INFO 6105 FINAL PROJECT

X-RAY PNEUMONIA PREDICTION MODEL

REPORT

TEAM 17

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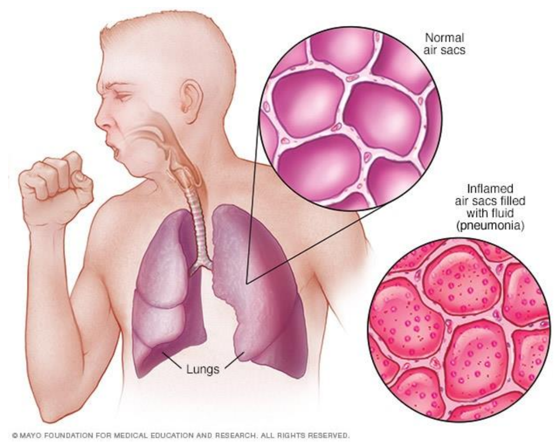
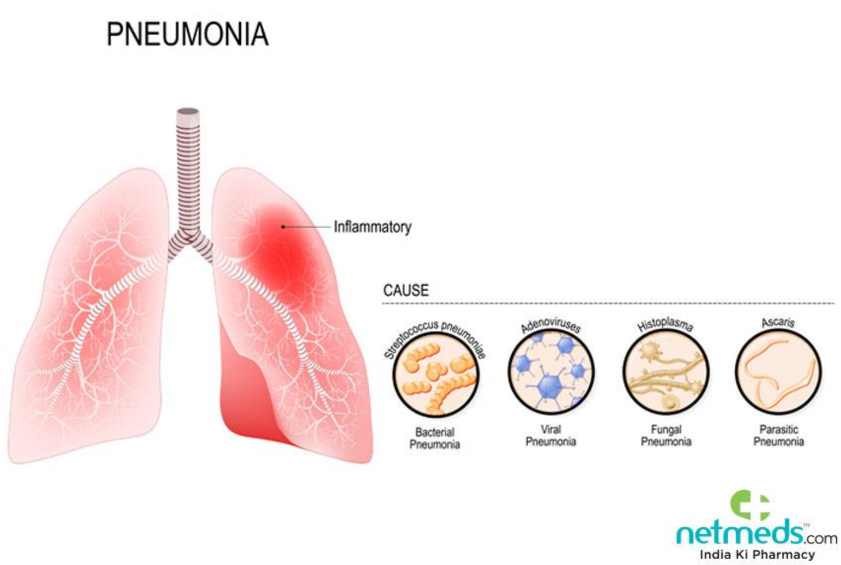
BACKGROUND

Pneumonia is an infection that inflames the air sacs in one or both lungs. The air sacs may fill with fluid or pus (purulent material), causing cough with phlegm or pus, fever, chills, and difficulty breathing. A variety of organisms, including bacteria, viruses and fungi, can cause pneumonia.

Pneumonia can range in seriousness from mild to life-threatening. It is most serious for infants and young children, people older than age 65, and people with health problems or weakened immune systems.

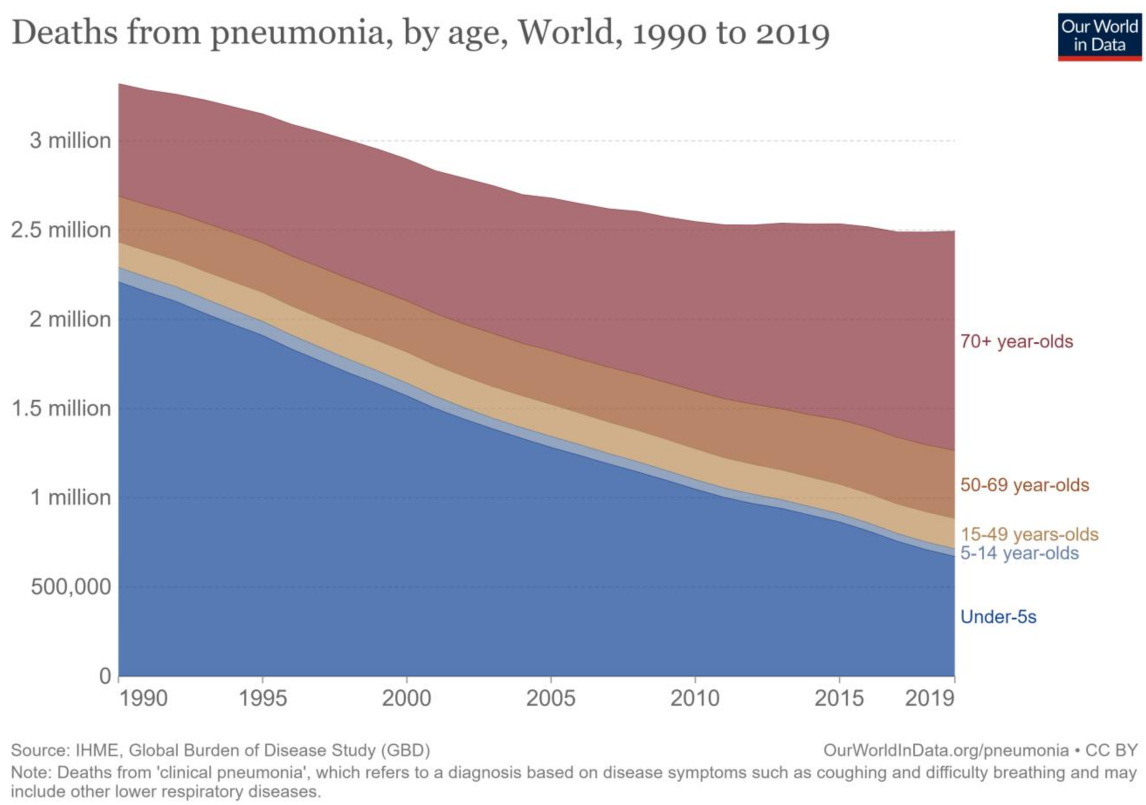




Who is at risk for pneumonia?

Anyone can get pneumonia. However, the following groups are at the highest risk:

- Adults ages 65 and older
- Children younger than age 2
- People with certain medical conditions
- People that smoke



PROBLEM STATEMENT

- To recognize the X-Ray Image and categorize/predict into a Normal Condition X-Ray Image or a Potential Pneumonia Condition X-Ray Image to reduce the spreading of infamous Pneumonia disease, especially in the times of COVID-19. All chest X-ray imaging during data gathering was performed as part of patients' routine clinical care. For the analysis of chest x-ray images, all chest radiographs were initially screened for quality control by removing all low quality or unreadable scans.

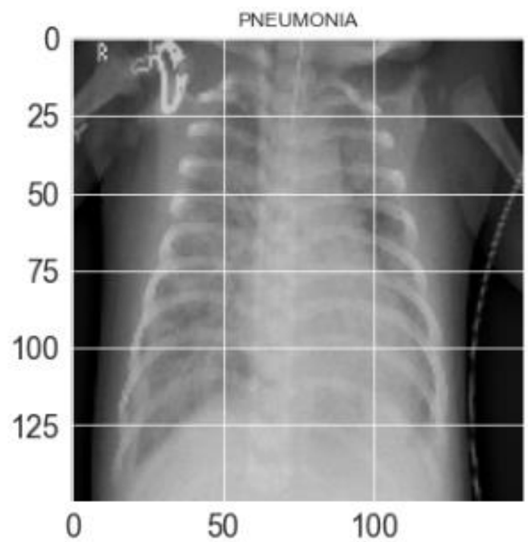
- Less dataset images available but to predict highest accuracy using Data Augmentation technique for Image Processing using Convolutional Neural Network Model.

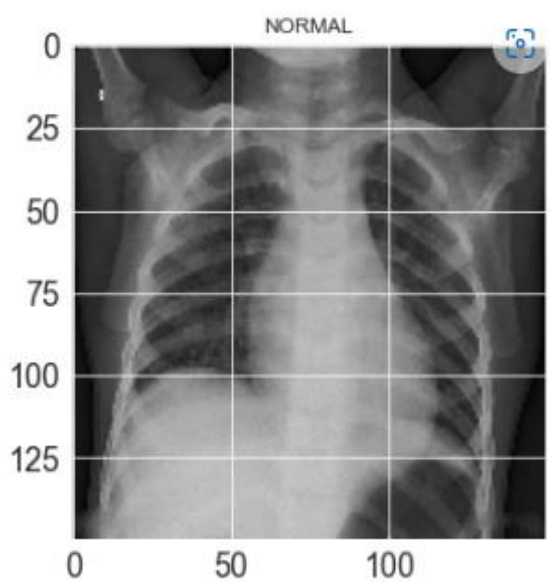
DATASET SOURCE

- The dataset is organized into 3 folders (train, test, valid) and contains subfolders for each image category (Pneumonia/Normal).
- There are **5,863** X-Ray images (JPEG) and 2 categories (**Pneumonia/Normal**). Chest X-ray images (anterior-posterior) were selected from retrospective cohorts of pediatric patients of one to five years old from **Guangzhou Women and Children's Medical Center**, Guangzhou.
- The diagnoses for the images were then graded by two expert physicians before being cleared for training the AI system. In order to

account for any grading errors, the evaluation set was also checked by a third expert

Link to Mendeley Data : https://data.mendeley.com/datasets/rscbjbr9sj/2





Here you can see the Pneumonia X-Ray Image to some extent Opaque, with human eye, as compare to Normal X-Ray Image which is one of the significant characteristics to differentiate among two classification.

ALGORITHM USED

1. **Creating Function to get training data**
   Iterating all the images to convert into image array using cv2 package, resizing the image size(considered 150), and storing into the data list with indexes.

2. **Grayscale Normalization to train, valid, and test image array.**
   Dividing the train, valid, and test data by maximum value of pixel that is 255 to normalize the data.

3. **Resizing the image data for deep learning.**
   For the data to get train in Convolutional Neural Network, we need to reshape the train, valid, and test data list to numpy array.

4. **Data Augmentation**

In order to avoid overfitting problem, we need to expand artificially our dataset. Approaches that alter the training data in ways that change the array representation while keeping the label the same are known as data augmentation techniques.(Using ImageDataGenerator)

5. **Training the model with Conv2D(CNN).**

- Using sequential model from Keras package, adding 5 Conv2D layer using 3*3 Window size having Strides as 1 and keeping padding “same” for adding & keeping filters in input and output same.
- Along with adding layers I have added Batch Normalization for Regularization and using Max pooling of strides 2(jumping by 2 steps).

- Flattening to change the dimension to 1D array for connected dense layer.
- A Dense layer of 128 units.
- Used Sigmoid Function for final output layer to classify as Pnuemonia or Normal X-Ray Image.
- Here I have used RMSprop instead of ADAM which is most commonly used. But I tested and observed RMSProp is giving less overfitting and minimum loss function with minimum value of cost function.

Normal Weight Updation Formula in

$W\ t = W_{t-1} - \eta\ dL/dw_{t-1}$

For Momentum

$Vdw_t = ß * Vdw_{t-1} + (1-ß) * dL/dw_{t-1}$

$Vdb_t = ß * Vdb_{t-1} + (1-ß) * dL/db_{t-1}$

For RMSProp Advantages

$\eta'_t = \eta \ / \sqrt{Sdw + \varepsilon}$

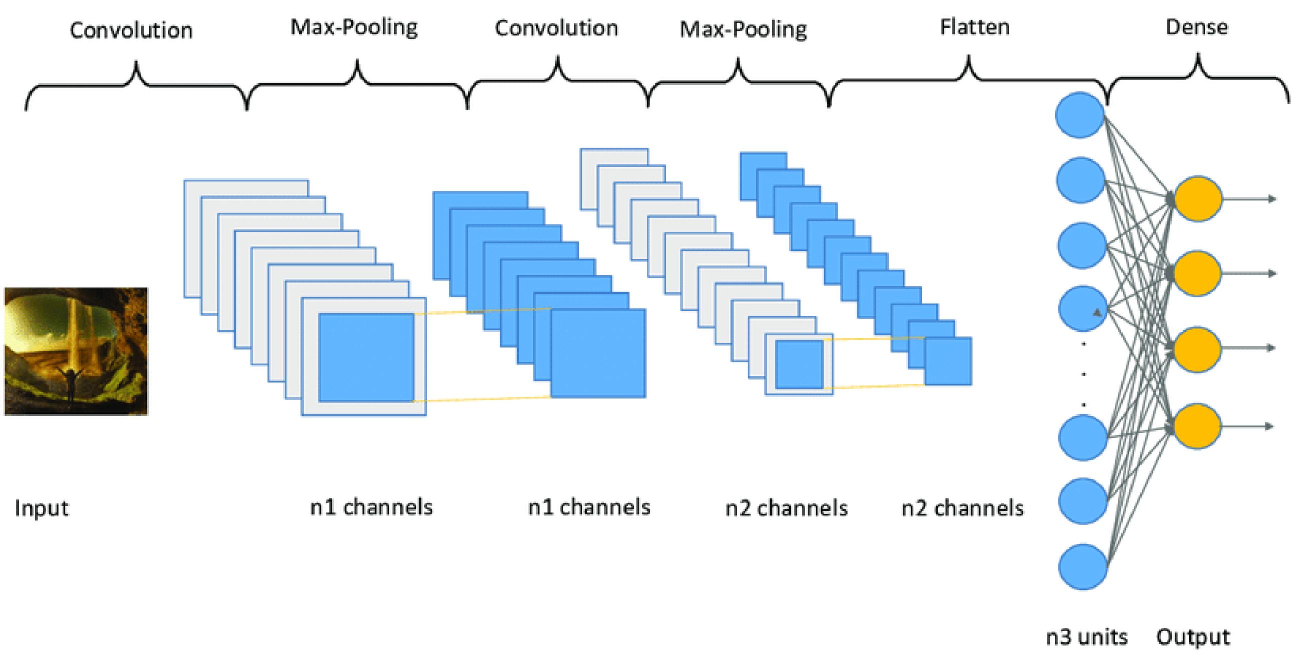
$Sdw_t = ß * Sdw_{t-1} + (1-ß) * (dL/dw_{t-1})^2$

$Sdb_t = ß * Sdb_{t-1} + (1-ß) * (dL/db_{t-1})^2$

Adam Formula

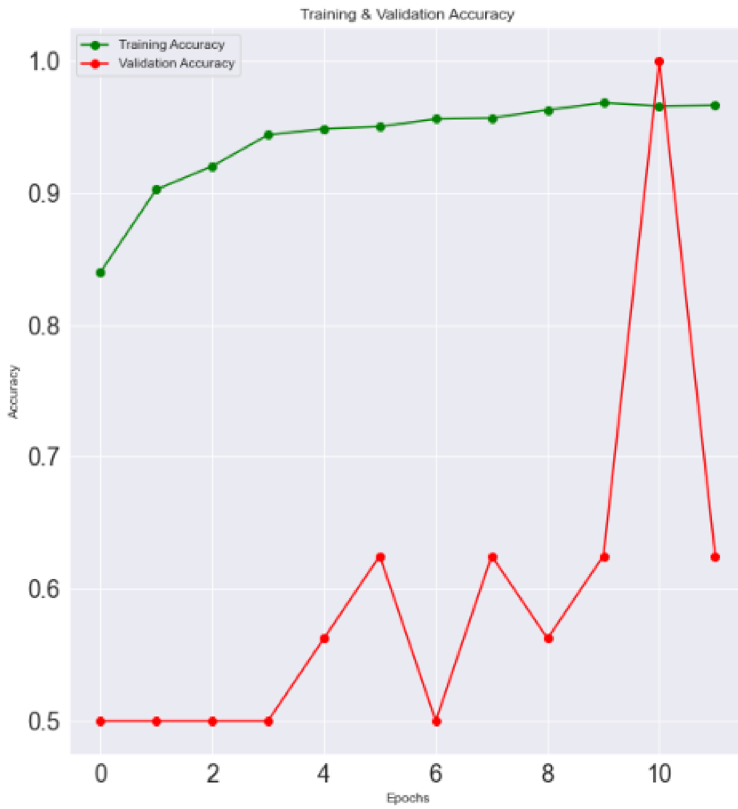
$$W_t = W_{t-1} - \frac{\eta * Vdw}{\sqrt{Sdw + \varepsilon}}$$

- Fitted the mode with **Batch size of 32**, **epoch of 12**, and defined a learning rate reduction using ReduceLROnPlatteau adjusting parameter of patience and verbose to pass as callbacks parameter during fitting of the model.



RESULTS

1. Training & Validation Accuracy



Test data accuracy

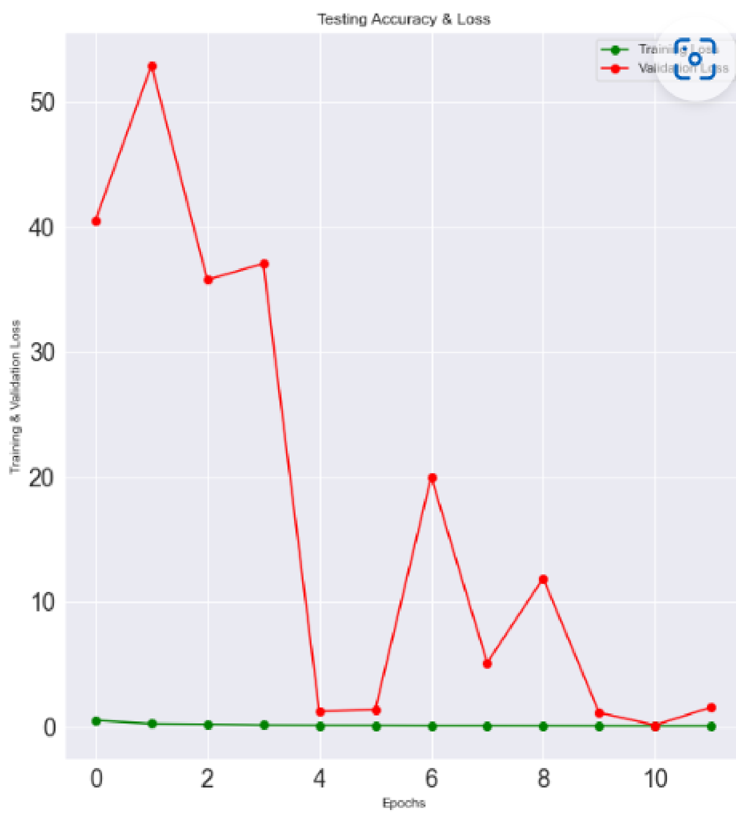
```
20/20 [==============================] - 5s 231ms/step - loss: 0.3237 - accuracy: 0.9247
Loss of the model is -  0.3237099051475525
20/20 [==============================] - 5s 231ms/step - loss: 0.3237 - accuracy: 0.9247
Accuracy of the model is -  92.46794581413269 %
```

Epoch 12^{th} train data accuracy

```
Epoch 12/12
163/163 [==============================] - ETA: 0s - loss: 0.0866 - accuracy: 0.9695
Epoch 12: ReduceLROnPlateau reducing learning rate to 8.100000013655517e-06.
163/163 [==============================] - 187s 1s/step - loss: 0.0866 - accuracy: 0.9695 - val_loss: 1.3529 - val_accuracy: 0.
6250 - lr: 2.7000e-05
```

Model gives 96.63% train accuracy, and test set accuracy of 91.34%.

2. Training & Validation Loss



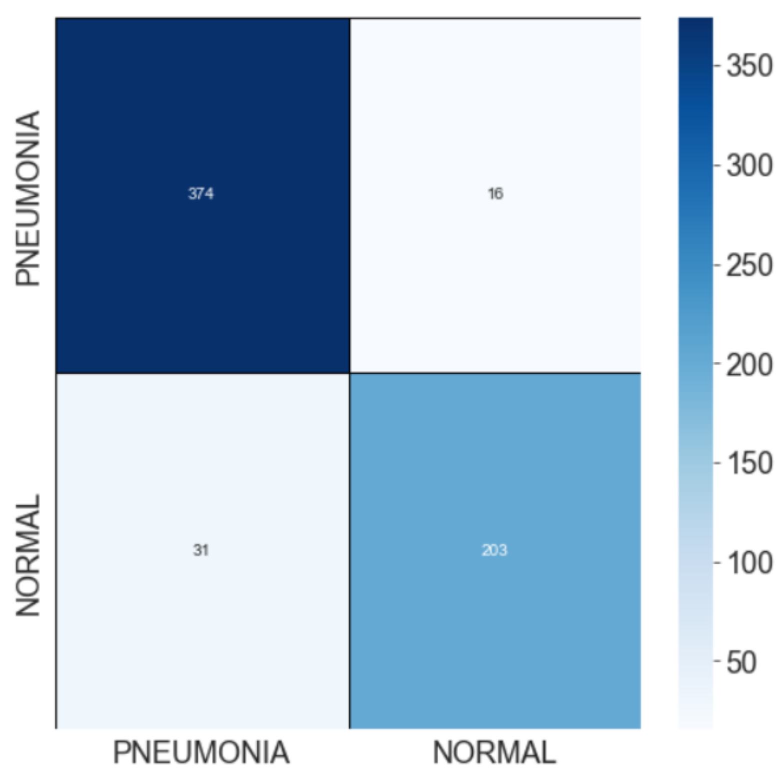
Loss of test data accuracy comes out to be 0.32.

3. Classification Report

	precision	recall	f1-score	support
Pneumonia (Class 0)	0.91	0.96	0.93	390
Normal (Class 1)	0.92	0.84	0.88	234
accuracy			0.91	624
macro avg	0.92	0.90	0.91	624
weighted avg	0.91	0.91	0.91	624

Harmonic Mean of Precision and recall i.e f1 score is 0.91.

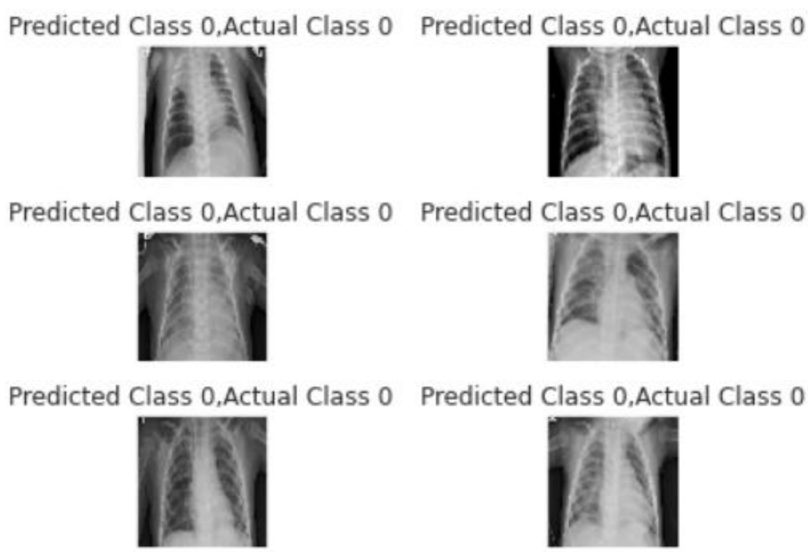
4. Confusion Matrix



<u>We can observe the true postives is 374 and true negative is 196.</u>

5. Correct and Incorrect Predicted Classes Images

Correct Classes



Incorrect Classes