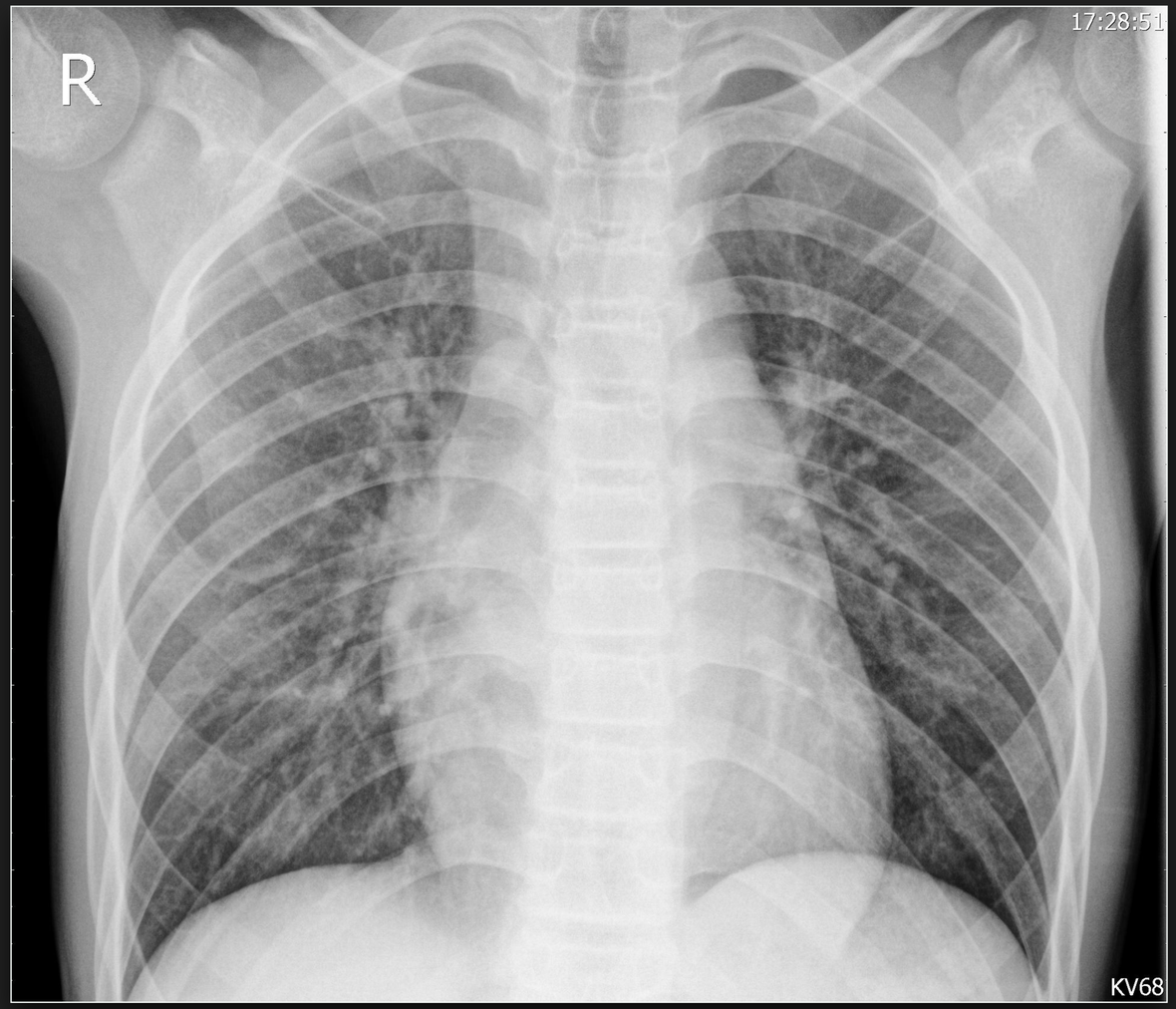
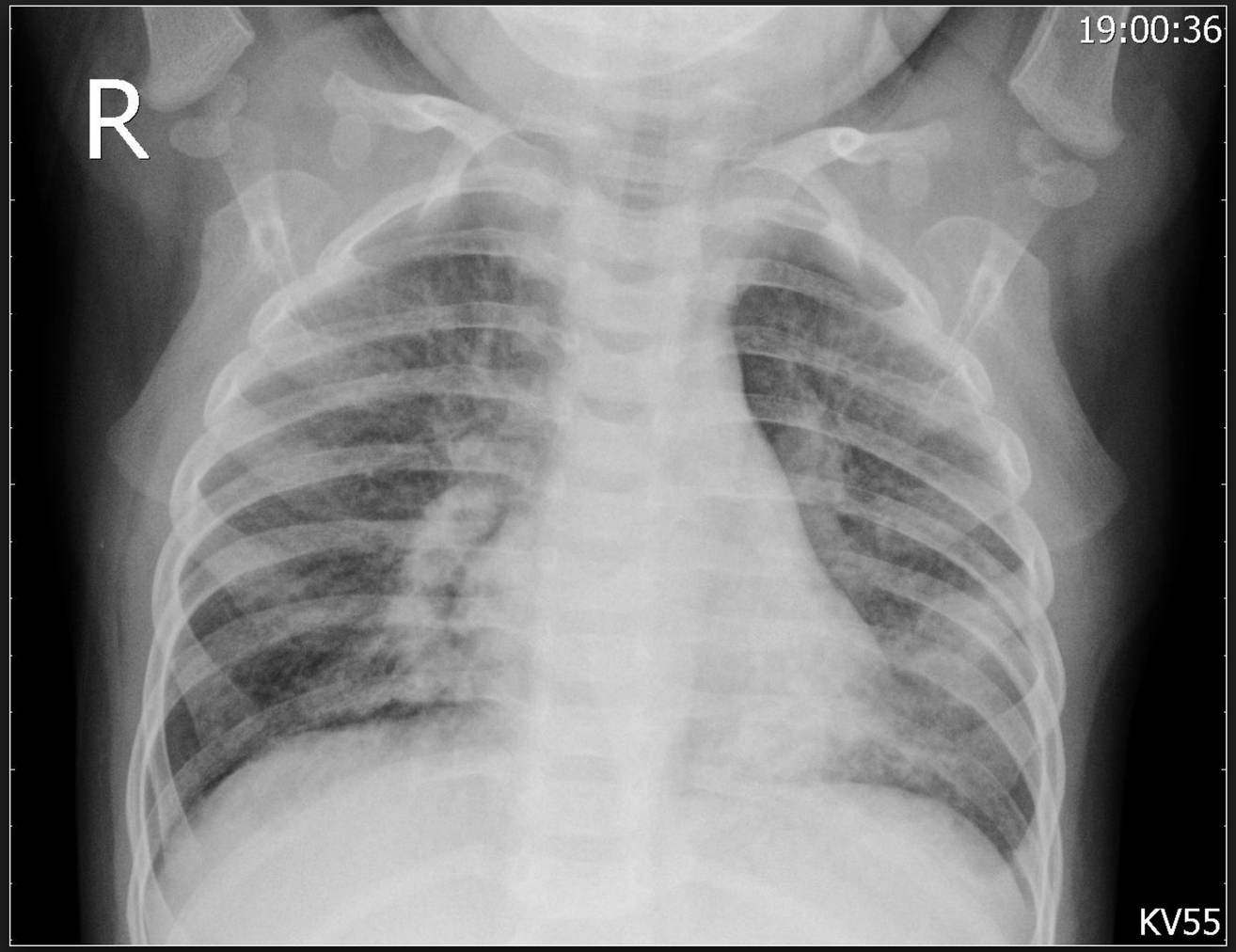
Chest X-Ray Classification

Brent Thayer

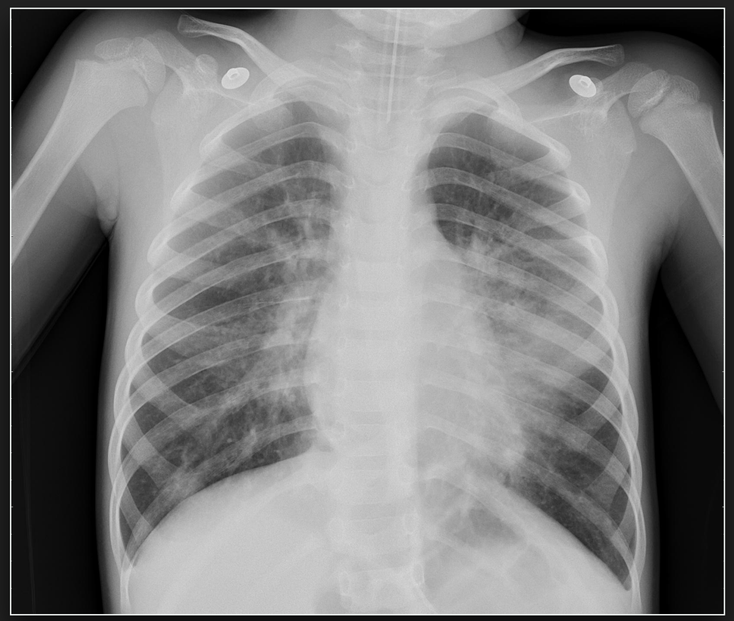


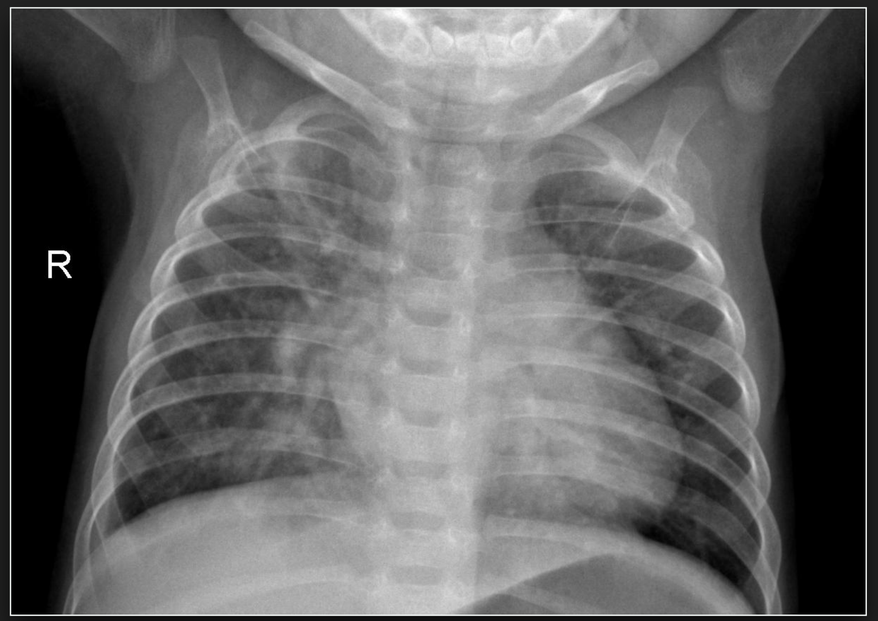


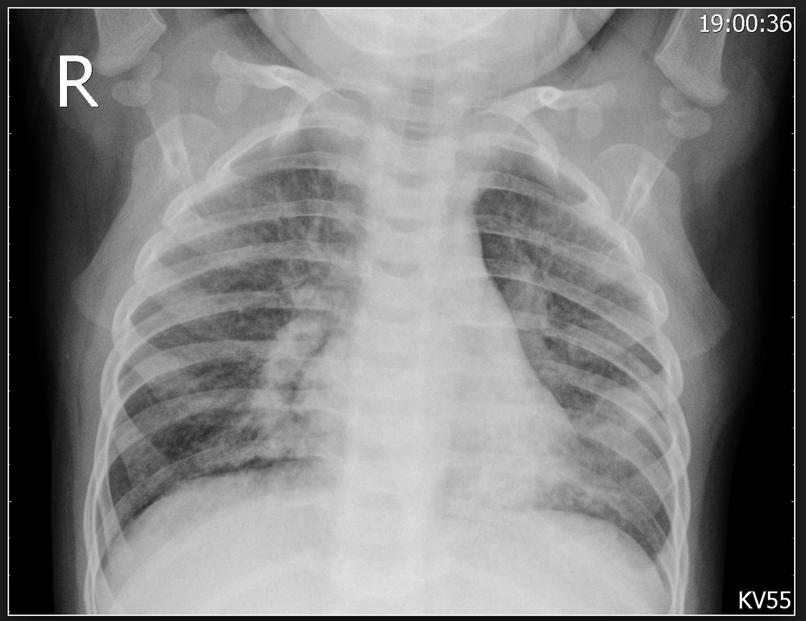
Is it possible to train a model to classify pneumonia from a chest X-ray?

An X-ray allows a radiologist to see the lungs, heart and blood vessels. When interpreting the X-ray, the radiologist will look for white spots in the lungs (called infiltrates) that identify an infection.

Pneumonia

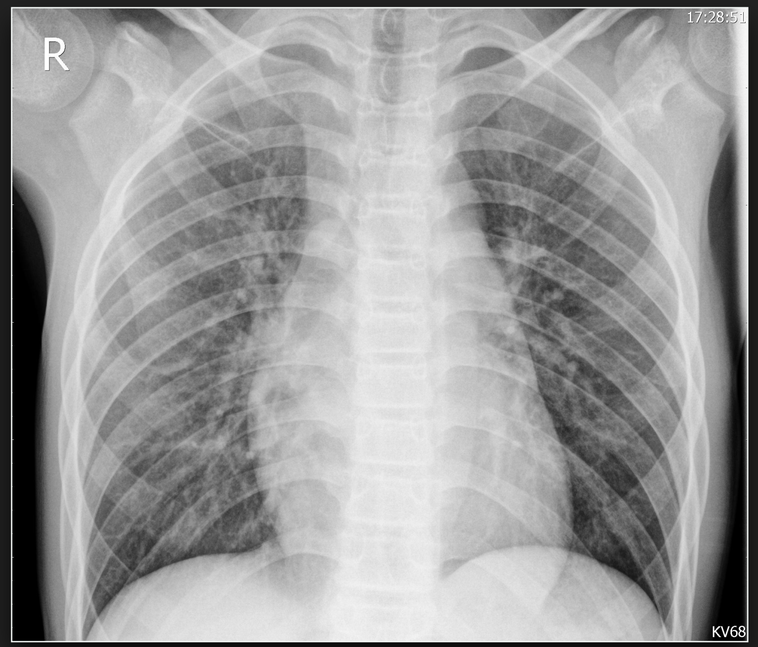


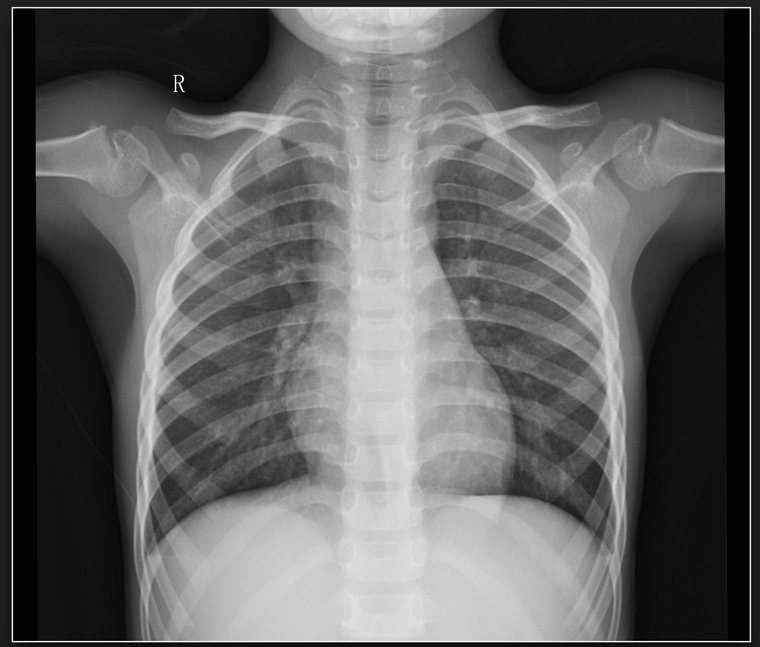


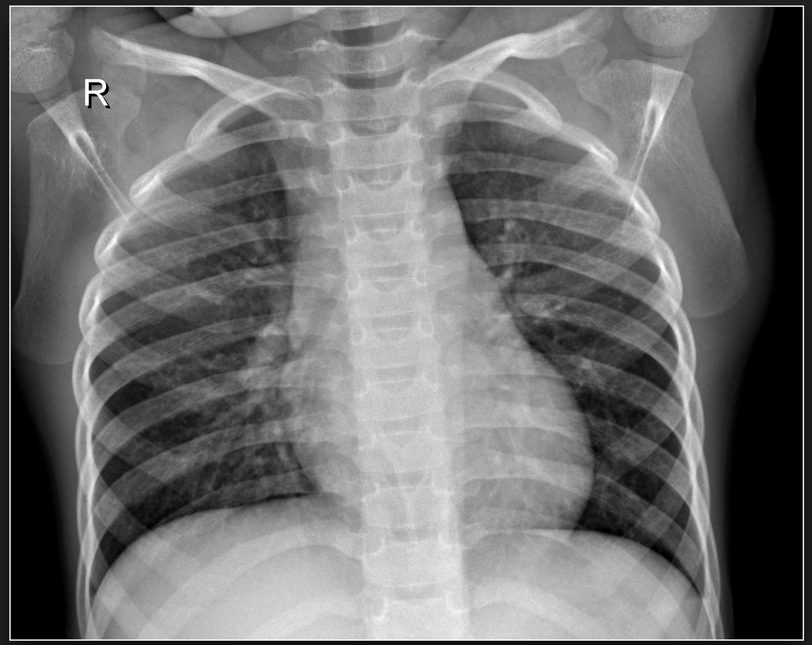


Pneumonia is an infection that inflames the air sacs in one or both lungs. The air sacs may fill with fluid or pus (purulent material), causing cough with phlegm or pus, fever, chills, and difficulty breathing. A variety of organisms, including bacteria, viruses and fungi, can cause pneumonia.

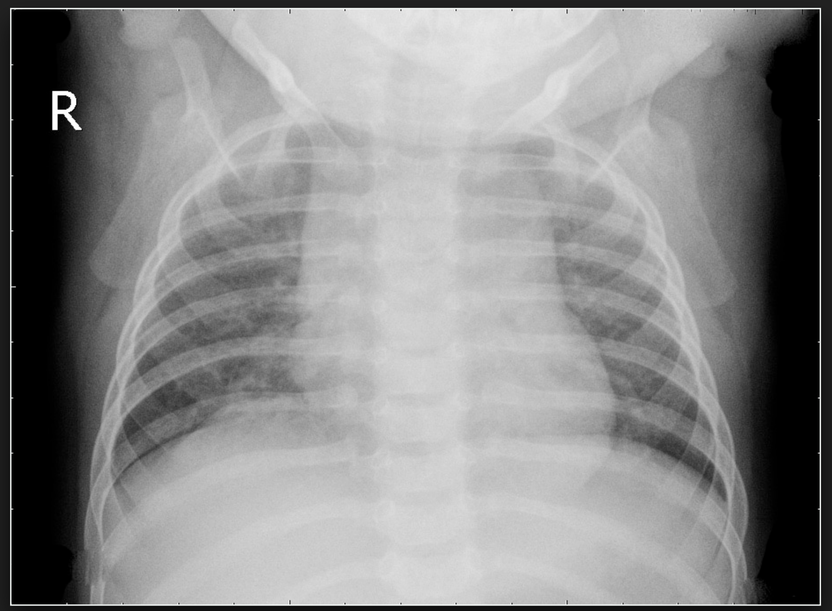
Normal

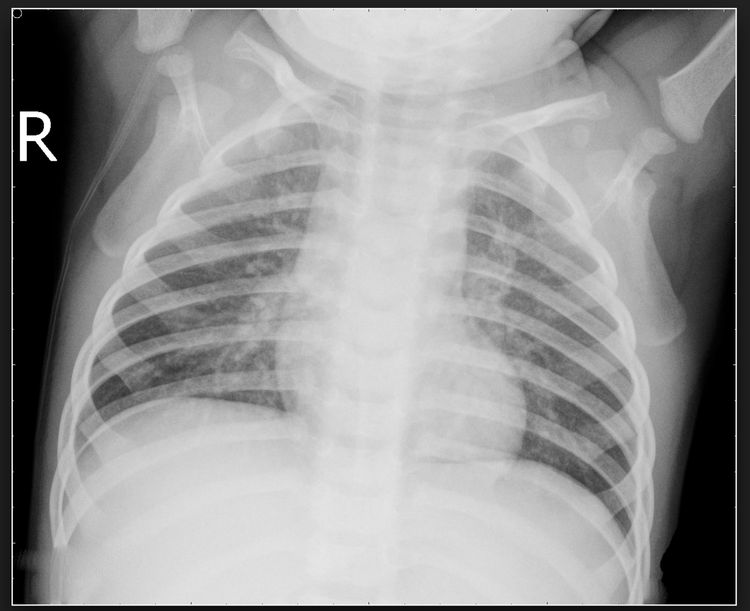


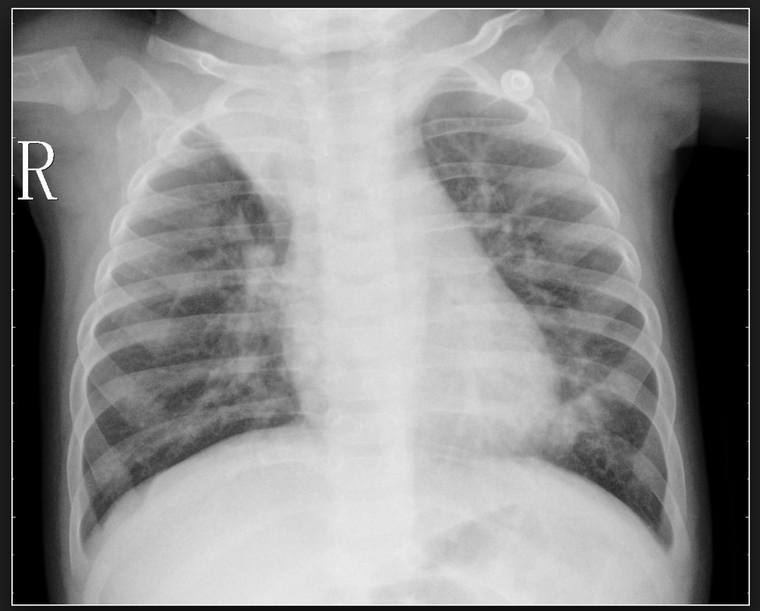




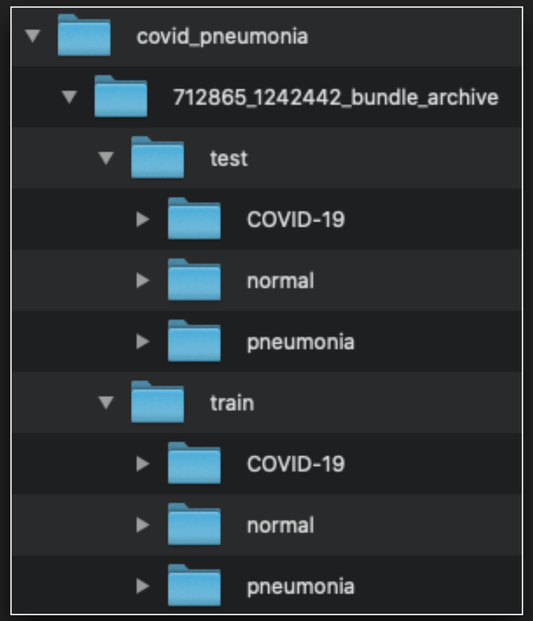
Anterior X-rays

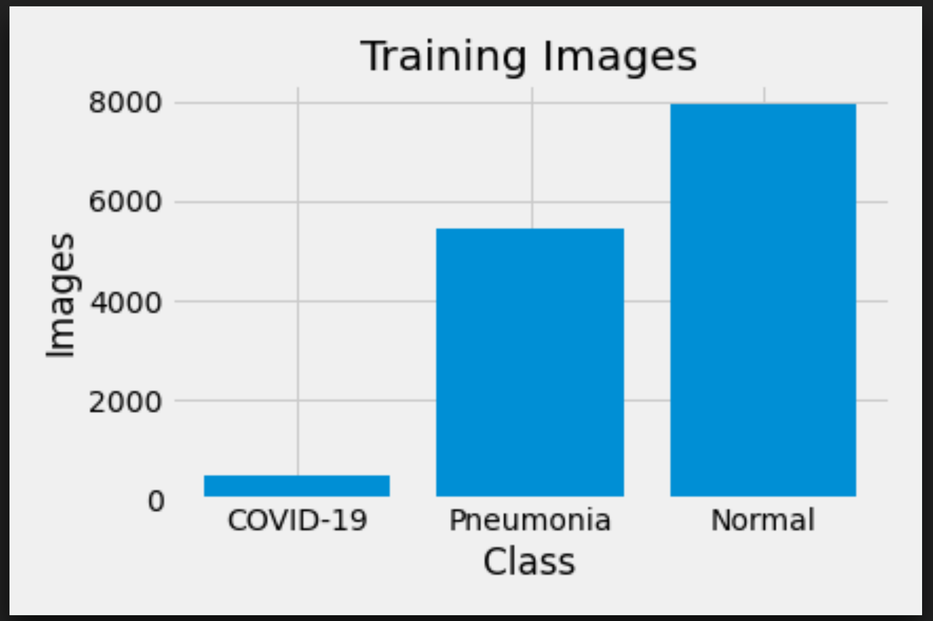


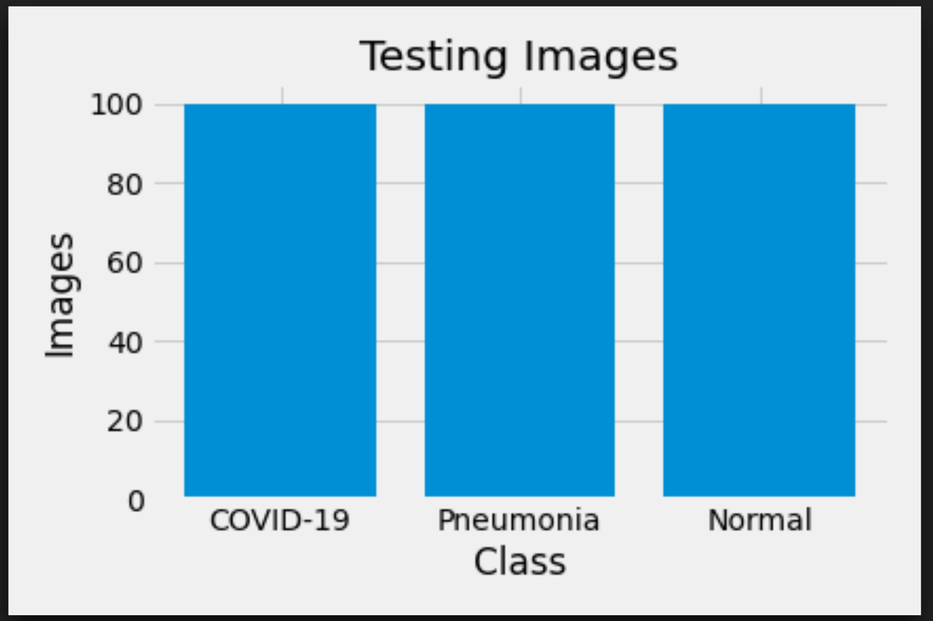




First Dataset



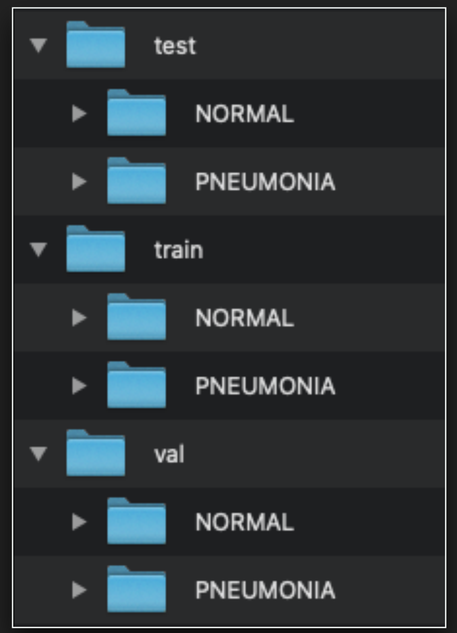


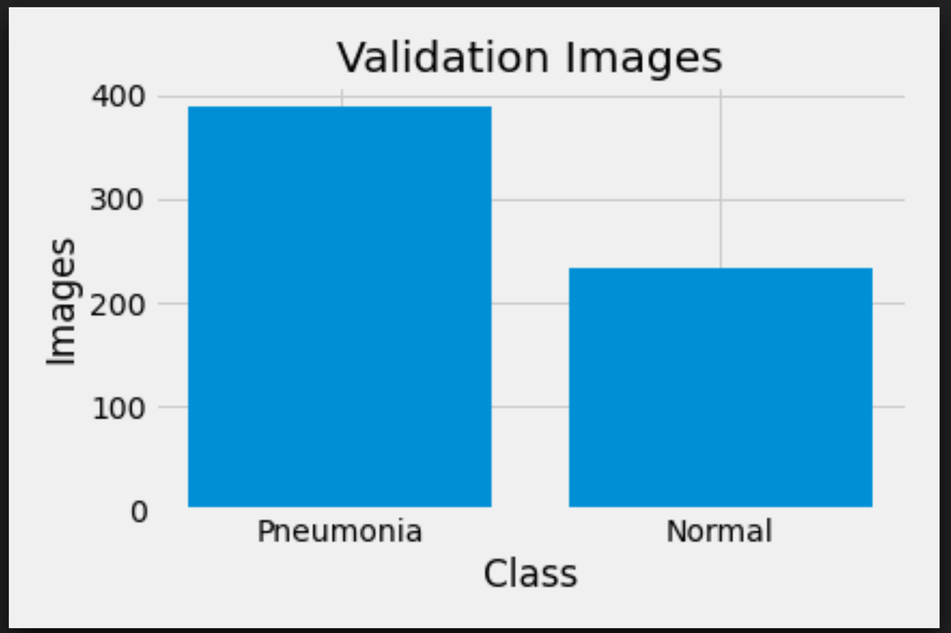


COVID-19 was removed to create a binary classification problem.

The model was learning to always predict normal.

New Dataset



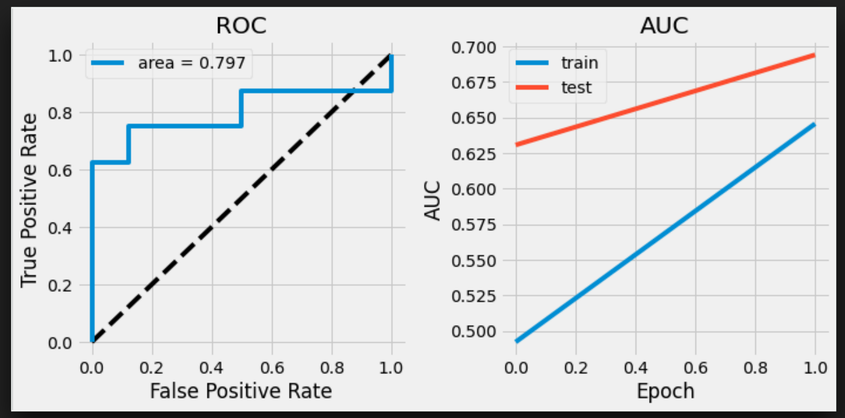


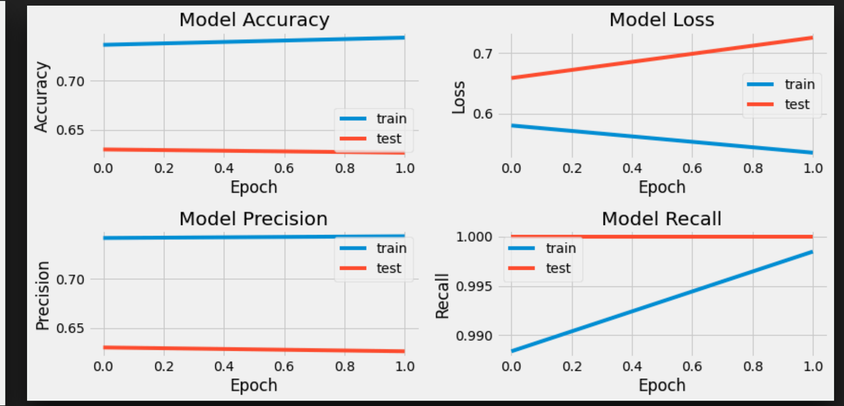
Interestingly enough, the model was now learning to always predict pneumonia after only a couple batches had processed.

Model Progress

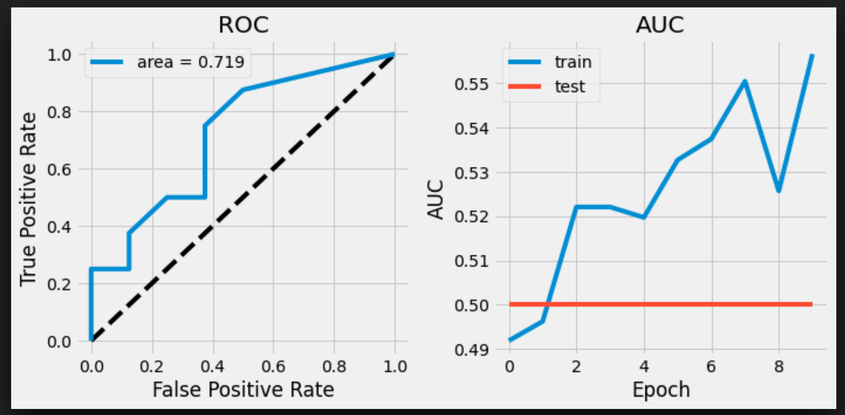
After Switching Datasets

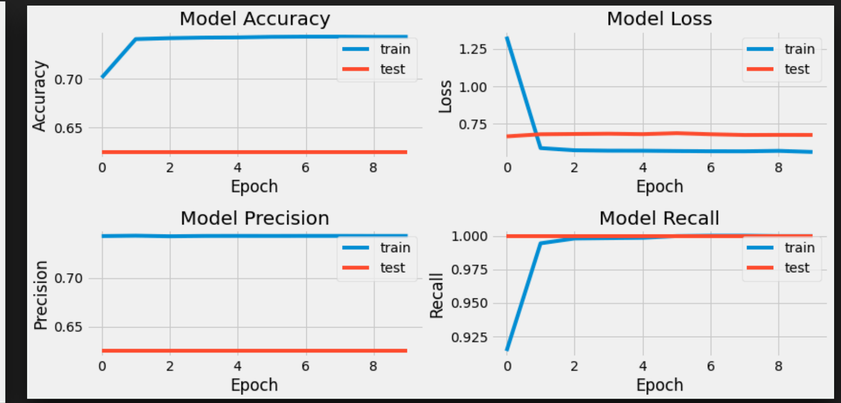
Initial



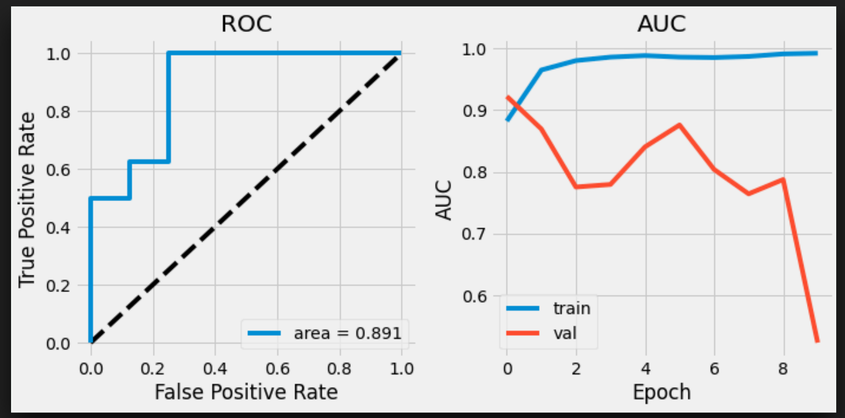


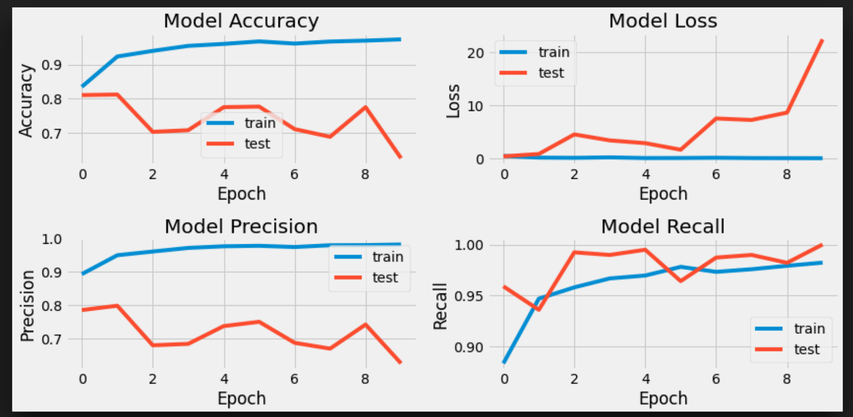
Removed Grayscale and Augmentation



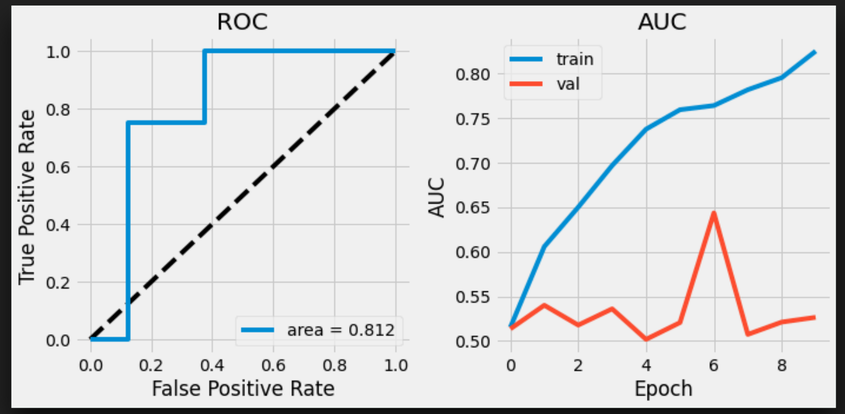


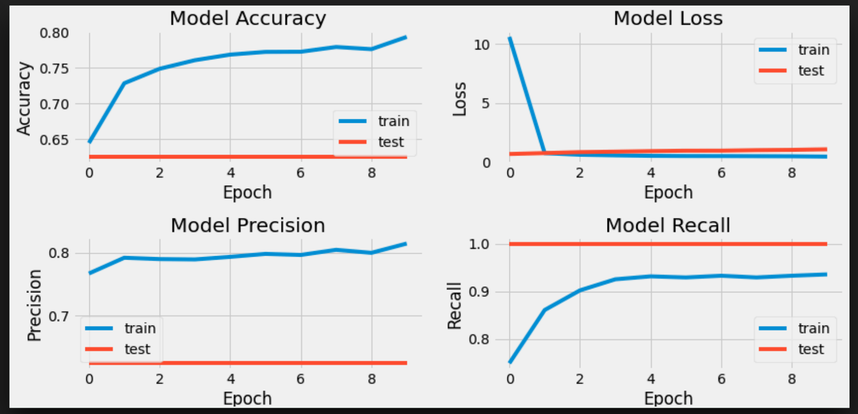
Unscaled Images /
Removed Dropout



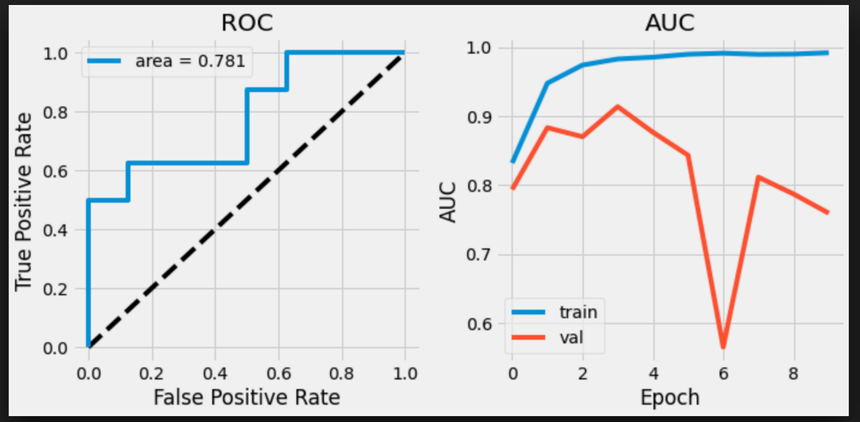


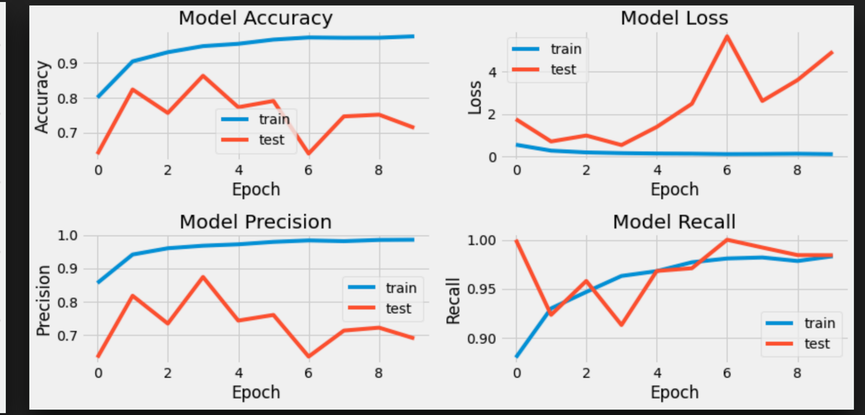
ReLU Activations /
Added Dropout



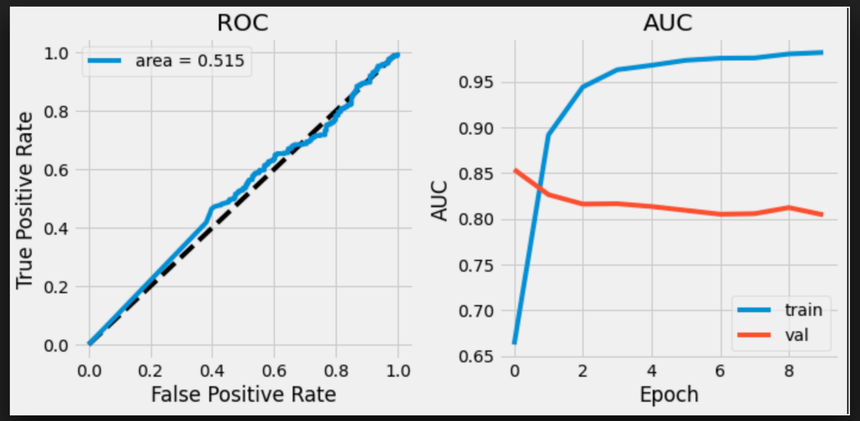


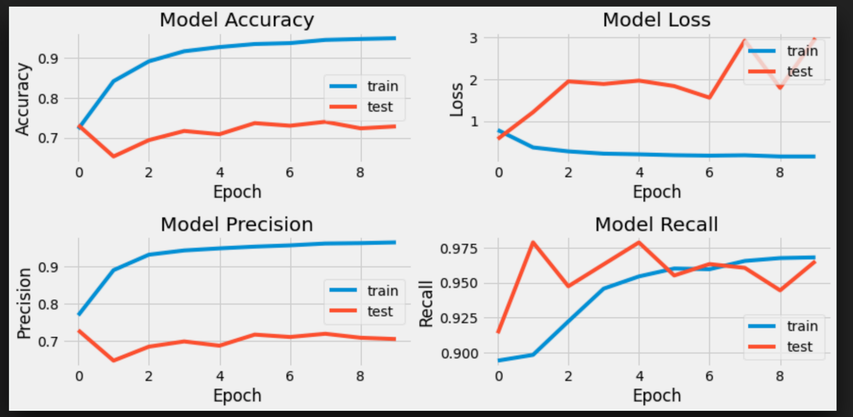
Weighted
Normal to 2



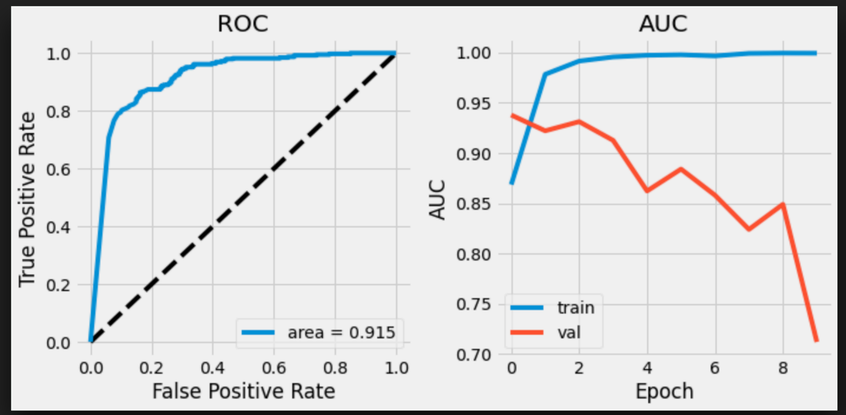


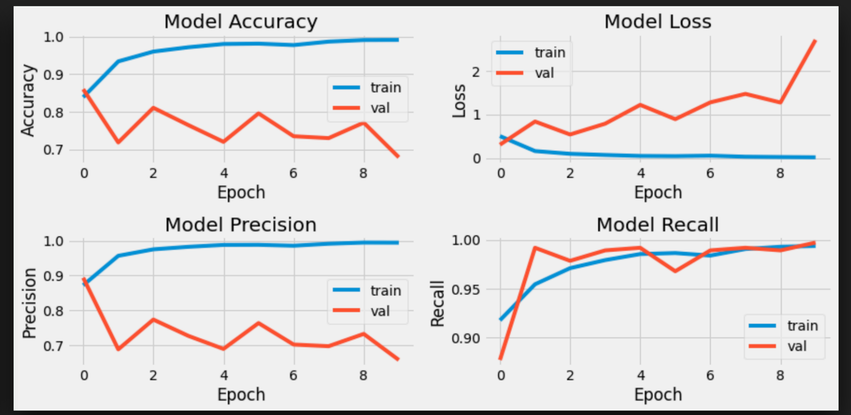
Changed Validation Images



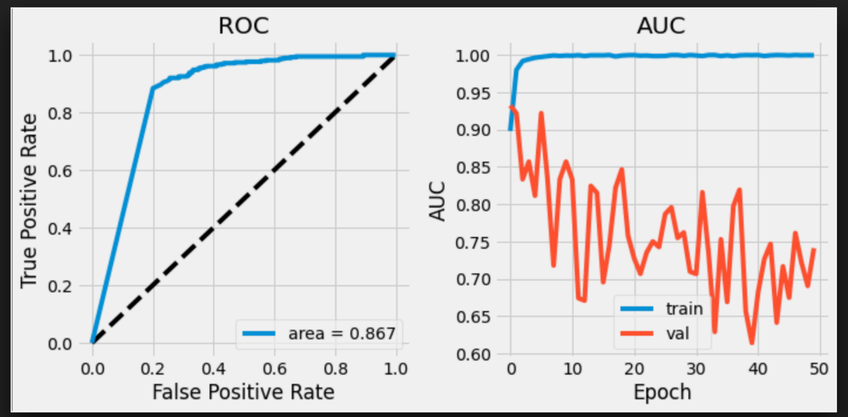


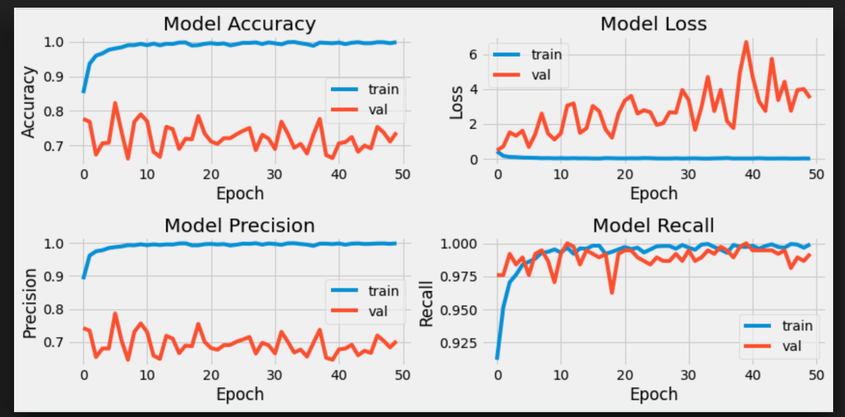
Removed Validation Shuffle



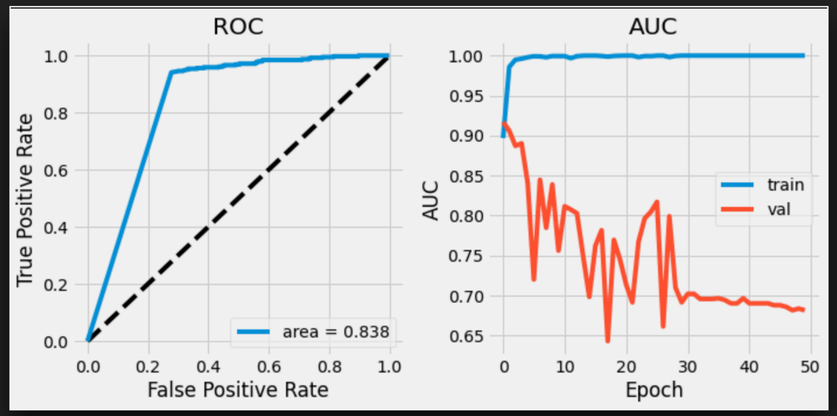


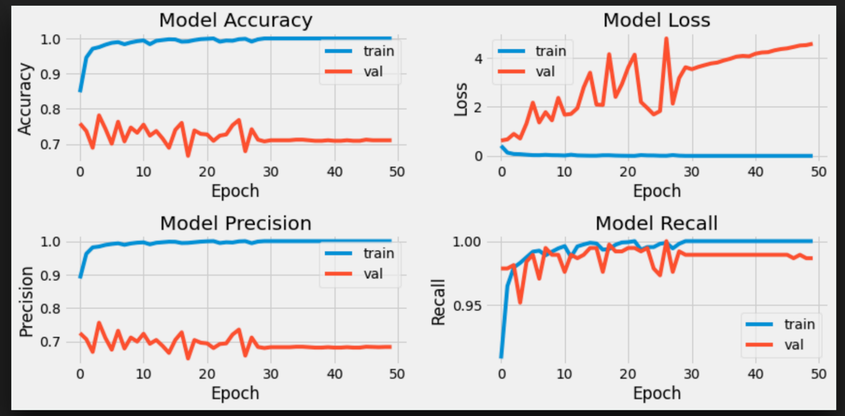
50 Epochs / 1 Dense Layer / Weighted Normal to 1.2



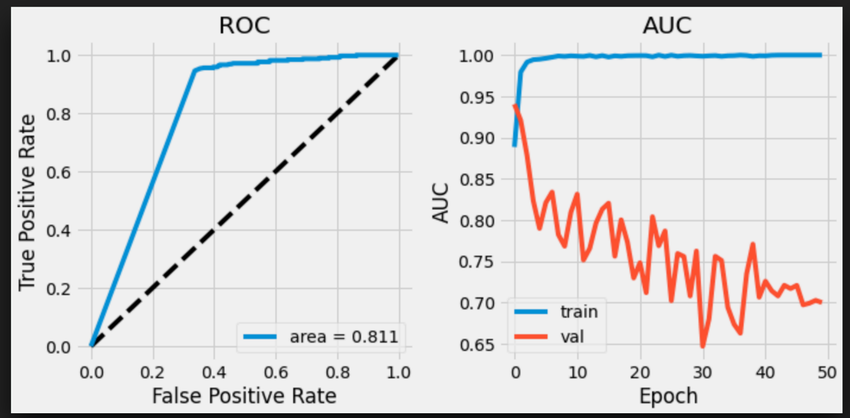


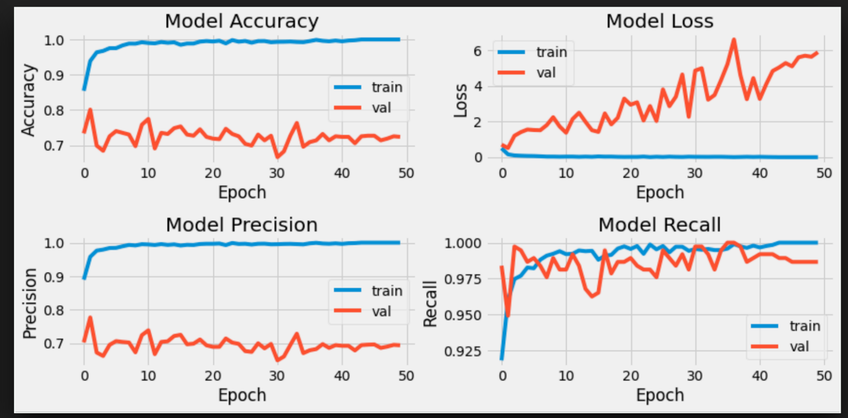
50 Epochs /
All Activations Swish



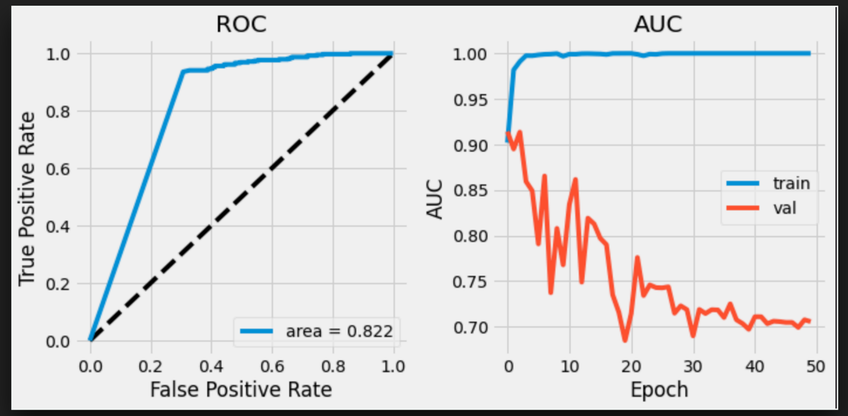


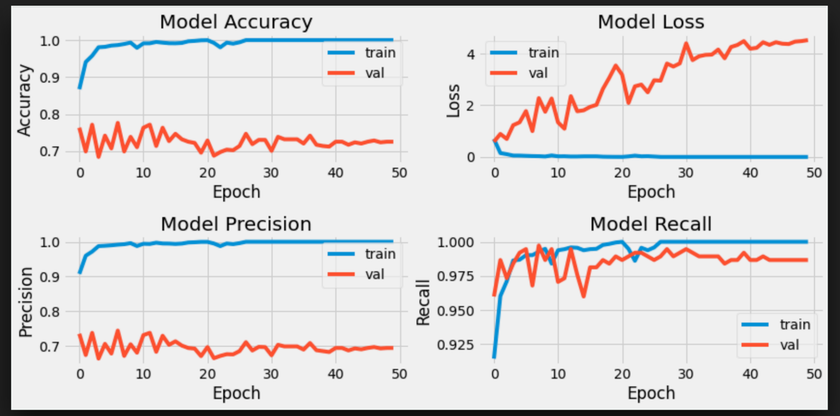
50 Epochs /
All Activations ReLU



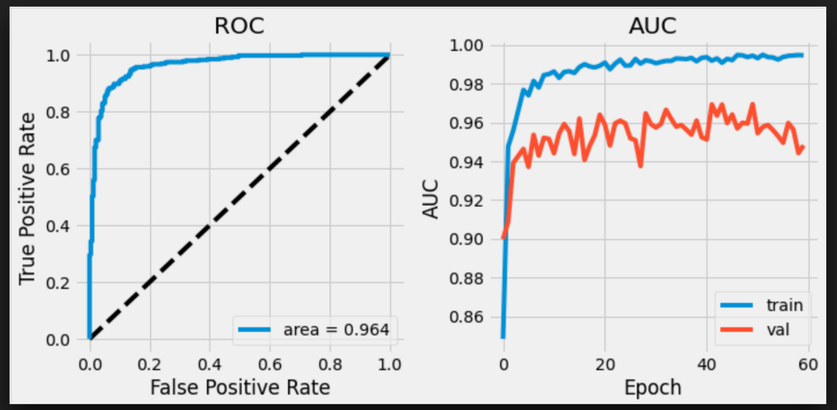


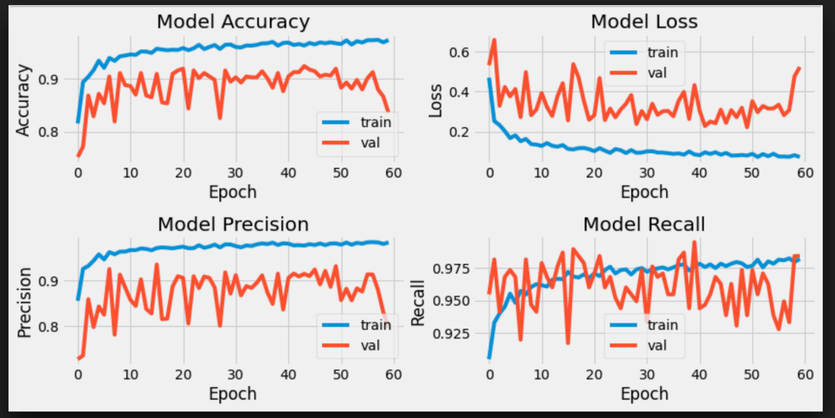
Removed last conv
layer. Dense units
512 to 256



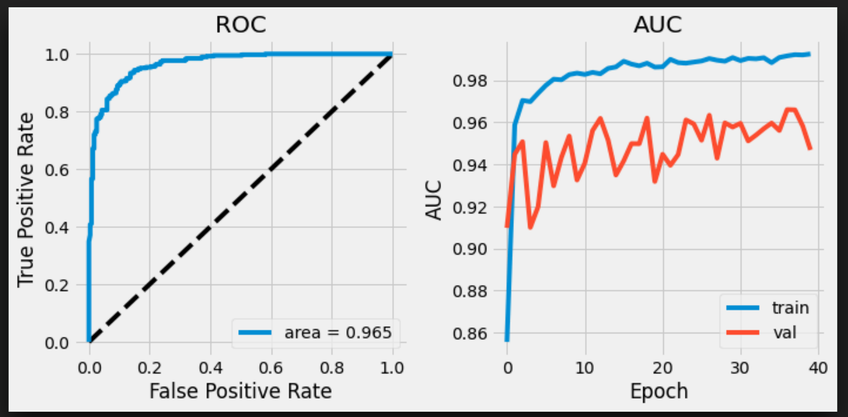


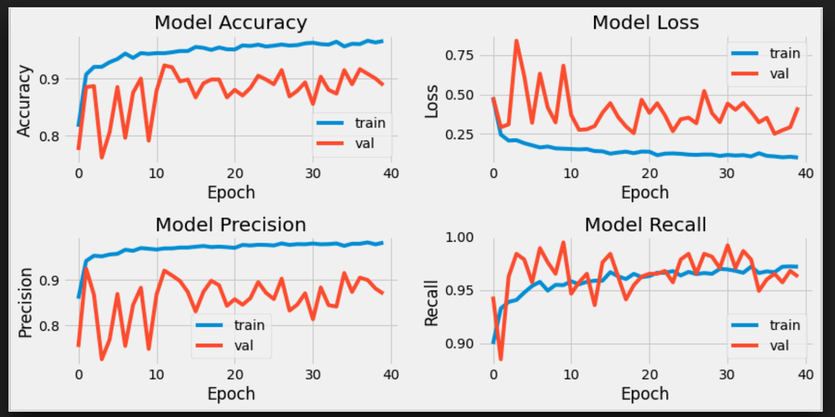
Added Augmentation / 60 Epochs / Swish Activation



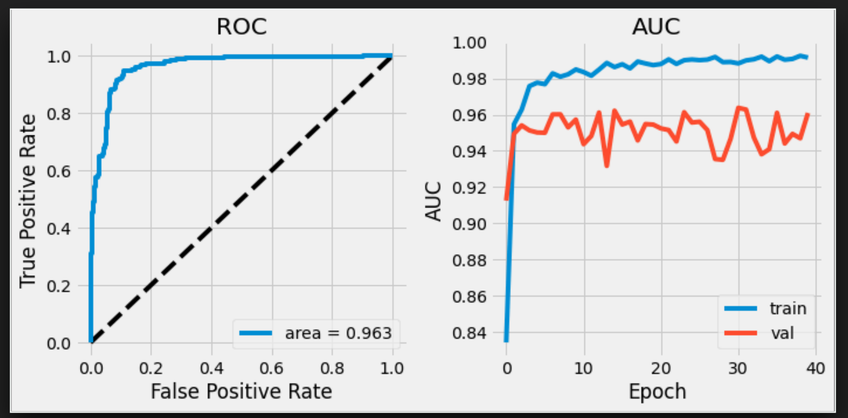


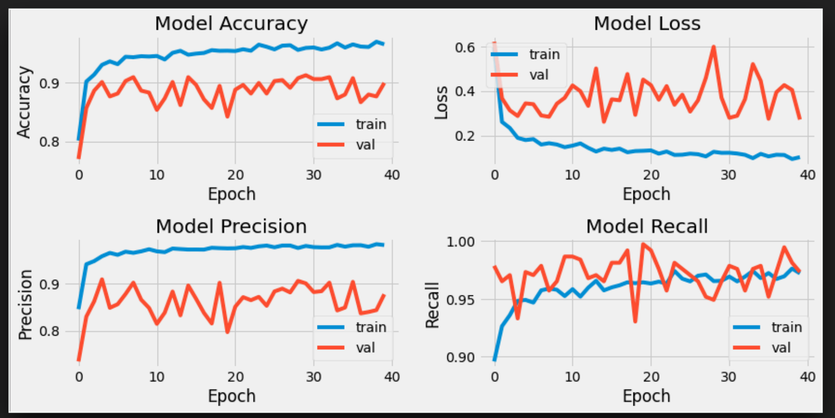
Added Second Dense Layer



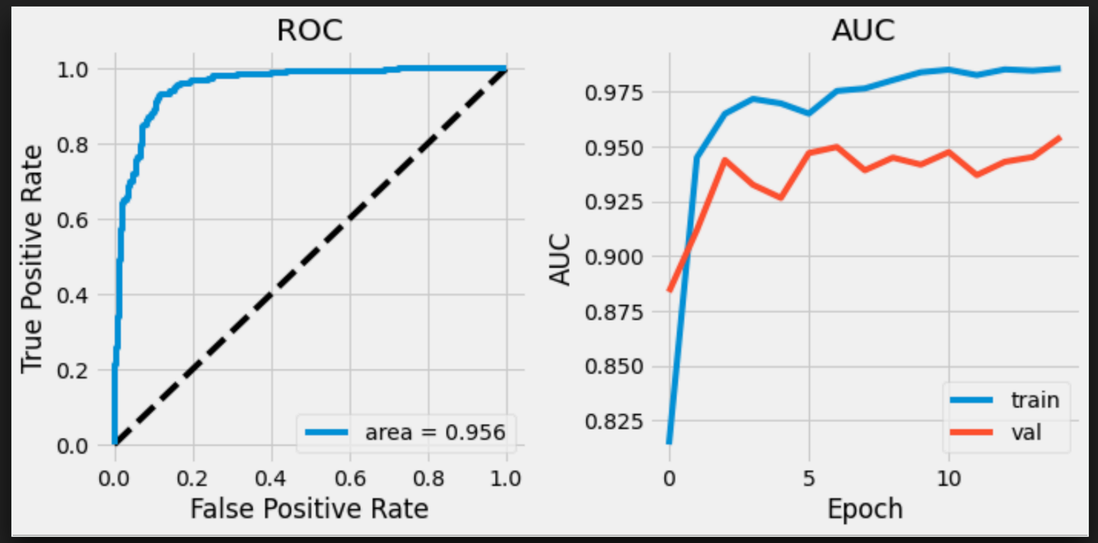


Added Second Dropout



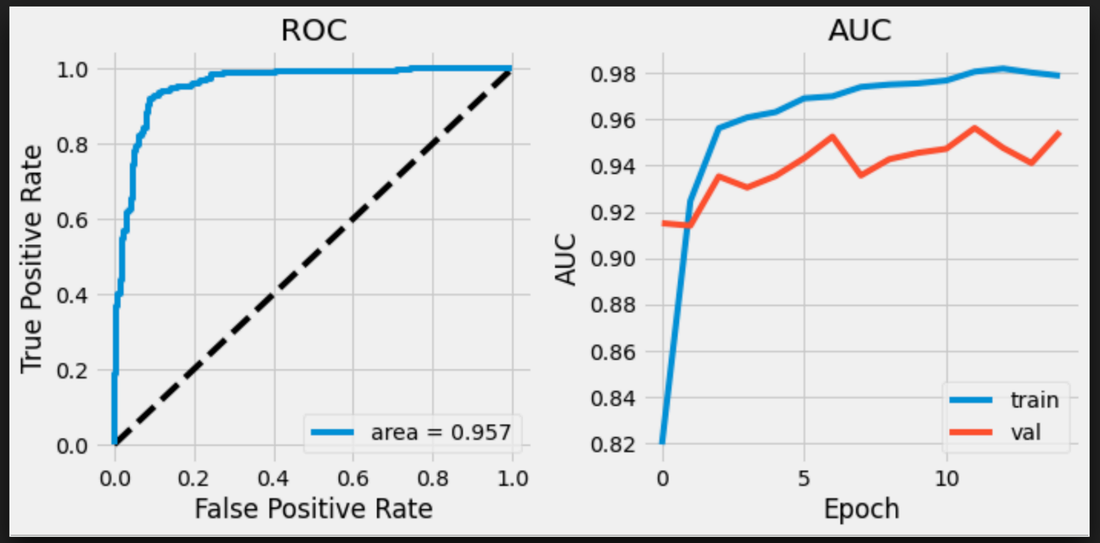


Swish




```
val_loss: 0.3222 - val_ACCURACY: 0.8832 - val_PRECISION: 0.8722
val_loss: 0.5814 - val_ACCURACY: 0.7845 - val_PRECISION: 0.7435
val_loss: 0.3392 - val_ACCURACY: 0.8882 - val_PRECISION: 0.8768
val_loss: 0.3694 - val_ACCURACY: 0.8882 - val_PRECISION: 0.8660
val_loss: 0.2897 - val_ACCURACY: 0.9030 - val_PRECISION: 0.8870
```

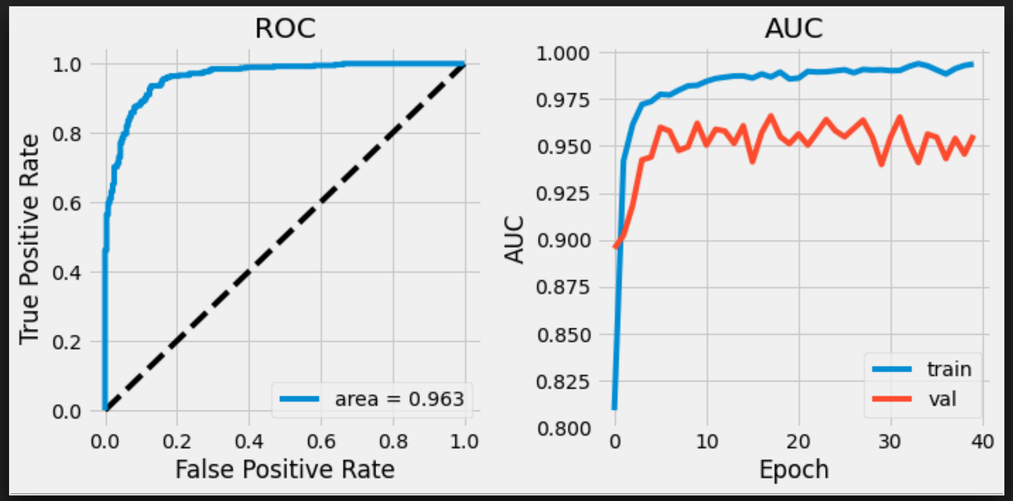
ReLU

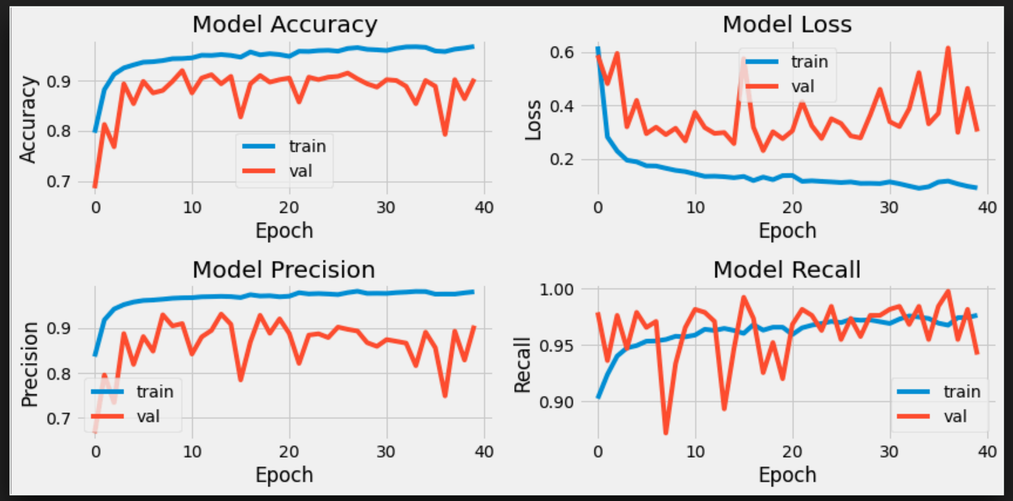



```
val_loss: 0.3002 - val_ACCURACY: 0.9062 - val_PRECISION: 0.8914
val_loss: 0.3494 - val_ACCURACY: 0.8684 - val_PRECISION: 0.8341
val_loss: 0.3133 - val_ACCURACY: 0.8898 - val_PRECISION: 0.8828
val_loss: 0.4338 - val_ACCURACY: 0.8618 - val_PRECISION: 0.8404
val_loss: 0.2806 - val_ACCURACY: 0.9013 - val_PRECISION: 0.8925
```

Layer (type)	Output Shape	Param #
conv2d_5 (Conv2D)	(None, 300, 300, 32)	896
max_pooling2d_5 (MaxPooling2)	(None, 150, 150, 32)	0
conv2d_6 (Conv2D)	(None, 150, 150, 64)	18496
max_pooling2d_6 (MaxPooling2)	(None, 75, 75, 64)	0
conv2d_7 (Conv2D)	(None, 38, 38, 64)	36928
max_pooling2d_7 (MaxPooling2)	(None, 19, 19, 64)	0
conv2d_8 (Conv2D)	(None, 10, 10, 128)	73856
max_pooling2d_8 (MaxPooling2)	(None, 5, 5, 128)	0
conv2d_9 (Conv2D)	(None, 3, 3, 128)	147584
max_pooling2d_9 (MaxPooling2)	(None, 1, 1, 128)	0
flatten_1 (Flatten)	(None, 128)	0
dense_2 (Dense)	(None, 256)	33024
dropout_1 (Dropout)	(None, 256)	0
dense_3 (Dense)	(None, 1)	257

Final Model





Accuracy: 0.9030 AUC: 0.9558

Precision: 0.9049 Recall: 0.9412

Conclusions

Even though I can not personally, differentiate between a chest X-ray showing pneumonia and one that does not, the network seemed to pick up on the difference fairly quickly.

Key Takeaways

Class Imbalance

True Positives | True Negatives

ROC Curves | Area Under the Curve

Model Complexity

Overfitting / Image Augmentation

Cloud Computing

Next Steps

Apply this model to X-rays from the local hospital

Go back and try COVID again