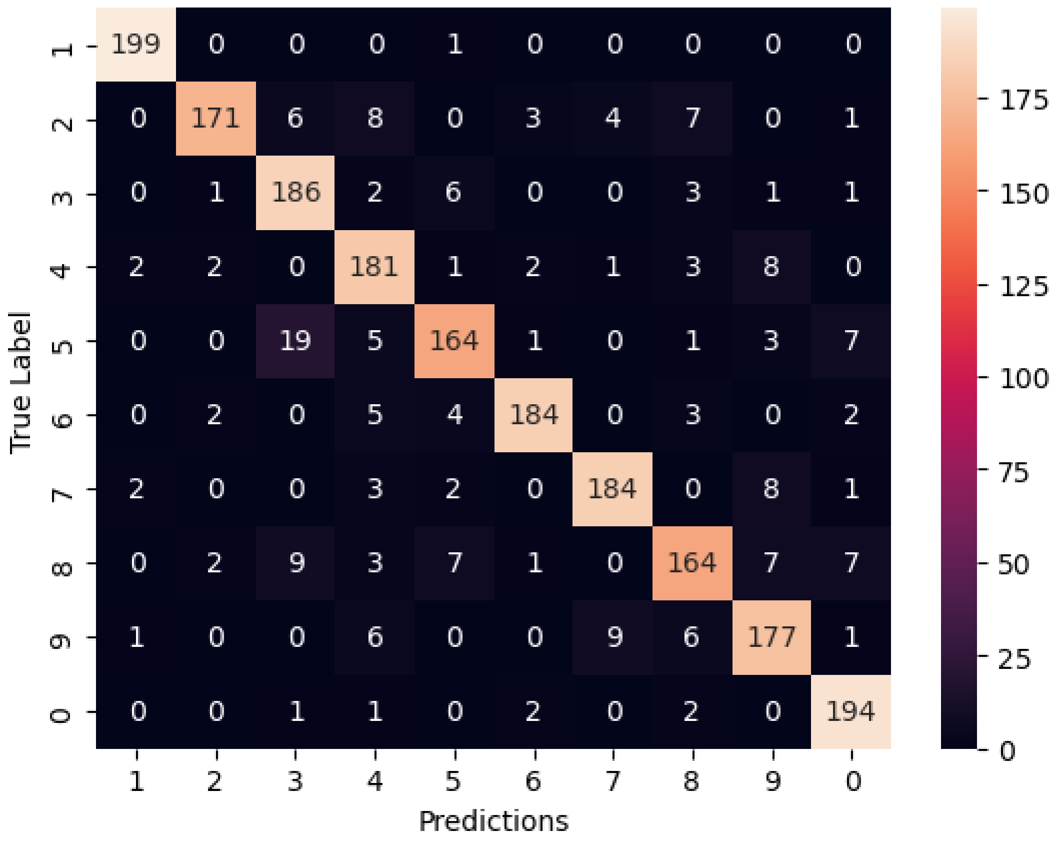
```
Test digit 1
The number of correct prediction: Digit - 1 : 199
The number of false prediction: not Digit - 1: 1
Test digit 2
The number of correct prediction: Digit - 2 : 171
The number of false prediction: not Digit - 2: 29
Test digit 3
The number of correct prediction: Digit - 3 : 186
The number of false prediction: not Digit - 3: 14
Test digit 4
The number of correct prediction: Digit - 4 : 181
The number of false prediction: not Digit - 4: 19
Test digit 5
The number of correct prediction: Digit - 5 : 164
The number of false prediction: not Digit - 5: 36
Test digit 6
The number of correct prediction: Digit - 6 : 184
The number of false prediction: not Digit - 6: 16
Test digit 7
The number of correct prediction: Digit - 7 : 184
The number of false prediction: not Digit - 7: 16
Test digit 8
The number of correct prediction: Digit - 8 : 164
The number of false prediction: not Digit - 8: 36
Test digit 9
The number of correct prediction: Digit - 9 : 177
The number of false prediction: not Digit - 9: 23
Test digit 10
The number of correct prediction: Digit - 10 : 194
The number of false prediction: not Digit - 10: 6
One vs All Prediction
[[199.   0.   0.   0.   1.   0.   0.   0.   0.   0.]
 [  0. 171.   6.   8.   0.   3.   4.   7.   0.   1.]
 [  0.   1. 186.   2.   6.   0.   0.   3.   1.   1.]
 [  2.   2.   0. 181.   1.   2.   1.   3.   8.   0.]
 [  0.   0.  19.   5. 164.   1.   0.   1.   3.   7.]
 [  0.   2.   0.   5.   4. 184.   0.   3.   0.   2.]
 [  2.   0.   0.   3.   2.   0. 184.   0.   8.   1.]
 [  0.   2.   9.   3.   7.   1.   0. 164.   7.   7.]
 [  1.   0.   0.   6.   0.   0.   9.   6. 177.   1.]
 [  0.   0.   1.   1.   0.   2.   0.   2.   0. 194.]]
Accuracy is:90.2%
```

Plots

In [ ]:

```
import seaborn as sns
col = [i for i in range(1,10)] + [0]
ax = sns.heatmap(C, annot=True,fmt=".0f")
ax.set(xlabel="Predictions", ylabel="True Label")
ax.set_xticklabels(col)
ax.set_yticklabels(col)
```

```
Out[ ]: [Text(0, 0.5, '1'),
         Text(0, 1.5, '2'),
         Text(0, 2.5, '3'),
         Text(0, 3.5, '4'),
         Text(0, 4.5, '5'),
         Text(0, 5.5, '6'),
         Text(0, 6.5, '7'),
         Text(0, 7.5, '8'),
         Text(0, 8.5, '9'),
         Text(0, 9.5, '0')]
```


True Label
Predictions
1: 199 0 0 0 1 0 0 0 0 0
2: 0 171 6 8 0 3 4 7 0 1
3: 0 1 186 2 6 0 0 3 1 1
4: 2 2 0 181 1 2 1 3 8 0
5: 0 0 19 5 164 1 0 1 3 7
6: 0 2 0 5 4 184 0 3 0 2
7: 2 0 0 3 2 0 184 0 8 1
8: 0 2 9 3 7 1 0 164 7 7
9: 1 0 0 6 0 0 9 6 177 1
0: 0 0 1 1 0 2 0 2 0 194