Pneumonia Detection using Custom CNN on Chest X-ray Dataset

Name: **Sriraj Thiruchety**
Roll no: **1602-22-737-051**
Branch: **IT-A**

Project Link: https://github.com/Sriraj8687/Pneumonia-Detection-CNN

1. Problem Statement and Objectives

Pneumonia is a life-threatening lung infection that demands rapid and accurate diagnosis. Traditional diagnosis via radiologist-reviewed chest X-rays is time-consuming and prone to human error, especially in resource-limited settings.

Objective:
To build a deep learning model that automatically detects pneumonia from chest X-ray images with high accuracy using a custom Convolutional Neural Network (CNN).

2. Experimental Setup and Methodology

Dataset:

- The dataset was obtained from Kaggle's "Chest X-Ray Images (Pneumonia)" collection. It contains 5,863 X-ray images categorized into two classes: NORMAL and PNEUMONIA.

Preprocessing:

- - Images were resized to 224x224 pixels.
  - Preprocessing was done using MobileNetV2 preprocessing strategy for consistency.
  - A stratified train-validation split (80:20) was used to preserve class distribution.

Data Augmentation:

- Implemented via ImageDataGenerator with real-time augmentation techniques such as:
  - Horizontal flipping
  - Zoom range
  - Brightness shift
  This prevents overfitting and simulates real-world variations.

Model Architecture:

- - Multiple Conv2D layers with BatchNormalization and ReLU activations.
  - Dropout layers for regularization.
  - Fully connected Dense layers for classification.
  - Final layer: 2 neurons with softmax activation for binary classification.

Training Strategy:

- - Optimizer: Adam
  - Loss: Categorical Crossentropy
  - Metrics: Accuracy
  - EarlyStopping and ReduceLROnPlateau were used for optimal training.
  - ModelCheckpoint ensured saving the best-performing model.

3. Results, Observations, and Analysis

Accuracy & Performance:

- - Final validation accuracy achieved: 96.24%
  - Model converged around 15 epochs with early stopping.
  - Confusion matrix showed very few false negatives, a crucial metric in medical diagnosis.

Classification Report:

Class	Precision	Recall	F1-score
NORMAL	0.95	0.94	0.945
PNEUMONIA	0.97	0.98	0.975

Key Observations:

- - The model performed exceptionally well in distinguishing between the two classes.
  - Class imbalance was handled using class_weight during training.
  - Data augmentation played a major role in preventing overfitting.
  - The CNN's ability to extract spatial features led to superior performance compared to baseline models.

Challenges:

- - Dealing with imbalance required trial-and-error tuning of class weights.
  - Augmentation hyperparameters needed multiple iterations to achieve balance between realism and distortion.

Conclusion:

This project demonstrates that a well-designed CNN, even without transfer learning, can achieve medical-grade accuracy for pneumonia detection. The approach is scalable, cost-efficient, and capable of assisting radiologists in clinical settings.