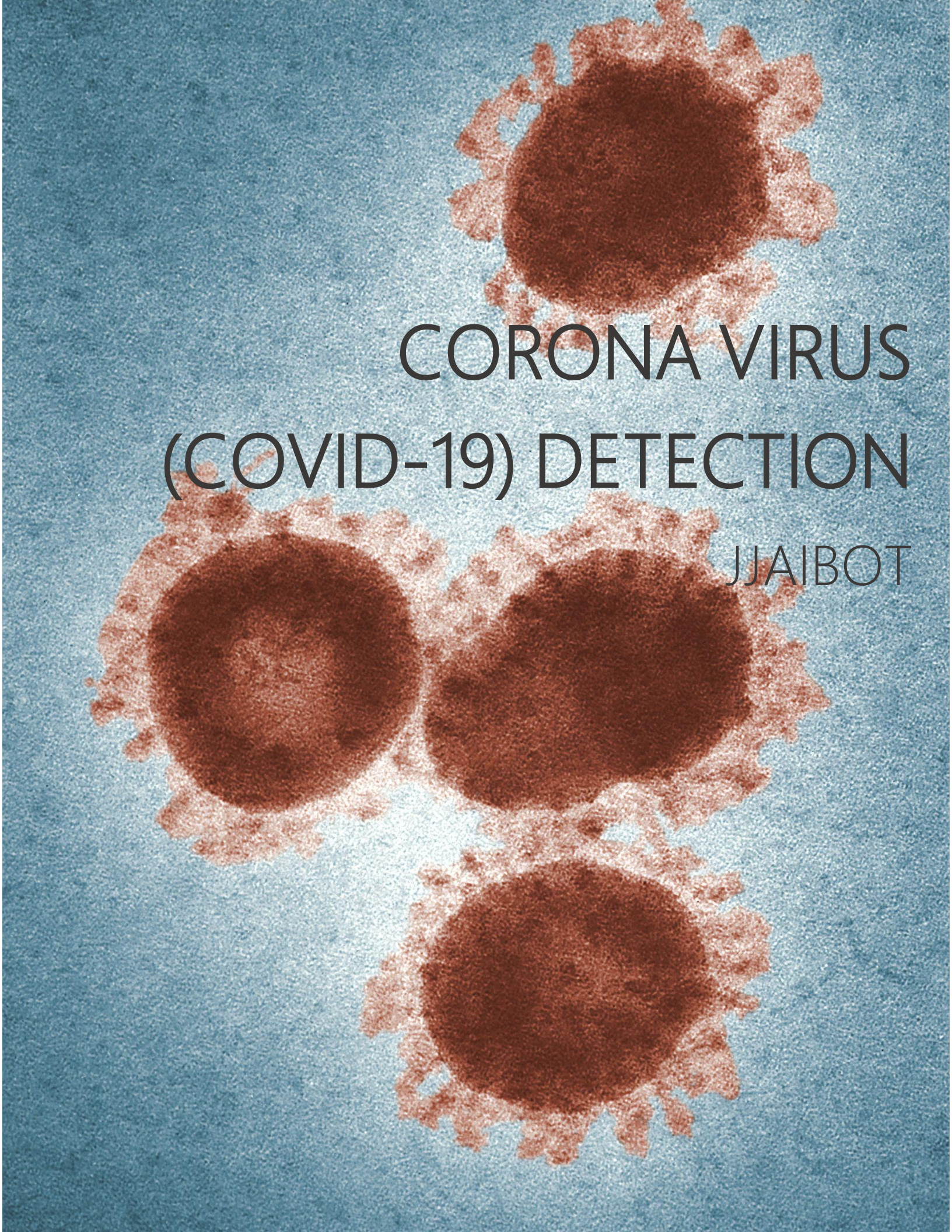


CORONA VIRUS (COVID-19) DETECTION

JJAIBOT

COVID-19

Introduction

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus. As stated by the World Health Organization (WHO), viral diseases continue to arise and represent a serious subject to public health. Over time, several viral epidemics like the Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV) in 2002 to 2003, and H1N1 influenza in 2009, have been recorded. Most recently, the Middle East Respiratory Syndrome Coronavirus (MERS-CoV) was first identified in Saudi Arabia in 2012.

The CoVs are becoming the major pathogens of emergent respiratory disease outbreaks. They represent a large family of single-stranded RNA viruses (+ssRNA) that can be isolated in various animal species. These viruses can cross species barriers and can cause illness in humans. Some may range from common cold to more severe diseases like MERS and SARS.

Etiology

CoVs are positive-stranded RNA viruses with a crown-like look under an electron microscope (*coronam* is the Latin term for crown) due to the presence of spike glycoproteins on the envelope. The subfamily *Orthocoronavirinae* of the *Coronaviridae* family (order *Nidovirales*) classifies into four genera of CoVs:

- Alphacoronavirus (alphaCoV)
- Betacoronavirus (betaCoV)
- Deltacoronavirus (deltaCoV), and
- Gammacoronavirus (gammaCoV).

Members of this large family of viruses can cause enteric, hepatic, neurological, and respiratory diseases. To date, seven human CoVs (HCoVs), capable of infecting humans, have been recognized. Some of HCoVs were identified in the mid-1960s, while others were only detected in the new millennium.

- Common human CoVs: HCoV-OC43, and HCoV-HKU1 (betaCoVs of the A lineage); HCoV-229E, and HCoV-NL63 (alphaCoVs). The common human CoVs feature common colds, lower respiratory tract infections, and self-limiting upper respiratory infections as major symptoms.
- Other human CoVs: SARS-CoV, SARS-CoV-2, and MERS-CoV (betaCoVs of the B and C lineage, respectively). These cause epidemics with variable clinical severity featuring respiratory and extra-respiratory manifestations.

Transmission

As with other respiratory pathogens, the transmission occurs through respiratory droplets from coughing and sneezing. Aerosol transmission is also a possibility in case of extended exposure to elevated aerosol concentrations in closed spaces.

Analysis of data relating to SARS-CoV-2 spread in China seems to indicate that close contact between individuals is necessary. The spread, in fact, is primarily limited to family members, healthcare professionals, and other close contacts.

Based on data from the first cases in Wuhan and investigations conducted by the China CDC and local CDCs, the incubation time could be generally within 3 to 7 days and up to 2 weeks as the longest time from infection to symptoms was 12.5 days.

This data also showed that this novel epidemic doubled about every seven days, whereas the basic reproduction number (R0 - R naught) is 2.2. In other words, on average, each patient transmits the infection to an additional 2.2 individuals.

Treatment / Management

There are no specific antiviral treatment or recommendation for COVID-19, and no vaccine is currently available. The treatment is symptomatic, and oxygen therapy represents a major treatment intervention for severe infection.

Most individuals infected with the COVID-19 virus will experience mild to moderate respiratory illness and recover without any special treatment. Older people, and those with underlying medical complications like cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness.

Prevention

Preventive measures are the current strategy to limit the spread of cases since an epidemic will increase as long as R0 is greater than 1 (COVID-19 is 2.2). Preventive strategies are focused on isolating patients and careful infection control. The WHO and other organizations have issued the following general recommendations:

- Avoid close contact with subjects suffering from acute respiratory infections.
- Avoid unprotected contact with farm or wild animals.
- Individuals that are immunocompromised should avoid public gatherings.
- Wash your hands frequently, especially after contact with infected people or their environment.
- People with symptoms of acute airway infection should keep their distance, cover coughs or sneezes with disposable tissues or clothes and wash their hands.
- Strengthen, in particular, in emergency medicine departments, the application of strict hygiene measures for the prevention and control of infections.

The most vital strategy for the masses is undertaking frequent hand wash and the usage hand sanitizer. Also, avoiding frequent contact with face and mouth after interaction in possibly contaminated environ.

Detection Approach

Presently, the two detection methods in use is chest CT scan and lab testing. In a study of over a 1,000 patients published in Radiology journal, chest CT outperformed lab testing in the diagnosis of 2019 novel coronavirus disease (COVID-19).

JJAIBOT COVID-19 Early Scan Approach

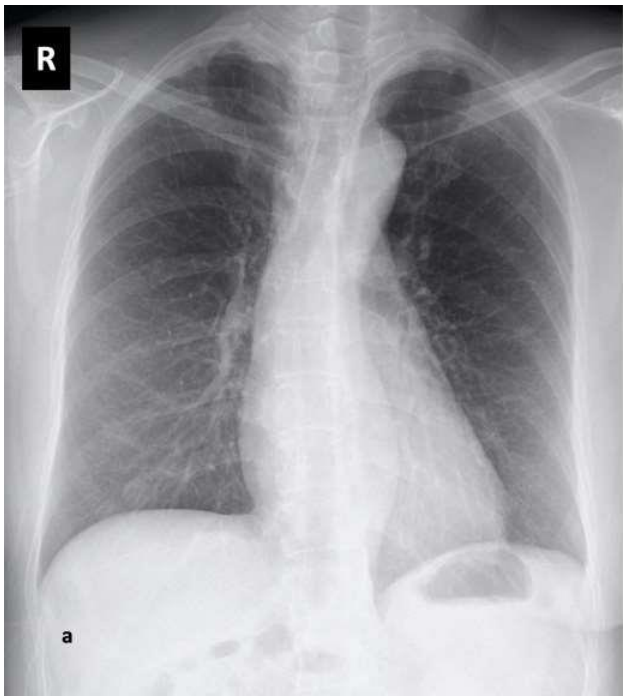
"Early diagnosis of COVID-19 is crucial for disease treatment and control. Compared to RT-PCR, chest CT imaging may be a more reliable, practical and rapid method to diagnose and assess COVID-19, especially in the epidemic area," the *Radiology* study authors wrote.

The need of efficient diagnosis and detection approach for COVID-19 is an ongoing challenge for the medical field globally. The objective of this project is to apply state-of-the-art deep learning techniques to the detection of COVID-19. Presently, the project aims to focus on the use of:

- X-ray PA view of the chest, and
- CT scan of the lungs.

Chest CT, a routine imaging tool for pneumonia diagnosis, is fast and relatively easy to perform. Recent research found that the sensitivity of CT for COVID-19 infection was 98% compared to RT-PCR testing sensitivity of 71%. The CT scans of COVID-19 patients have revealed white patches in the lungs - which radiologists have called ground-glass opacities (so-called because they show up on the scans similar to ground-glass windows). These white patches on the CT scan indicate pneumonia, as the spaces which are normally filled by air are being filled with something else instead.

The X-ray PA view of the chest is an imaging test that uses X-rays to look at the structures and organs within the chest. With Chest X-rays, changes in the structure of these organs serve for possible preliminary classification, due to its prevalent usage as a primary diagnostic test

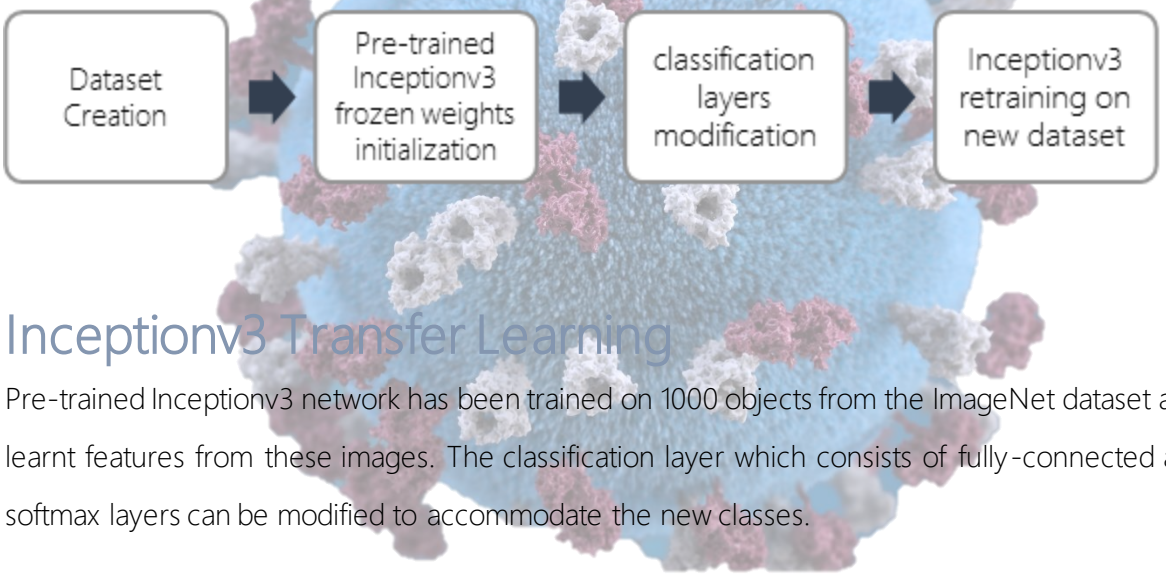


X- Ray Image Sample

Corona Virus (COVID-19) Detection Model

The detection model developed for Corona Virus (COVID-19) makes use of Artificial Intelligence that employs a Deep Learning Neural Network for accurate results. The Deep Learning Architecture plays a key role in the project.

The architecture developed uses Transfer Learning with Inceptionv3. The Transfer learning approach involves the use of a pre-trained neural network with learnt features from several classes of objects. The process involved in the model creation is given below:



Inceptionv3 Transfer Learning

Pre-trained Inceptionv3 network has been trained on 1000 objects from the ImageNet dataset and learnt features from these images. The classification layer which consists of fully-connected and softmax layers can be modified to accommodate the new classes.

With transfer learning, the feature extraction part of Inceptionv3 is reused on the new custom dataset and the classification layers are adjusted to the custom dataset. The learnt features are transferred to classify the new classes the new model is intended for, in this case CT scan and X-ray model. This approach is more useful when there is limited amount of training classes and faster training time is required.

Dataset Creation.

For the model, two neural networks is created with similar architecture to cater for CT scan and X-ray model. The data is sourced from various publicly available links.

For the X-ray PA view model

The X-ray PA view model makes use of a custom dataset created from the combination of two notable datasets.

- covid-chestxray-dataset is a public open dataset of chest X-ray and CT images of patients which are positive or suspected of COVID-19 or other viral and bacterial pneumonias. The data within the dataset are collected from public sources as well as through indirect collection from hospitals and physicians with approval from the University of Montreal's Ethics Committee #CERSES-20-058-D.

  To suit the peculiarities of our project, we further extracted X-ray PA view of x-rays from the covid-19 images by modifying a script (scripts/select_covid_patient_X_ray_images.py) provided. The extracted images are used for the Covid X-ray positive class.
- For the pneumonia and normal class, the Chest X-Ray Images (Pneumonia) from Kaggle is another dataset used. Also, the pneumonia and normal classes images are extracted from it.

The combination of the extracted images forms the dataset used to train the X-ray PA view model.

For CT scan view model

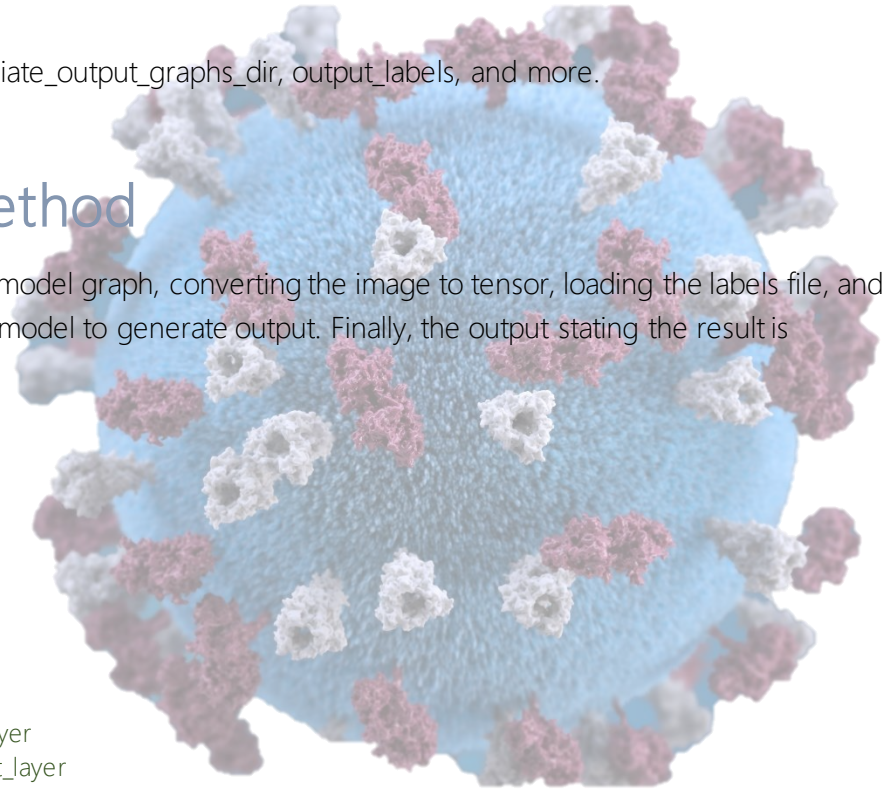
The COVID-CT-Dataset contains CT-scans for both positive and negative covid-19 cases. It features 349 CT images containing clinical findings of COVID-19 from 216 patients. The images are collected from COVID19-related papers from medRxiv, bioRxiv, NEJM, JAMA, Lancet, etc. CTs containing COVID-19 abnormalities are selected by reading the figure captions in the papers. All copyrights of the data belong to the authors and publishers of these papers. Additional dataset details are described in this preprint: COVID-CT-Dataset: A CT Scan Dataset about COVID-19.

This is used for training the CT scan model.

Model Training

The two neural networks (CT scan and X-ray) are trained differently using a large part of the created datasets. The two model uses a similar architecture, so is the training process. The model entails a new top layer (bottleneck) that is trained for the detection of COVID-19 through CT scan and X-ray.
For every image contained in the dataset, the top layer accepts as input (dimensional vector) and subsequently train the softmax layer which comprises of N labels. These corresponds to the learned biases and weights. The following parameters are also configured:

- distortion feature
- how_many_training_steps
- image_dir
- learning rate.
- output_graph, intermediate_output_graphs_dir, output_labels, and more.



Classification Method

The process entails loading the model graph, converting the image to tensor, loading the labels file, and running the tensor through the model to generate output. Finally, the output stating the result is provided.

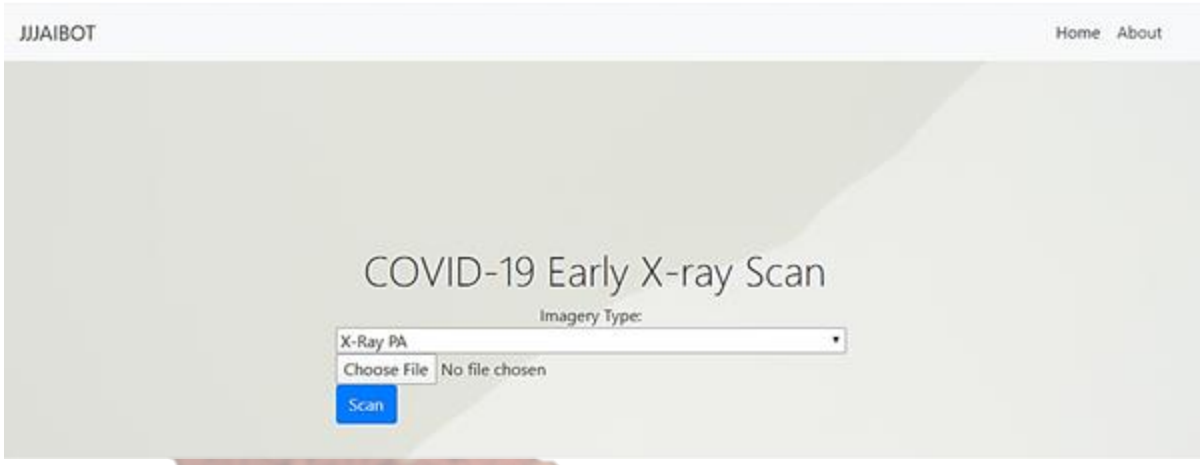
```
graph  = load_graph(model_file)
 t = read_tensor_from_image_file(
    file_name,
    input_height=input_height,
    input_width=input_width,
    input_mean=input_mean,
    input_std=input_std)

 input_name  = "import/"  + input_layer
 output_name  = "import/" + output_layer
 input_operation  = graph.get_operation_by_name(input_name)
 output_operation  = graph.get_operation_by_name(output_name)

 with tf.compat.v1.Session(graph=graph)  as sess:
   results = sess.run(output_operation.outputs[0],  {
       input_operation.outputs[0]:  t
   })
 results = np.squeeze(results)

 top_k  = results.argsort()[-5:][::-1]
 labels = load_labels(label_file)
 for i in top_k:
   print(labels[i], results[i])
```

COVID-19 Early X-ray Scan

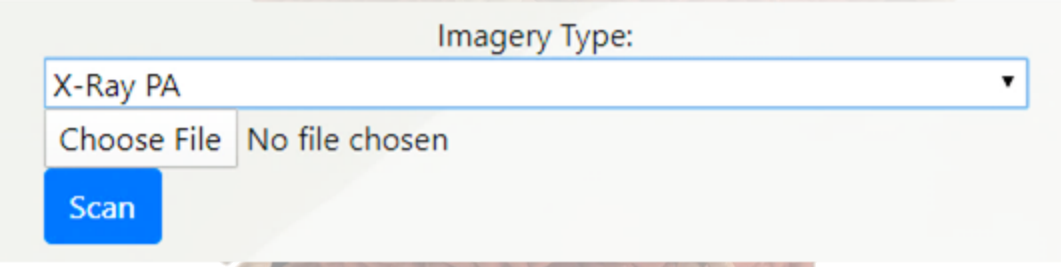


For the COVID-19 Early X-ray Scan model, the accepted file uploaded is processed and the model gives a suitable output at the end of the process.

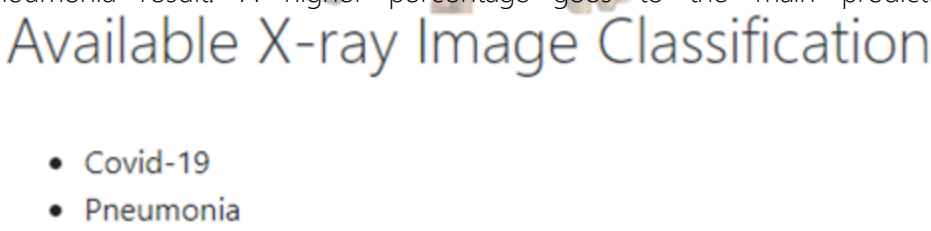
PROCESS FOR COVID-19 EARLY X-RAY SCAN

The method for the COVID-19 Early X-ray Scan includes:

- The system takes in an acceptable input file to be classified

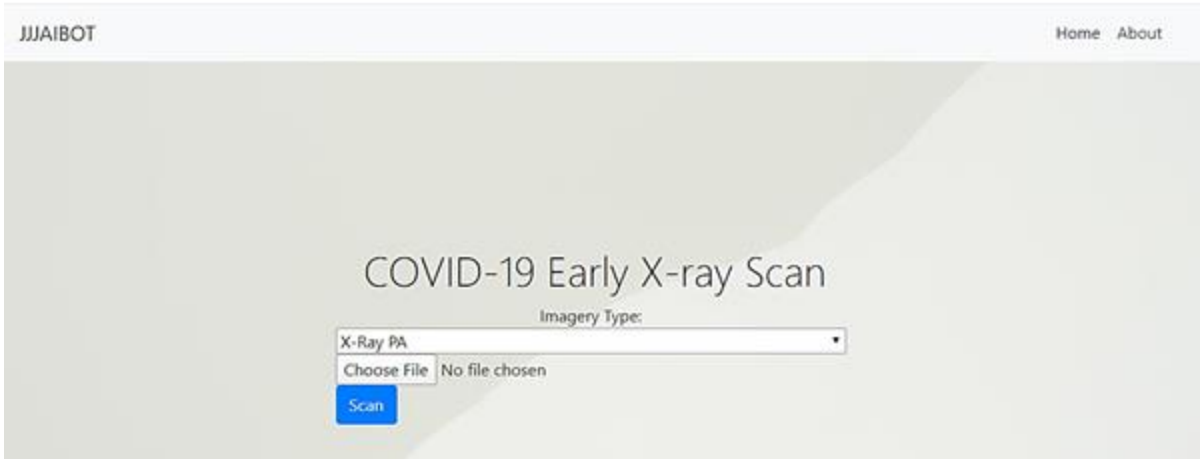


- The trained model accepts the input image file and scan them to give a COVID-19 or Pneumonia result. A higher percentage goes to the main predicted class.



- The predicted classes features a COVID-19 or Pneumonia result presented to the end-user

COVID-19 Early X-ray Scan



For the COVID-19 Early X-ray Scan model, the accepted file uploaded is processed and the model gives a suitable output at the end of the process.

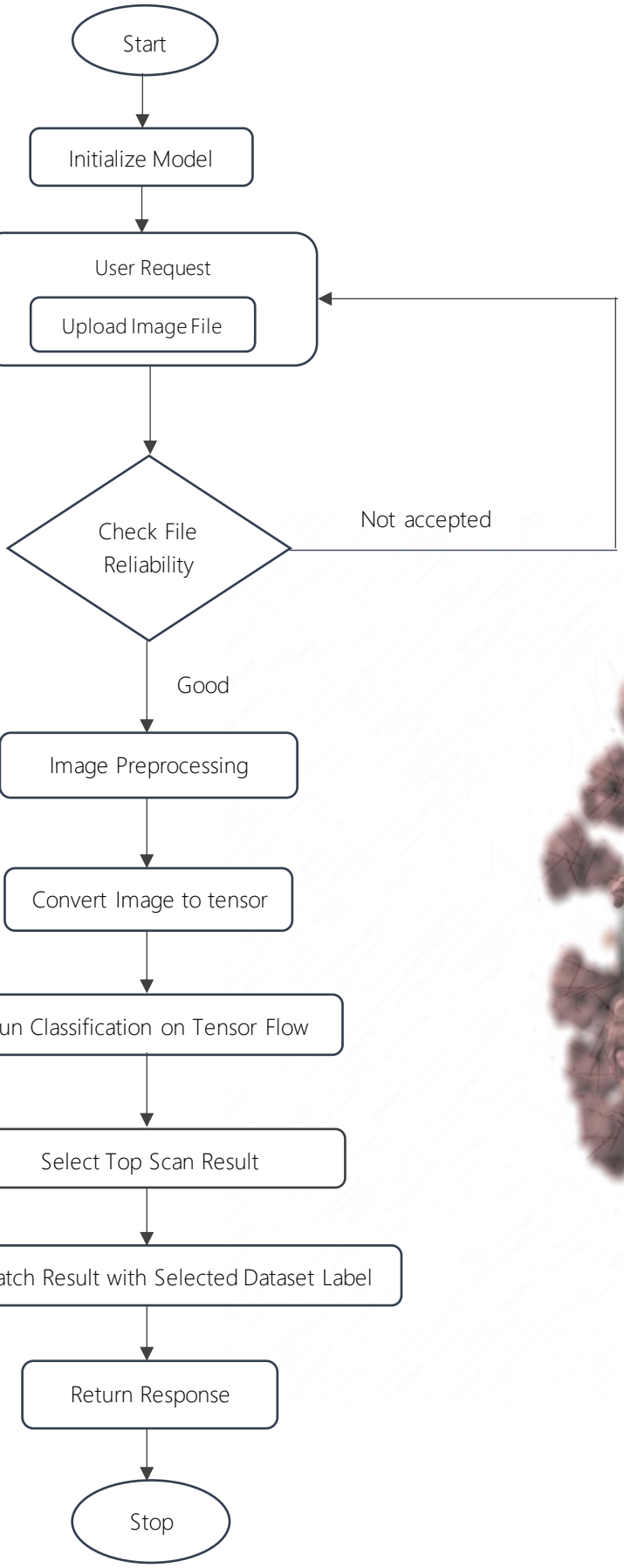
X-ray PA view model

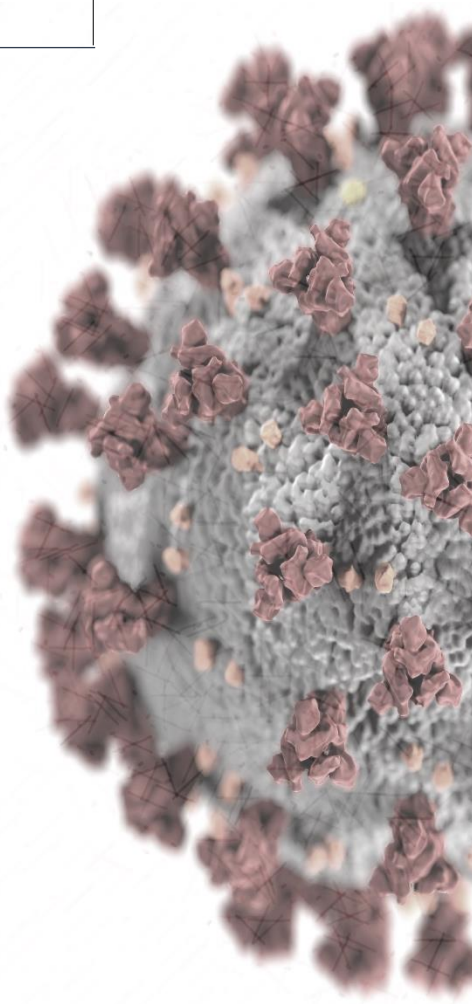
- Test accuracy = 98.1% with 52 testing samples
- Train accuracy - 100%
- Validation accuracy - 94%

CT scan model

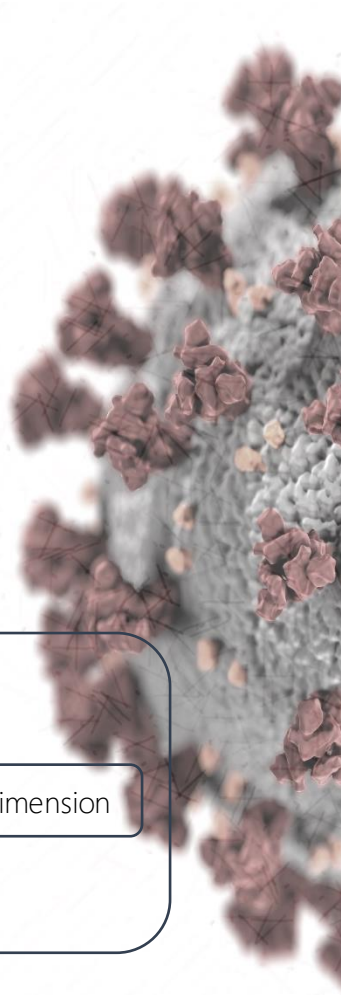
- Test accuracy = 85.9% with 64 testing samples
- Train accuracy= 98%
- Validation accuracy = 82%

Flowchart for the COVID-19 Early X-ray Scan Model





Substructure to Key Component in the Flowchart for COVID-19 Early X-ray Scan Model



Initialize Model

Load Tensor graph

Load Label

Image Preprocessing

Cast Image to Float

Resized Image (229 x 229 x 3)

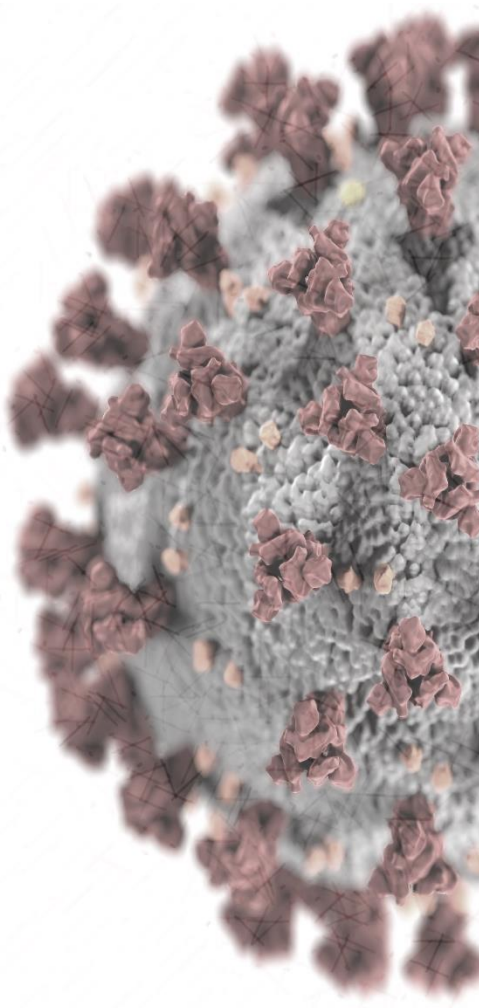
Normalized Image

Expand Dimension

Julian Jewel's Artificial Intelligence Bot (JJAIBOT)

Julian Jewel's Artificial Intelligence Bot (JJAIBOT) is an artificial intelligence bot that was created by Julian Jewel Jeyaraj in January 2019 as an initiative to help people understand the effects of climate change, mental illness and wildlife conservation through an interactive, emotion-based artificial intelligence bot's perspective.

JJAIBOT is capable of detecting human emotions such as anger, joy, happiness, contempt, fear, sadness, disgust, indifference, love confidence, regret, etc. JJAIBOT is also a chatbot capable of spreading awareness towards environmental, psychological, and wildlife preservation.



JJAIBOT