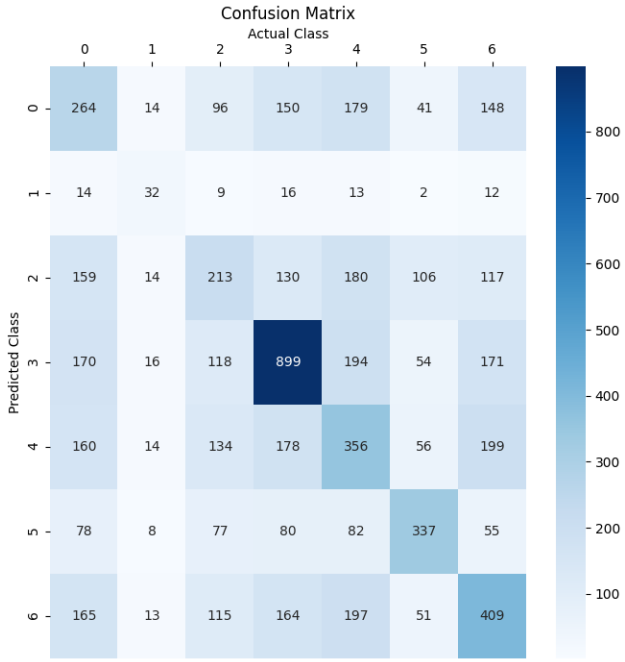
1 Vanilla Neural Network

Created a Neural Network having 1 hidden layer with 100 perceptrons and softmax as the output layer. Used cross entropy loss as a metric to calculate loss.

Observations:

1. `Training Time(s)`: 95.72
2. `Convergence`: Error = 0.00582 after 500 epochs
3. `Training Accuracy`: 99.2%
4. `Training Macro F1 Score`: 0.9922
5. `Test Accuracy`: 40.05%
6. `Test Macro F1 Score`: 0.37596

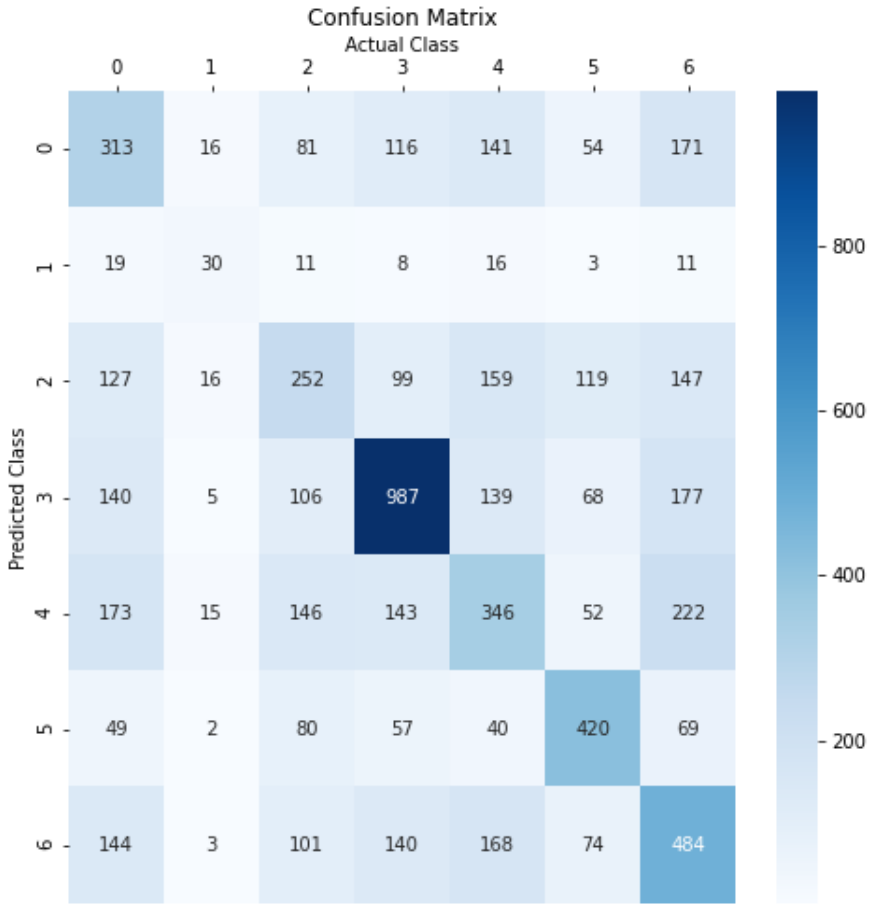


Conclusion: Clearly, the model overfits the training data. This can be observed from the low Test Accuracy and F1-Score as compared to the Training Accuracy. ReLU followed by Softmax as the output layer gives the best accuracy.

2 Feature Engineering

Implemented 2 feature extraction techniques using Gabor Filters and Hog Features.

Observations	Gabor Filters	HOG Features
Training Time	30.732	127.378
Training Accuracy	99.53%	99.44%
Training Macro F1 Score	0.99415	0.9938%
Test Accuracy	36.78%	43.84%
Test Macro F1 Score	0.3401	0.4101%



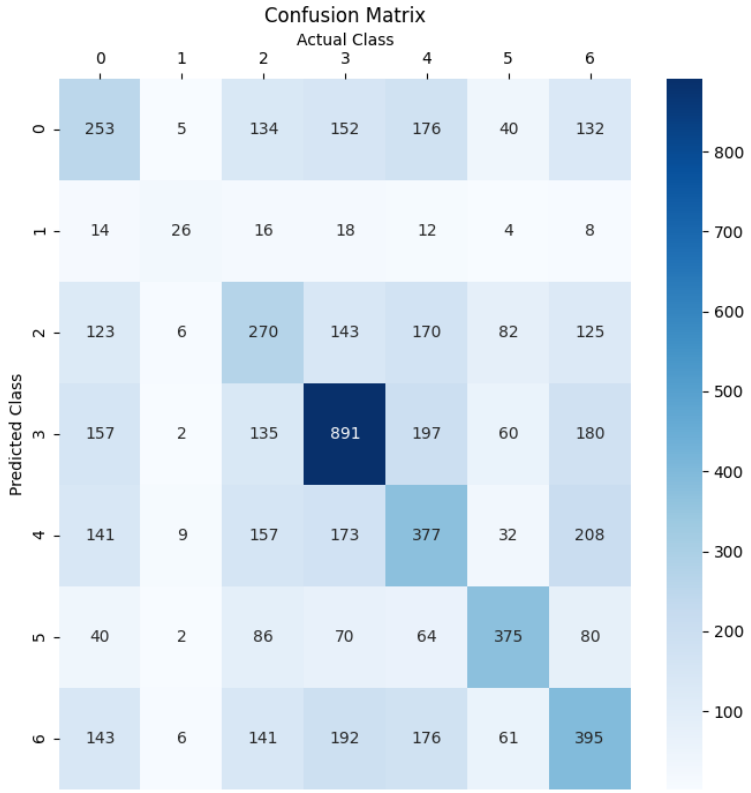
Conclusion: Histogram of Oriented Gradients perform better than Gabor Filters on the Fully Connected Model. However, the model still overfits the data.

3 Convolutional Neural Network

Implemented a Convolutional Neural Network with 2 convultion layers, 2 maxpool layers and 2 fully connected layers with softmax for the output layer.

Observations:

1. `Training Time(s)`: 111.63
2. `Convergence`: Error = 0.00006 after 77 epochs
3. `Training Accuracy`: 99.772%
4. `Training Macro F1 Score`: 0.9979
5. `Test Accuracy`: 41.5%
6. `Test Macro F1 Score`: 0.3859



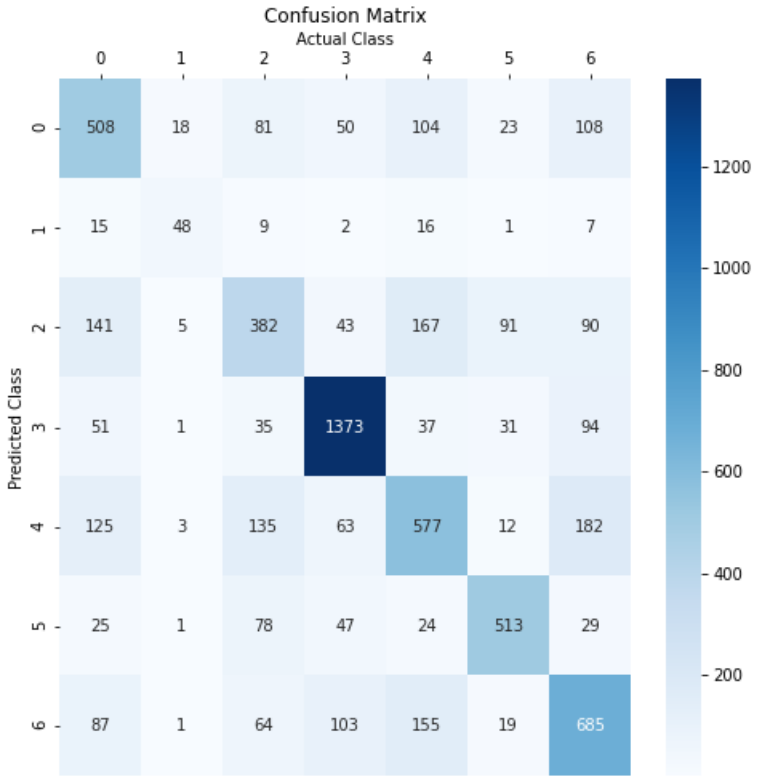
Conclusion: The F1-Score obtained in this part is slightly higher than the linear model. CNN Networks perform better than Fully Connected Models. However the model still overfits the data.

4 Competitive Part

Implemented VGG19 Model. Detailed structure can be seen in code. Created more training data by performing face alignment. Added mirror images of all images to the training data. Rotated the images by 45 degrees downwards.

Observations:

1. `Training Time(s)`: 3451.79
2. `Convergence`: Error = 0.00004 after 86 epochs
3. `Training Accuracy`: 99.998%
4. `Training Macro F1 Score`: 0.9971
5. `Test Accuracy`: 64.0%
6. `Test Macro F1 Score`: 0.60230



Conclusion: Tried models like ResNet18, ResNet34, VGG16, VGG19, DenseNet121. VGG19 performed the best and is also the fastest of all models. Accuracy and F1-Score obtained by this model is the highest.