



Amirkabir University of Technology
(Tehran Polytechnic)

Mask Detection Using Convolutional Neural Networks

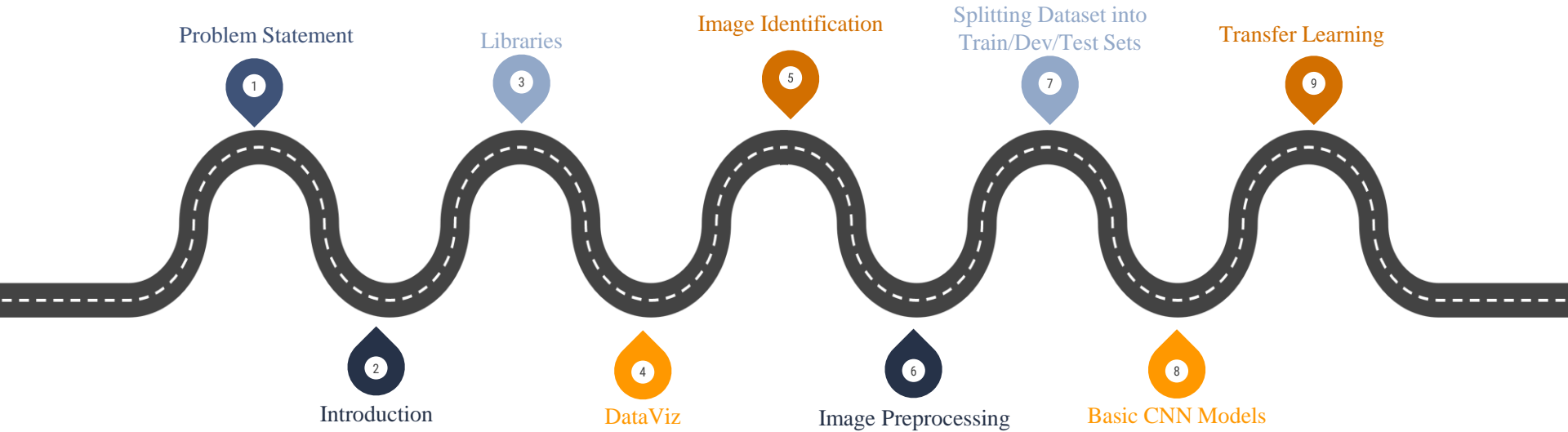
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Student: Pedram Peiro - 9825006

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Contents





Problem Statement

- Detect whether a person is wearing a mask or not

Objective

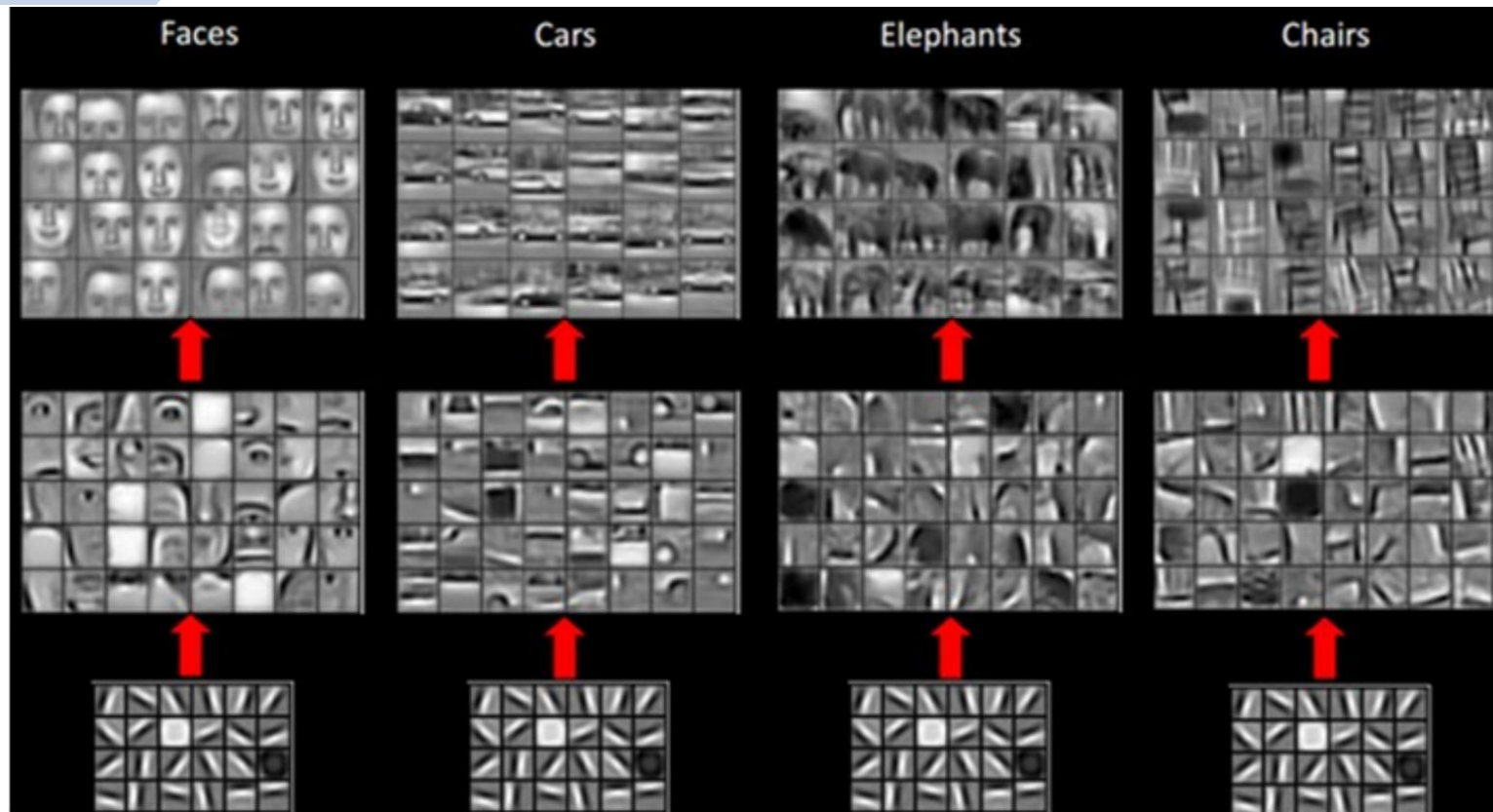
Application

- Medical pieces of advice
- Estimate the pace of spread
- Be readier



Example



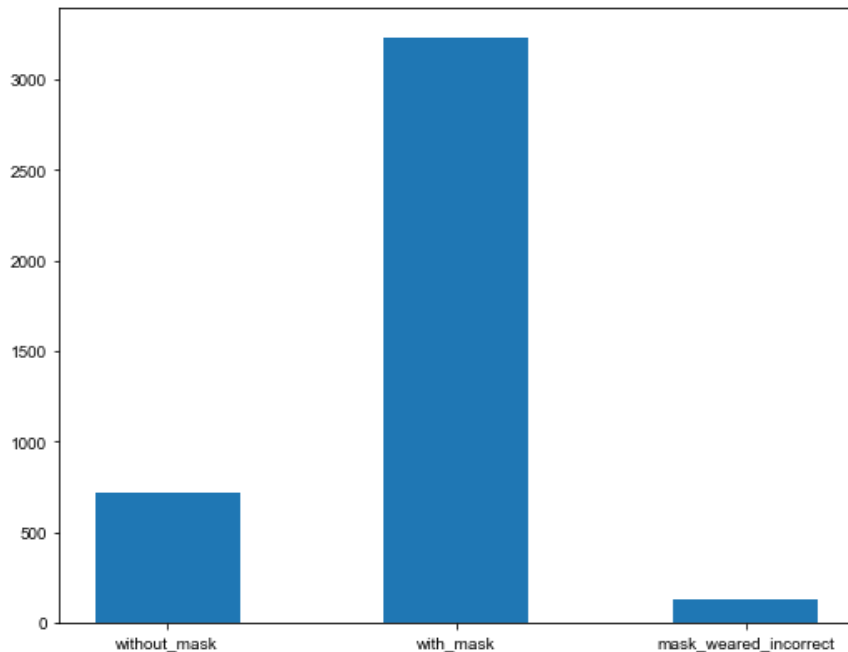
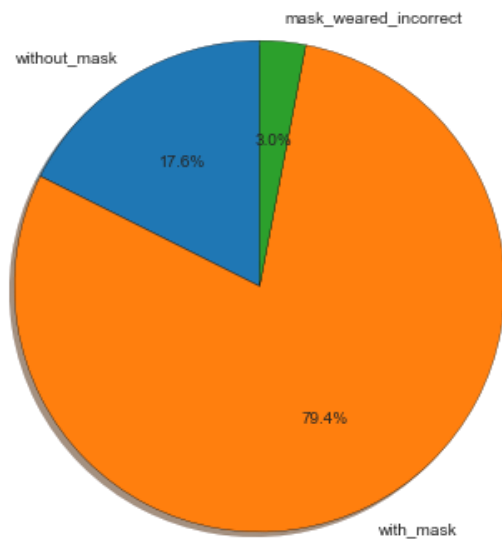


Libraries





Analysis of Data Label





Images Identification with Data Labels

Original Image



What we want



Red: without_mask

Green: with_mask

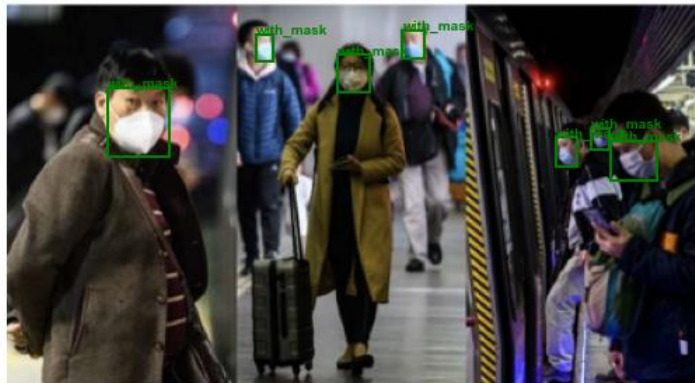
Yellow: mask_worned_incorrect



Images Identification with Data Labels

HOW TO ACHIEVE THIS?

XML files provided in “annotations”





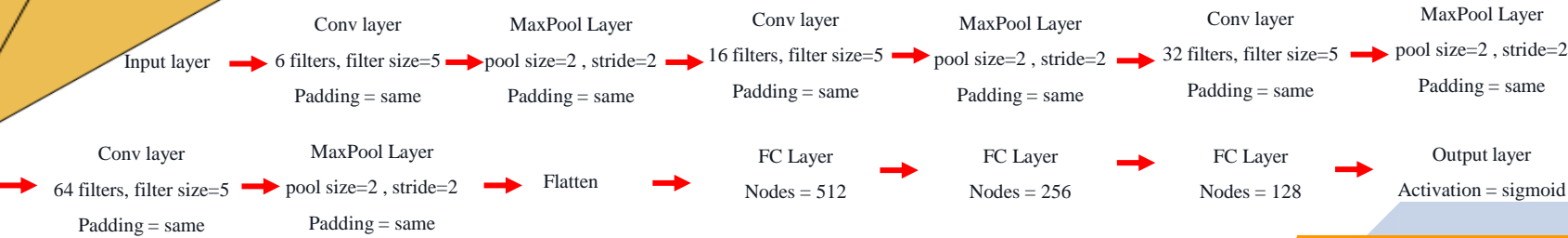
4072 images of all classes

3949 images of wear/not wear classes

Train Set: 3159

Dev Set: 395

Test Set: 394



```
99/99 [=====] - 98s 967ms/step - loss: 0.1774 - f1_score: 0.3107 - accuracy: 0.9319 -  
val_loss: 0.1805 - val_f1_score: 0.2937 - val_accuracy: 0.9316  
Epoch 2/10  
99/99 [=====] - 106s 1s/step - loss: 0.1277 - f1_score: 0.3198 - accuracy: 0.9588 -  
val_loss: 0.1273 - val_f1_score: 0.2937 - val_accuracy: 0.9468  
Epoch 3/10  
99/99 [=====] - 103s 1s/step - loss: 0.1194 - f1_score: 0.3112 - accuracy: 0.9579 -  
val_loss: 0.1082 - val_f1_score: 0.2937 - val_accuracy: 0.9544  
Epoch 4/10  
99/99 [=====] - 110s 1s/step - loss: 0.1075 - f1_score: 0.3107 - accuracy: 0.9658 -  
val_loss: 0.1035 - val_f1_score: 0.2937 - val_accuracy: 0.9595  
Epoch 5/10  
99/99 [=====] - 99s 1s/step - loss: 0.0997 - f1_score: 0.3117 - accuracy: 0.9664 -  
val_loss: 0.1081 - val_f1_score: 0.2937 - val_accuracy: 0.9595  
Epoch 6/10  
99/99 [=====] - 109s 1s/step - loss: 0.1159 - f1_score: 0.3138 - accuracy: 0.9585 -  
val_loss: 0.1239 - val_f1_score: 0.2937 - val_accuracy: 0.9468  
Epoch 6: early stopping
```

Parameters:

8,620,441

Optimizer:

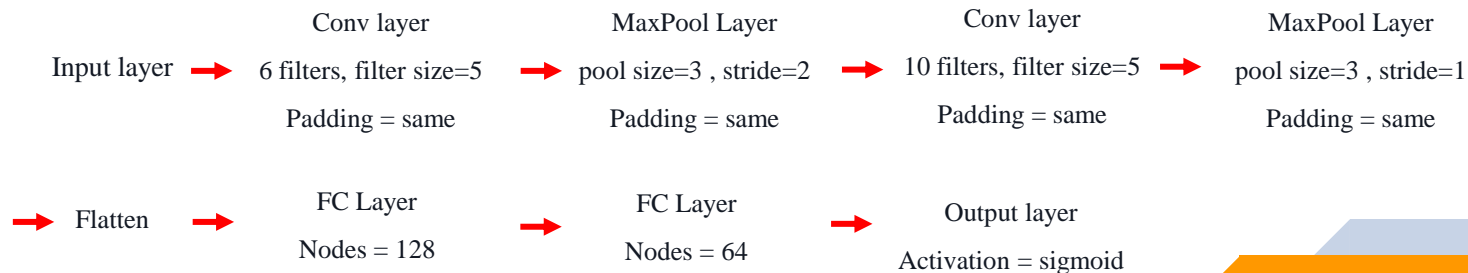
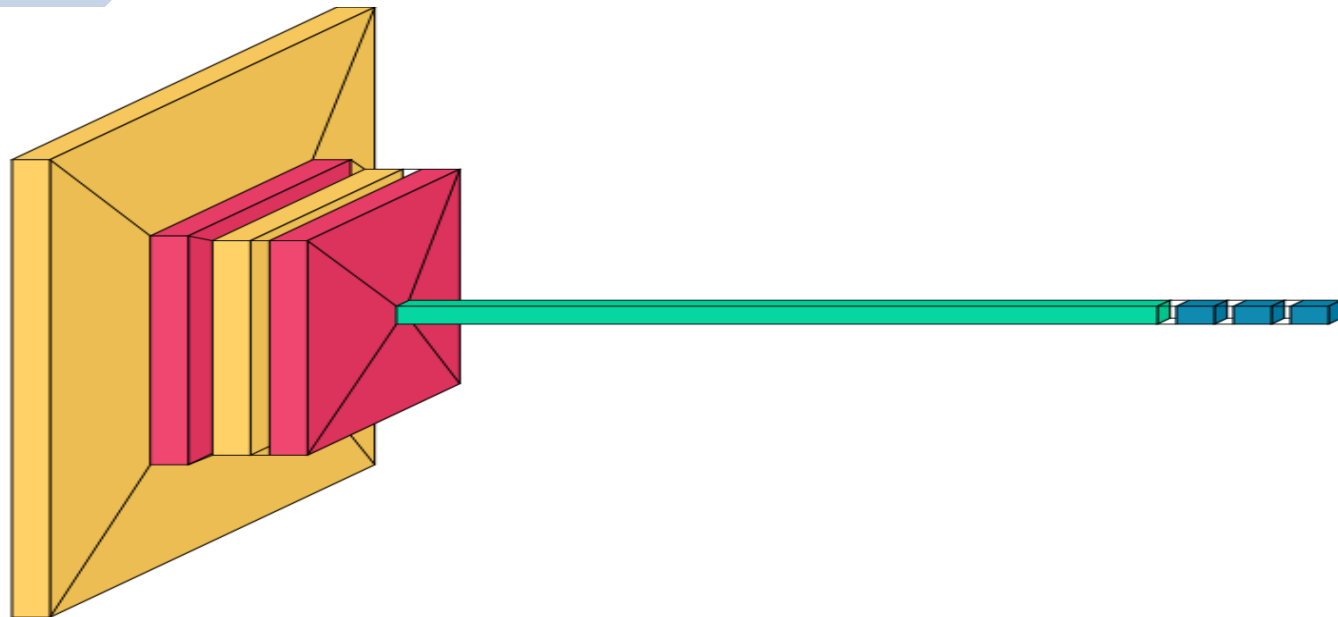
Adam

Loss Function:

Binary Cross Entropy

Type	Error
Human-level performance	0.00%
Train set	3%
Dev set	4%
Test set	2%

↑
Bias
↓



```
Epoch 1/10
99/99 [=====] - 90s 883ms/step - loss: 0.3108 - f1_score: 0.3122 - accuracy: 0.8949 -
val_loss: 0.1172 - val_f1_score: 0.2937 - val_accuracy: 0.9519
Epoch 2/10
99/99 [=====] - 91s 915ms/step - loss: 0.1008 - f1_score: 0.3141 - accuracy: 0.9677 -
val_loss: 0.1018 - val_f1_score: 0.2937 - val_accuracy: 0.9595
Epoch 3/10
99/99 [=====] - 90s 906ms/step - loss: 0.1030 - f1_score: 0.3111 - accuracy: 0.9642 -
val_loss: 0.1117 - val_f1_score: 0.2937 - val_accuracy: 0.9671
Epoch 4/10
99/99 [=====] - 94s 949ms/step - loss: 0.0725 - f1_score: 0.3120 - accuracy: 0.9750 -
val_loss: 0.1008 - val_f1_score: 0.2944 - val_accuracy: 0.9646
Epoch 5/10
99/99 [=====] - 88s 888ms/step - loss: 0.0790 - f1_score: 0.3221 - accuracy: 0.9734 -
val_loss: 0.1032 - val_f1_score: 0.2944 - val_accuracy: 0.9620
Epoch 6/10
99/99 [=====] - 94s 953ms/step - loss: 0.0678 - f1_score: 0.3230 - accuracy: 0.9788 -
val_loss: 0.1276 - val_f1_score: 0.2950 - val_accuracy: 0.9544
Epoch 6: early stopping
```

Parameters:

19,691,695

Optimizer:

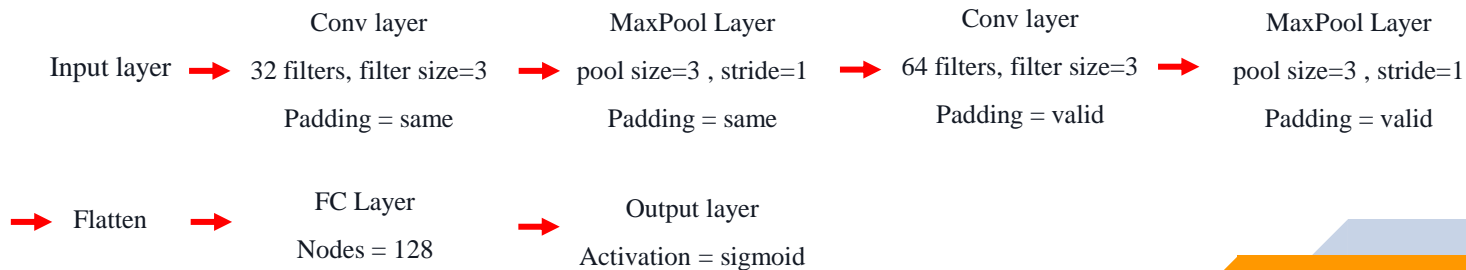
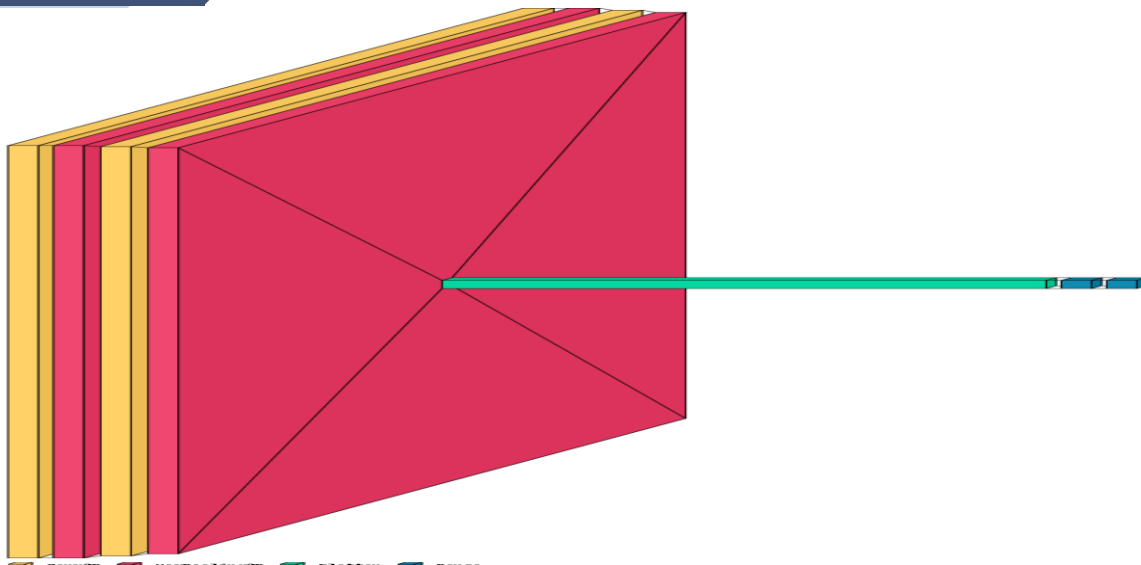
Adam

Loss Function:

Binary Cross Entropy

Type	Error
Human-level performance	0.00%
Train set	2%
Dev set	4%
Test set	3%

 Bias



```
99/99 [=====] - 2346s 24s/step - loss: 4.5316 - f1_score: 0.3920 - accuracy: 0.9240 -
val_loss: 0.1626 - val_f1_score: 0.3049 - val_accuracy: 0.9392
Epoch 2/5
99/99 [=====] - 2276s 23s/step - loss: 0.1124 - f1_score: 0.3404 - accuracy: 0.9661 -
val_loss: 0.1218 - val_f1_score: 0.3301 - val_accuracy: 0.9570
Epoch 3/5
99/99 [=====] - 2269s 23s/step - loss: 0.0961 - f1_score: 0.3474 - accuracy: 0.9715 -
val_loss: 0.1292 - val_f1_score: 0.3350 - val_accuracy: 0.9570
```

Parameters:

520,244,417

Optimizer:

Adam

Loss Function:

Binary Cross Entropy

Type	Error
Human-level performance	0.00%
Train set	3%
Dev set	4%
Test set	4%

 Bias



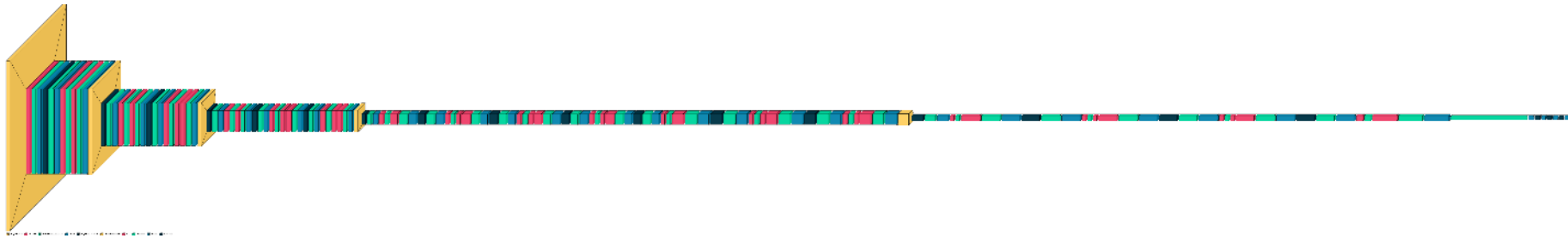
Transfer Learning

MobileNet – V2

VGG – 19

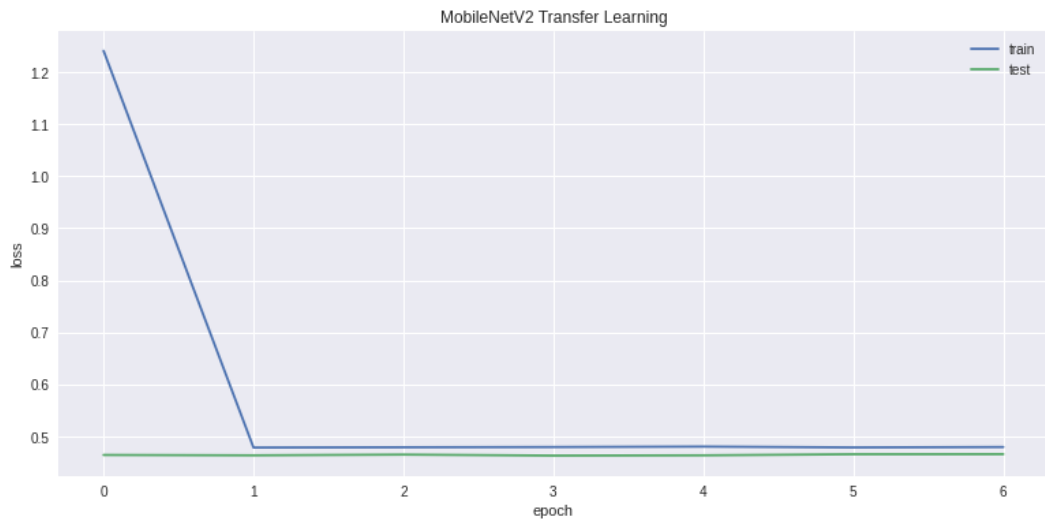
ResNet – 50

Inception – V3



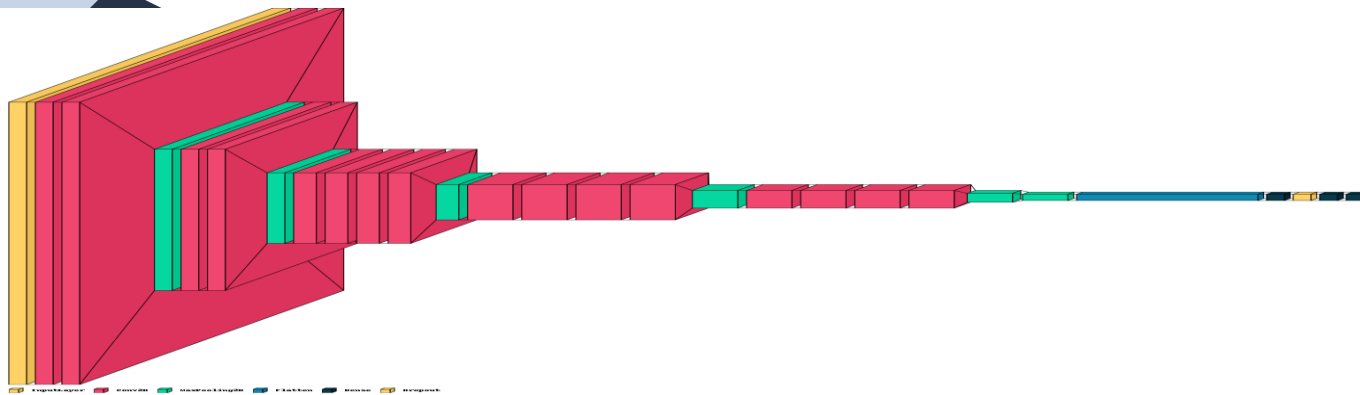
Total Parameters: 18,355,777 , **# Trainable Parameters:** 16,097,793 , **Optimizer:** Adam, **Loss Function:** Binary Cross Entropy

```
Epoch 1/50
3159/3159 [=====] - 68s 18ms/step - loss: 1.2406 - f1_score: 0.3088 - accuracy: 0.8060 - val_loss: 0.4646 - val_f1_sco
Epoch 2/50
3159/3159 [=====] - 39s 12ms/step - loss: 0.4788 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4639 - val_f1_sco
Epoch 3/50
3159/3159 [=====] - 40s 13ms/step - loss: 0.4793 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4653 - val_f1_sco
Epoch 4/50
3159/3159 [=====] - 39s 12ms/step - loss: 0.4798 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4633 - val_f1_sco
Epoch 5/50
3159/3159 [=====] - 38s 12ms/step - loss: 0.4806 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4639 - val_f1_sco
Epoch 6/50
3159/3159 [=====] - 38s 12ms/step - loss: 0.4790 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4659 - val_f1_sco
Epoch 7/50
3159/3159 [=====] - 39s 12ms/step - loss: 0.4798 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4661 - val_f1_sco
```



	precision	recall	f1-score	support
0	1.00	0.83	0.90	790
1	0.00	0.00	0.00	0
accuracy			0.83	790
macro avg	0.50	0.41	0.45	790
weighted avg	1.00	0.83	0.90	790

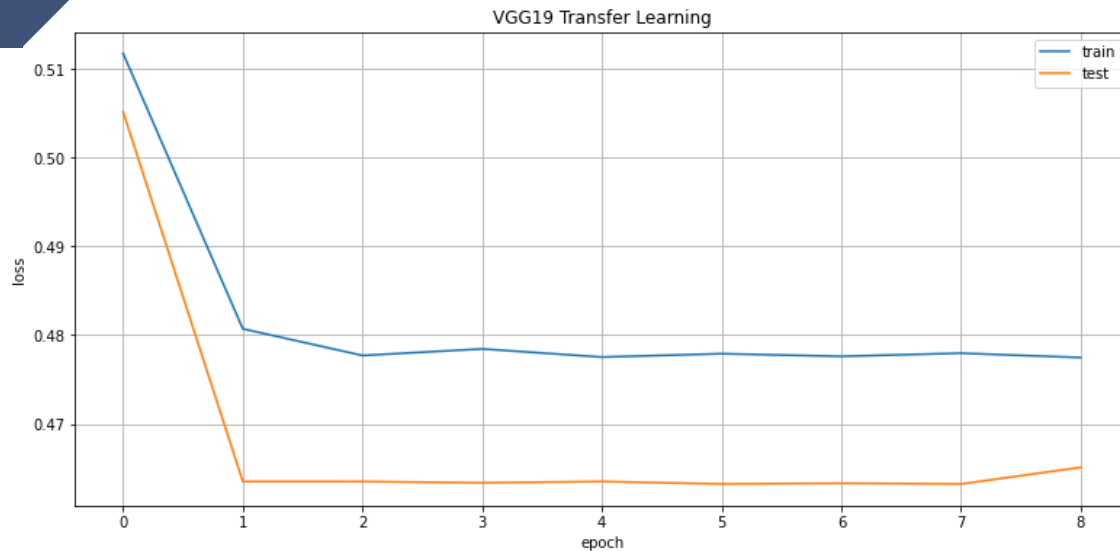
```
[[652 138]
 [ 0  0]]
```



Total Parameters: 20,294,977 , **# Trainable Parameters:** 270,593 , **Optimizer:** Adam, **Loss Function:** Binary Cross Entropy

```

Epoch 1/10
3159/3159 [=====] - 68s 18ms/step - loss: 0.5117 - f1_score: 0.3098 - accuracy:
Epoch 2/10
3159/3159 [=====] - 50s 16ms/step - loss: 0.4807 - f1_score: 0.3098 - accuracy:
Epoch 3/10
3159/3159 [=====] - 50s 16ms/step - loss: 0.4777 - f1_score: 0.3098 - accuracy:
Epoch 4/10
3159/3159 [=====] - 49s 16ms/step - loss: 0.4784 - f1_score: 0.3098 - accuracy:
Epoch 5/10
3159/3159 [=====] - 49s 16ms/step - loss: 0.4775 - f1_score: 0.3098 - accuracy:
Epoch 6/10
3159/3159 [=====] - 50s 16ms/step - loss: 0.4779 - f1_score: 0.3098 - accuracy:
Epoch 7/10
3159/3159 [=====] - 49s 16ms/step - loss: 0.4776 - f1_score: 0.3098 - accuracy:
Epoch 8/10
3159/3159 [=====] - 49s 16ms/step - loss: 0.4780 - f1_score: 0.3098 - accuracy:
Epoch 9/10
3159/3159 [=====] - 50s 16ms/step - loss: 0.4775 - f1_score: 0.3098 - accuracy:
  
```



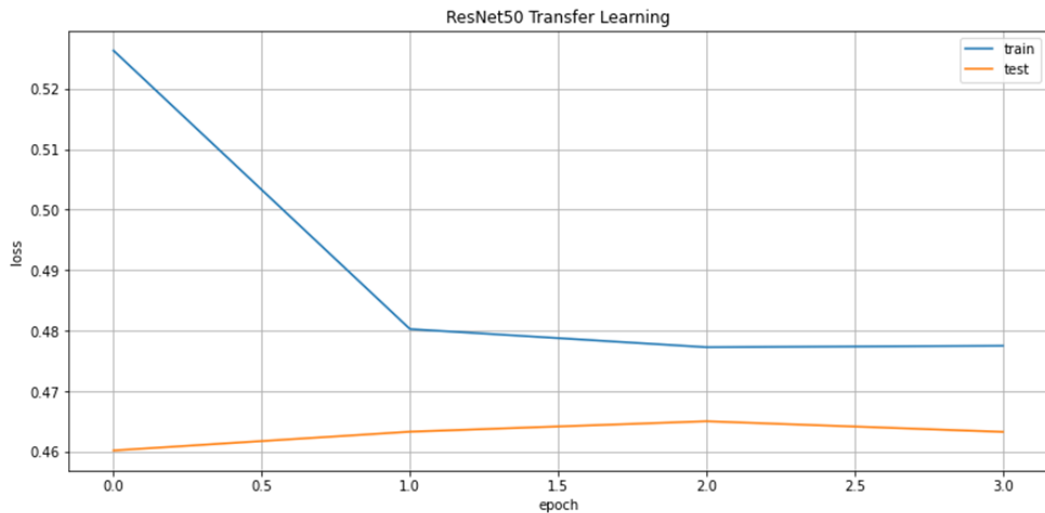
	precision	recall	f1-score	support
0	1.00	0.83	0.90	790
1	0.00	0.00	0.00	0
accuracy			0.83	790
macro avg	0.50	0.41	0.45	790
weighted avg	1.00	0.83	0.90	790

```
[[652 138]
 [ 0  0]]
```



Total Parameters: 24,644,737 , **# Trainable Parameters:** 1,057,025 , **Optimizer:** Adam, **Loss Function:** Binary Cross Entropy

```
Epoch 1/50
3159/3159 [=====] - 54s 14ms/step - loss: 0.5263 - f1_score: 0.3099 - accuracy: 0.8132 - val_loss: 0.4602 -
Epoch 2/50
3159/3159 [=====] - 41s 13ms/step - loss: 0.4803 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4633 -
Epoch 3/50
3159/3159 [=====] - 39s 12ms/step - loss: 0.4773 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4650 -
Epoch 4/50
3159/3159 [=====] - 43s 14ms/step - loss: 0.4775 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4633 -
```



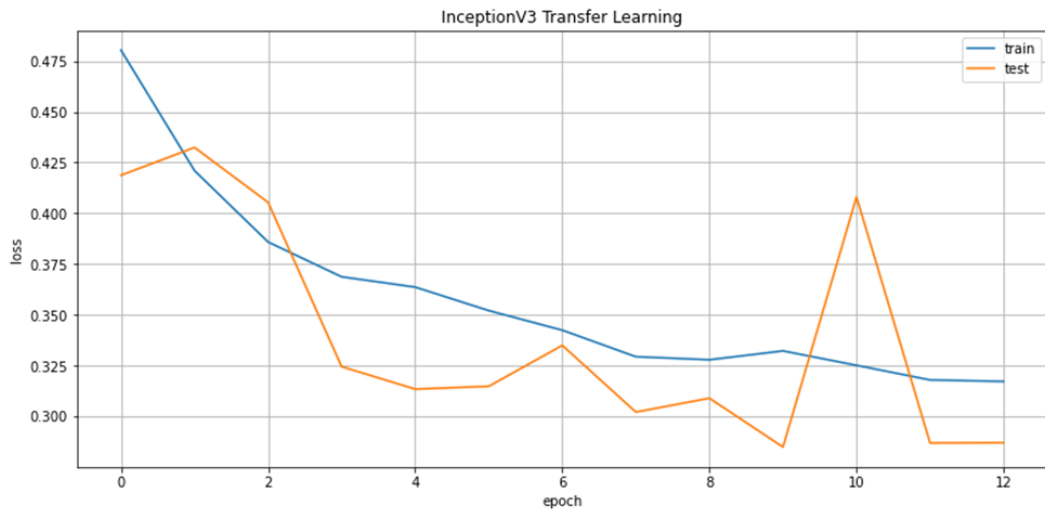
	precision	recall	f1-score	support
0	1.00	0.83	0.90	790
1	0.00	0.00	0.00	0
accuracy			0.83	790
macro avg	0.50	0.41	0.45	790
weighted avg	1.00	0.83	0.90	790

```
[[652 138]
 [ 0  0]]
```



Total Parameters: 22,073,377 , **# Trainable Parameters:** 270,593 , **Optimizer:** Adam, **Loss Function:** Binary Cross Entropy

```
Epoch 1/50
3159/3159 [=====] - 345s 108ms/step - loss: 0.4804 - f1_score: 0.3098 - accuracy: 0.8154 - val_loss: 0.4188 .
Epoch 2/50
3159/3159 [=====] - 336s 106ms/step - loss: 0.4210 - f1_score: 0.3098 - accuracy: 0.8164 - val_loss: 0.4325 .
Epoch 3/50
3159/3159 [=====] - 336s 106ms/step - loss: 0.3858 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.4054 .
Epoch 4/50
3159/3159 [=====] - 337s 107ms/step - loss: 0.3687 - f1_score: 0.3098 - accuracy: 0.8167 - val_loss: 0.3244 .
Epoch 5/50
3159/3159 [=====] - 335s 106ms/step - loss: 0.3636 - f1_score: 0.3098 - accuracy: 0.8177 - val_loss: 0.3134 .
Epoch 6/50
3159/3159 [=====] - 337s 107ms/step - loss: 0.3520 - f1_score: 0.3099 - accuracy: 0.8167 - val_loss: 0.3147 .
Epoch 7/50
3159/3159 [=====] - 339s 107ms/step - loss: 0.3424 - f1_score: 0.3100 - accuracy: 0.8135 - val_loss: 0.3349 .
Epoch 8/50
3159/3159 [=====] - 339s 107ms/step - loss: 0.3293 - f1_score: 0.3099 - accuracy: 0.8325 - val_loss: 0.3020 .
Epoch 9/50
3159/3159 [=====] - 338s 107ms/step - loss: 0.3278 - f1_score: 0.3100 - accuracy: 0.8325 - val_loss: 0.3089 .
Epoch 10/50
3159/3159 [=====] - 339s 107ms/step - loss: 0.3322 - f1_score: 0.3101 - accuracy: 0.8237 - val_loss: 0.2848 .
Epoch 11/50
3159/3159 [=====] - 339s 107ms/step - loss: 0.3251 - f1_score: 0.3104 - accuracy: 0.8310 - val_loss: 0.4081 .
Epoch 12/50
3159/3159 [=====] - 339s 107ms/step - loss: 0.3179 - f1_score: 0.3104 - accuracy: 0.8306 - val_loss: 0.2868 .
Epoch 13/50
3159/3159 [=====] - 342s 108ms/step - loss: 0.3171 - f1_score: 0.3104 - accuracy: 0.8348 - val_loss: 0.2870 .
```

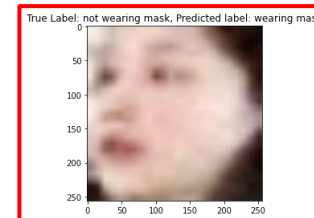
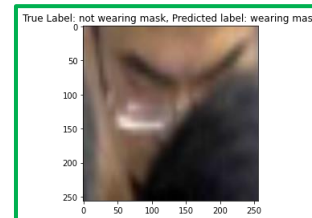
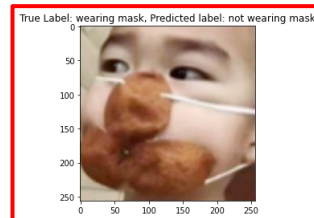
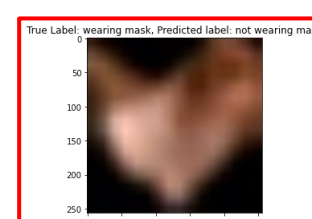
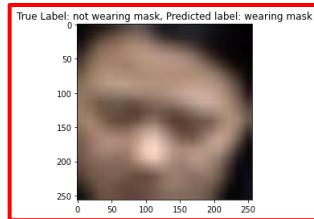
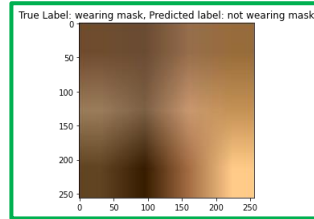
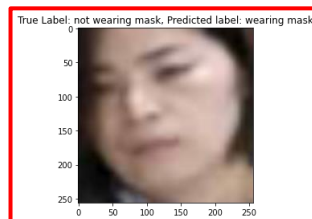
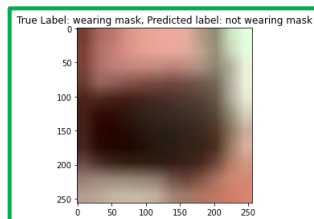
	precision	recall	f1-score	support
0	0.89	0.91	0.90	639
1	0.57	0.52	0.54	151
accuracy			0.83	790
macro avg	0.73	0.71	0.72	790
weighted avg	0.83	0.83	0.83	790

```
[[579 60]
 [ 73 78]]
```



Misclassified Images

	image_path	image_label	prediction
2924	363. 0.png	0	1
3851	80. 1.png	1	0
1069	1960. 1.png	1	0
879	179. 1.png	1	0
798	1716. 1.png	1	0
1068	196. 0.png	0	1
2732	3457. 0.png	0	1
789	1708. 1.png	1	0
3740	70. 1.png	1	0
1127	2011. 0.png	0	1
2058	2850. 0.png	0	1
2506	3253. 1.png	1	0
3739	7. 0.png	0	1





Thanks
Any Questions?