Pneumonia Detection Using Convolutional Neural Networks

A Study Based on Chest X-Rays

Name: Neha Podduturi

ID : 700759286

Author: Abdelbaki Souid , Nizar Sakli and Hedi Sakli

Motivation

- Using CNNs for pneumonia detection offers faster and more accurate diagnoses, crucial for timely treatment.
- CNNs support radiologists by providing a reliable second opinion and handling large volumes of X-ray images efficiently.
- They are adept at recognizing patterns in diverse imaging data, enhancing diagnostic robustness. Advances in deep learning technology make this approach feasible and innovative, improving healthcare delivery and patient outcomes.

Problem Statement

- Despite the advancements in medical imaging technology, the manual interpretation of chest X-rays remains prone to variability and error. There is a critical need for reliable, automated diagnostic tools to assist healthcare professionals in identifying pneumonia accurately and swiftly, potentially improving patient outcomes and resource allocation in healthcare settings.

Objectives

- **Develop a Reliable Model**: Create a CNN-based system capable of accurately detecting pneumonia from chest X-rays.
- **Assess Model Performance**: Use metrics such as accuracy, precision, recall, and F1score to evaluate the model.
- **Benchmarking**: Compare the performance of the CNN model against existing diagnostic methods.
- **Real-World Application**: Ensure the model's robustness and suitability for integration into clinical settings to assist healthcare professionals in diagnosing pneumonia efficiently and accurately

Contributions

- **Novel Application**: Applied advanced CNN architectures to pneumonia detection.
- **Dataset Utilization**: Leveraged a large, labeled dataset of chest X-rays for training and validation.
- **Performance Benchmarking**: Achieved high accuracy and other performance metrics, demonstrating the model's capability.
- **Clinical Implications**: Highlighted the potential for integrating the model into healthcare systems to aid radiologists and improve diagnostic workflows.

Result

The CNN model for pneumonia detection achieved an accuracy of 93% with a sensitivity of 91% and specificity of 95%. It successfully identified pneumonia cases with an F1score of 90% and an AUC-ROC of 0.97. The model demonstrated robustness through data augmentation and preprocessing, with consistent performance across crossvalidation and external datasets. Visualization of activation maps provided insights into the model’s decision-making process. Preliminary real-world trials confirmed the model's practical utility and accuracy in assisting radiologists.

Critical Analysis

- **Strengths**: High accuracy, effective feature extraction, potential for real-time application.
- **Weaknesses**: Limited by the quality and diversity of the dataset, potential overfitting, and computationally intensive training.
- **Opportunities for Improvement**: Incorporating more diverse datasets, exploring ensemble methods, and optimizing the model for faster inference.
- **Threats**: Dataset biases, ethical considerations in automated diagnostics, and dependency on large computational resources.

References

- [1]: Pneumonia https://www.mayoclinic.org/diseasesconditions/pneumonia/symptoms-causes/syc-20354204
- [2]: American Lung Association. (May 27, 2020). *Learn About Pneumonia*. https://www.lung.org/lung-health-diseases/lungdisease-lookup/pneumonia/learn-about-pneumonia
- [3]: American Thoracic Society. Top 20 Pneumonia Facts — 2019.

https://www.thoracic.org/patients/patientresources/resources/top-pneumonia-facts.pdf