

# PROGRAMMING ASSIGNMENT : 2

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## Exercise 1 : Classification - One vs One

### Confusion Matrix

|   | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 355 | 0   | 4   | 3   | 0   | 4   | 5   | 0   | 5   | 0   |
| 1 | 0   | 252 | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 2   |
| 2 | 2   | 1   | 182 | 8   | 5   | 1   | 3   | 2   | 4   | 1   |
| 3 | 0   | 0   | 3   | 148 | 0   | 9   | 0   | 0   | 2   | 0   |
| 4 | 1   | 6   | 2   | 0   | 188 | 1   | 3   | 7   | 0   | 3   |
| 5 | 0   | 0   | 1   | 5   | 1   | 144 | 2   | 1   | 3   | 0   |
| 6 | 0   | 3   | 0   | 0   | 2   | 0   | 156 | 0   | 1   | 0   |
| 7 | 0   | 2   | 1   | 0   | 1   | 0   | 0   | 135 | 0   | 2   |
| 8 | 1   | 0   | 5   | 2   | 0   | 0   | 1   | 1   | 148 | 1   |
| 9 | 0   | 0   | 0   | 0   | 2   | 1   | 0   | 1   | 3   | 168 |

### Metrics

F1 score:0.93477326195

Time taken: 20.9313671589 s

## Exercise 2: Classification - One vs Rest

### Confusion Matrix

|   | 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|---|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0 | 355 | 0   | 4   | 3   | 0   | 4   | 2   | 0   | 3   | 0   |
| 1 | 0   | 252 | 0   | 0   | 1   | 0   | 0   | 0   | 0   | 1   |
| 2 | 2   | 1   | 178 | 5   | 5   | 1   | 3   | 2   | 3   | 0   |
| 3 | 0   | 0   | 3   | 147 | 0   | 7   | 0   | 0   | 3   | 0   |
| 4 | 1   | 6   | 5   | 0   | 185 | 1   | 3   | 4   | 0   | 3   |
| 5 | 0   | 0   | 0   | 7   | 2   | 146 | 2   | 0   | 5   | 1   |
| 6 | 0   | 3   | 0   | 0   | 2   | 0   | 158 | 0   | 0   | 0   |
| 7 | 0   | 2   | 2   | 1   | 2   | 0   | 0   | 140 | 1   | 4   |
| 8 | 0   | 0   | 6   | 2   | 0   | 0   | 2   | 0   | 150 | 2   |
| 9 | 1   | 0   | 0   | 1   | 3   | 1   | 0   | 1   | 1   | 166 |

### Metrics

F1 score: 0.935269090839

Time taken: 34.9992671013 s

## Conclusion

Both the classification schemes performed well. The model generated was able to predict the labels for test data very well. The F1 score for One versus Rest is observed to be slightly higher than One versus One, thus making it a better scheme for this case. The number 5 is observed to be mistaken for 3 many times. The One vs Rest scheme takes more time when compared to One vs One. This could be because the size of the input to the classifier becomes larger in case of One versus Rest.

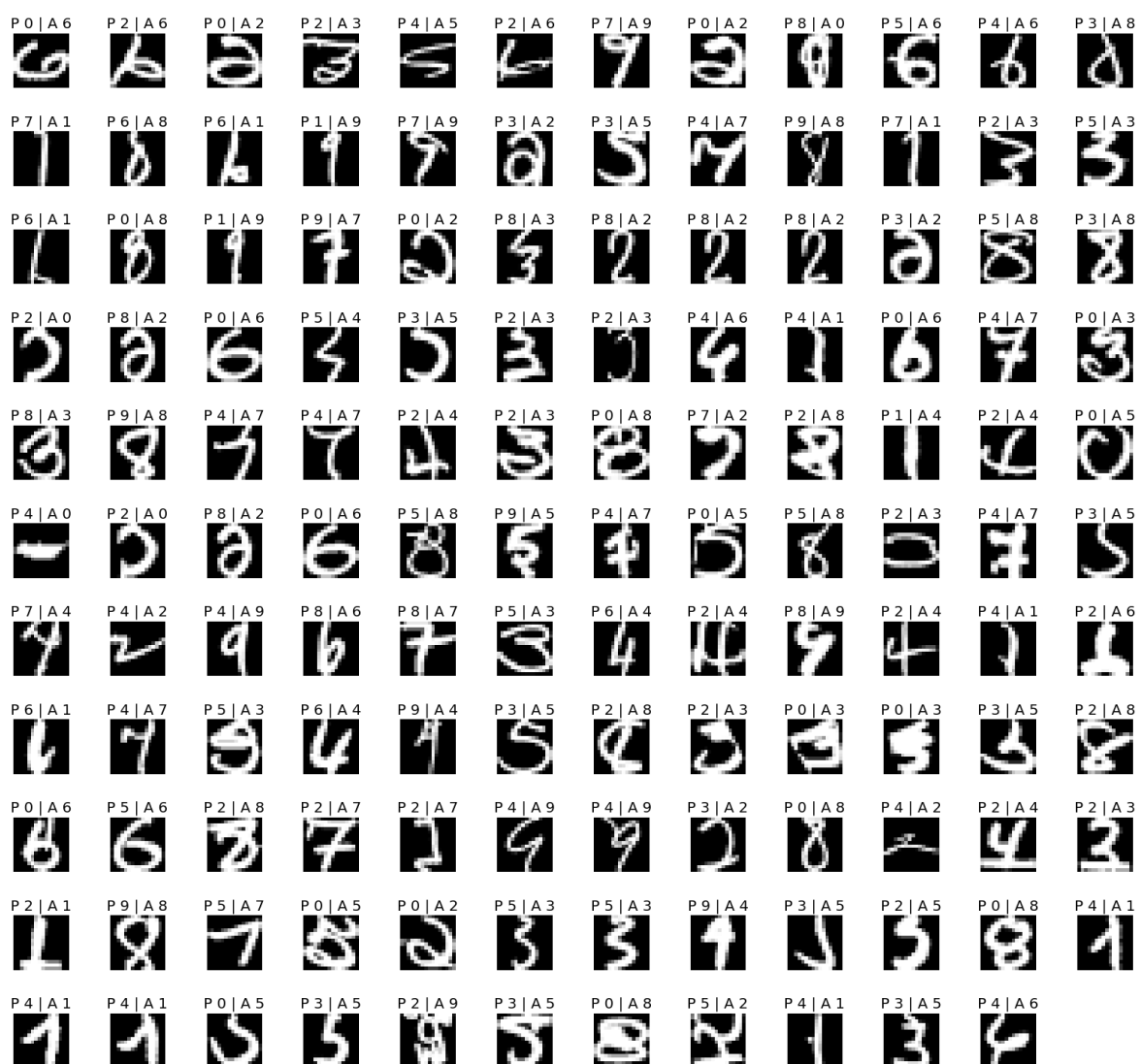


Figure 1: Misclassification for One Versus One

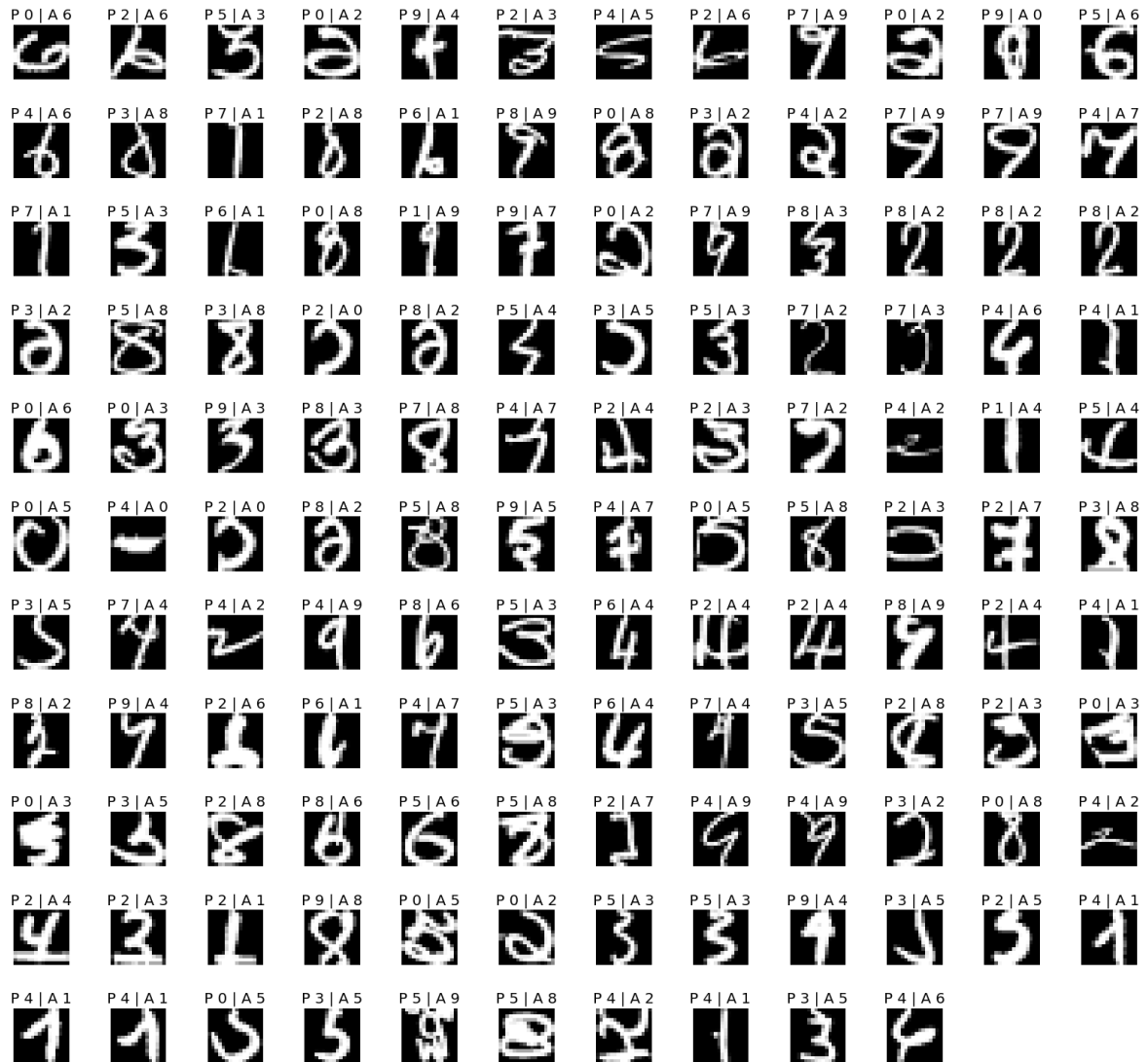


Figure 2: Misclassification for One Versus Rest