

Deep Learning Framework for Automated Disease Detection from Medical Imaging

Abstract:

The increasing availability of medical imaging data, coupled with advancements in artificial intelligence, has opened new possibilities in automated disease diagnosis. This project presents a Python-based deep learning framework designed for the automated detection of diseases from medical imaging modalities such as X-rays, CT scans, and MRIs. The core objective is to improve diagnostic accuracy, reduce human error, and provide faster analysis for clinical use.

The framework employs Convolutional Neural Networks (CNNs), known for their exceptional performance in image classification tasks. Transfer learning techniques are integrated using pre-trained models like ResNet, VGG, and EfficientNet, which are fine-tuned on disease-specific datasets. Data preprocessing techniques such as image normalization, augmentation, and resizing are applied to enhance model generalization and performance. The system is implemented in Python using TensorFlow and Keras libraries, enabling rapid prototyping and model training.

To evaluate the model's effectiveness, publicly available datasets like ChestX-ray14 and COVIDx are utilized. The performance is assessed using metrics such as accuracy, precision, recall, F1-score, and ROC-AUC. Early experimental results demonstrate high accuracy in identifying pneumonia, COVID-19, and lung cancer, confirming the potential of deep learning in diagnostic applications.

Additionally, Grad-CAM (Gradient-weighted Class Activation Mapping) is used to visualize the regions in the medical images that the model focuses on during prediction, thus increasing the explainability of the system and fostering trust among medical professionals. The architecture also supports multi-label classification to accommodate complex cases where multiple pathologies co-exist.

The proposed framework is modular, allowing easy integration with hospital information systems and adaptability for various imaging modalities and diseases. It emphasizes scalability, reusability, and robustness, making it a valuable tool for radiologists and healthcare providers. Future improvements include real-time deployment using cloud APIs and expanding the model's capabilities through federated learning for privacy-preserving medical AI.

In conclusion, this Python-based deep learning framework demonstrates the feasibility and effectiveness of using AI for disease detection from medical imaging, representing a significant step toward smart, automated, and accessible healthcare diagnostics.