Data Science Career Track

Capstone 2 -

Final Report

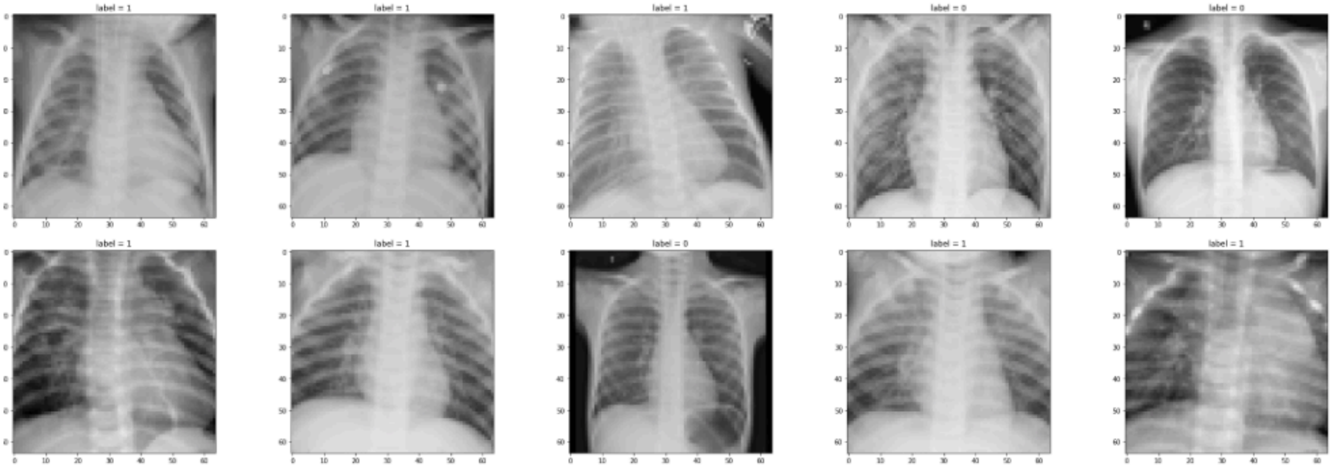
by Edward Franke
06/11/2019

Detect Pneumonia is chest x-rays Project – Final Report

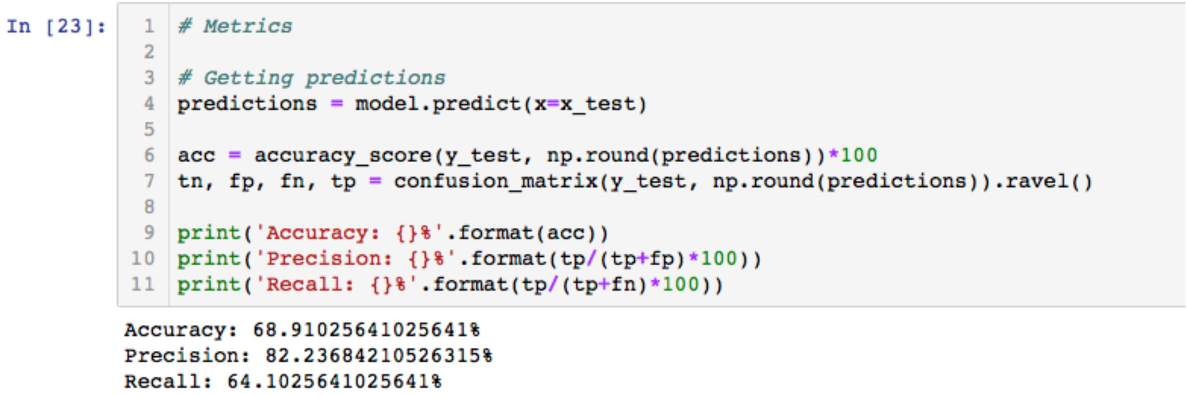
EXECUTIVE SUMMARY:

The purpose for this project is to find a correlation connected to chest x-rays containing pneumonia that can separate them in real time compared to normal healthy chest x-rays. The dataset is a cleaned dataset from Kaggle.com. Tensorflow and Keras has discovered connections and methods to determine which x-rays have pneumonia with varying success.

IDEA: A model to detect pneumonia is chest x-rays. (problem to solve)
CLIENT: Medical Industry
REASON: Pneumonia is a very serious condition that has the potential for death. I have personal knowledge of how serious it can be. The sooner it can be detected, the better the chance for survival and less damage to the lungs.
DATA: From Kaggle, 2 cleaned datasets with 5863 images and over 112,000 images.
SOLUTION: Create a model or analysis to discover what makes an x-ray image of the chest to have pneumonia and to capture this automatically.
DETAILS: See below.
DELIVERABLES: Code and a presentation outlining the discoveries.



Pneumonia Dataset

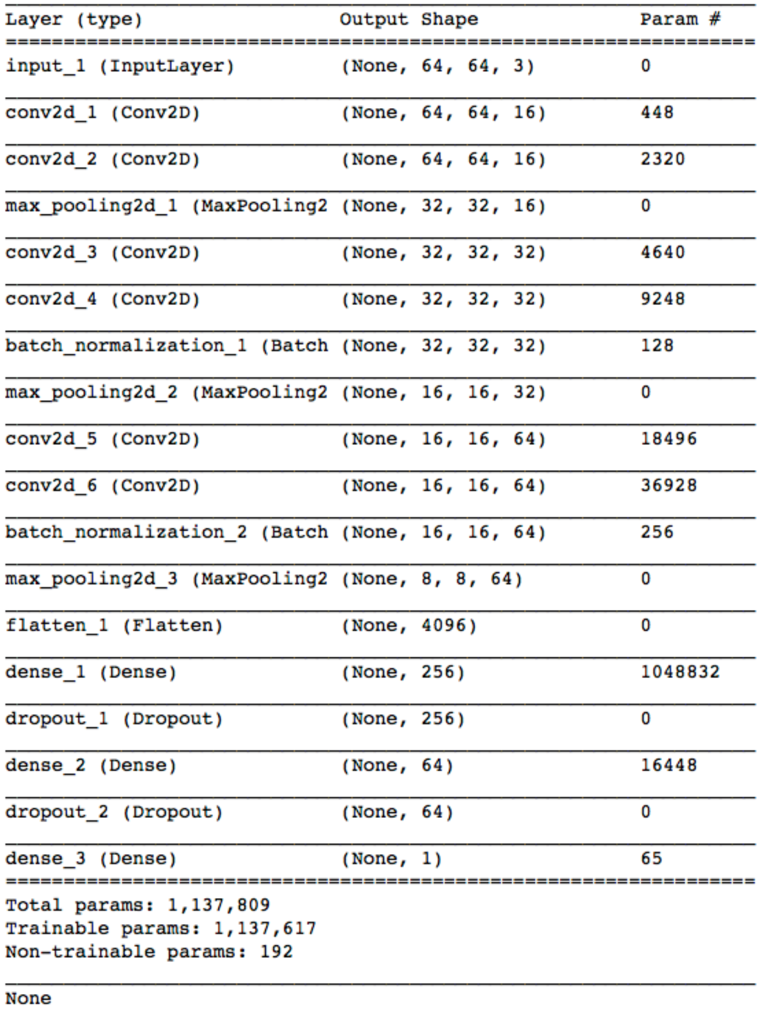


```
In [23]:
```

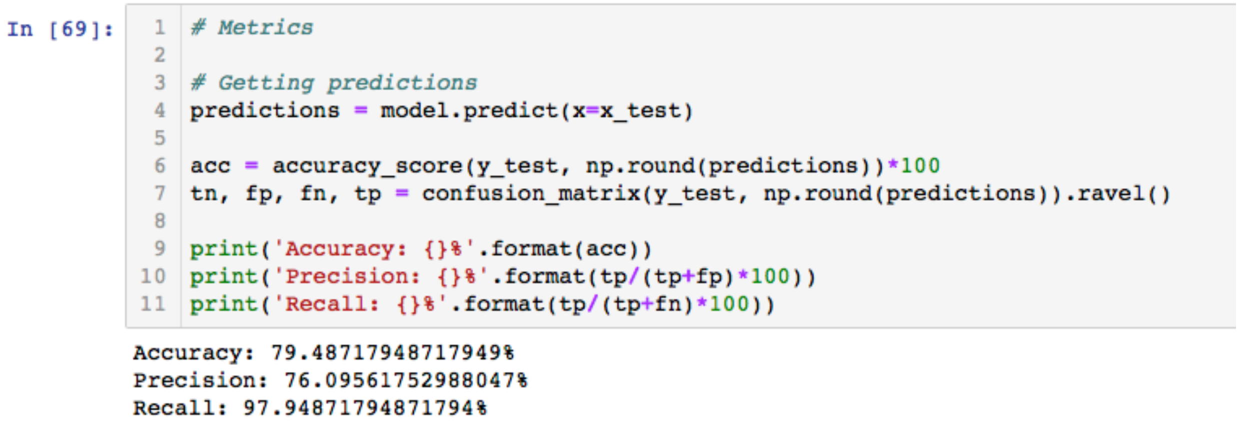
```python
# Metrics

# Getting predictions
predictions = model.predict(x=x_test)

acc = accuracy_score(y_test, np.round(predictions))*100
tn, fp, fn, tp = confusion_matrix(y_test, np.round(predictions)).ravel()

print('Accuracy: {}%'.format(acc))
print('Precision: {}%'.format(tp/(tp+fp)*100))
print('Recall: {}%'.format(tp/(tp+fn)*100))
```

```
Accuracy: 68.91025641025641%
Precision: 82.23684210526315%
Recall: 64.1025641025641%
```

Tensorflow and Keras has discovered some connections.



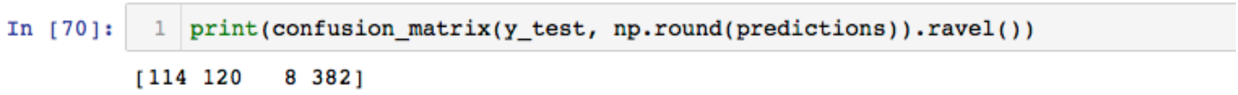
```
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
input_1 (InputLayer)         (None, 64, 64, 3)         0         
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 64, 64, 16)        448       
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 64, 64, 16)        2320      
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 32, 32, 16)        0         
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 32, 32, 32)        4640      
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 32, 32, 32)        9248      
_________________________________________________________________
batch_normalization_1 (Batch (None, 32, 32, 32)        128       
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 16, 16, 32)        0         
_________________________________________________________________
conv2d_5 (Conv2D)            (None, 16, 16, 64)        18496     
_________________________________________________________________
conv2d_6 (Conv2D)            (None, 16, 16, 64)        36928     
_________________________________________________________________
batch_normalization_2 (Batch (None, 16, 16, 64)        256       
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 8, 8, 64)          0         
_________________________________________________________________
flatten_1 (Flatten)          (None, 4096)              0         
_________________________________________________________________
dense_1 (Dense)              (None, 256)               1048832   
_________________________________________________________________
dropout_1 (Dropout)          (None, 256)               0         
_________________________________________________________________
dense_2 (Dense)              (None, 64)                16448     
_________________________________________________________________
dropout_2 (Dropout)          (None, 64)                0         
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 65        
=================================================================
Total params: 1,137,809
Trainable params: 1,137,617
Non-trainable params: 192
_________________________________________________________________
None
```



In [69]:

```
# Metrics

# Getting predictions
predictions = model.predict(x=x_test)

acc = accuracy_score(y_test, np.round(predictions))*100
tn, fp, fn, tp = confusion_matrix(y_test, np.round(predictions)).ravel()

print('Accuracy: {}%'.format(acc))
print('Precision: {}%'.format(tp/(tp+fp)*100))
print('Recall: {}%'.format(tp/(tp+fn)*100))
```

```
Accuracy: 79.48717948717949%
Precision: 76.09561752988047%
Recall: 97.94871794871794%
```



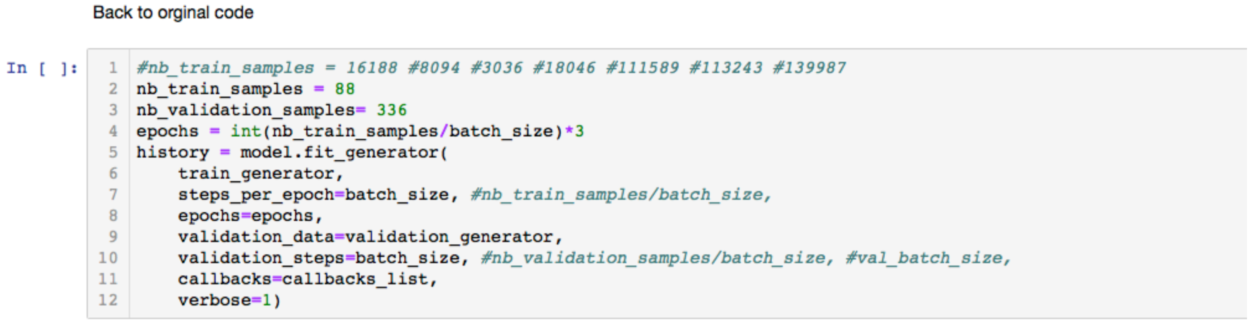
In [70]:

```
print(confusion_matrix(y_test, np.round(predictions)).ravel())
```

```
[114 120   8 382]
```

NIH Dataset

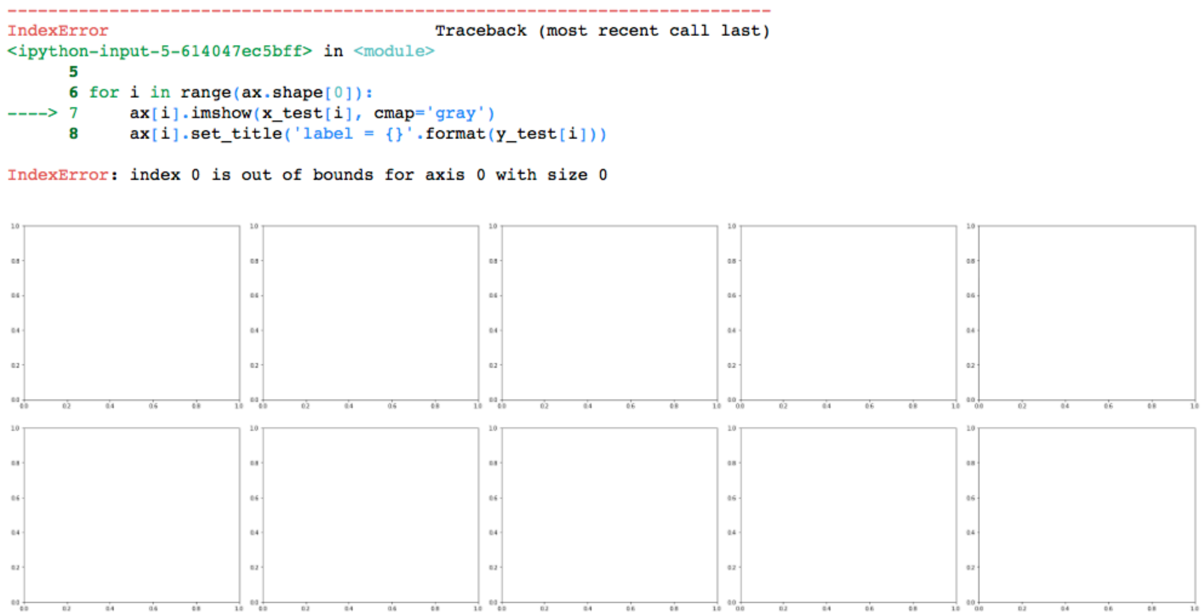
The NIH dataset contains 112,000 x-rays with varying ailments or no ailments. The code used for the Pneumonia dataset is ineffective on this dataset.



Back to orginal code

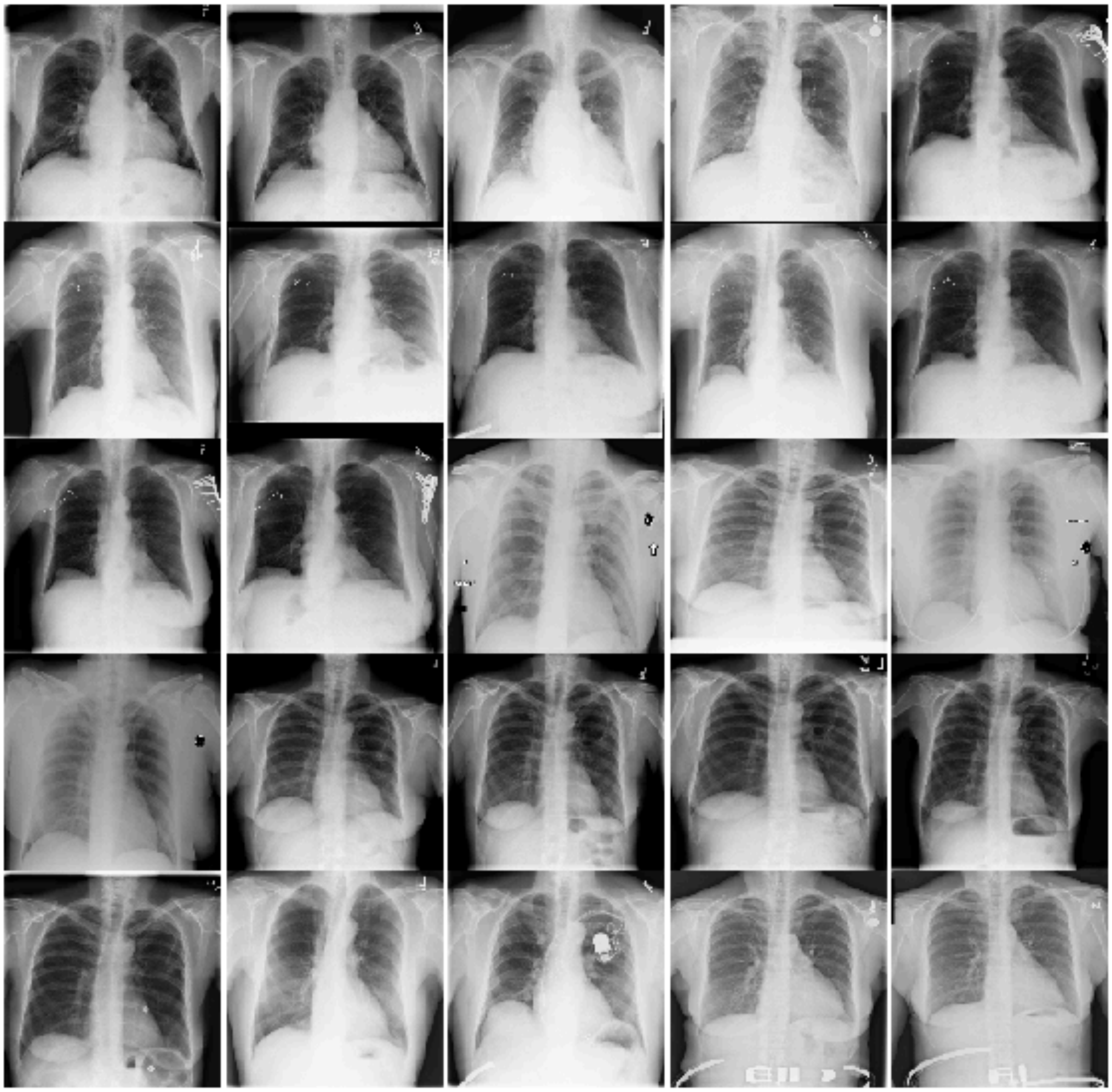
In [ ]:

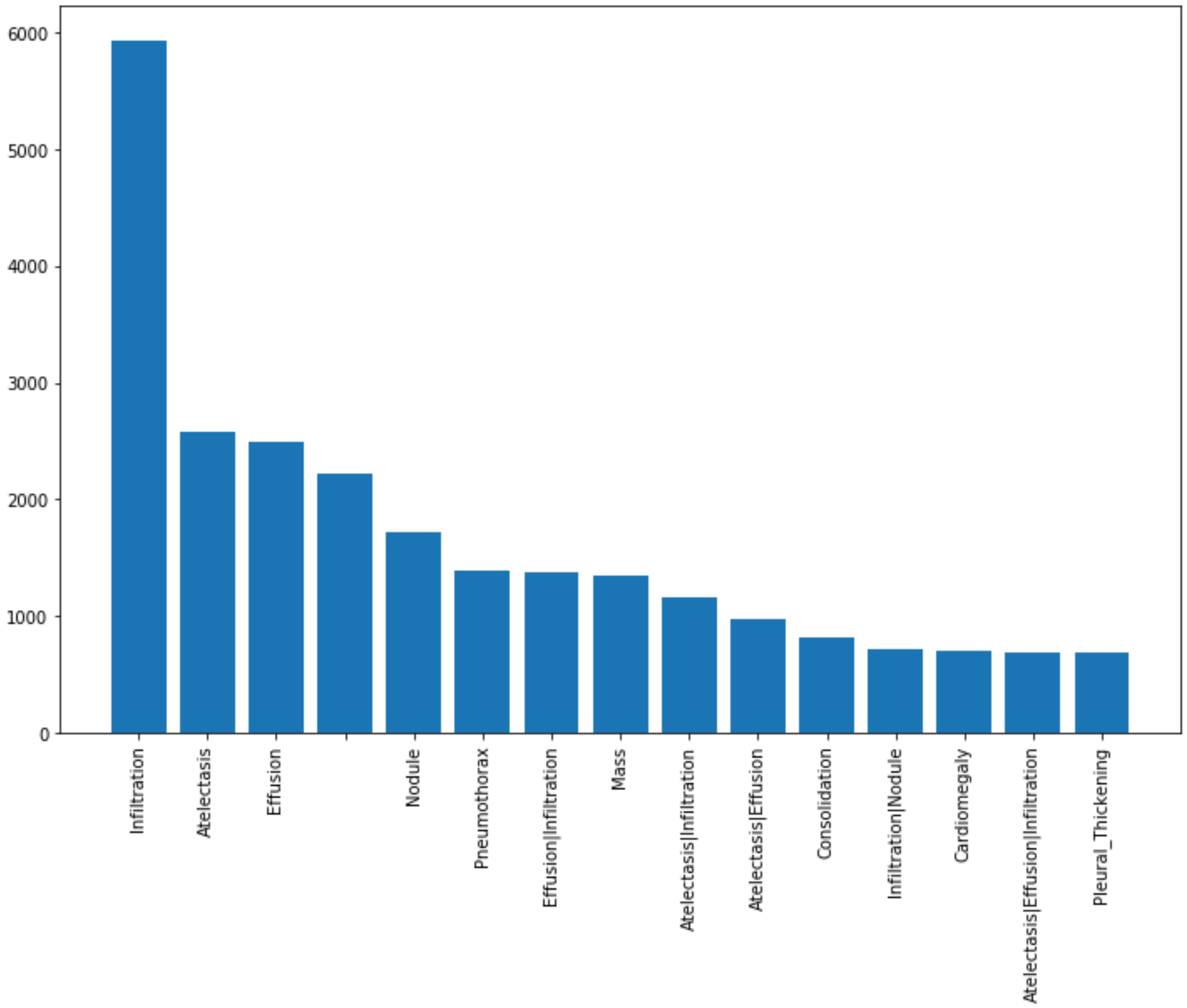
```
#nb_train_samples = 16188 #8094 #3036 #18046 #111589 #113243 #139987
nb_train_samples = 88
nb_validation_samples= 336
epochs = int(nb_train_samples/batch_size)*3
history = model.fit_generator(
    train_generator,
    steps_per_epoch=batch_size, #nb_train_samples/batch_size,
    epochs=epochs,
    validation_data=validation_generator,
    validation_steps=batch_size, #nb_validation_samples/batch_size, #val_batch_size,
    callbacks=callbacks_list,
    verbose=1)
```

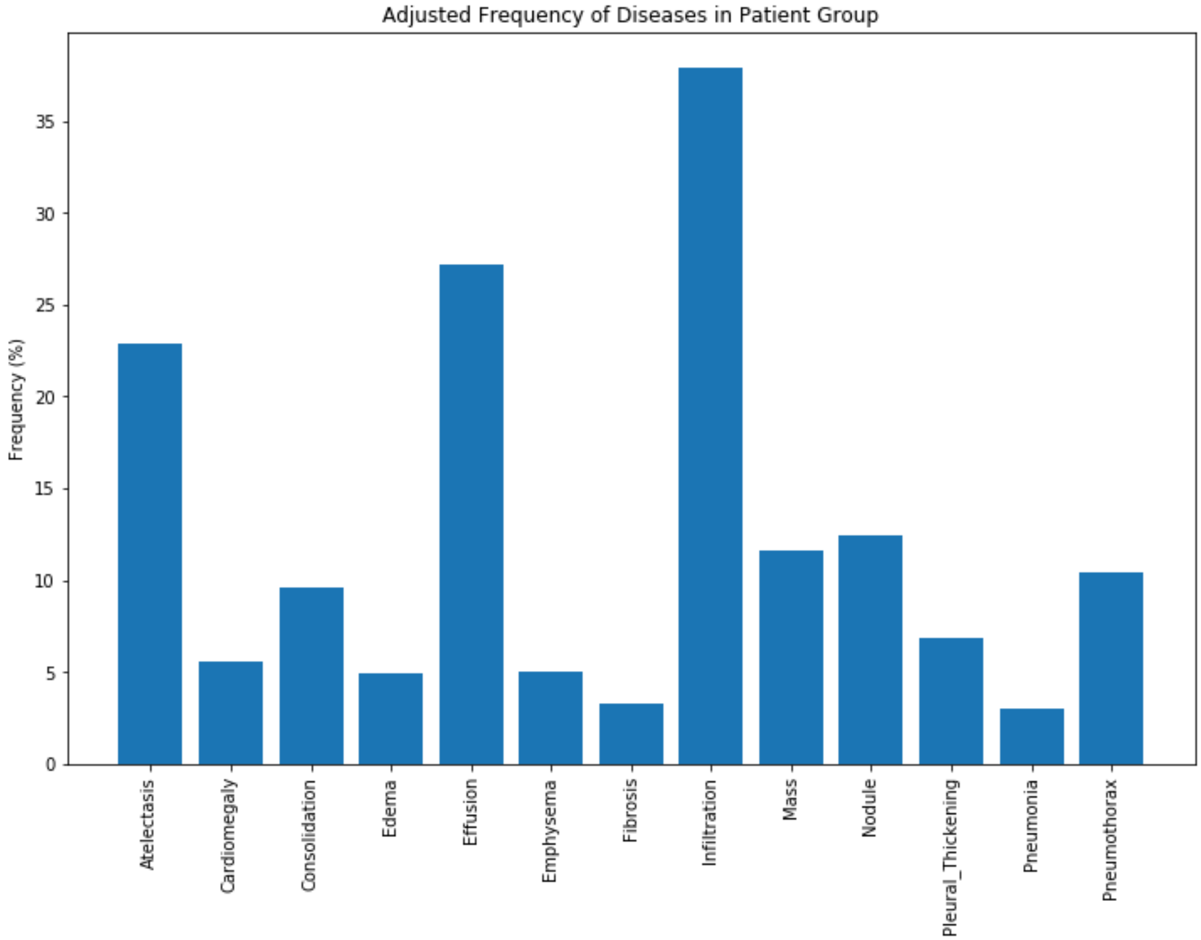


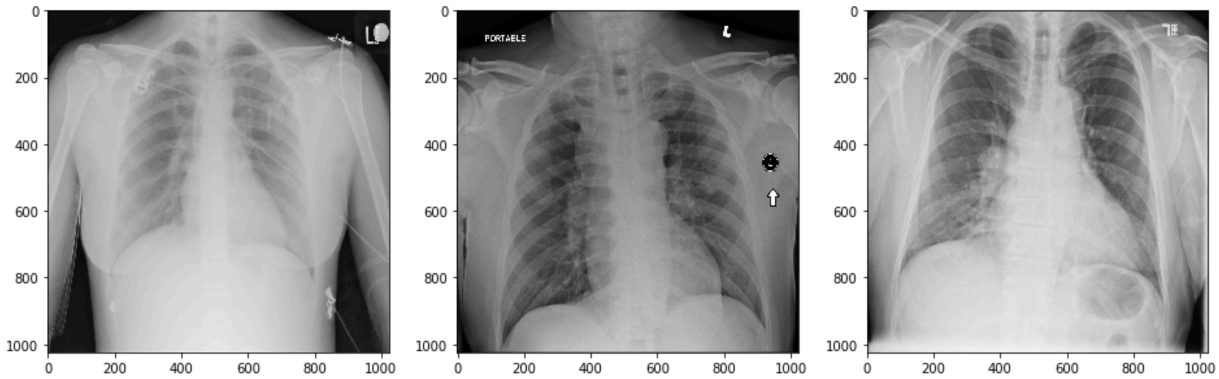
```
---------------------------------------------------------------------------
IndexError                                Traceback (most recent call last)
<ipython-input-5-614047ec5bff> in <module>
      5 
      6 for i in range(ax.shape[0]):
----> 7     ax[i].imshow(x_test[i], cmap='gray')
      8     ax[i].set_title('label = {}'.format(y_test[i]))

IndexError: index 0 is out of bounds for axis 0 with size 0
```

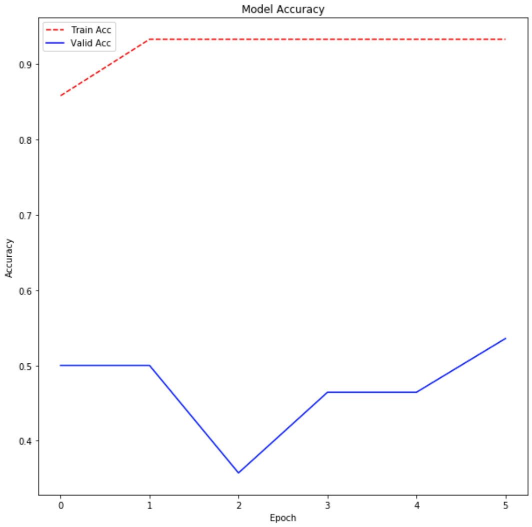
Code written specifically for this dataset gathers labels from a csv file and is also able to analyze the images to determine the ailment being searched for. This code was originally set to discover Fibromyalgia but was modified to detect Pneumonia.



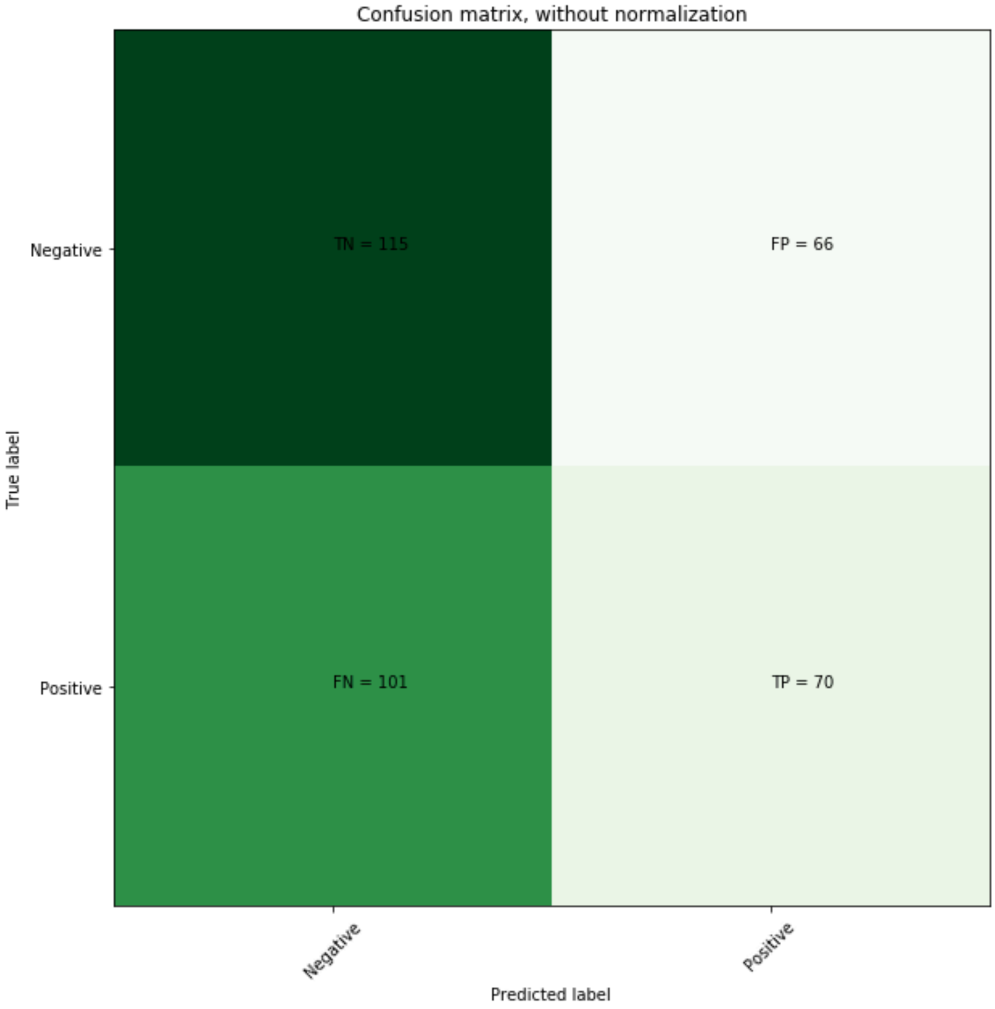

6000
5000
4000
3000
2000
1000
0
Infiltration
Atelectasis
Effusion
Nodule
Pneumothorax
Effusion|Infiltration
Mass
Atelectasis|Infiltration
Atelectasis|Effusion
Consolidation
Infiltration|Nodule
Cardiomegaly
Atelectasis|Effusion|Infiltration
Pleural_Thickening


Adjusted Frequency of Diseases in Patient Group
Frequency (%)
0
5
10
15
20
25
30
35
Atelectasis
Cardiomegaly
Consolidation
Edema
Effusion
Emphysema
Fibrosis
Infiltration
Mass
Nodule
Pleural_Thickening
Pneumonia
Pneumothorax


0
200
400
600
800
1000
PORTABLE
L



Tensorflow and Keras has discovered some connections. With the number of Epochs increased, the accuracy will also increased but this will also require decent computer processing power due to the number of images being processed.


Confusion matrix, without normalization
TN = 115
FP = 66
FN = 101
TP = 70
Negative
Positive
True label
Negative
Positive
Predicted label