Pneumonia Detection by Chest X-Ray Images

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Problem Statement

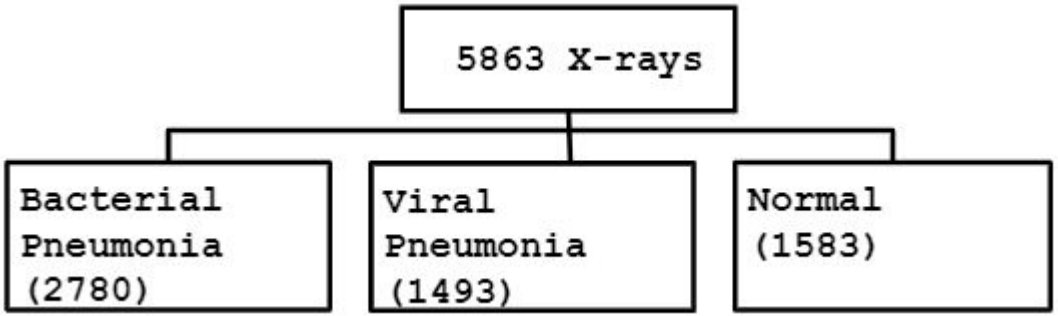
- Pneumonia is an inflammatory condition of the lung affecting primarily the small air sacs known as alveoli caused by infection with viruses or bacteria.
- Diagnosed by symptoms, physical examination, chest X-ray, blood tests.
- Severity is variable especially in developing countries.
- Early stage diagnosis is very crucial.

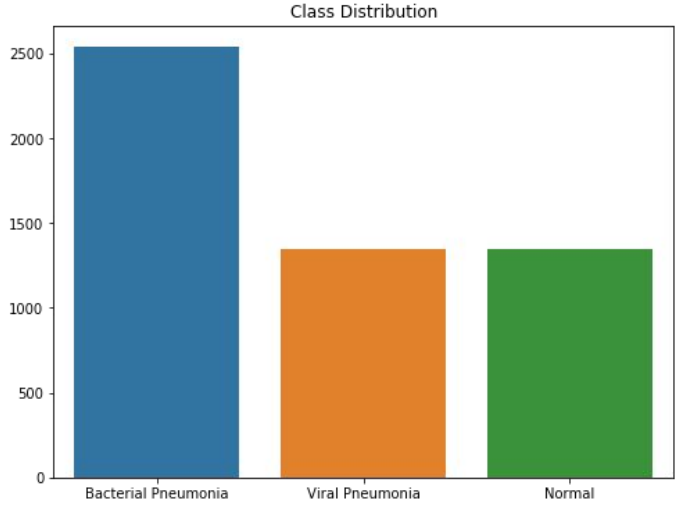
Goal

A robust convolutional neural network that will be trained with thousands of labeled chest X-ray images to provide fast and accurate diagnosis for the benefit of both patients and health professionals.

Data

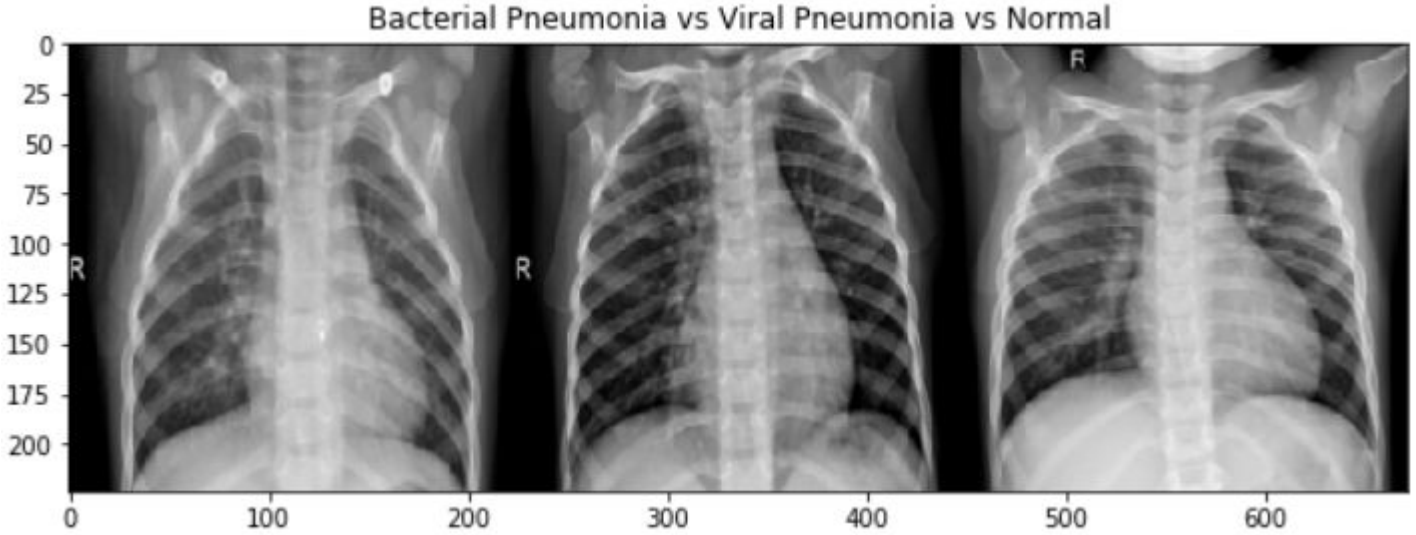
- Collected from **Mendeley** public datasets repository
- Labeled Optical Coherence Tomography (OCT) and Chest X-Ray Images for Classification
- Pediatric patients of one to five years old from Women and Children's Medical Center, Guangzhou.





X-rays Visualization

- Images are almost indifferentiable for non-experts
- Pneumonia positive images seem to be slightly more faint due to soft tissue (water) around the lungs



Black: Air

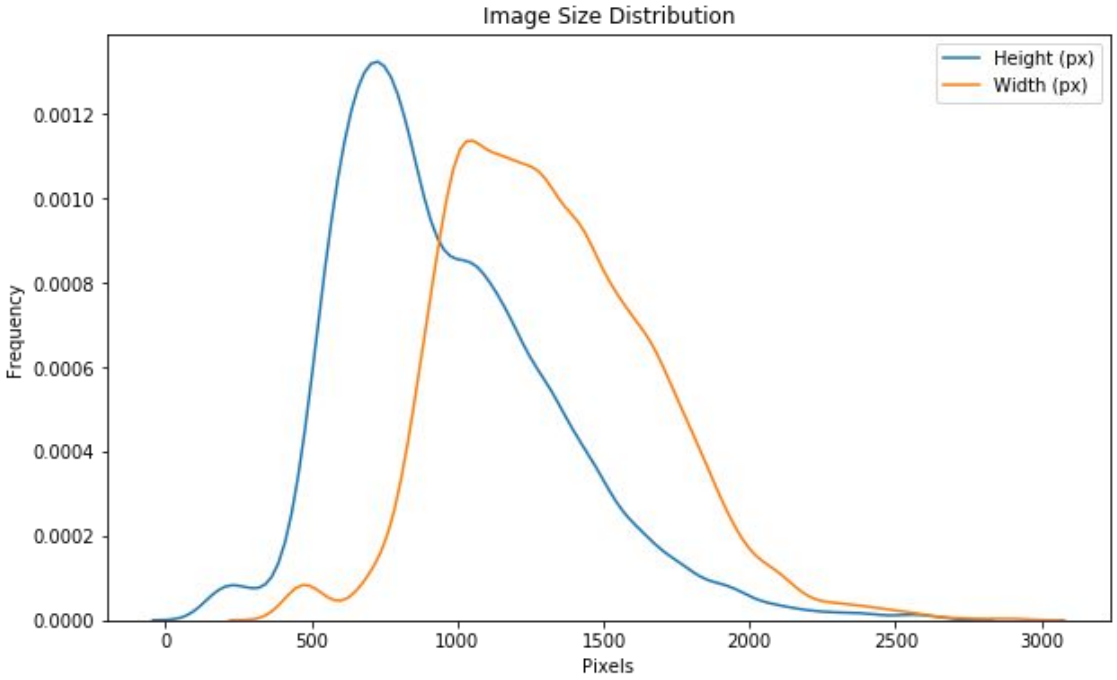
Dark Grey: Fat

Light Grey: Soft tissue

Off white: Bone

Bright white: Metal

Image Size Distribution (px)



- Most images are at least 256 × 256 pixels and RGB color channels
- Smaller and grayscale images are removed from analysis
- Downsized all images to 256x256x3 tensor
- Multiplied channels by 1./255

Data Augmentation

Problem: A lot of variations for such a small dataset (angle, opaqueness, body position, zooming etc)

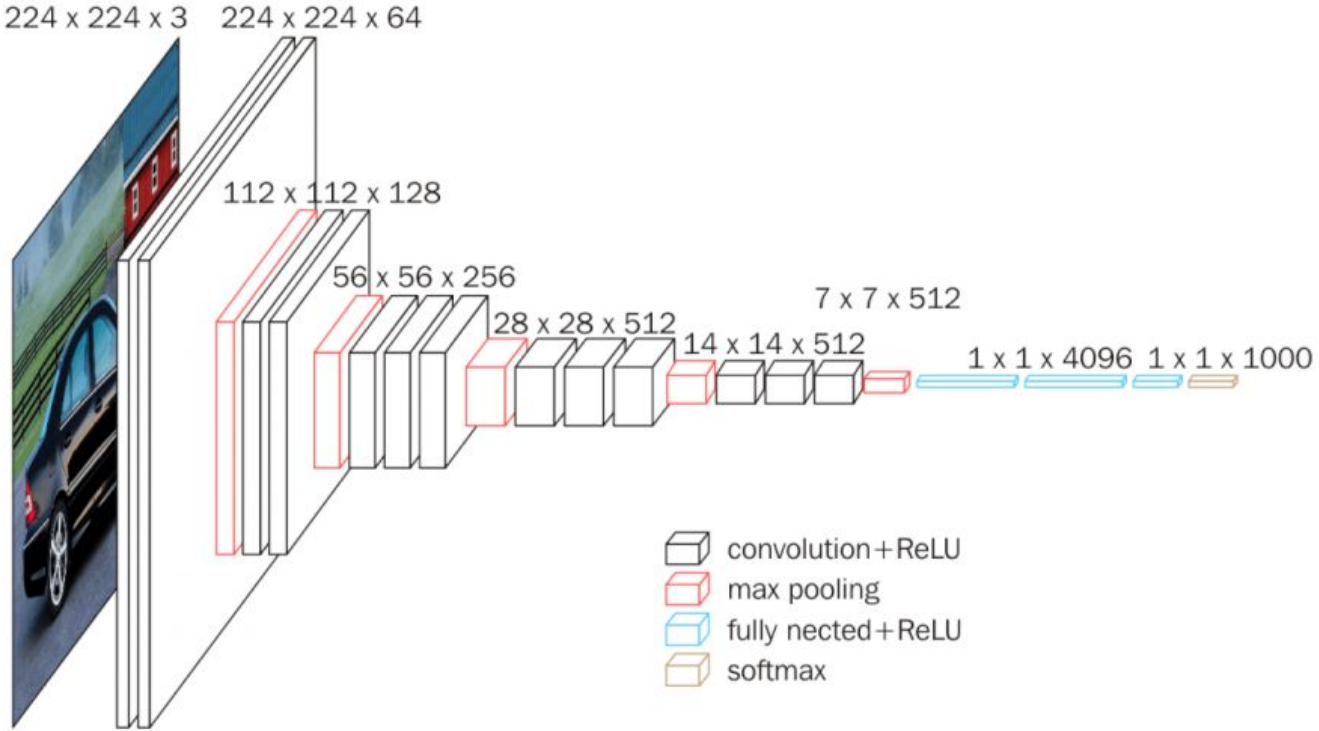
Solution: Image Data generator

rotation_range=20, width_shift_range=0.1, height_shift_range=0.1, shear_range=0.1, zoom_range=0.2, horizontal_flip=True, fill_mode='nearest'

Different versions of same image:

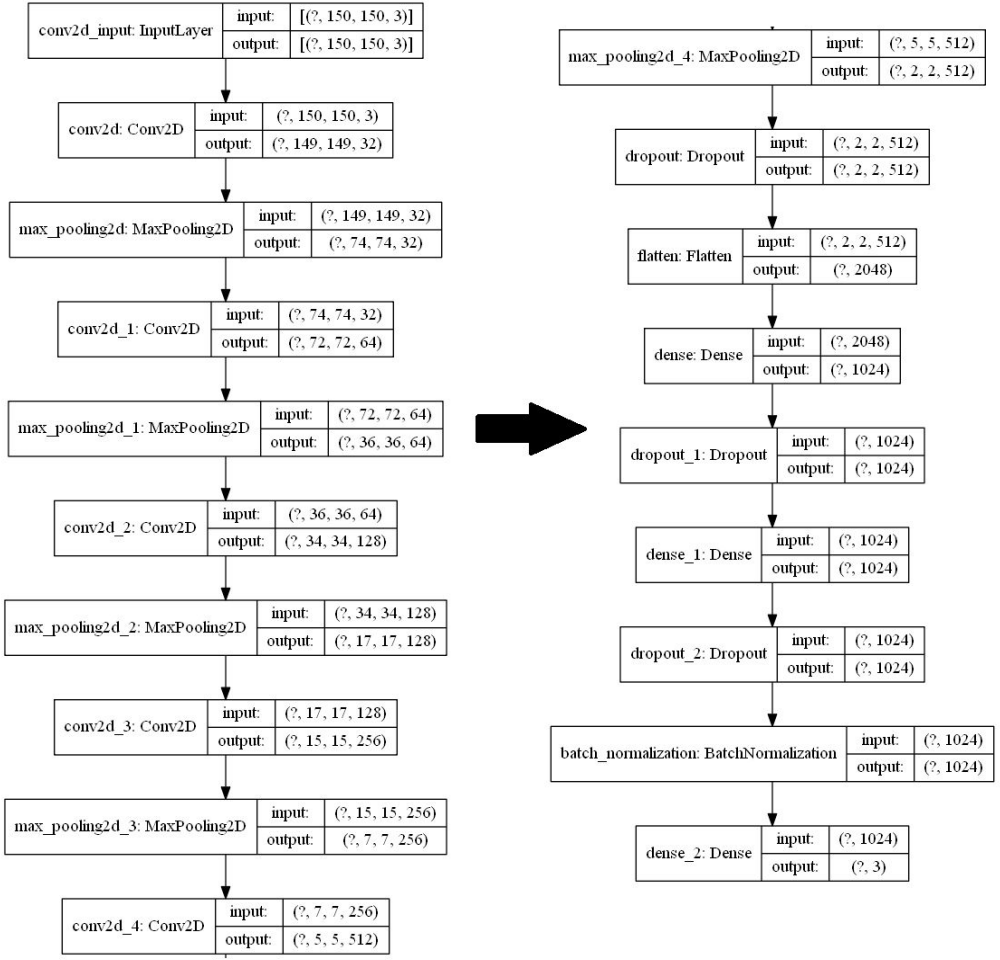
Modeling

VGG16 (Transfer Learning)



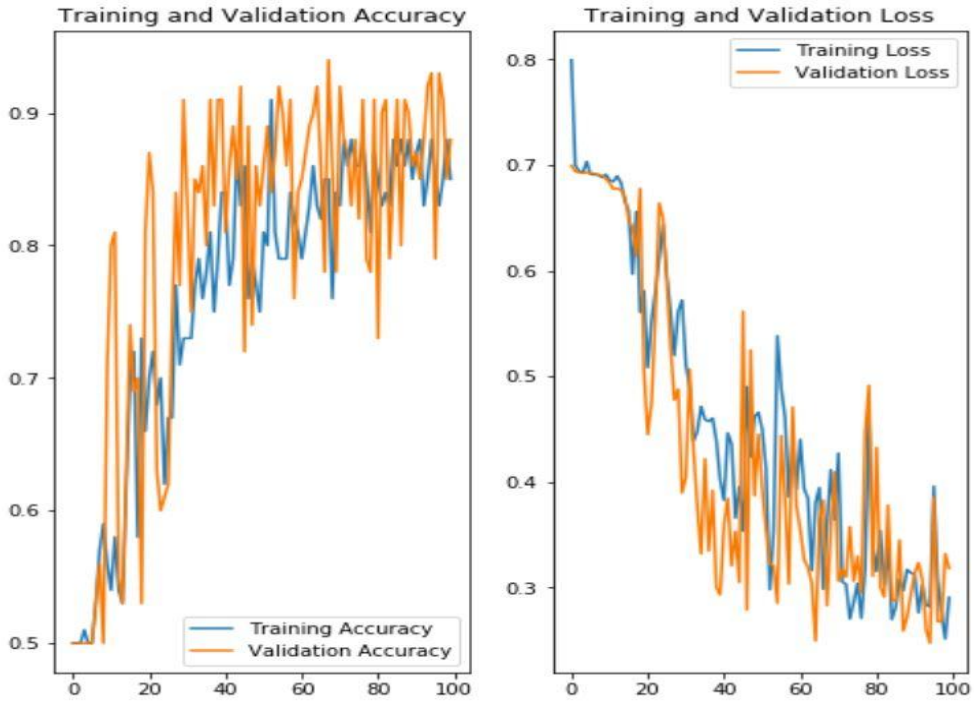
- ImageNet weights used only in first 2 layers (first few layers capture general details)
- Binary classification (P/N)
- Acc = 96%
- Val Acc = 91%

Final CNN


conv2d_input: InputLayer | input: [(?, 150, 150, 3)] | output: [(?, 150, 150, 3)]
conv2d: Conv2D | input: (?, 150, 150, 3) | output: (?, 149, 149, 32)
max_pooling2d: MaxPooling2D | input: (?, 149, 149, 32) | output: (?, 74, 74, 32)
conv2d_1: Conv2D | input: (?, 74, 74, 32) | output: (?, 72, 72, 64)
max_pooling2d_1: MaxPooling2D | input: (?, 72, 72, 64) | output: (?, 36, 36, 64)
conv2d_2: Conv2D | input: (?, 36, 36, 64) | output: (?, 34, 34, 128)
max_pooling2d_2: MaxPooling2D | input: (?, 34, 34, 128) | output: (?, 17, 17, 128)
conv2d_3: Conv2D | input: (?, 17, 17, 128) | output: (?, 15, 15, 256)
max_pooling2d_3: MaxPooling2D | input: (?, 15, 15, 256) | output: (?, 7, 7, 256)
conv2d_4: Conv2D | input: (?, 7, 7, 256) | output: (?, 5, 5, 512)
max_pooling2d_4: MaxPooling2D | input: (?, 5, 5, 512) | output: (?, 2, 2, 512)
dropout: Dropout | input: (?, 2, 2, 512) | output: (?, 2, 2, 512)
flatten: Flatten | input: (?, 2, 2, 512) | output: (?, 2048)
dense: Dense | input: (?, 2048) | output: (?, 1024)
dropout_1: Dropout | input: (?, 1024) | output: (?, 1024)
dense_1: Dense | input: (?, 1024) | output: (?, 1024)
dropout_2: Dropout | input: (?, 1024) | output: (?, 1024)
batch_normalization: BatchNormalization | input: (?, 1024) | output: (?, 1024)
dense_2: Dense | input: (?, 1024) | output: (?, 3)

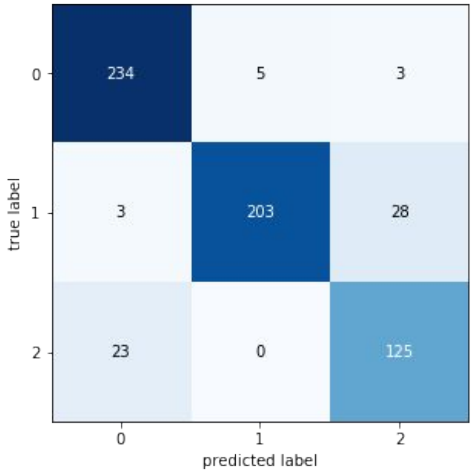

1st
PLACE
WINNER

Model Evaluation



Accuracy = 92.4 %
Val Accuracy = 90.1 %

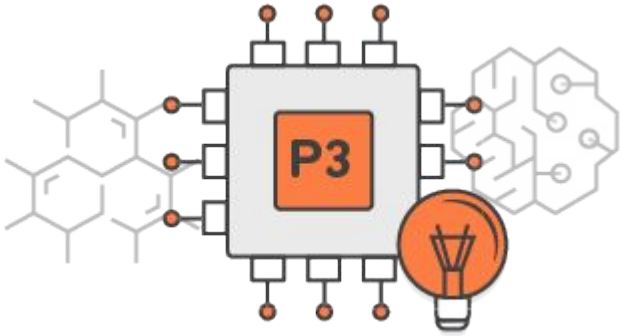
Confusion Matrix



0 = Bacteria
1 = Normal
2 = Virus

Workspace 1

- AWS EC2 P3 Instance pre-configured with ML packages
- Windows Server 2016
- NVIDIA Tesla V100GPU / CUDA Runtime
- 64 GB RAM
- 100 GB HDD



TensorFlow

NVIDIA

CUDA

Workspace 2

X-ray App Demo

Next Steps

- Collecting more data.
- Adding more complexity in model and using Keras gridsearch functionality.
- Creating additional model with PyTorch library and compare the results.
- Researching on how to detect most informative pixels on X-ray (highest weights) and emphasize (highlight) them on image.
- Partnering with radiologists to classify same X-rays and compare model's performance with professional interpretation.

Thank you...

Deep learning is shallow next to the depths of your greatness.

Repo: https://github.com/sibeltan/Capstone/