Part 1

Signature Classification

Reformatting Dataset Structure

- To Enable Tensorflow's Data api to read the data properly the data was restructured
  From :
  - Root
    - class1
      -Train
      -Test
    - class2
      - Train
      - Test
    ..

  To:
  - Root
    - Train
      - class1
      - class2
      -...
    - Test
      - class1
      - class2
      -...

  This structure allows keras to automatically read the files and infer the labels.

Data Specifications

- Image Size: **(256, 256)**
- Color mode: **grayscale**
- Validation percentage: **20%**
- Images are **rescaled in range (0, 1)**

Models

CNN1

Architecture:

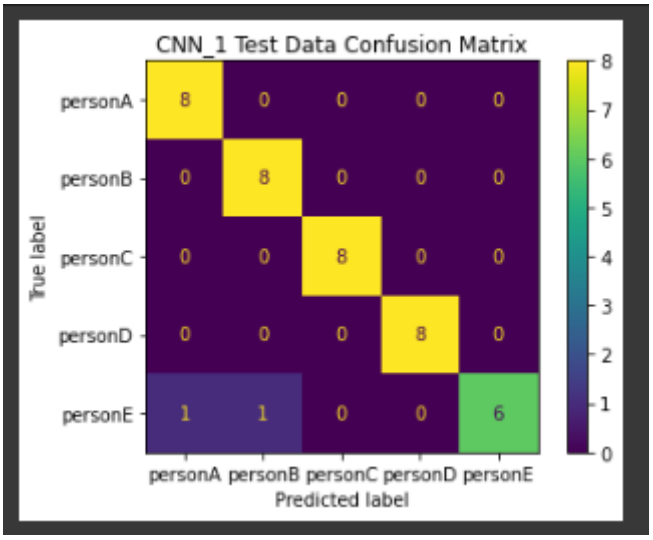
[10x10 Conv, 8] [MaxPool] -> [5x5 Conv, 16] [MaxPool] ->
[3x3 Conv, 32] [MaxPool] -> [Flatten] [Dense,32] [Dense, 5 (softmax)]

Training Time ~ 4s & Testing Time < 1s **[GPU]**

```
Epoch 1/10
5/5 [==============================] - 1s 87ms/step - loss: 1.7626 - accuracy: 0.2188 - val_loss: 1.5735 - val_accuracy: 0.2750
Epoch 2/10
5/5 [==============================] - 1s 59ms/step - loss: 1.5819 - accuracy: 0.2937 - val_loss: 1.5446 - val_accuracy: 0.2500
Epoch 3/10
5/5 [==============================] - 1s 54ms/step - loss: 1.4918 - accuracy: 0.3187 - val_loss: 1.3819 - val_accuracy: 0.4500
Epoch 4/10
5/5 [==============================] - 1s 54ms/step - loss: 1.2440 - accuracy: 0.6250 - val_loss: 1.0655 - val_accuracy: 0.6500
Epoch 5/10
5/5 [==============================] - 1s 51ms/step - loss: 0.7842 - accuracy: 0.7750 - val_loss: 0.6381 - val_accuracy: 0.7500
Epoch 6/10
5/5 [==============================] - 1s 50ms/step - loss: 0.2929 - accuracy: 0.9062 - val_loss: 0.5003 - val_accuracy: 0.9000
Epoch 7/10
5/5 [==============================] - 1s 60ms/step - loss: 0.1659 - accuracy: 0.9625 - val_loss: 0.2008 - val_accuracy: 0.9500
Epoch 8/10
5/5 [==============================] - 1s 58ms/step - loss: 0.0685 - accuracy: 0.9875 - val_loss: 0.1048 - val_accuracy: 0.9750
Epoch 9/10
5/5 [==============================] - 1s 52ms/step - loss: 0.0310 - accuracy: 0.9937 - val_loss: 0.1349 - val_accuracy: 0.9750
Epoch 10/10
5/5 [==============================] - 1s 50ms/step - loss: 0.0175 - accuracy: 1.0000 - val_loss: 0.1521 - val_accuracy: 0.9500
```

Results

```
CNN_1 model, train accuracy: 99.00%
CNN_1 model, test accuracy: 95.00%
```



CNN 2 **(Choosen Model)**

Architecture:

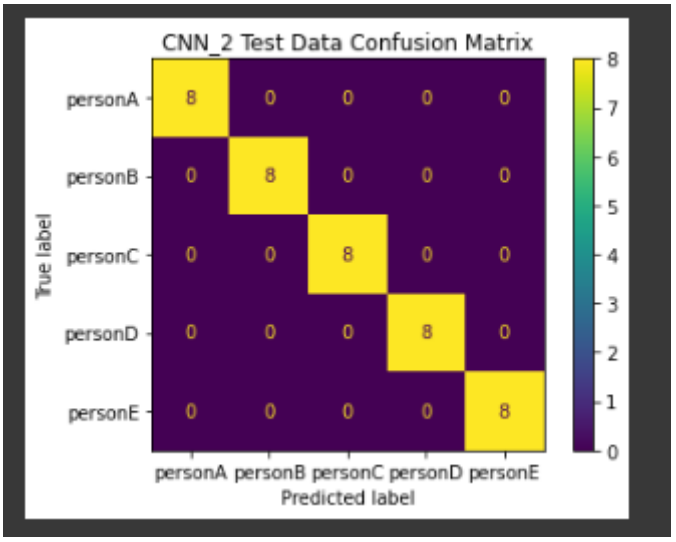
[**3x3** Conv, 8] [MaxPool] -> [5x5 Conv, 16] [MaxPool] ->
[3x3 Conv, 32] [MaxPool] **[Dropout 0.2]** -> [Flatten] [Dense,32] [Dense, 5 **(ReLU)**]

Training Time ~ 35s & Testing Time ~1s

```
Epoch 1/7
5/5 [==============================] - 6s 944ms/step - loss: 1.6021 - accuracy: 0.2625
Epoch 2/7
5/5 [==============================] - 5s 987ms/step - loss: 1.2723 - accuracy: 0.5562
Epoch 3/7
5/5 [==============================] - 5s 936ms/step - loss: 0.8463 - accuracy: 0.8313
Epoch 4/7
5/5 [==============================] - 6s 1s/step - loss: 0.4821 - accuracy: 0.8875
Epoch 5/7
5/5 [==============================] - 5s 953ms/step - loss: 0.1735 - accuracy: 0.9875
Epoch 6/7
5/5 [==============================] - 5s 949ms/step - loss: 0.0518 - accuracy: 1.0000
Epoch 7/7
5/5 [==============================] - 5s 933ms/step - loss: 0.0150 - accuracy: 1.0000
```

Results

```
CNN_2 model, train accuracy: 100.00%
CNN_2 model, test accuracy: 100.00%
```



Test Set Sample

Signature Verification

Model:

Architecture:

(three input layers [anchor - positive - negative] images of size (256,256,3)) -> (Xception architecture with average pooling) -> (Flatten layer) -> (Dense layer, 512, relu activation) -> (Batch normalization layer) -> (Dense layer, 256, relu activation) -> (Lambda, l2_normalization) -> (Distance layer).

Training & Testing time: 9s , 31 ms

```
...
    EPOCH 1/2:
    8/8 [==============================] - 9s 617ms/step
     loss:  0.1877  - test_acc:  0.9917

    EPOCH 2/2:
    8/8 [==============================] - 3s 465ms/step
     loss:  0.0553  - test_acc:  0.9000
```

```
  1/1 [==============================] - 0s 22ms/step
  1/1 [==============================] - 0s 21ms/step
  1/1 [==============================] - 0s 21ms/step
  1/1 [==============================] - 0s 22ms/step
  1/1 [==============================] - 0s 20ms/step
  1/1 [==============================] - 0s 20ms/step
  1/1 [==============================] - 0s 20ms/step
  1/1 [==============================] - 0s 22ms/step
  1/1 [==============================] - 0s 23ms/step
  1/1 [==============================] - 0s 23ms/step
  1/1 [==============================] - 0s 21ms/step
  1/1 [==============================] - 0s 31ms/step
  ...
  Precision:0.900
  Recall: 0.900
  F1 score: 0.900
```

Results: