Pneumonia Detection

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Overview:

The detection of Pneumonia utilizing chest radiography images constitutes the primary focus of the application. Pneumonia, characterized by a bacterial infection affecting one or both lungs, manifests with varying degrees of severity, ranging from mild to fatal. According to the World Health Organization, Pneumonia stands as the predominant infectious cause of mortality in children globally. In 2019, it claimed the lives of 740,180 children under the age of 5, comprising 14% of all deaths in this age group, and a significant 22% of deaths in children aged 1 to 5 years. While Pneumonia exerts its impact universally, it is most prominent in southern Asia and sub-Saharan Africa. The potential to shield children from Pneumonia exists through straightforward interventions that include prevention and treatment with cost-effective, low-tech medications and care. Notably, the challenge in treating Pneumonia lies in its frequent conflation with other respiratory ailments. This project holds promise in aiding medical professionals by confirming the presence of Pneumonia. This, in turn, contributes to the early and accurate diagnosis of patients afflicted by the disease.

Input:

The dataset utilized for this endeavor was sourced from Kaggle, comprising a total of 5,856 chest X-ray images. These images were separated into three distinct folders for training, validation, and testing. Within each folder, the data underwent further categorization into two classes: chest X-rays classified as Normal and those indicating the presence of Pneumonia.

Output:

To assess the performance of the model, performance metrics including accuracy, precision, recall, and F1 score were meticulously computed across the training, validation, and test sets.

Approach:

1. Importing all the required libraries
2. Visualization of data
3. Augmentation of image dataset
    a. Resizing
    b. Flipping
    c. Scaling
    d. Normalization
4. Model Training
5. Model Validation
6. Calculating Performance Metrics
7. Model Testing

The algorithms utilized are pre-trained Convolutional Neural Network (CNN) models, specifically "vgg16" and "inception v3." These models were sourced from the PyTorch library. The details of each layer of the CNN, as well as the activation function, were defined independently.

Experimental Protocol:

Dataset distribution:

Class	Train	Validation	Test
Normal	1341	8	234
Pneumonia	3875	8	390

To evaluate the success of the model, performance metrics, including accuracy, precision, recall, and F1 score, were calculated across the training, validation, and testing datasets.

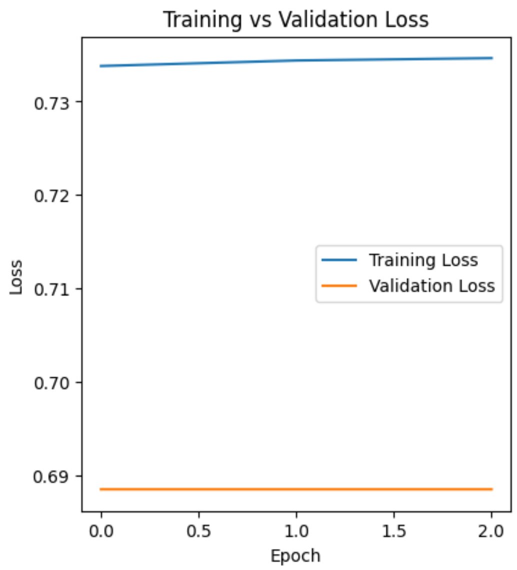
To evaluate the success of our model we calculated accuracy, precision, recall, and F1 score on training, validation, and testing data.

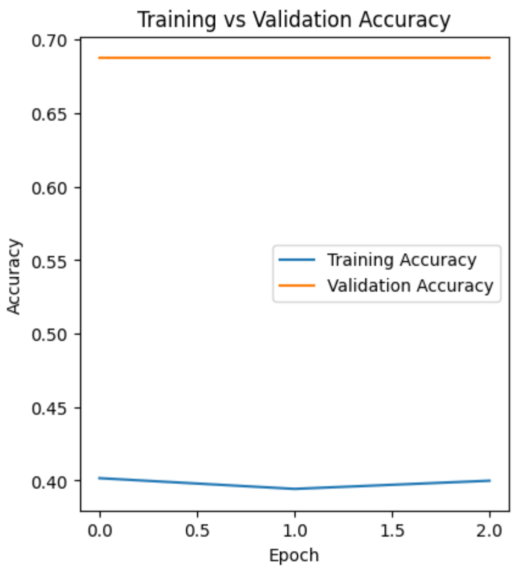
Accuracy - It is a measure of the overall correctness of the model. Accuracy is defined as the ratio of the number of correctly predicted instances to the total number of instances.
Precision - It is defined as the measure of correctly predicted positive observations to the total predicted positives.
Recall - Recall is the fraction of correctly predicted positive observations to all observations in the class.
F1 score - The F1 score is the harmonic mean of “Precision” and “Recall”.

The computational demands for the project were met without necessitating additional computing resources. The entire modeling process was efficiently conducted on the team's existing systems.

Results:

VGG16:
After training the model, the following plots display the “Training vs Validation Losses” and “Training vs Validation Accuracy” for the VGG16 model:

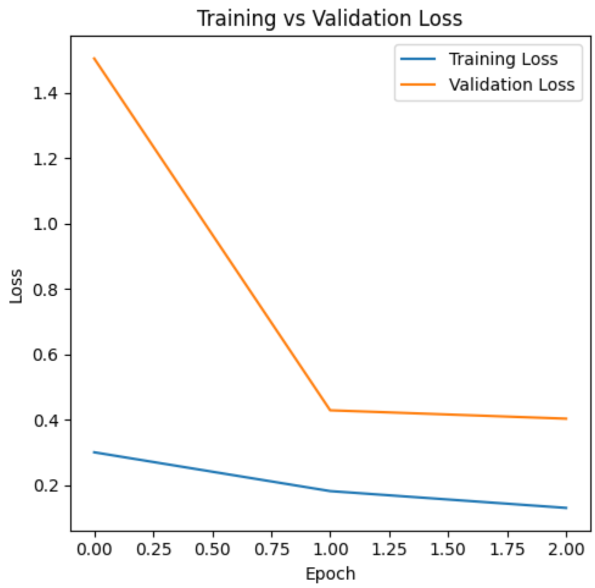


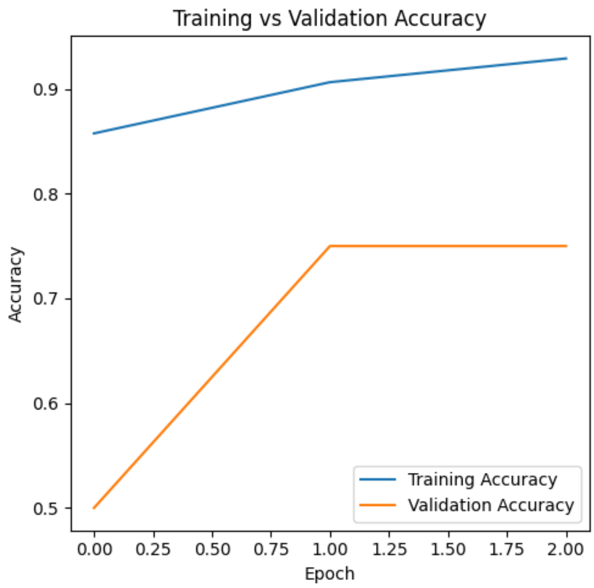


Performance metrics for VGG16:

Metric	Training Set	Validation Set	Test Set
Average Accuracy(%)	39.86	68.75	46
Average Precision	0.3988	0.6875	0.4663
Average Recall	0.6768	0.8077	0.5940
Average F1 Score	0.3901	0.6537	0.4304

Inception V3:
The graphs below display "Training vs Validation Losses" and "Training vs Validation Accuracy" for the Inception V3 model:





Performance metrics for Inception V3:

Metric	Training Set	Validation Set	Test Set
Average Accuracy(%)	89.77	66.66	81
Average Precision	0.896	0.6388	0.8345
Average Recall	0.897	0.6666	0.8173
Average F1 Score	0.8894	0.5999	0.8054

From the above results, it is observed that Inception V3 performed much better than VGG16. Accuracy, precision, recall, and F1 score values were generally higher on average compared to VGG16.

Analysis:

The VGG16 model is a pre-trained CNN model with the capability to extract rich features from images. Suited for image classification tasks, it employs a 3×3 filter and consists of 16 layers, comprising 3 fully connected layers and 13 convolution layers, with ReLU serving as the activation function.

Advantages of VGG16 include its high accuracy and effective feature extraction. However, it has a large number of parameters, rendering it computationally expensive and slow to train.

Inception V3, on the other hand, is a 48-layer deep CNN that utilizes both 3×3 and 5×5 filters. Similar to VGG16, it employs ReLU as its activation function, rendering it suitable for image classification tasks.

The advantage of Inception V3 is that it gives even higher accuracy and efficient usage of computing resources. However, limitations include poor initialization and computational expense.

Discussions and Lessons Learned:

Through the course of this project, an understanding of the importance of image processing and augmentation before training a machine learning model was learned. The necessity of undergoing these steps to develop an efficient model and extract the maximal information required for a given application from the image. This project also provided deep insight into the usage of machine learning algorithms, specifically for image classification tasks. An understanding of trade-offs between different model architectures and their performance was also developed.

The project has laid the groundwork for continued exploration and improvement. In the future, the knowledge and experience gained from this project will serve as a solid foundation to address different projects related to computer vision, image processing, and machine learning.

Bibliography:

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