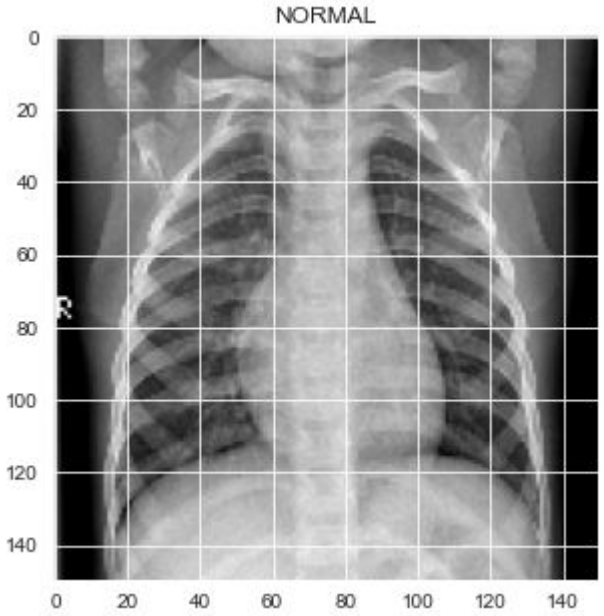
X-ray Image Classification

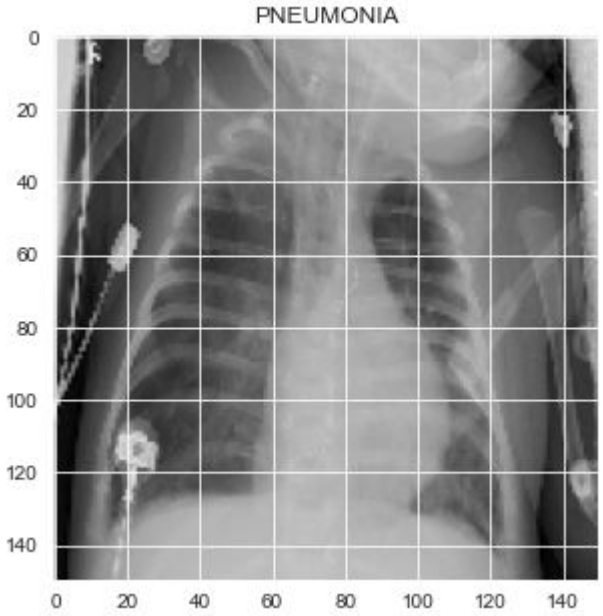
Business Problem

- We need to be able to quickly and accurately identify which patients have pneumonia using a model, so that doctors themselves spend less time reviewing images.
- We recommend using a convolution neural network to assist doctors with this task.

Image Data

- When interpreting the x-ray, the radiologist will look for white spots in the lungs (called infiltrates) that identify an infection.





How does a computer view images?

- A digital image is a binary representation of visual data. It contains a series of pixels arranged in a grid-like fashion that contains pixel values to denote how bright and what color each pixel should be.

What I see

What a computer sees

How does a Convolution Neural Network classify images?

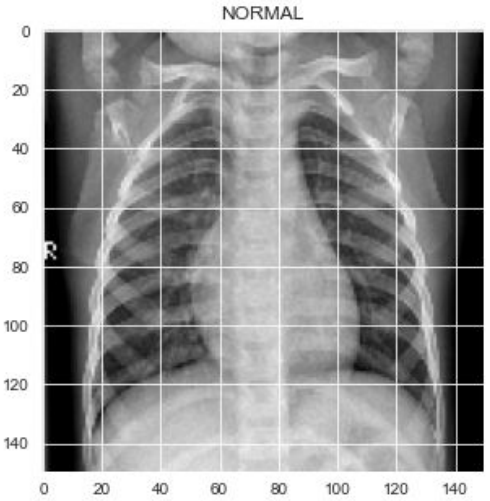
- In human understanding characteristics like the trunk or large ears are how we recognize an elephant. For the computer, we need to provide it an algorithm to teach it these characteristics as boundaries or curvatures. And then through the groups of convolutional layers the computer constructs more abstract concepts.

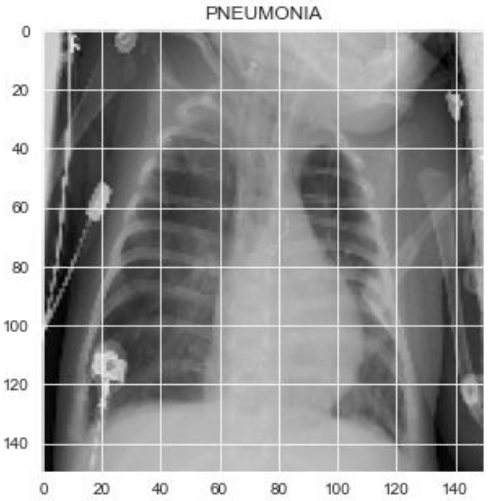
What I see

What a computer sees

How does a Convolution Neural Network classify images?

- For our model to correctly interpret an x-ray image, we will first need to show our model pneumonia x-ray images and normal images so it can discover patterns in the image matrices which make pneumonia images different from normal lung images.





What data did we use?

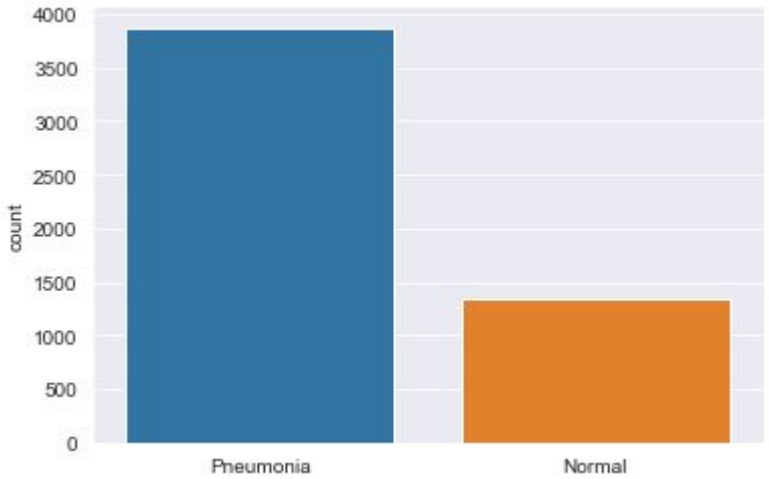
We developed a convolution neural network model to classify x-ray images.

We trained our model on 5,863 X-Ray images divided into 2 categories (Pneumonia/Normal).

Chest X-ray images were selected from pediatric patients of one to five years old from Guangzhou Women and Children’s Medical Center, Guangzhou.

Data Imbalance

- We have an imbalance of Pneumonia image examples so one of our main data steps was to adjust for this imbalance.



Data Imbalance Adjustment: Data Augmentation

We should artificially expand our data. We will alter the training data with small transformations to reproduce variations. 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.

Data Augmentation

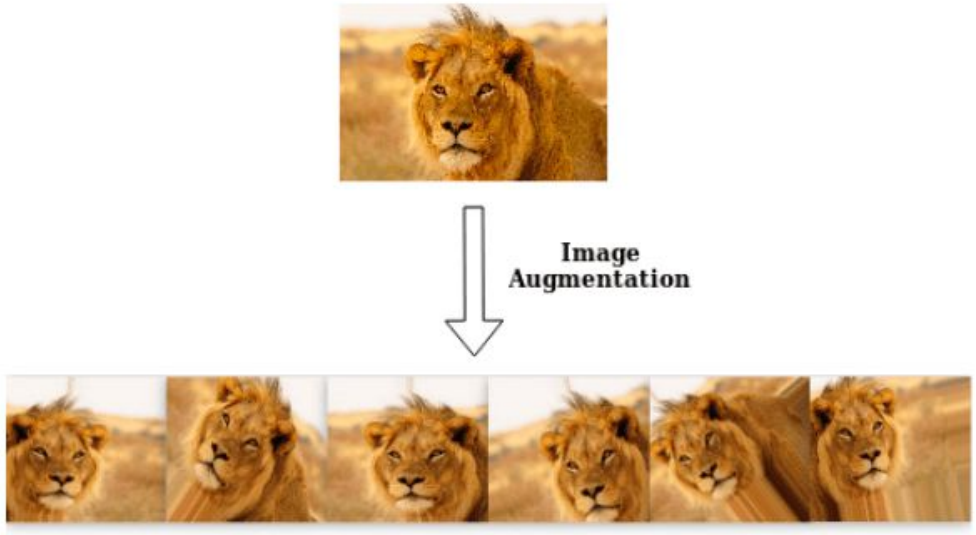
Randomly rotate some training images by 30 degrees

Randomly Zoom by 20% some training images

Randomly shift images horizontally by 10% of the width

Randomly shift images vertically by 10% of the height

Randomly flip images horizontally. Once our model is ready, we fit the training dataset.



How did our model perform?

- Overall are model did well at identifying which patients had pneumonia but did poorly identifying which patients were normal classifying many of them as having pneumonia as well

Model Performance

- Our validation AUC stopped improving between 10 and 15 epochs
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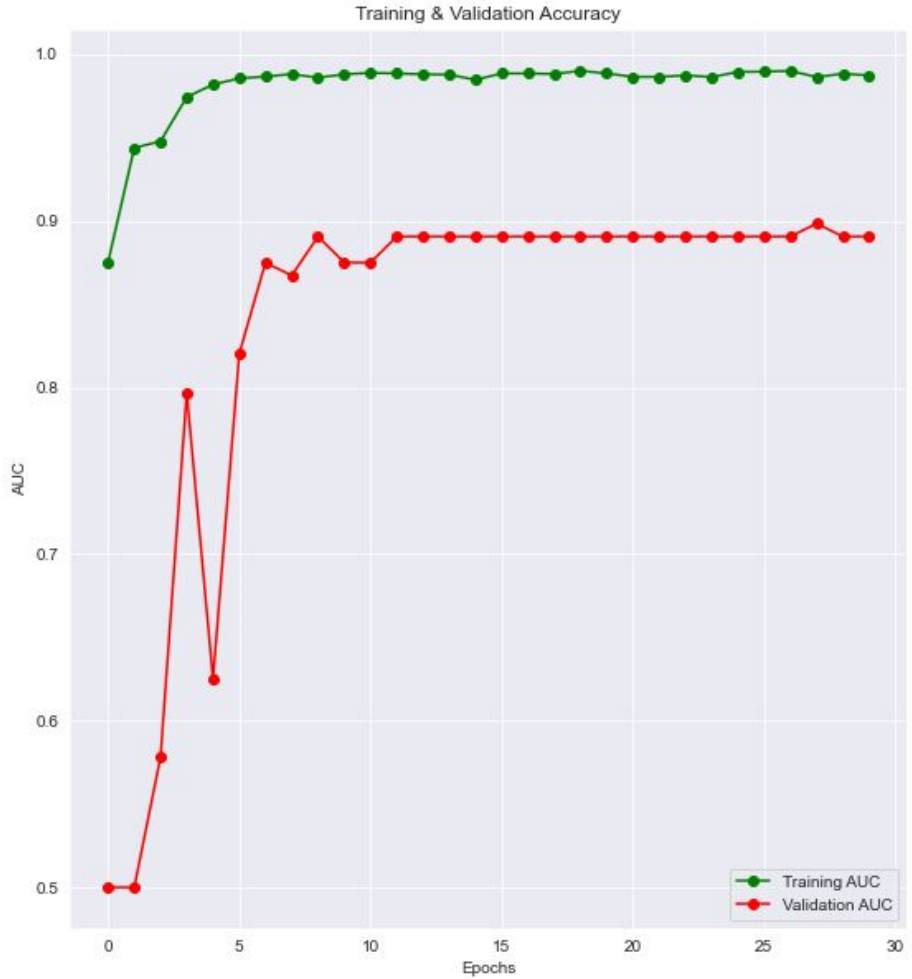
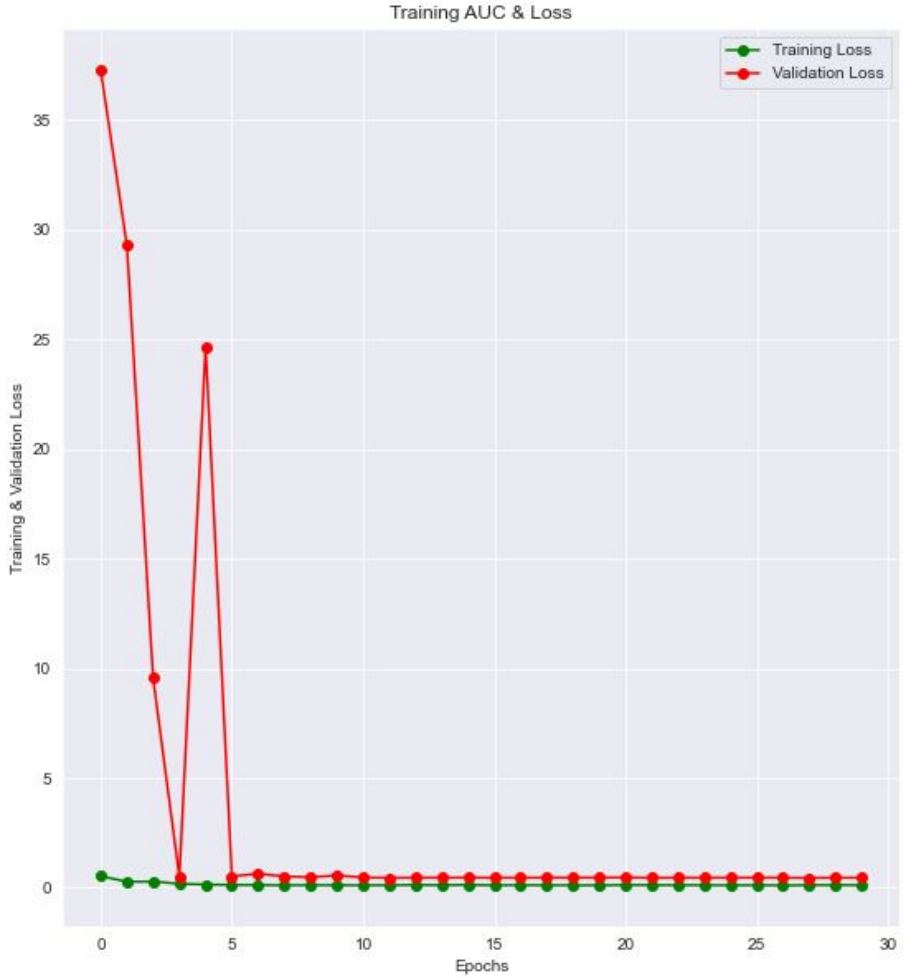


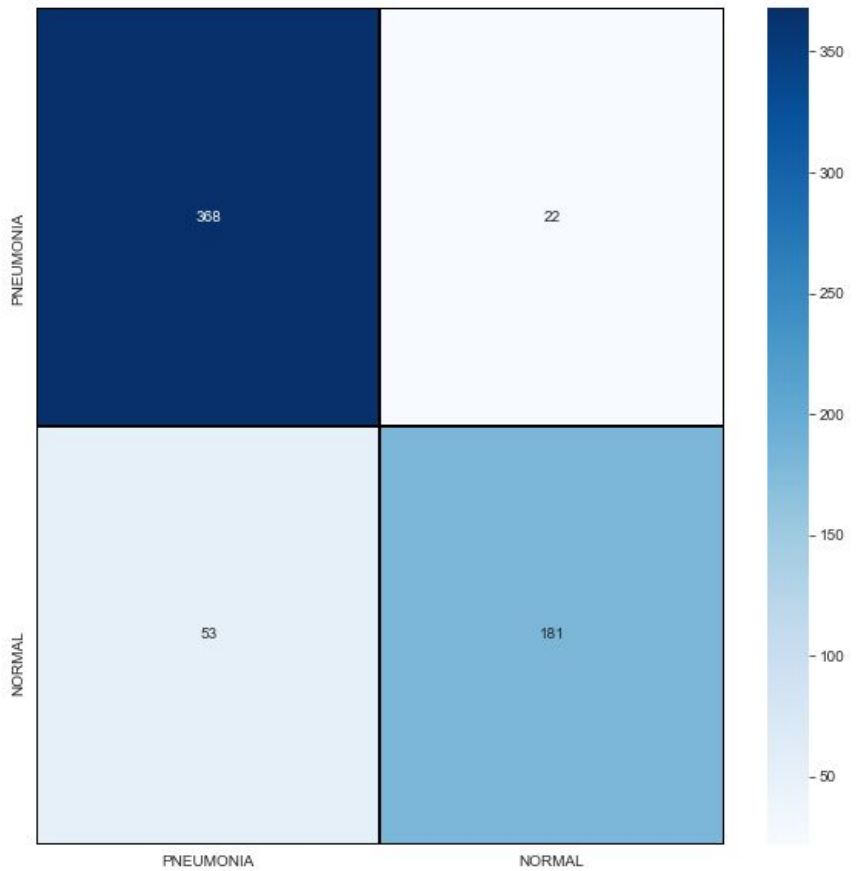
Model Performance

- After 5 epochs our training and validation loss remained constant



Confusion Matrix

- The bad news is our model is still not performing well enough for medical use but the good news is most of our classification mistakes were classifying normal patients as having pneumonia
- From a medical care perspective catching which patients have pneumonia is the more important than correctly classifying normal patients



Misclassified Images

- Examples of Correctly Predicted pneumonia when patient had pneumonia





- Examples of the Incorrectly Predicted Normal when patient had pneumonia





Conclusions

- Our model performed decently but not at the level necessary for medical accuracy
- Pneumonia images which had less cloudiness or lung infiltrates were difficult for the model to classify
- 7% of pneumonia patients were misclassified as normal which is good enough to corroborate more obvious images but not good enough to classify patients with more mild pneumonia

Recommendations

- Utilize the model for corroboration of physician assessment of x-ray images
- Wait until future work is completed to use a model as a primary classification technique
- Explore the use of other performance metrics in the model - Does another metric perform better than AUC?
- Expand validation set with some of the training set - the validation set provided was far too small
- Iterate the model with more layers - initially additional layers didn't seem important when run with limited epochs but when running with a larger number of epochs there were improvements in AUC metric

Future Work

- Incorporate transfer learning: if a model is trained on a large and general enough dataset, this model will effectively serve as a model to classify images. This would also help the model to perform better on the images of normal patients as the class imbalance seems to be affecting the model performance in this class.
- Iterate the model with more layers
- Expand validation set with some of the training set - the validation set provided was far too small

Questions

Thank you for your time!

Sources

- https://towardsdatascience.com/convolutional-neural-networks-explained-9cc5188c4939
- https://www.upgrad.com/blog/basic-cnn-architecture/#:~:text=There%20are%20three%20types%20of,CNN%20architecture%20will%20be%20formed