X-Ray Image Classification for Pneumonia Detection Using PyTorch CNN

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Pneumonia is a leading cause of morbidity and mortality worldwide, particularly among children under five years of age. Chest X-ray imaging remains the most widely used diagnostic tool, yet manual interpretation is time-consuming and subject to variability across radiologists. To address this challenge, we developed a convolutional neural network (CNN)-based framework for automated pneumonia detection using chest X-ray images. The dataset, sourced from the publicly available Kaggle repository, contains 5,863 pediatric anterior-posterior chest X-ray images categorized as “Normal” or “Pneumonia.” Images underwent quality control to remove unreadable scans and were validated by expert physicians to ensure reliable ground truth annotations. Data were split into training, validation, and test sets, with augmentation techniques such as flipping, rotation, and scaling applied to improve model generalization.

The classification model was implemented in PyTorch using a CNN architecture, with experiments comparing custom-designed models and transfer learning with pre-trained networks such as VGG16. Model performance was evaluated using accuracy, precision, recall, and F1-score. The results demonstrated that CNN-based models achieved high diagnostic performance, with transfer learning approaches further enhancing classification accuracy. The system reliably differentiated between normal and pneumonia cases, reducing the risk of false negatives, which are critical in medical diagnosis. This study highlights the potential of deep learning models to serve as efficient, cost-effective diagnostic support tools in healthcare, particularly in resource-limited settings where radiologist expertise may be scarce. Future work will focus on expanding the dataset, integrating multi-class classification for bacterial versus viral pneumonia, and validating the approach in clinical workflows.

The normal chest X-ray(left panel) depicts clear lungs without any areas of abnormal opacification in the image. Bacterial pneumonia (middle panel) typically exhibits a focal lobar consolidation, in this case in the right upper lobe (white arrows), whereas viral pneumonia(right panel) manifets with a more diffuse "interstitial" pattern in both lungs.

Biography

Janvier Nshimyumukiza is a Microsoft-certified AI engineer and senior data scientist with expertise in machine learning, big data systems, and scalable cloud solutions. He holds two master’s degrees, an MS in Electrical and Computer Engineering from Carnegie Mellon University and an MS in Business Analytics from Emory University, where he earned the 2023 Student Excellence in Tech Award. With experience spanning healthcare, finance, and enterprise AI, Janvier has built predictive analytics platforms, generative AI applications, and recommender systems. His passion lies in leveraging AI-driven solutions for impactful applications in biostatistics, infrastructure optimization, and business intelligence.