# DEEP LEARNING-BASED MULTICLASS CLASSIFICATION OF LUNG ABNORMALITIES USING X-RAY AND CT SCAN IMAGES

## SAIRAM SDG INNOVATHON 4.0

# SDGs and TARGETs

- **Primary Goal No : SDG 3 – Good Health and Well-Being**
  - SDG TARGET1: SAP030D
  - SDG TARGET2: SAP0309
  - SDG TARGET3: SAP0308
- **Secondary Goal No : SDG 9 – Industry, Innovation and Infrastructure**
  - SDG TARGET1: SAP0905
  - SDG TARGET2: SAP0904
  - SDG TARGET3: SAP0903
- **Tertiary Goal No : SDG 17 – Partnership for the Goals**
  - SDG TARGET1: SAP1701
  - SDG TARGET2: SAP1705
  - SDG TARGET3: SAP1708

# Problem Statement

Lung diseases remain a major global health concern, demanding early and accurate diagnosis. However, limited access to radiologists, especially in resource-constrained areas, impedes timely detection. They require an AI-powered deep learning model to automatically detect and classify lung abnormalities from X-rays and CT scans. Key challenges include poor image quality, class imbalance, high computational needs, domain generalization issues, annotation inconsistencies, and limited model explainability. Tackling these hurdles through robust training, curated datasets, and optimized model design can enhance diagnostic accuracy and accessibility, reducing healthcare disparities and enabling scalable solutions for widespread clinical adoption.

# Abstract

Lung conditions such as pneumonia, tuberculosis, COVID19, and cancer are significant global health problems that need timely and precise diagnosis. But early detection is hampered by poor access to expert radiologists and diagnostic imaging facilities in most areas. This project presents a deep learning framework for multiclass classification of lung abnormalities from X-ray and CT scan images. Transfer-learning-based convolutional neural network (CNN) architecture is trained on a large, diversified dataset collected from public repositories. Contrast enhancement, noise reduction, and normalization preprocessing methods enhance image quality. Class imbalance and overfitting are corrected by data augmentation. The model successfully categorizes several lung conditions normal, pneumonia, COVID-19, tuberculosis, and lung nodules accurately, precisely, and with good recall. To enable clinical applicability, the system is implemented via a web-based platform that enables medical professionals to upload images and receive instant diagnostic predictions along with confidence scores. This end-to-end solution increases diagnostic effectiveness and accuracy, lowers the opportunity for human error, and increases access to high-quality lung disease screening, particularly in resource-limited and remote environments. Our research shows how the combination of deep learning with deployable tools can assist clinicians in the provision of accelerated, more informed decisions and the enhancement of patient outcomes.

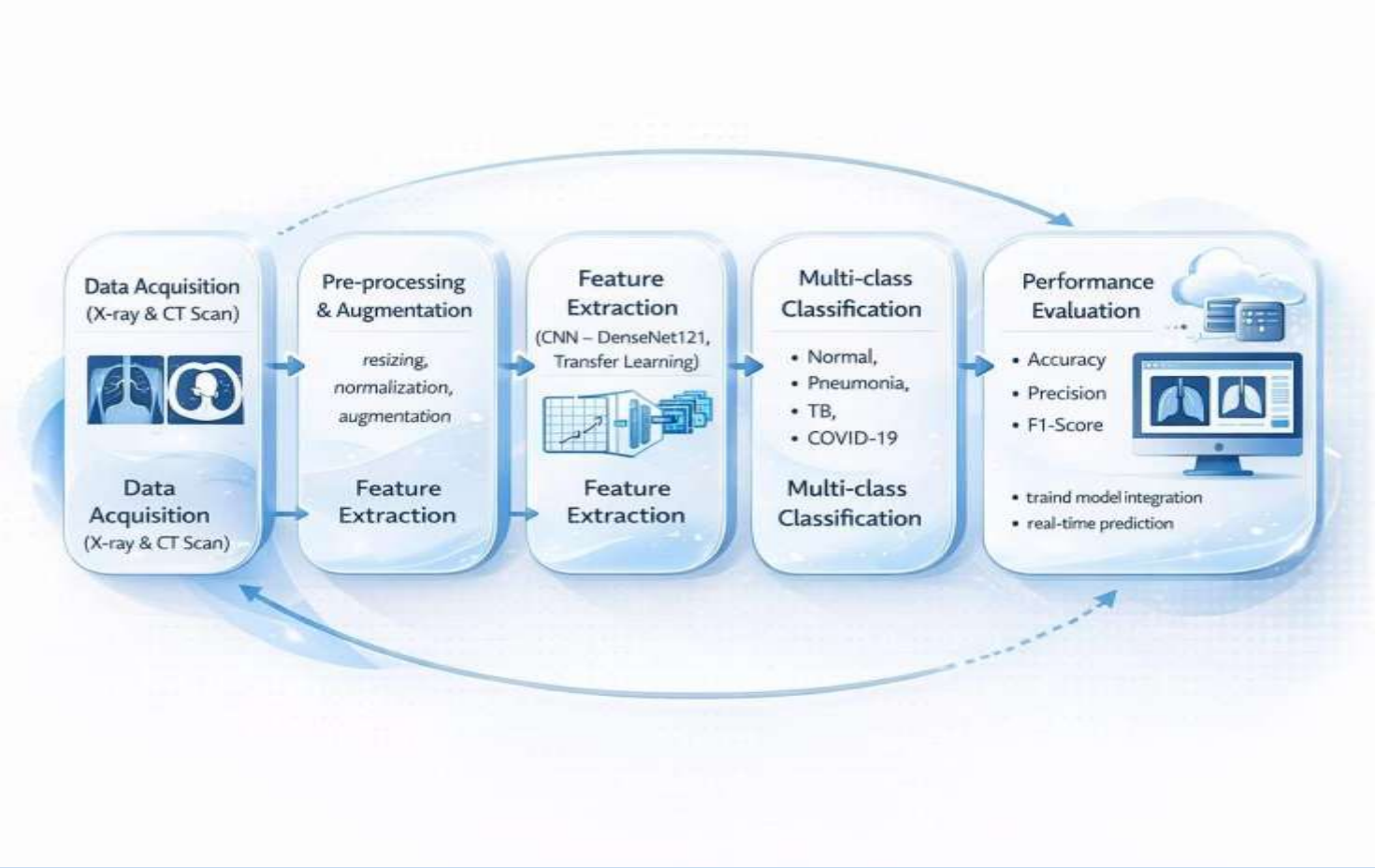
# Research and Literature Review

| S.NO | Name of the Article | Name of the journal | Findings | Drawbacks |
|---|---|---|---|---|
| 1. | Deep Hierarchical Multi-Label Classification Applied to Chest X-Ray Abnormality Taxonomies | Medical Image Analysis | 1. Achieved mean AUC 0.887 on PLCO;<br>2. Improved AUC & AP on Pad Chest ;<br>3. Handled incomplete labels effectively. | Built on previous work, method is straightforward, limited to CXR, does not explore annotation noise fully. |
| 2. | Multi-Class Classification of Lung Diseases Using CNN Models | Applied Sciences | 1. Accuracy 85.32% (NIH) & 96.1% ;<br>2. High sensitivity (92.2%) & specificity (97.4%);<br>3. Inference time 0.2s | Limited diseases, retrospective design, no new data |
| 3. | A Transfer Learning-Based Approach for Multi-class Classification of Pulmonary Diseases. | ICAICCIT | 1. Proposed TL approach using 4500 images;<br>2. Tested on COVID-19, Viral Pneumonia, Normal. | -- |
| 4. | A multiclass deep learning algorithm for healthy lung, Covid-19 and pneumonia disease detection. | Discover Artificial Intelligence | 1. Accuracy 97%;<br>2. Sensitivity 98.21%;<br>3. Specificity 96.62%;<br>4. F1-score 98% | Dataset diversity affects performance, risk of overfitting, public datasets only. |

# Research and Literature Review

| S.NO | Name of the article | Name of the Journal | Findings | Drawbacks |
|---|---|---|---|---|
| 5. | Pneumonia Classification Using Deep Learning During COVID-19. | Cognitive Computation | Accuracy: 91.43–99.62% → (2-class), 94%→ (3-class), 93.42% → (4-class) | Small COVID dataset, limited generalization, need for hybrid models, deeper CNNs. |
| 6. | Deep learning-based multi-class COVID-19 classification with x-ray images. | Image-Guided Procedures | High classification accuracy for COVID-19, pneumonia, and normal; showed generalizability to cancer dataset | High false positives, similarity in COVID vs pneumonia, dataset imbalance. |
| 7. | Four Types of Multiclass Frameworks for Pneumonia Classification. | Diagnostics | Accuracies: DenseNet201 → (99.84%), VGG16 → (96.7%), NasnetMobile → (92.67%); outperformed existing methods by 1.2%. | Cannot detect severity, no k-fold CV, need denoising |

# Product Architecture and Design/ Block Diagram



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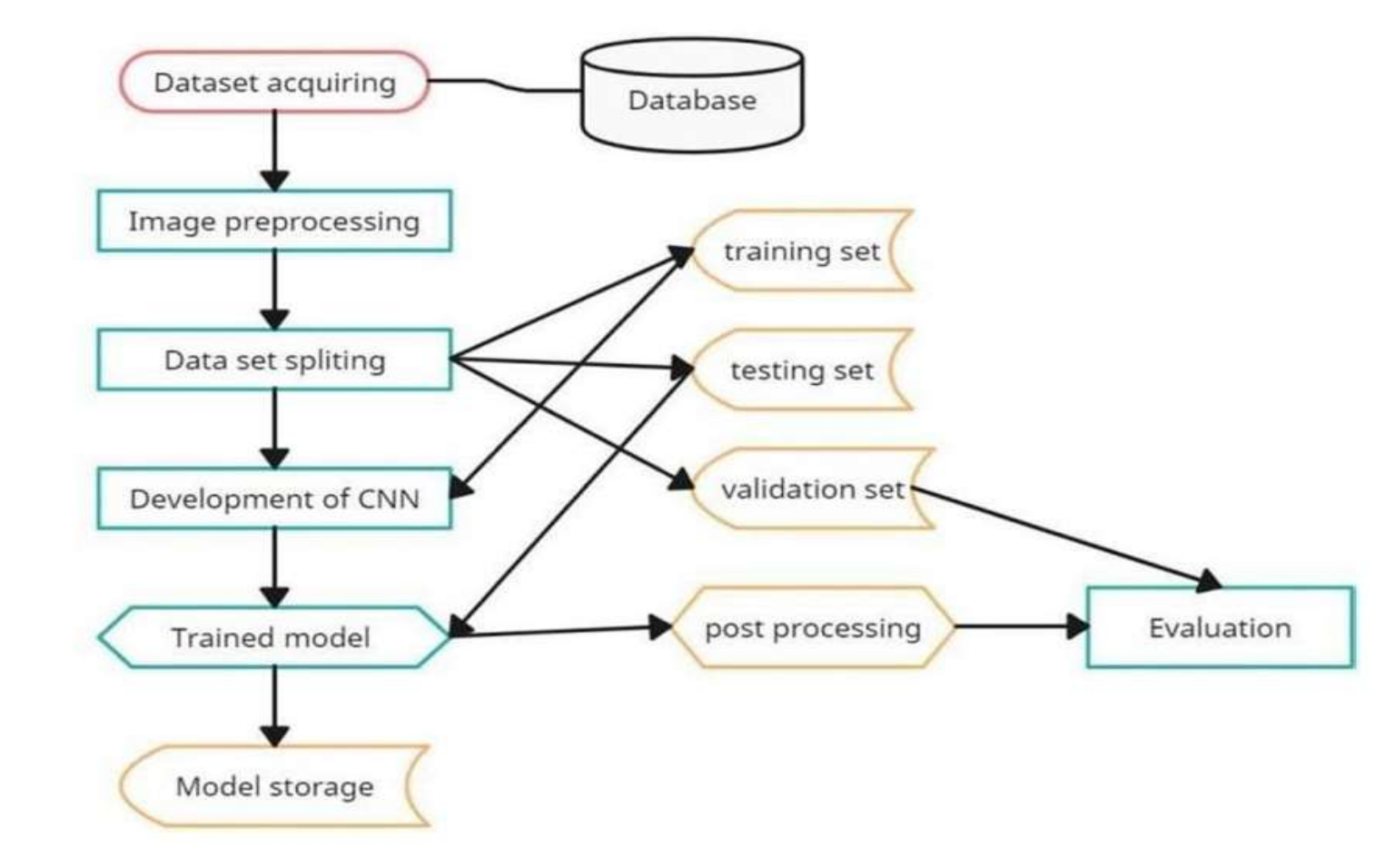

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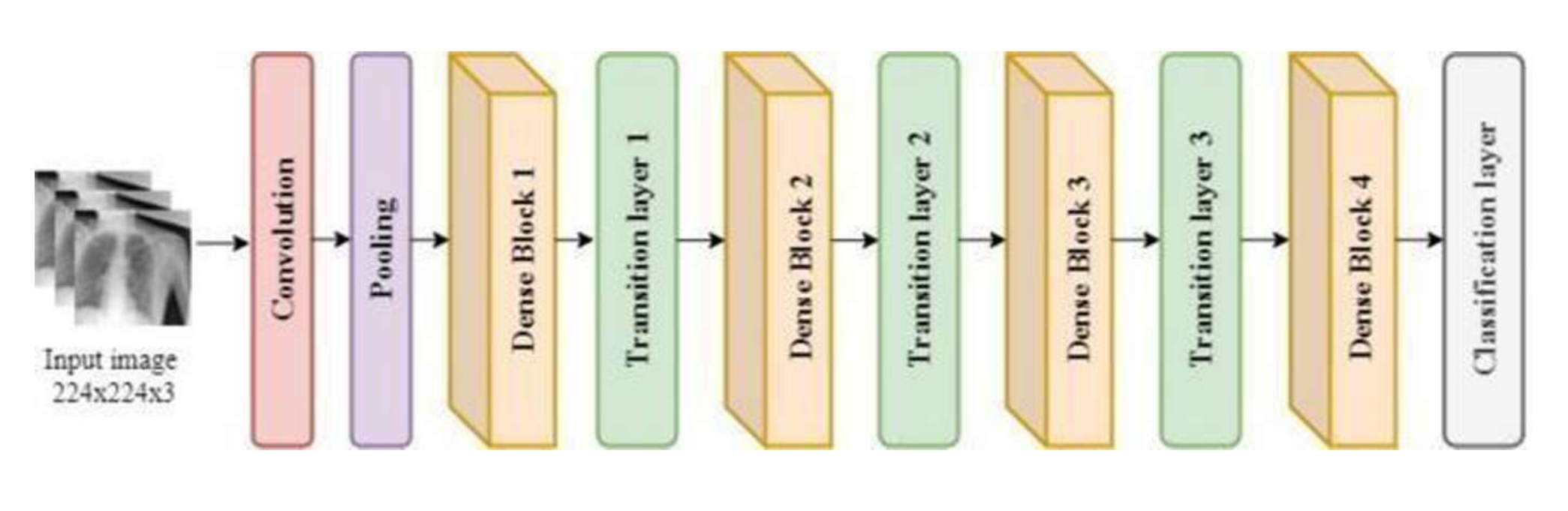


# Module Description/ Component Specifications

- **Image Acquisition**

  **Input**: Chest X-ray and CT scan images.

  **Specification**: Images collected from publicly available medical datasets.

- **Image Preprocessing & Enhancement**

  **Tool**: **OpenCV CLAHE (Contrast Limited Adaptive Histogram Equalization)**.

  **Purpose**: Improves contrast and visibility of lung structures, reduces noise, and enhances fine details for better feature extraction.

- **Data Augmentation**

  **Techniques**: Rotation, scaling, flipping, zooming, and brightness adjustment.

  **Purpose**: Handles class imbalance, prevents overfitting, and improves generalization.

- **Feature Extraction & Classification**

  **Models Used**:

  **MobileNetV2** – Lightweight CNN for fast, efficient classification.

  **DenseNet121** – Deep CNN with dense connections for better feature reuse.

  **ResNet50** – Residual connections to overcome vanishing gradient and improve accuracy.

  **Output**: Multiclass classification into **Normal, Pneumonia, Lung Cancer, and COVID-19**.

- **Evaluation Metrics**

  **Accuracy, Precision, Recall, F1-Score, Sensitivity, Specificity, Confusion Matrix**.

  **Purpose**: Ensures robust validation of the model performance.

# Justification for POSITIVE

**Productable**: The system can be developed into a practical AI tool for hospitals and diagnostic centers.

**Technology**: Uses deep learning with CNNs and transfer learning on X-ray and CT scans.

**Opportunities**: Addresses the global need for faster, accurate lung disease detection.

**Innovative**: Integrates dual-modality imaging with multiclass classification in one framework.

**Sustainable**: Designed for low-resource settings with scalable deployment.

**Viable**: Technically and economically feasible using existing datasets and computing resources.

**Ethical**: Ensures patient privacy, supports clinicians, and reduces human diagnostic errors.

**Informative**: Provides clear, reliable results that assist in early detection and treatment planning.

# Experimental Results

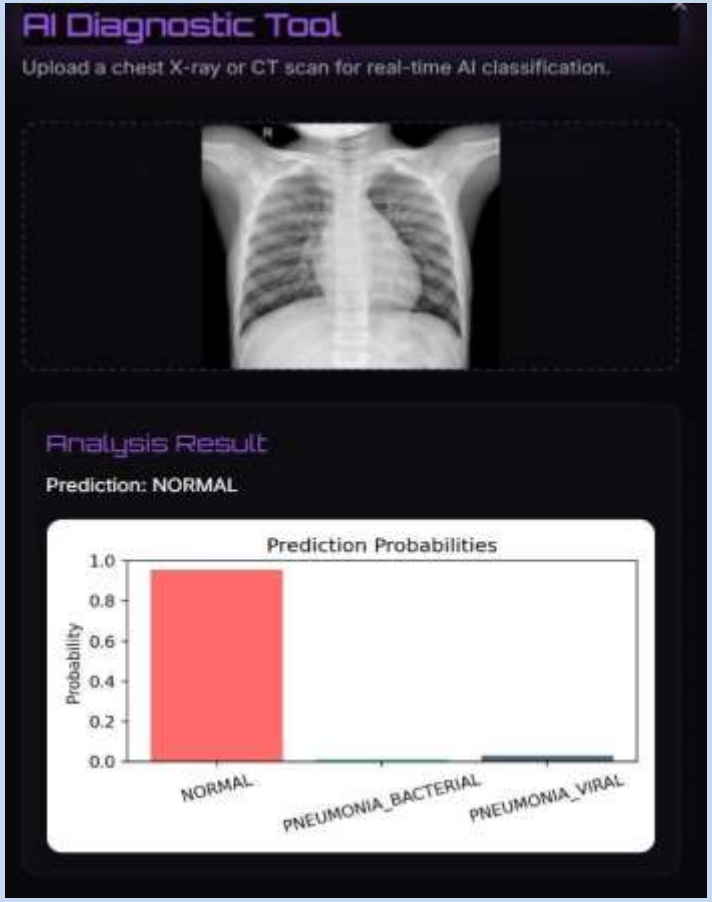
**DATASETS:**

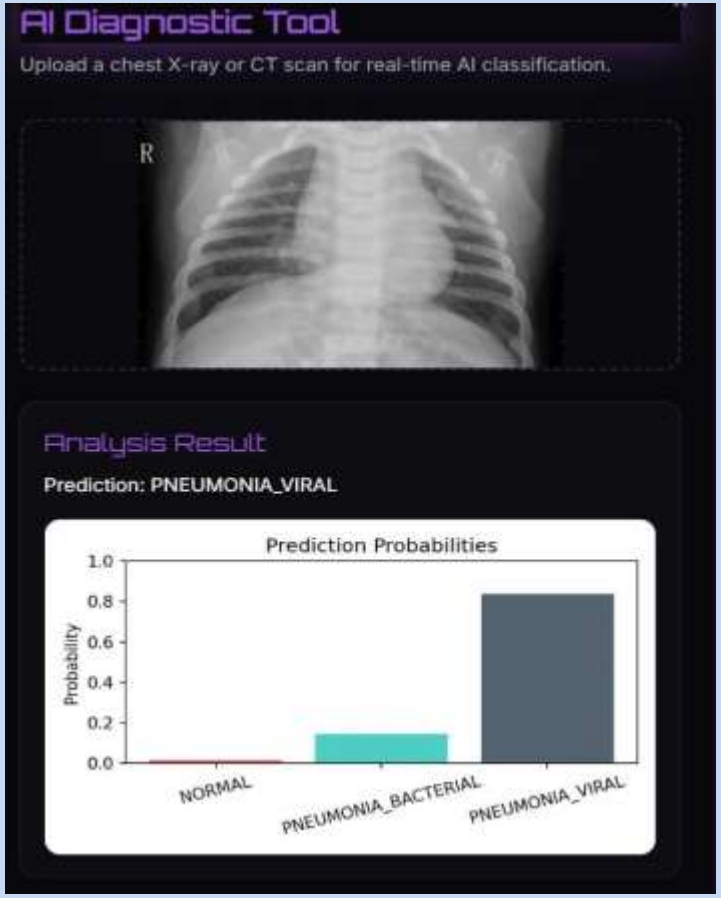
https://www.kaggle.com/datasets/paultimothymooney/chest-xray-pneumonia

https://www.kaggle.com/datasets/tawsifurrahman/tuberculosis-tb-chest-xray-dataset

https://github.com/ieee8023/covid-chestxray-dataset

# Experimental Results



# Project Showcase and Future Steps

# Interaction with External Entities

# Project Budget

| Budget | Amount |
|---|---|
| a) Materials (GPU enabled system, licensed software) | Rs.20,000/- |
| b) Consumables (Printings, Documentation) | Rs.3000/- |
| c) Miscellaneous (Conference/Journal submission charges, Travel charges) | Rs.7000/- |
| Total | Rs.30,000/- |

# Conclusion

This project demonstrates the use of MobileNetV2 and DenseNet121 as different approaches to perform multiclass classification of lung abnormalities from X-ray and CT images. MobileNetV2 provided an efficient and lightweight model for deployment, while DenseNet121 provided a deeper and clearer picture of the learning process through more features extracted from the images. After data set image enhancement and implementing the transfer learning approach, the models performed well to classify, "Normal," "Pneumonia," and "Tuberculosis" images, indicating that the models have valid applications as AI-assisted diagnostics methods. In the future, the focus will be on larger datasets that represent other lung diseases as well, and this will also entail clinical validation to ensure capacity and real-world application.

# Reference


1. Kalkeseetharaman P K and Thomas George S (2023) **“A Bird’s Eye View Approach on the Usage of Deep Learning Methods in Lung Cancer Detection and Future Directions Using X-Ray and CT Images”** , Springer.

2. Naveen A, Nandana R, Tarunika K, Ramesh Munirathinam (2024) **“Effective Categorization of Lung Abnormalities using Squeezent Features ana Machine Learning Models”** , IEEE Xplore.

3. Rudresh Pillai, Neha Sharma, Rahul Chauhan, Garima Verma, Rupesh Gupta (2023) **“Detection & Diagnosis of COVID-19 from CXR Images Through VGG19 Transfer Learning Model”** , IEEE Xplore.

4. Ali Abdulquader Bin-Salem , Mowafa Househ , Arfan Ahmed (2021) “**Computer Methods and Programs in Biomedicine Update” .**

# Research Professional Practice

- Publications - Yes/ No
- Patent details - Yes/ No
- IEEE Xtreme Participation - Yes/ No
- Proposal submission to Community services - (EPICS, SIGHT, UBA)Yes/ No

# Publication Proof

# Patent Proof

# IEEE Xtreme Participation Proof

# Proposal submitted -Proof

# Competition/ Funding

- Hackathon Participation- (SIH, NIRAL) -Yes/no
- Project based Competition- Winner/Participation/ not participated
- Academic level International level participation- Yes/No
- Proposal submission - Submitted/ grant received

# Competition/ Funding

- Second round of Project Expo-Yes/no
- Real time validation of Project idea
- Same project from

-Ideathon to Solveathon

-Solveathon to Innovathon

- Winner in -Ideathon/Solveathon

# Proof for Slide 18 & 19 (attach extra slides if necessary)

# Startup & Entrepreneurship

- Startup Registered- Yes/no
- Incubation Support- Yes/No
- IDEX proposal Submitted- Yes/No
- Yukthi Portal Registered - Yes/No

# Proof for Slide 21 (attach extra slides if necessary)

# Any Other Reward

# Thank You