Utilizing Convolutional Neural Networks (CNN) and Transfer Learning for Pneumonia Detection using Chest X-ray Images

Problem Overview:

- Pneumonia is one of the potential life-threatening illnesses and the primary diagnosis can be done by the help of X-ray images.
- Mostly interpreting these X-Rays accurately can be challenging and time consuming and considering the Covid - 19 pandemic has shown the importance of diagnosis on prior and early basis.
- CNN can automatically learn the features from X-Ray images and then accurately classify these images based on the content.
- Transfer learning uses the pre-trained CNN model for training on new task.
- This will be the faster and accurate method for training of such small datasets.

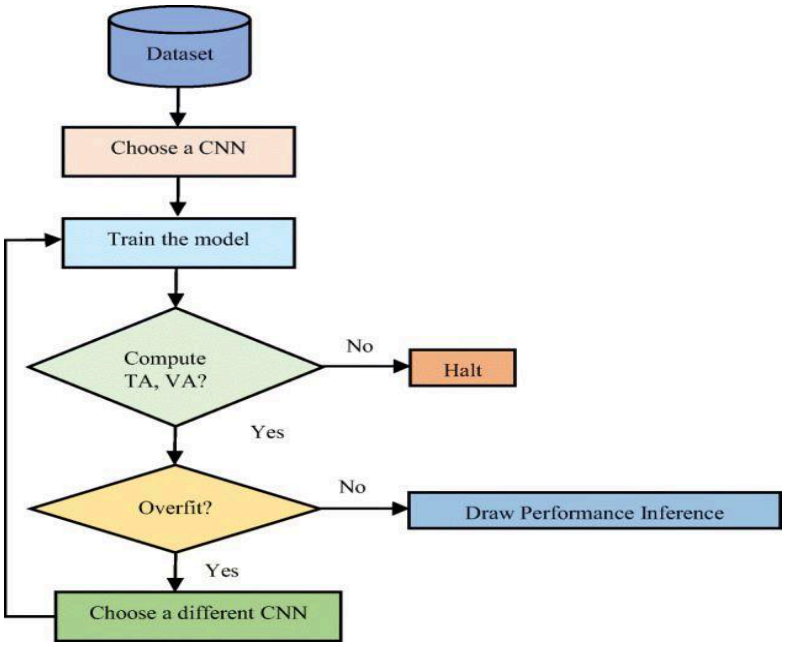
Motivation:

- Our primary goal from this project is to use the CNN (Convolutional Neural Networks) on chest X-Ray images to determine the samples which are positive and negative with pneumonia.
- We have used the CNN and transfer learning methods because these will help us in increasing the accuracy and efficiency of pneumonia diagnosis.
- About 1 million adults in the US seek care in a hospital due to pneumonia every year, and 50,000 die from this disease.
- This has the potential to reduce workload on clinicians. So that they can focus on more complex cases and help in improving healthcare delivery.

Architecture:

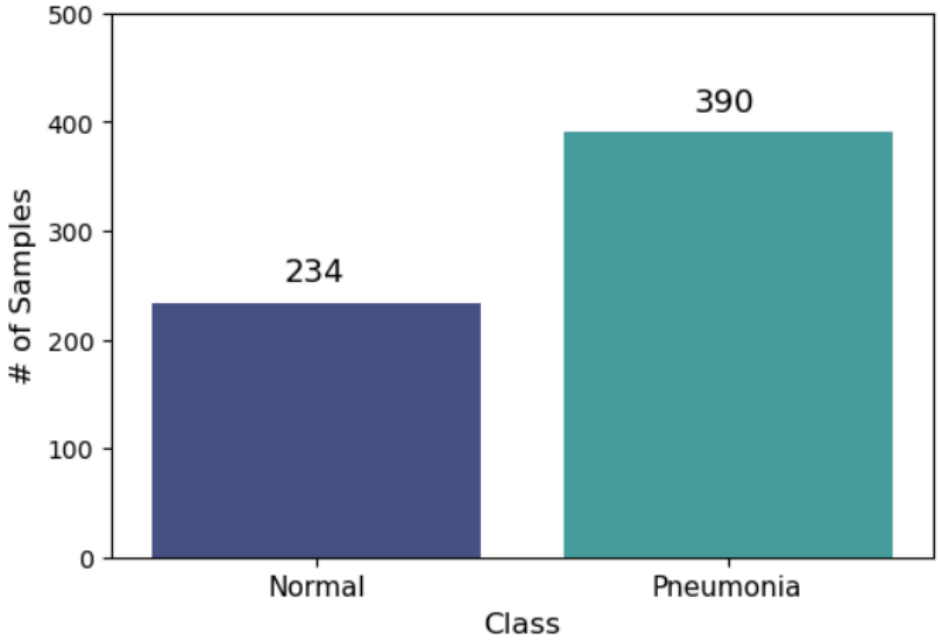
First, we will upload the dataset and define a convolution neural network with the following blocks as

- Batch Normalization: To stabilize and accelerate the training process.
- Activation Function: ReLU (Rectified Linear Unit) is commonly used for hidden layers.
- Max-pooling: To reduce spatial dimensions and extract essential features.

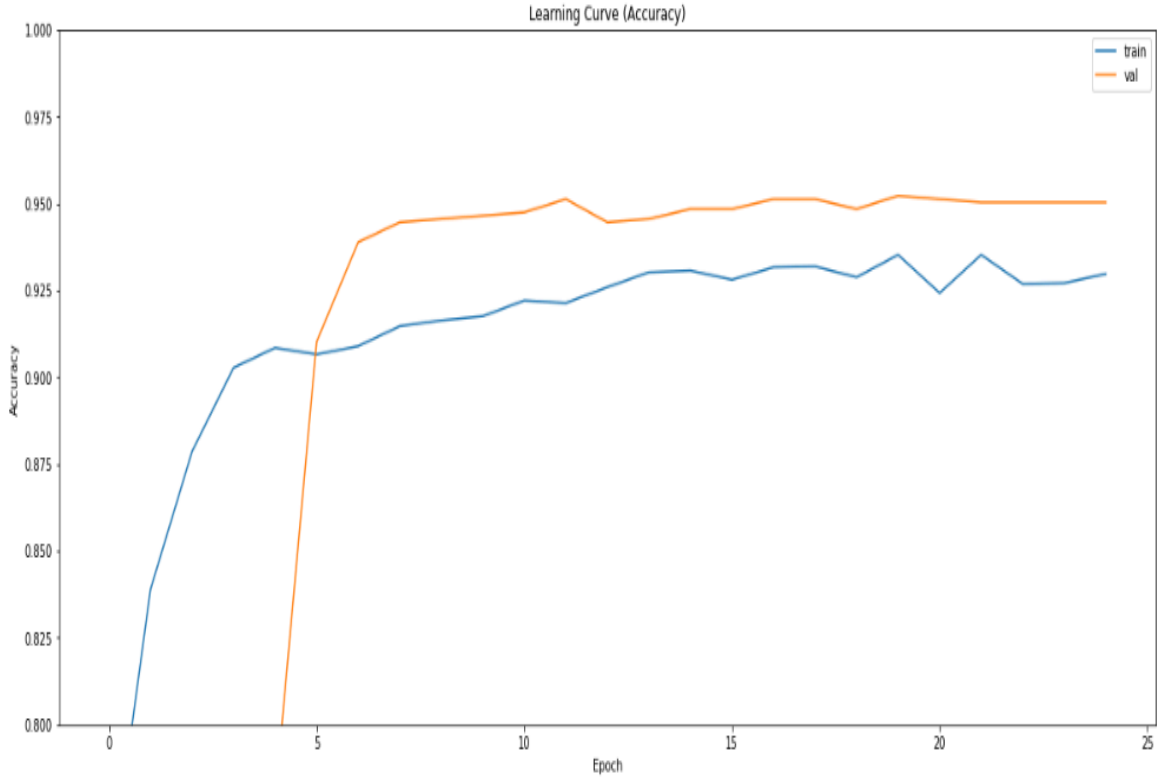


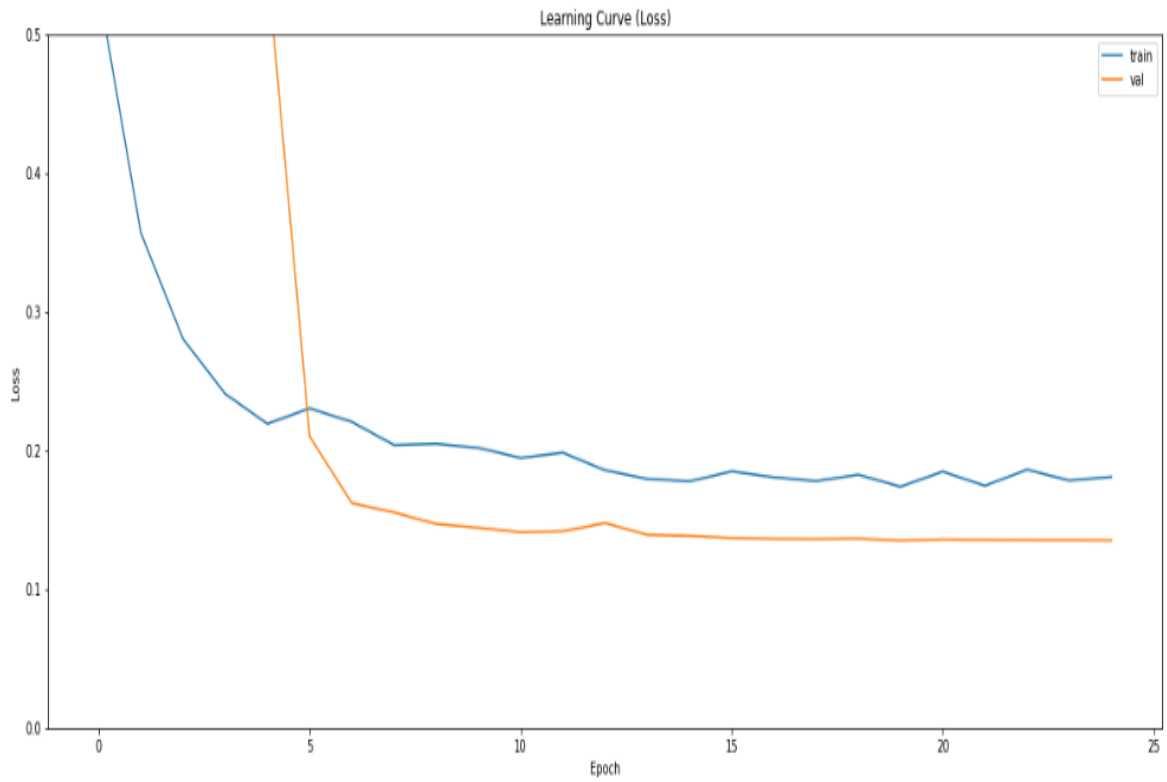
Challenges:

Challenges that were encountered during the development of model were:
a. Data Imbalance.
b. Pre - processing.
c. complexity of model.
d. Transfer learning.


500
400
300
200
100
0
# of Samples
390
234
Normal
Pneumonia
Class

Results:


Learning Curve (Accuracy)
train
val
1.000
0.975
0.950
0.925
0.900
0.875
0.850
0.825
0.800
Accuracy
0
5
10
15
20
25
Epoch



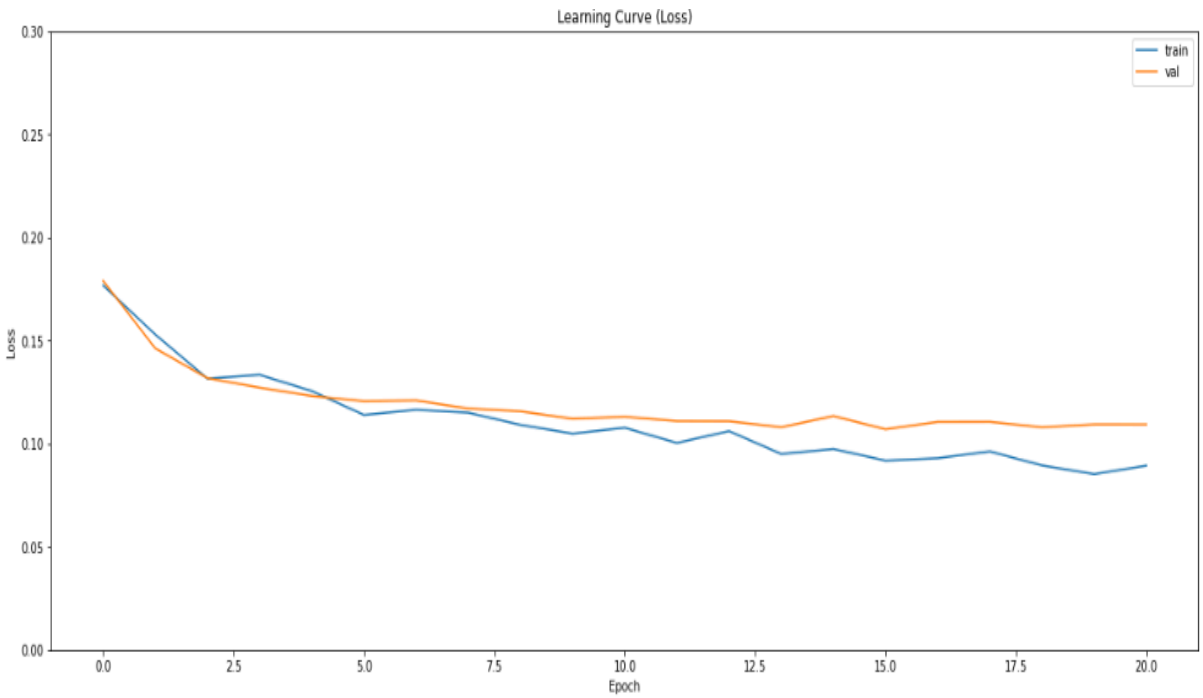

```
score = model.evaluate(ds_val, steps = len(val_df)/BATCH, verbose = 0)
print('Val loss:', score[0])
print('Val accuracy:', score[1])
```

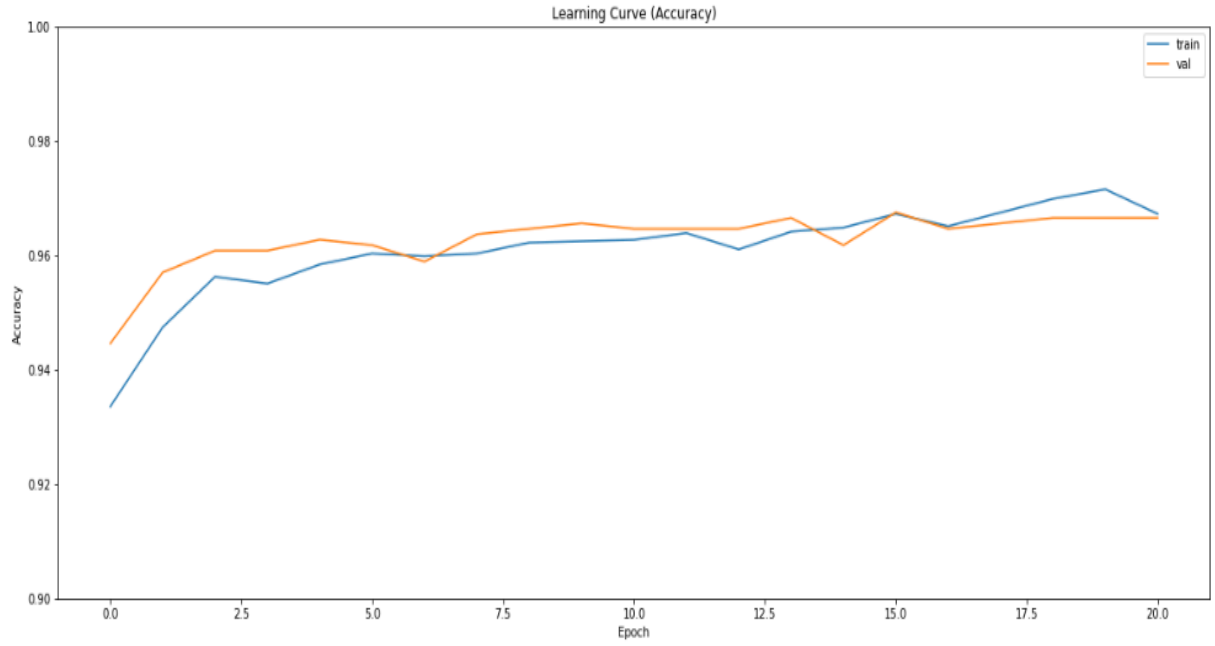
```
Val loss: 0.1349286437034607
Val accuracy: 0.9522445201873779
```

```
score = model.evaluate(ds_test, steps = len(df_test), verbose = 0)

print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Test loss: 0.4296790361404419
Test accuracy: 0.8493589758872986
```


Learning Curve (Loss)
train
val
Loss
Epoch
0.30
0.25
0.20
0.15
0.10
0.05
0.00
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0


Learning Curve (Accuracy)
train
val
Accuracy
Epoch
1.00
0.98
0.96
0.94
0.92
0.90
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0

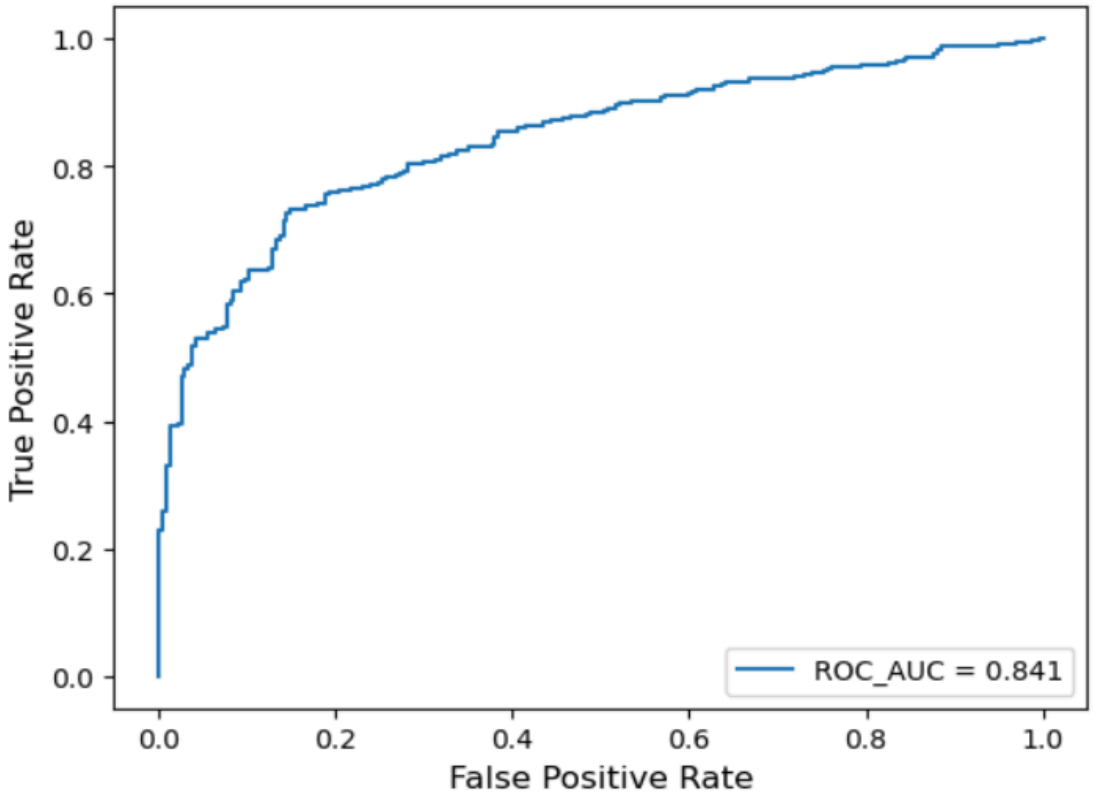
```
score = model_pretrained.evaluate(ds_val, steps = len(val_df)/BATCH, verbose = 0)
print('Val loss:', score[0])
print('Val accuracy:', score[1])
```

```
Val loss: 0.10701081901788712
Val accuracy: 0.9675262570381165
```

```
score = model_pretrained.evaluate(ds_test, steps = len(df_test), verbose = 0)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
Test loss: 0.21019524335861206
Test accuracy: 0.9198718070983887
```

```
ROC_AUC:  0.8406421214113522
```



Conclusion:

- Can provide highly effective and efficient results in early diagnosis for pneumonia.
- With this we are trying to provide an aid to clinician and to smoothen the process of diagnosis.

References:

- https://vijayabhaskar96.medium.com/tutorial-on-keras-flow-from-dataframe-1fd4493d237c
- https://github.com/mrdbourke/tensorflow-deep-learning/blob/main/03_convolutional_neural_networks_in_tensorflow.ipynb
- https://www.tensorflow.org/guide/keras/transfer_learning
- https://www.tensorflow.org/api_docs/python/tf/keras/preprocessing/image/ImageDataGenerator
- https://www.kaggle.com/code/jonaspalucibarbosa/chest-x-ray-pneumonia-cnn-transfer-learning/notebook

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