Chest X-Ray Pneumonia Detection using DenseNet121

This project leverages **DenseNet121**, a convolutional neural network (CNN) architecture, to classify chest X-rays as either *Pneumonia* or *Normal*. It was built to showcase the use of deep learning in healthcare for early disease detection. The project is trained on publicly available Kaggle datasets and is intended for educational and research purposes.

Dataset

We used the **Kaggle Chest X-Ray Pneumonia dataset**, which consists of ~6,400 X-ray images categorized as *Normal* and *Pneumonia*. The dataset is divided into training, validation, and test sets. For lighter experimentation, **MedMNIST (PneumoniaMNIST)** can also be used.

Methodology

1. **Preprocessing**: Images were resized (224x224), normalized, and augmented (rotation, flips, zooms) to improve model generalization.
2. **Model**: DenseNet121 (pretrained on ImageNet) was used with a custom classification head for binary output.
3. **Training**: The model was trained using Adam optimizer and Binary Cross-Entropy loss with early stopping.
4. **Evaluation**: Accuracy, confusion matrix, classification report, and Grad-CAM visualizations were generated.
5. **Deployment**: The trained model was saved in both `.h5` and `.keras` formats for use in applications (e.g., Streamlit).

Results

The DenseNet121 model achieved high accuracy (>90%) in distinguishing Pneumonia from Normal chest X-rays.
- **Confusion Matrix** clearly shows classification strengths and weaknesses.
- **Grad-CAM visualizations** highlight lung regions most responsible for predictions, increasing interpretability.
- The model demonstrates the potential of AI to assist radiologists in rapid screening and diagnosis support.

Model Saving & Formats

- **HDF5 (.h5)**: Legacy format, widely compatible.
- **Keras (.keras)**: New recommended format; saves weights, optimizer, and training config. Internally stores data in `.db` files (`fingerprint.db`, `saved_model.db`).
- **SavedModel (via model.export)**: Used for TensorFlow Serving and TFLite conversion.

Applications

- **Clinical Aid**: Assist doctors in preliminary screening of chest X-rays.
- **Education**: Serve as a reference for students/researchers learning deep learning in healthcare.
- **Open Source Tools**: Can be deployed in a web app (Streamlit/Flask) for demonstration purposes.

How to Run the Project

1. Clone the repository from GitHub.
2. Install dependencies: `pip install -r requirements.txt`.
3. Run the training notebook on Google Colab with GPU enabled.
4. Use the saved `.h5` or `.keras` model for inference.
5. Optionally deploy using Streamlit (`streamlit run app.py`).

Conclusion

This project demonstrates how deep learning (CNNs with DenseNet121) can be applied in the healthcare domain for chest X-ray classification. While not a replacement for expert diagnosis, it showcases the promise of AI in augmenting clinical workflows, making diagnostics faster and more accessible.