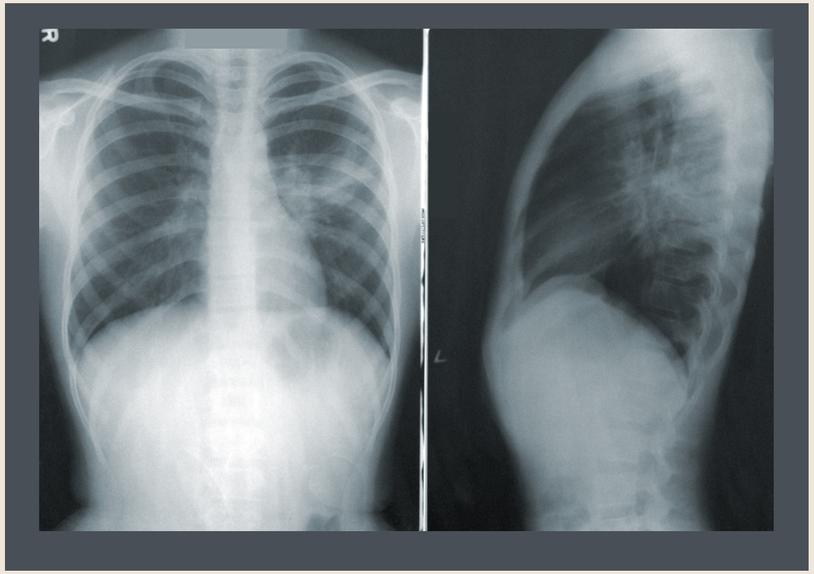
IDENTIFYING PNEUMONIA IN X-RAY IMAGES

IMAGE CLASSIFICATION UTILIZING NEURAL NETWORKS



TRAVIS ROYCE

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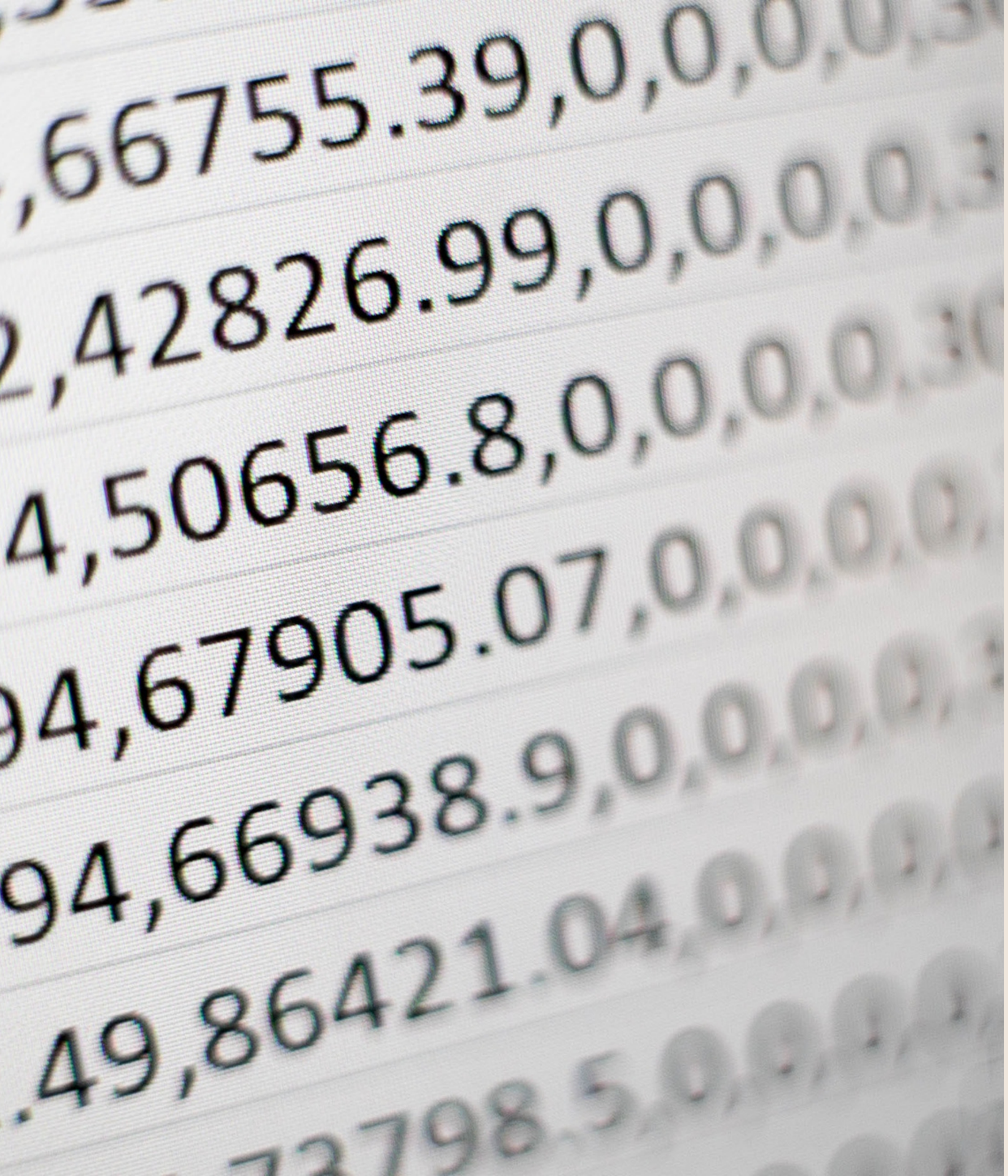
TABLE OF CONTENTS

PROJECT OVERVIEW

The goal of this project was to utilize convolutional neural networks to build an image classification algorithm that predicts the presence of pneumonia in lung X-rays.

PRODUCT OVERVIEW

The end product is a web application which can be used by individuals and/or health care professionals to upload X-ray results and determine the presence of pneumonia within said X-rays.



THE DATA

The data consists of approximately **5,900 images** in two categories - 1) **normal**, and 2) **pneumonia** (see bottom images).

The given data included pre-split testing and training data. However, I found the number of both test images and training images to be lacking, as test images accounted for **less than 15%** of total data and there were only **18 total** provided training images.

I re-split the data so the final data split was approximately **3,200 images** in the training set, **1,750 images** in the test set, and **800 images** in the validation set.

THE METRIC

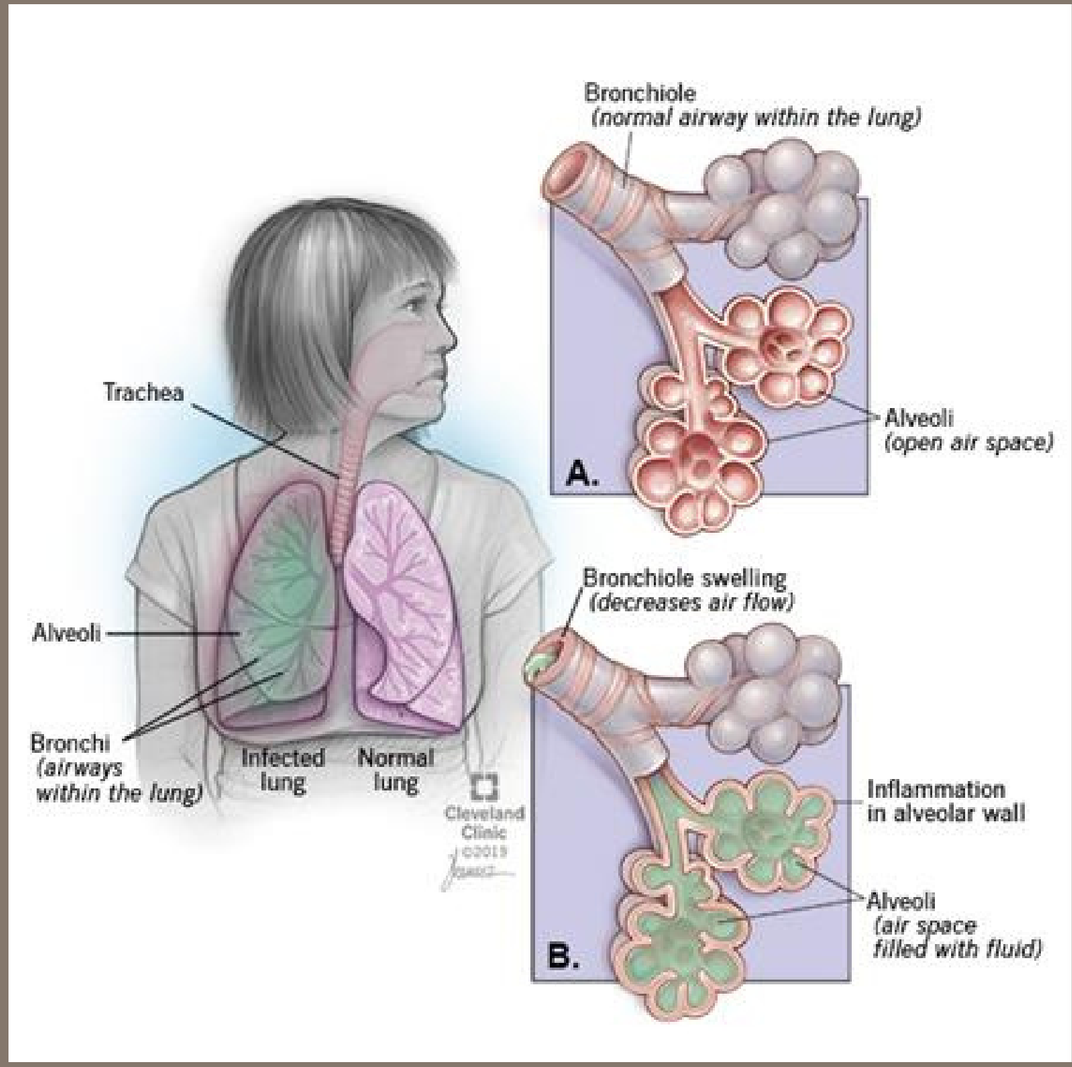
My chosen metric for this project is a F-beta score, with a weight of 3x for recall. This is because in the context of a diagnosis, misdiagnosing a sick person as healthy is much more harmful than misdiagnosing a healthy person as sick.

For simplicity's sake, I refer to the metric as the RW-score, or the recall-weighted score.

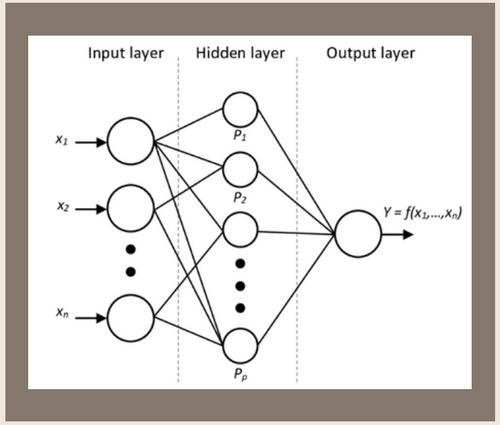
PNEUMONIA

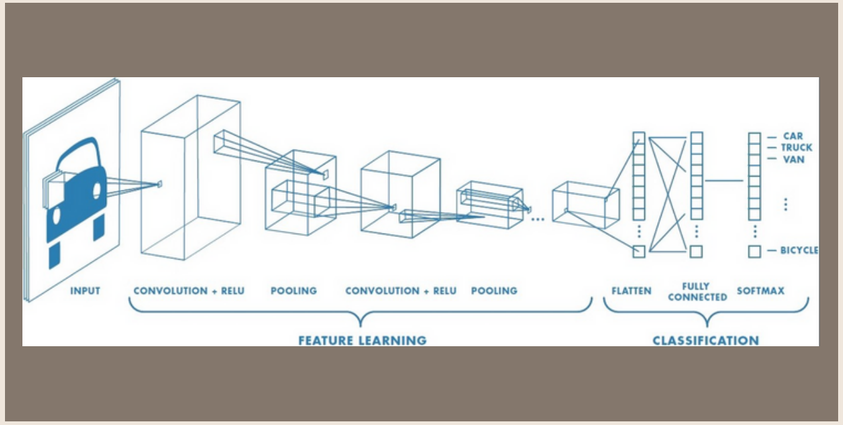
Pneumonia is an infection that inflames the air sacs in one or both lungs. These air sacs then may fill with fluid or pus, which can cause a cough with phlegm or pus, fever, chills, and difficulty breathing.

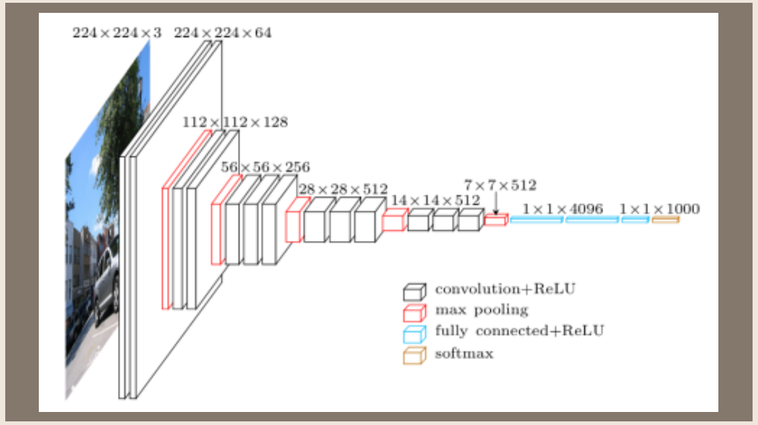
While most people eventually recover from pneumonia, the 30-day mortality rate is 5 to 10 percent of hospitalized patients, and can be up to 30 percent in those admitted to intensive care.



MODELING OVERVIEW







INITIAL MODEL: FULLY-CONNECTED NEURAL NETWORK

This is a 'simple' neural network model that is connected deeply, which means each neuron in the dense layer receives input from all neurons of its previous layer.

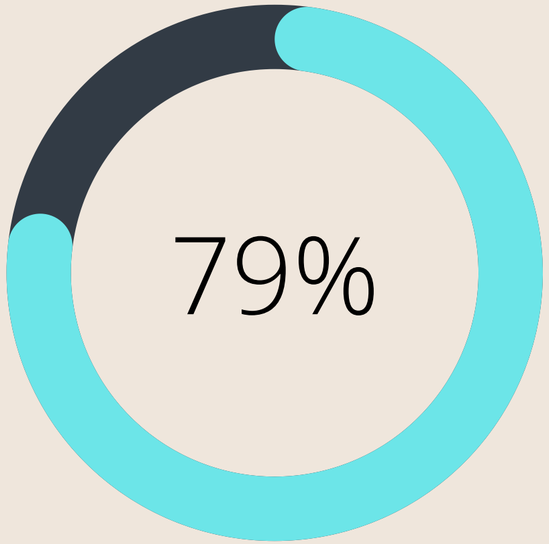
MODELS 2-10: CONVOLUTIONAL NEURAL NETWORKS

Convolutional Neural Networks add the concepts of convolution and pooling, as well as utilizing a 3D structure.

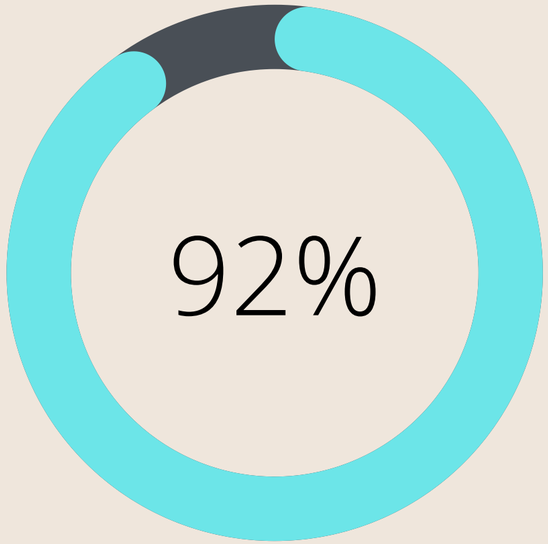
VISUAL GEOMETRY GROUP (VGG) MODEL

The VGG Model won the 2014 ImageNet visual recognition challenge.

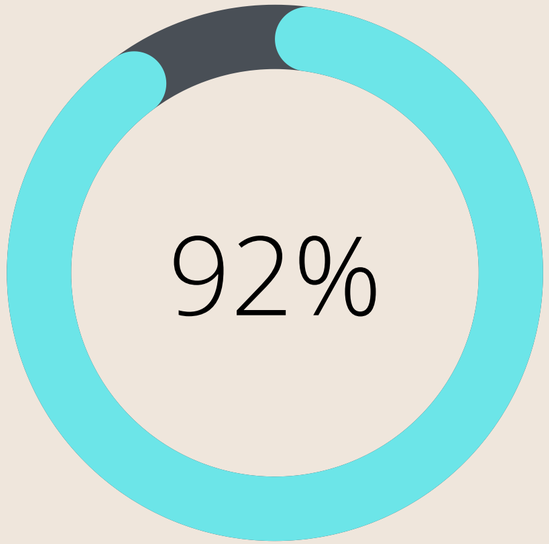
MODEL TESTING RESULTS: RECALL-WEIGHTED (RW) F-SCORE



INITIAL MODEL: DENSELY TRAINED



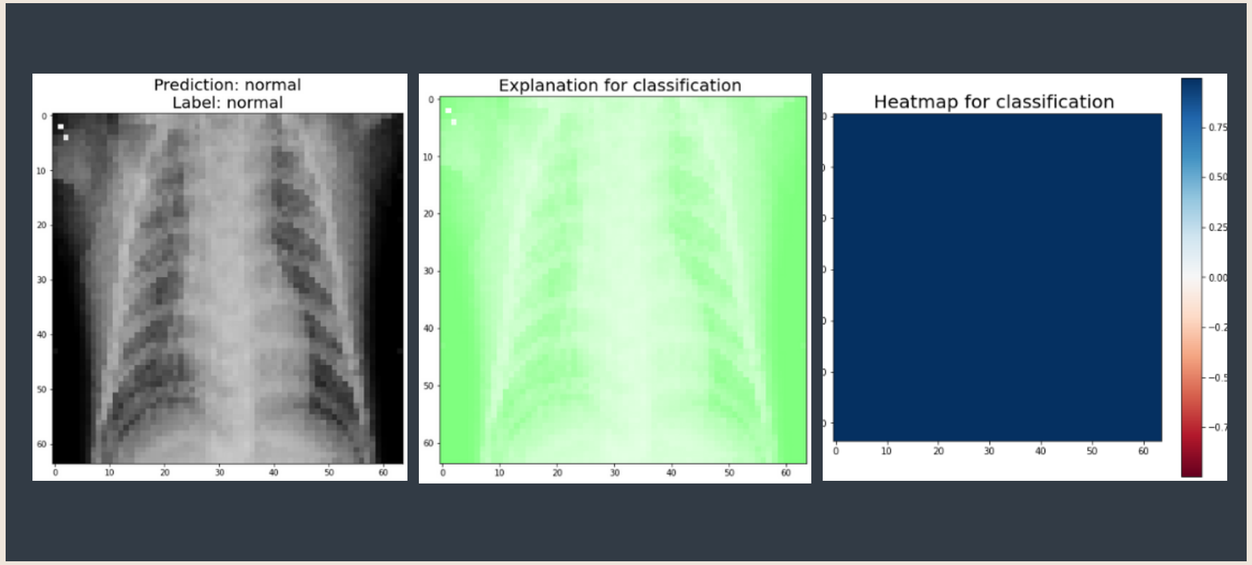
MODELS 2-10: CONVOLUTIONAL NEURAL NETWORK ITERATIONS



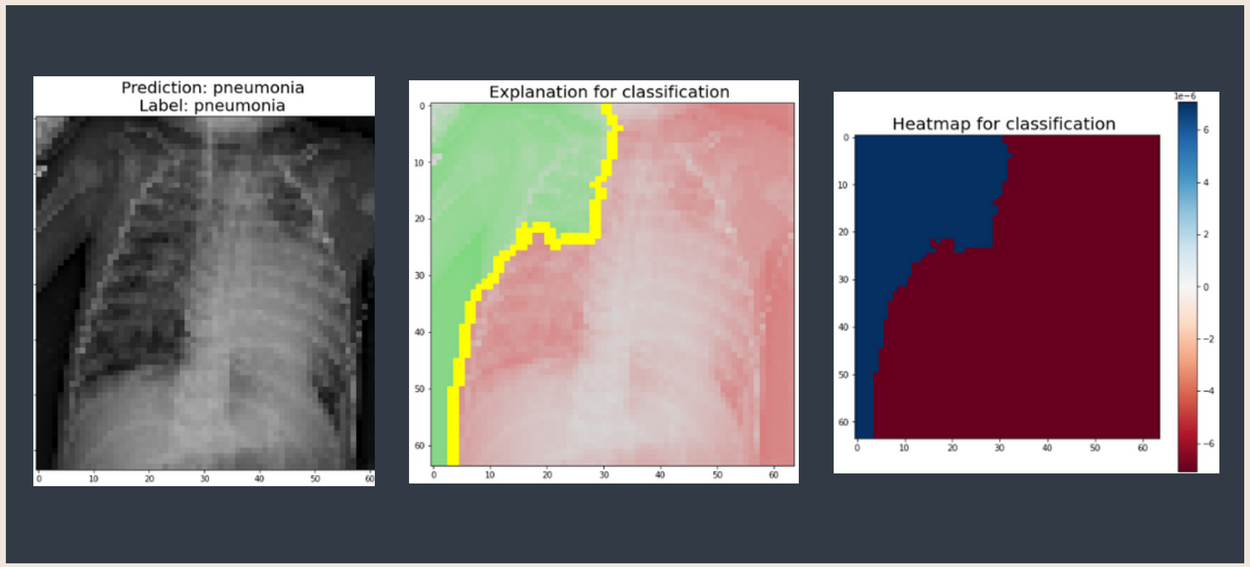
VGG16 MODEL

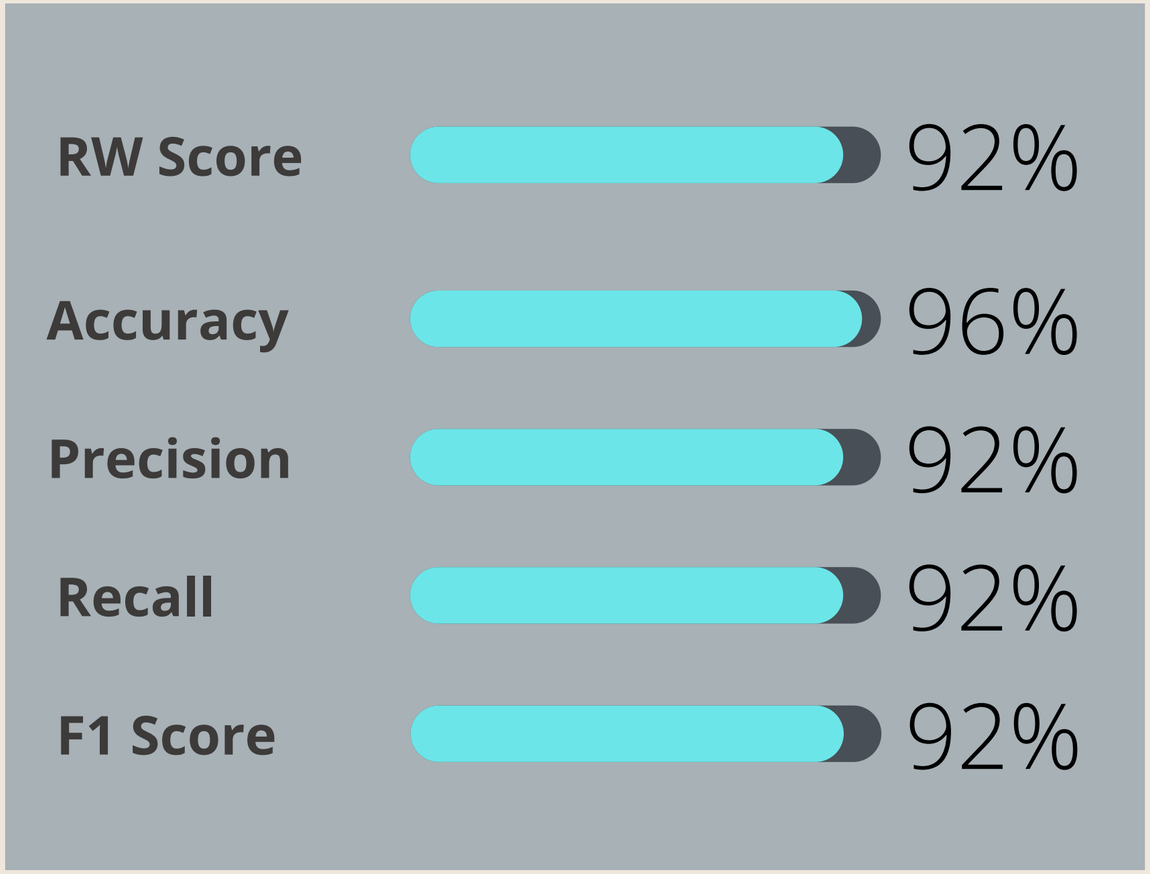
FINAL MODEL - LIME VISUALIZATIONS

Normal Example



Pneumonia Example





FINAL MODEL

The final - and best performing - model was the Visual Geometry Group (**VGG) Model.**

The final result included **1,243** true positives, **433** true negatives, 40 false negatives, and 36 false positives.

In **product terms**, this means that we could expect our web application to **correctly** pick if an individual has pneumonia based on their X-ray **95.7 percent** of the time.

While 95.7 percent is solid accuracy, this product could potentially be used by doctors as a tool to confirm their diagnosis. This would be **helpful** in the **following way:**

If a doctor has a **2 percent** misdiagnosis rate, and this model had a 44 **percent** error rate, the chance that both the doctor AND the model would misdiagnose the same X-ray would be just **0.08 percent**.

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