MAJOR PROJECT

AI-Driven Chest X-ray Analysis for Automated Disease Detection

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TABLE OF CONTENT

PROBLEM OVERVIEW

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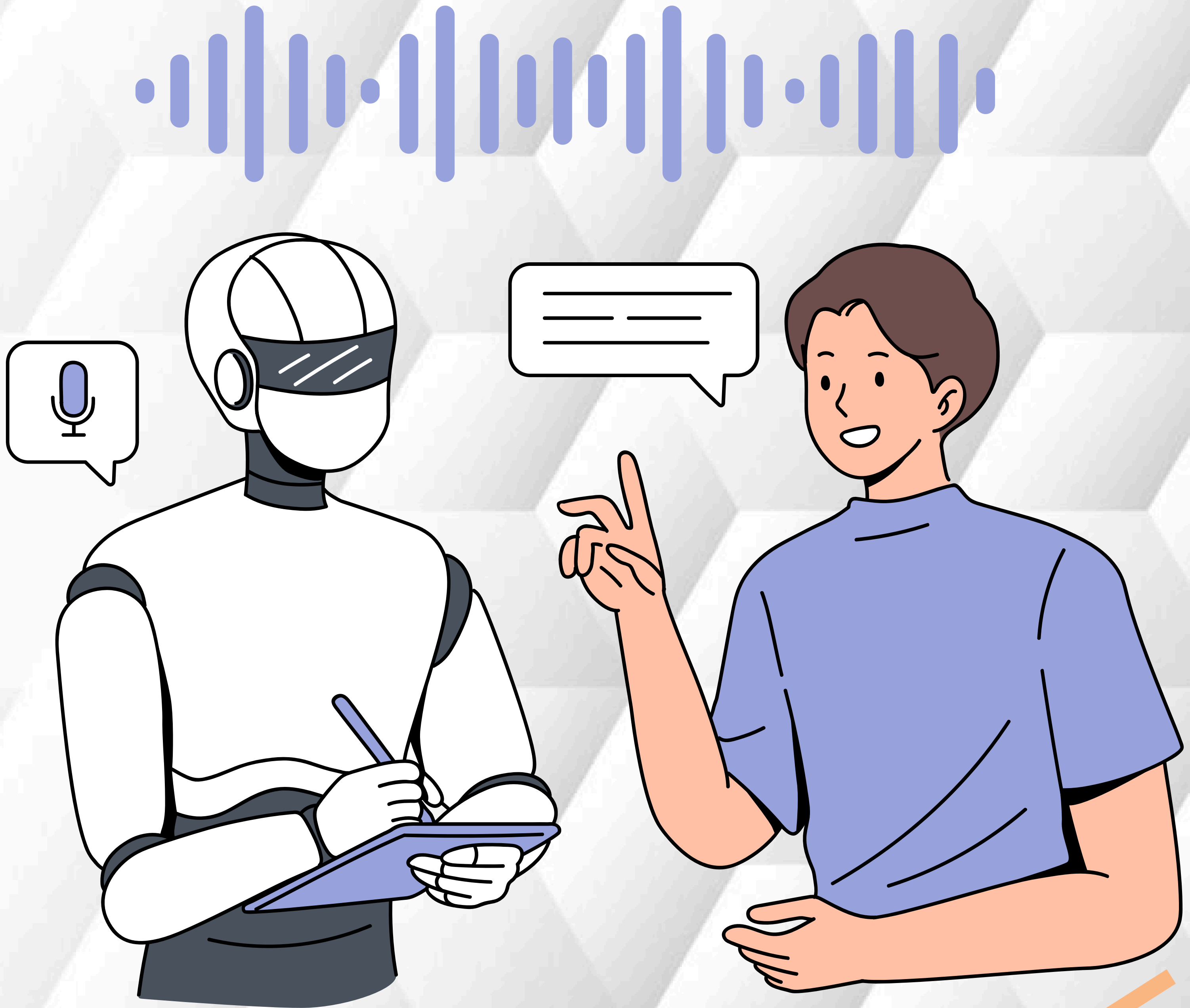
EXPLORE INNOVATE EXCEL

- Diagnosing lung conditions such as atelectasis, consolidation, and pneumothorax through X-ray imaging is challenging due to the complexities involved in interpretation and the high patient loads faced by healthcare facilities.

- This project aims to automate the detection of these conditions and generate preliminary reports, facilitating quicker and more accurate diagnoses for healthcare professionals.

SCOPE OF THE PROJECT

- **Disease Classification:** Deep learning model identifies lung diseases from X-rays.
- **Report Generation:** RAG model provides diagnosis and treatment suggestions.
- **User Interface:** Simple platform for uploading X-rays and receiving results.



TECH STACK

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LLM

An LLM processes and generates human-like text based on input data.

Tensorflow

Used for building and training deep learning models for image processing

Flask

Flask is a lightweight web framework for Python for building backend-web applications.

ChromaDB

ChromaDB is a vector database for querying high-dimensional embeddings.

React.Js

React is a JS library for building user interfaces with a component-based architecture.

Dataset

Field	Description
Image Index	File name
Finding Labels	Disease type (class label)
#Follow-up	Follow-up number
Patient ID	Unique patient identifier
Patient Age	Age of the patient
Patient Gender	Gender of the patient
View Position	X-ray orientation
OriginalImageWidth	
OriginalImageHeight	Image height (pixels)
OriginalImagePixelSpacing_x	Pixel spacing (X-axis)
OriginalImagePixelSpacing_y	Pixel spacing (Y-axis)

	Image Index	Finding Labels	Follow-up #	Patient ID	Patient Age	Patient Gender	View Position	OriginalImage[Width	Height]	OriginalImagePixelSpacing[x	y]	Unnamed: 11
0	00000001_000.png	Cardiomegaly	0	1	58	M	PA	2682	2749	0.143	0.143	NaN
1	00000001_001.png	Cardiomegaly|Emphysema	1	1	58	M	PA	2894	2729	0.143	0.143	NaN
2	00000001_002.png	Cardiomegaly|Effusion	2	1	58	M	PA	2500	2048	0.168	0.168	NaN
3	00000002_000.png	No Finding	0	2	81	M	PA	2500	2048	0.171	0.171	NaN
4	00000003_000.png	Hernia	0	3	81	F	PA	2582	2991	0.143	0.143	NaN

- The dataset contains X-ray images with metadata such as patient details (ID, age, gender) and image properties (dimensions, pixel spacing).
- Labels include lung disease types, follow-up information, and X-ray orientation, supporting classification tasks.

Preprocessed Dataset

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- **Column Consolidation:** Original image width and height are merged into a single column for better handling of image properties.
- **Data Cleaning:** Missing or irrelevant entries (e.g., NaN values) are handled, and consistent labels for diseases are applied across the dataset.
- **Pixel Spacing Adjustments:** Original image pixel spacing for X and Y axes is retained for accurate scaling during analysis.
- **Path Field Inclusion:** File paths for each X-ray image are included to link the data to the corresponding images for easy access during training.

	Image Index	Finding Labels	Follow-up #	Patient ID	Patient Age	Patient Gender	View Position	OriginalImage[Width	Height]
601	00020826_009.png	Consolidation	9	20826	22	M	AP	3056	2544
211	00000583_001.png		1	583	38	F	PA	2500	2048
343	00005566_004.png	Atelectasis|Infiltration	4	5566	85	M	PA	2500	2048

OriginalImagePixelSpacing[x	y]	Unnamed: 11	path	Atelectasis	Cardiomegaly	Consolidation
0.139	0.139	NaN	../input/images_009/images/00020826_009.png	0.0	0.0	1.0
0.168	0.168	NaN	../input/images_001/images/00000583_001.png	0.0	0.0	0.0
0.171	0.171	NaN	../input/images_003/images/00005566_004.png	1.0	0.0	0.0

Edema	Effusion	Emphysema	Fibrosis	Hernia	Infiltration	Mass	Nodule	Pleural_Thickening	Pneumonia	Pneumothorax
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0

Handling Class Imbalance

- **Definition:** Data augmentation is a technique to increase the diversity of a training dataset by applying various transformations to existing images.
- **Purpose:** It helps improve model generalization and reduces overfitting by exposing the model to a wider range of data variations.
- **Common Techniques:** Includes transformations like flipping, rotation, shifting, zooming, and normalization.
- **Keras Implementation:** Use ImageDataGenerator for real-time augmentation during training, allowing parameters like horizontal flip, rotation range, and zoom range to be easily set.

```python
from keras.preprocessing.image import ImageDataGenerator
IMG_SIZE = (128, 128)
core_idg = ImageDataGenerator(samplewise_center=True,
                              samplewise_std_normalization=True,
                              horizontal_flip = True,
                              vertical_flip = False,
                              height_shift_range= 0.05,
                              width_shift_range=0.1,
                              rotation_range=5,
                              shear_range = 0.1,
                              fill_mode = 'reflect',
                              zoom_range=0.15)
```

Models and Results

Model	Number of Parameters	Accuracy Score	Average ROC-AUC Score
mobilenet	3.3 Million	0.88	0.68
densenet	8 Million	0.85	0.72
Resnet-50	25 Million	0.9	0.74
VGG-16	138 Million	0.91	0.76
VGG-19	144 Million	0.92	0.75
efficientnet	66 Million	0.9	0.73
inception	24 Million	0.89	0.72

FINDINGS OF LITERATURE REVIEW

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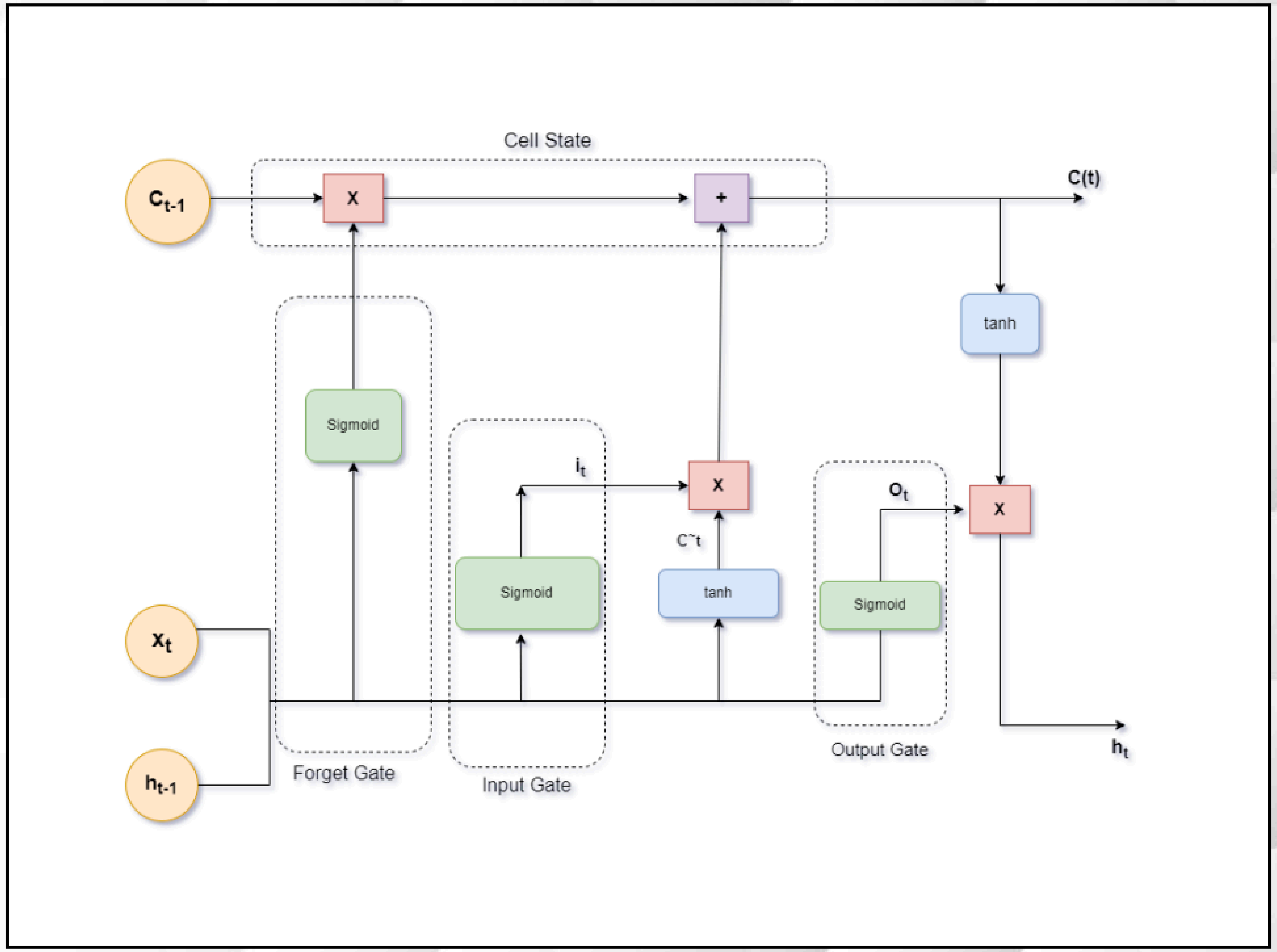
1. Long Short Term Memory

- **Purpose:** Captures relationships between different medical conditions in chest X-rays.
- **Feature Extraction:** Images are processed by a DenseNet encoder to extract relevant features.
- **Prediction:** An LSTM decoder predicts the presence or absence of multiple diseases sequentially, one label at a time, based on previous label predictions.
- **Dependency Modeling:** Helps model dependencies between conditions (e.g., if one disease is present, another might be likely).



FINDINGS OF LITERATURE REVIEW

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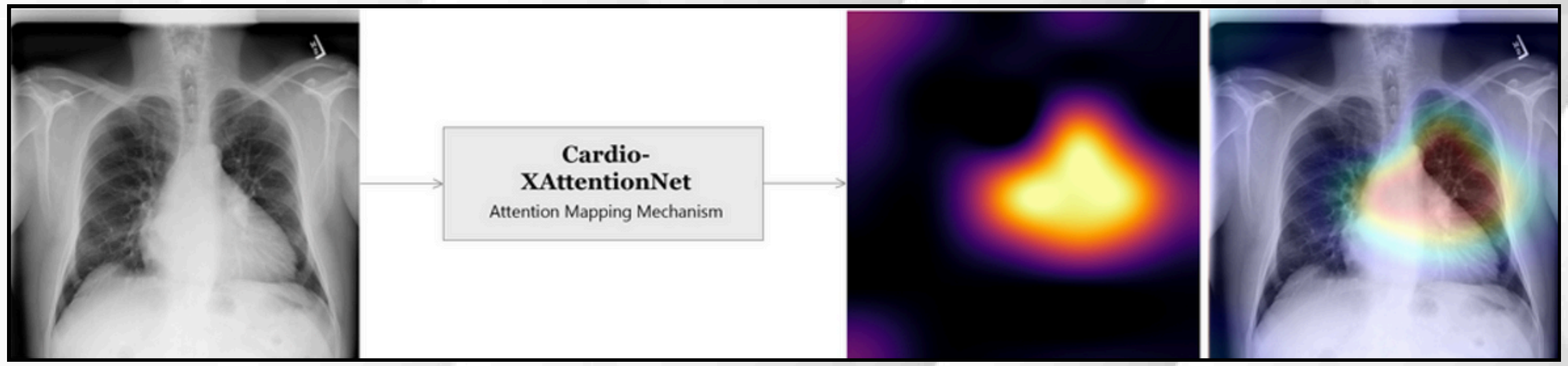
2. Class Activation Maps

- **Technique:** Class Activation Maps (CAM), specifically Grad-CAM, enhance interpretability of deep learning models for chest X-ray analysis.
- **Feature Processing:** A convolutional neural network (CNN) extracts features from the images.
- **Heatmap Visualization:** Grad-CAM generates heatmaps to highlight areas of abnormalities, aiding in localization of conditions like pneumonia.
- **Trustworthiness:** Provides visual explanations that enhance model trustworthiness and help validate predictions against expert assessments.



FINDINGS OF LITERATURE REVIEW

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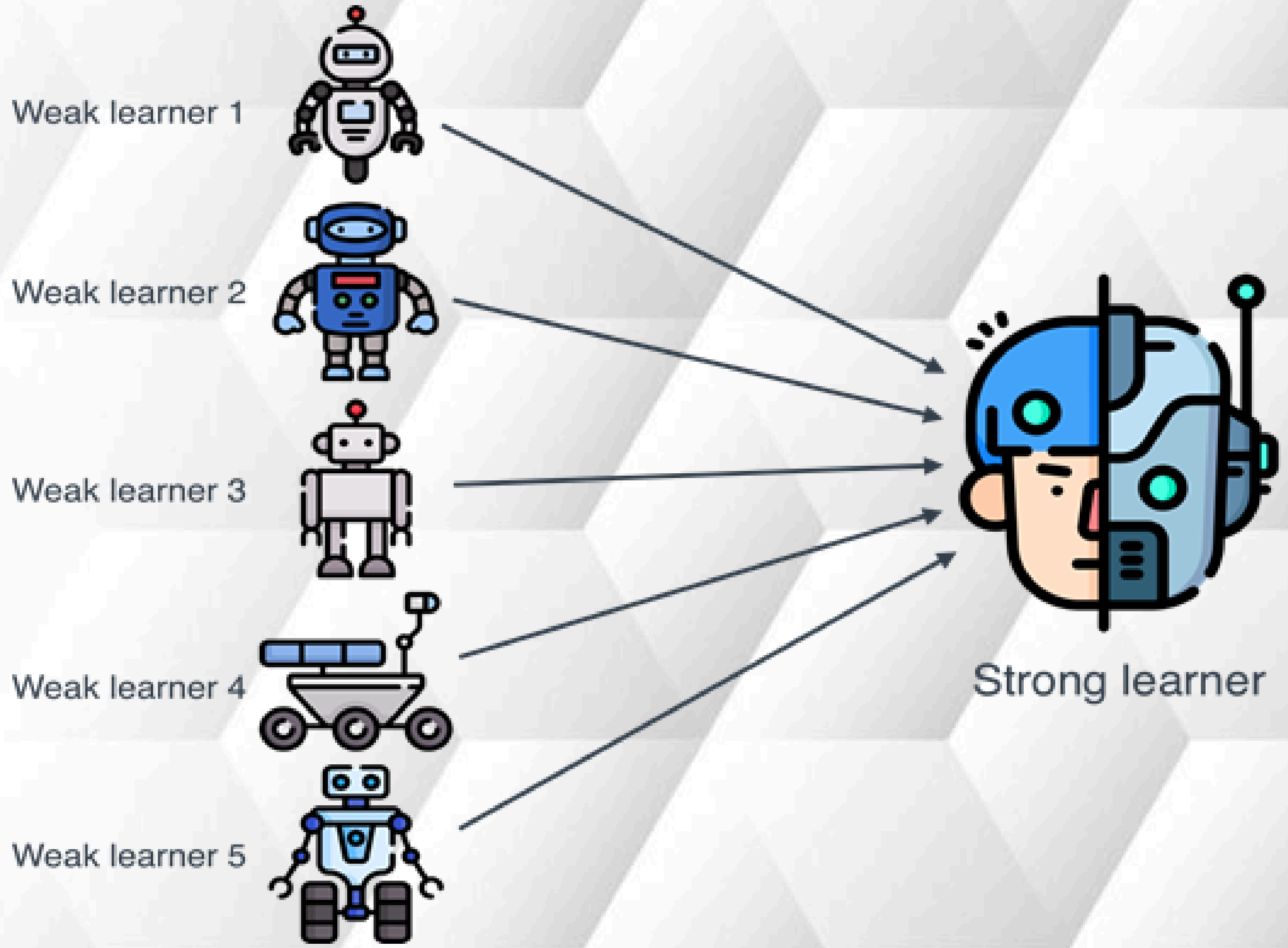
3. Ensemble Method

- **Purpose:** Improves accuracy of chest X-ray classification and disease localization by combining multiple pre-trained models.
- **Feature Extraction:** Uses deep learning models like ResNet, VGG, and AlexNet to extract relevant image features for disease detection.
- **Prediction:** Each model predicts the presence of multiple thoracic diseases, and their outputs are combined for better classification.
- **Localization:** Uses activation maps and pooling to generate heatmaps and localize disease areas in the X-ray images.



Thank You