Pneumonia Detection on Chest X-Ray Images Using Deep Learning Based on Convolutional Neural Network

Mr. N.Kesava Rao, M. Tech, Ph.D, Associate professor, Department of CSE, Narayana Engineering College, Gudur.

Shaik Imran, Department of CSE, Narayana Engineering College, Gudur.

ABSTRACT:

Artificial intelligence (AI) has become integral to numerous fields, especially with the exponential growth in data availability in recent years. Its primary function is to enhance decision-making processes, making them faster, more accurate, and more reliable. One prominent application of AI and machine learning (ML).The objective of this model is to address a classification problem: determining whether a chest X-ray image indicates pneumonia.

Index Terms— artificial intelligence, convolutional neural networks, deep learning, image processing, machine learning, pneumonia detection.

I. INTRODUCTION

Artificial intelligence (AI) emerged as an academic discipline in the 1950s, but its early practical applications were limited, which restrained its exploration by the scientific community for many years. In the last few decades, The most notable of these is the "AI Winter," spanning from the 1970s to the early 2000s, a period of stagnation largely due to insufficient processing capabilities.

The resurgence of AI began in earnest with IBM's development of Deep Blue, a chess-playing computer that defeated world champion Garry Kasparov in 1997.

Though the concept of Artificial Neural Networks (ANNs) dates back to the 1940s, their practical significance was dramatically revived in 2016. This was highlighted when Google's AlphaGo, utilizing deep learning, triumphed over the world champion.

This achievement is considered one of AI's most significant milestones. For context, in chess, the opening has 20 possible moves, whereas Go offers 361 options. This breakthrough spurred further AI research, and ANN and DL algorithms are now employed in image recognition, speech recognition, sensor data processing, and more.

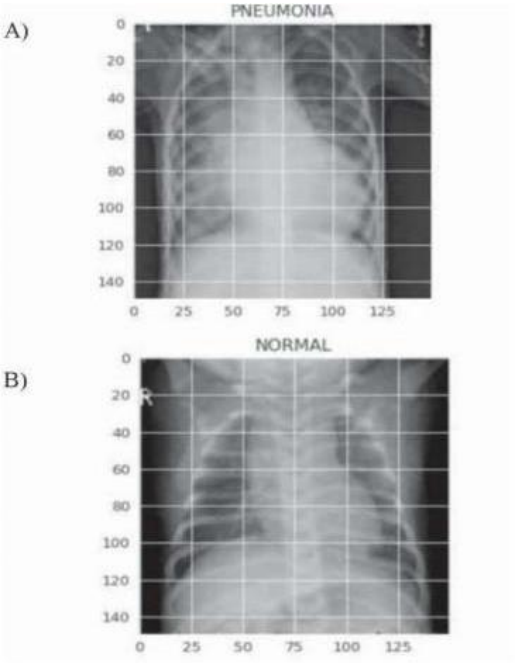
The integration of AI in medical image processing support tools aims to enhance accuracy, consistency, and efficiency in reporting. Additionally, pneumonia is frequently detected in hospitalized patients with COVID-19, further driving our exploration of this issue during the global pandemic.

II. MATERIALS AND METHODS

A. Images of Chest X-Rays

The dataset employed in this research is provided by Guangzhou This dataset consists of 5,856 chest X-ray images (JPEG format), organized into three main directories: Initially, the validation directory contained only 16 images. For the purposes of this study, an 80/10/10 split was implemented, distributing 80% of the images to training, 10% to validation, and 10% to testing. Thus, the training folder includes 4,684 images.

The images are of high quality and come in various dimensions, which were resized for model training. Given the predominance of "Pneumonia" images in the training dataset thereby ensuring a more balanced training dataset. Below are examples of chest X-ray images used in this research.



B. Pre-processing o f Images, Dataset Preparation

The first crucial step before constructing a model is preprocessing the imported data. The original images were in RGB format, but for this experiment, they were converted to grayscale and resized to 200x200 pixels. After this, the pixel intensity values were normalized by dividing each value by 255, transforming the pixel values to floating-point numbers between 0 and 1 instead of integers from 0 to 255.

All these preprocessing techniques were implemented using Keras's preprocessing tools.

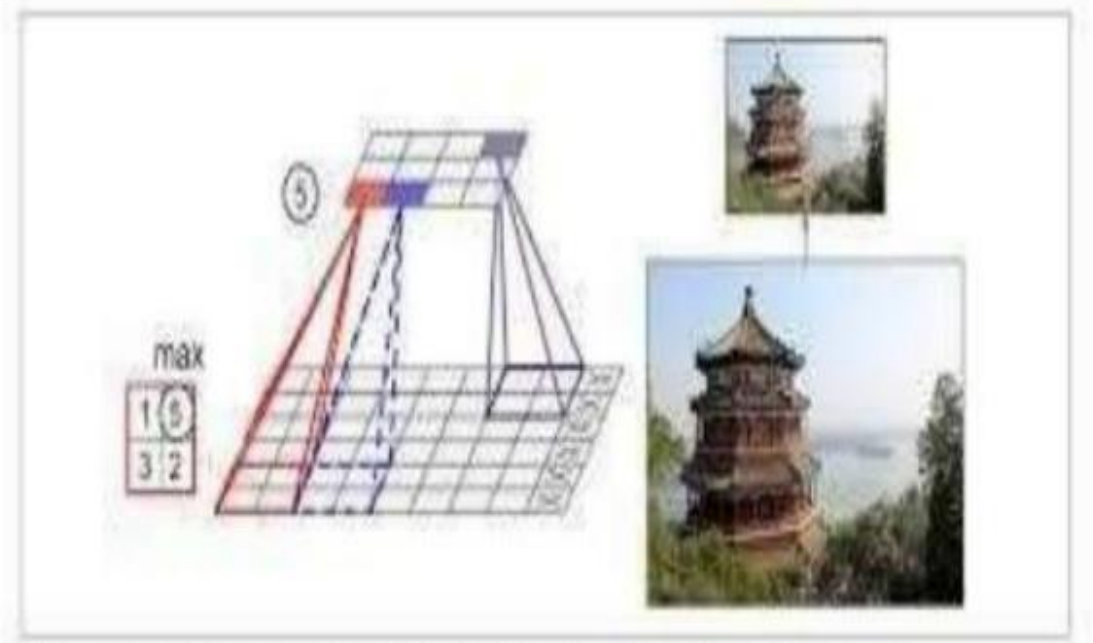
C. Convolutional Neural Network and Tools Selection

CNNs, or Convolutional Neural Networks, stand as a cornerstone in deep learning, particularly renowned for their adeptness in image recognition and classification tasks. Within the CNN architecture lie layers including input, output, and hidden layers, with the latter bearing the brunt of computational tasks.

Pooling layers play an indispensable role in CNNs, tasked with downsampling input images while preserving crucial information.

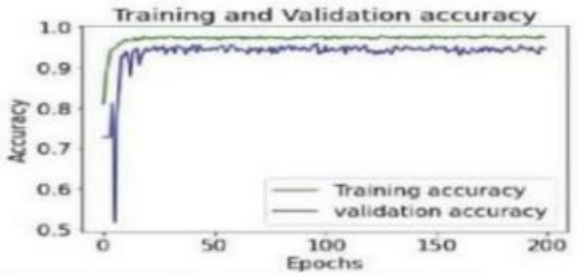
In our experiments, we employed the Rectified Linear Unit (ReLU) activation function. Recognized for its efficacy in deep neural networks.

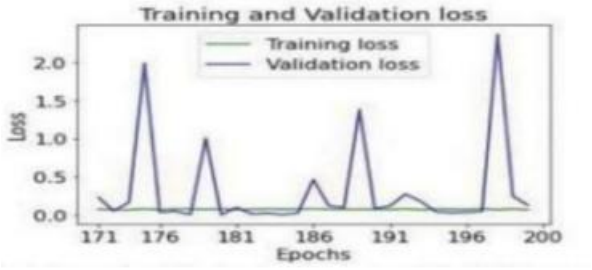
Furthermore, dropout, a technique integrated into model creation, plays a pivotal role in enhancing performance. The simple inclusion of dropout can yield a notable 1-2% improvement in the network's accuracy.



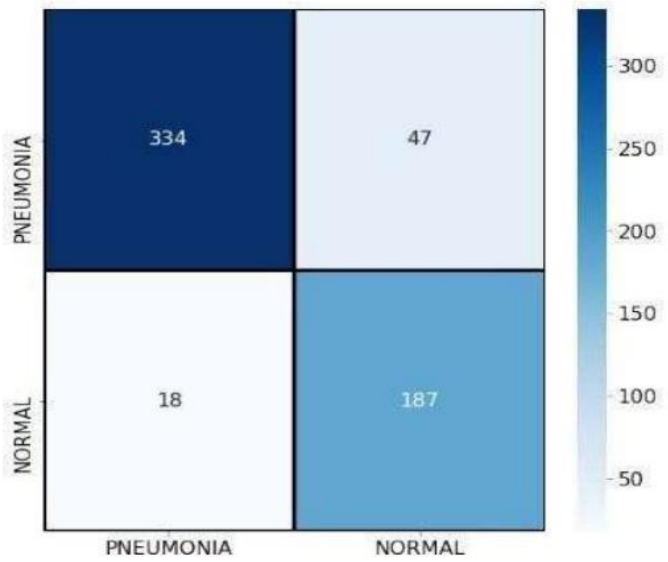
III. RESULTS AND DISCUSSION

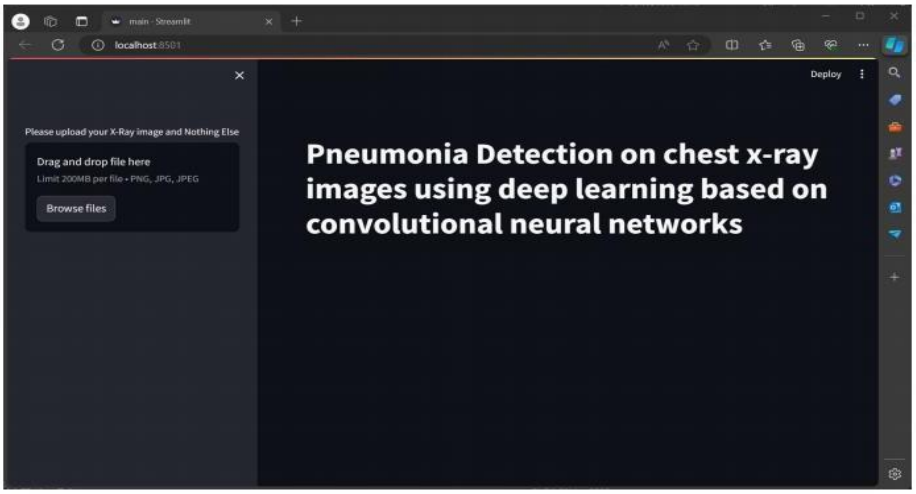
Evaluation of the results can be done by analysing the various parameters such as training accuracy and loss, validation accuracy and loss and of course model accuracy. The progress of the training and validation accuracy and loss during time is shown in Figures 5 and 6.Figure 6 shows that the validation loss has spikes in the last 30 epochs, especially at epochs 198, but at the end it comes to a good level of near 0.





The Y-axis of the confusion matrix holds the predicted values.With the trained model, 334 out of 381 were accurately predicted as images of X-rays with pneumonia, while 187 out of 205 were accurately predicted as X-rays without pneumonia. This gives us a model accuracy of 88.90%, which is comparable to the results in





IV. CONCLUSION

This paper delves into the utilization of deep learning methodologies to categorize digital chest X-ray images based on the presence or absence of pneumonia-related indicators. Employing Python programming and an array of scientific tools, the approach centers on the convolutional neural network (CNN) model Although a 90% accuracy holds promise for employing the prediction model as a decision support tool,CNN configurations, and data augmentation strategies.

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