

Pneumonia Classification from Chest X-ray Images Using Convolutional Neural Networks

Introduction

Pneumonia, which can have serious complications for a person's lungs, is a very severe infectious disease of the respiratory system. It is especially serious for young children, the elderly, and those who have weakened immune systems. Accurately diagnosing pneumonia at an early stage is critical in reducing the number of people that die from pneumonia. The traditional way of diagnosing pneumonia is by relying on the physician's clinical examination and other imaging techniques like a chest x-ray. Interpreting x-ray images manually can take a lot of time; furthermore, the amount of time that it takes to interpret an x-ray image is reliant on the radiologist's experience level. In the last few years, there has been significant interest in applying artificial intelligence (AI) and deep learning techniques to analyze medical images. The most promising AI model for automatically extracting meaningful features from chest x-ray images and classifying them as either normal or pneumonia, is Convolutional Neural Networks (CNNs). By using CNNs, healthcare providers will have a lower risk of making human errors in diagnosis and further assist them in making clinical decisions in a faster manner. In this project, the goal is to evaluate the effectiveness of CNN-based models for diagnosing pneumonia from chest x-ray images. Additionally, additional levels of deep learning architectures used, will be evaluated to identify which model is most accurate and reliable for detecting pneumonia through automated analysis of chest x-ray images.

1.1 Background

Pneumonia The lungs can suffer from pneumonia, which is an infectious illness that, if not detected early, can lead to death. Typically, pneumonia is diagnosed with the help of a physical examination and a type of radiology called chest X-ray. The more quickly pneumonia is diagnosed, the less the chance of complications from the disease and of dying from the disease. Recently, deep learning methods have been successfully used in medical image processing. Convolutional Neural Networks (CNNs) are very effective in analyzing chest X-ray images and detecting pneumonia automatically, making a rapid and accurate diagnostic support system available to the clinician.

Related Work

1. Pneumonia Detection Using Chest Radiographs with Novel EfficientNetV2L Model

Pneumonia is a potentially life-threatening infectious disease that is typically diagnosed through physical examinations and diagnostic imaging techniques such as chest X-rays, ultrasounds or lung biopsies. The models are trained on a dataset of 5856 chest X-ray images and show 87.78%, 88.94%, 90.7%, 91.66%, 87.98% and 94.02% accuracy for CNN, InceptionResNetV2, Exception, VGG16, ResNet50 and EfficientNetV2L, respectively. Notably, EfficientNetV2 demonstrates the highest accuracy and proves its robustness for pneumonia detection.

2. A Noise-Robust Framework for Automatic Segmentation of COVID-19 Pneumonia Lesions From CT Images

Segmentation of pneumonia lesions from CT scans of COVID-19 patients is important for accurate diagnosis and follow-up. Deep learning has a potential to automate this task but requires a large set of high-quality annotations that are difficult to collect. (EMA) of a student model is used as a teacher model that is adaptively updated by suppressing the contribution of the student to EMA when the student has a large training loss.

3. Predictive Factors of the Responses to Treatment of *Mycoplasma pneumoniae* Pneumonia

The prevalence of refractory *Mycoplasma pneumoniae* (MP) pneumonia is increasing. The present study aimed to identify the predictive factors of responses to treatment of MP pneumonia in children. The severity of pneumonia, based on the extent of pneumonia lesions on chest x-ray (adjusted odds ratio (aOR), 10.573; 95% confidence intervals (CIs), 2.303–48.543), and lactate dehydrogenase (LDH) levels (aOR, 1.002; 95% CIs, 1.000–1.004) at the time of admission were associated with slow response to treatment of MP pneumonia.

Data set:

Chest X-Ray Images (Pneumonia) Dataset for this project. The dataset contains 5863 chest x-ray images, all of which are labeled as either normal or with pneumonia, and the images in the dataset are further divided into 3 sets that include training data.

Dataset Link:

<https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia>

Comparative Analysis of Related Work:

Ref	Model	Dataset	Best model	Result
[1]	EfficientNetV2L	5856 chest X-ray images with pneumonia	NN, InceptionResNetV2, Exception, VGG16, ResNet50 and EfficientNetV2L	accuracy of 94.02%, precision of 94.40%, recall of 97.24% and F1 score of 95.80%.
[2]	COPLE-Net with the proposed adaptive self-ensembling framework.	CT scans of 558 COVID-19 patients from 10 hospitals	COPLE-Net + Noise-Robust Dice Loss (LNR-Dice) + Adaptive Self-Ensembling	The entire proposed framework achieved average Dice of 80.72%, RVE of 15.96% and HD95 of 17.12 mm respectively
[3]	(ROC)	A total of 149 children were diagnosed with MP pneumonia	Laboratory and radiologic factors analyzed to predict response (Good, Slow, No response)	Best prediction model reached AUC = 0.94

Reference:

- [1] Ali, M., Shahroz, M., Akram, U., Mushtaq, M. F., S. C., Obregon, S.I., & Ashraf, I. (2024). *Pneumonia detection using chest radiographs with novel EfficientNetV2L model*. IEEE Access, 12, 34691–34704. <https://doi.org/10.1109/ACCESS.2024.3370355>
- [2] Wang, G., Liu, X., Li, C., Xu, Z., Ruan, J.Meng, T., Li, K., Huang, N., & Zhang, S. (2020). A noise-robust framework for automatic segmentation of COVID-19 pneumonia lesions from CT images. *IEEE Transactions on Medical Imaging*, 39(8), 2653–2663. <https://doi.org/10.1109/TMI.2020.3000314>
- [3] Lee, E., & Lee, (2021). Predictive factors of the responses to treatment of Mycoplasma pneumoniae pneumonia. *Journal of Clinical Medicine*, <https://doi.org/10.3390/jcm10061154>