

Harnessing RNN for Omicron Prediction via CT Scan Analysis

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Abstract—In recent trends we are again hearing the name SARS Cov-2, it underscored the urgent need for rapid and accurate diagnostic tools to combat the ongoing pandemic. This research introduces a fresh approach utilizing deep learning techniques to detect Omicron infection early, achieved through the analysis of CT scans.. Our research leverages a substantial dataset comprising 14,482 CT images obtained from diverse sources, including individuals with confirmed Omicron infection. A Convolutional Neural Network (CNN) is frequently utilized for image detection along with classification.. CNN are inspired by the structure of human brain. In CNNs, artificial neurons or nodes, similar to neurons in the brain, receive input, undergo processing, and produce output. However another challenge encountered when dealing with infection detection in terms of execution time and performance of prediction. Lack of inputs is the main cause for this, the proposed RNN technique using 14,482 CT scan images outperformed the existing in terms of accuracy and execution time. RNNs have the ability to examine temporal patterns found in CT images illustrating viral infections. Analyzing temporal patterns allows our model to grasp intricate patterns present in the dataset.

Index Terms— Severe acute respiratory syndrome corona virus SARS-2, Omicron, Computer tomography CT, Convolution Neural Networks, Recurrent Neural Networks RNN, Artificial Neurons, temporal patterns.

I. INTRODUCTION

Past few months, the SARS-2[13] variant has raised significant concerns due to its heightened transmissible[1] and potential to evade immune responses. Early detection and accurate diagnosis of Omicron[2] infection are crucial for effective management and control of its spread. Computed Tomography (CT)[22] imaging has emerged as a valuable tool in the diagnosis of SARS, providing detailed insights into pulmonary abnormalities[12] associated with the disease. CNN[3] and other various techniques likes VGG-19, Inception Net[5] had astonishing results while dealing with CT scans [3] [6], however it is quite intensive in terms of execution time and limited amount of data. With progress in deep learning techniques, particularly Recurrent Neural Networks (RNNs), there is an opportunity to leverage CT scans for the early detection of Omicron infection. RNNs, known for their ability to capture sequential dependencies[8] in data and offer a promising approach to analyze temporal patterns[9] in CT images indicative of viral infection. Through extensive training and fine-tuning procedures, the model learns discriminative patterns characteristic of Omicron infection. To evaluate the performance of our proposed approach, we conduct rigorous experiments

using standard metrics such as accuracy, sensitivity. Additionally, we validate the generalizability of the model on unseen datasets to assess its robustness and real-world applicability. Our results demonstrate promising outcomes, with the proposed deep learning model achieving high accuracy in distinguishing Omicron-infected individuals from other groups. Furthermore, the model exhibits excellent sensitivity and specificity, indicating its potential for early and reliable diagnosis of Omicron infection using CT scans.

II. LITERATURE SURVEY

Various methods and studies have been performed on SARS using Artificial Intelligence[20], Machine Learning[21] and deep neural network[19]. Dev Baloni [1] has explained the significant concerns of omicron disease and need of prevention. Zeinab Mohseni Afshar [2] had briefly explained about omicron transmissibility pathogenicity and infectivity. Dr. Avinash Sharma and DR. Asadi Srinivasulu [2] has the most gravity on CT scan image prediction for omicron, they achieved 99% accuracy on 960 Ct images dataset, however several factors are hindering those spectacular results like less data amount and time intensity. The other recent researches are given below,

TABLE I. SHOWING VARIOUS CITED PAPERS AND ACCURACY OF MODELS

Author	Method	Classification Accuracy
Dr Avinash Sharma and Dr.Asadi Srinivasulu [3]	ECNN	99%
Shuai Wang, et al.[5]	Transfer learning, Inception Net	82.9%
Vruddhi Shah[7]	VGG-19	94.5%
Monika Grewal[8]	Rad-Net	82%
Michael. J.Horry[18]	VGG-19	84%

III. METHODOLOGY

A. Dataset

Descriptive Characteristics of Dataset: The dataset consists of 14,482 CT scan images, out of which 12,231 are of positive class (infected) and 2,251 are negative class (not infected). The data is available at 512x512 JPG which is obtained from kaggle. The dataset is initially divided into training and testing parts. The partitioned images are normalized to pixel values between 0 and 1 for better model efficiency to predict the class labels.

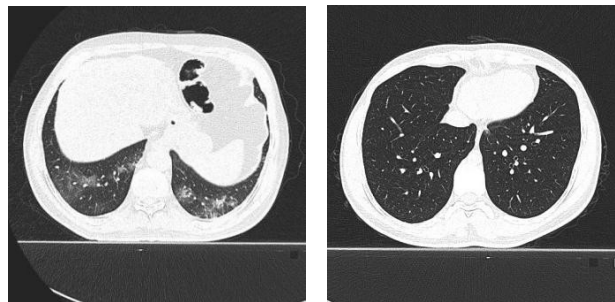


Fig 1. Sample images of infected lungs from dataset

B. Method

RNN is proven to be best in analyzing the temporal patterns in dataset, which seemed to be good to suit our dataset which comes with accurate results and better efficiency. Our model endeavors to address the key objectives :

- 1) Preprocessing CT images to enhance relevant features while minimizing noise and artifacts.
- 2) Designing and training RNN architectures tailored to capture temporal dynamics in CT scan sequences.
- 3) Analyzing the performance of the RNN model by standard evaluation criteria such as accuracy, loss function.
- 4) Validating the model's generalizability on unseen datasets to assess its real-world applicability.

C. Pre-processing

Before feeding our input dataset images into the model, we preprocessed them to reduce noise and ensure compatibility with our model, enabling exploration of various spatial features in the validation data. The images are set to size of 64*64 to get a consistent size in all input images, which is often necessary for feeding into a network model, re-sizing of image is employed. We also adjust the images contrast to improve the visibility of structures. We achieve this by using Histogram Equalizer. Employing the Gaussian blur to reduce the noise in CT scan images. And then we normalize the pixel values into consistent range, between 0 and 1. This step is crucial in our model to ensure convergence during training. Finally the data is augmented by applying transformations like rotating or flipping and the images are flattened into a single dimension while preserving the batch size.

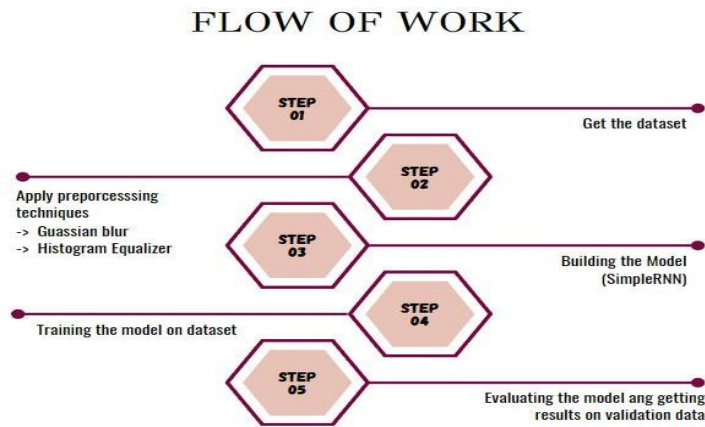


Fig 2. Showing the detailed flow of work

D. Build Model

In our approach we build a Simple recurrent Neural Network (SimpleRNN) model that process sequences of data. In each time step, SimpleRNN takes an input vector, in our approach a flattened CT scan image is provided as input to SimpleRNN. A hidden state vector from the previous time step, processes them through a set of weights, and produces an output vector and a new hidden state vector. The output vector is typically passed through a dense layer with an activation function, in our approach a sigmoid function to produce the final output of the network, which represents the probability of the input image belonging to a certain class (infected or not infected).

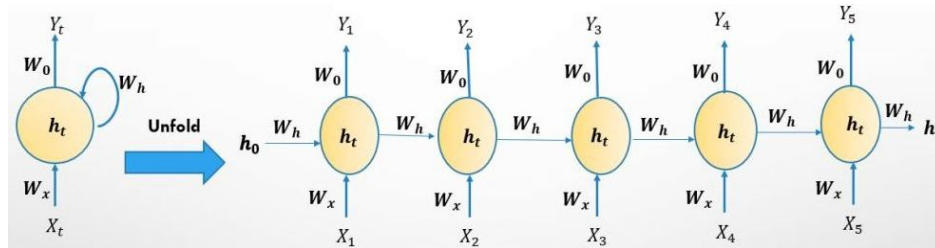


Fig 3. Depicting the RNN Algorithm about How Neurons are Taking Inputs and Giving Outputs

Where,

h_t - represents current state i.e state at time t

h_{t-1} - shows previous state i.e state at time step $t-1$

X_t - denotes Input at time step t

W_h -denotes weight at recurrent neuron

W_x - weight at input neuron

Y_t - output at time step t

Finally, the model is compiled with the Adam optimizer, Adam is an adaptive learning rate algorithm that combines the idea of RMSprop and momentum. Adam maintains adaptive learning rates for each parameter and

updates them based on first and second moments of gradients. Adam helps our model to model to adjust the learning rates to improve the convergence and performance.

E. Mathematical Equations

The output of a RNN model is based on both current input as well as past inputs, various activation functions are used in RNN like tanh, sigmoid, relu etc, but in we use sigmoid activation for our model development.

Activation Function :

Sigmoid Function - $(1 + e^x) / (1 + e^{-x})$

Equation to calculate the unfold Network at any time step, $h_{t+1} = f(x_t, h_t, w_x, w_h, b_h)$

$= f(w_x x_t + w_h h_t + b_h)$

The output y at time t is computed as :

$y_t = f(h_t, w_y)$

$= f(w_y \cdot h_t + b_y)$ Here $\cdot$ is dot product.

IV. EXPERIMENTAL RESULTS

We run the RNN model upon the selected parameters on the extracted features of data explained in method. The final classification of the images produces a accuracy of 96%. Below is the result of Omicron virus detection and prediction.

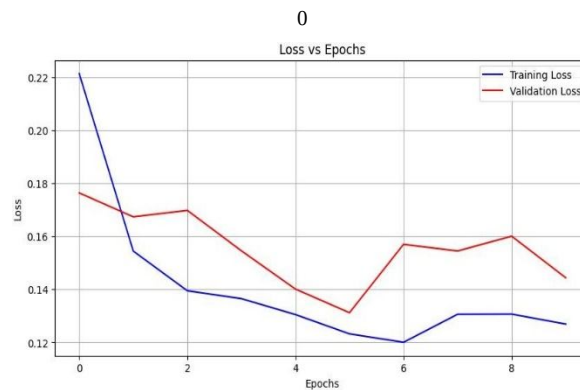


Fig 4. Shows the trends in loss function with respect to number of epochs

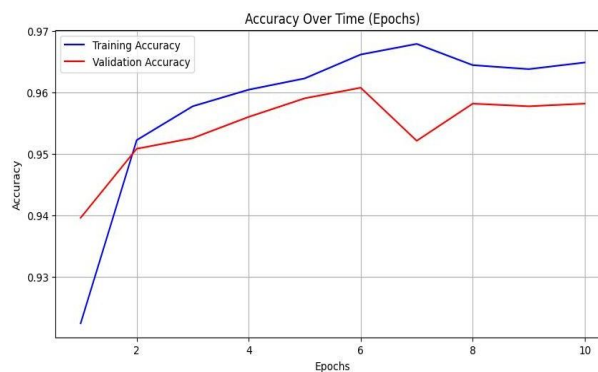


Fig 5. Shows Accuracy vs Loss on omicron image dataset

V. CONCLUSION

Diagnosing the respiratory diseases such as SARS -2 by using PCR swab test, saliva PCR test swab and antigen tests are sometimes difficult to handle in order to get the result, these lead to making false predictions. Various research methods are held by around the globe in order to produce accurate results. Exploring on various types of methods may helpful to predict the disease in earlier. Predicting using CT scan images present in paper is proven to be most dependable. The model doesn't contain any bias or variance for prediction of SARS -2 with the accuracy of 96%.

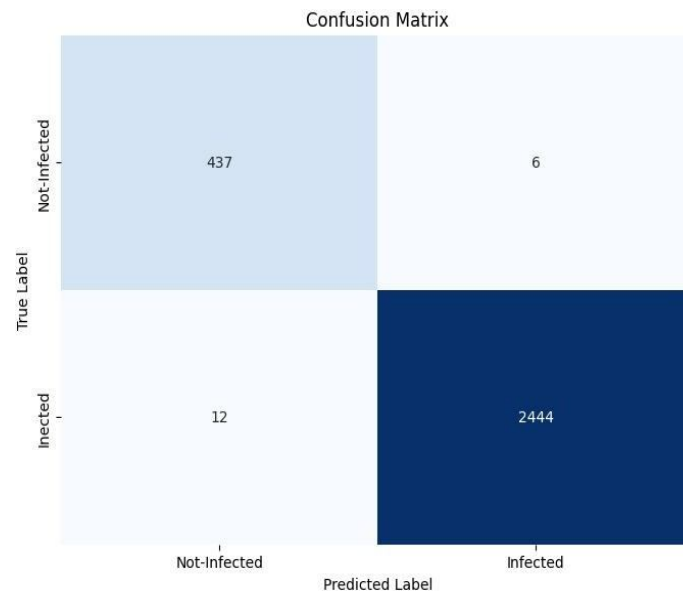


Fig 6. Depicts Confusion Matrix of Classes of CT Scan Images

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