# X-RAY PNEUMONIA IMAGE CLASSIFICATION WITH DEEP LEARNING

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https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-deep-learning-tips-and-tricks

# The Problem

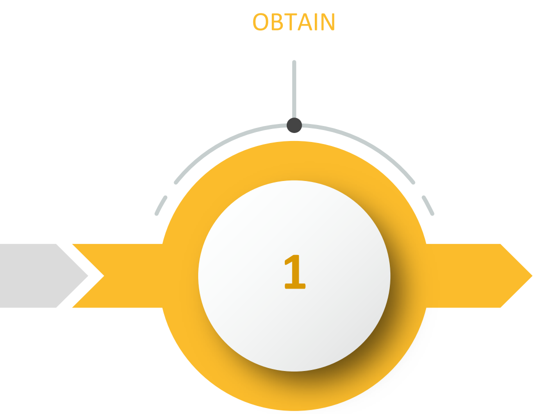
- Globally, a child dies of pneumonia every 39 seconds.
- Pneumonia is a leading cause of morbidity and mortality in children younger than the age of 5 years, killing more children than HIV/AIDS, malaria, and measles combined.
- Chest X-rays are primarily used for the diagnosis of this disease. However, even for a trained radiologist, it is a challenging task to examine chest X-rays.

- https://stanford.edu/~shervine/teaching/cs-230/cheatsheet-deep-learning-tips-and-tricks

# The Solution

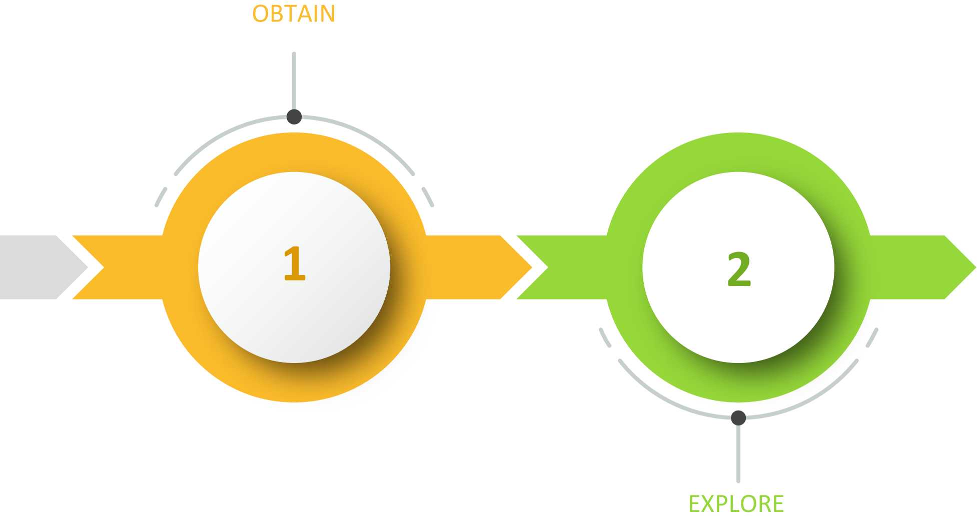
To solve this, deep learning (DL), a branch of machine learning (ML), inspired by the make-up of the human brain, are developed to detect hidden features in images which are not apparent or cannot be detected even by medical experts.

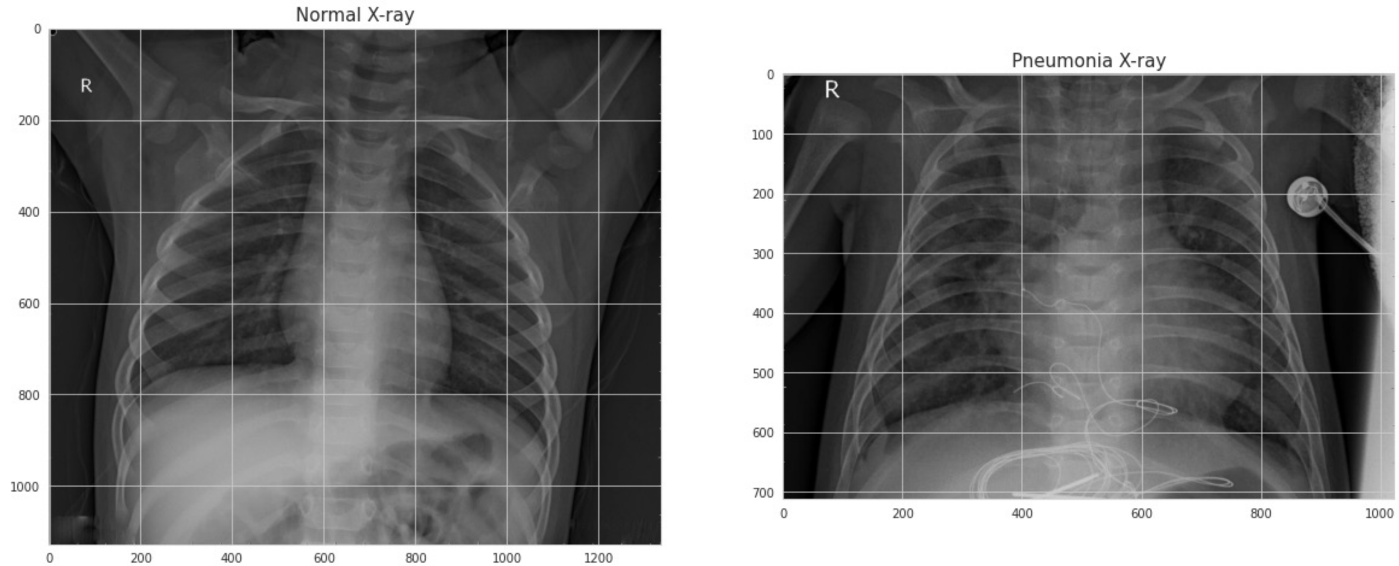
With AI system aiding medical experts in expediting the diagnosis, earlier treatment can be prescribed, resulting in improved clinical outcomes.




- Chest X-ray images (anterior-posterior) were selected from pediatric patients of one to five years old from Guangzhou Women and Children's Medical Center.

- There are 5,863 X-Ray images (JPEG)
- 2 categories: Normal & Pneumonia


OBTAIN
1
2
EXPLORE

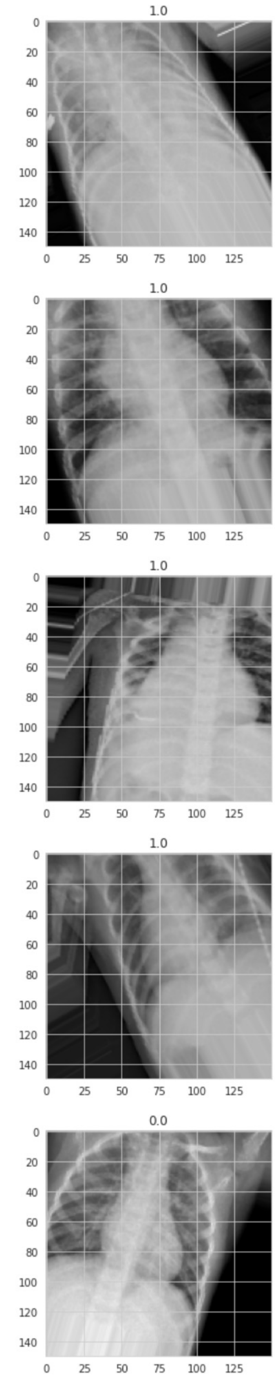


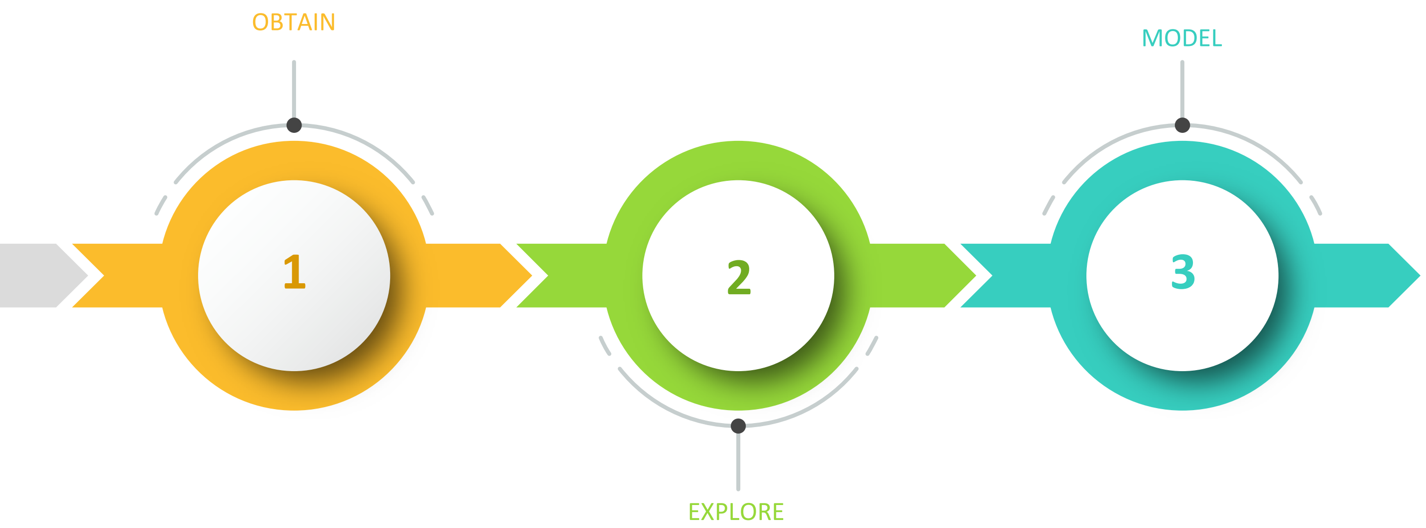
Normal X-ray
Pneumonia X-ray
R
R


X-ray Condition in Training Set
Count
Condition
NORMAL
PNEUMONIA

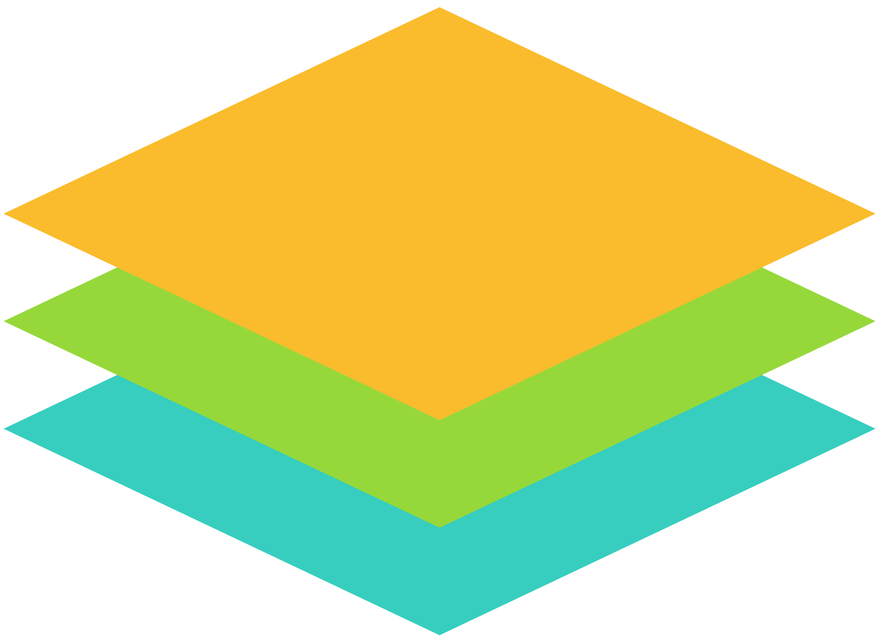
# Data Augmentation

- Small training dataset will overfit model.
- Augment data to artificially create training images through different ways of processing images such as random rotation, shifts, shear and flips, etc. of each training instances.




OBTAIN
1
2
3
MODEL
EXPLORE

Keras

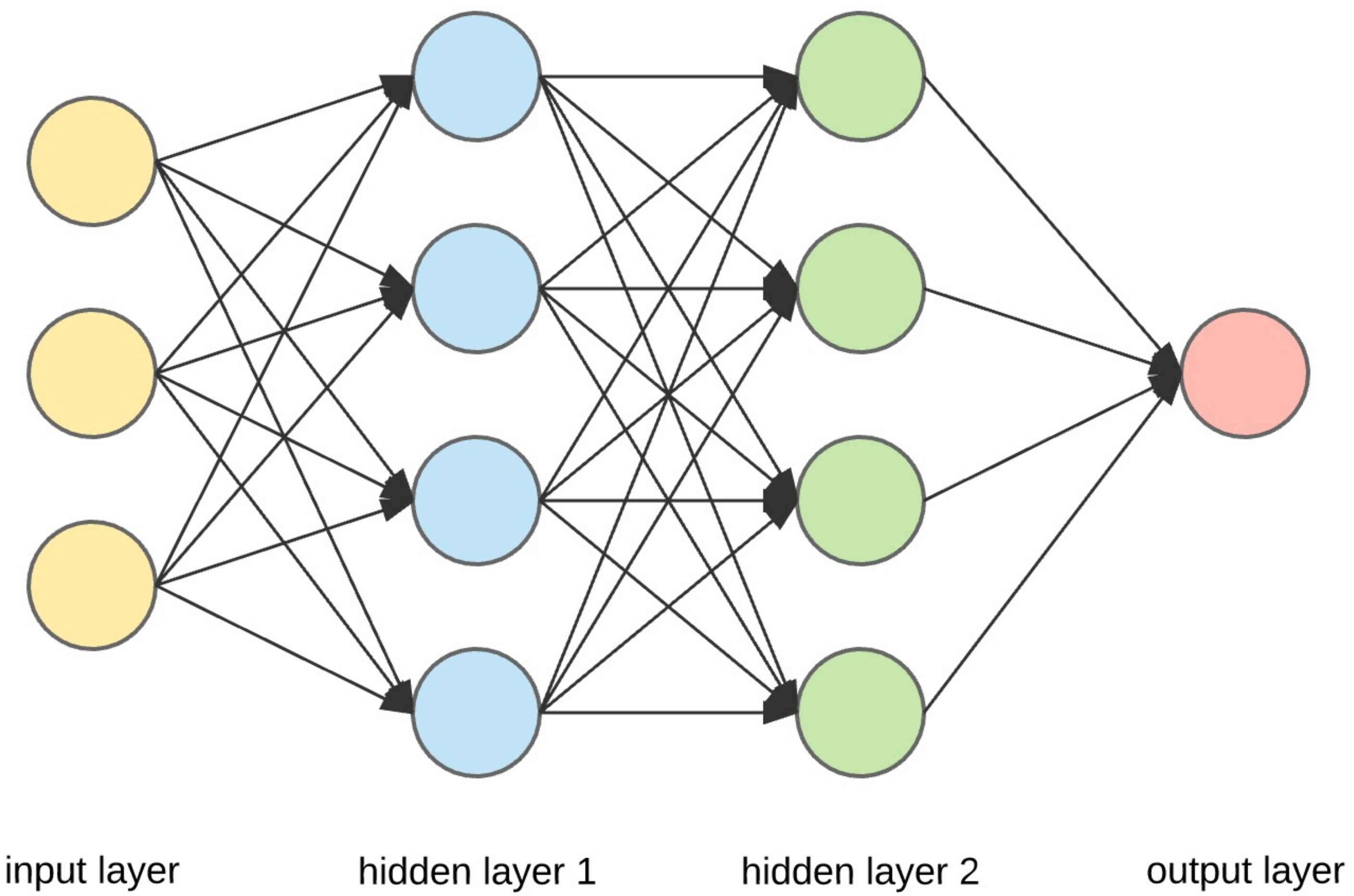


MULTILAYER PERCEPTRON MODEL

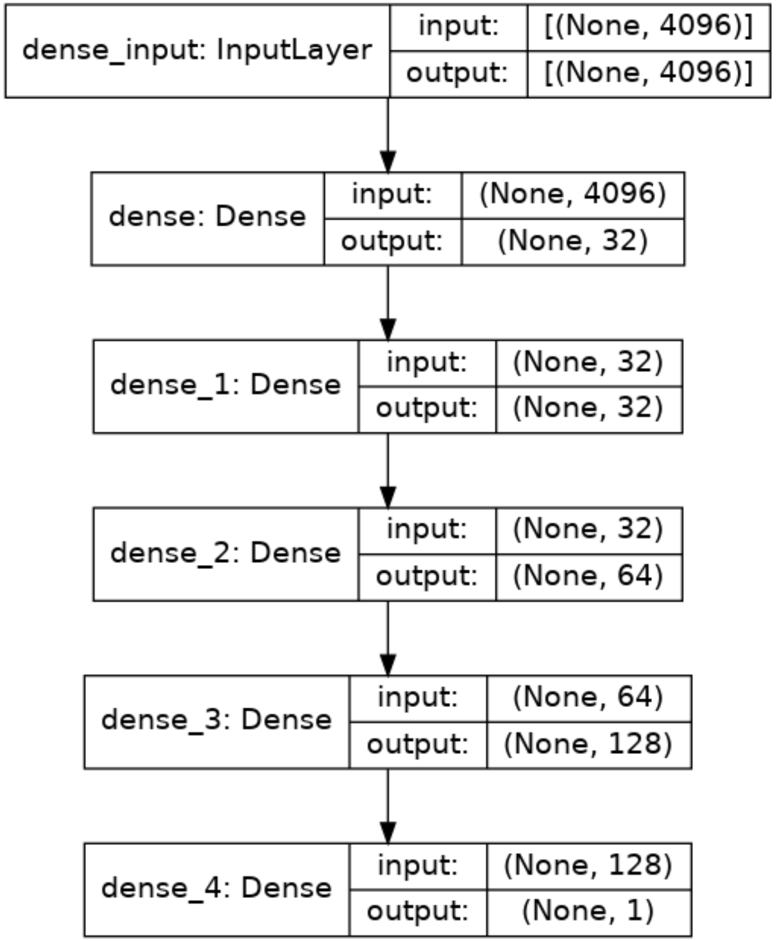
CONVOLUTIONAL NEURAL NETWORK MODEL

TRANSFER LEARNING VGG16 CNN MODEL

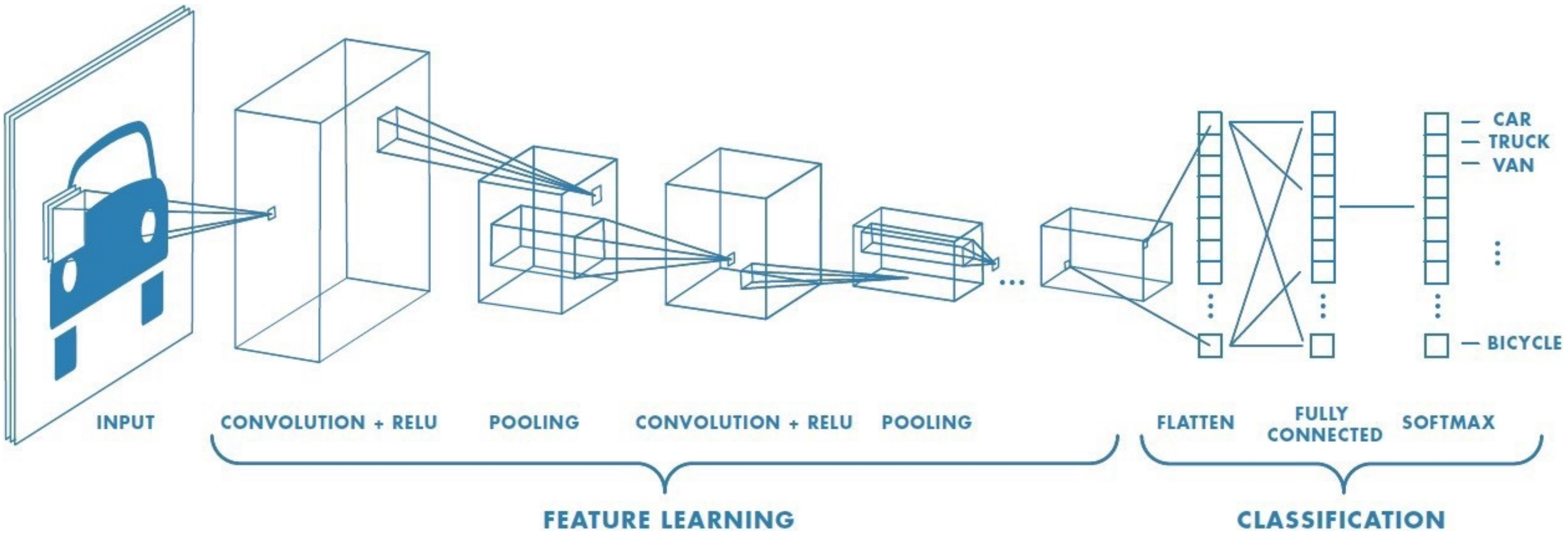
# Multilayer Perceptron



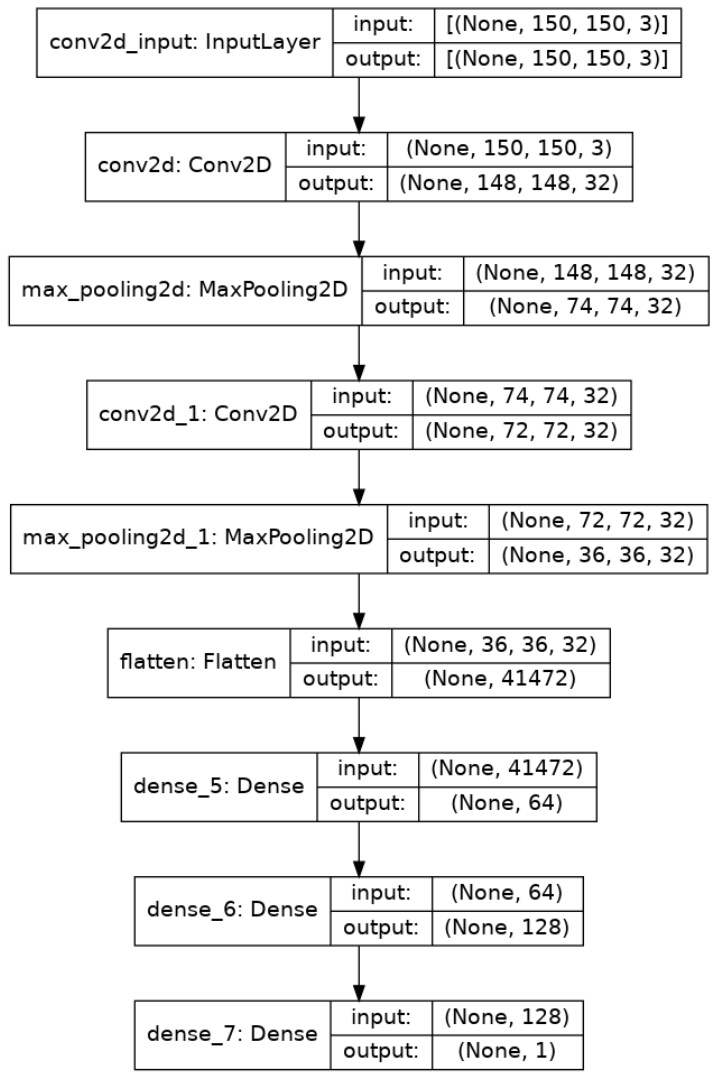
# Multilayer Perceptron



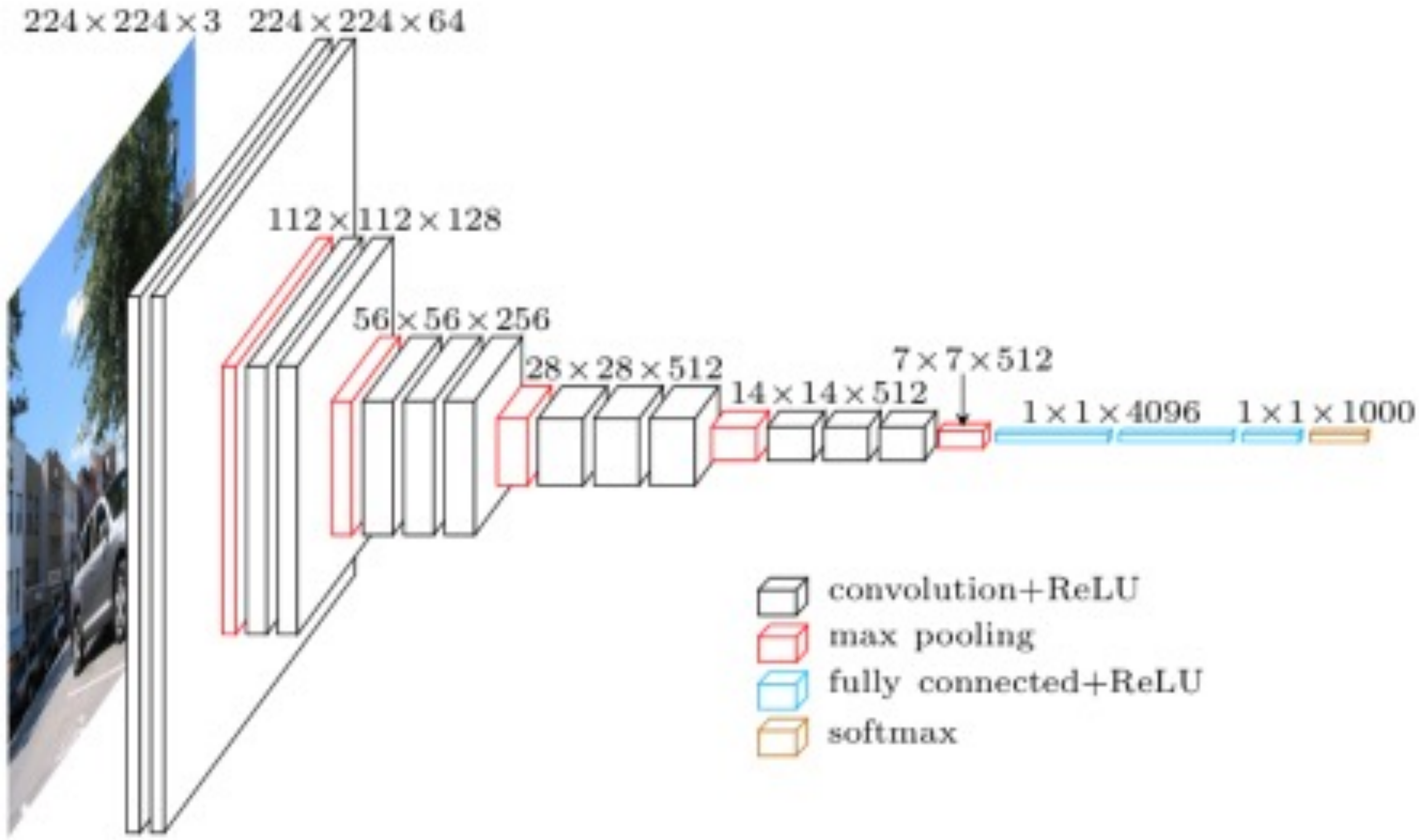
# Convolutional Neural Network



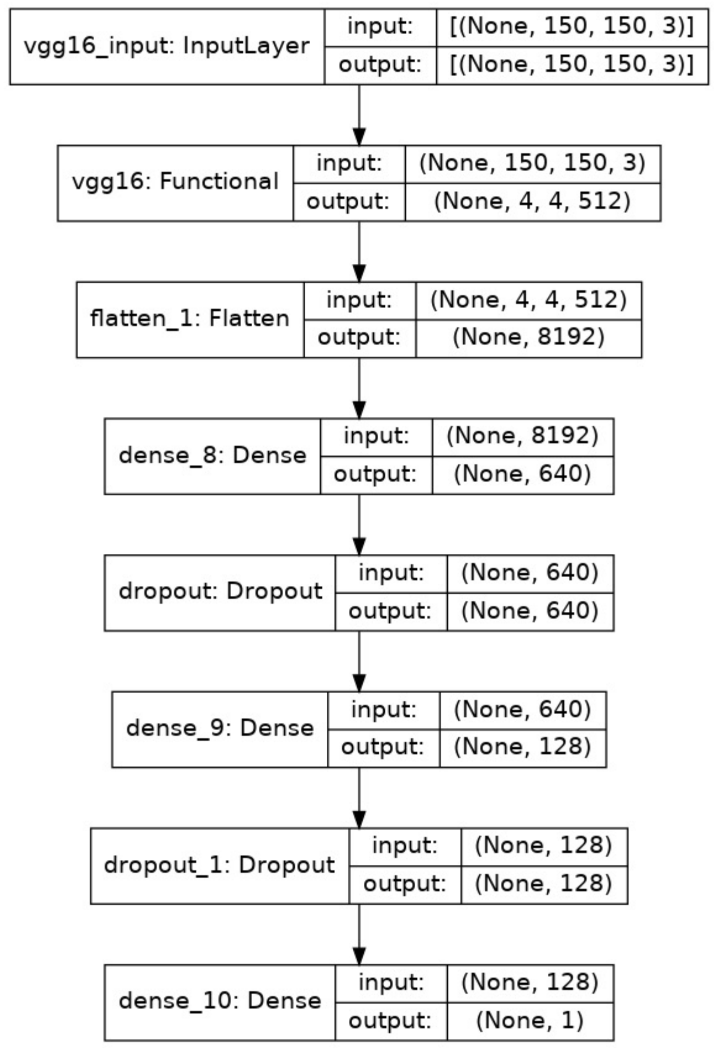
# Convolutional Neural Network



# Transfer Learning with VGG16

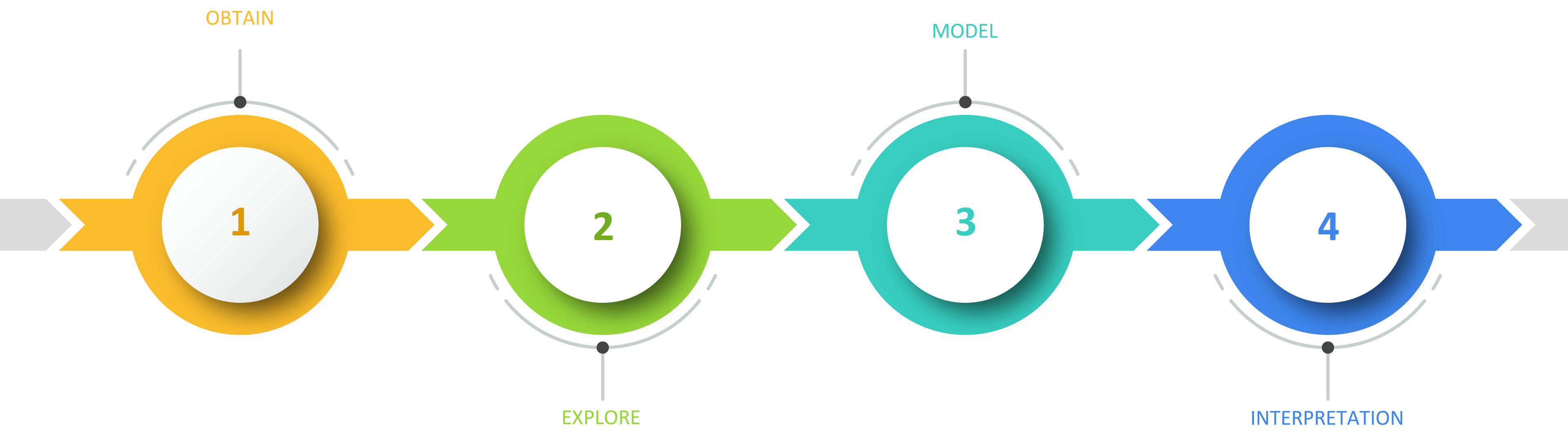


# Transfer Learning with VGG16



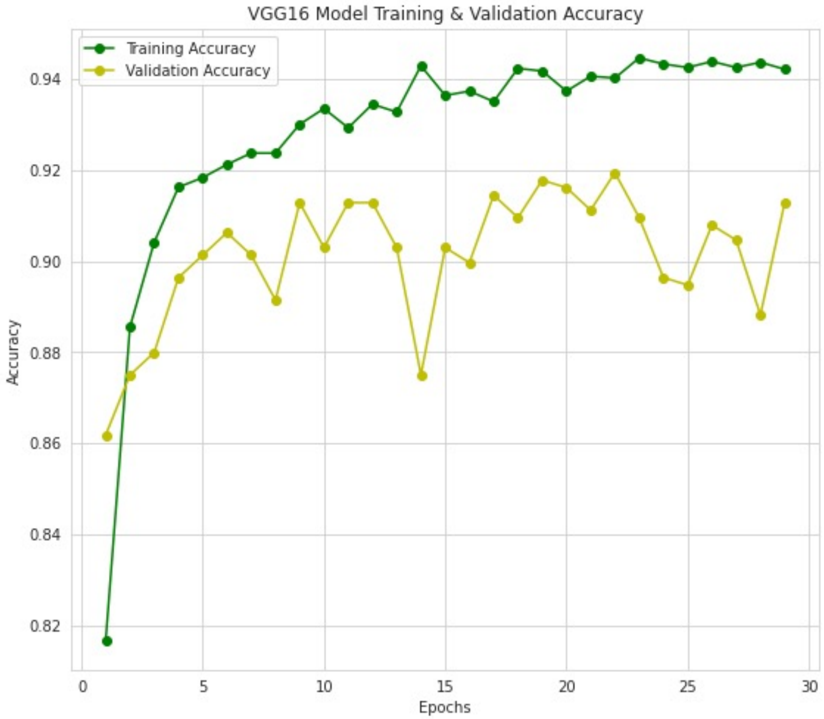
# Summary of Key Findings

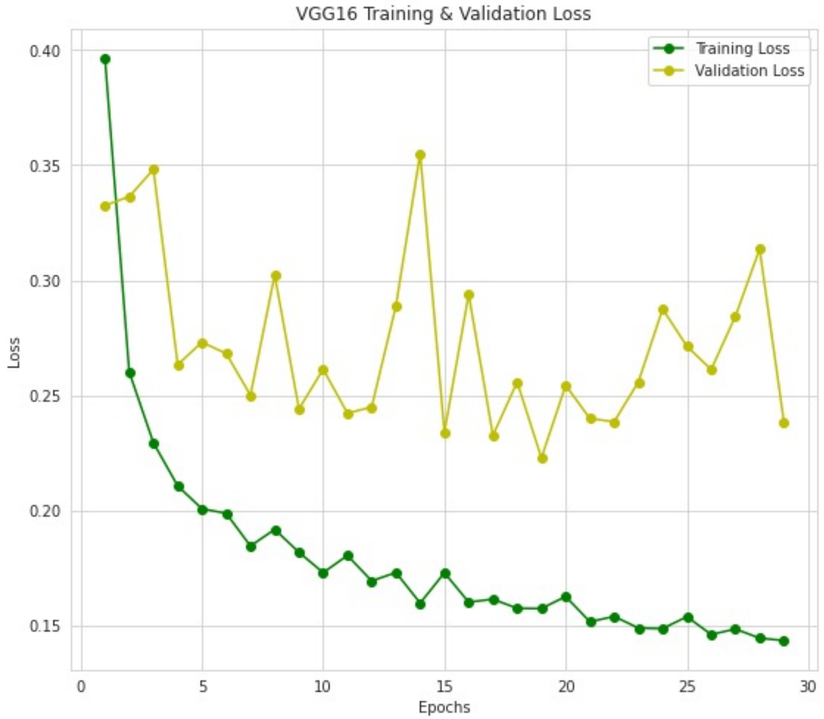
| | Model | Accuracy | Precision | Recall | F1 Score | AUC |
|---|---|---|---|---|---|---|
| 0 | Multilayer Perceptron Model | 0.79 | 0.84 | 0.74 | 0.75 | 0.74 |
| 1 | Convolutional Neural Network Model | 0.88 | 0.89 | 0.85 | 0.86 | 0.85 |
| 2 | Transfer Learning: VGG16 CNN Model | 0.92 | 0.91 | 0.90 | 0.91 | 0.90 |


OBTAIN
1
2
EXPLORE
MODEL
3
4
INTERPRETATION

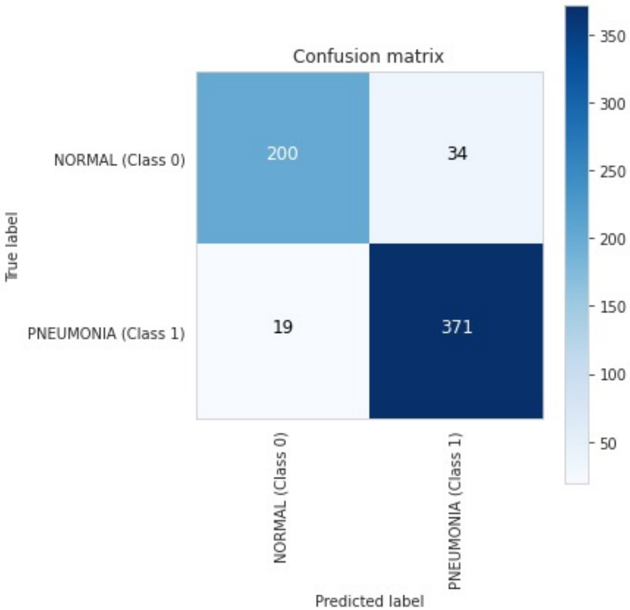
# Best Model

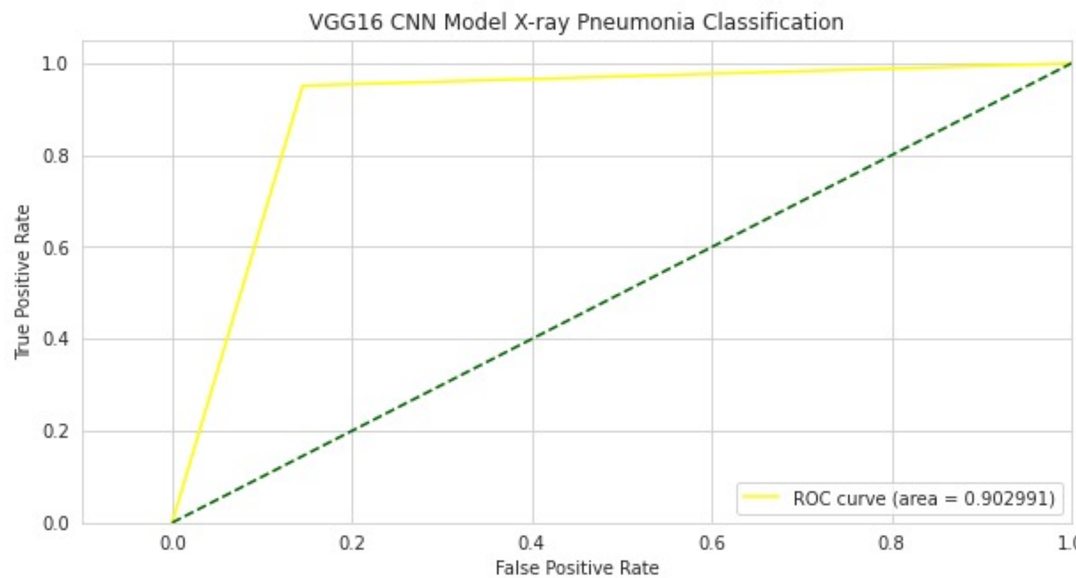
## Transfer Learning with VGG16




Train accuracy = 95%
Validation accuracy = 92%



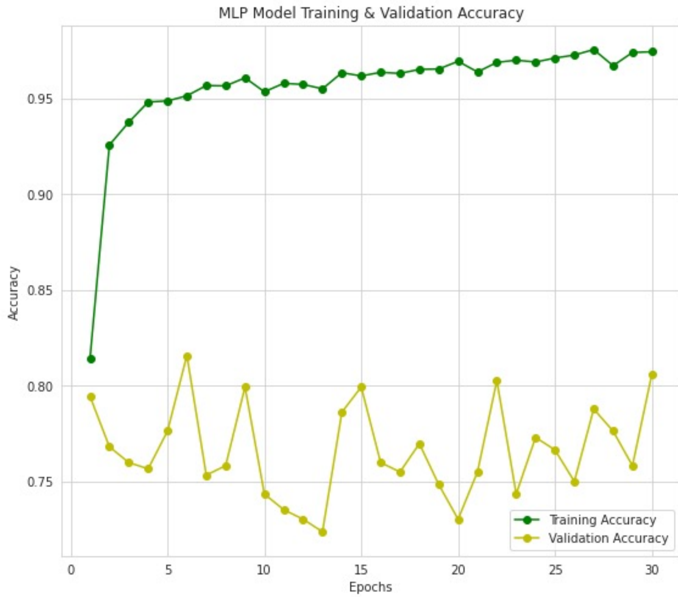

Accuracy of 92%
Recall/sensitivity of 90%
Precision/specificity of 91%
The area under the ROC curve of 90%

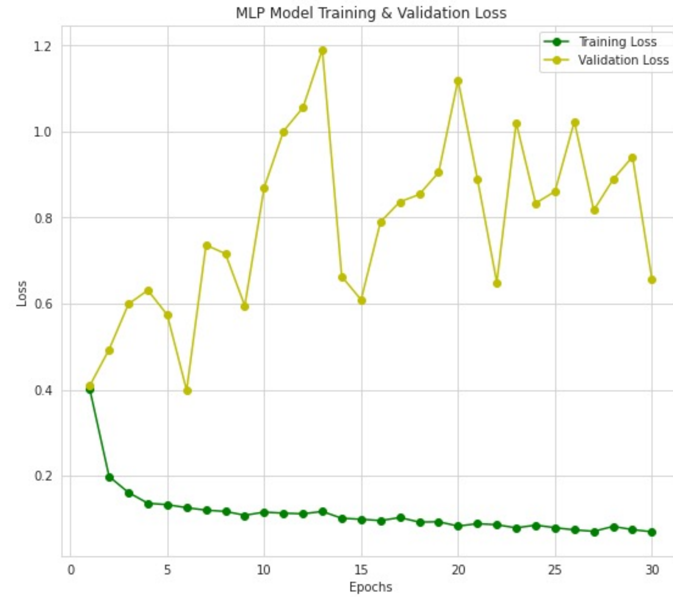
# Future Work

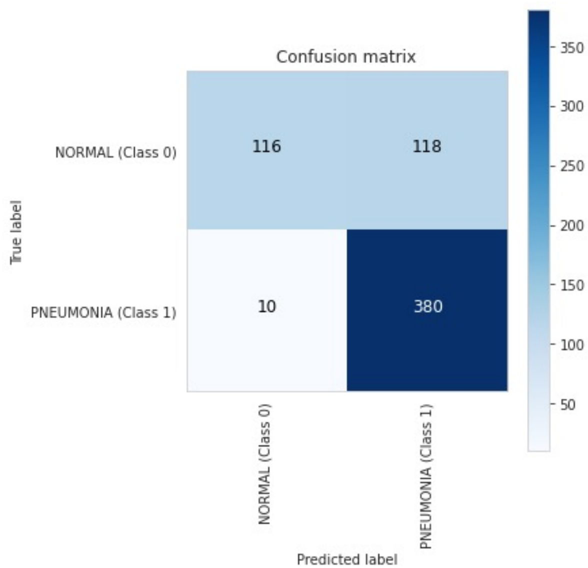
1. Build a multi-class classification deep learning model to distinguish between Normal, Viral Pneumonia, and Bacterial Pneumonia
2. Combine CNN models with other classifiers such as Support Vector Machine (SVM)
3. Tune parameters such as learning rate, batch size, try another optimizer, number of layers, different types of layer, number of neurons per layer, and the type of activation functions for each layer. GridSearchCV or RandomizedSearchSV can be used to achieve this.

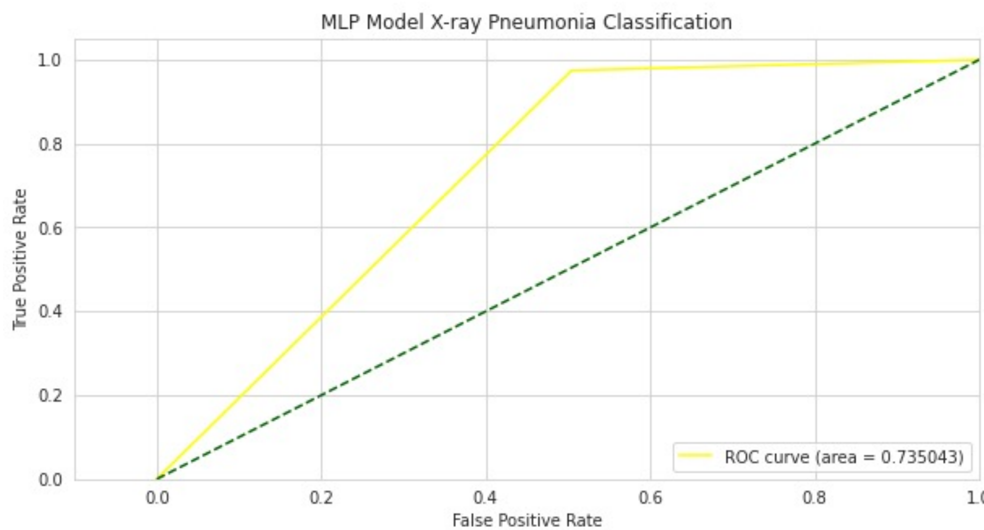
# THANK YOU

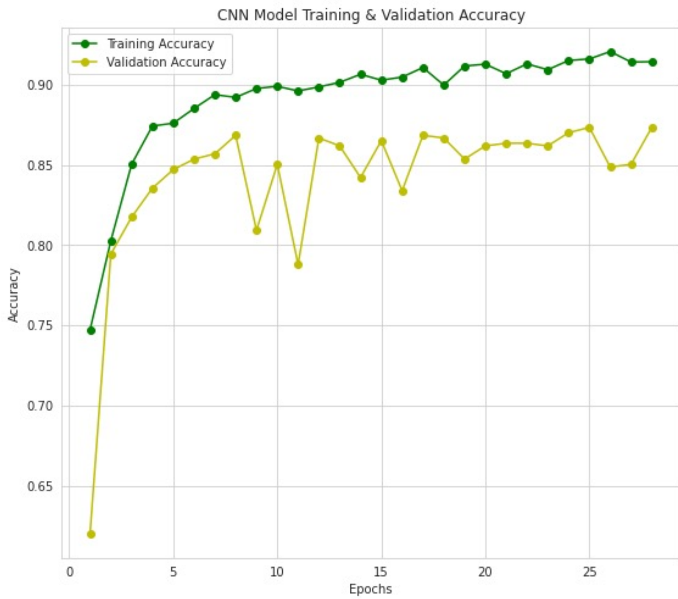
# APPENDIX

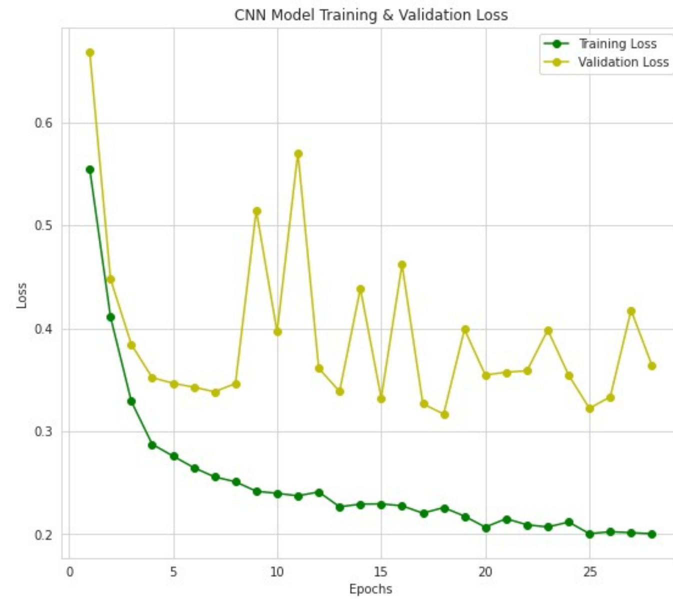

MLP Model Training & Validation Accuracy
Accuracy
Epochs
Training Accuracy
Validation Accuracy

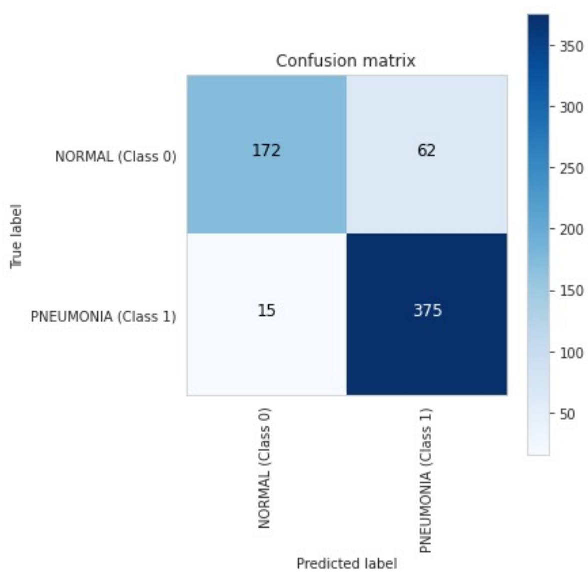

MLP Model Training & Validation Loss
Loss
Epochs
Training Loss
Validation Loss

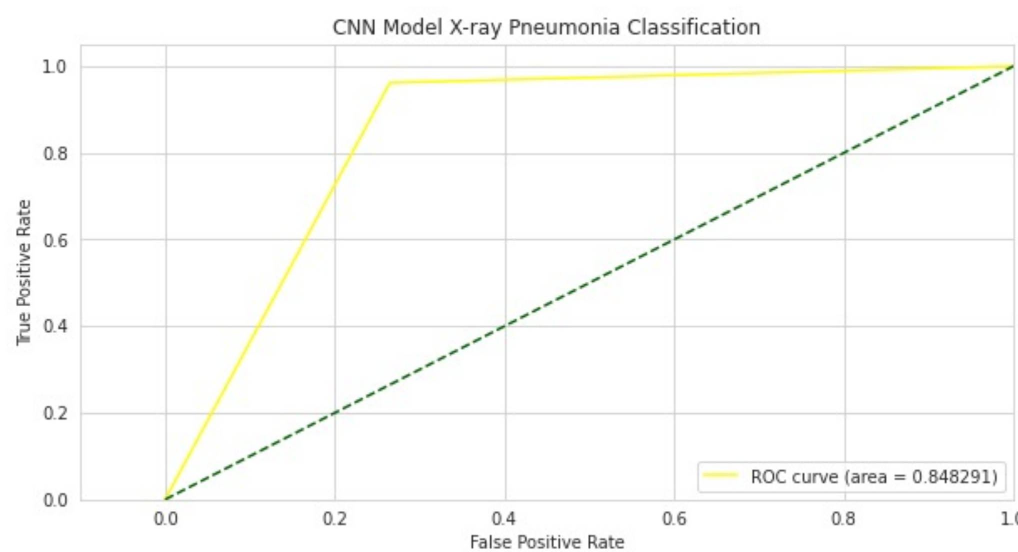

Confusion matrix
NORMAL (Class 0)
PNEUMONIA (Class 1)
True label
Predicted label
116
118
10
380


MLP Model X-ray Pneumonia Classification
True Positive Rate
False Positive Rate
ROC curve (area = 0.735043)

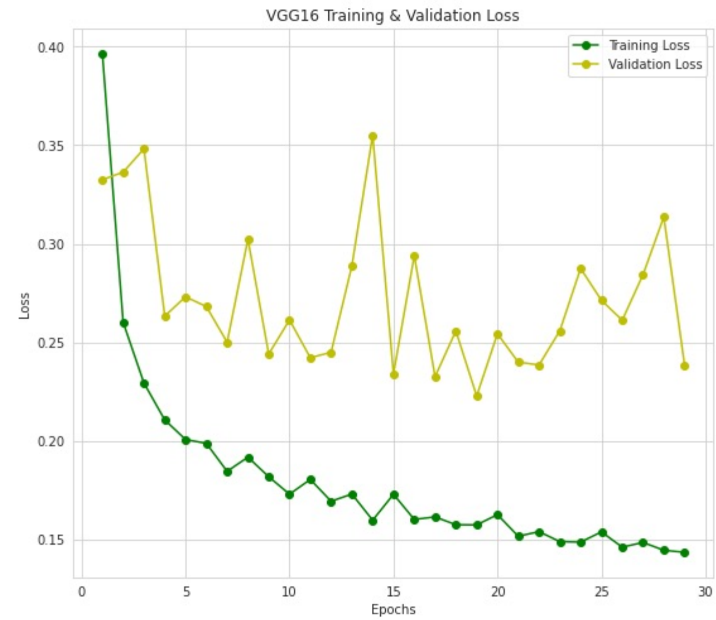

CNN Model Training & Validation Accuracy
Training Accuracy
Validation Accuracy
Accuracy
Epochs
0.90
0.85
0.80
0.75
0.70
0.65
0
5
10
15
20
25

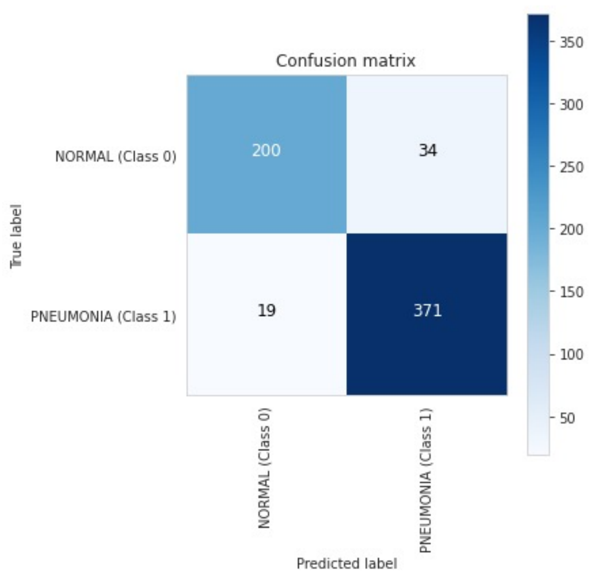

CNN Model Training & Validation Loss
Training Loss
Validation Loss
Loss
Epochs
0.6
0.5
0.4
0.3
0.2
0
5
10
15
20
25

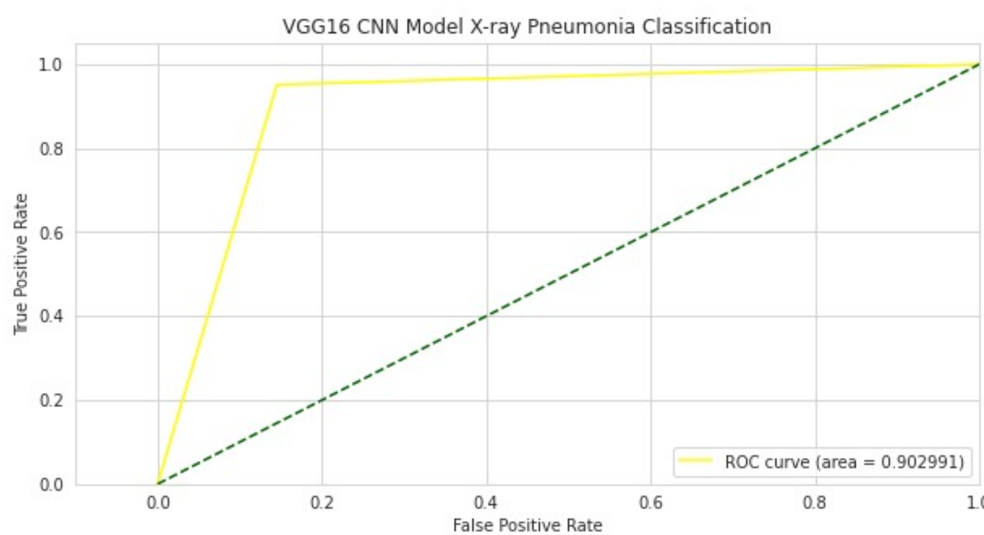

Confusion matrix
NORMAL (Class 0)
PNEUMONIA (Class 1)
True label
Predicted label
172
62
15
375
350
300
250
200
150
100
50


CNN Model X-ray Pneumonia Classification
True Positive Rate
False Positive Rate
ROC curve (area = 0.848291)
0.0
0.2
0.4
0.6
0.8
1.0


VGG16 Model Training & Validation Accuracy
Training Accuracy
Validation Accuracy
Accuracy
Epochs


VGG16 Training & Validation Loss
Training Loss
Validation Loss
Loss
Epochs


Confusion matrix
NORMAL (Class 0)
PNEUMONIA (Class 1)
True label
Predicted label
200
34
19
371


VGG16 CNN Model X-ray Pneumonia Classification
True Positive Rate
False Positive Rate
ROC curve (area = 0.902991)