Project Report

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1. INTRODUCTION

1.1 Project Overview

The main objective of this project is to create a robust and accurate AI-based system for the early detection of COVID-19 using chest X-ray images. By training a deep learning model, the system will be able to classify X-ray images into four categories: COVID-19 positive, non-COVID-19 pneumonia, Lung Opacity, and normal (non-infected).

Key Components of the Project:

1) Data Collection:

   Gather a diverse and well-labelled dataset of chest X-ray images that includes COVID-19-positive cases, non-COVID-19 pneumonia cases, and normal cases. Ensure data quality and appropriate metadata for each image.

2) Data Preprocessing:

   Standardize image sizes, orientations, and formats to ensure consistency.
   Augment the dataset to increase the diversity of training samples, improving the model's generalization.

3) Model Development:

   Select and implement an appropriate deep learning architecture (Stacked model of MobileNet and DenseNet) for image classification.
   Train the model on the prepared dataset, using techniques like transfer learning, fine-tuning, and optimization to achieve high accuracy.

4) Evaluation and Validation:

   Assess the model's performance using various evaluation metrics, such as accuracy, precision, recall, F1-score, and Classification report. Validate the model on an independent dataset to ensure its generalizability.

5) User Interface:

   Develop a user-friendly interface for healthcare professionals to upload chest X-ray images and receive instant predictions for COVID-19 infection.

6) Deployment:

   Deploy the model as a web application or integrate it into existing healthcare systems for widespread usage.

1.2 Purpose

The primary purpose is to enable the early and accurate diagnosis of COVID-19. By using chest X-ray images, this project aims to provide a valuable tool for healthcare professionals to identify potential COVID-19 cases swiftly. Early detection is essential for timely isolation and treatment, which can significantly reduce the spread of the virus and improve patient outcomes.

The project seeks to aid healthcare systems in efficiently allocating resources. By assisting in the early identification of COVID-19 cases.

2. LITERATURE SURVEY

2.1 Existing problem

Here we address the limitations and challenges associated with current COVID-19 detection methods. While traditional PCR tests have their merits, they may be limited by factors like speed, availability, and cost. Manual interpretation of chest X-ray images by radiologists can also be time-consuming and prone to human error. Data collection and curation for AI-based models present their own challenges, including the need for diverse, high-quality datasets. These issues collectively impact resource allocation, disease transmission, and healthcare system efficiency. Our project aims to mitigate these challenges by developing an AI-driven solution for COVID-19 detection using chest X-rays, offering a valuable tool for healthcare professionals and contributing to public health management during the pandemic.

2.2 References

1.CNN:

https://towardsdatascience.com/basics-of-the-classic-cnn-a3dce1225add

2.VGG16:

https://medium.com/@mygreatlearning/what-is-vgg16-introduction-to-vgg16-f2d63849f615

3. ResNet-50:

https://towardsdatascience.com/understanding-and-coding-a-resnet-in-keras-446d7ff84d33/

4.Inception-V3:

https://iq.opengenus.org/inception-v3-model-architecture

5. Xception:

https://pyimagesearch.com/2017/03/20/imagenet-vggnet-resnet-inception-xception-keras

6. Covid -WHO:

https://covid19.who.int/

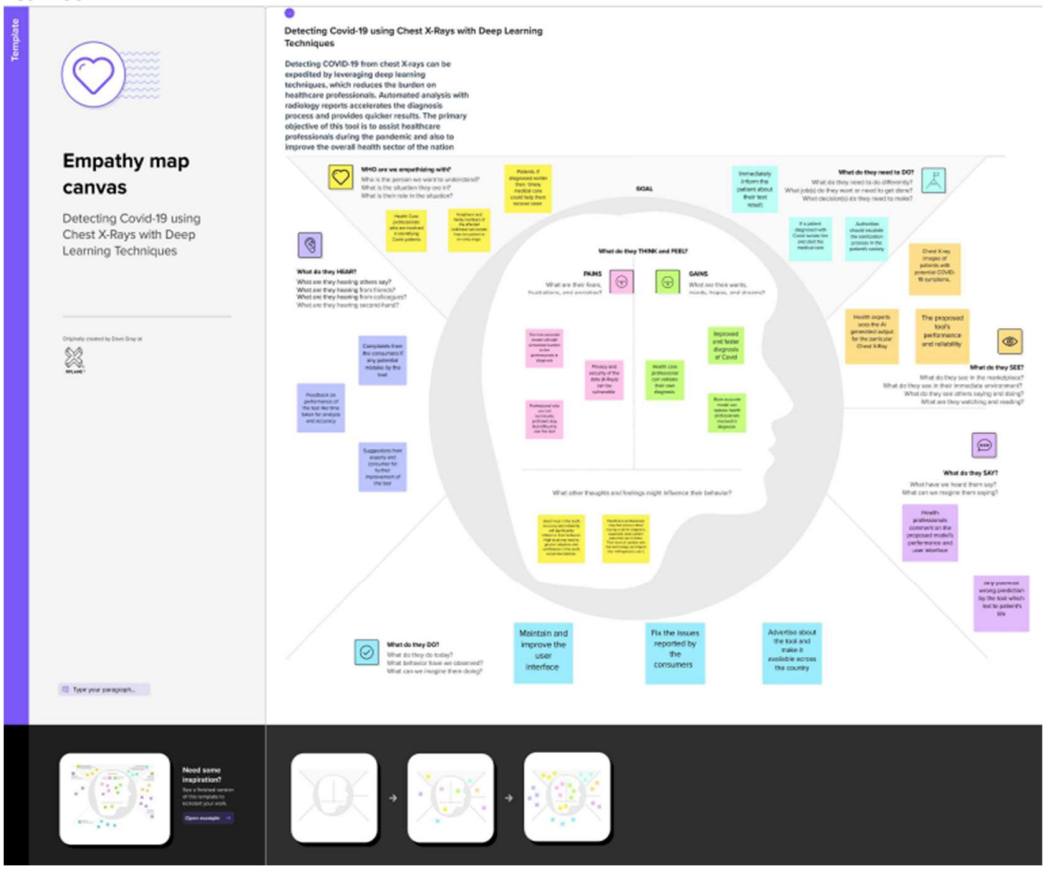
2.3 Problem Statement Definition

Detecting Covid-19 from Chest X-Rays using Deep Learning Techniques

3. IDEATION & PROPOSED SOLUTION

3.1 Empathy Map Canvas

An empathy map is a simple, easy-to-digest visual that captures knowledge about a user's behaviours and attitudes. It is a useful tool to help teams better understand their users. Creating an effective solution requires understanding the true problem and the person who is experiencing it. The exercise of creating the map helps participants consider things from the user's perspective along with his or her goals and challenges.



GitHub link: https://github.com/smartinternz02/SI-GuidedProject-594590-1697299997/blob/main/1.%20Ideation%20Phase/1.a)%20Empathy%20Map%20Canvas.pdf

3.2 Ideation & Brainstorming

Brainstorming provides a free and open environment that encourages everyone within a team to participate in the creative thinking process that leads to problem solving. Prioritizing volume over value, out-of-the-box ideas are welcome and built upon, and all participants are encouraged to collaborate, helping each other develop a rich amount of creative solutions. 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.

GitHub link: https://github.com/smartinternz02/SI-GuidedProject-594590-1697299997/blob/main/1.%20Ideation%20Phase/2.a)%20Brainstorming%20Canvas.pdf

4. **REQUIREMENT ANALYSIS**

4.1 Functional requirement

Functional requirements specify what the system or application should do. In the context of "COVID-19 Detection Using Chest X-Rays" project, functional requirements outline the specific capabilities and functions of the system. Here are some functional requirements for such a project:

- Image Upload and Processing
- COVID-19 Detection Algorithm
- Data Augmentation
- Model Training and Updates
- User Interface
- Data Management and Security
- Results Presentation
- Notification System
- Performance Metrics
- Patient Data Management

4.2 Non-Functional requirements

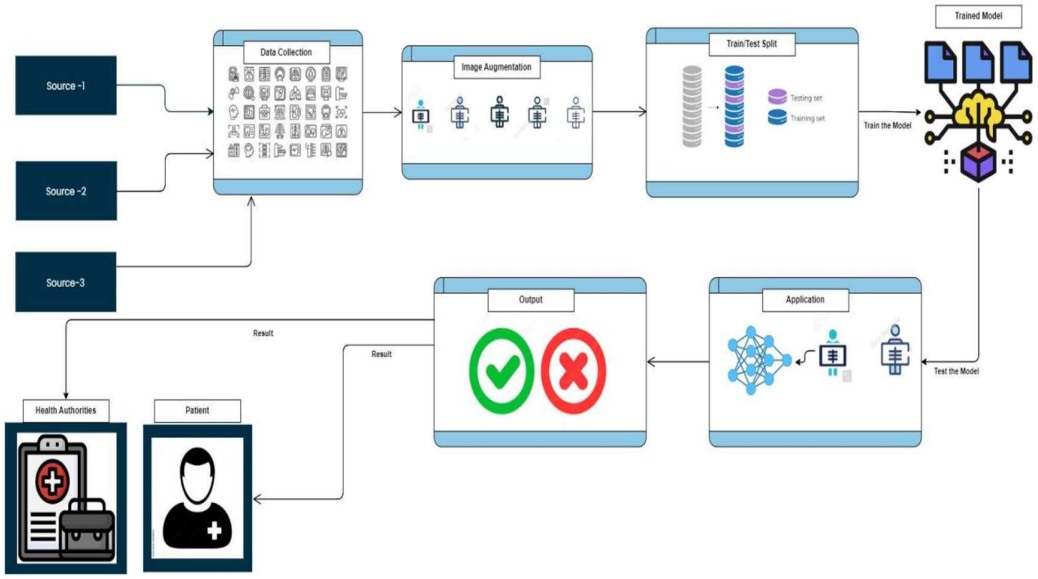
Non-functional requirements specify the quality attributes and constraints that the system must adhere to. In the context of a "COVID-19 Detection Using Chest X-Rays" project, non-functional requirements focus on aspects like performance, security, scalability, and usability. Here are some non-functional requirements for this project:

- Performance
- Response Time
- Scalability
- Data Privacy
- Authentication and Authorization
- Usability
- User-Friendly Interface
- Reliability
- Accuracy
- Data Backup and Recovery
- Load Testing

5. PROJECT DESIGN

5.1 Data Flow Diagrams & User Stories

A Data Flow Diagram (DFD) is a traditional visual representation of the information flows within a system. A neat and clear DFD can depict the right amount of the system requirement graphically. It shows how data enters and leaves the system, what changes the information, and where data is stored



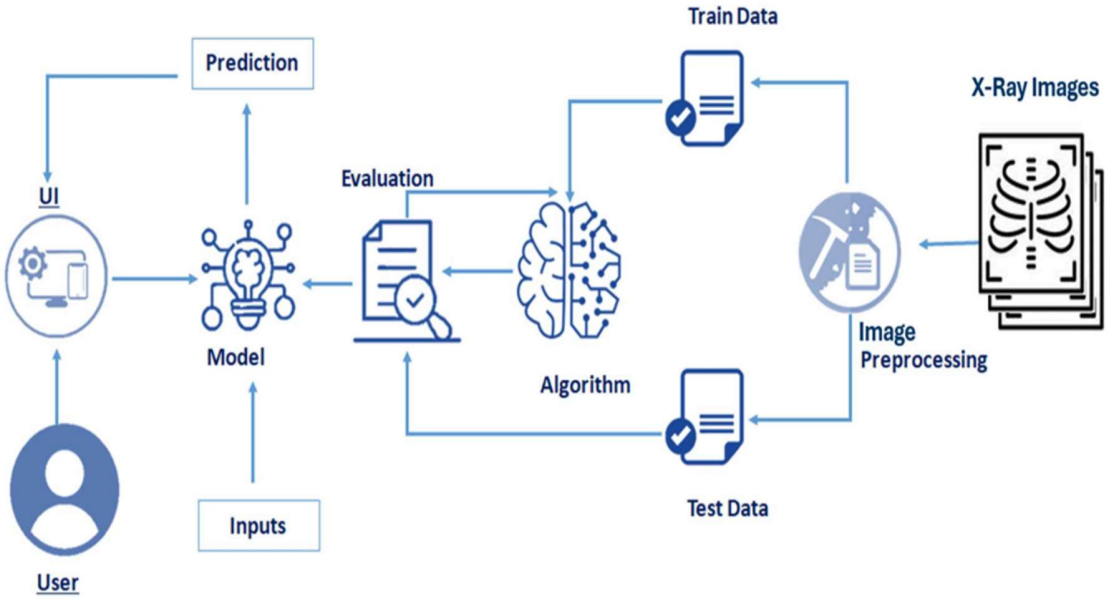
User Stories:

Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority
Sprint-1	Project setup & Infrastructure	USN-1	Set up the development environment with the required tools and frameworks to start the Covid-19 Detection	1	High
Sprint-1	Data Collection	USN-2	Gather a diverse dataset of images containing different types of Chest X-rays for training the deep-learning model	2	High
Sprint-2	Data preprocessing	USN-3	Preprocess the collected dataset by resizing images, normalizing pixel values, and splitting it into training and validation sets.	2	High
Sprint-2	Model Development	USN-4	Explore and evaluate different deep learning architectures (e.g., CNNs) and transfer learning models to select the most suitable model for Covid Detection.	3	High
Sprint-3	Model Training	USN-5	Train the selected deep learning model using the preprocessed dataset and monitor its performance on the validation set.	4	High
Sprint-2	Data Augmentation	USN-6	Implement data augmentation techniques (e.g., rotation, flipping) to improve the model's robustness and accuracy.	6	medium
Sprint-4	Model deployment and integration	USN-7	Deploy the trained deep learning model as an API or web service to make it accessible for COVID-19 detection. integrate the model's API into a user-friendly web interface for users to upload images and receive COVID-19 detection results.	1	medium
Sprint-5	Testing & quality assurance	USN-8	Conduct thorough testing of the model and web interface to identify and report any issues or bugs. fine-tune the model hyperparameters and optimize its performance based on user feedback and testing results.	1	medium

5.2 Solution Architecture

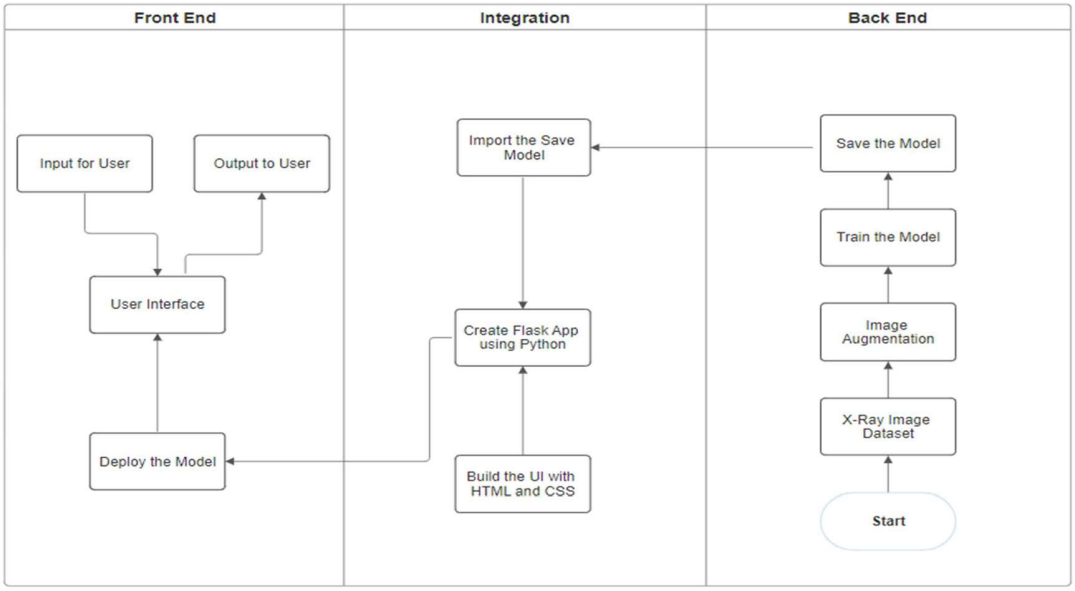
Our solution leverages Convolutional Neural Networks (CNNs) and the Transfer learning models effectively to address Covid detection as follows:

- Data Collection (X-Ray Images)
- Image Preprocessing
- Model Building (CNN, Xception, Efficient-net)
- Covid 19 Classification
- Deployment of the built model



6. PROJECT PLANNING & SCHEDULING

6.1 Technical Architecture



6.2 Sprint Planning & Estimation

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	1	High	Avinash
Sprint-1	Data Collection	USN-2	Gather a diverse dataset of images containing different types of Chest X-rays for training the deep-learning model	2	High	Ashwanth
Sprint-2	Data preprocessing	USN-3	Preprocess the collected dataset by resizing images, normalizing pixel values, and splitting it into training and validation sets.	2	High	Sreyas
Sprint-2	Model Development	USN-4	Explore and evaluate different deep learning architectures (e.g., CNNs) and transfer learning models to select the most suitable model for Covid Detection.	3	High	Avinash
Sprint-3	Model Training	USN-5	Train the selected deep learning model using the preprocessed dataset and monitor its performance on the validation set.	4	High	Divya
Sprint-2	Data Augmentation	USN-6	Implement data augmentation techniques (e.g., rotation, flipping) to improve the model's robustness and accuracy.	6	medium	Ashwanth
Sprint-4	Model deployment and integration	USN-7	Deploy the trained deep learning model as an API or web service to make it accessible for COVID-19 detection. integrate the model's API into a user-friendly web interface for users to upload images and receive COVID-19 detection results.	1	medium	Divya
Sprint-5	Testing & quality assurance	USN-8	Conduct thorough testing of the model and web interface to identify and report any issues or bugs. fine-tune the model hyperparameters and optimize its performance based on user feedback and testing results.	1	medium	Sreyas

6.3 Sprint Delivery Schedule

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	2 Days	28 Oct 2023	30 Oct 2023	3	30 Oct 2023
Sprint-2	5	5 Days	31 Oct 2023	3 Nov 2023	5	2 Nov 2023
Sprint-3	10	2 Days	4 Nov 2023	5 Nov 2023	10	4 Nov 2023
Sprint-4	1	2 Day	5 Nov 2023	6 Nov 2023	1	5 Nov 2023
Sprint-5	1	1 Day	7 Nov 2023	7 Nov 2023	1	5 Nov 2023

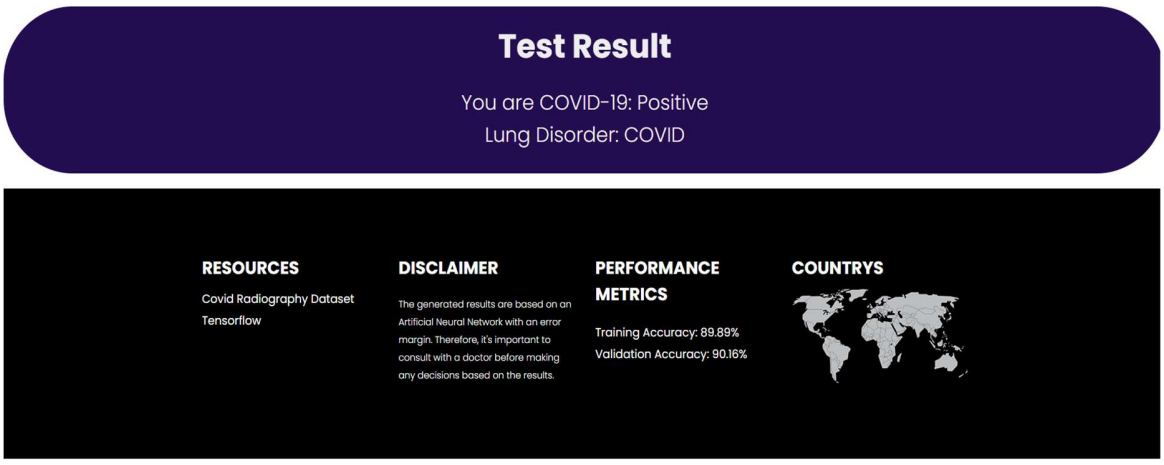
7. CODING & SOLUTIONING (Explain the features added in the project along with code)

7.1 Feature 1

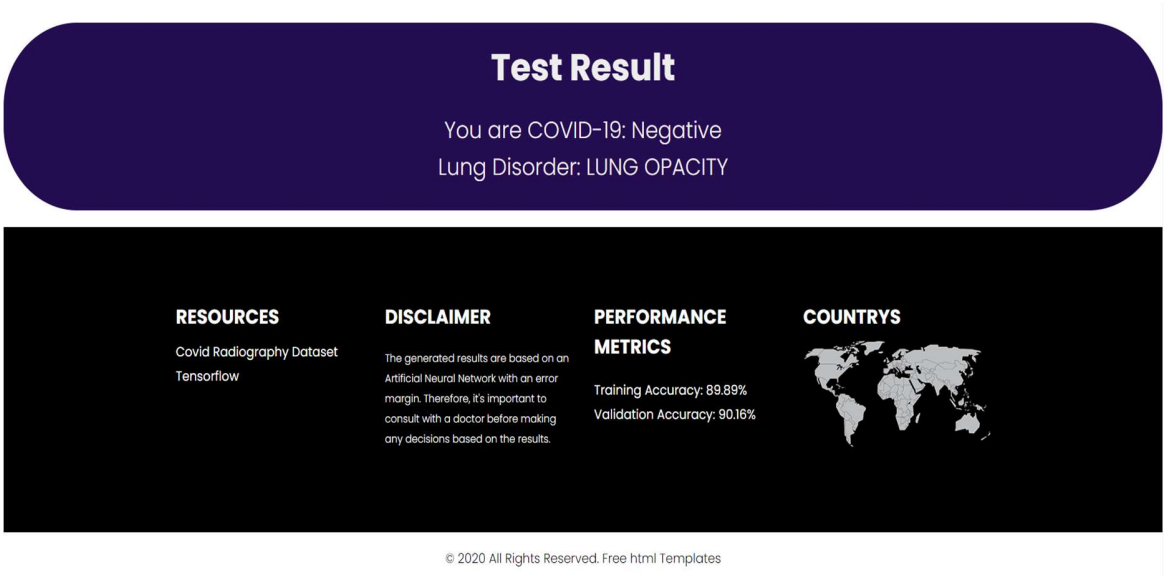
Given that our primary goal is to determine the presence of COVID-19 in a given chest X-ray, it's noteworthy that the dataset includes chest X-ray images depicting four distinct disorders. To address this diversity, we have introduced an additional feature that enables the model to not only identify COVID-19 but also predict any other lung disorders that may be evident in the X-ray image.

```
@app.route('/predict',methods = ['GET','POST'])
def upload():
    if request.method=='POST':
        f = request.files['image']
        basepath=os.path.dirname(__file__)
        filepath = os.path.join(basepath,'uploads',f.filename)
        f.save(filepath)

        img = image.load_img(filepath,target_size =(224,224))
        x = image.img_to_array(img)/255
        x = np.expand_dims(x,axis = 0)
        pred =np.argmax(model.predict(x),axis=1)
        print(int(pred))

        lis=['COVID','LUNG OPACITY','NORMAL','PNEUMONIA']
        # Process the prediction result and format it as needed
        if int(pred)==0:
            covid_prob="Positive"
        else:
            covid_prob="Negative"

        lung_disorder_prob = lis[int(pred)]

        return render_template('index.html', covid_prob=covid_prob, lung_disord

if __name__ == '__main__':
    app.run(debug=True)
```

Output:



Output 2:


Test Result
You are COVID-19: Negative
Lung Disorder: LUNG OPACITY
RESOURCES
Covid Radiography Dataset
Tensorflow
DISCLAIMER
The generated results are based on an Artificial Neural Network with an error margin. Therefore, it's important to consult with a doctor before making any decisions based on the results.
PERFORMANCE METRICS
Training Accuracy: 89.89%
Validation Accuracy: 90.16%
COUNTRYS
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8. PERFORMANCE TESTING

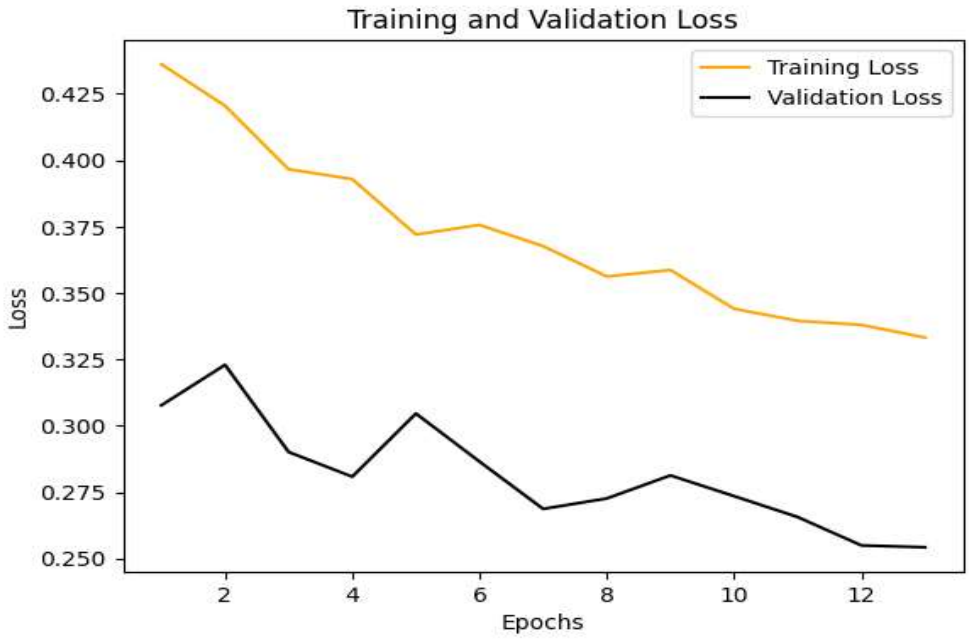
8.1 Performance Metrics

Model	Training Accuracy	Validation Accuracy
VGG-16	**90.37**	89.27
Resnet 50	66.78	64.89
Inception	90.24	88.5
Exception	88.04	84.90
Efficient Net	48.05	48.16
Stacked Model (Densnet, Mobile_Net)	88.90	**90.17**

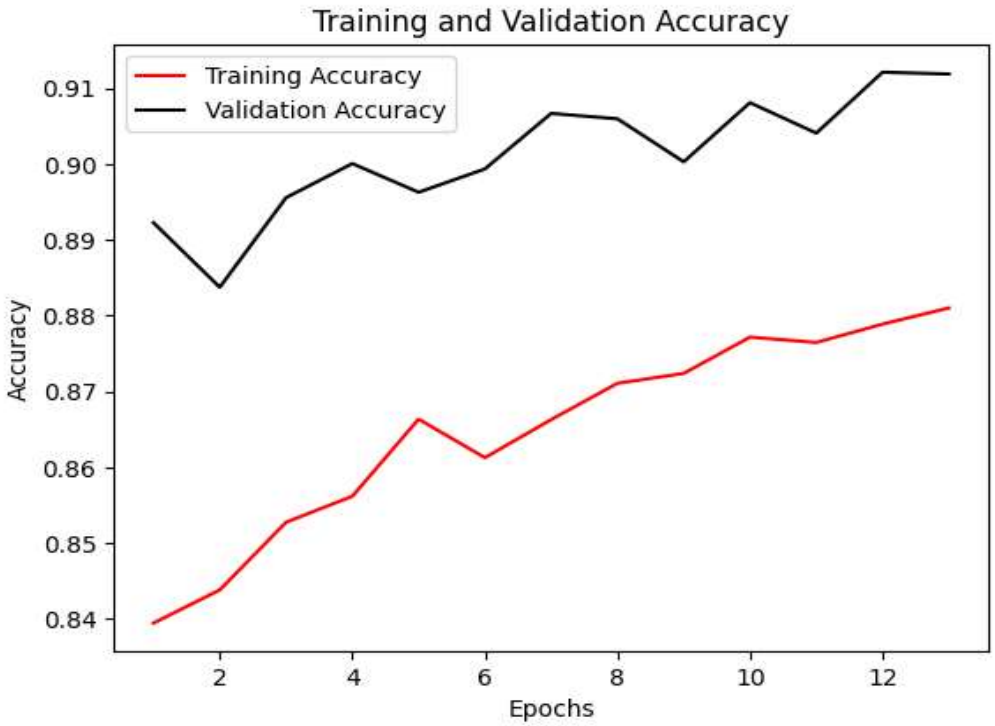
Classification Report:

	precision	recall	f1-score	support
COVID	0.91	0.82	0.86	723
LUNG_OPACITY	0.90	0.88	0.89	1202
NORMAL	0.89	0.95	0.92	2038
PNEUMONIA	0.94	0.88	0.91	269
accuracy			0.90	4232
macro avg	0.91	0.88	0.90	4232
weighted avg	0.90	0.90	0.90	4232

Loss Curves:



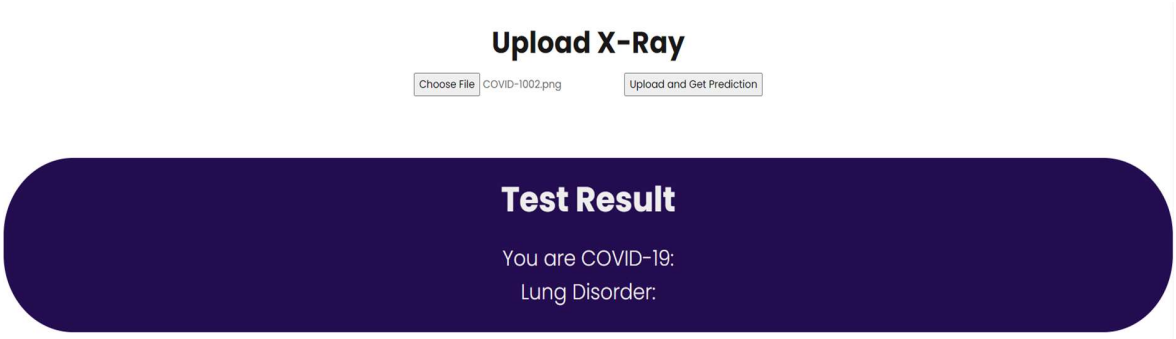
Accuracy Curves:



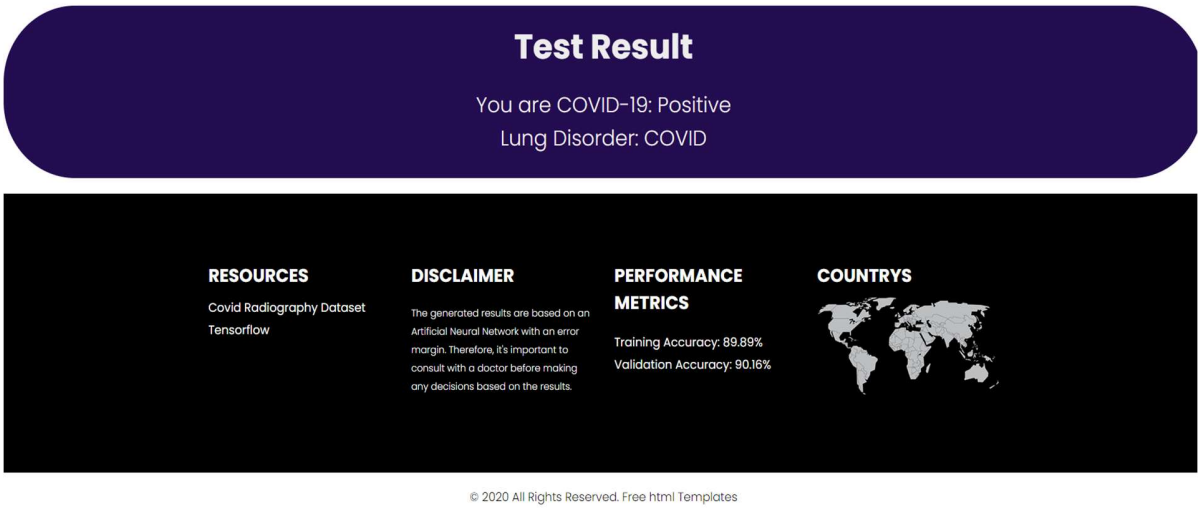
9. RESULTS

9.1 Output Screenshots

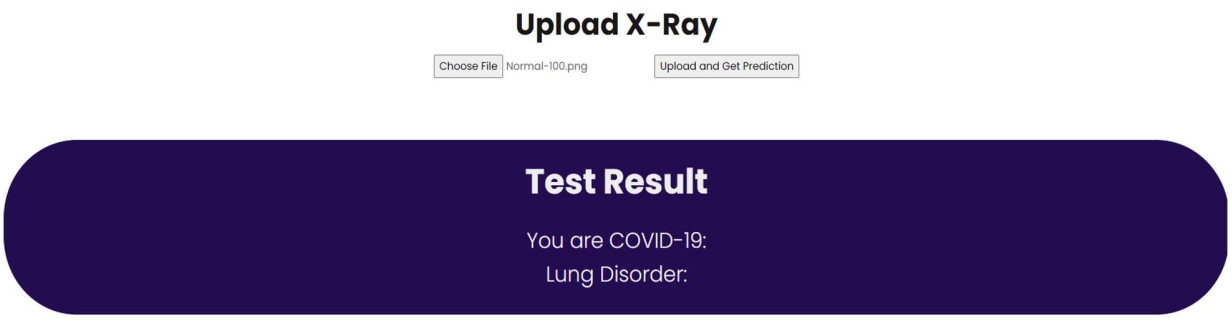
1. Covid X Ray



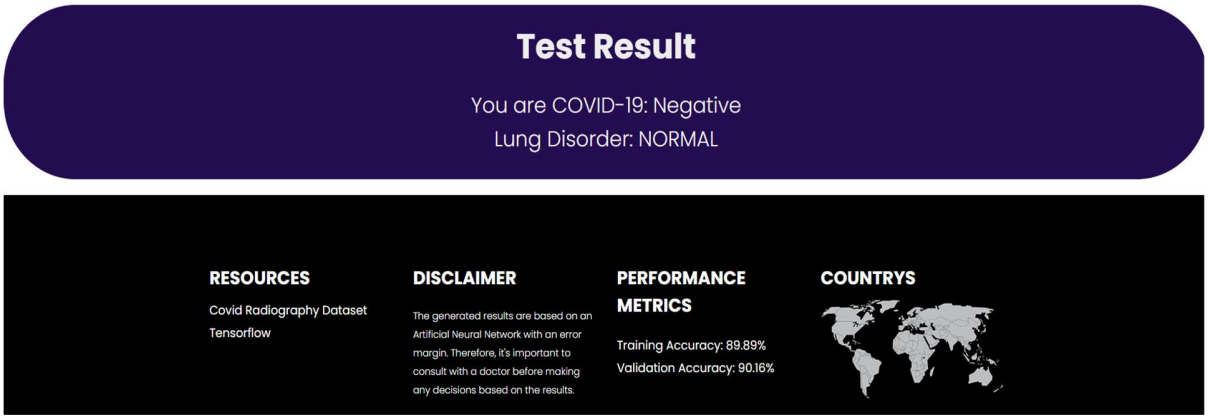
Output:



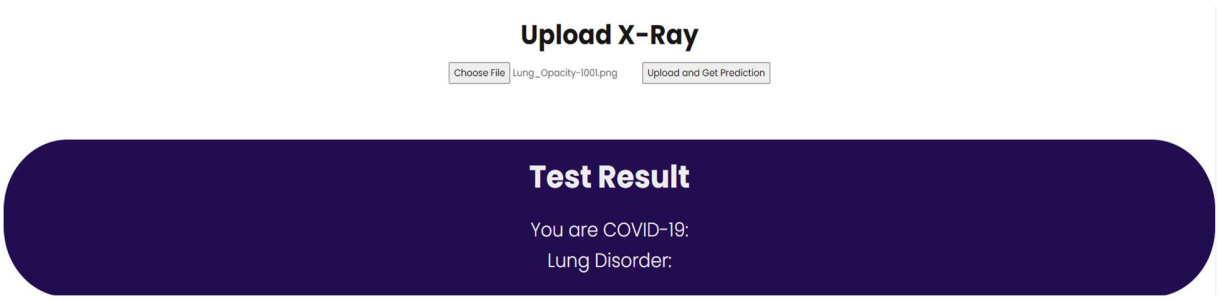
2. Normal X Ray



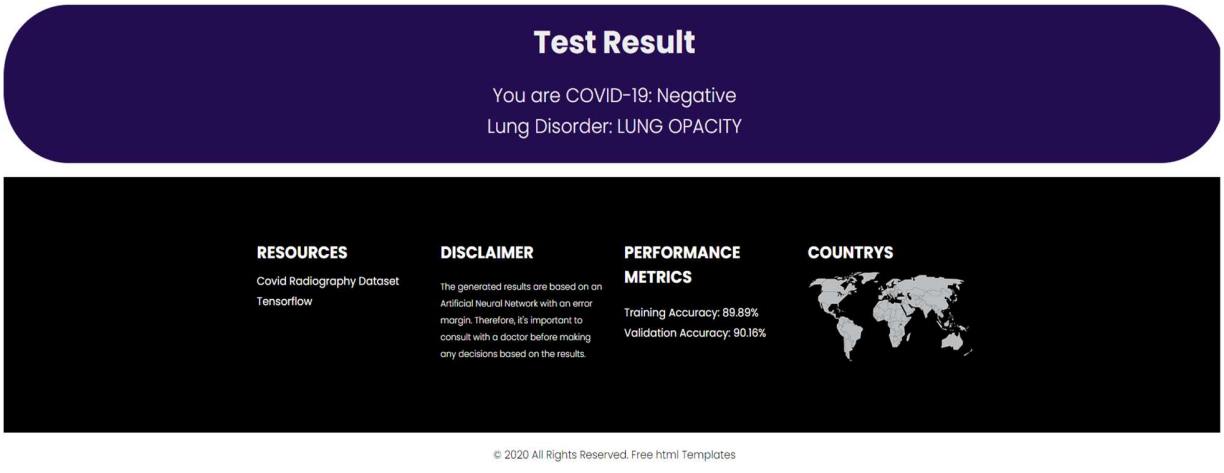
Output:



3.Lung Opacity X Ray



Output:



10. ADVANTAGES & DISADVANTAGES

Advantages:

- Early Detection: The project enables early and rapid detection of COVID-19, allowing for prompt isolation and treatment, which can help reduce the spread of the virus.
- Resource Allocation: It aids healthcare systems in efficiently allocating resources, such as ICU beds, ventilators, and medical staff, to areas with the greatest need.
- Reduced Transmission: Timely detection helps in breaking the chain of transmission and mitigating the impact of the pandemic on public health.
- Cost-Effective: Chest X-rays are a cost-effective and widely available diagnostic tool, making the system accessible even in resource-constrained settings.
- AI Assistance: The project leverages AI to assist healthcare professionals in diagnosing COVID-19, reducing the burden on radiologists and improving diagnostic accuracy.
- Remote Diagnosis: It facilitates remote diagnosis, making it suitable for telemedicine and regions with limited access to healthcare facilities.
- Data for Research: The project contributes to scientific research by providing a dataset for the study of radiological features of COVID-19.
- Technological Advancement: It showcases the potential of AI and deep learning in healthcare, setting a precedent for future applications.

Disadvantages:

- Accuracy Limitations: AI models, while powerful, may have limitations in terms of accuracy, especially with rare or complex cases.
- Data Availability: The availability of diverse and high-quality chest X-ray datasets can be a challenge, potentially affecting model performance.
- Ethical Concerns: Ensuring the ethical use of AI in healthcare, including patient privacy and informed consent, is crucial and may pose challenges.
- Overdiagnosis: False positives can lead to unnecessary testing and treatments, which may have implications for patient health and healthcare costs.
- Resource Intensiveness: Developing, training, and maintaining AI models can be resource-intensive, requiring a skilled workforce and computational resources.
- Interoperability Challenges: Ensuring that the system integrates smoothly with existing healthcare systems and follows healthcare standards can be complex
- Model Evolution: Continuous model improvement and adaptation to evolving COVID-19 patterns may require ongoing resources and expertise.
- Data Security: Safeguarding patient data and ensuring compliance with data protection regulations is critical and can be challenging.
- Healthcare Disparities: Implementation may exacerbate healthcare disparities if not accessible to underserved populations or regions.

11. CONCLUSION

The "COVID-19 Detection Using Chest X-Rays" project represents a significant advancement in our ongoing battle against the global COVID-19 pandemic. By harnessing the capabilities of artificial intelligence, this project seeks to provide a groundbreaking solution for the early and accurate detection of COVID-19, utilizing chest X-ray images as a vital diagnostic tool. In conclusion, the project offers several key takeaways: first, it addresses the urgent need for timely diagnosis, enabling healthcare professionals to swiftly identify potential COVID-19 cases and facilitating immediate isolation and treatment. Second, it enhances resource allocation in healthcare systems, ensuring that critical resources such as ICU beds, ventilators, and medical staff are directed to areas with the highest need, thereby improving the efficiency of pandemic response. Furthermore, by reducing transmission and preventing the further spread of the virus, the project significantly contributes to improved public health outcomes and aids in safeguarding communities worldwide. Additionally, the project serves as a testament to the potential of artificial intelligence in healthcare, providing a model for future applications and research in the field. It also underscores the project's commitment to ethical AI development, respecting patient privacy and ensuring responsible usage in healthcare. Finally, in recognition of the ever-evolving nature of COVID-19 and healthcare needs, the project pledges to continuously improve its model and adapt to meet the challenges of the future. In conclusion, the "COVID-19 Detection Using Chest X-Rays" project is a beacon of hope and progress in these challenging times, with the potential to save lives, reduce healthcare system strain, and protect public health.

12. FUTURE SCOPE

- Develop a messaging system that can notify the patients regarding their result
- Integrate the web UI with database which can hold and manage the demographics of the patients
- Consider incorporating geospatial data analysis to identify COVID-19 hotspots, helping public health authorities in strategic resource allocation and containment strategies(Geospatial Data Analysis).
- Enhance the accessibility of the system by adding multilingual support, allowing users from diverse linguistic backgrounds to utilize the platform effectively.
- Continuously update and fine-tune the machine learning models with new data and evolving understanding of the disease, improving accuracy and adaptability.
- Implement advanced data visualization tools to help healthcare professionals better interpret X-ray images and diagnostic results, aiding in more accurate patient management.

13. APPENDIX

Source Code :https://github.com/smartinternz02/SI-GuidedProject-594590-1697299997/blob/main/4.Project%20Development%20Phase/4.Covid_Detection_Stacked_Model.ipynb

GitHub : https://github.com/smartinternz02/SI-GuidedProject-594590-1697299997/tree/main

Project Demo Link:

https://drive.google.com/file/d/1dd4TVk2iIKExyY8TixQTEfnrLF0FBnkl/view?usp=sharing