Annexure

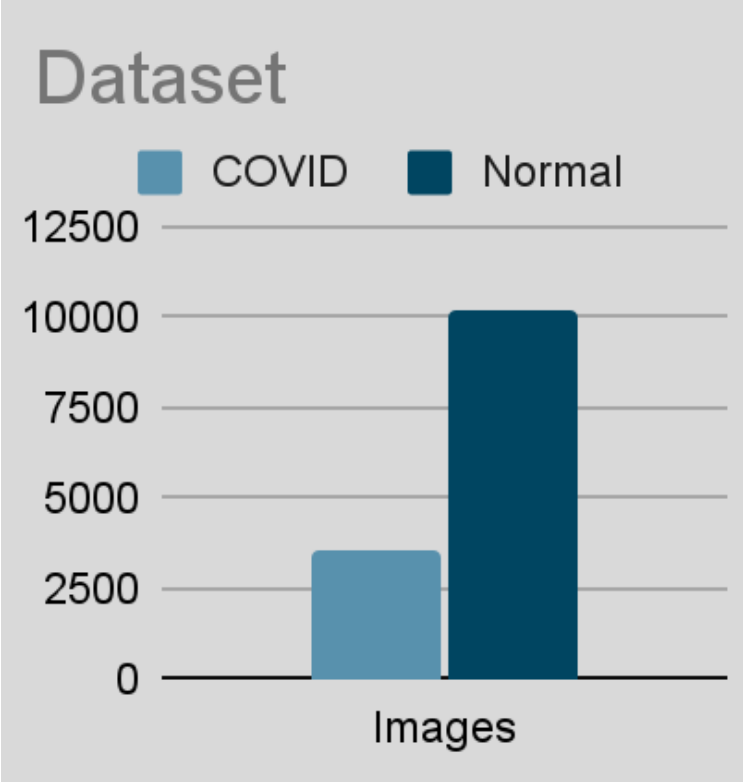

Figure 1. Dataset - Class distribution

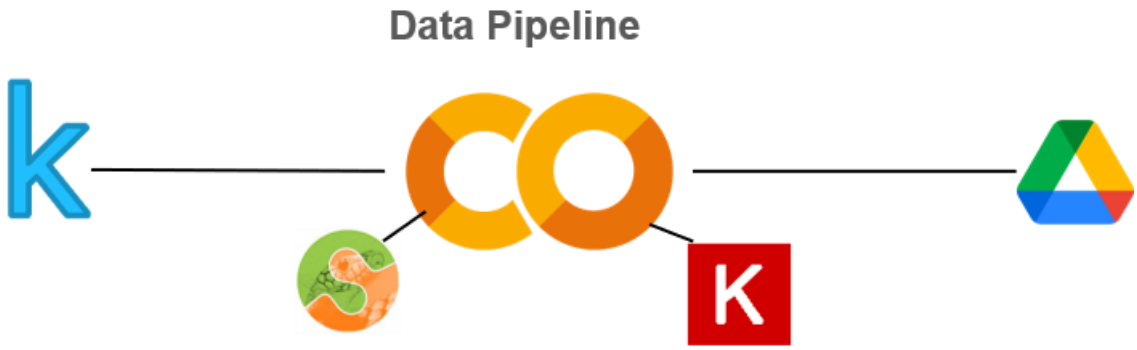

Figure 2. Data pipeline

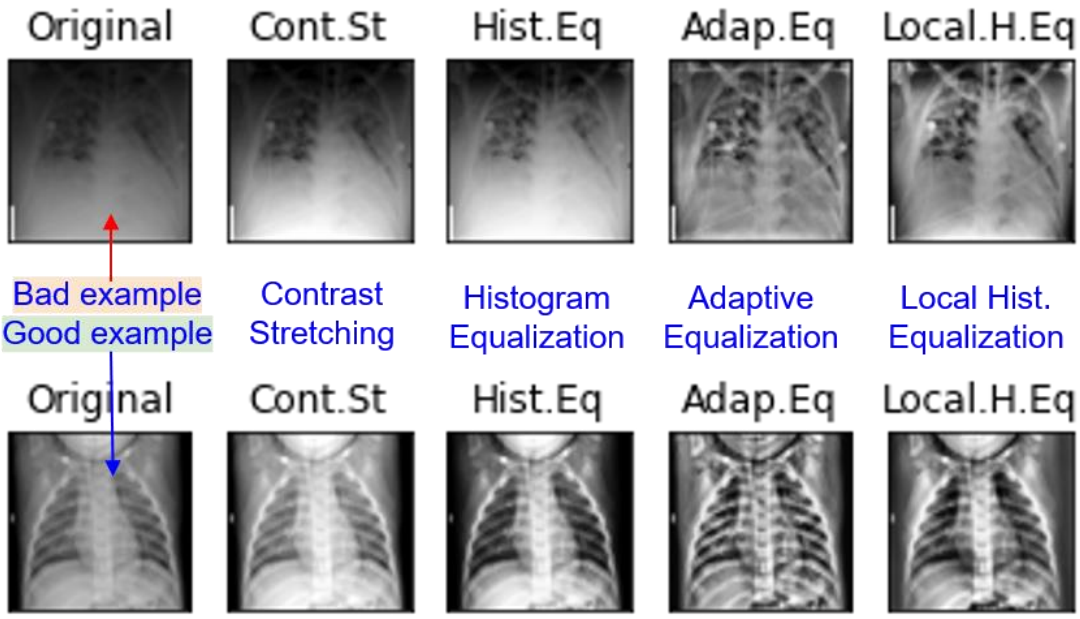

Figure 3. Image pre-processing using scikit-image

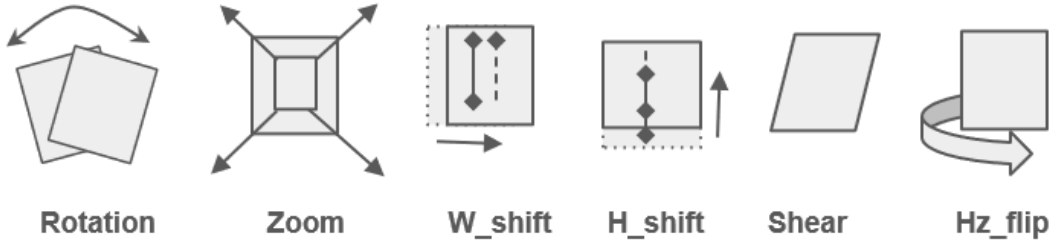

Figure 4. Data Augmentation using Keras image data generator

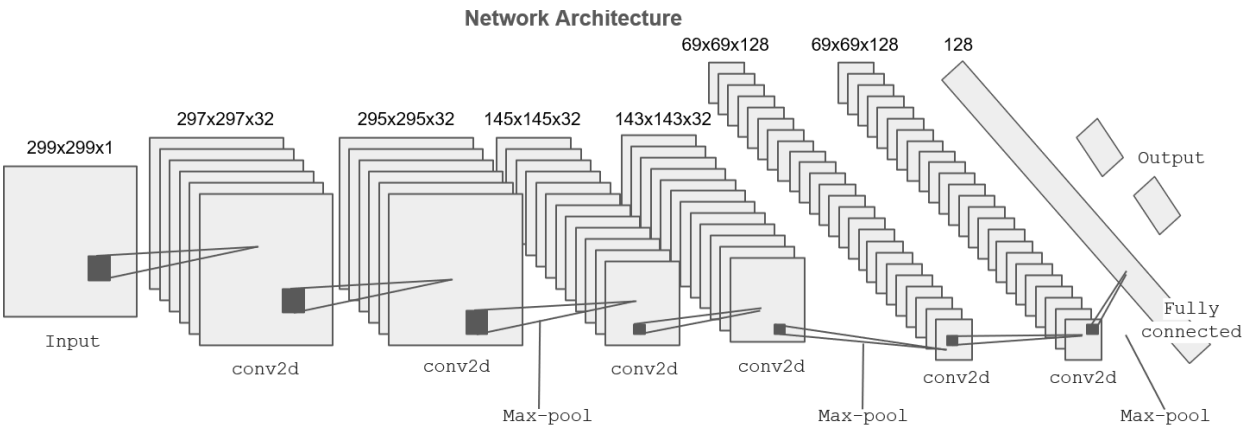

Figure 5. CNN Architecture

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 297, 297, 32)	320
conv2d_1 (Conv2D)	(None, 295, 295, 32)	9248
batch_normalization (BatchNo	(None, 295, 295, 32)	128
max_pooling2d (MaxPooling2D)	(None, 147, 147, 32)	0
conv2d_2 (Conv2D)	(None, 145, 145, 64)	18496
conv2d_3 (Conv2D)	(None, 143, 143, 64)	36928
batch_normalization_1 (Batch	(None, 143, 143, 64)	256
max_pooling2d_1 (MaxPooling2	(None, 71, 71, 64)	0
conv2d_4 (Conv2D)	(None, 69, 69, 128)	73856
conv2d_5 (Conv2D)	(None, 67, 67, 128)	147584
batch_normalization_2 (Batch	(None, 67, 67, 128)	512
max_pooling2d_2 (MaxPooling2	(None, 33, 33, 128)	0
flatten (Flatten)	(None, 139392)	0
dense (Dense)	(None, 128)	17842304
dense_1 (Dense)	(None, 2)	258

Total params: 18,129,890

Figure 6. CNN model summary

```
Epoch 37/100
9/9 - 61s - loss: 0.6260 - accuracy: 0.7465 - val_loss: 0.5180 - val_accuracy: 0.7891
Epoch 38/100
9/9 - 53s - loss: 0.5824 - accuracy: 0.7326 - val_loss: 0.5426 - val_accuracy: 0.7656
Epoch 39/100
9/9 - 60s - loss: 0.6080 - accuracy: 0.7083 - val_loss: 0.5955 - val_accuracy: 0.7188
Epoch 40/100
9/9 - 52s - loss: 0.5519 - accuracy: 0.7604 - val_loss: 0.5871 - val_accuracy: 0.7266
Epoch 41/100
9/9 - 46s - loss: 0.5804 - accuracy: 0.7361 - val_loss: 0.5879 - val_accuracy: 0.7266
Epoch 42/100
9/9 - 49s - loss: 0.5450 - accuracy: 0.7674 - val_loss: 0.6834 - val_accuracy: 0.7266
Epoch 43/100
9/9 - 47s - loss: 0.5663 - accuracy: 0.7465 - val_loss: 0.5348 - val_accuracy: 0.7734
Epoch 44/100
9/9 - 42s - loss: 0.5912 - accuracy: 0.7222 - val_loss: 0.7126 - val_accuracy: 0.7031
Epoch 45/100
9/9 - 48s - loss: 0.5919 - accuracy: 0.7222 - val_loss: 0.5789 - val_accuracy: 0.7344
Epoch 46/100
9/9 - 47s - loss: 0.5429 - accuracy: 0.7674 - val_loss: 0.5714 - val_accuracy: 0.7422
Epoch 47/100
9/9 - 41s - loss: 0.5504 - accuracy: 0.7604 - val_loss: 0.5874 - val_accuracy: 0.7266
```

Figure 7. Training log – Early Stopping

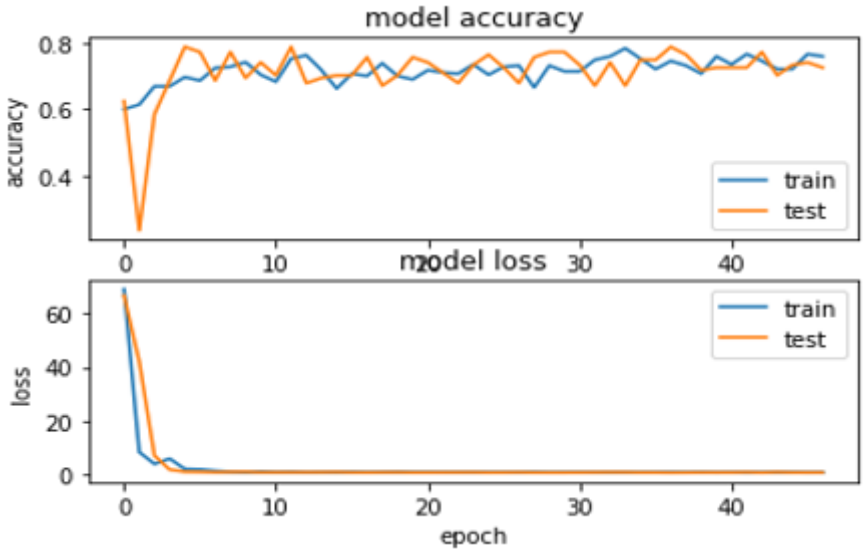

Figure 8. Training - Model learning curve

```
Model: "functional_5"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_4 (InputLayer)         [(None, 224, 224, 3)]     0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 224, 224, 64)      1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 224, 224, 64)      36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 112, 112, 64)      0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 112, 112, 128)     73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 112, 112, 128)     147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 56, 56, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 56, 56, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_conv4 (Conv2D)        (None, 56, 56, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 28, 28, 256)       0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 28, 28, 512)       1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_conv4 (Conv2D)        (None, 28, 28, 512)       2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 14, 14, 512)       0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_conv4 (Conv2D)        (None, 14, 14, 512)       2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 7, 7, 512)         0
_________________________________________________________________
global_max_pooling2d_3 (Glob (None, 512)               0
_________________________________________________________________
flatten_2 (Flatten)          (None, 512)               0
=================================================================
Total params: 20,024,384
Trainable params: 0
Non-trainable params: 20,024,384
_________________________________________________________________
```

Figure 9. Reference model - Summary of VGG19 used in the background

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
model (Functional)           (None, 512)               20024384
_________________________________________________________________
dense (Dense)                (None, 128)               65664
_________________________________________________________________
dense_1 (Dense)              (None, 2)                 258
=================================================================
Total params: 20,090,306
Trainable params: 65,922
Non-trainable params: 20,024,384
_________________________________________________________________
```

Figure 10. Reference Model - Summary with untrainable VGG19

```
Epoch 28/100
9/9 - 136s - loss: 0.3944 - accuracy: 0.8647 - val_loss: 0.2355 - val_accuracy: 0.8984
Epoch 29/100
9/9 - 131s - loss: 0.3224 - accuracy: 0.8889 - val_loss: 0.2830 - val_accuracy: 0.8594
Epoch 30/100
9/9 - 137s - loss: 0.3216 - accuracy: 0.8576 - val_loss: 0.3658 - val_accuracy: 0.8594
Epoch 31/100
9/9 - 119s - loss: 0.4742 - accuracy: 0.8125 - val_loss: 0.2673 - val_accuracy: 0.8828
Epoch 32/100
9/9 - 117s - loss: 0.3636 - accuracy: 0.8576 - val_loss: 0.3485 - val_accuracy: 0.8750
Epoch 33/100
9/9 - 125s - loss: 0.3489 - accuracy: 0.8472 - val_loss: 0.4496 - val_accuracy: 0.8125
Epoch 34/100
9/9 - 110s - loss: 0.3378 - accuracy: 0.8472 - val_loss: 0.2952 - val_accuracy: 0.9141
Epoch 35/100
9/9 - 116s - loss: 0.3548 - accuracy: 0.8368 - val_loss: 0.3977 - val_accuracy: 0.8828
Epoch 36/100
9/9 - 119s - loss: 0.3742 - accuracy: 0.8368 - val_loss: 0.3220 - val_accuracy: 0.8828
Epoch 37/100
9/9 - 108s - loss: 0.3331 - accuracy: 0.8542 - val_loss: 0.2928 - val_accuracy: 0.8594
Epoch 38/100
9/9 - 101s - loss: 0.4664 - accuracy: 0.7744 - val_loss: 0.3407 - val_accuracy: 0.8750
```

Figure 11. Reference Model - Training log

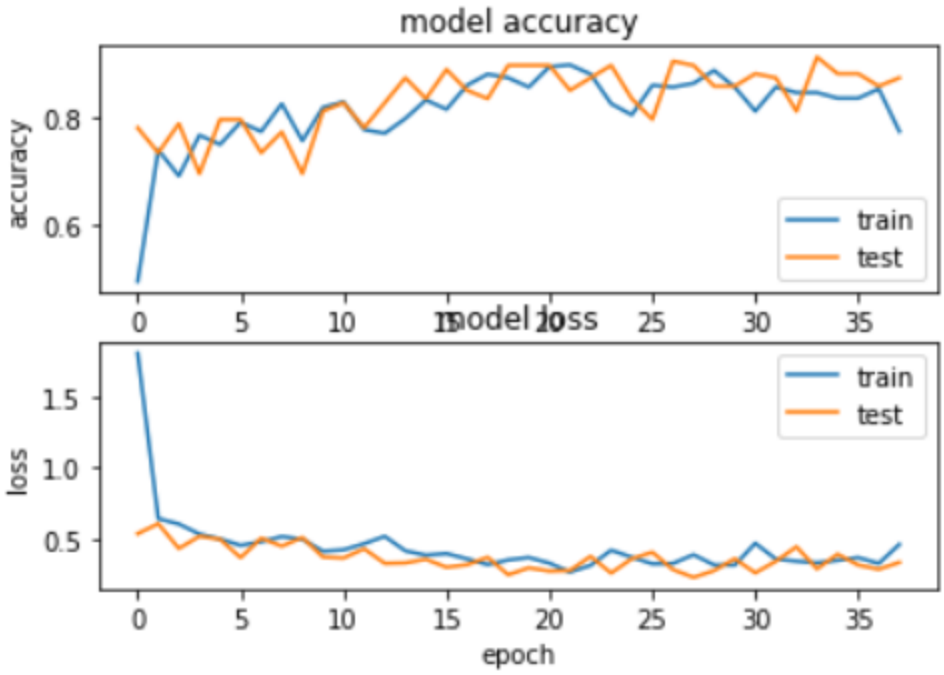

Figure 12. Reference Model - Learning curve