**Pneumonia Detection using VGG16**

**Overview**

Pneumonia is a common and potentially deadly lung infection that can be difficult to diagnose. In this graduation project, we developed two deep learning models for pneumonia detection in chest X-ray images: one based on a **custom CNN architecture** and the other using the **VGG16 architecture**. **Both** models were trained on a dataset of **5,863** chest X-ray images obtained from the Chest X-Ray Images (pneumonia) dataset available on Kaggle.

**Requirements**

Python 3.6 or higher

TensorFlow 2.0 or higher

Keras 2.0 or higher

**Installation**

Clone this repository to your local machine.

Install the required packages using pip install -r requirements.txt.

Download the dataset from [Kaggle](https://www.kaggle.com/paultimothymooney/chest-xray-pneumonia) and extract the files to the data directory.

<https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia>.

**Data**

The dataset consists of 5,863 chest X-ray images, including 3,799 images with pneumonia and 1,157 normal images. We performed data augmentation by randomly rotating, zooming, and flipping the images to increase the size of the dataset and improve the model's ability to generalize.

**Data Preprocessing**

The dataset was preprocessed using the following steps*:*

**Resizing**: All images were resized to 224 x 224 pixels.

**Data augmentation**: The training dataset was augmented using various techniques, including random rotation, horizontal flipping, and zooming.

The augmentation was performed using the Keras ImageDataGenerator class with the following hyperparameters:

**Rotation Range**: 20

**Width Shift Range:** 0.2

**Height Shift Range:** 0.2

**Horizontal Flip :** True

**Zoom Range:** 0.2

**Normalization**: The pixel values of the images were normalized to the range [0, 1].

**Model Architecture**

**Custom CNN:**

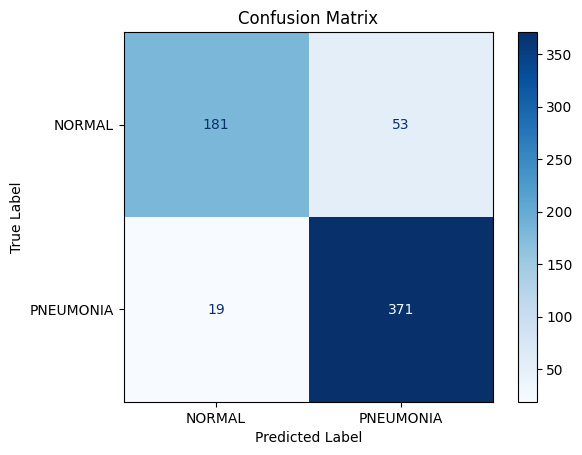
The custom CNN architecture consists of 11 convolutional layers organized into 5 blocks. Each block consists of convolutional layers followed by max pooling and batch normalization layers. The output from the convolutional layers is flattened and passed through fully connected layers, and finally, a softmax output layer is applied to predict the pneumonia condition.

**VGG16:**

Architecture: The VGG16 architecture is a widely used convolutional neural network architecture for image classification. It consists of 13 convolutional layers organized in 5 blocks and 3 fully connected layers. We used the pre-trained VGG16 model and added a few additional layers on top for pneumonia detection. We added two fully connected layers and a SoftMax output layer to the base VGG16 model. The model was trained using the Adam optimizer and a categorical cross-entropy loss function.

**Training**

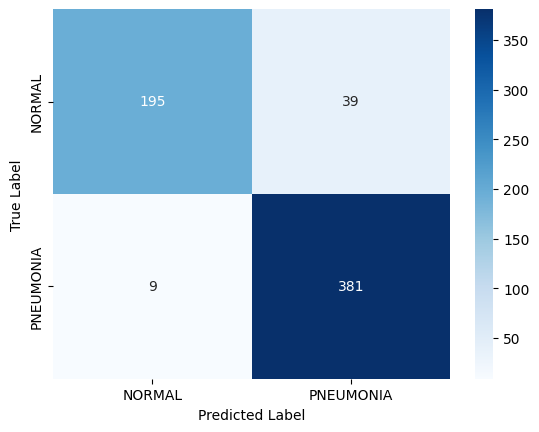
We split the dataset into training, validation, and test sets with a ratio of 70:15:15. The model was trained for 10 epochs with a batch size of 32. We used early stopping to prevent overfitting and reduce training time.

**Results**

**Custom CNN Model**

Our model achieved an **Accuracy score of 88.4%** on the 624 images test set, with a **Precision of 87.5%**, **Recall of 95%**, and **F1 score of 91%**. These results suggest that our model can effectively detect pneumonia in chest X-ray images. The precision and recall scores for each class are **shown in the confusion matrix**.

Figure 1: Confusion matrix for the custom CNN model

**VGG16 Model**

Our model achieved an **Accuracy score of 92%** on the 624 images test set, with a **Precision of 91%**, **Recall of 98%**, and **F1 score of 94%**. These results suggest that our model can effectively detect pneumonia in chest X-ray images. The precision and recall scores for each class are **shown in the confusion matrix**.

Figure 2: Confusion matrix for the VGG16 model

**Comparison:**

In this project, we successfully developed and evaluated two deep learning models, a custom CNN and VGG16, for pneumonia detection in chest X-ray images. **The VGG16 model achieved higher accuracy**, **precision**, **recall**, and **F1-score** compared to the custom **CNN model**. Both models show promise in automating the detection of pneumonia, which can aid in early diagnosis and treatment. Further advancements and improvements in the models and data collection can contribute to enhancing the accuracy and practicality of pneumonia diagnosis in real-world medical scenarios.

**Limitations**

Our model was trained on a relatively small dataset and may not generalize well to other types of chest X-ray images or medical imaging tasks.

The model's performance may be affected by factors such as the quality of the X-ray image or the skill of the radiologist who took the image.

**Future Work**

Train the model on a larger and more diverse dataset to improve its generalizability.

Investigate the use of transfer learning and other deep learning techniques to further improve the model's performance.

Incorporate additional clinical and demographic data into the model to improve its accuracy and relevance to real-world medical settings.

**Conclusion**

In this project, we developed a deep learning model based on the VGG16 architecture to automatically detect pneumonia in chest X-ray images. Our model achieved a high level of accuracy and provides a promising approach for automated pneumonia diagnosis.