MACHINE LEARNING IN HEALTHCARE

DETECTING PNEUMONIA WITH CONVOLUTIONAL NEURAL NETWORKS

BACKGROUND

Pneumonia is an infection of one or both lungs. Although treatments/vaccines are usually available, pneumonia can lead to serious complications if not spotted on time. Also, **it can be very hard to diagnose.**

GOALS

Our goal is to create a model that is able to detect pneumonia within x-rays. This would help doctors making more accurate diagnoses.

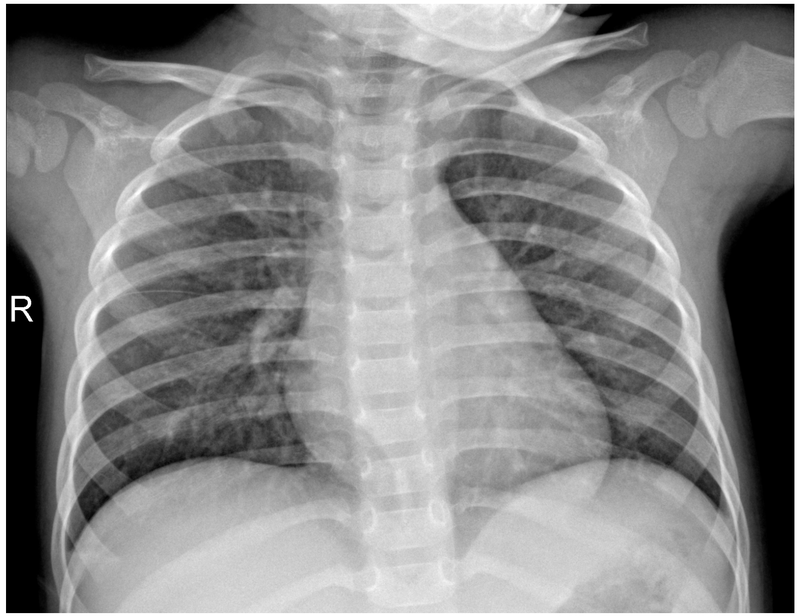
PERFORMANCE

Used two metrics, **accuracy and ROC score.** Anything in the region of **80%+** will be considered as good performance for our purposes.

APPROACH

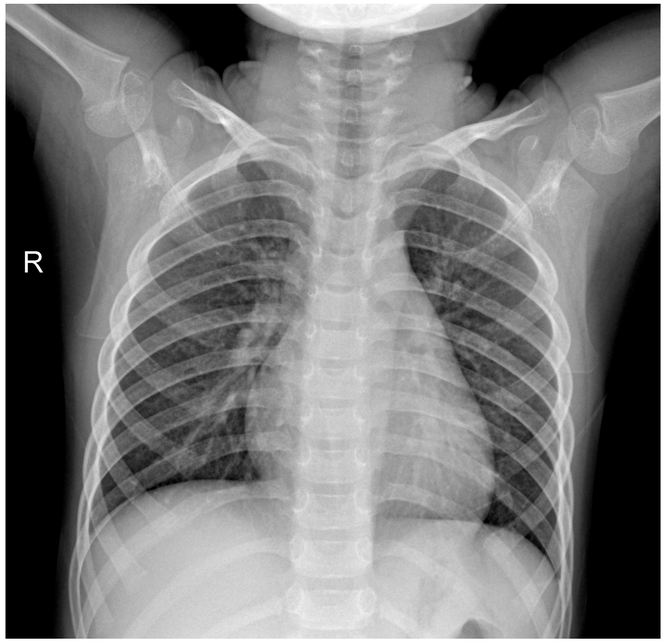
Analysed 5,832 x-rays images collected from hospitals in China. A baseline model was initially created and then different iterations were run in order to get increasingly better results.

HOW DIFFICULT IS IT TO SPOT PNEUMONIA?



Healthy

Pneumonia



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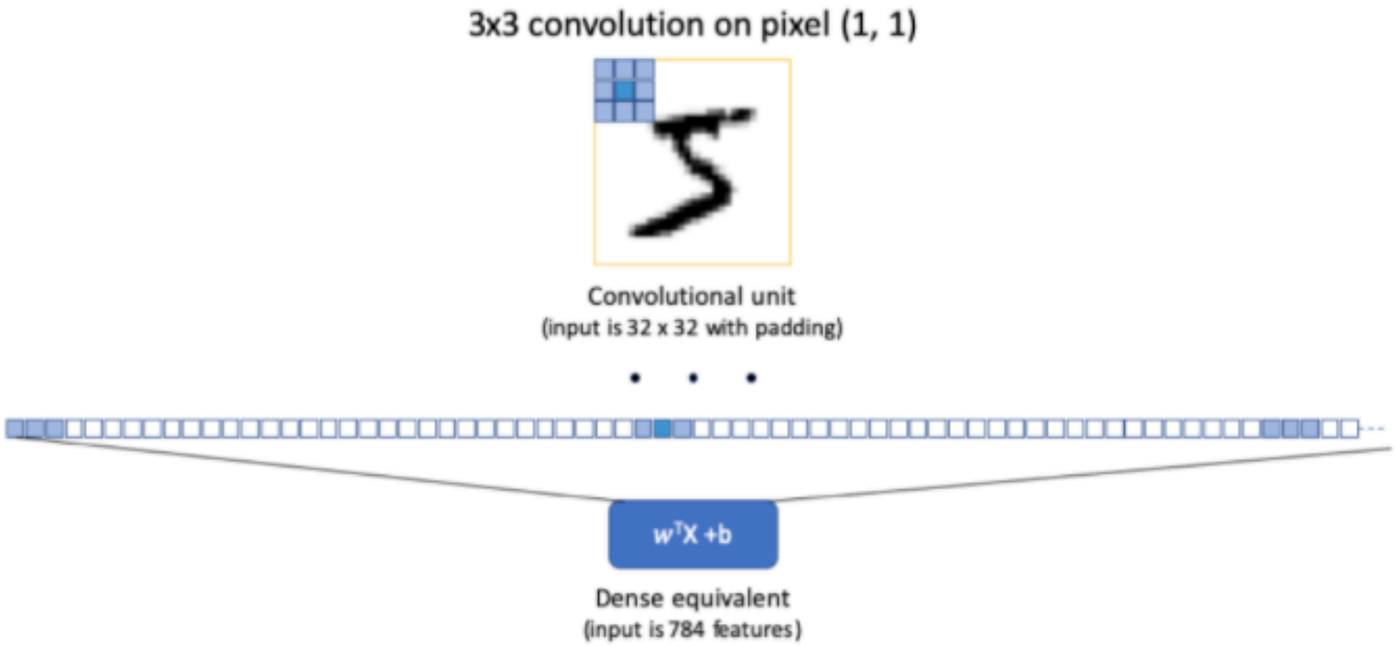
Healthy!

HOW DO NEURAL NETWORKS READ IMAGES?

In simple terms Neural Networks are able to scan through the pixels that make up an image



Source: Analytics Vidaya

There are different ways in which this can be done but for our project we used:

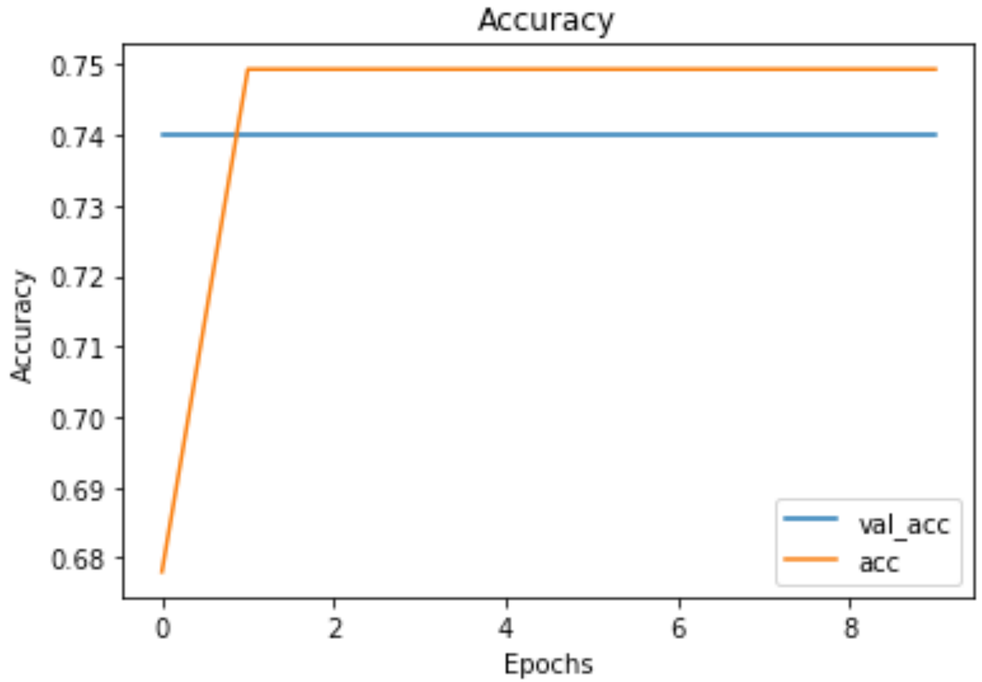
- One Dense Neural Network Baseline (picture below) and optimisations on it
- One Convolutional Neural Network (picture above) and optimisations on it

OVERALL METHODOLOGY

The total number of images available (5,832) are divided into three groups:

1) *Training***.** These are the images we use to teach our model how to identify pneumonia
2) *Validation.* Additional set of images not used in the training process used to assess how well our model is learning
3) *Test.* Similar to validation but it is used only with our best performing model.

BASELINE DENSE PERFORMANCE

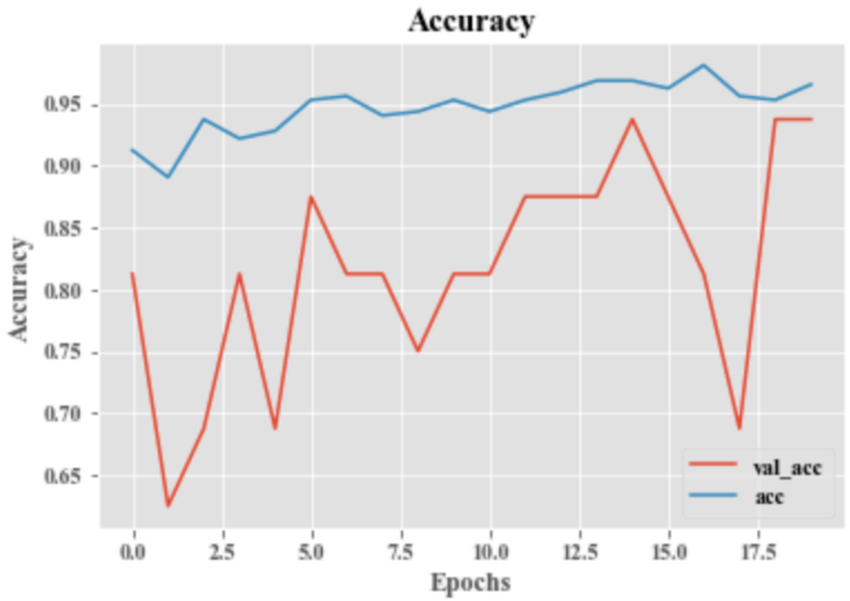


Relatively good initial results with overall accuracy of 74%

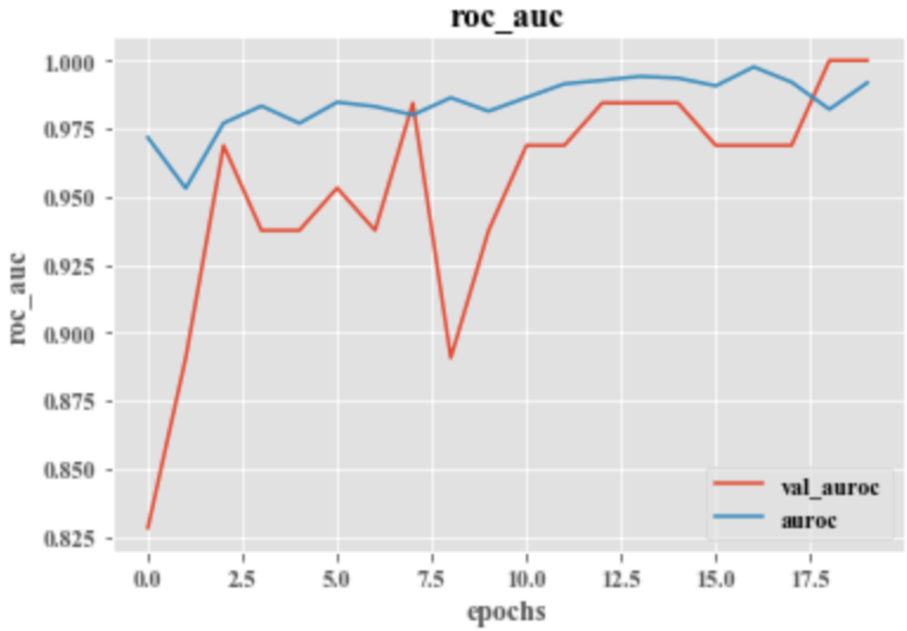
CONVOLUTIONAL NEURAL NETWORK (CNN) MODEL

Convolutional neural networks are by design better at dealing with image recognition compared to dense layers ones. They can detect geometric patterns and also facilitate computation in the way images are processed.

OUR WINNING CNN MODEL



Accuracy in the region of 95%

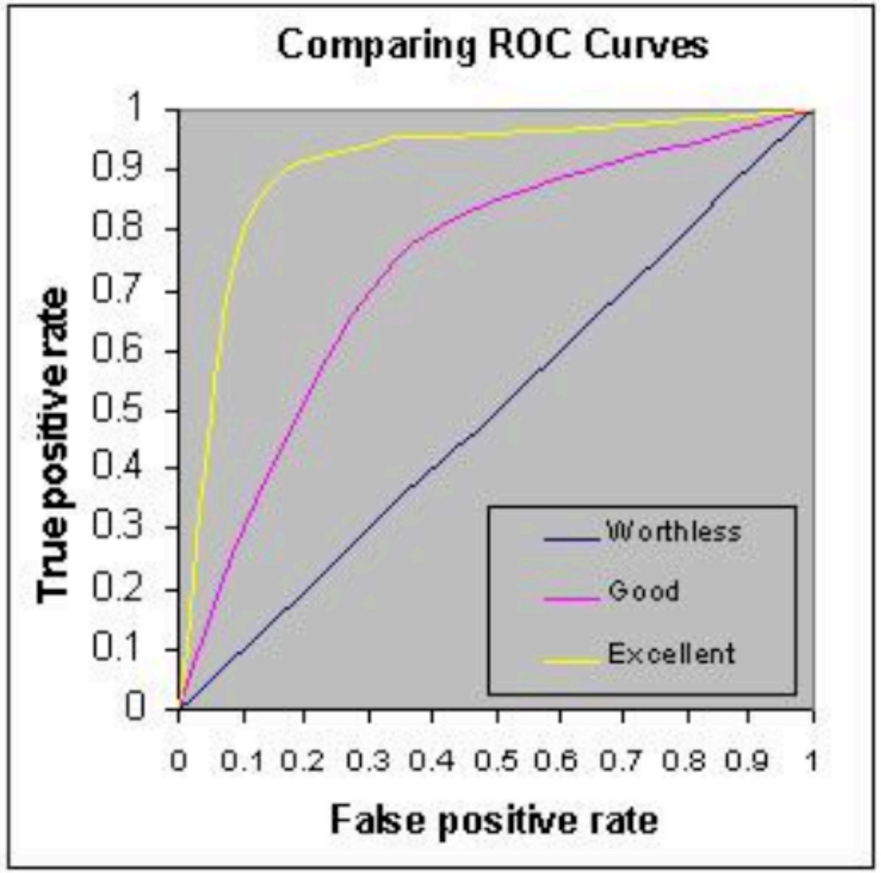


Roc_auc score 98%

Wait, what is roc_auc?

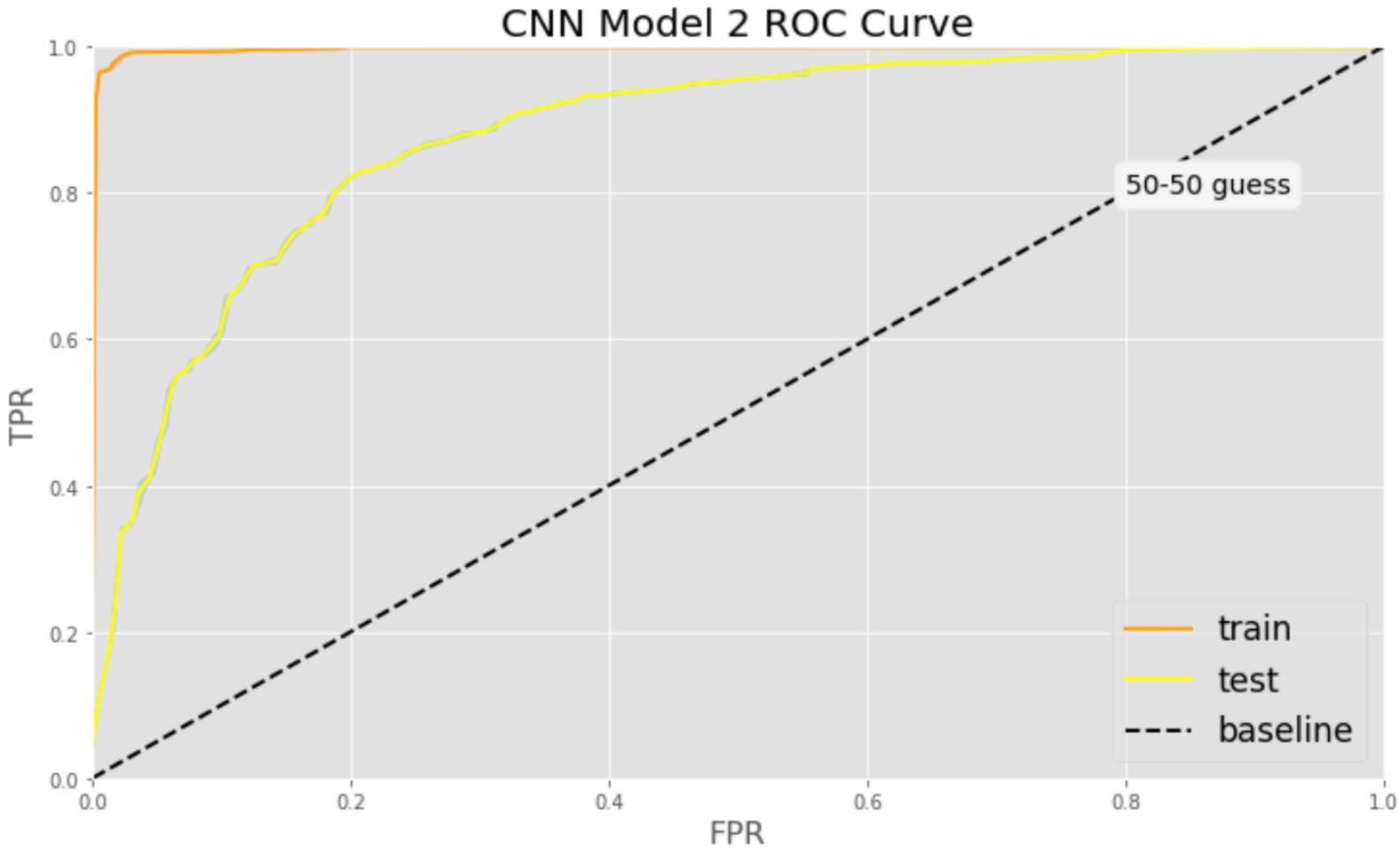
ROC_SCORE EXPLAINED

Roc AUC (area under the curve) plots the rate of your model identifying correctly pneumonia cases (true positive rates) against the rate of the model mistakenly thinking someone had pneumonia (false positive rate)



Source: UNMC Edu

ROC SCORE OF OUR WINNING MODEL



Final ROC AUC score in the test set (made of 600 images) was in the region of 0.88%.

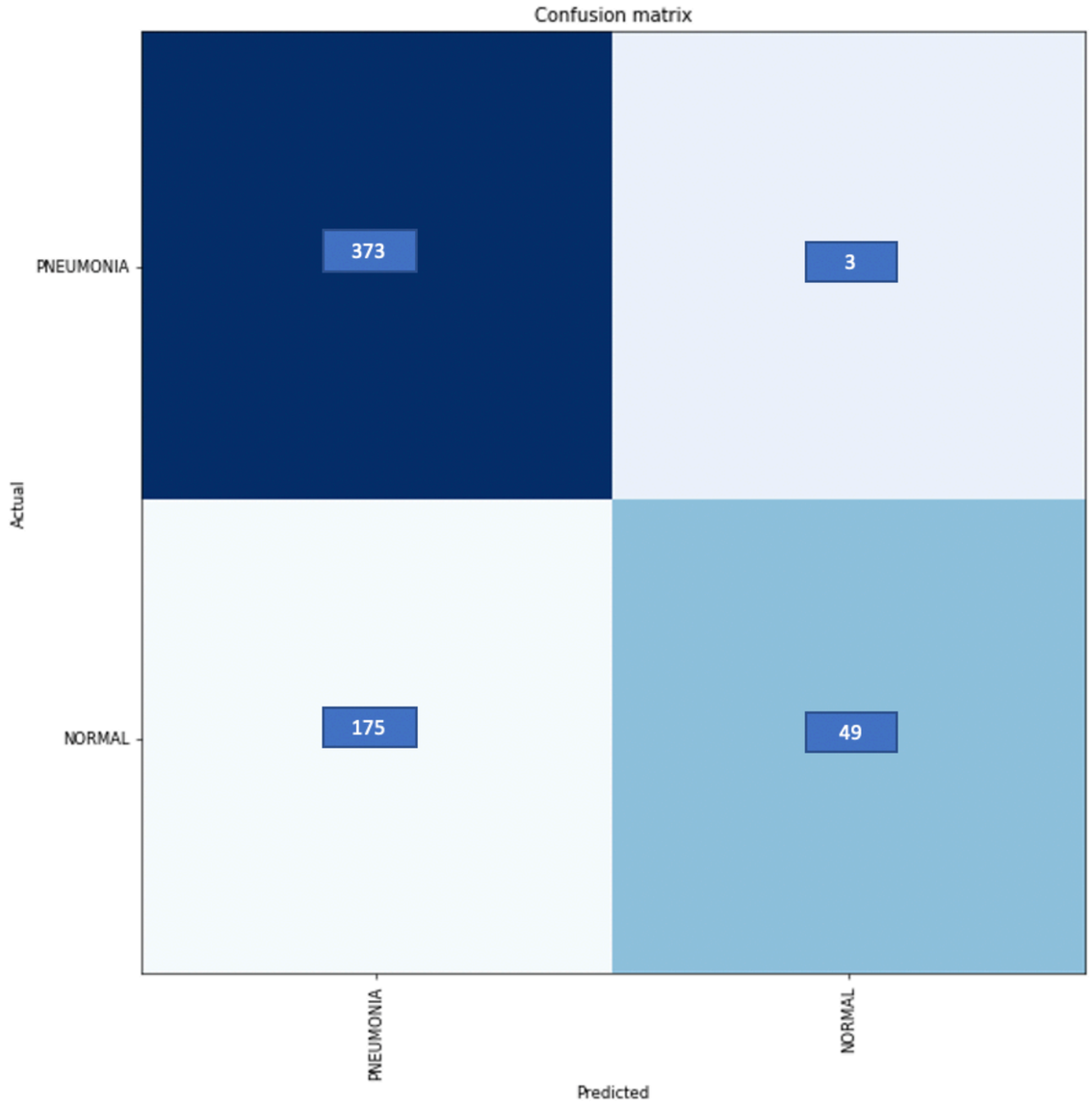
EVALUATING FINAL PERFORMANCE ON TEST SET

After our cost evaluation for all the possible outcomes of our model, we have created a final confusion matrix based on custom threshold and on the final test set of 600 images.

Accuracy 70%
This model correctly identified 7 times out of 10 people with and without pneumonia.

Recall 99%
The Neural Network correctly identified 99% of people with pneumonia

Other metrics:
Precision: 68%
F1 score: 80%



LIMITATIONS AND NEXT STEPS

The primary intent of this analysis was only to create a model that would help doctors in their diagnosis. It is not suited to completely replace human judgement because of current performance.

However, this model is currently able to identify correctly 7 times out of 10 people who have pneumonia

As next steps:

- Introduce other types of data points such medical record of each patient to get better predictions
- Collecting more x-ray images to further improve performance