A High Performance Deep Learning based Approach for Detecting COVID-19 with Chest X-Ray Images

Mushfiqur Rashid Khan[1], Atanu Das Bapon[2]

[1,2]Dept. of Computer Science and Engineering,
Ahsanullah University of Science and Technology
[1]prottoy.mushfiq@gmail.com, [2]atanudasbapon@gmail.com

Introduction:

"COVID-19", the buzzword of neoteric life and the most threatening disease that has shaken the entire globe has left researchers around the world vigilant and curious like us. Being a completely new and nescient challenge, sentient researchers have undergone relentless labor for tackling it. Our curiosity has driven us to perform a proper detection of the Chest X-Ray Images of different cases like COVID-19, Viral Pneumonia, Bacterial Pneumonia, and normal cases collected from assorted sources using several Deep Learning (DL)approaches to trace down the best one that can surely offer an admissible eventuality.

Research Area:

Our research confides in the vast scope of Deep Learning. Infliction of Artificial Intelligence (AI) has assisted particular programs to find patterns in voluminous datasets.

Objective:

A plethora of Deep Learning approaches is there to deal with diverse datasets. But not every approach can uphold the substantive purpose of dispensation. This bewilderment paves us towards exerting an experiment on a couple of DL approaches to determine which particular approach provides the best accuracy score as well as the least processing time for our massive dataset containing COVID-19 Chest X-Ray Images of different cases. Hence, our prime objective is to redact a comparative study on eight Deep Learning approaches to unearth the appropriate one that works best for our collected dataset.

Methodology:

The entire contexture initiated with the acquisition of a large dataset followed several preprocessing steps. The massive dataset had been excerpted from the different sources like Kaggle COVID-19 Radiography Database, GitHub COVID-19 Chest X-Ray Dataset. It comprises 1,144 COVID-19 Chest X-Ray Images, 1,493 Viral Pneumonia Chest X-Ray Images, 2,780 Bacterial Pneumonia Chest X-Ray Images, and 1,583 Normal Chest X-Ray Images. Some preprocessing and augmentation strategies like Flip (Horizontal Flip and Vertical Flip), Rotation (45° angle), Jitter, Shearing (in the scale [0.1, 0.35]), and Resize (778x778 pixels) are applied to improve the Chest X-Ray Images which are in different resolutions. Afterward, 8 DL approaches were applied while maintaining the 70%-30% training-testing ratio of the dataset. These approaches included Artificial Neural Network (ANN), Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), Support Vector Machine (SVM), Gated Recurrent Units (GRU), CNN-RNN, CNN-LSTM. The experiment was set up by the parameters i.e., Number of Units, Number of Layers, Activation Function (Softmax), Learning Rate (0.01), Loss Function (Categorical Cross-Entropy), Number of epochs (100), Optimizer (Adam), Batch Size, Decay, Momentum (0.6), Number of fully-connected units, Number of fully-connected layers, Number of LSTM units, Number of RNN units, and Dropout for each Deep Learning approach. Confusion matrices were generated to calculate the accuracy, precision, recall, and F1-score. The elapsed time for each approach was ascertained later on.

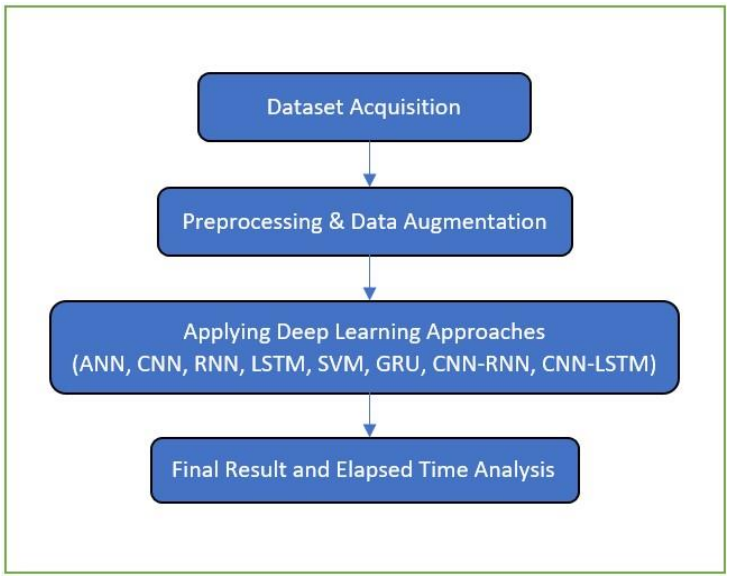


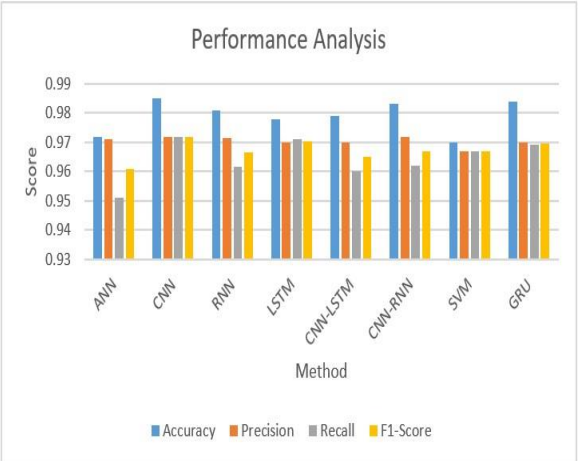
Fig. 1. Flow diagram of our proposed methodology

Results and Analysis:

Concise analysis and comparison among the Deep Learning models provided us with a noticeable conclusion. Such recapitulation is illustrated in Table 1.

Table 1. A comparison of various Deep Learning approaches

Method	Accuracy (%)	Precision	Recall	F1-score	Elapsed Time (seconds)
ANN	97.20	0.971	0.951	0.961	5.299
CNN	98.50	0.972	0.972	0.972	6.089
RNN	99.54	0.972	0.962	0.967	7.998
LSTM	97.80	0.970	0.971	0.971	5.878
SVM	97.00	0.967	0.967	0.967	6.916
GRU	98.40	0.970	0.969	0.969	7.094
CNN-RNN	98.30	0.972	0.962	0.967	6.612
CNN-LSTM	97.90	0.970	0.960	0.965	5.338



It is discernible that Convolutional Neural Network offers the best performance according to the accuracy (98.5%), precision (0.972), recall (0.972), and F1-score (0.972). In contrast, Artificial Neural Network holds the crown for providing the bestaccuracy according to the elapsed time (5.299 seconds) for our collected dataset. Although our research work is performed with a limited number of images, it demonstrates us a brilliant performance in a very short time. The rest of the DL approaches mightwork better if there had been less scarcity of those data. However, this research work clinches to the crying need for investigating the suitable approach considering two distinct aspects.

References:

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