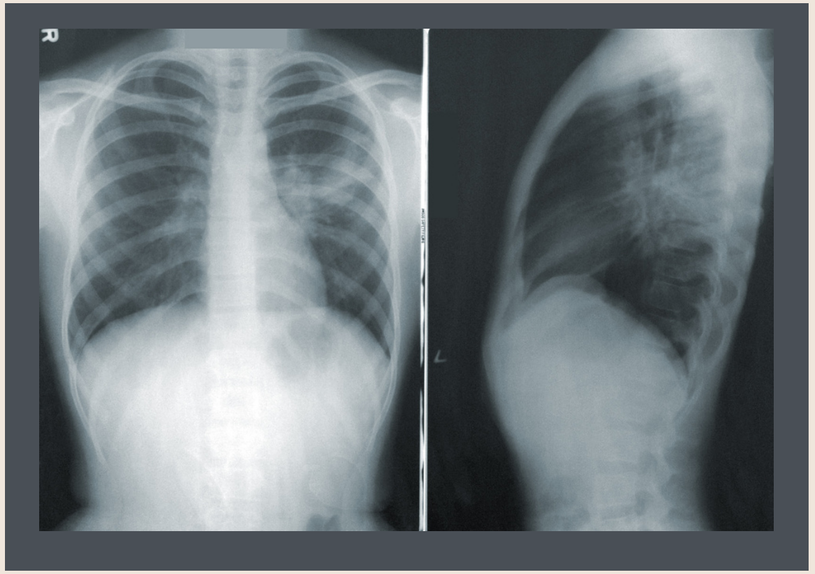
IDENTIFYING PNEUMONIA IN X-RAY IMAGES

IMAGE CLASSIFICATION UTILIZING CONVOLUTIONAL NEURAL NETWORKS



TRAVIS ROYCE

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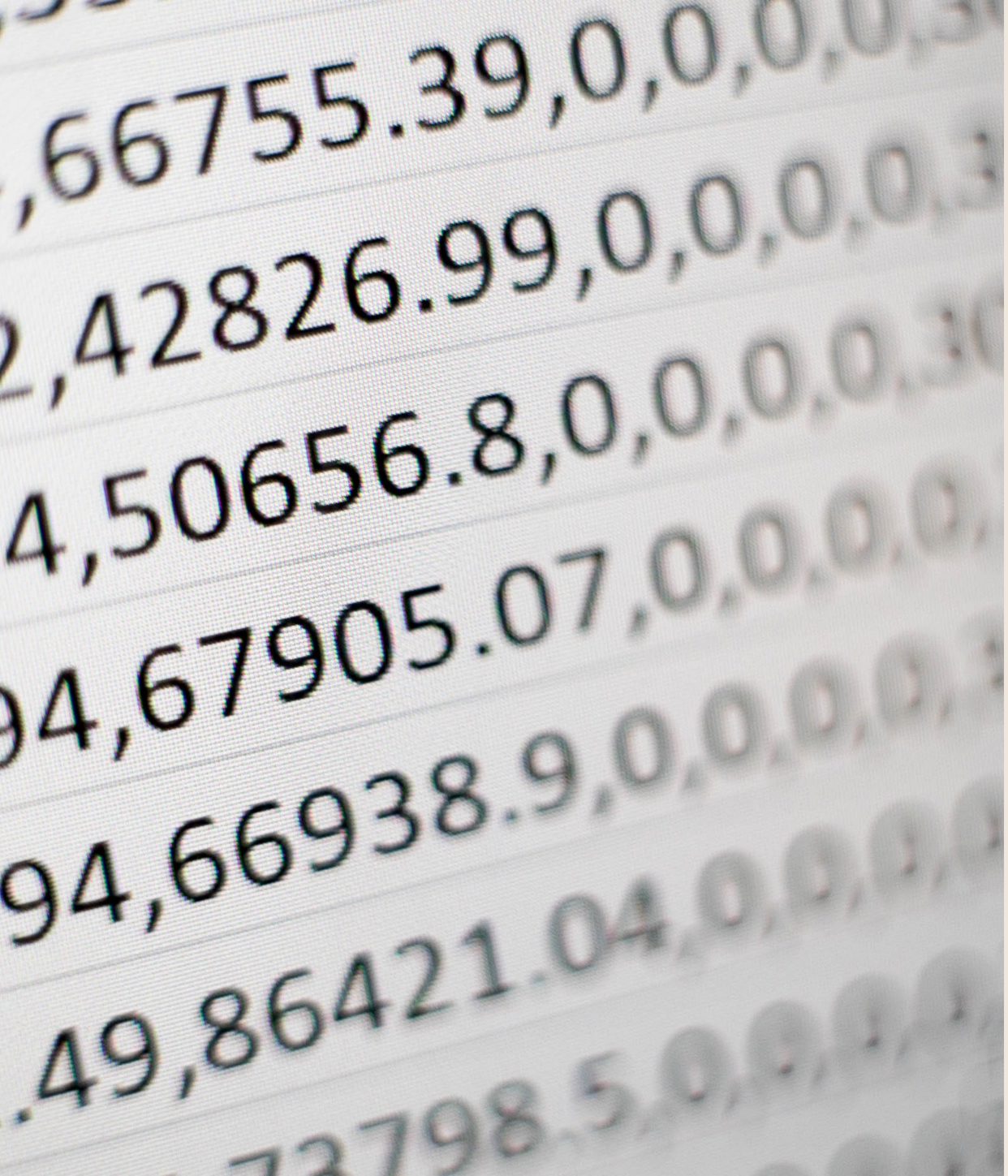
PROJECT OVERVIEW

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).

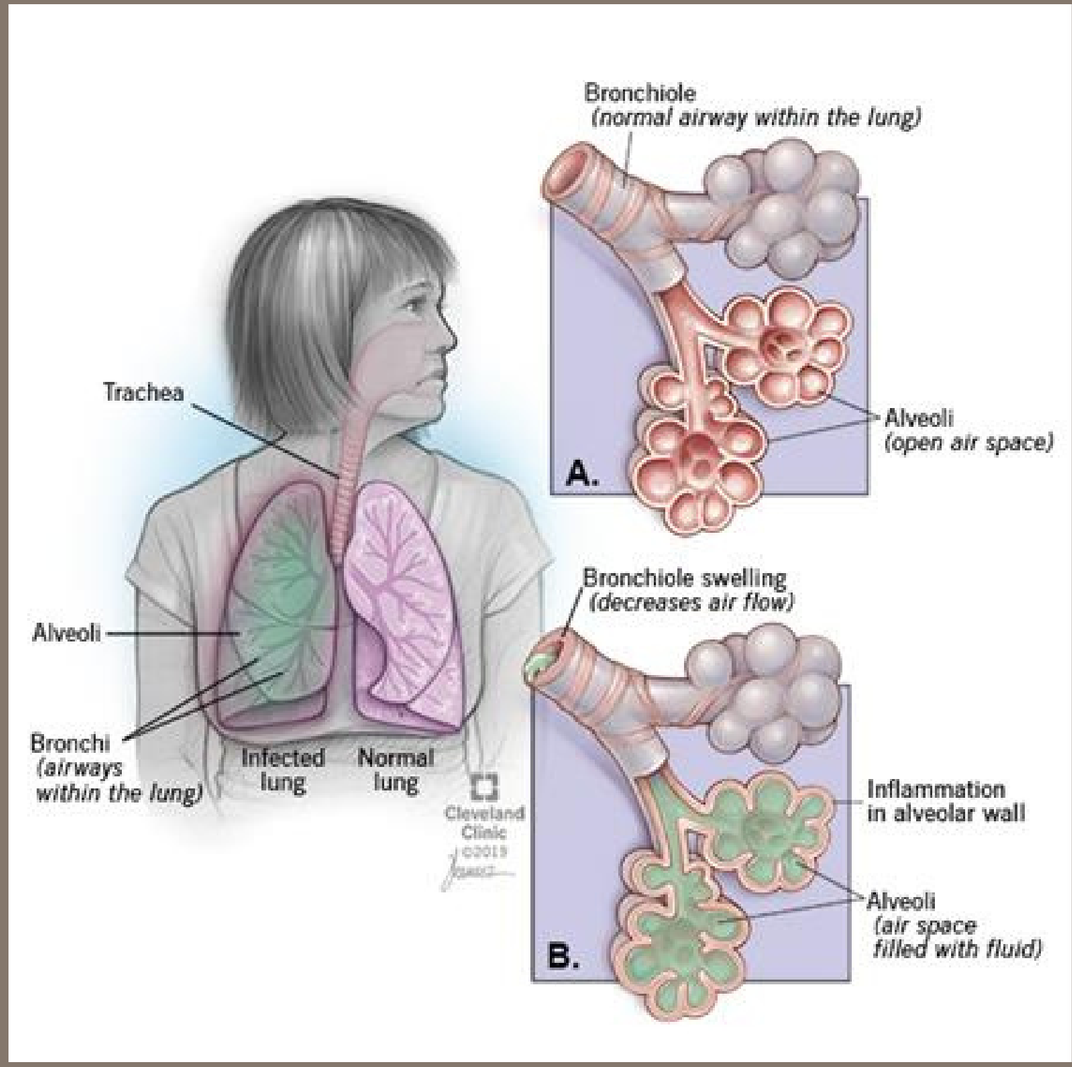
The given data included pre-split testing and training data. However, I found the number of both test images and training images to be lacking, as test images accounted for **less than 15%** of total data and there were only **18 total** provided training images.

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.

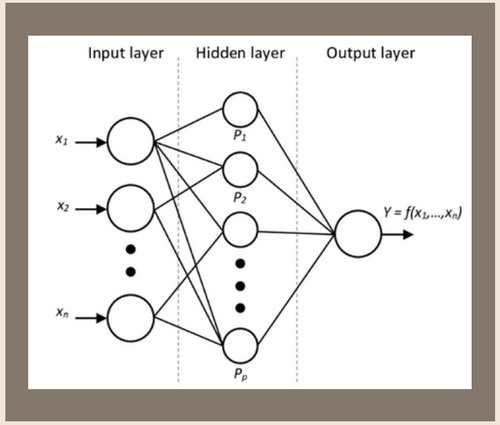
PNEUMONIA

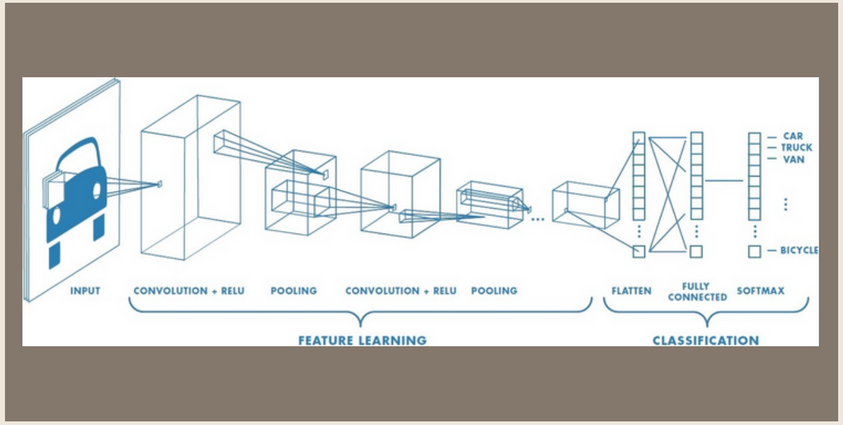
Pneumonia is an infection that inflames the air sacs in one or both lungs. These air sacs then may fill with fluid or pus, which can cause a cough with phlegm or pus, fever, chills, and difficulty breathing.

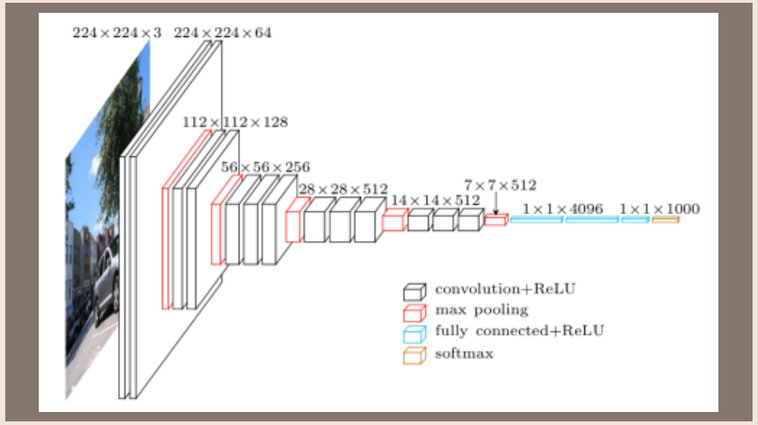
While most people eventually recover from pneumonia, the 30-day mortality rate is 5 to 10 percent of hospitalized patients, and can be up to 30 percent in those admitted to intensive care.



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.

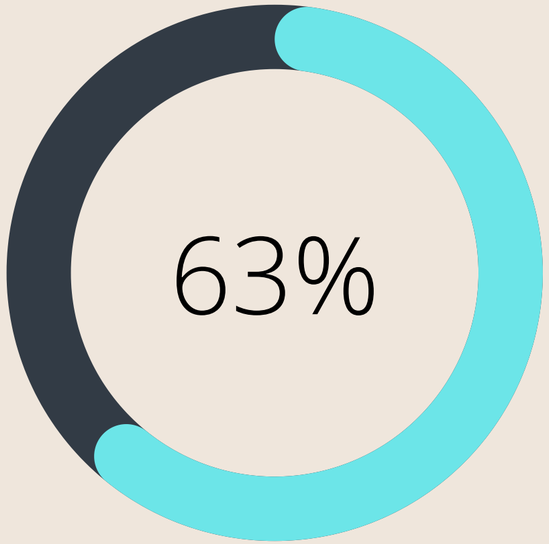
MODELS 2-10: CONVOLUTIONAL NEURAL NETWORKS

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

VISUAL GEOMETRY GROUP (VGG) MODEL

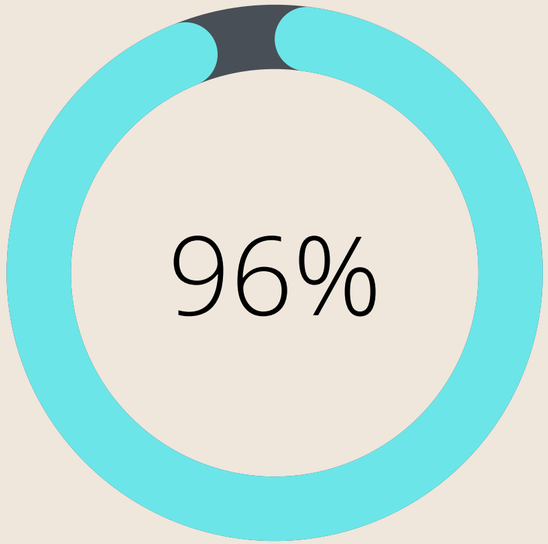
The VGG Model won the 2014 ImageNet visual recognition challenge.

MODEL TESTING RESULTS



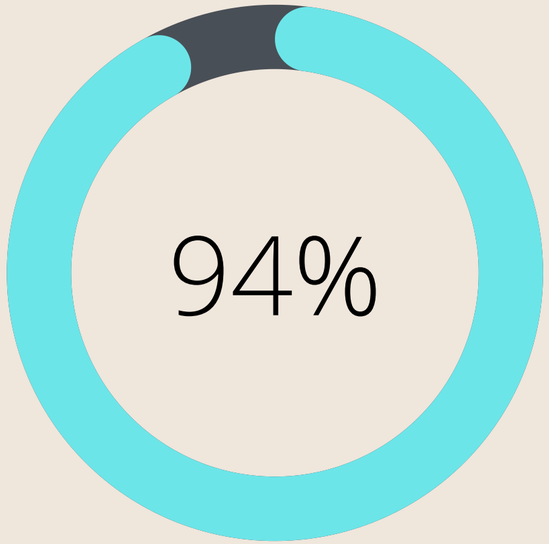
INITIAL MODEL: DENSELY TRAINED

80 Percent Accuracy



MODELS 2-10: CONVOLUTIONAL NEURAL NETWORK ITERATIONS

The accuracy ranged from 84 percent to 95.5 percent.

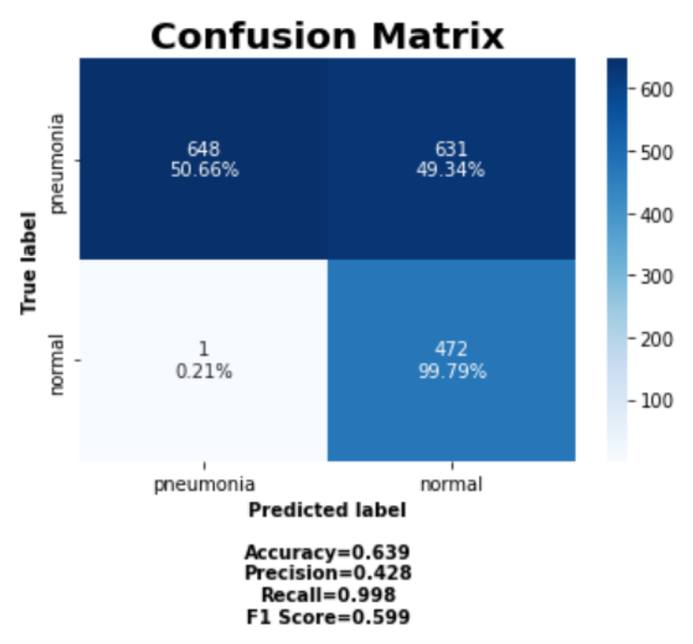


VGG16 MODEL

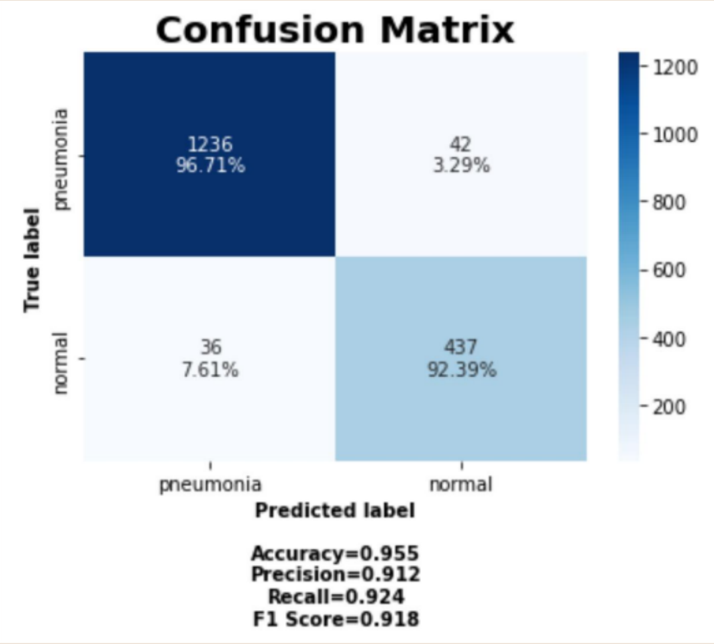
The VGG16 Model predicted with 94 percent accuracy

MODEL TESTING RESULTS

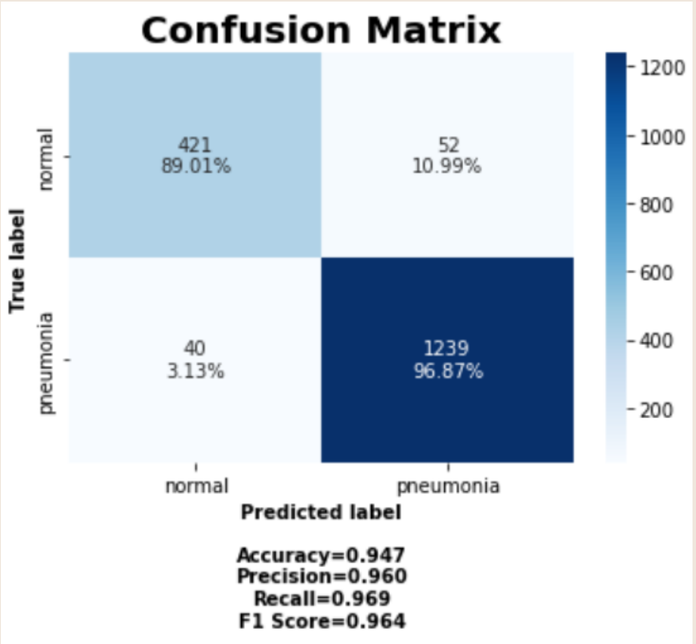
INITIAL MODEL: DENSELY TRAINED

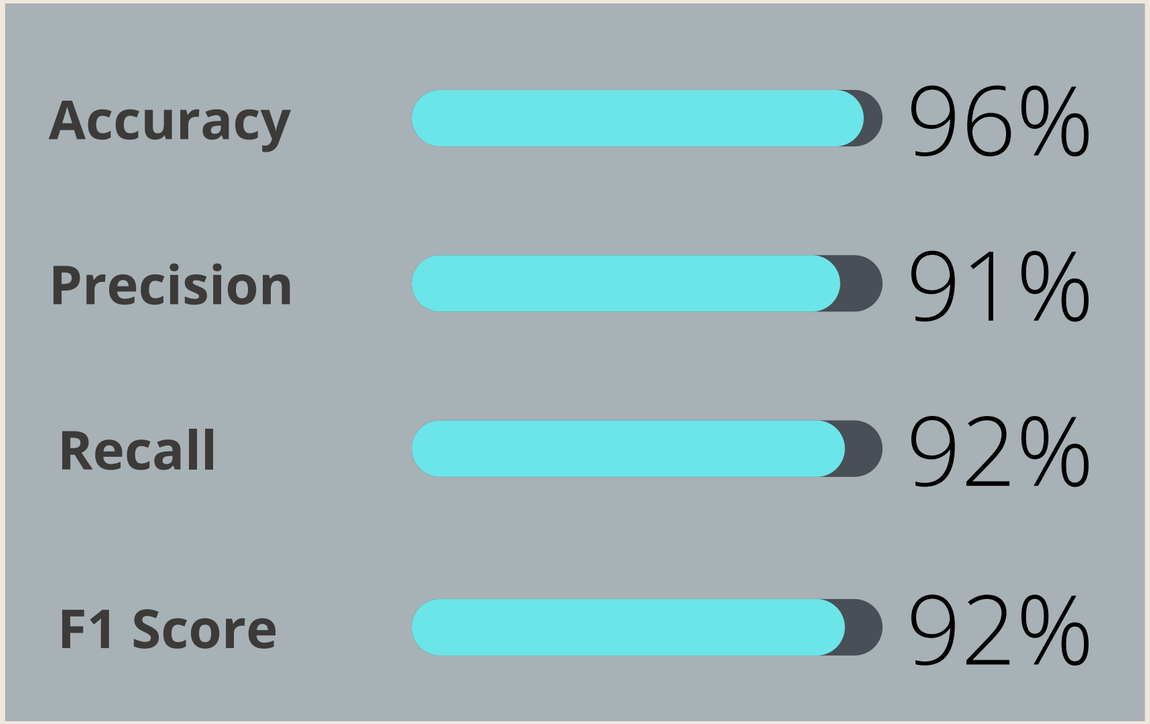


CONVOLUTIONAL NEURAL NETWORK ITERATIONS



VGG16 MODEL





FINAL MODEL

The final model is the **fourth** iteration of the convolutional neural network (CNN) models.

The final result included **1,236** true positives, **437** true negatives, **36** false negatives, and **42** 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 **95.5 percent** of the time.

While 95.5 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 **4 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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