Predicting Pneumonia from Chest X-ray Images

Using Neural Networks to Diagnose Better than Human Experts

The Problem

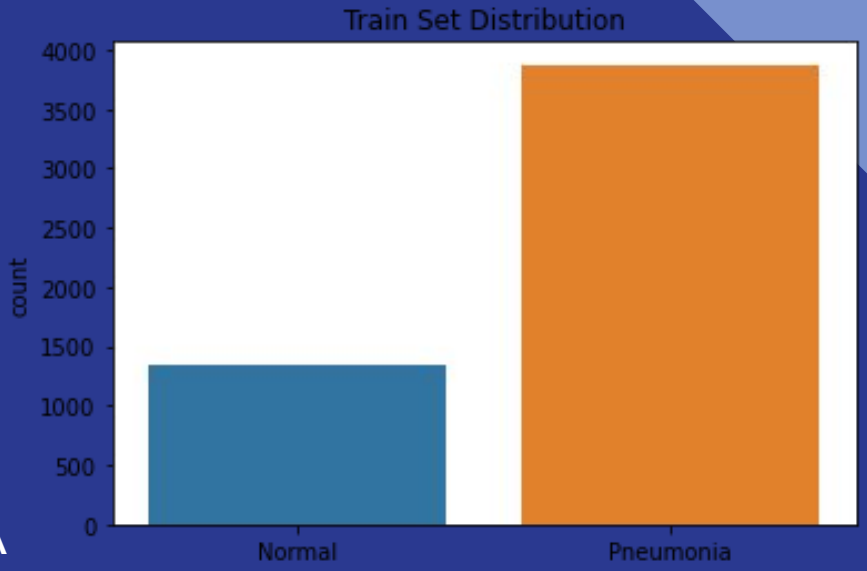
- Chest X-rays are an extremely common first line diagnostic tool
  - Have poor sensitivity for many pathologies including pneumonia
    - Overall sensitivity of 48%
    - Pneumonia sensitivity between 38 and 76%
- Either pathologies are not being picked up by the imaging or radiologists are not able to see them

Solution

- CNN model predicts pneumonia with high accuracy
- Sensitivity higher than human experts
- CNN models should be used in the field to ensure radiologists are not missing anything
    - If not, ERs should at least switch to chest Ultrasound as it has much higher sensitivity than chest X-rays

The Data

- 5863 chest X-ray images from the Guangzhou Women and Children's Medical Center
  - Pediatric patients 1-5 years old
- Images broken up into 3 sets:
  - Train, Test and Validation sets
  - Each of these sets broken down into NORMAL and PNEUMONIA images
- Class distribution was not balanced for Train and Test sets



Processing the Images

Raw Images

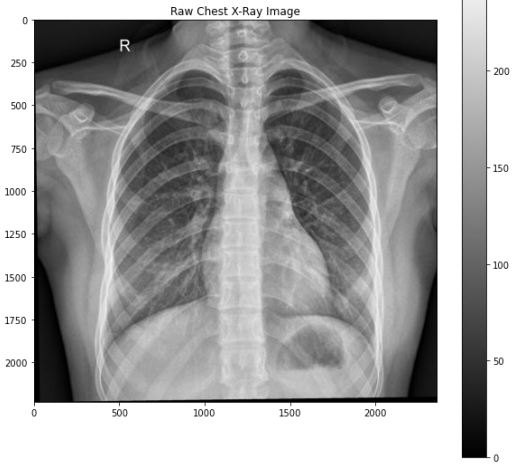
- Each image has unique size/dimensions
- Also unique in mean pixel value and pixel standard deviation

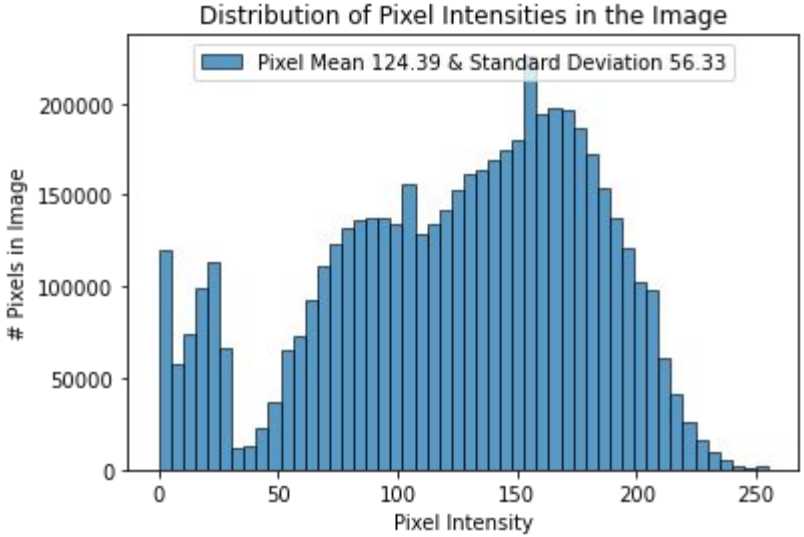
Normalizing

- All images reshaped to same size
- All images pixel intensity range reduced from 255 to 1

Augmentation

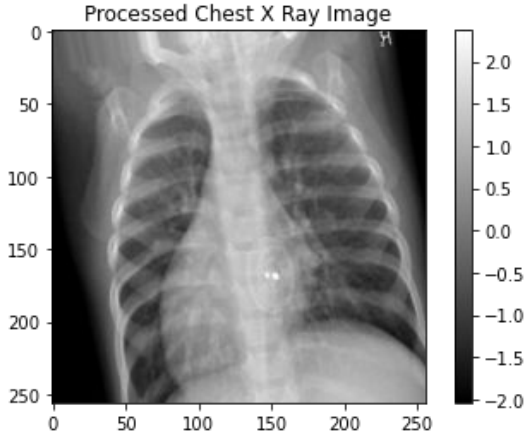
- ImageDataGenerator used to alter image rotation, zoom, height shift and width shift
- Also normalize pixel mean and standard deviation
- Provide CNN with batches of images

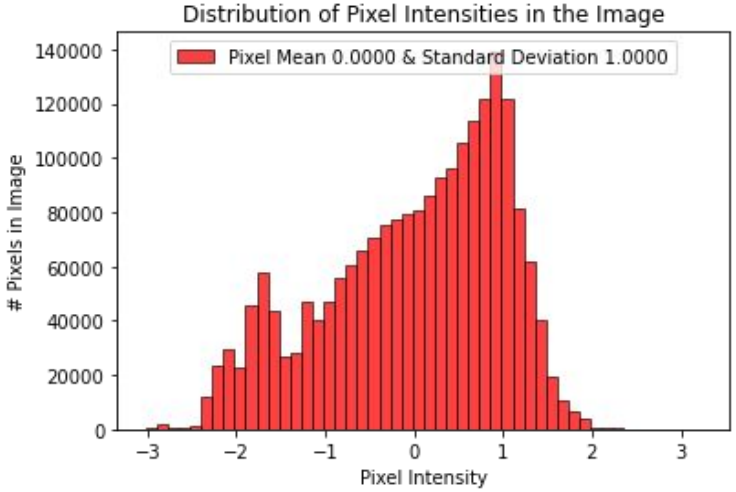




⇐==== Raw Image

Processed ==========>

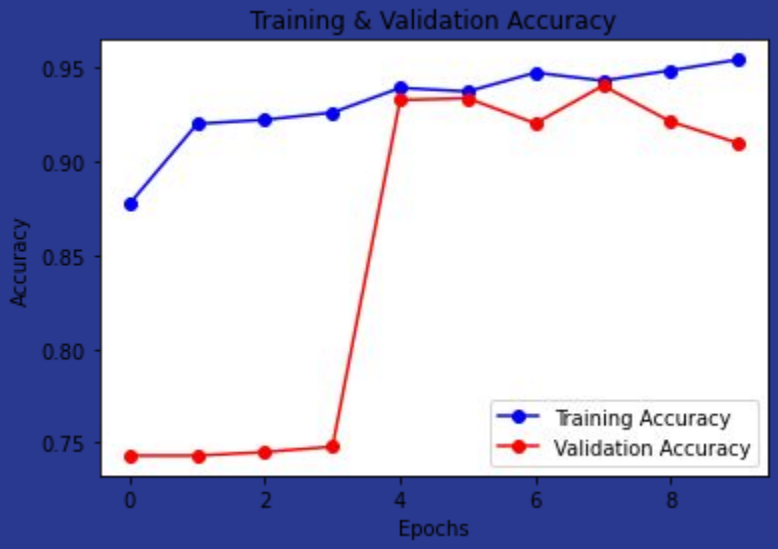


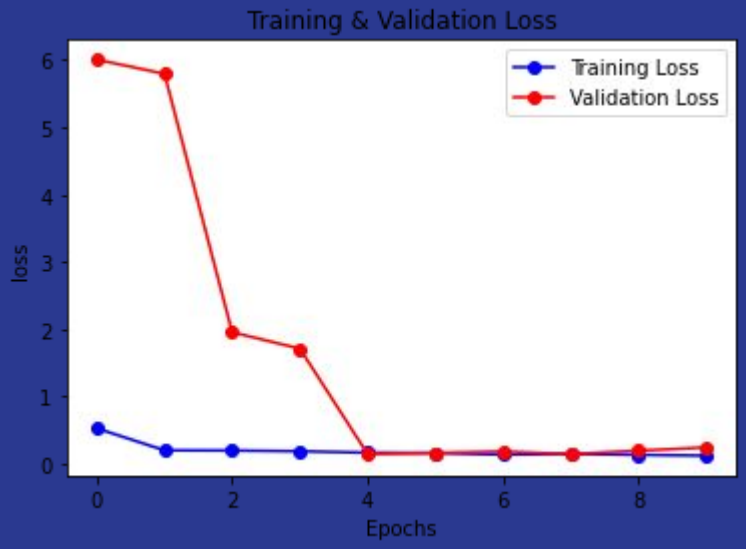


Building the Model

- 5 convolutional/pooling pair layers
- Dropouts to minimize overfitting
- 2 callbacks
  - Learning rate
  - Early stopping

Model Metrics



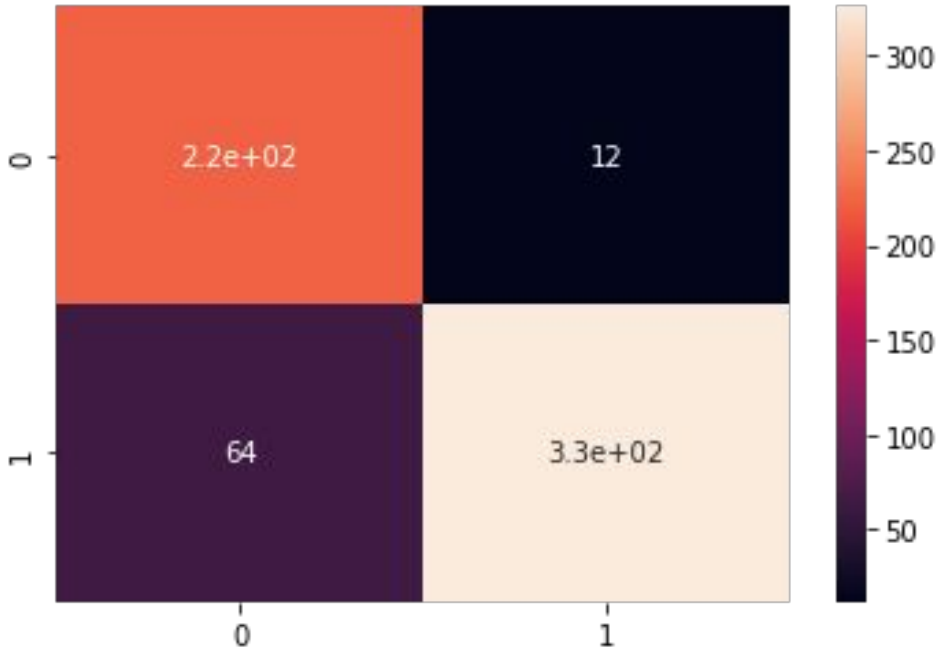


Accuracy: 0.88

Loss: 0.33

Sensitivity: 83%

ROC_AUC: 0.966



Conclusion

- 2 possible solutions:
  - start using CNN models in the field of medicine or
  - start using different diagnostic tools that have higher sensitivity when observed by human experts.