SML Assignment-1
Report

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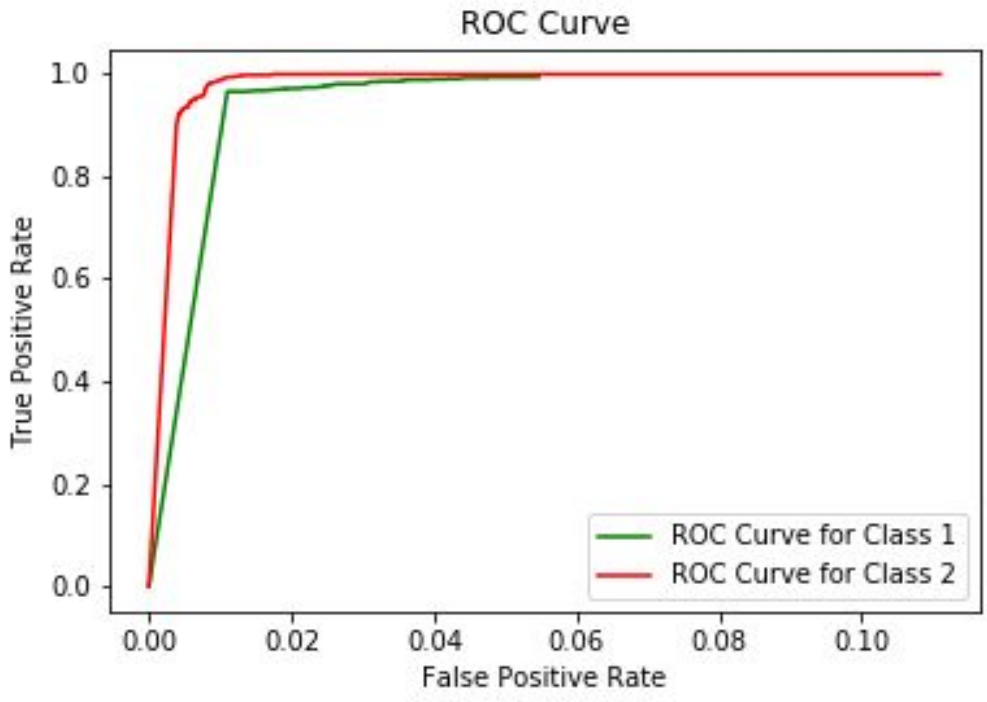
Q1 FMNIST Dataset

1. Two classes: Trouser[1] and Pullover[2]
   Accuracy for two classes: **93.2%**
   a. Confusion Matrix

Actual Class x Predicted Class

Class	**1**	**2**
1	**964**	36
2	100	**900**

   b. ROC Curve



   c. Precision & Recall
   Precision for Class 1 = 0.9077212806026366
   Recall for Class 1 = 0.0964

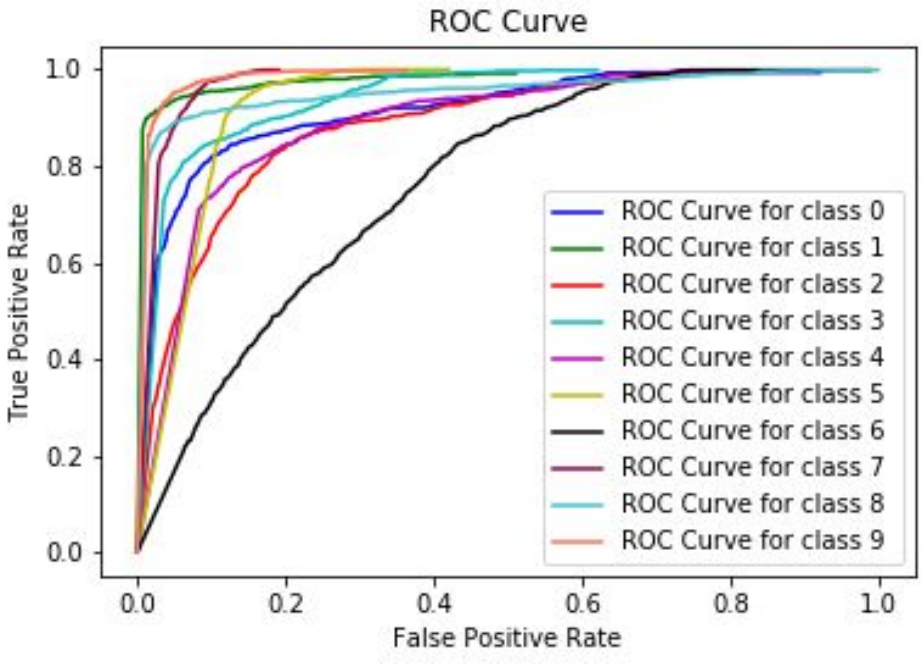
Precision for Class 2 = 0.9625668449197861
Recall for Class 2 = 0.09

2. All 10 classes:
   Accuracy: **65.89%**
   a. Confusion Matrix

Actual Class x Predicted Class

Class	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
0	**602**	33	26	89	29	105	103	0	13	0
1	27	**874**	3	54	14	16	10	0	2	0
2	4	6	**279**	10	351	109	219	0	22	0
3	32	17	1	**731**	66	96	53	0	4	0
4	2	3	60	64	**709**	64	86	0	12	0
5	0	0	0	1	0	**737**	7	185	5	65
6	167	3	77	55	270	182	**210**	0	36	0
7	0	0	0	0	0	133	0	**801**	0	66
8	3	1	9	44	11	74	61	9	**787**	1
9	0	0	0	1	0	69	11	57	3	**859**

   b. ROC Curve



c. Precision & Recall

Precision for Class 0 = 0.7192353643966547
Recall for Class 0 = 0.0602

Precision for Class 1 = 0.9327641408751334
Recall for Class 1 = 0.0874

Precision for Class 2 = 0.6131868131868132
Recall for Class 2 = 0.0279

Precision for Class 3 = 0.6968541468064824
Recall for Class 3 = 0.0731

Precision for Class 4 = 0.4889655172413793
Recall for Class 4 = 0.0709

Precision for Class 5 = 0.4649842271293375
Recall for Class 5 = 0.0737

Precision for Class 6 = 0.27631578947368424
Recall for Class 6 = 0.021

Precision for Class 7 = 0.7614068441064639
Recall for Class 7 = 0.0801

Precision for Class 8 = 0.8902714932126696
Recall for Class 8 = 0.0787

Precision for Class 9 = 0.8668012108980827
Recall for Class 9 = 0.0859

d. CMC Curve

Class 1 is best classified as compared to other classes. False Positive Rate of class 1 is less, which means that there were very less images that were wrongly classified as positive. Class 6 have a very low precision, and Roc curve of class 6 also shows that many images were wrongly classified.

Q2 MNIST Dataset

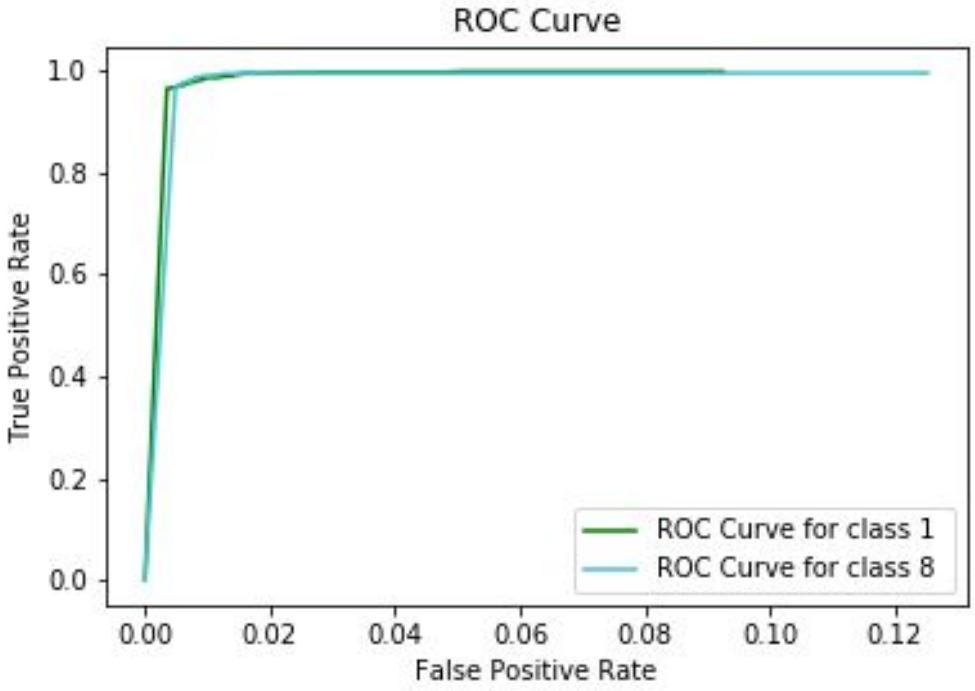
1. Two classes: 1 and 8
    a. Accuracy: **96.42%**
    Confusion Matrix

Actual Class x Predicted Class

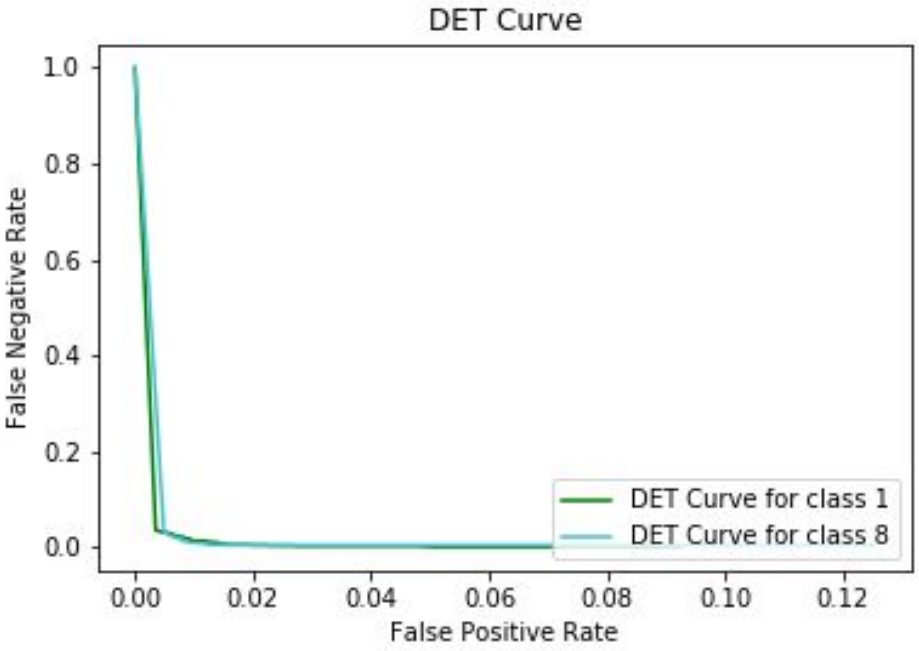
Class	**1**	**8**
1	**1091**	44
8	30	**944**

Precision for Class 1 = 0.9732381801962533
Recall for Class 1 = 10.91
Precision for Class 8 = 0.9554655870445344
Recall for Class 8 = 9.44

ROC Curve



DET Curve



b. Random 5 Fold and Stratified 5 Fold
For Random 5 Fold

Train Bins	Testing Bin	Validation Accuracy	Testing Accuracy

2, 3, 4, 5	1	95.63%	95.37%
1, 3, 4, 5	2	95.83%	96.49%
1, 2, 4, 5	3	95.55%	95.21%
1, 2, 3, 5	4	95.16%	95.18%
1, 2, 3, 4	5	95.68%	96.44%

Mean Validation Accuracy = 95.57%
Standard Deviation of Validation Accuracy = 0.22441033844277

Mean Training Accuracy = 95.73%
Standard Deviation of Training Accuracy = 0.59730729109898

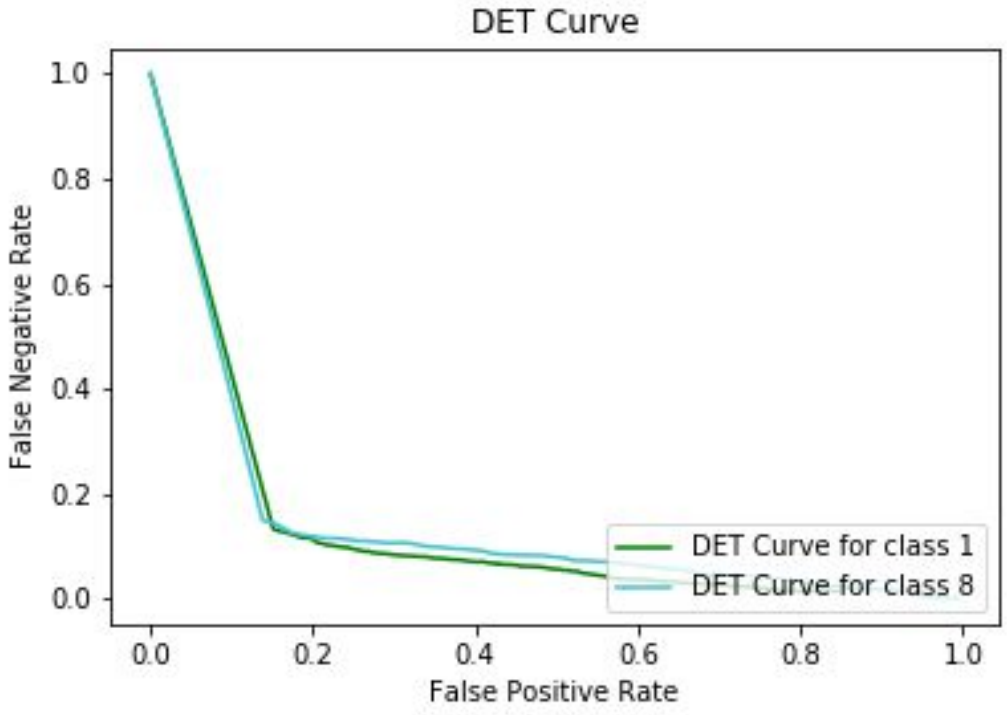
Stratified 5 Fold
No of Data points of class 1 and class 8 = 5850 each
Each bin maintains equal ratio of data points from both classes

Train Bins	Testing Bin	Validation Accuracy	Testing Accuracy
2, 3, 4, 5	1	36.45%	76.48%
1, 3, 4, 5	2	37.17%	76.52%
1, 2, 4, 5	3	38.07%	76.38%
1, 2, 3, 5	4	36.94%	76.24%
1, 2, 3, 4	5	36.28%	76.33%

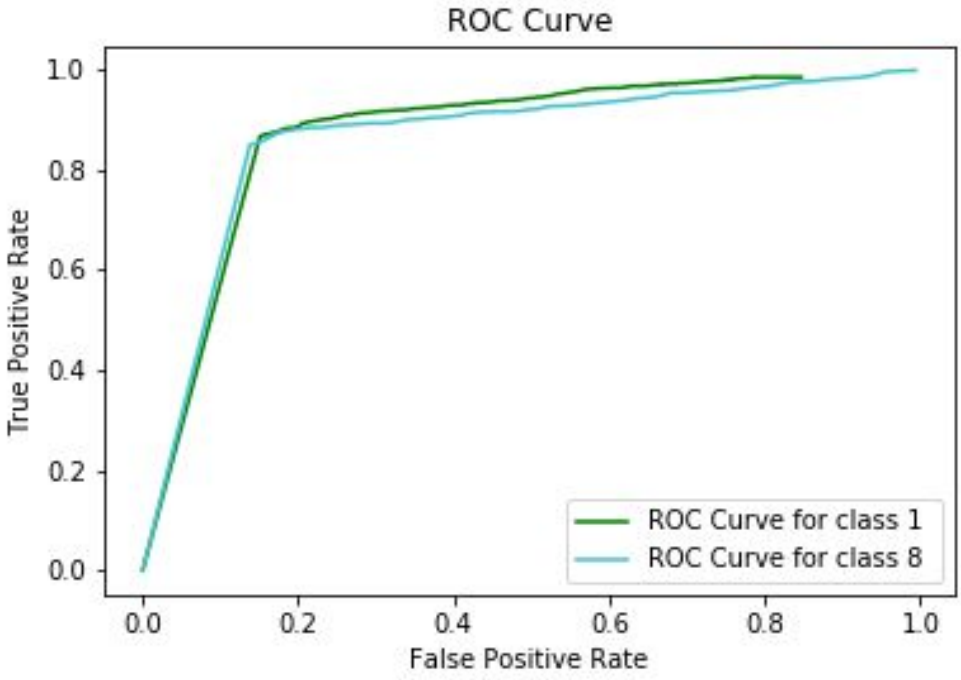
Mean Validation Accuracy = 36.98%
Standard Deviation of Validation Accuracy = 0.63193037591178

Mean Training Accuracy = 76.39%
Standard Deviation of Training Accuracy = 0.10119288512539

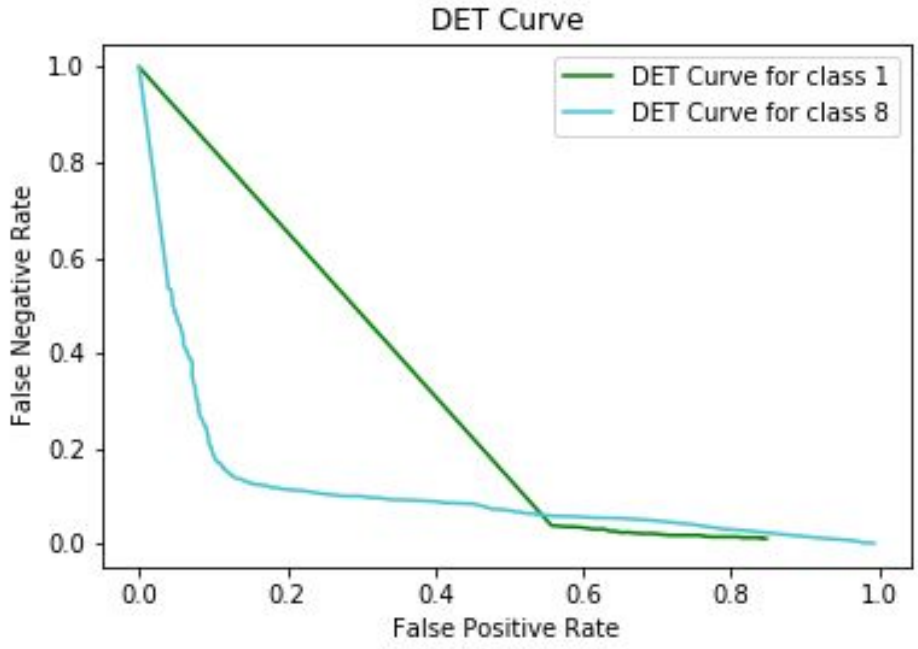
c. For Random 5 Fold
DET Curve



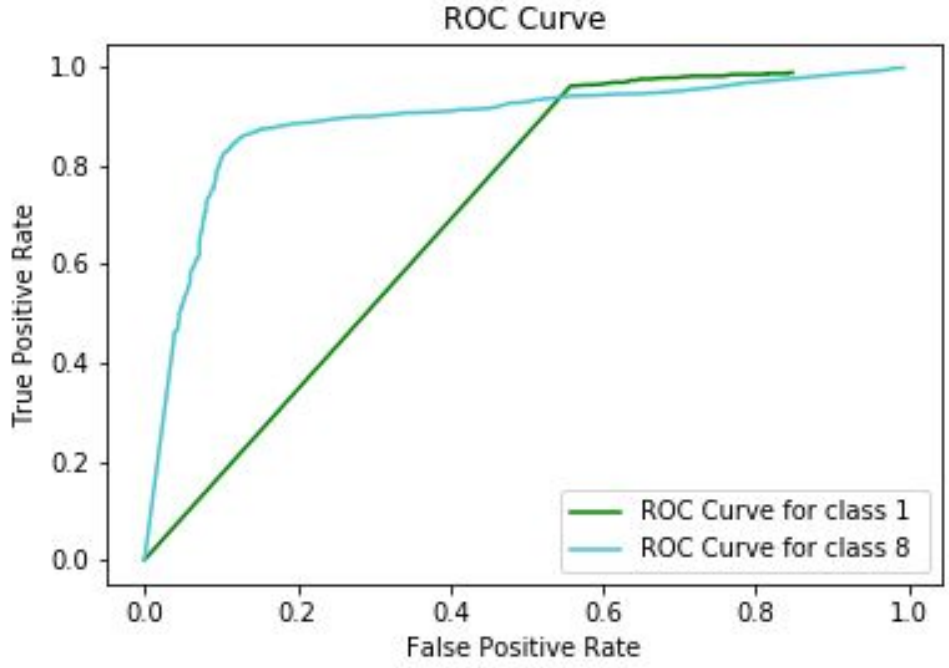
ROC Curve



For Stratified 5 Fold
DET Curve



ROC Curve



d.

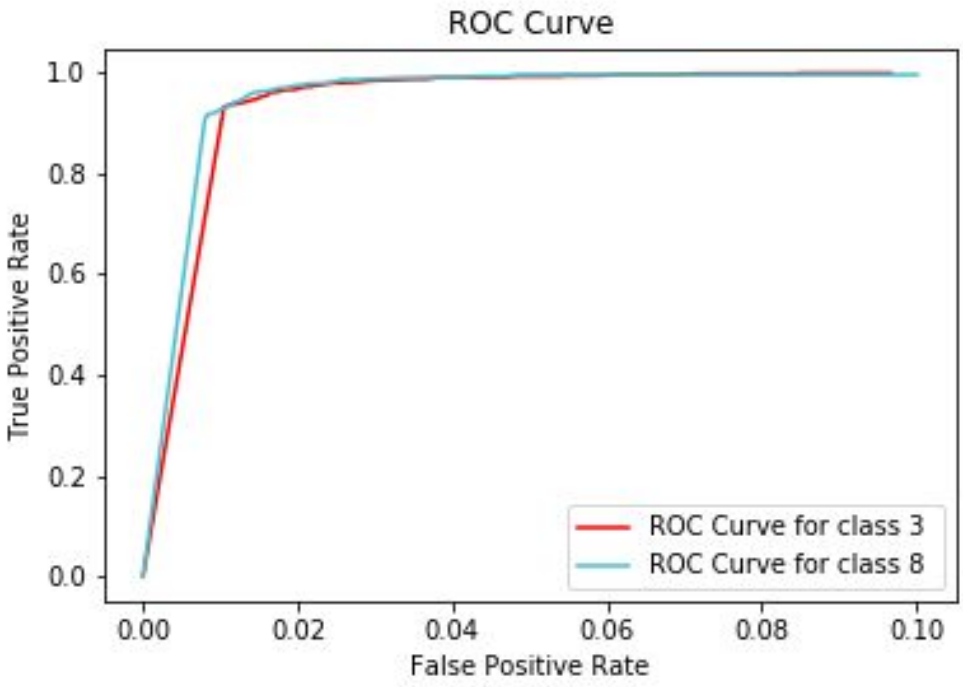
2. Two classes: 3 and 8
    a. Accuracy: **91.68%**
    Confusion Matrix

Actual Class x Predicted Class

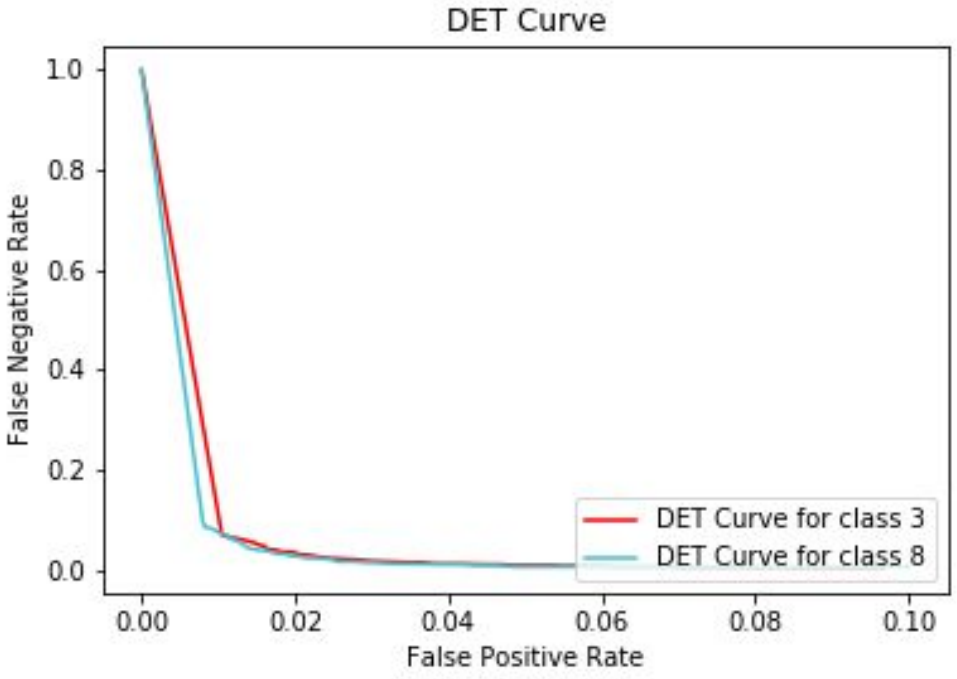
Class	1	8
1	**1876**	144
8	186	**1762**

Precision for Class 3 = 0.9097963142580019
Recall for Class 3 = 18.759999999999998
Precision for Class 8 = 0.9244491080797481
Recall for Class 8 = 17.62

ROC Curve



DET Curve



b. Random 5 Fold and Stratified 5 Fold

For Random 5 Fold

Train Bins	Testing Bin	Validation Accuracy	Training Accuracy
2, 3, 4, 5	1	90.11%	91.63%
1, 3, 4, 5	2	90.51%	91.68%
1, 2, 4, 5	3	90.62%	91.53%
1, 2, 3, 5	4	90.07%	91.88%
1, 2, 3, 4	5	92.67%	91.78%

Mean Validation Accuracy = 90.80%
Standard Deviation of Validation Accuracy = 0.96149050957355

Mean Training Accuracy = 91.7%
Standard Deviation of Training Accuracy = 0.12083045973594

Stratified 5 Fold

No of Data points of class 1 and class 8 = 5850 each

Each bin maintains equal ratio of data points from both classes

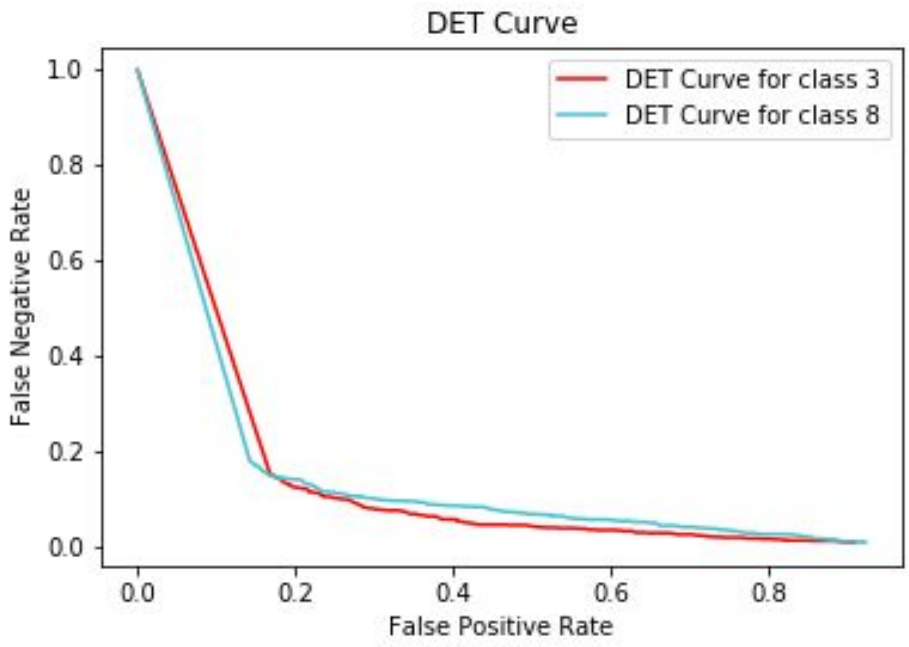
Train Bins	Testing Bin	Validation Accuracy	Training Accuracy

2, 3, 4, 5	1	38.18%	74.44%
1, 3, 4, 5	2	38.18%	74.34%
1, 2, 4, 5	3	36.60%	74.54%
1, 2, 3, 5	4	37.05%	74.49%
1, 2, 3, 4	5	37.41%	73.89%

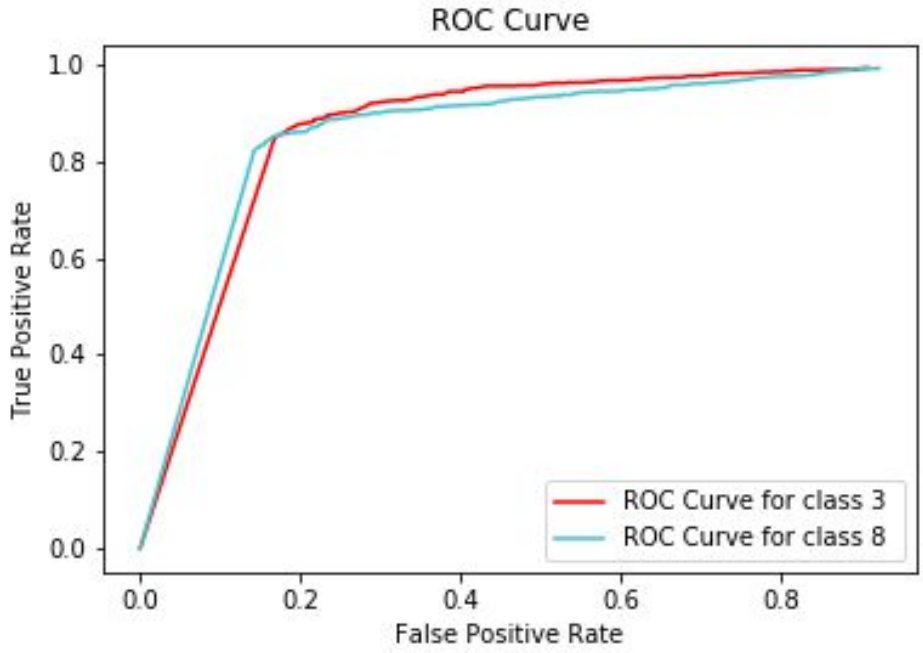
Mean Validation Accuracy = 37.48%
Standard Deviation of Validation Accuracy = 0.62355753543679

Mean Training Accuracy = 74.34%
Standard Deviation of Training Accuracy = 0.23452078799117

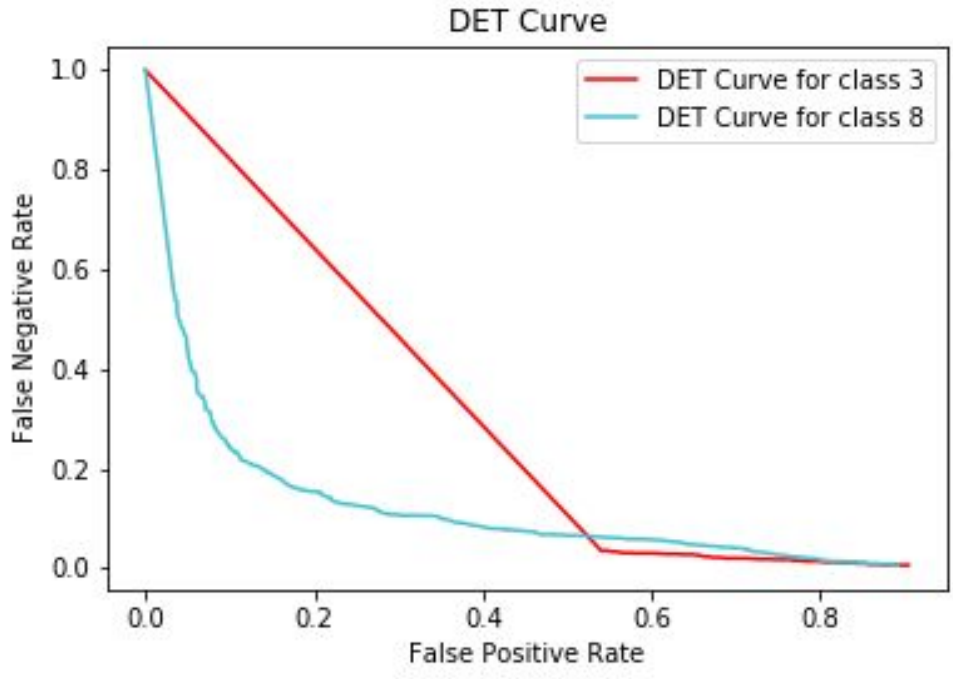
c. For random 5 Fold
DET Curve



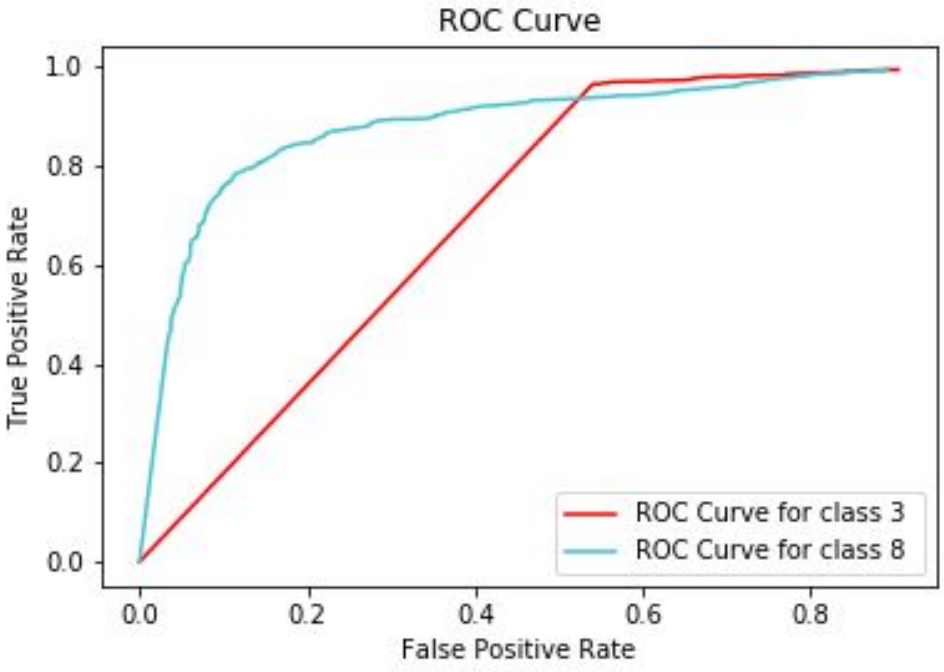
ROC Curve



For Stratified 5 Fold
DET Curve



ROC Curve



Validation and Testing Accuracy of classes 3 and 8 is less as compared to accuracy obtained with classes 1 and 8. Number 3 and 8 have similar representation of pixels which makes it difficult to classify since pixel overlap is high in class(3, 8) as compared to class(1, 8). This reduces no of correctly classified image count and thus reduces Validation and Testing Accuracy.