Project Report

1. INTRODUCTION

- Project overview

In the midst of the global COVID-19 pandemic, the integration of advanced technologies has played a pivotal role in the fight against the virus. One such technological advancement is the development of DeepLearningDiagnose, a cutting-edge web application that we have designed for the classification of COVID-19 and non-COVID-19 chest X-ray images using deep learning algorithms.

The rapid spread of the virus necessitated the need for swift and accurate diagnostic tools to aid healthcare professionals in making informed decisions. DeepLearningDiagnose addresses this urgency by harnessing the power of deep learning to automate the classification process, enabling faster and more efficient identification of potential COVID-19 cases.

- Purpose

This COVID19 detection project aims to revolutionize the diagnostic process for COVID-19 by employing advanced deep learning technology in a user-friendly web application. Its primary objectives include facilitating early and accurate diagnoses, optimizing healthcare resources through efficient triage, and providing timely support in emergency situations. By offering global accessibility, continuous improvement, and prioritizing data security, the project not only addresses immediate healthcare needs but also contributes valuable insights to medical research. Ultimately, DeepLearningDiagnose strives to enhance the capabilities of healthcare professionals in the fight against the COVID-19 pandemic while laying the groundwork for advancements in medical image analysis and diagnostics.

2. LITERATURE SURVEY

- Problem Statement

Detecting asymptomatic or mildly symptomatic cases presents a challenge, as these individuals may have subtle or no visible abnormalities in imaging. Developing models that can identify early or less severe manifestations of the disease is crucial for effective screening and containment.Models trained on data from one population may not generalize well to diverse populations with different demographics and healthcare practices. Ensuring that detection models are adaptable and effective across various global settings is a critical consideration.

- References

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8286881/

https://www.unglobalpulse.org/2020/05/need-for-greater-cooperation-between-practitioners-and-the-ai-community/

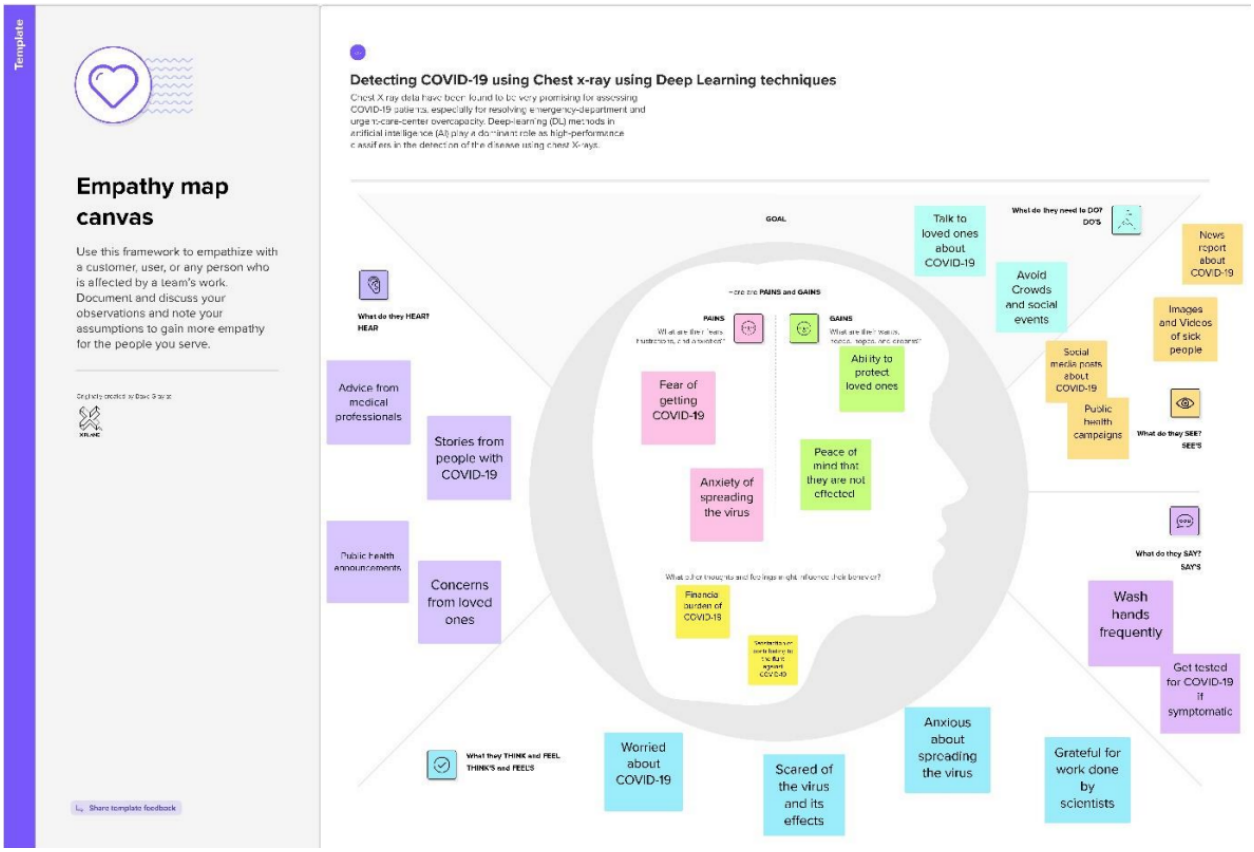
https://www.who.int/dg/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19

- Problem Statement

The whole world is facing a health crisis, that is unique in its kind, due to the COVID-19 pandemic. As the coronavirus continues spreading, researchers are concerned by providing or help provide solutions to save lives and to stop the pandemic outbreak.We design a deep learning system to extract features and detect COVID-19 from chest X-ray images. Three powerful networks, namely ResNet50, InceptionV3, and VGG16, have been fine-tuned on an enhanced dataset, which was constructed by collecting COVID-19 and normal chest X-ray images from different public databases. Transfer learning is proven to be effective, showing strong performance and easy-to-deploy COVID-19 detection methods. This enables automatizing the process of analyzing X-ray images with high accuracy and it can also be used in cases where the materials and RT-PCR tests are limited.

3. IDEATION & PROPOSED SOLUTION

- Empathy Map Canvas



- Ideation and Brainstorming

Template

Brainstorm & idea prioritization

Use this template in your own brainstorming sessions so your team can unleash their imagination and start shaping concepts even if you're not sitting in the same room.

- **10 minutes** to prepare
- **1 hour** to collaborate
- **2-8 people** recommended

Before you collaborate

A little bit of preparation goes a long way with this session. Here's what you need to do to get going.

10 minutes

Team gathering
Define who should participate in the session and send an invite. Share relevant information or pre-work ahead.

Set the goal
Think about the problem you'll be focusing on solving in the brainstorming session.

Learn how to use the facilitation tools
Use the Facilitation Superpowers to run a happy and productive session.

Open article →

1 Define your problem statement

What problem are you trying to solve? Frame your problem as a How Might We statement. This will be the focus of your brainstorm.

5 minutes

PROBLEM

How might we develop a deep learning model to detect COVID-19 from chest X-rays that is accurate, reliable, affordable, and accessible?

Key rules of brainstorming

To run an smooth and productive session

- Stay in topic.
- Defer judgment.
- Go for volume.
- Encourage wild ideas.
- Listen to others.
- If possible, be visual.

2 Brainstorm

Write down any ideas that come to mind that address your problem statement.

10 minutes

TIP
You can select a sticky note and hit the pencil [switch to sketch] icon to start drawing!

Sri Sai Ratna Abhishek Kosuri

- Create an Image Visualization Tool using CNN
- Develop a web app that can be used at home
- Implement visual disease detection by gaining knowledge
- Utilize transfer learning from a pre-trained model
- Partner with medical professionals for domain expertise
- Deploy the system on a cloud-based platform

Hritik Kumar

- Develop a mobile app for accessibility
- Apply data augmentation for robust training
- Use a lightweight model architecture for efficiency
- Employ mixed precision training for faster convergence
- Utilize a post-processing technique for refining results
- Make the model open-source for transparency and collaboration

Dhruv

- Create a user-friendly interface for ease of use
- Conduct a clinical trial to validate accuracy
- Seek regulatory approval for medical use
- Use a synthetic dataset for diverse training data
- Implement self-supervised learning techniques
- Utilize federated learning and differential privacy for data security

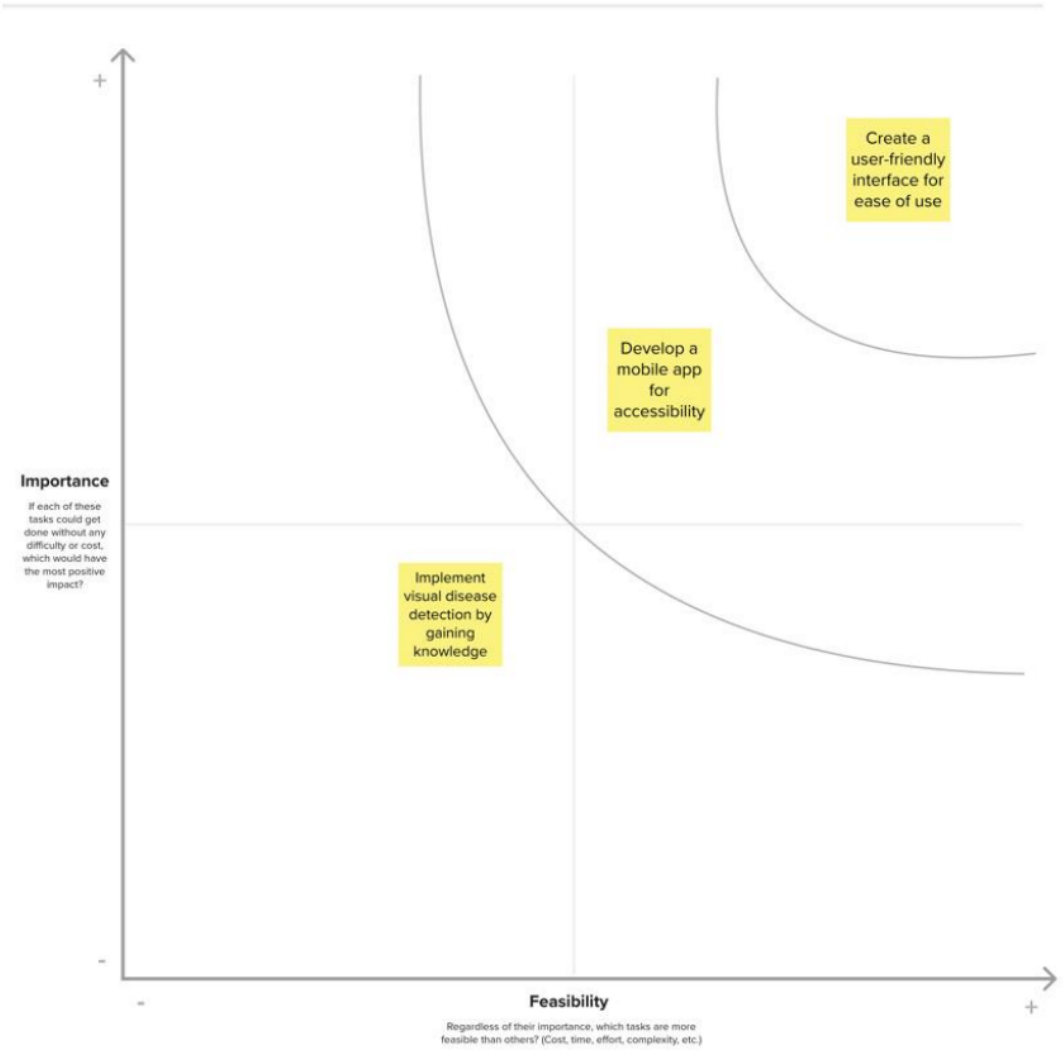
3 Group ideas

Take turns sharing your ideas while clustering similar or related notes as you go. Once all sticky notes have been grouped, give each cluster a sentence-like label. If a cluster is bigger than six sticky notes, try and see if you and break it up into smaller sub-groups.

20 minutes

TIP
Add customizable tags to sticky notes to make it easier to find, browse, organize, and categorize important ideas as themes within your mural.

- Create a user-friendly interface for ease of use
- Implement visual disease detection by gaining knowledge
- Develop a mobile app for accessibility



4. REQUIREMENT ANALYSIS

- **Functional Requirements**

  User Authentication and Authorization:

  Implement secure user authentication mechanisms to ensure that only authorized healthcare professionals can access the application. Define roles and permissions to control user access levels and functionalities.

User Interface:

Design an intuitive and user-friendly interface for easy navigation and use by healthcare professionals with varying levels of technical expertise.Include features for uploading chest X-ray images, initiating classification, and viewing results.

Image Upload and Processing:

Enable users to upload chest X-ray images in common formats.Implement image preprocessing steps to standardize input data for the deep learning model.

Deep Learning Model Integration:

Integrate a pre-trained deep learning model capable of classifying chest X-ray images into COVID-19 and non-COVID-19 categories.Implement real-time model inference for immediate classification results.

Result Display and Interpretation:

Display classification results in a clear and understandable format.Provide additional information or visualizations to aid healthcare professionals in interpreting the model's output.

Data Security and Privacy:

Implement robust encryption protocols to secure sensitive medical data. Ensure compliance with data privacy regulations and ethical standards for handling patient information.

- **Non-Functional Requirement**

  Performance:

  The application should provide classification results within a reasonable response time, ensuring timely assistance to healthcare professionals.The system should handle a concurrent user load without significant degradation in performance during peak usage.

  Scalability:

  The application should be designed to scale horizontally to accommodate an increasing number of users and growing datasets.Scalability should not compromise the performance or responsiveness of the system.

  Reliability:

  The system should have a high level of reliability, minimizing downtime and ensuring continuous availability to healthcare professionals.Implement mechanisms for automated backup and recovery to prevent data loss.

  Security:

  Employ robust security measures to protect patient data, ensuring compliance with healthcare privacy regulations.Implement encryption for data in transit and at rest to safeguard sensitive information.

  Usability:

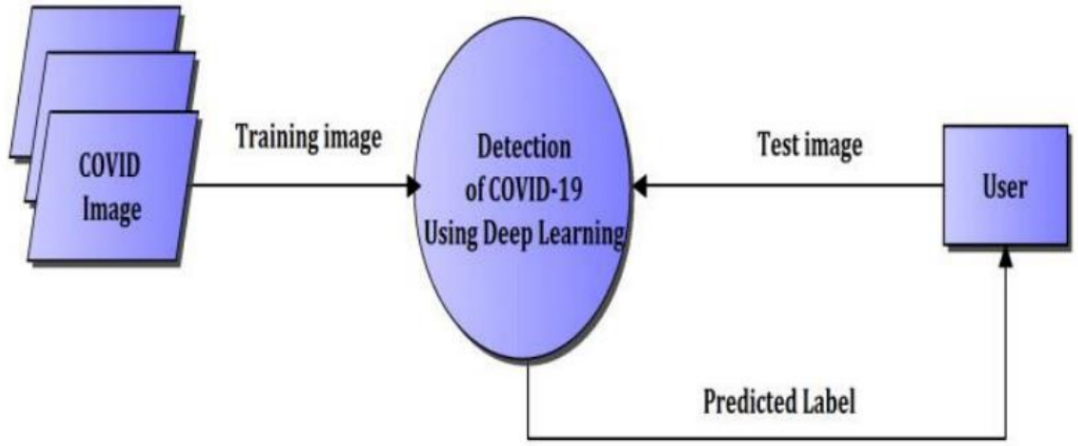
  The user interface should be intuitive, requiring minimal training for healthcare professionals to use the application effectively.Ensure accessibility features to accommodate users with varying levels of ability.

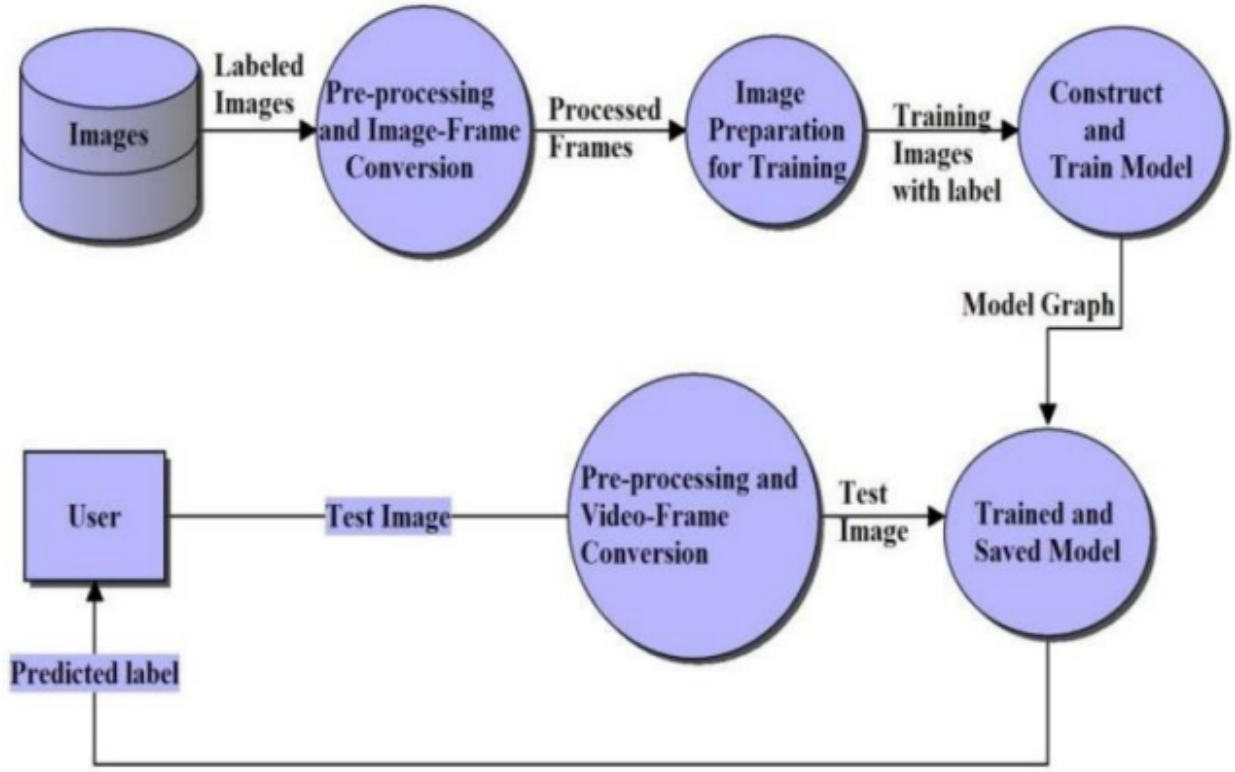
  Compatibility:

  The application should be compatible with a variety of devices and browsers commonly used by healthcare professionals.

5. PROJECT DESIGN

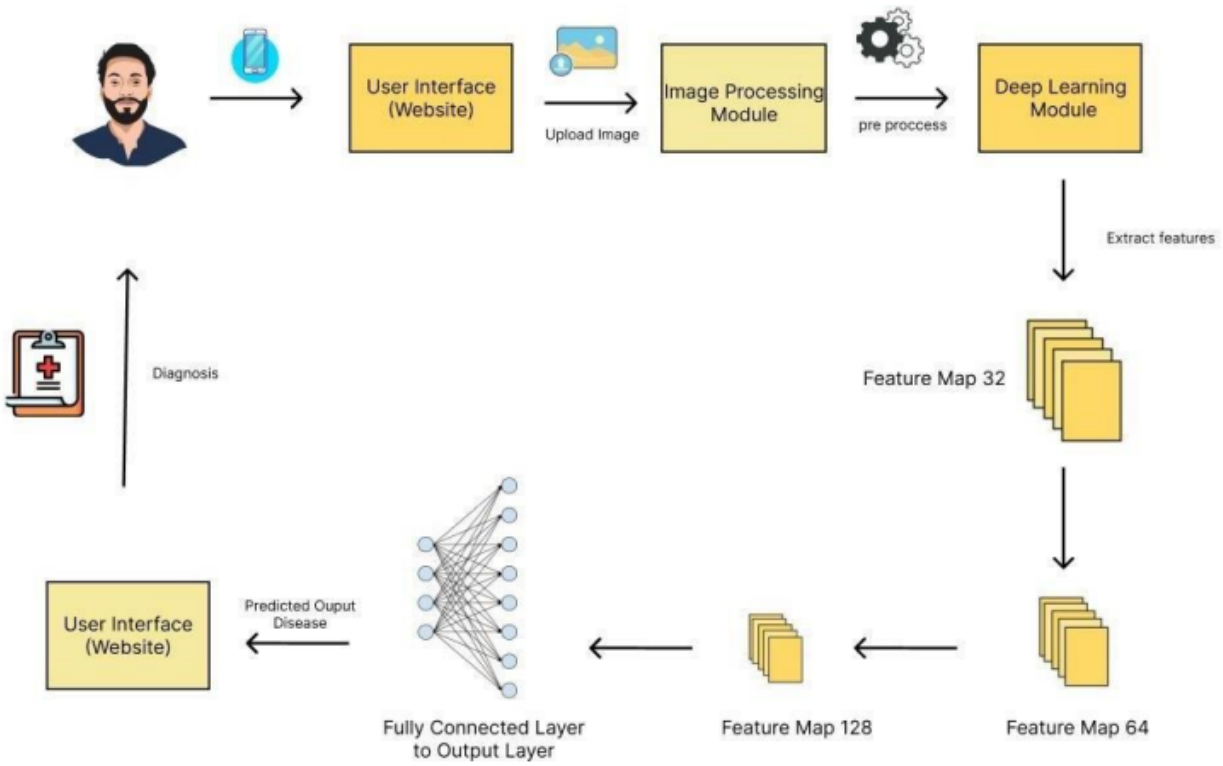
- Data Flow Diagram and User Stories





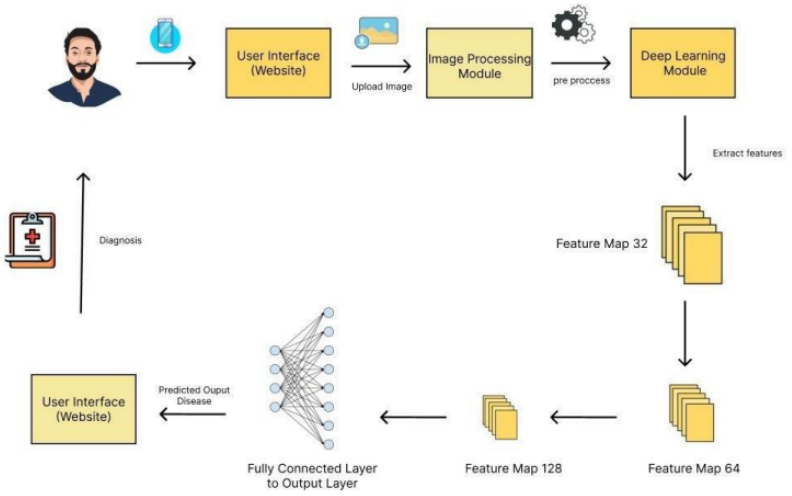
User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Healthcare Professionals	Project setup	USN-1	As a healthcare professional, I want to upload patient data and test results to the system so that it can analyse the likelihood of COVID-19 infection accurately and provide recommendations for further action.	The system should allow healthcare professionals to securely upload patient data and test results	High	Sprint 1
Researchers	Research facility	USN-2	As a researcher, I want to access a diverse and extensive dataset of COVID-19 cases globally to train the machine learning model effectively and improve its predictive accuracy.	The system should allow access to a comprehensive up-to-date dataset of COVID-19 cases from various sources	High	Sprint 1
Patients and individuals	User Interface	USN-3	As a patient, I want to input my symptoms into the system to receive an assessment of my risk of being affected by COVID-19, which will help me determine whether I should seek immediate medical attention or take precautionary measures.	The system interface should allow users to input symptoms easily and provide a straight-forward assessment of the risk of COVID-19 infection	High	Sprint 2
Medical administrators	Data classification	USN-4	As a healthcare administrator, I want to monitor the performance and accuracy of the COVID-19 detection model to ensure that it aligns with latest medical guidelines and reliable results for effective decision making.	The system should generate regular reports on the performance and accuracy of the COVID-19 detection model	High	Sprint 2
Data scientists	Model training	USN-5	As a data scientist, I want to access model's training data and performance metrics to fine-tune the algorithm and improve its sensitivity and specificity in identifying COVID-19 cases, especially in different demographic groups.	The system should provide access to training data, model architecture and performance metrics for the data scientists	High	Sprint 3

- Solution Architect



6. PROJECT PLANNING

- Technical Architecture



- Sprint Planning & Estimation

Product Backlog, Sprint Schedule, and Estimation (4 Marks)

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Project setup & Infrastructure	USN-1	Set up the development environment with the required tools and frameworks to start the covid-19 detection project.	1	High	Hritik
Sprint-1	Development environment	USN-2	Gather a diverse dataset of images that contains different types of chest x-ray images (covid, non-covid, pneumonia).	2	High	Dhruv
Sprint-2	Data collection	USN-3	Data preprocess of the collected data set by resizing images, normalizing pixel values, and splitting it into training and validation sets.	2	High	Abhishek
Sprint-2	Data preprocessing	USN-4	Opting for the best deep learning architecture among VGG19, ResNet-101, ResNet-152, etc. which gives the best accuracy and performance for COVID-19 detection.	3	High	Dhruv
Sprint-3	Model development	USN-5	Training the selected deep learning model using the pre-processed dataset and monitoring its performance on the validation set.	4	High	Abhishek
Sprint-3	Training	USN-6	Implementing data augmentation techniques like rotation and flipping to improve model's robustness and accuracy.	6	medium	Hritik
Sprint-4	Model deployment & Integration	USN-7	Deploy the trained deep learning model as an API or web service to make it accessible for garbage classification. integrate the model's API into a user-friendly web interface for users to upload images and receive garbage classification results.	1	medium	Hritik
Sprint-5	Testing & quality assurance	USN-8	Conduct thorough testing of the model and web interface to identify any issue and bugs and fine-tune the model hyperparameters and optimize its performance based on user feedback and testing result.	1	medium	Dhruv

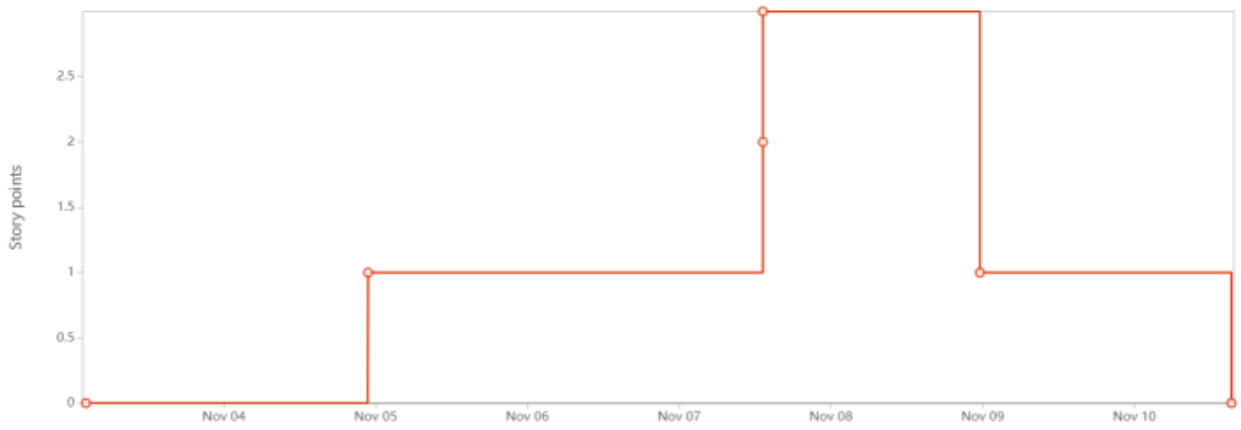
Project Tracker, Velocity & Burndown Chart: (4 Marks)

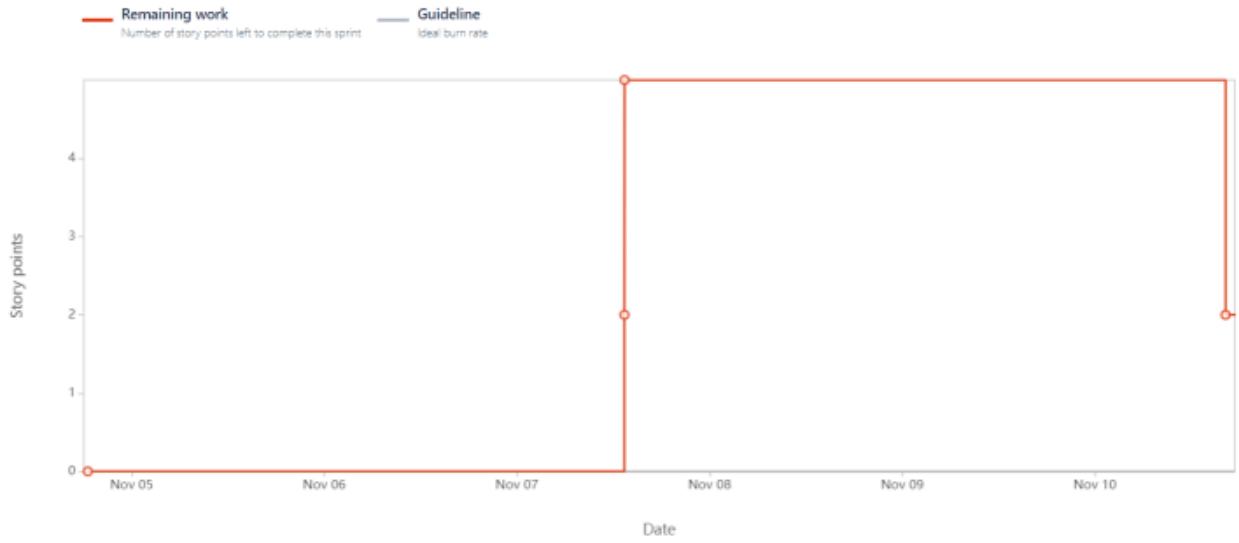
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	3	8 Days	3 Nov 2023	10 Nov 2023	20	3 Nov 2023
Sprint-2	5	7 Days	4 Nov 2023	10 Nov 2023		
Sprint-3	10	7 Days	4 Nov 2023	10 Nov 2023		
Sprint-4	1	7 Days	4 Nov 2023	10 Nov 2023		
Sprint-5	1	7 Days	4 Nov 2023	10 Nov 2023		

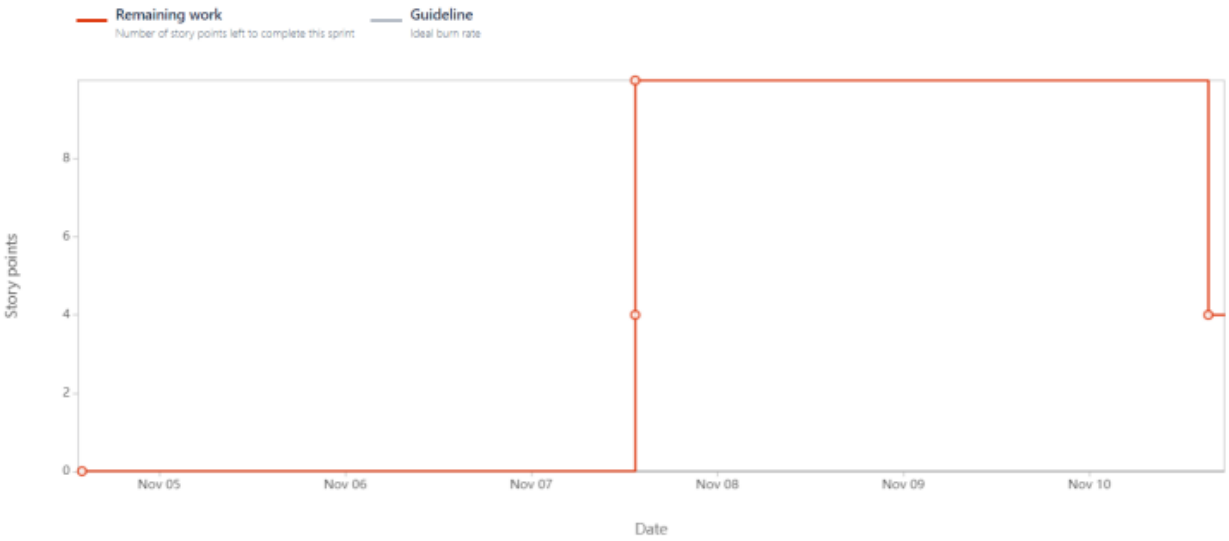
$$AV = \frac{sprint\ duration}{velocity} = \frac{20}{10} = 2$$

AV= 36/20 = 1.8

- Burn Down Chart:




Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
Story points
0
1
2
3
4
Nov 05
Nov 06
Nov 07
Nov 08
Nov 09
Nov 10
Date


Remaining work
Number of story points left to complete this sprint
Guideline
Ideal burn rate
Story points
0
2
4
6
8
Nov 05
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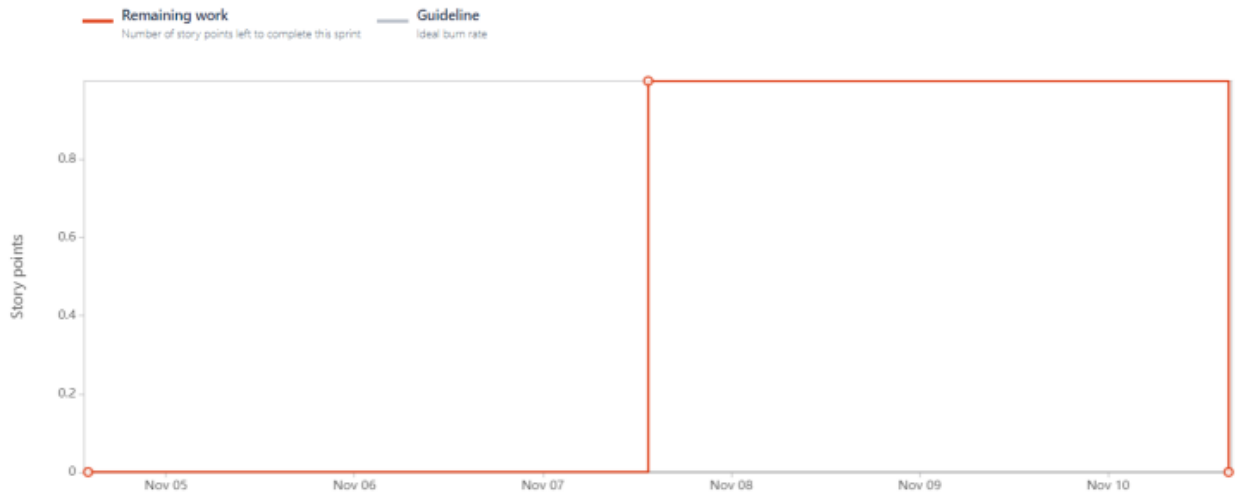
Date


Remaining work
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Guideline
Ideal burn rate
Story points
0
0.2
0.4
0.6
0.8
Nov 05
Nov 06
Nov 07
Nov 08
Nov 09
Nov 10

7. CODING & SOLUTION

- Import Libraries

```
import os
from flask import Flask, render_template, request
from keras.models import load_model
from keras.preprocessing import image
import numpy as np
```

- Loading The Model & Initializing Flask App

```
app = Flask(__name__)

# Load the trained model
model = load_model('covid.h5')
```

- Render HTML Pages

```python
# Home route
@app.route('/')
def home():
    return render_template('Index.html')

@app.route('/About')
def about():
    return render_template('About.html')

@app.route('/Precautions')
def precautions():
    return render_template('Precautions.html')

@app.route('/Vaccinations')
def vaccinations():
    return render_template('Vaccinations.html')

@app.route('/Test')
def test():
    return render_template('Test.html')
```

Once we uploaded the file into the app, then verifying the file uploaded properly or not.Here we will be using declared constructor to route to the HTML page which we have created earlier.

In the above example, '/' URL is bound with home.html function. Hence, when the home page of the web server is opened in browser, the html page will be rendered. Whenever you enter the values from the html page the values can be retrieved using POST Method.

- Image Upload & Processing

```python
# Predict route
@app.route('/predict', methods=['POST'])
def predict():
    if 'file' not in request.files:
        return render_template('Test.html', prediction_text='No file part')

    file = request.files['file']

    if file.filename == '':
        return render_template('Test.html', prediction_text='No selected file')

    if file and allowed_file(file.filename):
        # Load and preprocess the image
        img_path = os.path.join(app.config['UPLOAD_FOLDER'], file.filename)
        file.save(img_path)
        img = image.load_img(img_path, target_size=(500, 500))
        img_array = image.img_to_array(img)
        img_array = np.expand_dims(img_array, axis=0)
        img_array = np.expand_dims(img_array[:, :, :, 0], axis=-1)
        img_array /= 255.0

        # Make predictions
        predictions = model.predict(img_array)
        prediction = class_names[int(predictions[0, 0] > 0.5)]

        # Display the result on the web page
        return render_template('Test.html', prediction_text=f'The image is classified as: {prediction}')

    else:
        return render_template('Test.html', prediction_text='Invalid file format')
```

Here we are routing our app to res function. This function retrieves all the values from the HTML page using Post request. That is stored in an array. This array is passed to the model.predict() function. This function returns the prediction. And this prediction value will rendered to the text that we have mentioned in the index.html page earlier.

- Main Function

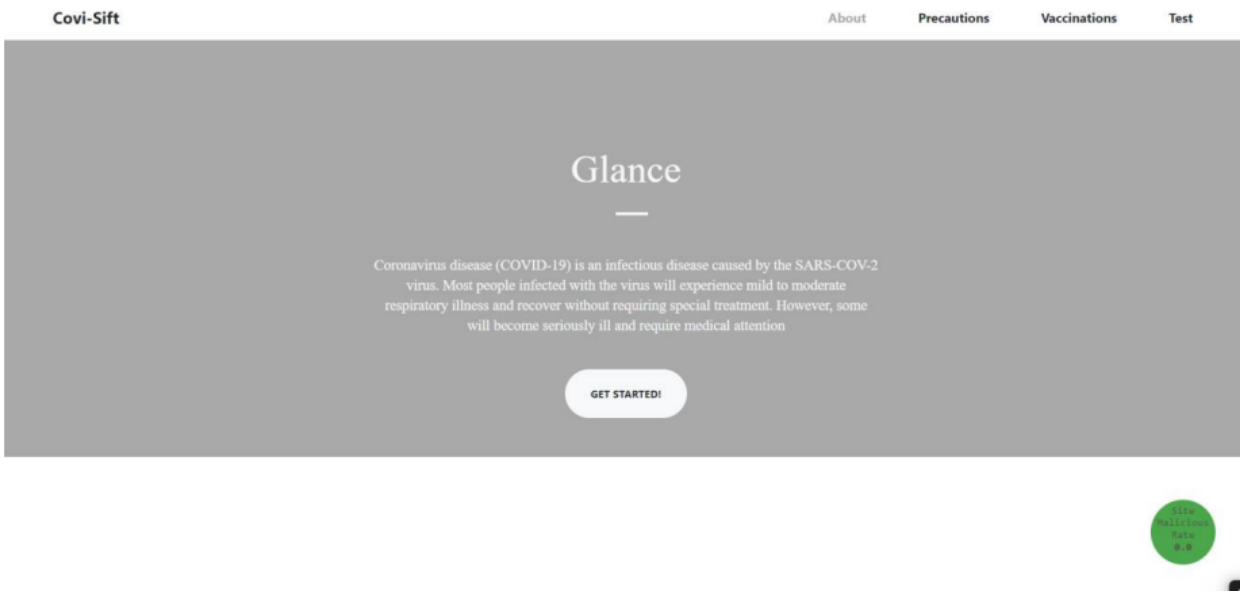
```python
if __name__ == '__main__':
    #app.run(debug=True)
    app.run(host='0.0.0.0', port=5000, debug=True)
```

8. RESULT

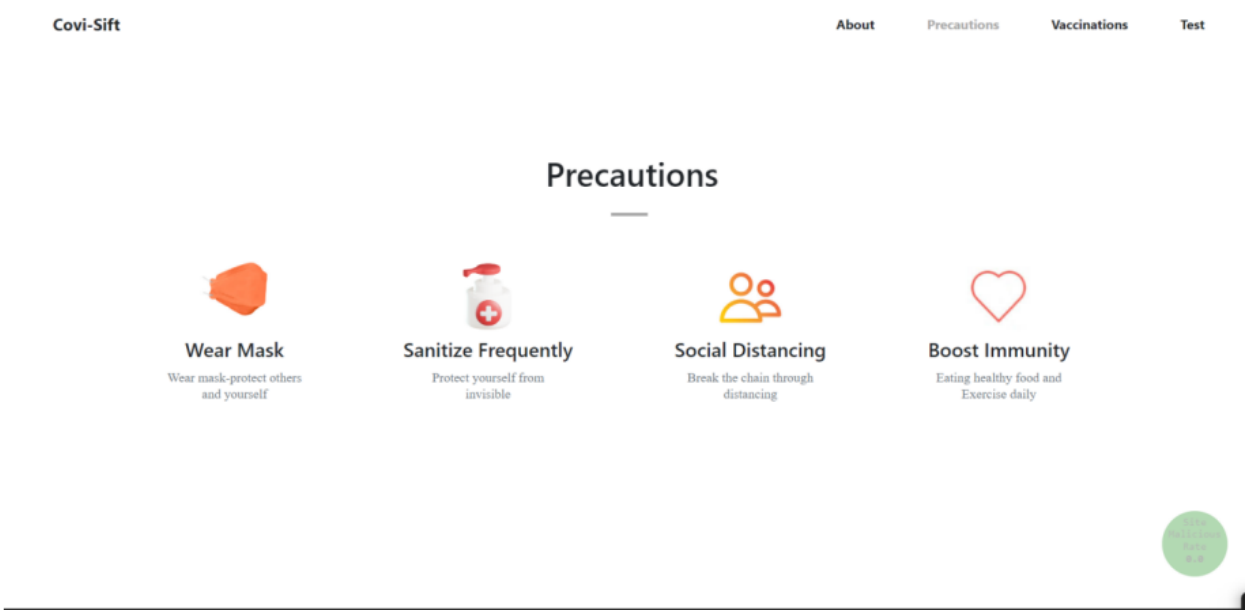
Website

- Home page

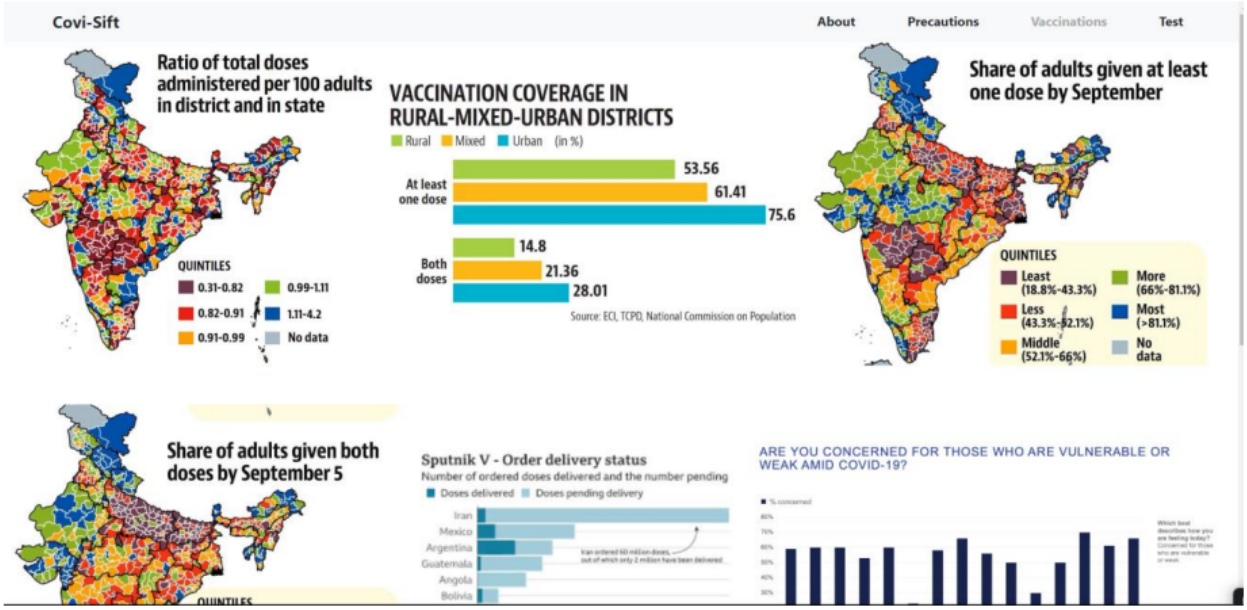
- About Page



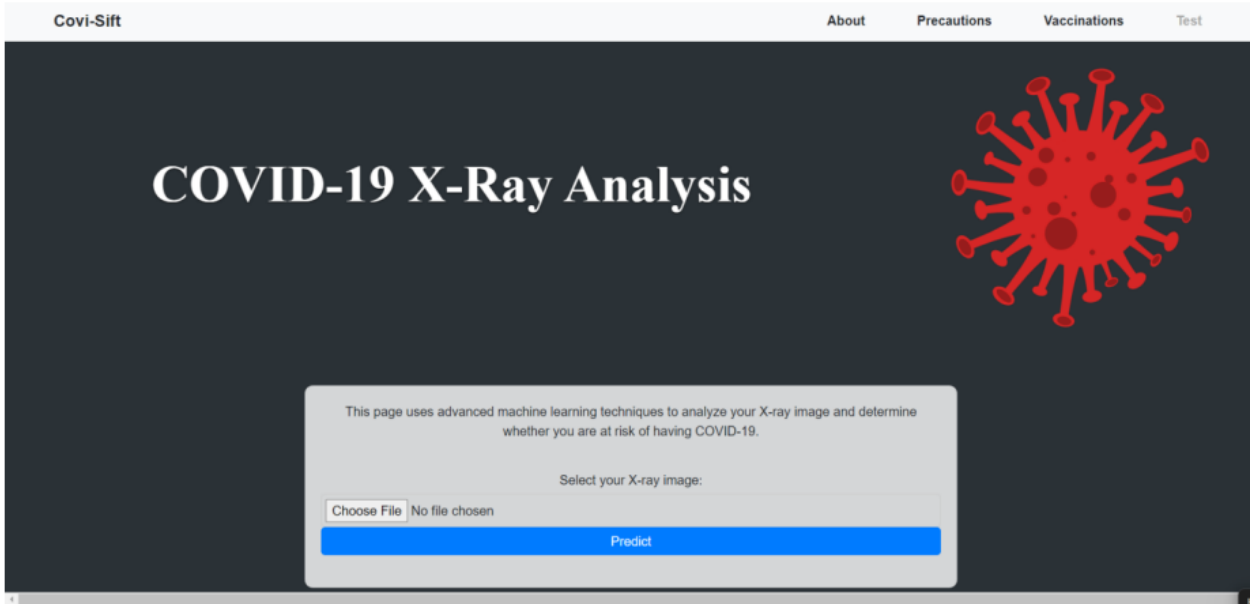
- Precautions Page



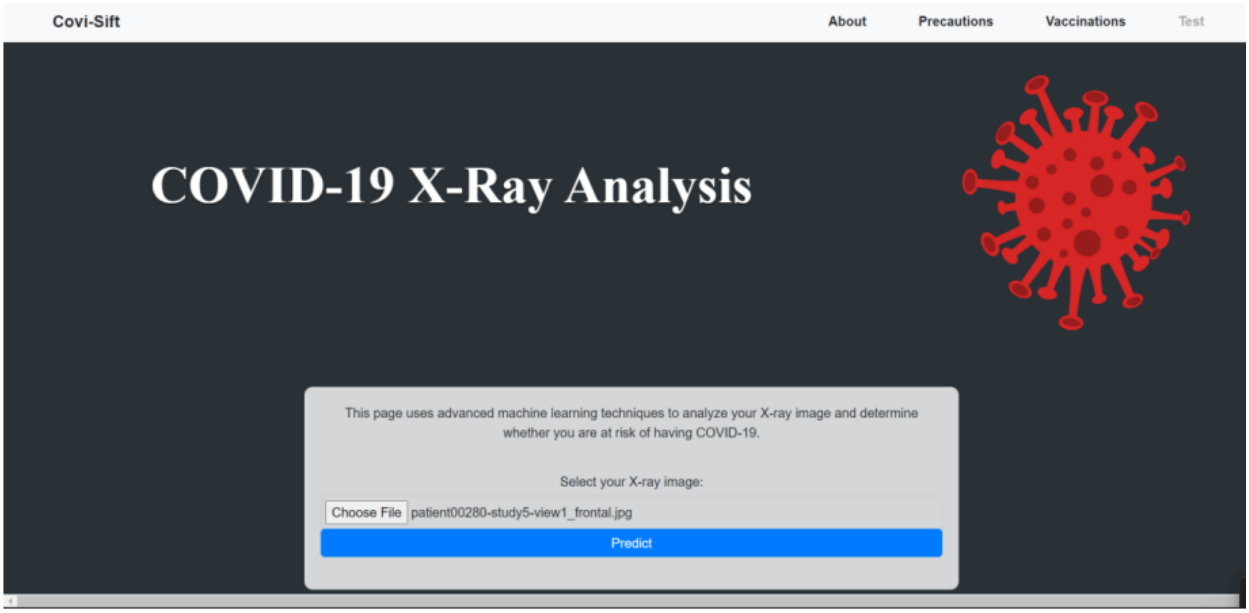
- Vaccinations Page



- Test Page

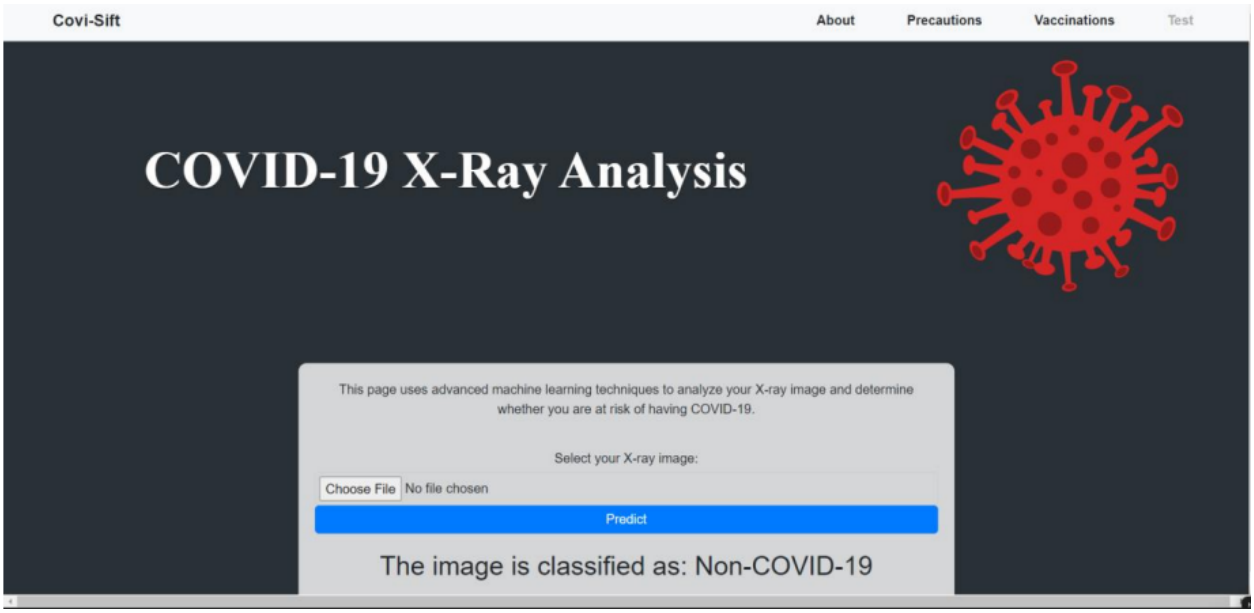


GIVEN INPUT FOR PREDICTION



We choose file(image of chest x-ray) as input for prediction.

PREDICTED OUTPUT



The image is classified as given above.

9. ADVANTAGES & DISADVANTAGES

- Advantages

Swift and Accurate Diagnosis:

The deep learning model employed by the project enables rapid and accurate classification of chest X-ray images, aiding healthcare professionals in quickly identifying potential COVID-19 cases.

Efficient Resource Allocation:

By automating the classification process, the project facilitates efficient triage and resource allocation in healthcare settings. It helps prioritize and deploy resources to areas with higher concentrations of COVID-19 cases.

Global Accessibility:

The web-based nature of the application allows for global accessibility, enabling healthcare professionals worldwide to utilize the tool in the fight against the pandemic. This fosters international collaboration and knowledge sharing.

Reduced Workload for Healthcare Professionals:

Automation of image classification reduces the workload on healthcare professionals, allowing them to focus on critical aspects of patient care and treatment rather than spending significant time on manual image analysis.

Real-time Results:

The provision of real-time results enhances the speed of decision-making, enabling healthcare professionals to initiate timely interventions and isolation measures for confirmed COVID-19 cases.

- Disadvantages

Dependency on Imaging Data:

The project heavily relies on chest X-ray images for COVID-19 classification. This may limit its effectiveness in situations where alternative diagnostic data or tests are more informative, potentially leading to false negatives or overlooking cases with atypical presentations.

Limited Sensitivity to Asymptomatic Cases:

Deep learning models may struggle to detect asymptomatic or mildly symptomatic cases, as these cases may not exhibit clear abnormalities in chest imaging. This limitation could result in an incomplete assessment of COVID-19 prevalence.

Data Bias and Generalization Issues:

If the training data used to develop the deep learning model is biased or not representative of diverse populations, the model may struggle to generalize accurately. This can lead to disparities in diagnostic accuracy across different demographics.

Ethical and Privacy Concerns:

The use of medical data for training the deep learning model raises ethical concerns related to patient privacy and consent. Ensuring compliance with ethical standards and data protection regulations is crucial to prevent misuse of sensitive information.

Algorithm Transparency and Interpretability:

Deep learning models are often considered "black boxes" with limited transparency and interpretability. Healthcare professionals may find it challenging to trust and interpret the model's decisions, potentially impacting their confidence in the diagnostic results.

10. CONCLUSION

Early diagnosis of the novel coronavirus is extremely important to avoid further spread of the virus to others. Along this work, we design a method based on deep transfer learning that uses chest X-ray images related to patients affected with COVID-19 and patients without COVID-19 to automatically detect the disease. The suggested classification model for detecting COVID-19 can reach an accuracy of more than 98 %. According to our research results, due to its high overall performance, we believe it is of nature to help doctors and health experts make clinical decisions. To discover COVID-19 as early as possible, this study has an in-depth understanding of how to use deep transfer learning approaches.

COVID-19 presents a threat to the world’s healthcare community and kills millions of people. Due to the large number of patients seen outdoors or in emergencies, doctors have limited time, and computer-aided analysis could rescue lives through early screening as well as appropriate care.

11. FUTURE SCOPE

This COVID-19 detection project represents a pioneering step in leveraging deep learning technology for the accurate and rapid classification of COVID-19 and non-COVID-19 chest X-ray images. While the current implementation provides valuable advantages, its future scope is brimming with potential enhancements. By integrating multi-modal diagnostic approaches, incorporating clinical data, and adapting to emerging virus variants, the project can evolve into a more comprehensive diagnostic tool. The envisioned expansion into real-time monitoring, collaboration with telemedicine platforms, and integration with electronic health records holds the promise of extending the project's impact, making it an integral component in the dynamic landscape of healthcare technology.

Moreover, the commitment to ethical considerations, continuous model improvement, and global research collaboration underscores the project's dedication to responsible and impactful innovation. As the healthcare industry embraces technological advancements, the project's potential mobile application development, integration with augmented reality, and collaboration with public health systems position it at the forefront of shaping the future of respiratory disease diagnostics. With an eye toward universal accessibility, adaptability, and user-centric design, the COVID-19 detection project is poised to contribute significantly to global efforts in combatting not only COVID-19 but also a spectrum of respiratory diseases, fostering a more resilient and responsive healthcare ecosystem.

12. PROJECT DEMO LINK

https://drive.google.com/file/d/1PJobSFm757pqAP4WoYDlkg-ggPHh-U5X/view?usp=sharing