ಬಿ.ಎಂ.ಎಸ್. ತಾಂತ್ರಿಕ ಮತ್ತು ವ್ಯವಸ್ಥಾಪನಾ ಮಹಾವಿದ್ಯಾಲಯ
(ವಿ.ಟಿ.ಯು. ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)
BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT
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DETECTION OF COVID-19 AND PNEUMONIA USING MACHINE LEARNING

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Introduction

- The COVID-19 pandemic has presented significant challenges for global healthcare systems, necessitating timely and accurate detection of COVID-19 cases.
- This project develops an automated system using Convolutional Neural Networks (CNNs) to accurately detect COVID-19 and pneumonia from X-ray images.
- Training the CNN on a diverse dataset enables effective differentiation between healthy individuals, pneumonia cases, and COVID-19 patients.
- Visualization techniques like Grad-CAM highlight important regions in X-ray images, providing insights into the model's decision-making process and fostering trust in its predictions.
- The integration of deep learning and visualization techniques offers an interpretable solution, enhancing collaboration between clinicians and AI systems.
- The outcomes of this project have the potential to revolutionize healthcare by enabling early and accurate diagnoses, leading to timely interventions and improved patient outcomes.

Problem Statement

Develop a deep learning model to classify chest X-ray images as either covid-19, pneumonia or normal. Additionally, provide an interpretable visualization method to highlight the regions in the image that contribute most to the model's prediction, aiding in the understanding and analysis of the model's decision-making process.

Goals of the Project

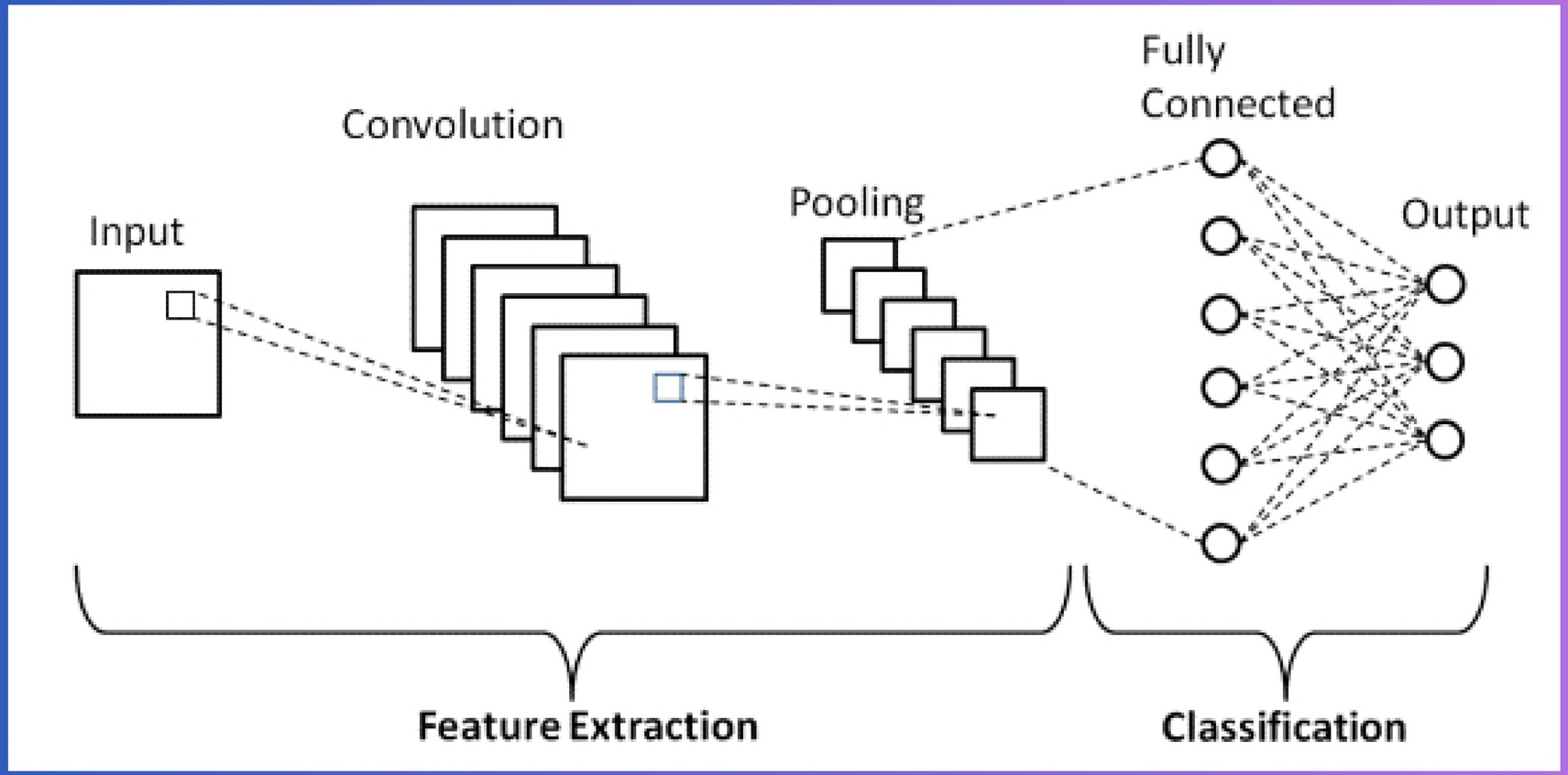
01 Develop a cohesive system integrating different techniques and algorithms for Medical Image Analysis.

02 Evaluate the system using a publicly available dataset of medical images and standard evaluation metrics.

03 Showcase the potential of Machine Learning in improving the accuracy and efficiency of medical diagnoses and treatments.

04 Highlight the importance of developing robust and efficient pipelines for Medical Image Analysis in the field of medical imaging research.

System Architecture



System Architecture

Deep-CNN Structure:

- A Deep-CNN is a type of Deep Neural Network (DNN) that consists of multiple hidden layers, including convolutional layers, ReLU layers, pooling layers, and fully connected (FC) normalized layers.

Convolution Layer:

- The convolution layer produces a feature map by convolving different sub-regions of the input image with a learned kernel. This operation helps extract meaningful features from the input data.

ReLU Layer:

- After the convolution layer, a non-linear activation function, typically ReLU (Rectified Linear Unit), is applied to improve the network's convergence properties when the error is low.

System Architecture

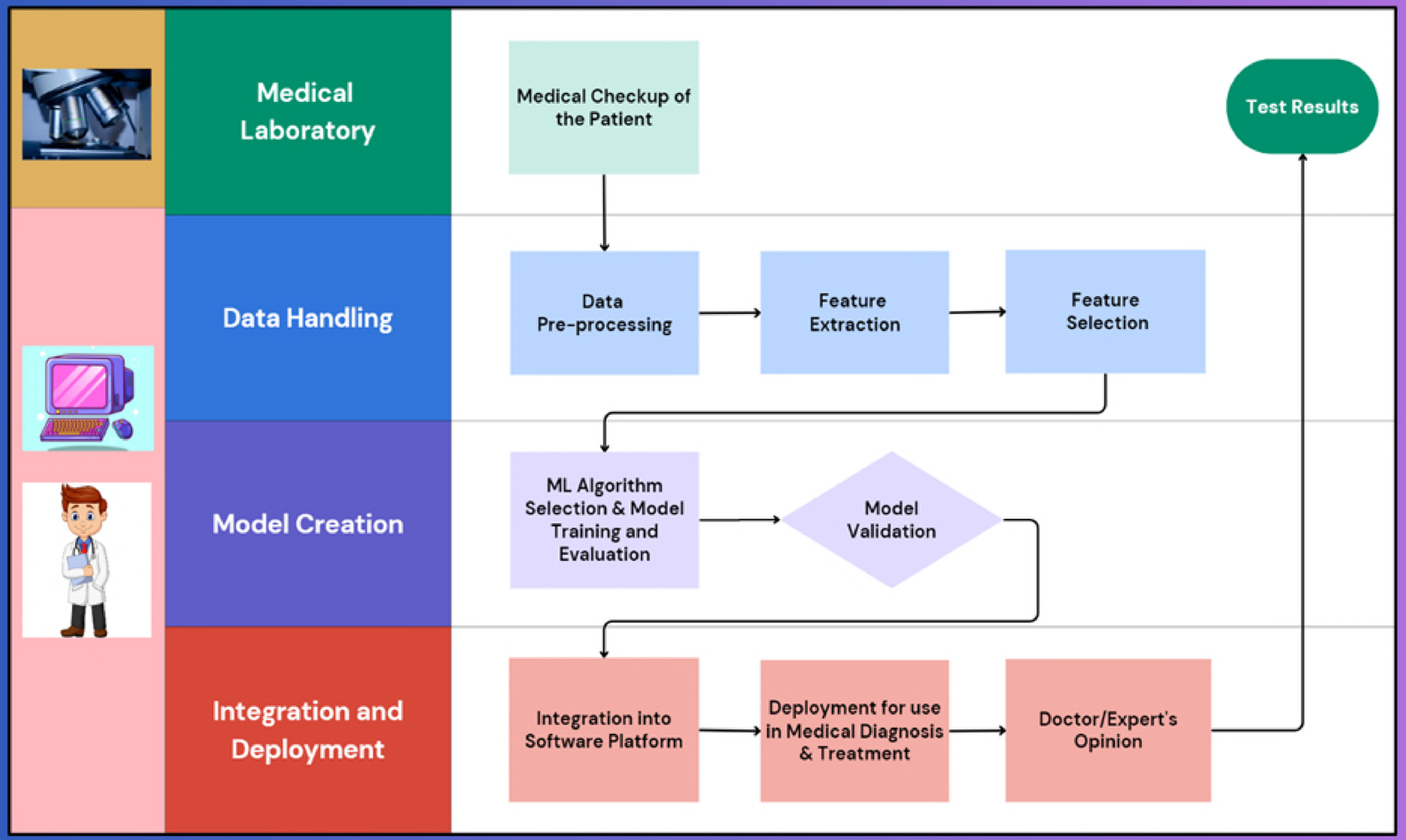
Pooling Layer:

- The pooling layer selects a region of the image or feature map and chooses the maximum or average pixel value within that region as the representative value. This operation leads to a reduction in the sample size and helps retain important information.

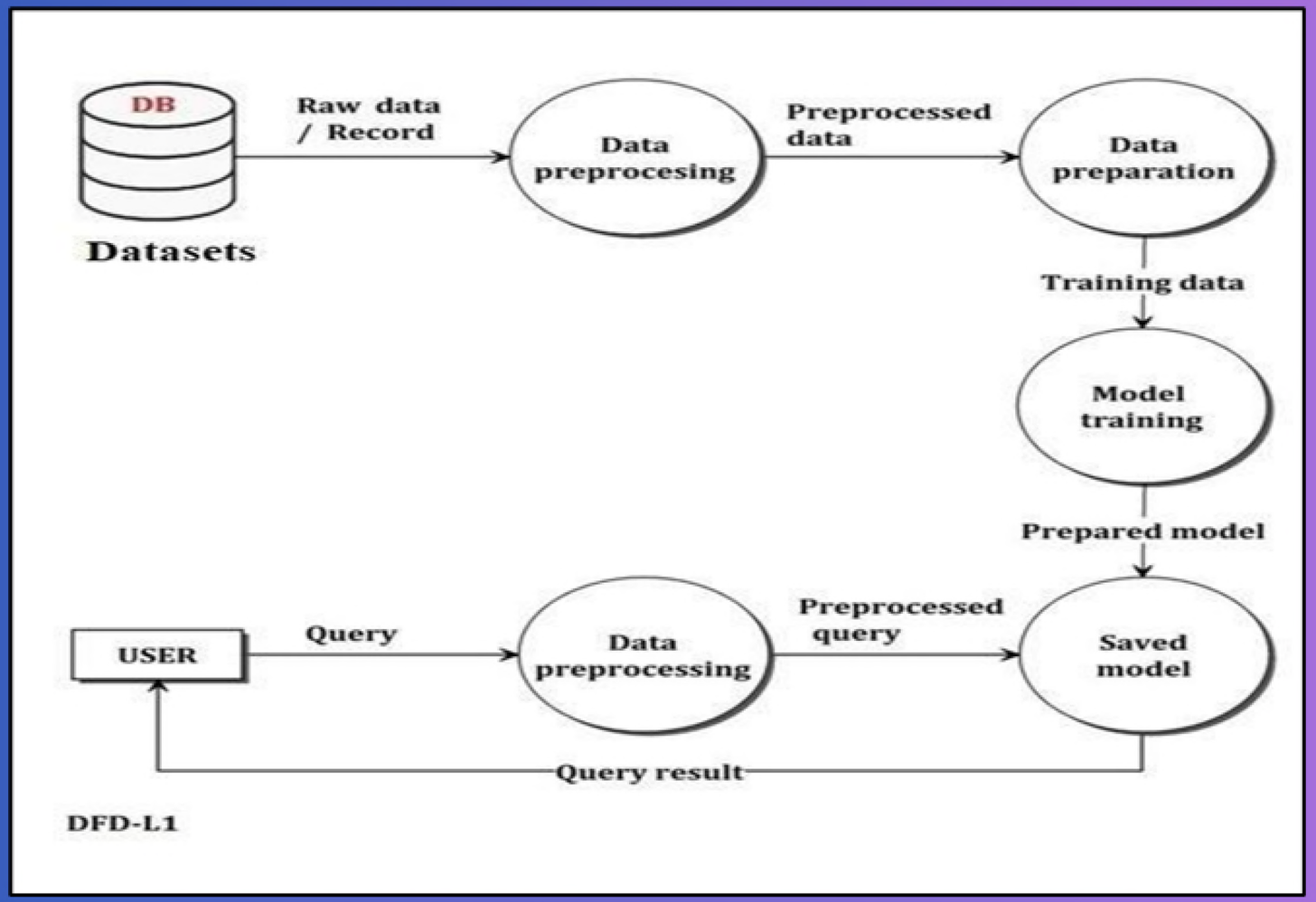
Fully Connected (FC) Layer:

- Traditional FC layers are sometimes used in conjunction with convolutional layers towards the output stage of the CNN architecture. FC layers connect every neuron from the previous layer to every neuron in the current layer.

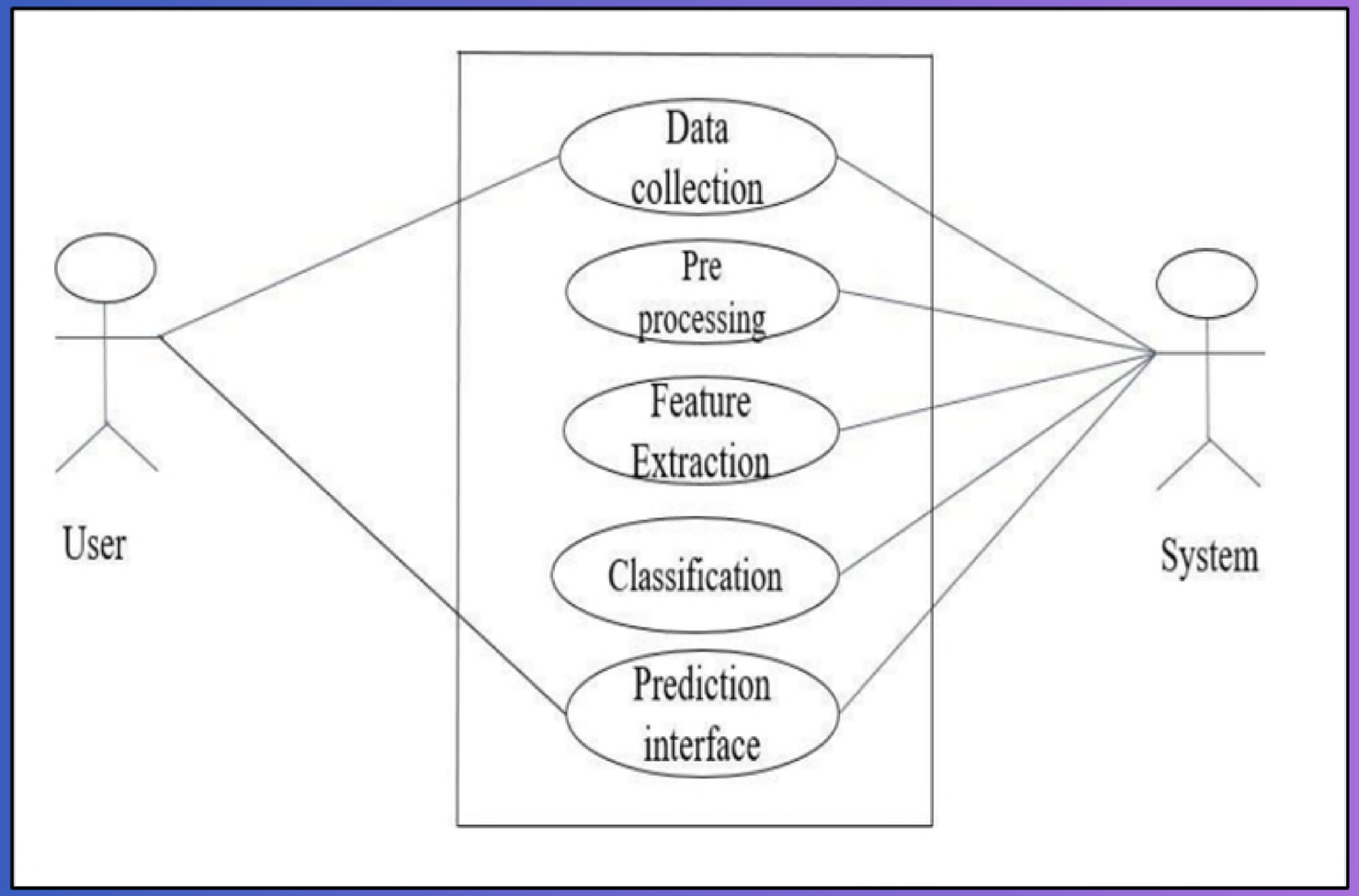
Block Diagram of the System



Data Flow Diagram



Use Case Diagram



System Requirements

OpenCV

OpenCV is a library of programming functions mainly for real-time computer vision. Originally developed by Intel, it was later supported by Willow Garage, then Itseez. The library is cross-platform and licensed as free and open-source software under Apache License 2.

TensorFlow

TensorFlow is a free and open-source software library for machine learning and artificial intelligence. It can be used across a range of tasks but has a particular focus on training and inference of deep neural networks

scikit-learn

scikit-learn is a free software machine learning library for the Python programming language. It features various classification, regression and clustering algorithms including support-vector machines

numpy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

matplotlib

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. It provides an object-oriented API for embedding plots into applications using general-purpose GUI toolkits like Tkinter, wxPython, Qt, or GTK.

Streamlit

Streamlit is an open-source Python library that allows you to create interactive and customizable web applications for data science and machine learning projects.

Implementation

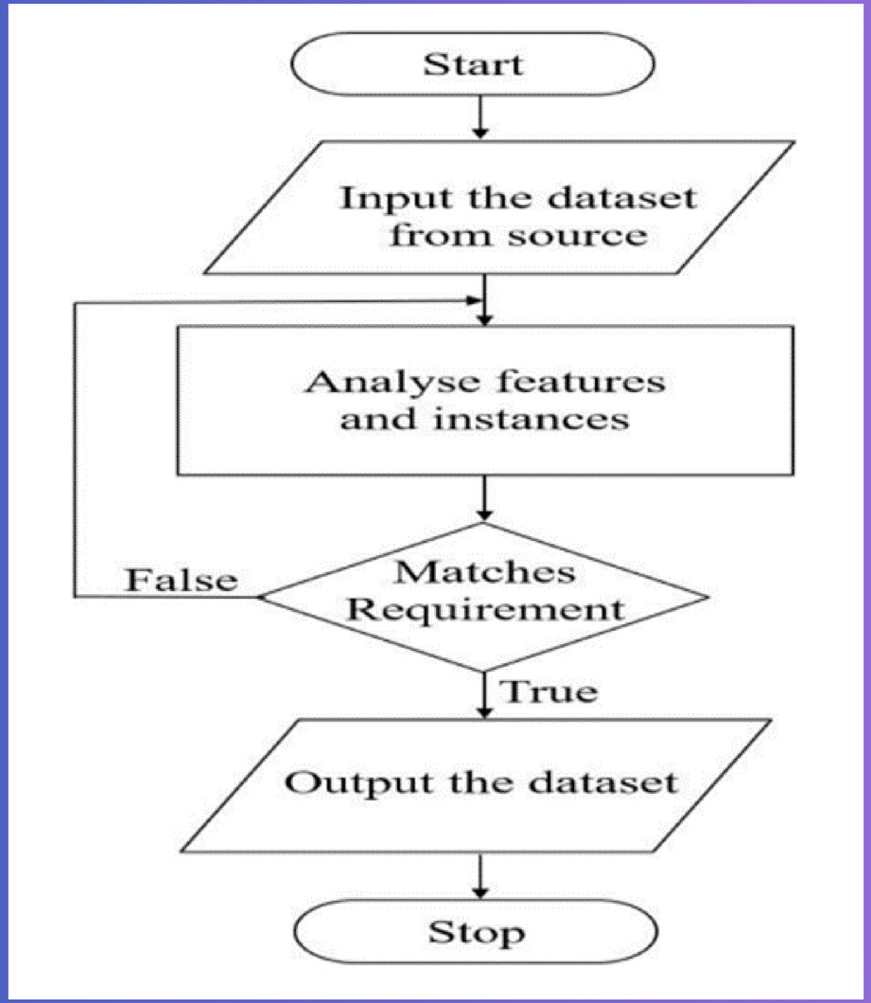
Three major steps invloved in the implementation of Project are

- Image Acquisition: Image acquisition refers to the process of obtaining or capturing digital images for analysis and processing by an algorithm or model.

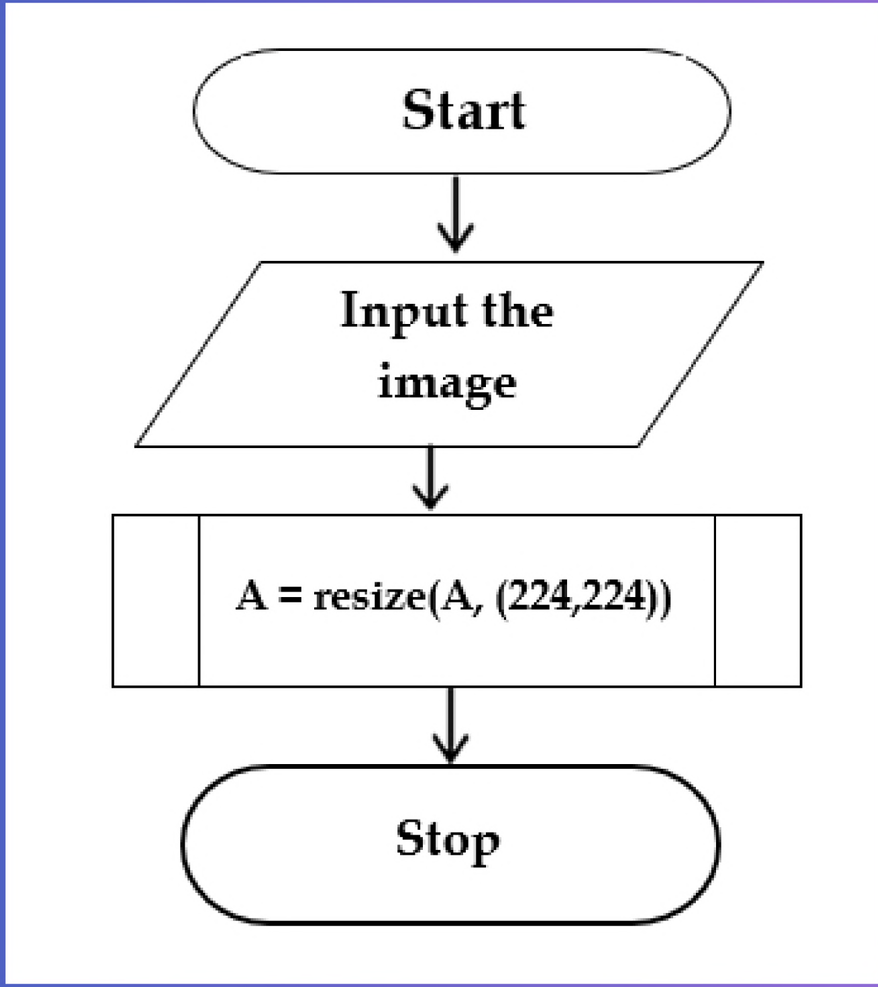
- Image Pre-Processing: Image pre-processing in machine learning refers to a set of techniques and operations applied to digital images before they are fed into a machine learning algorithm or model.

- Classification: Classification using Convolutional Neural Networks (CNNs) in machine learning refers to the application of CNN architectures for solving classification tasks.

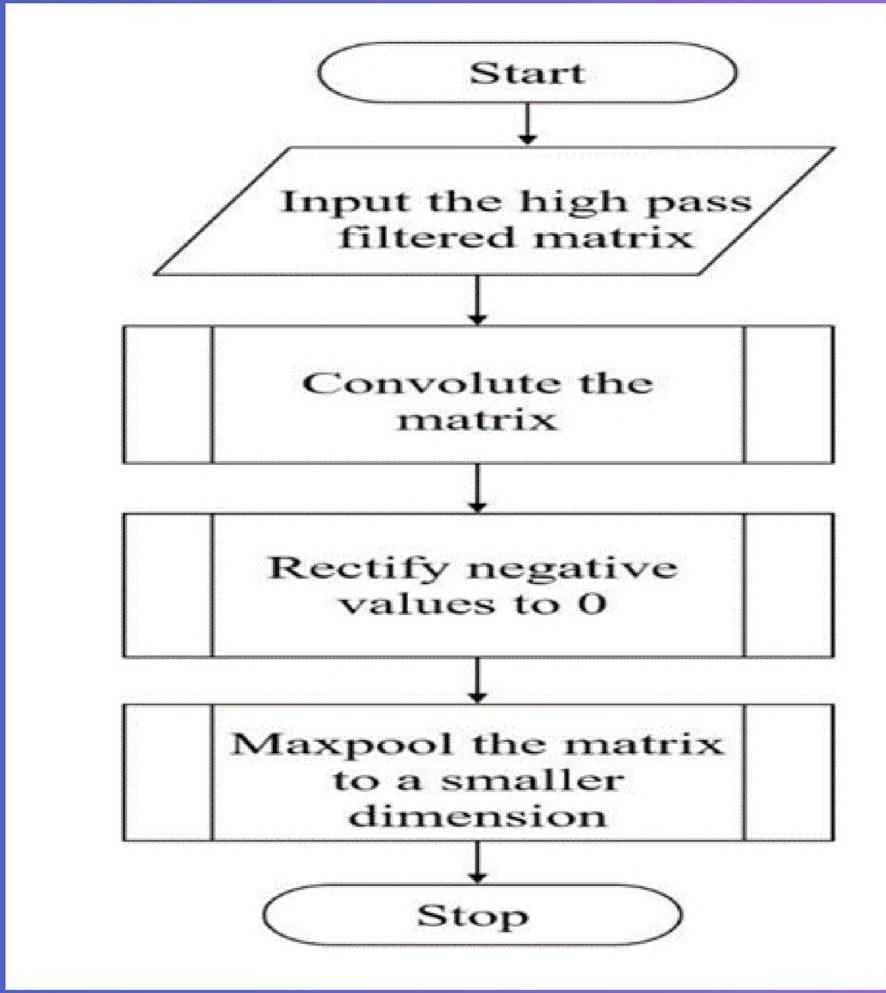
Flowchart of Image Acquisition



Flowchart of Image Pre-Processing



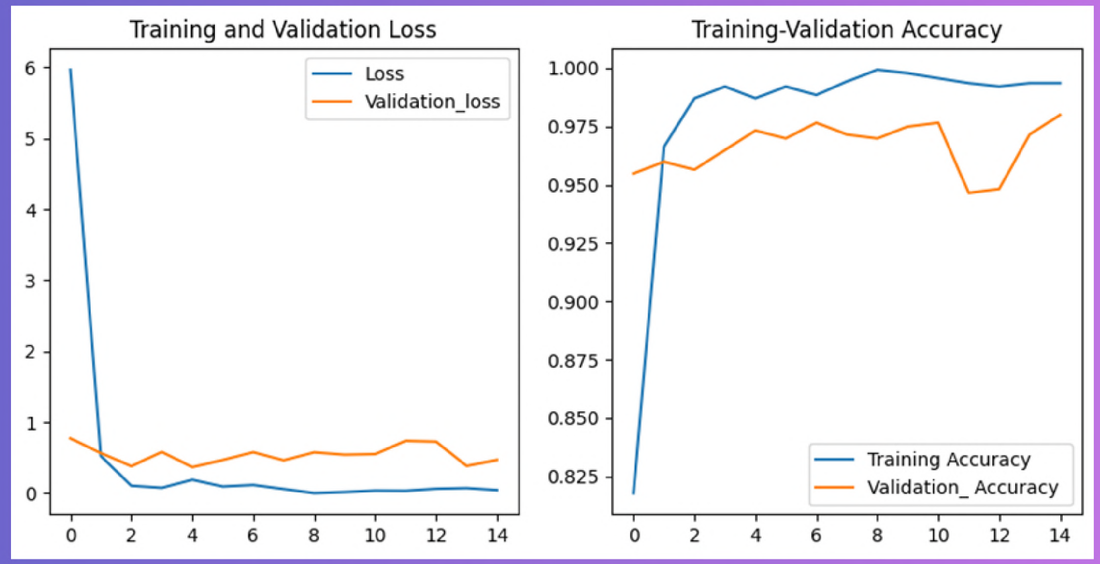
Flowchart of Classification



Results

1. Attained an accuracy of 98%

	covid	normal	virus
covid	113	0	0
normal	0	248	3
virus	2	6	127



2. The model has the precision of 98% for all three cases.

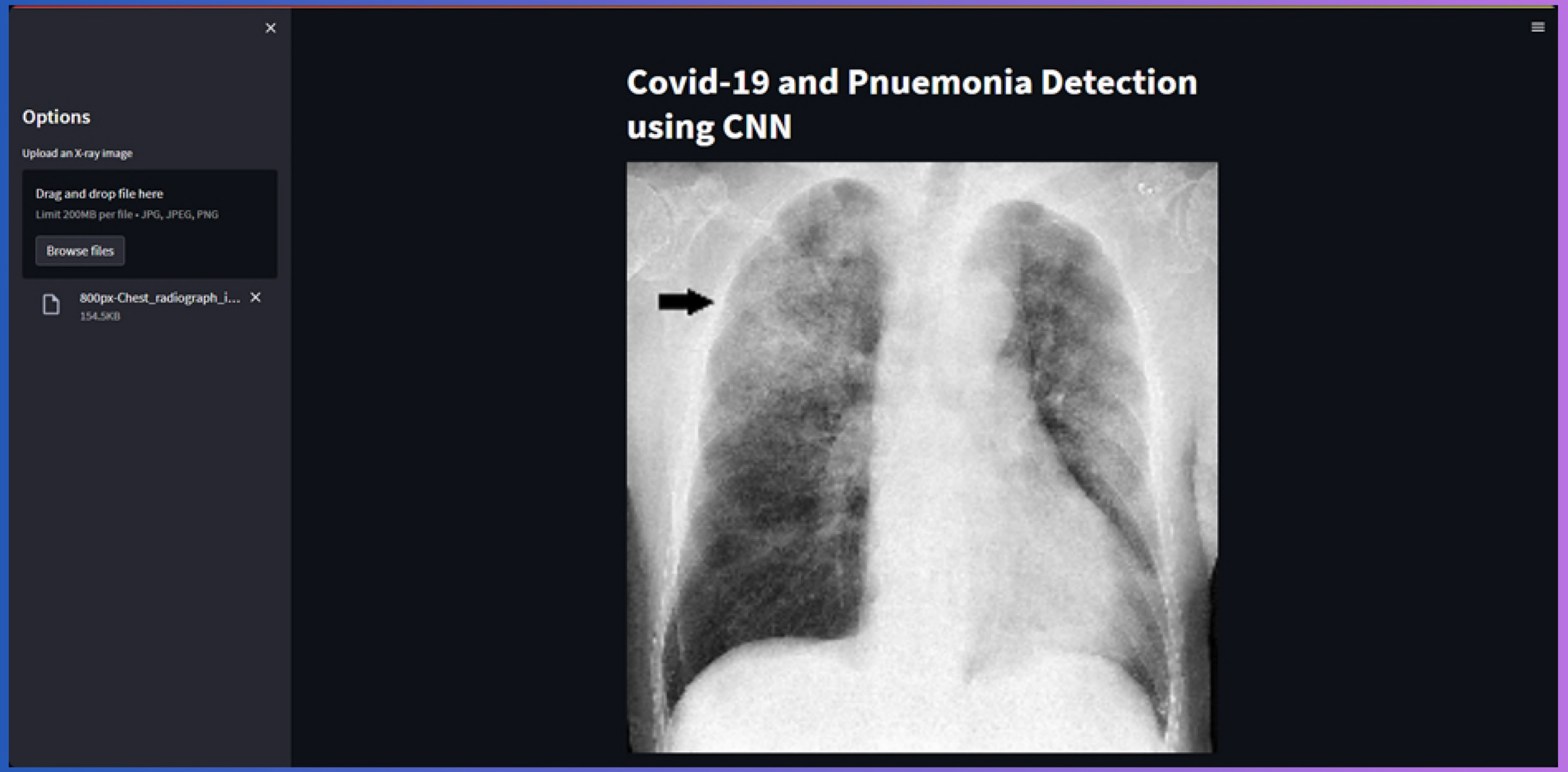
3. The model has recall of 100% for Covid cases, 99% for Normal cases, 94% for Virus cases (eg: Pneumonia).

Results

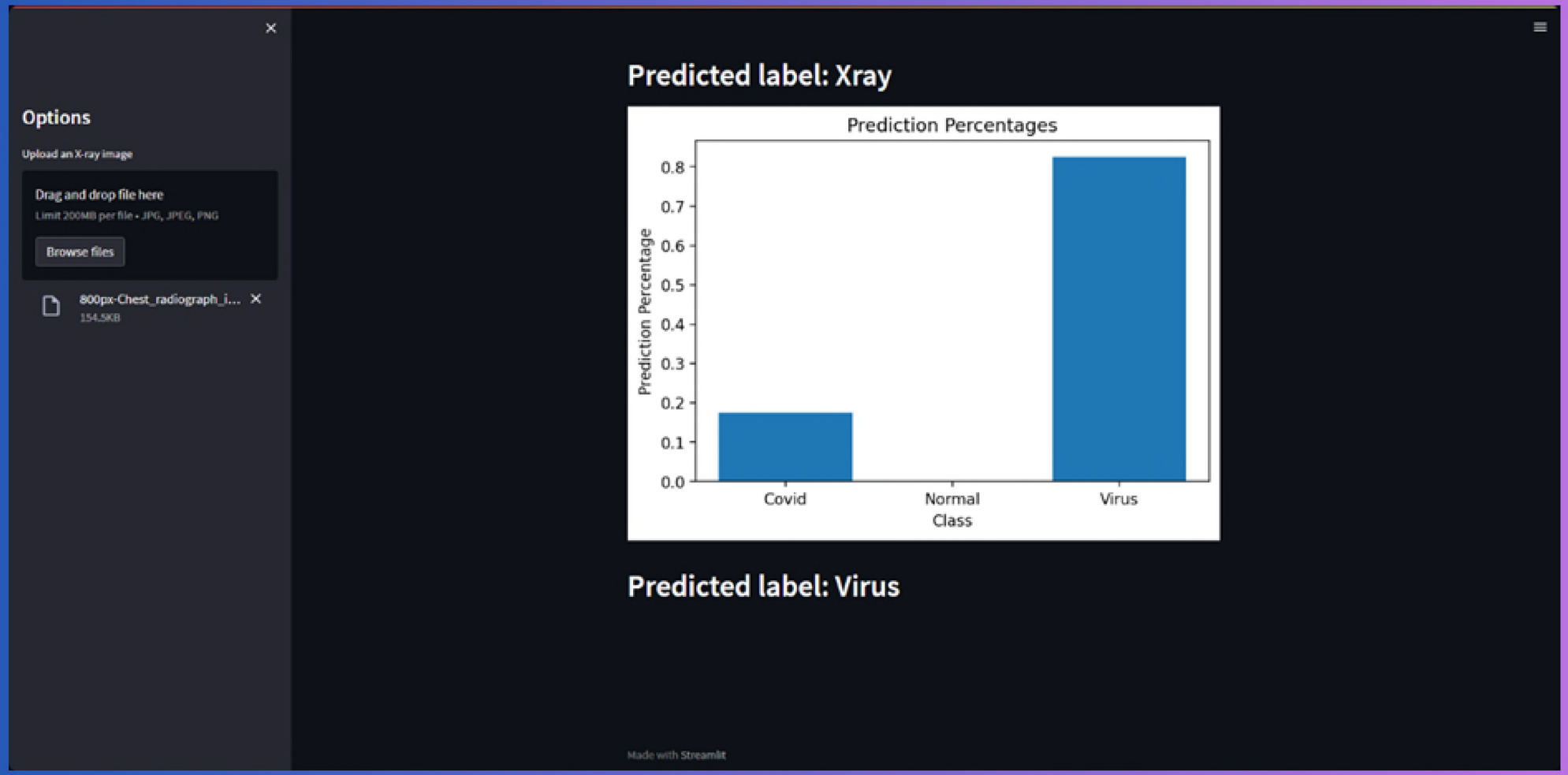
4. The model has F1-Score of 99% for Covid cases, 98% for Normal cases, 96% for Virus Cases (eg: Pneumonia).

	precision	recall	f1-score	support
0	0.98	1.00	0.99	113
1	0.98	0.99	0.98	251
2	0.98	0.94	0.96	135
accuracy			0.98	499
macro avg	0.98	0.98	0.98	499
weighted avg	0.98	0.98	0.98	499

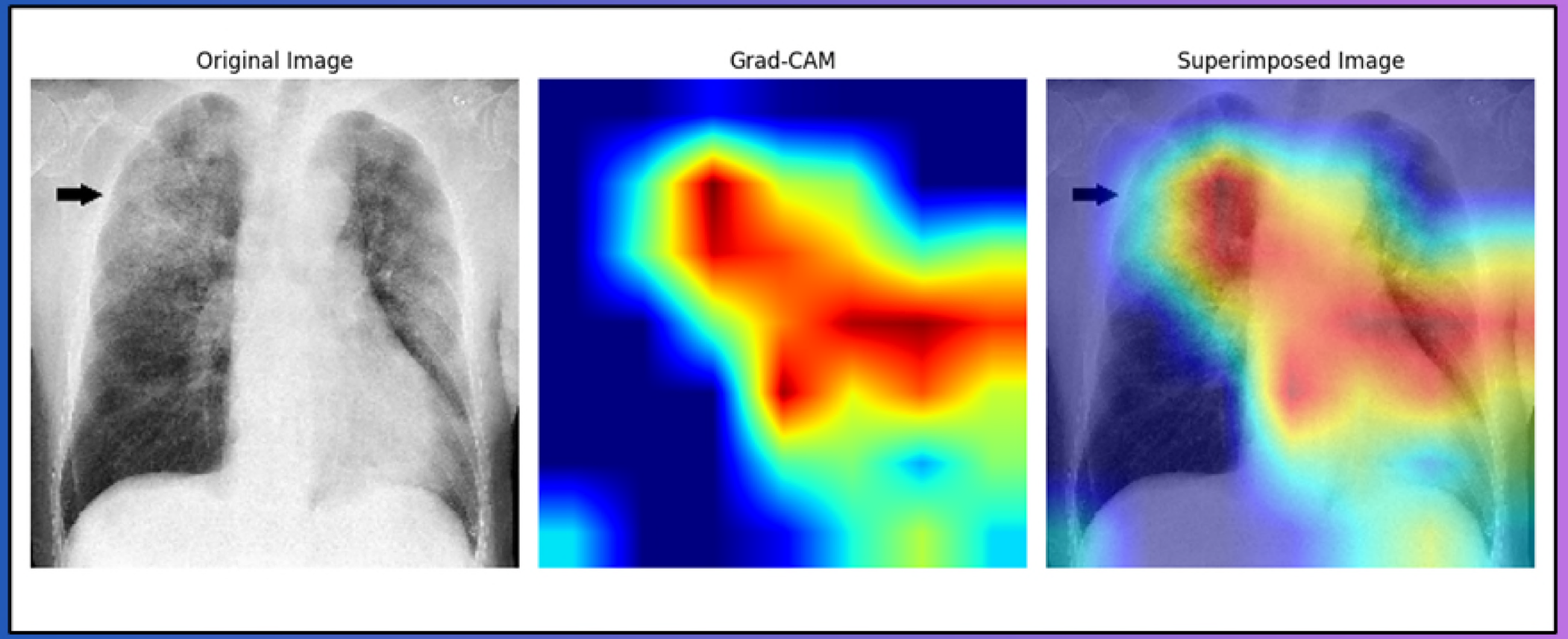
Web Deployment



Web Deployment



Features detected in an Xray



Applications

- Screening and Triage
- Diagnostic Support
- Resource Allocation
- Telemedicine and Remote Diagnosis
- Research and Development
- Public Health Surveillance

Advantages

- Efficiency
- Speed and Automation
- Scalability
- Consistency
- Potential for Early Detection
- Augmented Decision Support
- Generalization to New Cases

Limitations

- Dependance on Training Data
- Interpretability and Explainability
- Generalization to Different Populations
- False Positives/Negatives
- Ethical considerations
- Validation and Regulatory Challenges
- Dynamic Nature of the Virus

Conclusion

- Deep learning techniques, specifically convolutional neural networks (CNNs), effectively detect pneumonia and COVID-19 from chest X-ray images, providing insights into the decision-making process and regions of interest.
- Results indicate promising performance, accurately identifying cases and assisting healthcare professionals in diagnosis, potentially reducing radiologists' workload and improving patient outcomes.
- Future improvements include expanding the dataset, optimizing the model, integrating additional imaging modalities, and conducting extensive clinical validation.
- Real-time application development and deployment in healthcare settings offer immediate assistance for faster and more accurate diagnoses.
- Continued research in AI-driven pneumonia and COVID-19 detection can revolutionize respiratory condition diagnosis and management.

Future Scope

- Dataset expansion: Including larger and diverse datasets can improve the model's performance and generalization by encompassing a wider range of chest X-ray images from different sources and demographics.
- Model optimization: Continual efforts in fine-tuning the model, exploring different architectures, and optimizing hyperparameters can lead to improved performance and effectiveness in pneumonia and COVID-19 detection.
- Integration of multiple imaging modalities: Incorporating additional modalities like CT scans or ultrasound can enhance the diagnostic system's accuracy and provide a more comprehensive analysis of respiratory conditions.
- Real-time application development: Optimizing the model for deployment on edge devices or cloud-based systems enables rapid and on-the-spot diagnosis, facilitating faster decision-making and timely intervention.
- Clinical validation and deployment: Thorough validation studies in collaboration with healthcare professionals are necessary to ensure the system's accuracy, reliability, and usability before deploying it as an assistive tool in healthcare settings.

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THANK YOU