Report for Project:

AdaBoost for Face Detection

A. Features

The information of the selected top 10 features is as follows.
[feature index, threshold, error, polarization]

```
[10521, -111.5, 0.13132687184719666, 1]
[30320, -205.5, 0.22461629047942996, 1]
[22671, 183.0, 0.27167702775084707, -1]
[47809, 18.5, 0.27756304108053514, -1]
[30688, 2.5, 0.28774085164152274, -1]
[26574, -39.5, 0.28900970396450154, 1]
[22012, 99.5, 0.26472491147244265, -1]
[12122, 149.5, 0.3255109268440368, -1]
[42840, -64.5, 0.3413054334410764, 1]
[40529, 23.5, 0.35645157164302715, -1]
```

polarization = 1: samples which have feature values smaller than threshold would be classified to 1.
polarization = 0: samples which have feature values smaller than threshold would be classified to 0.

And the coordinates of the selected features are obtained as follows. The types A, B, C, D are defined in the same way with the original Viola-Jones paper.

```
Type A feature: [8, 3, 9, 10]
Type B feature: [15, 3, 16, 8]
Type B feature: [5, 0, 15, 1]
Type D feature: [12, 15, 17, 16]
Type B feature: [16, 17, 17, 18]
Type B feature: [8, 11, 10, 12]
Type B feature: [4, 6, 6, 15]
Type A feature: [10, 2, 11, 15]
Type D feature: [2, 15, 7, 18]
Type D feature: [0, 0, 1, 5]
```

To make the results more straightforward, the visualized features on a face sample image are shown as follows.

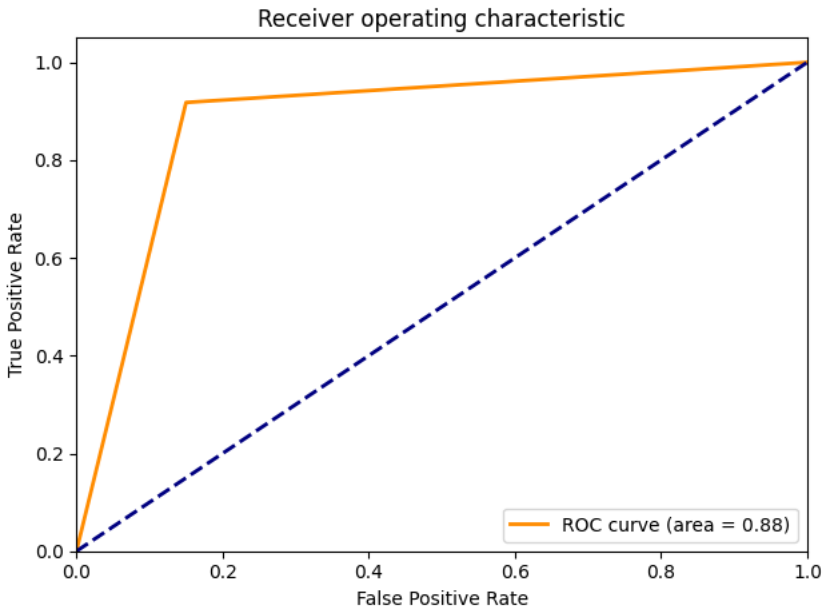
As the above shown, the selected features captured characteristics of human face such as nose, eyes, eyebrows, mouth and cheek.

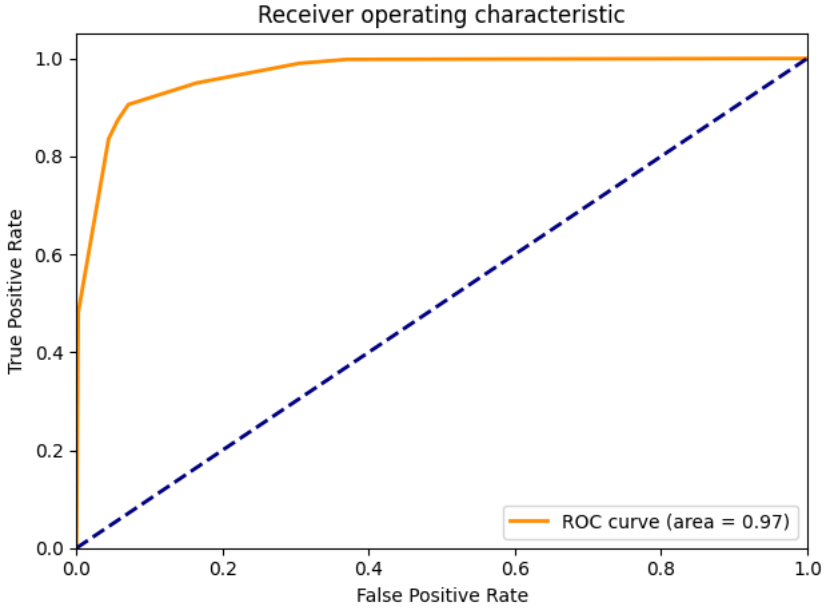
B. Combined Classifiers

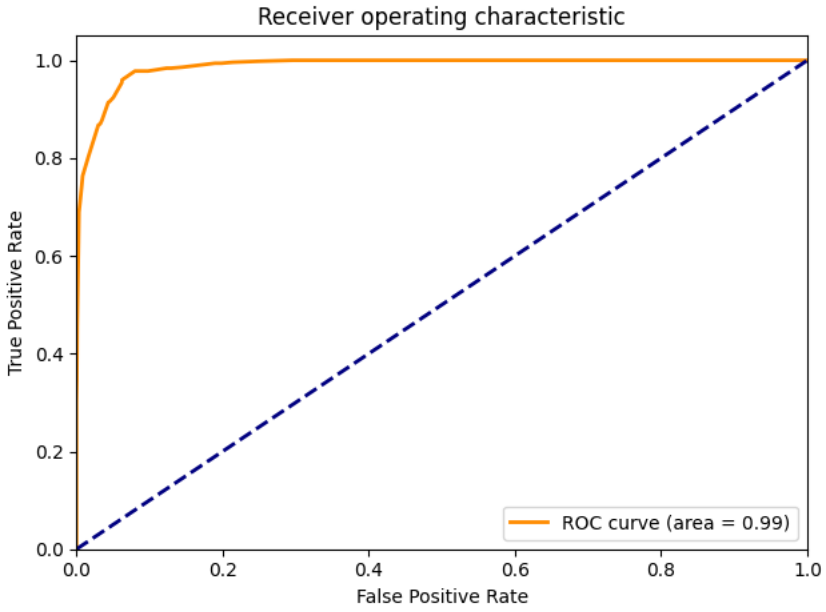
The alpha coefficients which are computed from betas for the top 10 classifiers are shown as follows.
[2.0300658586956506, 1.4933617082331123, 1.3031413161764824, 1.281707196531004, 1.2456950246170033, 1.241295013701585, 1.3290640620789616, 1.1223592484836298, 1.0749775033571198, 1.0315568922739846]
Higher value suggests that the simple classifier, which is trained using specific weight distribution in that round, performs better with lower error rate.

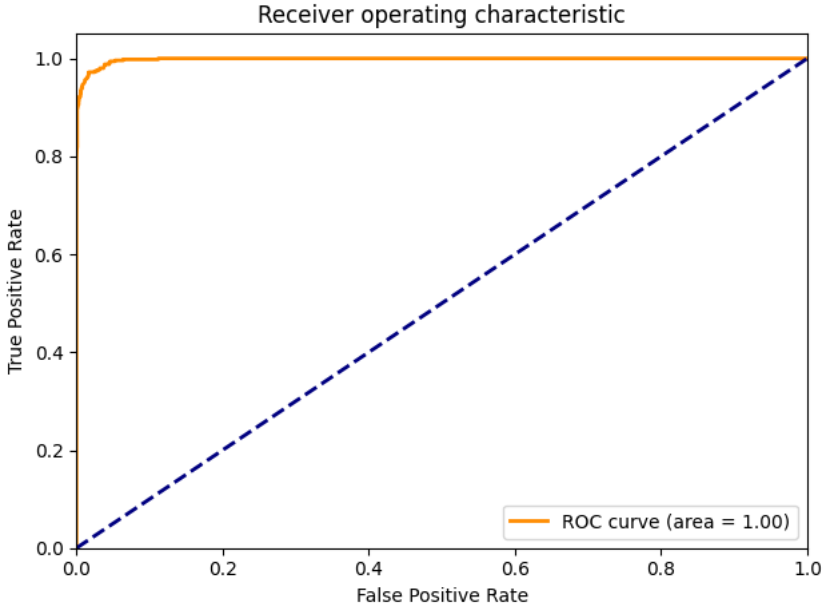
C. ROC Curve

The ROC curve of the combined classifiers after running 1, 3, 5, 10 boosting rounds on the trainset:

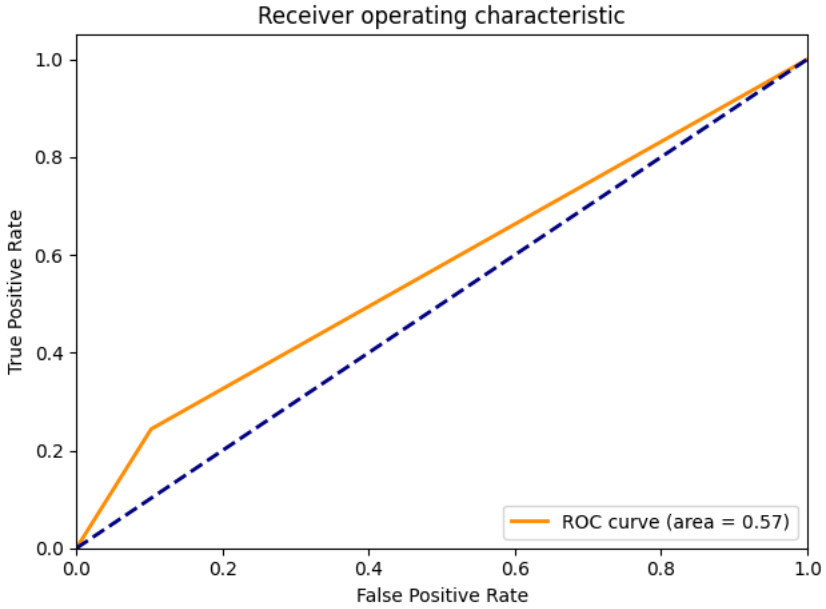


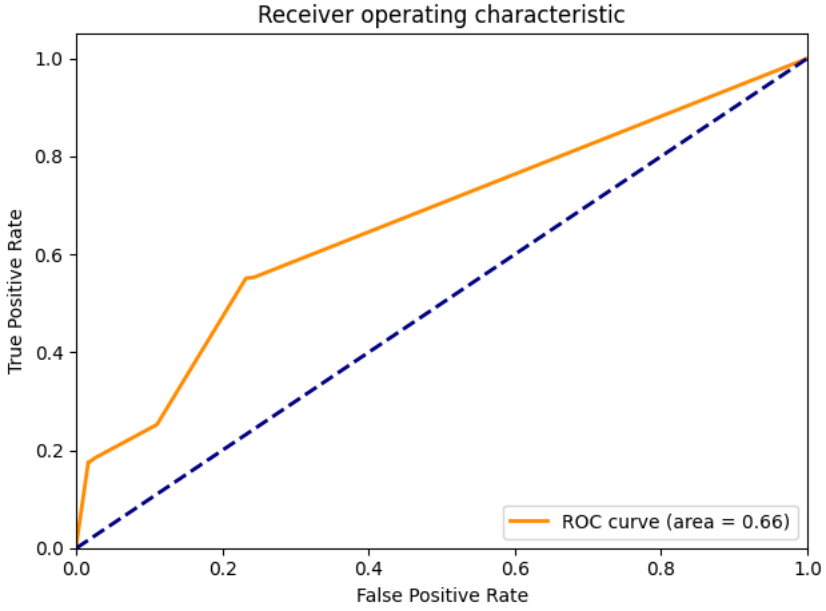

Receiver operating characteristic
True Positive Rate
False Positive Rate
ROC curve (area = 0.97)
0.0
0.2
0.4
0.6
0.8
1.0

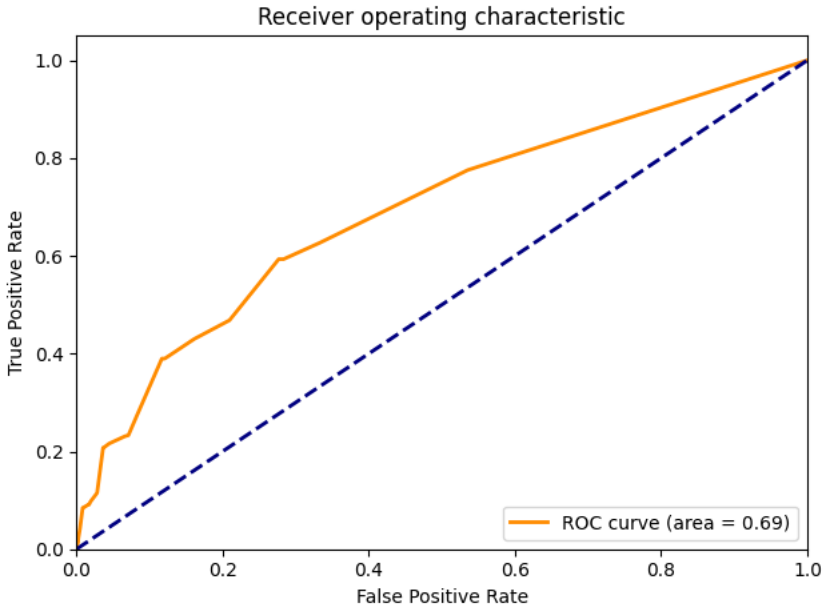

Receiver operating characteristic
True Positive Rate
False Positive Rate
ROC curve (area = 0.99)
0.0
0.2
0.4
0.6
0.8
1.0

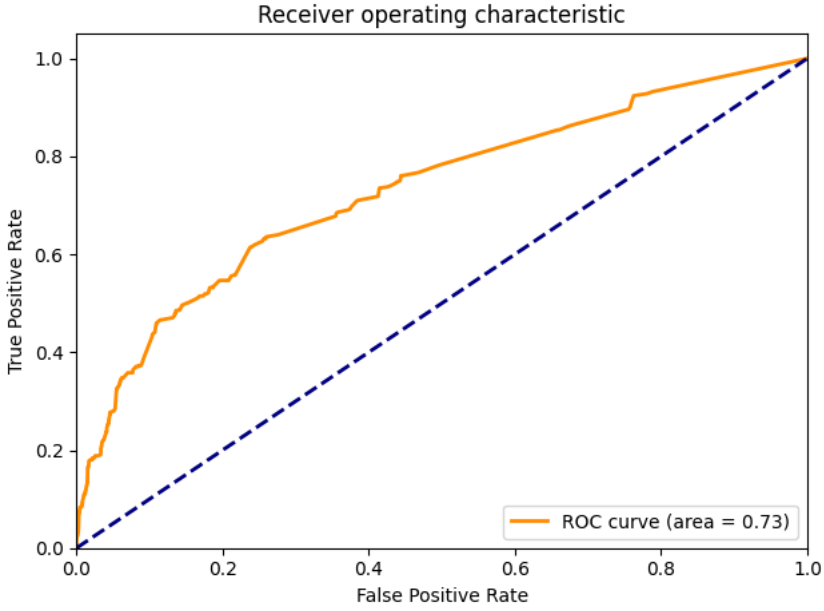


The ROC curve of the combined classifiers after running 1, 3, 5, 10 boosting rounds on the test set:




Receiver operating characteristic
True Positive Rate
False Positive Rate
ROC curve (area = 0.66)
0.0
0.2
0.4
0.6
0.8
1.0


Receiver operating characteristic
True Positive Rate
False Positive Rate
ROC curve (area = 0.69)
0.0
0.2
0.4
0.6
0.8
1.0



Analysis:

As the results shown, for the train set and test set, the ROC curve becomes more and more steep with greater AUC area as the number of boosting rounds increases. This demonstrates the effectiveness of the selected features. Also, the combined classifier trained with more boosting rounds can achieve better performance with greater AUC area.