Radiology Image Classification

Detecting Pneumonia in Children

IST 718 Final Project Presentation - Group 2

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Agenda

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- Project Goals
- Data Description
- Data Modeling
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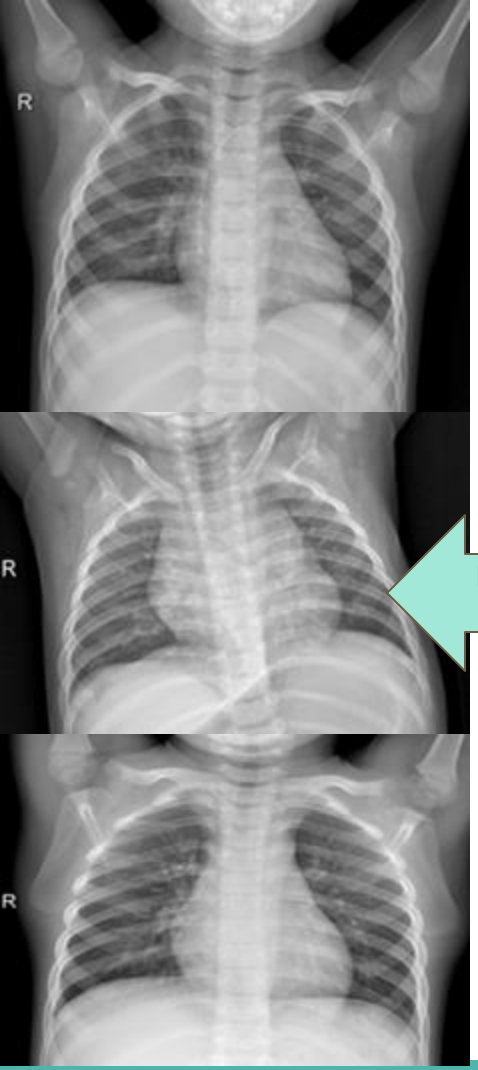
Project Goals

- Develop a classification model for accurately classifying chest x-ray images into “normal” and “pneumonia”
- Develop reliable auto-screening of X-Rays for pneumonia in the medical field
- Enhance the efficiency in identifying pneumonia or pneumonia-like X-ray and help doctors



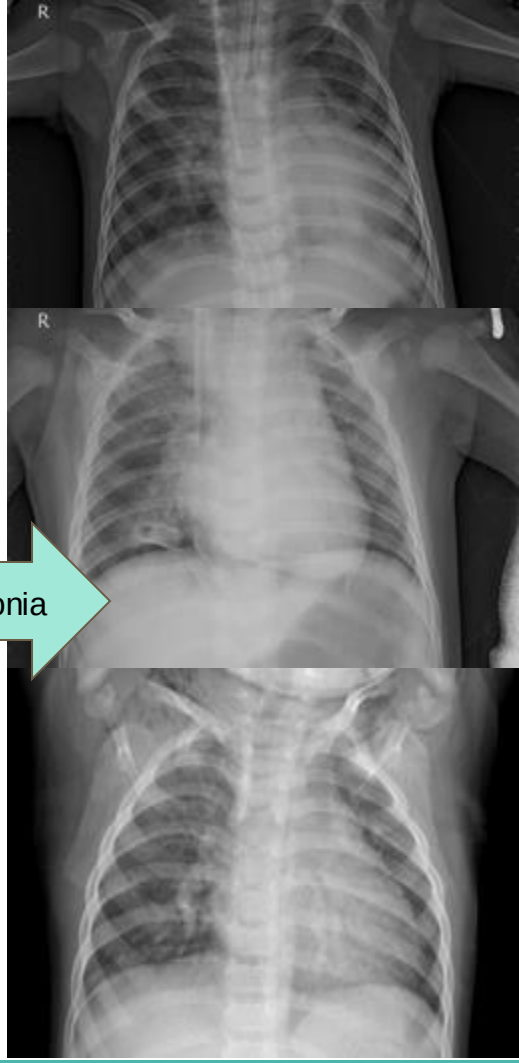
Business question(s)

How accurately can we predict pneumonia?

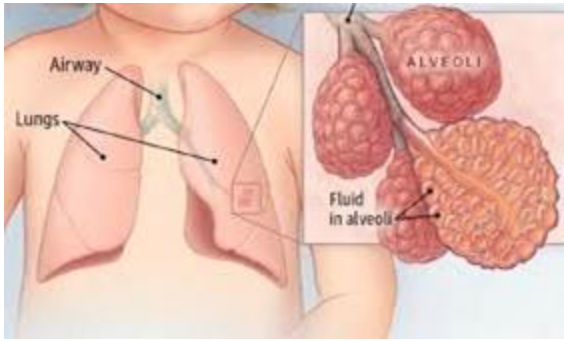
1. Which model best identifies/predicts the pneumonia vs. normal lung x-rays?
2. How accurate are the respective models?

Normal Lungs

Pneumonia



Background



- Pneumonia is a respiratory infection caused by bacteria or viruses.
- It affects many individuals, with high levels of pollution, unhygienic living conditions, and overcrowding are relatively common, together with inadequate medical infrastructure.
- Pneumonia causes pleural effusion, a condition in which fluids fill the lung, causing respiratory difficulty.
- Early diagnosis of pneumonia is crucial to ensure curative treatment and increase survival rates.
- Chest X-ray imaging is the most frequently used method for diagnosing pneumonia.
- The examination of chest X-rays is a challenging task and is prone to subjective variability.

Right lower lobe consolidation in a patient with bacterial pneumonia

Note: Kundu R, Das R, Geem ZW, Han GT, Sarkar R. Pneumonia detection in chest X-ray images using an ensemble of deep learning models. PLoS One. 2021 Sep 7;16(9):e0256630. doi: 10.1371/journal.pone.0256630. PMID: 34492046; PMCID: PMC8423280.

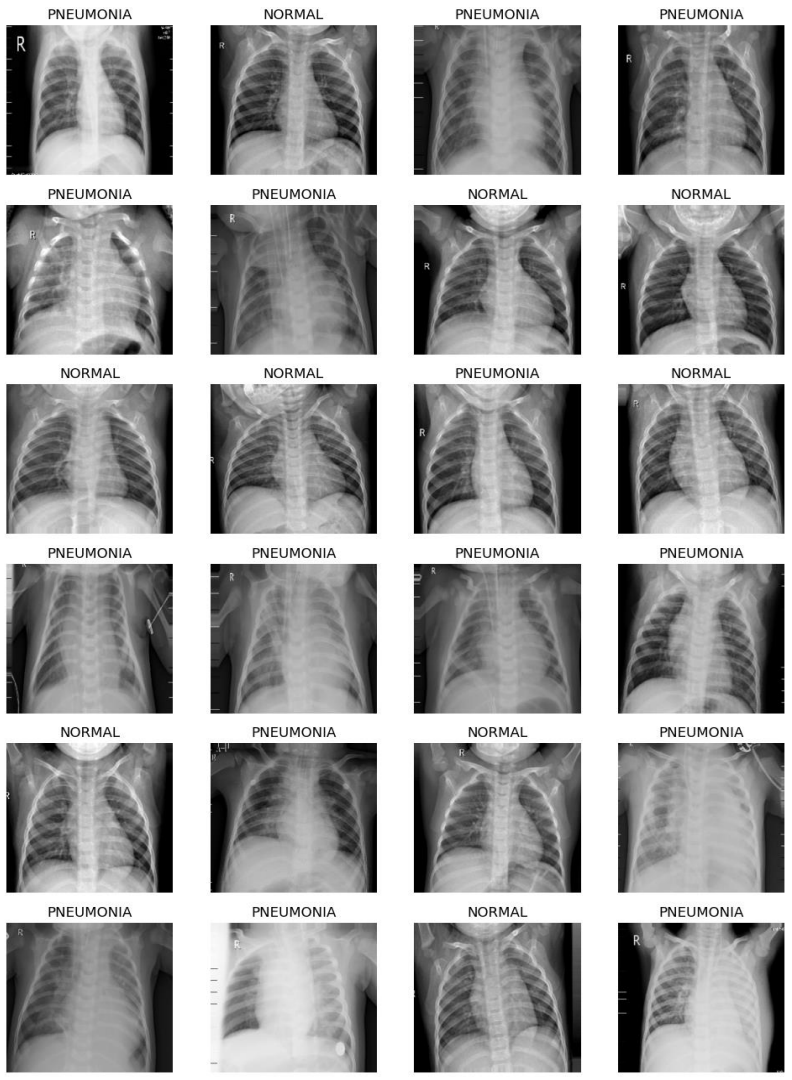
Dataset

Data source:
https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

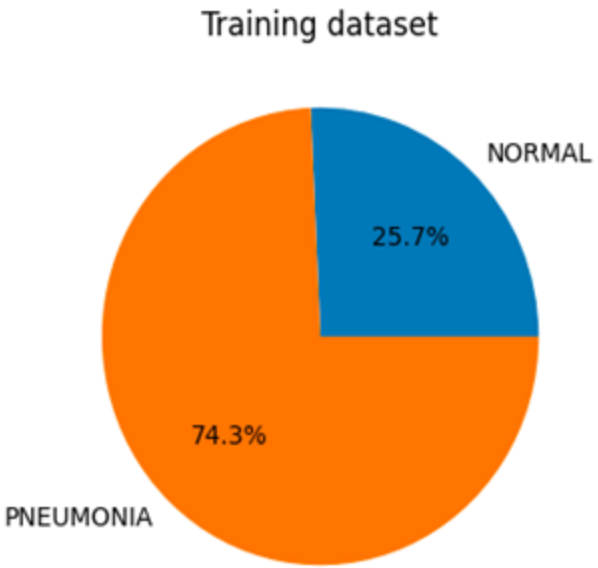
Data description:

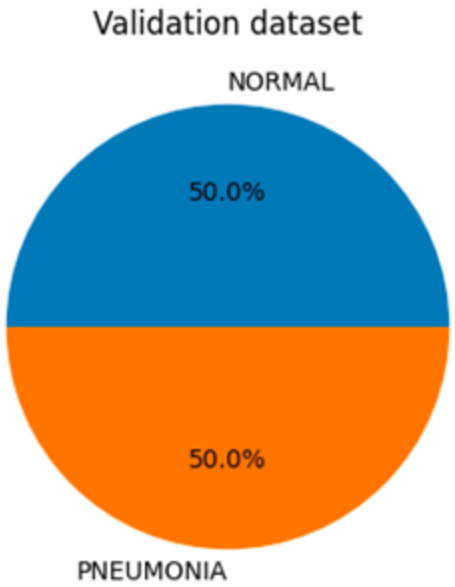
- 5863 chest x-ray images in total
- Pediatric Patient Ages: 1-5 years
- Guangzhou Women and Children's Medical Center in China

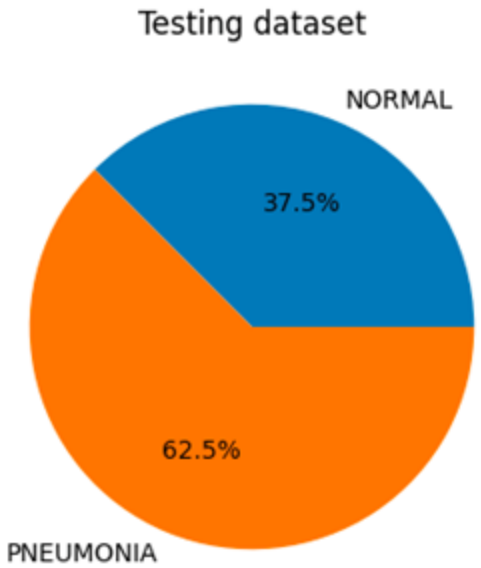
Data format: X-ray Images split in three datasets (Train, Validation, and Test)



Descriptive Analysis of the Train/Val/Test Data







5216 images

16 images

624 images

Data Analysis: ResNet Modeling

PyTorch

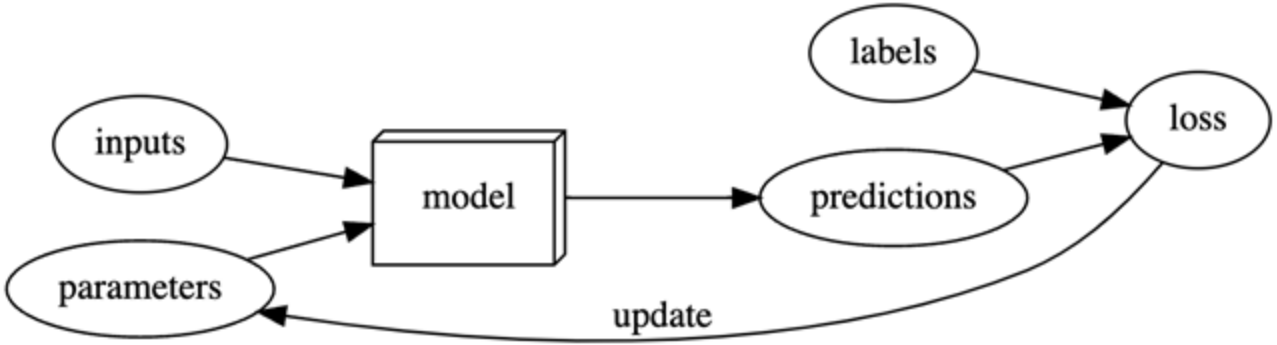
- Deep learning python-framework
- PyTorch vs TensorFlow
- PyTorch for Image Classification

Fastai

- Why fastai?
- Fastai for Image Classification
- Fastai and PyTorch

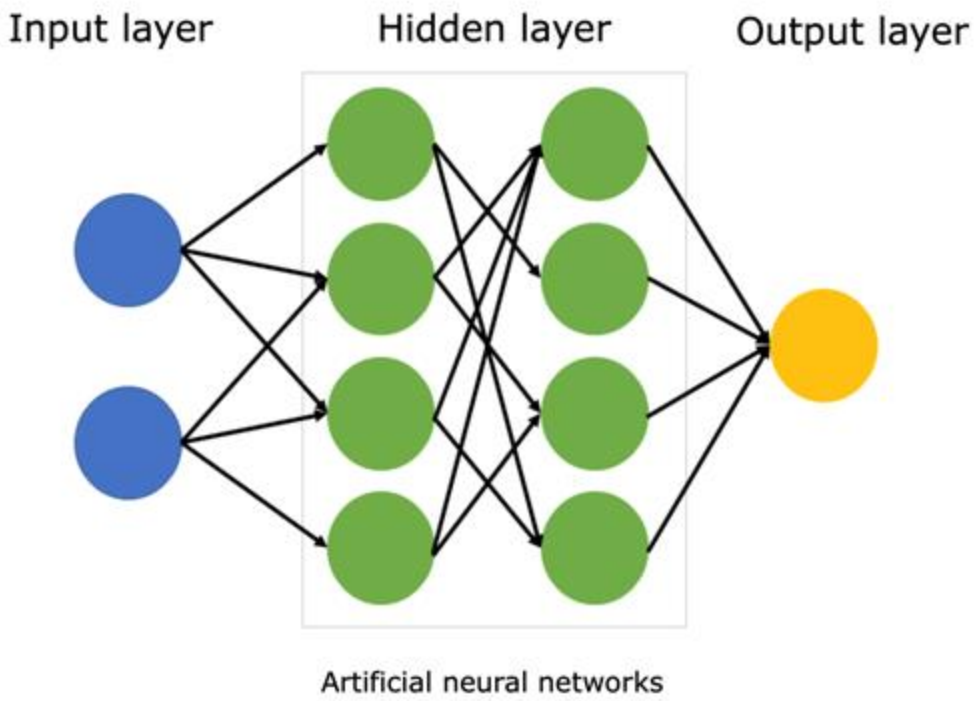
Models | Framework

- Backpropagation
  - What is it?
  - How does it work?
  - Why is it important?



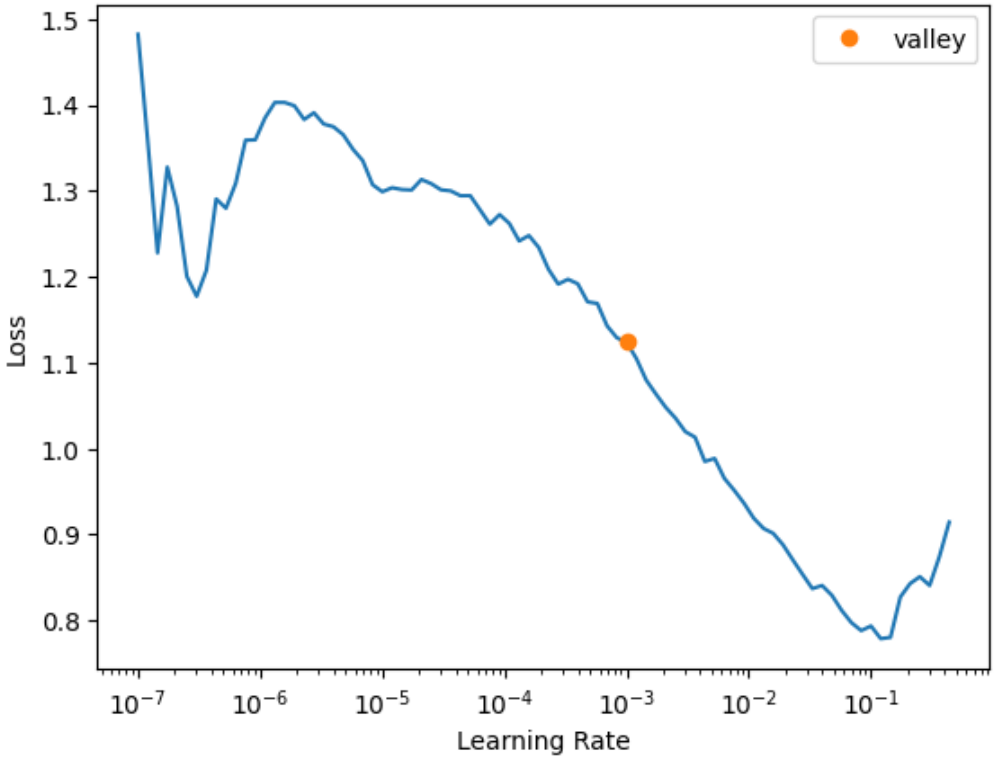
Models

- Resnet18
- Resnet50
- Resnet152



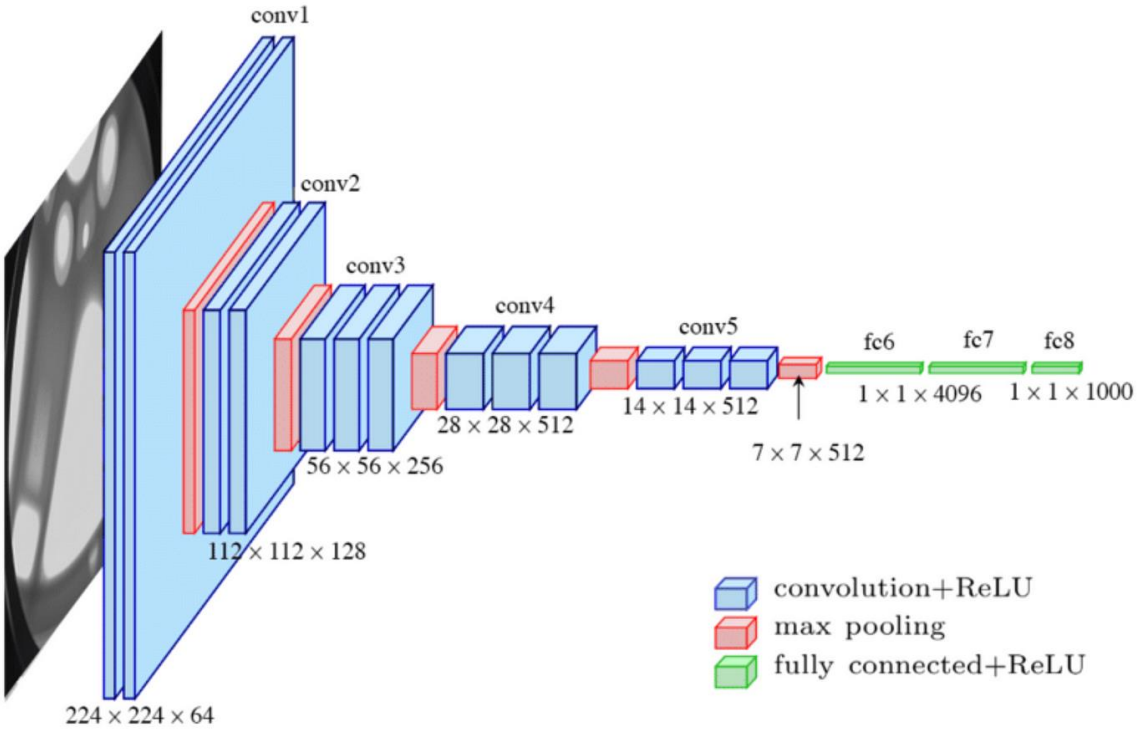
Results for Resnet Modeling

Model	Accuracy
RESNET18	84.78%
RESNET50	81.89%
RESNET152	85.58%
RESNET18 (Learning Rate Optimized)	85.26%



Data Analysis: VGG-16 Modeling

Model 2: VGG 16



•All configurations of VGG have block structures.

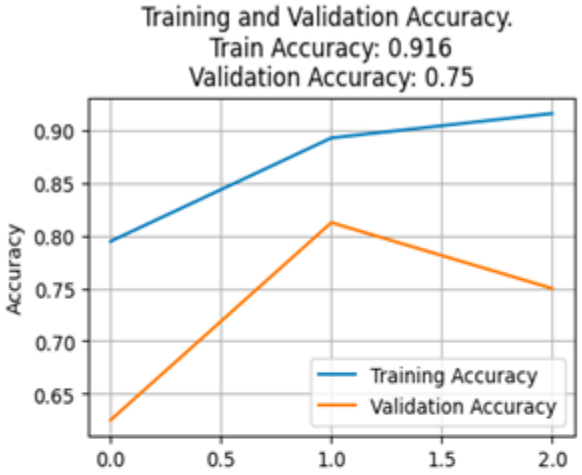
•Each VGG block consists of a sequence of convolutional layers which are followed by a max-pooling layer. The same kernel size (3 × 3) is applied over all convolutional layers.

• A padding size of 1 is applied to keep the size of the output after each convolutional layer.

•A max-pooling of size 2 × 2 with strides of 2 is also applied to halve the resolution after each block.

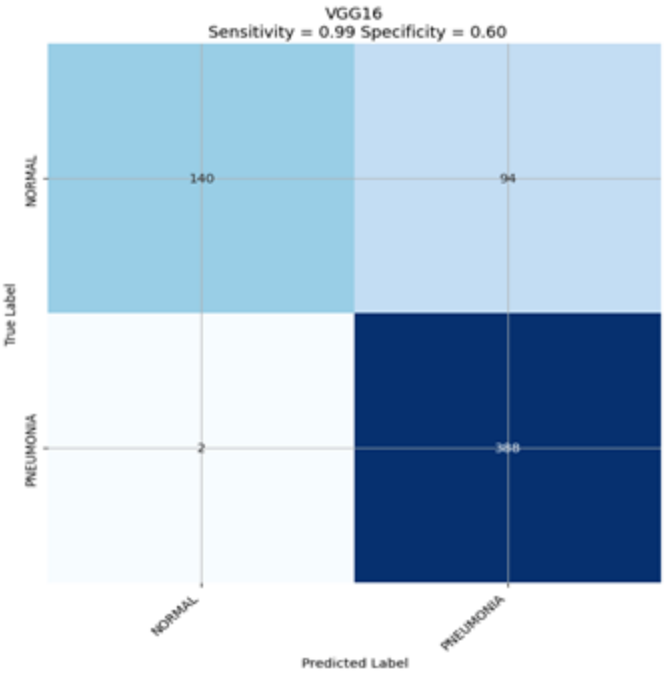
•Each VGG model has two fully connected hidden layers and one fully connected output layer.

Results from VGG-16 Modeling



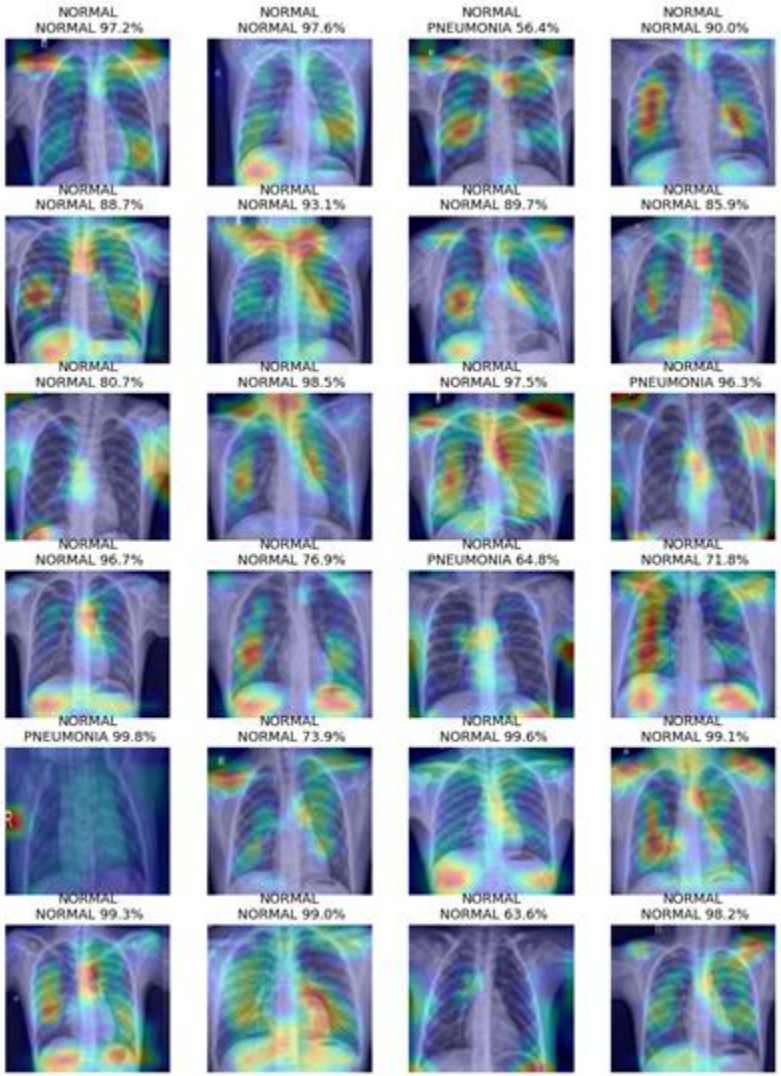
Results with training dataset:

```
163/163 [==============================
163s 930ms/step - loss: 0.4182 - accura
0.7947 - val_loss: 0.7801 - val_accurac
0.6250

Epoch 2/3

163/163 [==============================
159s 975ms/step - loss: 0.2603 - accura
0.8928 - val_loss: 0.4858 - val_accurac
0.8125

Epoch 3/3

163/163 [==============================
160s 982ms/step - loss: 0.2140 - accura
0.9160 - val_loss: 0.6476 - val_accurac
0.7500
```



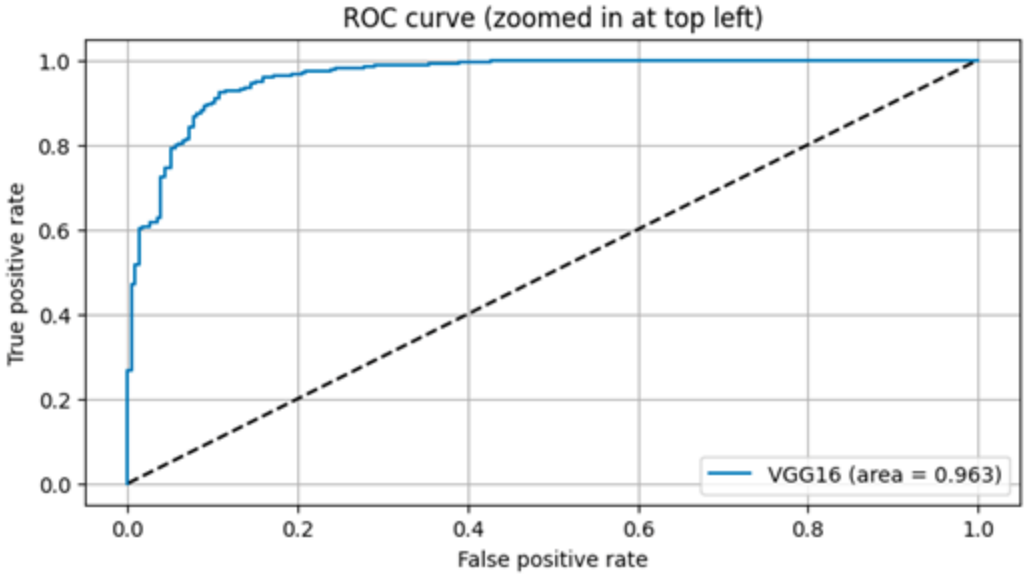
Results with test dataset:

```
20/20 [==============================] - 18s 891ms/step -
loss: 0.5482 - accuracy: 0.8413
[0.5482422709465027, 0.8413461446762085]
Accuracy: 84.13%
Loss: 0.548
```



ROC curve for VGG-16 model

The ROC curve showed that VGG-16 model performs nearly perfectly at all classification levels.



Conclusion and Recommendations

- Machine Learning can assist current radiological examiners in screening for pneumonia, but our current accuracy results (~85%) do not warrant a replacement of their work. Use cases may include remote regions which lack sufficient medical staff, but which would benefit from screenings to prioritize the work of available professionals.

- We recommend continued research into refining existing models and exploring new ones which would improve on these concepts with the aim in providing augmented medical services to regions which would not otherwise have sufficient trained people.