# 1. INTRODUCTION

In the realm of healthcare and medical diagnostics, the battle against lung cancer has taken a significant stride forward with the advent of advanced technologies. Our college project harnesses the power of Convolutional Neural Networks (CNN) and deep learning to create a cutting-edge solution for lung cancer detection. Lung cancer is a formidable adversary, often diagnosed in later stages when treatment options are limited. However, our CNN-based approach aims to revolutionize early detection through the analysis of medical imaging data, including chest X-rays. By leveraging the capacity of deep learning, our system can identify potential malignancies with remarkable accuracy, offering the promise of timely intervention, improved patient outcomes, and a crucial step toward reducing the global burden of this devastating disease within our college community.

**OBJECTIVE:** The primary objective of the project is to develop and implement a Convolutional Neural Network (CNN) based system for the early detection of lung cancer using medical imaging data, primarily chest X-rays. I aim to create a robust and accurate model capable of identifying potential malignancies with a high degree of precision. Through rigorous training and evaluation, I seek to demonstrate the effectiveness of deep learning techniques in improving the efficiency of lung cancer diagnosis. The ultimate goal of my project is to contribute to the field of healthcare technology by providing a reliable tool for early detection, potentially enhancing patient outcomes and reducing the burden of this disease.

## MAJOR MODULES:

- Module 1 – Index
- Module 2 – Prediction
- Module 3 – Analysis
- Module 4 – Train and test model

## Functionalities of Modules:

**Index**: This is the index or home page of the project. It presents the user with various information about the project like, technologies used in the project and about the project. The user can also navigate to various sections of the page using navigation links.

**Prediction**: This module enables the user to interact and use the trained model to predict lung cancer by inputting various data such as chest X-ray and other patient details. The response is generated quickly and in real time.

**Analysis**: This module comprises of various analytical aspects of the project using the dataset. Analytics like age diseases by patient gender, or finding diseases, or view positions and more. Various classifications are also presented with the help of this module.

**Train & test model**: In this module we have trained and tested three different models using 3 different methods. This is by far the most time-consuming module as this comprises of training the model on a large data set. This module also has metrics to measure precision, recall and Fscore.

- Optimized CNN – Created a model using only 64x64 images instead of its original height and width as the model was able to recognize the patterns even in a 64x64 image and also uses spatial transformer. Hence to improve performance and reduce space we can use this model.
- Vanilla CNN – This is the original unaltered algorithm of CNN used to train and test the model. Also, this method does not use spatial transformer.

## 2. Requirement Specifications

In this section we will look at the various requirements needed to run and deploy this project. As a pre-requisite some basic computer and programming knowledge will be required in order to setup the code base.

### Software requirements:

- Python 3.11.x
- Code editor
- Terminal
- Windows 10/11
- Web browser.
- Python libraries to be installed:
  - TensorFlow
  - NumPy
  - OpenCV
  - Matplotlib
  - Flask
  - Scikit-Learn

### Hardware requirements:

- RAM: 8GB - 16GB DDR4
- CPU: Multicore CPU with at least 4-8 cores
- GPU: VRAM of 4GB – 8GB
- Storage: 60GB – 100GB
- Internet connectivity to train and test model online (optional)

## 3. Software Description

The Lung Cancer Detection System is a software application designed to assist healthcare professionals in the early detection of lung cancer. This innovative tool combines cutting-edge technologies in machine learning and medical image analysis to analyze medical images, such as X-rays, and provide valuable insights into potential lung cancer lesions. The system aims to improve the accuracy and efficiency of diagnosis, ultimately enhancing patient outcomes.

### Key Features

- **Medical Image Analysis**: The system's core functionality involves the analysis of medical images to identify suspicious areas in the lungs. It employs advanced algorithms to detect and categorize potential cancerous lesions.
- **Machine Learning Models:** The system incorporates machine learning models trained on a comprehensive dataset of lung images. These models continuously learn and adapt, improving their accuracy over time.
- **User-Friendly Interface**: To ensure seamless integration into clinical practice, the system boasts an intuitive and user-friendly interface. Healthcare professionals can easily upload images, view results, and access diagnostic insights.
- **Performance Metrics:** The software provides detailed performance metrics to evaluate the accuracy of its predictions. This includes sensitivity, specificity, and positive predictive value (PPV), enabling clinicians to make informed decisions.

### Technical Stack

- **Programming Languages:** The software is primarily developed using Python, making use of popular libraries such as TensorFlow and scikit-learn for machine learning tasks.
- **Image Processing:** It employs OpenCV for image preprocessing and manipulation, enhancing the quality and suitability of input images.
- **User Interface:** The user interface is designed using HTML/CSS and JavaScript, ensuring cross-platform compatibility.

## Use Cases

The Lung Cancer Detection System is intended for use in clinical settings by radiologists, oncologists, and other healthcare professionals. Its primary use cases include:

- **Early Detection:** Identifying potential lung cancer lesions at an early stage, enabling timely intervention.
- **Treatment Planning:** Assisting in the development of personalized treatment plans based on the severity and location of detected lesions.
- **Progress Monitoring:** Continuously monitoring changes in lesion size and characteristics over time to assess treatment effectiveness.

## Conclusion

This section provides an overview of the Lung Cancer Detection System's software components, features, and technical stack. In subsequent sections of this documentation, we will delve deeper into each aspect, discussing system architecture, data flow, algorithmic details, and user interface design. This comprehensive understanding will equip users and developers with the knowledge needed to effectively utilize and maintain this vital tool in the fight against lung cancer.

# 4. System Analysis

In this section, we conduct a system analysis for the Lung Cancer Detection System, developed by a solo developer, with a focus on understanding its purpose, requirements, and constraints.

The primary purpose of the Lung Cancer Detection System, created by a solo developer, is to enable the early detection of lung cancer through the analysis of medical images, specifically X-rays. The key objectives include:

- Enhancing the accuracy of lung cancer diagnosis, particularly in early stages.
- Aiding healthcare professionals by providing valuable diagnostic insights.
- Offering a practical, standalone solution for lung cancer detection.

## Requirements

### Functional Requirements

- **Image Analysis:** The system should accurately analyze medical images (X-rays) for potential lung cancer lesions.
- **User Interface:** Develop an intuitive user interface that allows for image upload and presents analysis results in an easily interpretable format.
- **Machine Learning:** Implement machine learning models for lesion detection and classification, ensuring that these models can adapt and improve over time.
- **Data Management:** Create a secure data storage system for managing patient data and images, prioritizing data privacy.
- **Performance Metrics:** Incorporate performance metrics, such as sensitivity, specificity, and positive predictive value (PPV), for evaluating diagnostic accuracy.

**Non-Functional Requirements**

- **Accuracy:** Strive for a high level of accuracy in lesion detection and classification to instill confidence in the system's results.
- **Usability:** Ensure that the user interface is intuitive and user-friendly, requiring minimal training for healthcare professionals.
- **Scalability:** Design the system in a way that allows for future enhancements and scalability if additional features or capabilities are required.
- **Security:** Prioritize data security to protect patient information, adhering to relevant data protection regulations.
- **Performance:** Optimize system performance to handle image analysis efficiently and provide rapid results to users.
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## Constraints

As a solo developer, there are certain constraints that need to be considered:

- **Resource Limitations:** Limited resources in terms of time and manpower may affect the speed of development and testing.
- **Expertise:** The developer's expertise in both healthcare and software development may influence the system's capabilities and complexity.
- **Budget:** A solo developer may have budget constraints, potentially limiting access to specialized tools or technologies.

## Conclusion

This system analysis provides insight into the Lung Cancer Detection System developed by a solo developer. It outlines the system's purpose, functional and non-functional requirements, and constraints. While the project may face limitations in terms of resources and expertise, it demonstrates the potential for a single developer to contribute significantly to the advancement of lung cancer detection through innovative software solutions.

## Algorithm and methods

This is a problem with the new datasets that have never been fully modeled, so I do not want to get stuck, and so I come up with the following approach:

### Convolutional Neural Network

A CNN, or Convolutional Neural Network, is a deep learning algorithm primarily designed for processing and analyzing visual data, such as images and videos. CNNs have become the foundation for various computer vision tasks, including image classification, object detection, facial recognition, and more. They are exceptionally effective at extracting relevant features from complex visual data, some parameters are considered and used as follows:

- Neural network architecture: Choose the appropriate architecture
- Preprocessing parameters
- Fine tuning
- Spatial transformer
- Add more data in network not only images
- Convolution Layers: CNNs employ convolutional layers to scan input data (e.g., an image) using small filters or kernels. These filters move across the input, computing dot products at each location. The result is a feature map that represents localized features within the input.
- Pooling Layers: Pooling layers, typically max-pooling or average-pooling, reduce the spatial dimensions of the feature maps while retaining the most important information. Pooling helps make the model more robust to variations in scale and position.
- Convolutional Neural Network Architecture: CNNs often follow a specific architecture pattern, consisting of multiple convolutional layers followed by pooling layers, followed by one or more fully connected layers. The final layer produces output predictions based on the learned features.

- Feature Learning: CNNs are capable of automatically learning hierarchical features from the data. Lower layers capture simple features like edges and corners, while deeper layers capture more complex features and patterns.
- Weight Sharing: CNNs share weights (parameters) across the input data, which significantly reduces the number of parameters compared to fully connected networks. This weight sharing helps in learning translation-invariant features.
- Activation Functions: Non-linear activation functions (e.g., ReLU - Rectified Linear Unit) are applied to the output of each convolutional layer, introducing non-linearity into the model and allowing it to capture complex relationships in the data.
- Dropout: Dropout is a regularization technique commonly used in CNNs to prevent overfitting. It randomly drops a fraction of neurons during training, forcing the network to become more robust.

CNNs have achieved remarkable success in various computer vision tasks and have been used in the development of self-driving cars, facial recognition systems, medical image analysis, and more. They have also been used for tasks beyond computer vision, such as natural language processing when combined with recurrent neural networks (RNNs) to form hybrid models like CNN-RNNs.

## Metrics

The evaluation metrics used here will be precision, recall and F-beta scores (beta is 0.5) for binary classification – found diseases or not. In this case F score is better than accuracy because with binary classification found diseases or not, the classes are imbalanced. For example, consider you have a trivial classifier that just guesses the majority class, it will obtain 80% accuracy when there is an 80/20 split and 50% accuracy when there is a 50/50 split.

These indexes will be evaluated on a separate testing data set from the original dataset.

These indicators will be evaluated for all diseases – found disease or not.

If the case is positive and not negative, then the indicators:

tp: True Positive - The number of people affected is expected to be affected

fp: False Positive - The number of people who are sick is predicted to be unwell

fn: False Negative - The number of people without the disease is predicted to be wrong

$$\text{Precision} = \frac{tp}{tp + fp} \qquad \text{Recall} = \frac{tp}{tp + fn}$$

Precision and Recall will focus on the number of people expected to be affected, thereby overcoming the skew data status and the importance of predicting a person's illness.

Precision represents the proportion of people who correctly predicted the disease in the total number of people who were predicted to be sick. Recall represents the proportion of people who correctly predicted illness on the total number of people actually infected. Both of these indicators are very important in predicting the disease, and we need an index that can be both Precision and Recall.

From here we have a combination of Precision and Recall F score:

$$F_\beta = (1 + \beta^2) \cdot \frac{\text{precision} \cdot \text{recall}}{\beta^2 \cdot \text{precision} + \text{recall}}$$

With different β will show the importance between different and precision different. There are two main ideas for choosing the importance of precision and recall:

- Models need to be sure that a patient is expecting a disease, which means that each expectation is highly confident because when a patient is diagnosed with a disease, it is very shocking. It is very important, as this is a method to assist doctors with other diagnostic procedures. So, we want high precision and low recall, corresponding to small β, taking β = 0.5 for F beta score.

- Models need to avoid mispronouncing sick people to avoid illness, avoiding missing patients at risk. This case will select low precision and high recall, corresponding to large β, taking β = 2 for F beta score.

For the purpose of this project is to prove the technology as well as support the doctors in diagnosing the disease because to determine the disease will need many tests on the patient. The patient will be anxious before knowing further results, so I choose F-0.5-score is β = 0.5. With β = 0.5 to represent precision will be more important than recall in this case.

## Data Preprocessing

My preprocessing data for both sample dataset and full dataset in “Data preprocessing” notebook consists of following steps:

- For images:
  - The images are rescaled, reducing the size of the image reduces the feature that makes training faster.
  - The images are converted to gray and RGB. Both are used for different models.
  - Read the image to NumPy array then normalize by dividing the image matrix by 255
- For extra data:
  - Separate individual features into individual features.
  - Standardize the age field to the numeric form and, according to the year, then normalization field
  - Remove the outliers point due to data about age too large.
  - One hot two important attributes they will use are 'Patient Gender' and 'View Position'
  - Random both dataset

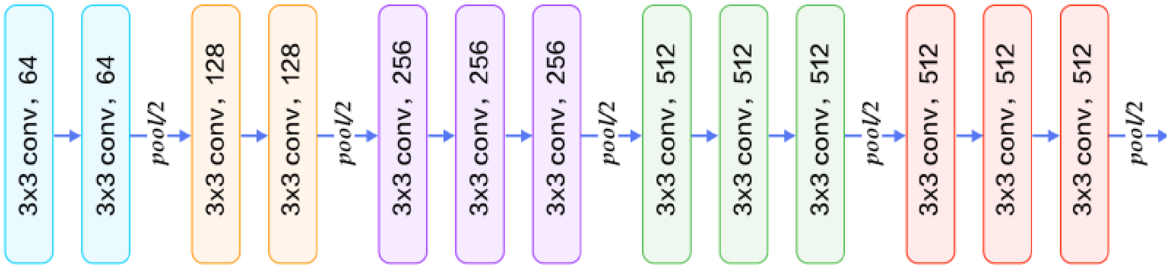
All data after processing is stored for later use.

The preprocessing process has the following adjustable parameters: Images resize shape

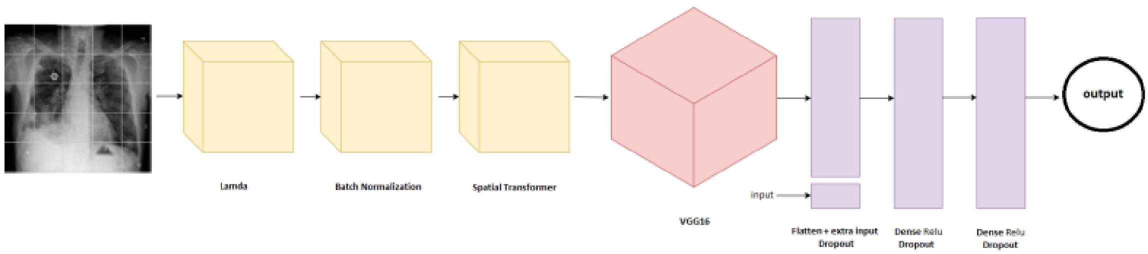
## Implementation

This is the main method of this project and can be seen on notebooks: “Optimized CNN - Full Dataset” and “Optimized CNN - Sample Dataset”.

Here is the Architecture for this approach:




VGG16 architect extract feature




Full architecture

The architecture consists of three main layers in the following order:

- Spatial transformer layers (The first three layers)
  - ◦ The first is lambda to transfer the routing features [-0.5: 0.5], which means that the features of the image have an average value of 0.
  - The second is Batch Normalization.
  - The third layer is Spatial Transformer, which is used to extract the most valuable features for classification.

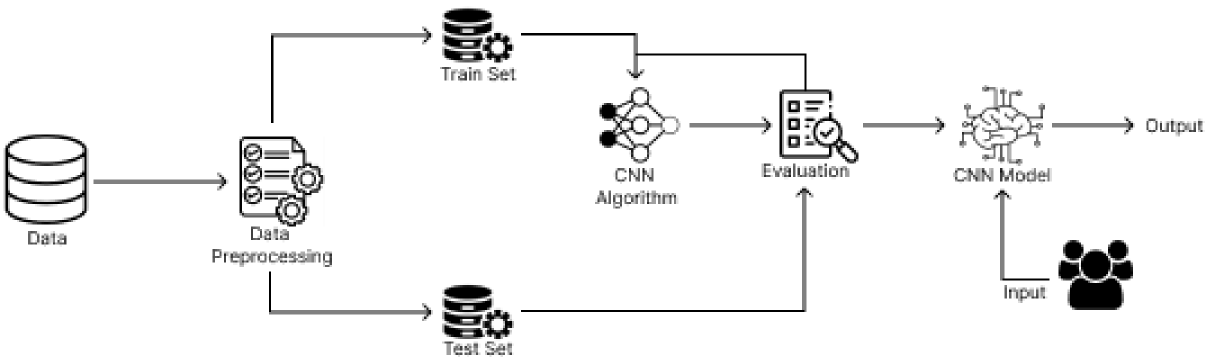
- Extract features layers (VGG16 pretrained model)
  - A set of 13 layers as shown in the first image of the VGG is the extract features, there are many pretrained model but now I am trying before with VGG16 because this is a simple model for learning time and training faster.
- Classification layers (Last 3 layers)

  - The first layer is the Flattened layer from the output of the layers VGG16 and 5 features plus 'Age', 'Gender Male', 'Gender Female', 'View position AP', 'View position PA'. These additional features will also affect the sorting, as we have seen above, so they are added to this layer. Following this layer is the dropout layer.
  - The next two layers are Dense after each Dropout layer, with a gradual decrease in depth.

The order of steps is as follows:

- Load data has been processed into ram, data is processed as before. Images are in RGB format.
- Implement Network architecture as designed by the architect.
- Implement Metric function including Binary accuracy, Precision score with threshold, recall score with threshold, Fbeta score with beta and threshold.
- Implement data generator, model checkpoint, model loss function.
- Training model with training parameters, logging training / validation loss and training / validation accuracy.
- Save best model and test model on testing set.

## 5. Data Flow Diagram




1. Data Source: The starting point where you acquire medical datasets containing images of lung scans. These datasets can come from various sources such as hospitals or research institutions.

2. Data Preprocessing and Augmentation: This process involves cleaning, enhancing, and augmenting the acquired dataset to improve its quality and diversity. Data preprocessing may include tasks like noise reduction and image resizing.

3. Dataset Preparation (Training and Testing): The dataset is divided into training and testing sets for machine learning model development and evaluation.

4. Machine Learning Model Training: Using the training dataset, machine learning models are trained to detect lung cancer lesions. This process involves feature extraction, model training, and parameter tuning.

5. Trained Model and Configuration: After training, the machine learning model and its configuration are saved for later use in the system.

6. User Interface (Image Submission): Users (typically healthcare professionals) submit medical images through the user interface for analysis.

7. Image Processing and Preprocessing: The uploaded images undergo preprocessing to prepare them for analysis. This may include standardization, noise reduction, and image enhancement.

8. Image Analysis (Lung Cancer Detection): The preprocessed images are analyzed using the pre-trained machine learning model to detect lung cancer lesions.

9. Diagnostic Report (Result Presentation): The system generates diagnostic reports based on the analysis results and presents them to the user through the user interface. These reports include information on lesion presence, location, and classification.

This DFD begins with the acquisition and preparation of the dataset, which is a critical step in training your machine learning model for lung cancer detection. The flow then proceeds through image submission, analysis, and result presentation. Depending on the specifics of your system, you may need to further expand or refine this DFD to include additional processes or details.

## 6. Source Code

The source code of this project will be classified into 2 parts: the back-end and the front-end.

## Front-end:

**Index.html**

```
<!DOCTYPE html>
    <head>
        <meta charset="utf-8">
        <meta http-equiv="X-UA-Compatible" content="IE=edge">
        <title>Lung Detect</title>
        <meta name="description" content="">
        <meta name="viewport" content="width=device-width, initial-scale=1">
        <link rel="icon" type="image/x-icon" href="/static/css/logo/tabicon.svg">
        <link rel="stylesheet" href="../static/css/index.css">
        <link rel="stylesheet" href="../static/css/header.css">
        <link rel="stylesheet" href="../static/css/about.css">
        <link rel="stylesheet" href="../static/css/tech.css">
        <link rel="stylesheet" href="../static/css/contact.css">
        <link rel="stylesheet" href="../static/css/footer.css">
    </head>
    <body>
        <header>
            <a class="logo" href="index.html"><img src="../static/css/logo/logoicon-
white.svg"alt="logo"></a>
```

```
<div class="right">
    <nav>
        <ul class="links">
            <li><a href="#main">Home</a></li>
            <li><a href="#about">About</a></li>
            <li><a href="#tech">Technology</a></li>
            <li><a href="#contact">Contact</a></li>
        </ul>
    </nav>
    <a class="try-now" href="model.html">Try Now</a>
</div>
</header>
<main id="main" class="main">
<div class="main-text">
    <p>Clearing the Path to Lung Health: <span>Advanced Diagnosis and Insights.</span></p>
    <a class="tryBtn" href="model.html">Test Now</a>
</div>
<div class="main-lungs">
    <svg class="lungs" fill="#000000" height="450px" width="450px" version="1.1" id="Capa_1" xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink" viewBox="0 0 59.999 59.999" xml:space="preserve">
    <g id="SVGRepo_bgCarrier" stroke-width="0"/>
    <g id="SVGRepo_tracerCarrier" stroke-linecap="round" stroke-linejoin="round"/>
```

```
<g id="SVGRepo_iconCarrier"> <g>

<path fill="#7f5af0" class="lung-outer" d="M59.13,49.933c-3.954-7.817-4.88-
14.927-5.697-21.199c-0.373-2.867-0.726-5.576-1.333-8.133 c-1.469-6.182-4.787-9.937-
9.864-11.16c-2.349-0.568-4.82-0.099-6.779,1.285c-0.544,0.384-1.027,0.832-
1.456,1.321V6.5v-4h-8v4 v5.547c-0.429-0.489-0.912-0.937-1.456-1.321c-1.96-1.384-4.43-
1.853-6.779-1.285c-5.078,1.224-8.396,4.979-9.865,11.16 c-0.616,2.593-0.972,5.459-
1.349,8.493c-0.822,6.609-1.753,14.101-5.681,21.867c-1.004,1.984-1.14,3.502-0.415,4.639
C1.466,57.182,3.827,57.5,6.77,57.5c0.951,0,1.963-0.033,3.01-0.067l0.625-0.021c10.91-
0.346,16.984-3.87,18.57-10.775 c0.697-3.035,0.152-7.095-0.374-11.02c-0.309-2.302-0.601-
4.475-0.601-6.204c0-1.099,0.894-1.992,2.008-1.992
c1.098,0,1.992,0.894,1.992,1.992c0,1.729-0.292,3.902-0.601,6.204c-0.526,3.925-
1.071,7.984-0.374,11.02 c1.582,6.886,7.656,10.401,18.571,10.747c4.027,0.133,8.351-
0.063,9.863-2.44C60.276,53.664,60.165,51.978,59.13,49.933z M32.001,10.5h-4v-2h4V10.5z
M32.001,12.5v2h-4v-2H32.001z M29.617,18.375c-0.073-0.014-0.141-0.04-0.21-0.062 c-
0.049-0.015-0.1-0.026-0.147-0.045c-0.093-0.038-0.181-0.086-0.266-0.137c-0.019-0.011-
0.04-0.019-0.059-0.031 c-0.093-0.059-0.179-0.127-0.26-0.201c-0.009-0.008-0.02-0.015-
0.029-0.023c-0.074-0.069-0.14-0.146-0.203-0.225 c-0.015-0.018-0.032-0.034-0.046-0.053c-
0.043-0.058-0.078-0.123-0.115-0.186c-0.029-0.05-0.063-0.098-0.088-0.151 c-0.012-0.024-
0.019-0.05-0.029-0.075c-0.04-0.094-0.076-0.189-0.101-0.289c-0.001-0.005-0.003-0.009-
0.004-0.014 c-0.021-0.087-0.029-0.179-0.038-0.27c-0.004-0.039-0.01-0.076-0.012-
0.115h3.987c-0.001,0.039-0.008,0.077-0.012,0.115 c-0.009,0.091-0.017,0.183-0.038,0.27c-
0.001,0.005-0.003,0.009-0.004,0.014c-0.025,0.1-0.061,0.195-0.101,0.289 c-0.011,0.024-
0.018,0.051-0.029,0.075c-0.025,0.053-0.058,0.101-0.088,0.151c-0.037,0.063-0.072,0.128-
0.115,0.186 c-0.014,0.019-0.031,0.035-0.046,0.053c-0.064,0.079-0.13,0.156-0.203,0.225c-
0.009,0.008-0.02,0.015-0.029,0.023 c-0.082,0.073-0.168,0.142-0.26,0.201c-0.019,0.012-
0.04,0.02-0.059,0.031c-0.086,0.051-0.173,0.099-0.266,0.137 c-0.047,0.019-0.098,0.029-
0.147,0.045c-0.07,0.022-0.138,0.048-0.21,0.062c-0.125,0.024-0.253,0.038-0.384,0.038
S29.742,18.399,29.617,18.375z M28.001,4.5h4v2h-4V4.5z M57.775,53.869c-1.105,1.736-
6.378,1.568-8.114,1.517 c-10.015-0.318-15.316-3.24-16.685-9.196c-0.616-2.682-0.096-
6.558,0.407-10.307c0.318-2.369,0.618-4.607,0.618-6.47 c0-2.201-1.791-3.992-4.008-3.992c-
2.201,0-3.992,1.791-3.992,3.992c0,1.862,0.3,4.101,0.618,6.47
c0.503,3.749,1.023,7.625,0.407,10.307c-1.354,5.894-6.812,8.911-16.685,9.225l-0.627,0.02c-
3.21,0.104-6.849,0.226-7.571-0.908 c-0.3-0.47-0.118-1.415,0.513-2.661c4.085-8.077,5.04-
```

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<path fill="#7f5af0" class="lung-inner" d="M9.001,48.5c-0.552,0-1,0.447-1,1c0,0.552-0.449,1-1,1c-0.552,0-1,0.447-1,1s0.448,1,1,1c1.654,0,3-1.346,3-3 C10.001,48.947,9.554,48.5,9.001,48.5z"/> </g> </g>

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      </div>

    </main>

    <section class="about" id="about">

      <div class="about-heading">

        <h1>About LungDetect</h1>

        <p>Get to know a little about LungDetect.</p>
```

```
        </div>

        <div class="about-content">

          <div class="about-cards">

            <h2>Our Mission</h2>

            <p>At LungDetect, our mission is to harness the power of artificial intelligence, machine learning, and deep learning to make a meaningful impact on the early detection and diagnosis of lung cancer.</p>

          </div>

          <div class="about-cards">

            <h2>Cutting-Edge Technology</h2>

            <p>We are at the forefront of utilizing cutting-edge technologies such as AI and deep learning to create innovative solutions that can potentially save lives.</p>

          </div>

          <div class="about-cards">

            <h2>Team of Experts</h2>

            <p>Our dedicated team of data scientists, machine learning engineers, and healthcare professionals brings a wealth of experience and expertise to the field of AI-driven healthcare solutions.</p>

          </div>

          <div class="about-cards">

            <h2>Patient-Centered Approach</h2>

            <p>We prioritize the well-being of patients by developing tools and technologies that enable earlier and more accurate detection of lung cancer, ultimately leading to improved patient outcomes.</p>

          </div>

          <div class="about-cards">
```

```
<h2>Collaboration with Medical Community</h2>

<p>We collaborate closely with healthcare providers, radiologists, and medical researchers to ensure that our AI-powered tools align with the best practices in the field of lung cancer diagnosis.</p>

</div>

<div class="about-cards">

<h2>Continuous Innovation</h2>

<p>We are committed to ongoing research and development, continually refining and enhancing our AI algorithms to stay at the forefront of lung cancer detection, and working towards a future with reduced mortality rates and improved quality of life for patients.</p>

</div>

</div>

</section>

<section class="tech" id="tech">

<h1>Technologies Used</h1>

<div class="tech-content">

<div class="tech-cards">

<div class="tech-icon">

<h2>Python</h2>

<img class="python" src="../static/css/logo/tech/python.png" alt="">

</div>

<div class="tech-text">

<p>Python is a versatile and easy-to-read programming language known for its simplicity and readability. It's widely used for web development, data analysis, artificial intelligence, and more. Python's dynamic typing, extensive standard library, and active
```

```html
community make it a popular choice for a wide range of applications, and its open-source nature ensures accessibility for developers worldwide.</p>

        </div>

    </div>

    <div class="tech-cards">

        <div class="tech-icon">

            <h2>NumPy</h2>

            <img class="numpy" src="../static/css/logo/tech/numpy.png" alt="">

        </div>

        <div class="tech-text">

            <p>NumPy, short for "Numerical Python," is a fundamental Python library for numerical and scientific computing. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays efficiently. NumPy is a cornerstone in the Python data science ecosystem and is often used for tasks like data manipulation, statistical analysis, and linear algebra operations. Its efficiency and ease of use make it a vital tool for researchers and data scientists working with numerical data in Python.</p>

        </div>

    </div>

    <div class="tech-cards">

        <div class="tech-icon">

            <h2>TensorFlow</h2>

            <img class="tensor" src="../static/css/logo/tech/tensorflow.png" alt="">

        </div>

        <div class="tech-text">
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            <p>TensorFlow is an open-source machine learning framework developed by Google. It's designed to build and train deep learning models efficiently. TensorFlow offers a comprehensive ecosystem of tools, libraries, and resources to develop and deploy machine learning and artificial intelligence applications. It's widely used for tasks like image recognition, natural language processing, and reinforcement learning, making it a go-to choice for researchers and developers in the field of AI.</p>
        </div>
    </div>
    <div class="tech-cards">
        <div class="tech-icon">
            <h2>Matplotlib</h2>
            <img class="matplot" src="../static/css/logo/tech/matplotlib.svg" alt="">
        </div>
        <div class="tech-text">
            <p>Matplotlib is a popular Python library used for creating static, animated, and interactive visualizations. It provides a versatile framework for generating a wide range of plots and charts, making it a valuable tool for data scientists, researchers, and engineers to visualize and communicate data effectively. Matplotlib's flexibility and customization options make it suitable for creating publication-quality graphs and charts for various data analysis and presentation needs.</p>
        </div>
    </div>
    <div class="tech-cards">
        <div class="tech-icon">
            <h2>Scikit-learn</h2>
            <img class="scikit" src="../static/css/logo/tech/scikit-learn.png" alt="">
        </div>
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```html
<div class="tech-text">

<p>Scikit-learn, often abbreviated as sklearn, is a widely-used Python library for machine learning and data mining. It offers a simple and efficient toolkit for various machine learning tasks, including classification, regression, clustering, dimensionality reduction, and more. Scikit-learn provides a consistent API and a wide range of algorithms, making it accessible for both beginners and experienced data scientists. It's a valuable resource for building, evaluating, and deploying machine learning models in Python.</p>

</div>

</div>

<div class="tech-cards">

<div class="tech-icon">

<h2>Pandas</h2>

<img class="pandas" src="../static/css/logo/tech/pandas.svg" alt="">

</div>

<div class="tech-text">

<p>Pandas is a powerful Python library for data manipulation and analysis. It provides data structures like DataFrames and Series, which are highly efficient for working with structured data, such as spreadsheets or SQL tables. Pandas simplifies tasks like data cleaning, exploration, and transformation, making it a go-to tool for data scientists and analysts. Its capabilities for handling, querying, and analyzing datasets make it an essential library for data-related tasks in Python.</p>

</div>

</div>

<div class="tech-cards">

<div class="tech-icon">

<h2>OpenCV</h2>

<img class="opencv" src="../static/css/logo/tech/opencv.png" alt="">
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                </div>

                <div class="tech-text">

                    <p>OpenCV (Open Source Computer Vision Library) is an open-source computer vision and image processing library. It offers a vast array of tools and functions to perform tasks such as image and video analysis, object detection, facial recognition, and machine vision applications. OpenCV is widely used in fields like robotics, computer vision research, and industrial automation, making it an essential resource for developers and researchers working on visual data and image-related tasks in Python and C++.</p>

                </div>

            </div>

        </div>

    </section>

    <section class="contact" id="contact">

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        <div class="contact-container">

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                </form>

            </div>

        </div>
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      <h3>Useful Links</h4>

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    <li><a href="#main">Home</a></li>
    <li><a href="#about">About</a></li>
    <li><a href="#tech">Technology</a></li>
    <li><a href="#contact">Contact</a></li>
</ul>
</div>
</div>
<div class="socials">
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        <a href="https://github.com/hakai2k/">
            <svg width="46" height="45" viewBox="0 0 46 45" fill="none" xmlns="http://www.w3.org/2000/svg">
                <path d="M15.791 44.836C16.502 44.53 17 43.823 17 43V37.6C17 37.403 17.016 37.198 17.041 36.99C17.027 36.994 17.014 36.997 17 37C17 37 14 37 13.4 37C11.9 37 10.6 36.4 10 35.2C9.3 33.9 9 31.7 7.2 30.5C6.9 30.3 7.1 30 7.7 30C8.3 30.1 9.6 30.9 10.4 32C11.3 33.1 12.2 34 13.8 34C16.287 34 17.62 33.875 18.422 33.445C19.356 32.056 20.649 31 22 31V30.975C16.332 30.793 12.711 28.909 11.025 26C7.36 26.042 4.169 26.405 2.348 26.707C2.391 27.038 2.29 26.38 2.348 26.707C4.145 26.411 7.5 26.5 11.025 26C10.913 25.724 10.333 24.447 10.251 24.157C10.251 24.157 3.71 24.118 2.064 24.254C2.068 24.59 2.044 23.922 2.064 24.254C3.713 24.119 10.251 24.157 10.251 24.157C10.172 23.657 9.901 22.133 9.901 21.601C9.901 19.901 10.501 18.101 11.601 16.601C11.101 14.901 10.401 11.301 11.801 10.001C14.501 10.001 16.401 11.301 17.301 12.101C19 11.4 20.9 11 23 11C25.1 11 27 11.4 28.6 12.1C29.5 11.3 31.4 10 34.1 10C35.6 11.4 34.8 15 34.3 16.6C35.4 18.1 36 19.8 35.9 21.6C35.9 22.084 35.6351 23.6108 35.5701 24.0688C39.0691 23.8968 42.323 24.364 44 24.5C43.998 24.837 43.961 23.777 43.943 24.11C42.272 23.972 39.168 23.83 35.584 24.021C35.495 24.357 34.905 25.678 34.777 25.995C38.323 26.041 41.8777
```

```
26.377 43.7607 26.677C43.7177 27.009 43.714 26.351 43.656 26.677C41.744 26.371 38.485 26.013 34.777 25.995C33.112 28.873 29.557 30.75 24 30.969V31C26.6 31 29 34.9 29 37.6V43C29 43.823 29.498 44.53 30.209 44.836C39.37 41.804 46 33.164 46 23C46 10.318 35.683 0 23 0C10.317 0 0 10.318 0 23C0 33.164 6.63 41.804 15.791 44.836Z" fill="#7F5AF0"/>

          </svg>

        </a>

        <a href="https://www.linkedin.com/in/js0691/">

          <svg fill="#7f5af0" xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink" viewBox="0 0 50 50" width="50px" height="50px">

            <path d="M41,4H9C6.24,4,4,6.24,4,9v32c0,2.76,2.24,5,5,5h32c2.76,0,5-2.24,5-5V9C46,6.24,43.76,4,41,4z M17,20v19h-6V20H17z M11,14.47c0-1.4,1.2-2.47,3-2.47s2.93,1.07,3,2.47c0,1.4-1.12,2.53-3,2.53C12.2,17,11,15.87,11,14.47z M39,39h-6c0,0,0-9.26,0-10c0-2-1-4-3.5-4.04h-0.08C27,24.96,26,27.02,26,29c0,0.91,0,10,0,10h-6V20h6v2.56c0,0,1.93-2.56,5.81-2.56c3.97,0,7.19,2.73,7.19,8.26V39z"/>

          </svg>

        </a>

        <a href="https://www.instagram.com/l3eerusx/">

          <svg fill="#7f5af0" xmlns="http://www.w3.org/2000/svg" xmlns:xlink="http://www.w3.org/1999/xlink" viewBox="0 0 50 50" width="50px" height="50px">

            <path d="M34,3H16C8.83,3,3,8.83,3,16v18c0,7.17,5.83,13,13,13h18c7.17,0,13-5.83,13-13V16C47,8.83,41.17,3,34,3z M25,36c-6.07,0-11-4.93-11-11s4.93-11,11-11s11,4.93,11,11S31.07,36,25,36z M37,15c-1.1,0-2-0.9-2-2s0.9-2,2-2s2,0.9,2,2S38.1,15,37,15z"/>

            <path d="M34,25c0,4.96-4.04,9-9,9s-9-4.04-9-9s4.04-9,9-9S34,20.04,34,25z"/>
```

```
                    </svg>
                </a>
                <a href="https://www.facebook.com/I3eerus">
                    <svg fill="#7f5af0" xmlns="http://www.w3.org/2000/svg" x="0px" y="0px" width="100" height="100" viewBox="0 0 50 50">
                        <path d="M41,4H9C6.24,4,4,6.24,4,9v32c0,2.76,2.24,5,5,5h32c2.76,0,5-2.24,5-5V9C46,6.24,43.76,4,41,4z M37,19h-2c-2.14,0-3,0.5-3,2 v3h5l-1,5h-4v15h-5V29h-4v-5h4v-3c0-4,2-7,6-7c2.9,0,4,1,4,1V19z"></path>
                    </svg>
                </a>
            </div>
        </div>
    </footer>
  </body>
</html>
```

## model.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <link rel="stylesheet" href="../static/css/model.css">
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Document</title>
</head>
```

```
<body>
    <header>
        <a href="/"> < Go back to main page </a>
    </header>
    <main>
        <form id="preForm" method="post" enctype="multipart/form-data"
action="http://127.0.0.1:5000/model.html">
            <h2>Patient Details</h2>
            <div class="form-main-container">
                <div class="image-container">
                    <img id="new-image" src="../static/css/logo/model/image-place-holder.png"
alt="">
                    <input type="file" id="image" class="select-image" name="image"
accept="image/*" required>
                    <label for="image">Upload image</label>
                </div>
                <div class="form-container">
                    <h4>Select Gender</h4>
                    <div class="radio-container">
                        <input type="radio" id="mgender" name="gender" value="M" required>
                        <label for="mgender">Male</label>
                        <input type="radio" id="fgender" name="gender" value="F" required>
                        <label for="fgender">Female</label>
                    </div>
                    <input type="text" id="age" name="age" placeholder="Enter your age" required>
```

```
            <h4>Select view type</h4>
            <div class="radio-container">
                <input type="radio" id="viewap" name="view" value="AP" required>
                <label for="viewap">AP</label>
                <input type="radio" id="viewpa" name="view" value="PA" required>
                <label for="viewpa">PA</label>
            </div>
            <input type="submit" class="submit">
          </div>
        </div>
      </form>
      <div class="response-text">
        <p id="output">Your diagnosis will be updated here</p>
      </div>
    </main>
    <script>
      const inputImage = document.getElementById('image')
      const newImage = document.getElementById('new-image')
      inputImage.onchange = function () {
        newImage.src = URL.createObjectURL(inputImage.files[0])
      }

      const APIURL = 'http://127.0.0.1:5000/model.html'
      const preForm = document.getElementById('preForm')
```

```
        const response_block = document.getElementsByClassName('response-text')

        preForm.addEventListener('submit', async (e) => {

          e.preventDefault()

          const data = new FormData(preForm)

          const response = await fetch(APIURL, {method:'POST', body:data})

          const prediction = await response.json()

          output = document.getElementById('output')

          if (prediction < 40){

            output.innerHTML = `According to the predictions, only less than ${prediction}% of the patterns indicate that there maybe cancer present in the lungs. However do not take this seriously as this model is still learning from new data.`

          }

          else if(prediction > 40 && prediction < 60){

            output.innerHTML = `I have found over ${prediction}% patterns that match the symptoms that indicate that there is cancer being developed in the lungs. `

          }

          else{

            output.innerHTML = `Over ${prediction} of the patterns match that there is cancer present in the lungs. There is enough evidence of cancer being present.`

          }

        })

    </script>

</body>

</html>
```

**model.css**

```
:root{
    --bgColor: #151519;
    --bgColor2: #242629;
    --headerColor: #fffffe;
    --paraColor: #94a1b2;
    --btnColor: #7f5af0;
    --btnText: #fffffe;
    --secondary: #72757e;
    --tertiary: #2cb67d;
}
@font-face {
    font-family: 'Product Sans Regular';
    src: url('../fonts/product-sans/Product Sans Regular.ttf');
}
*{
    padding: 0;
    margin: 0;
    box-sizing: border-box;
}
html::-webkit-scrollbar{
    width: 7px;
}
```

```
html::-webkit-scrollbar-thumb{
    background-color: var(--btnColor);
}
html::-webkit-scrollbar-track{
    background-color: var(--bgColor);
}
html{
    scroll-behavior: smooth;
}
body{
    background-color: var(--bgColor);
    font-family: 'Product Sans Regular';
    color: var(--headerColor);
}
header{
    height: 10vh;
    width: 100vw;
    padding: 0% 10%;
    display: flex;
    align-items: center;
    & a{
        text-decoration: none;
        color: var(--headerColor);
```

```
 font-size: 20px;
    }
}
main{
    height: 80vh;
    padding: 5% 10%;
    display: flex;
    flex-direction : column;
    align-items: center;
    justify-content: space-evenly;
    gap: 1.5rem;
}
form{
    height: 50vh;
    width: 40vw;
    background-color: var(--bgColor2);
    border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    display: flex;
    flex-direction: column;
    align-items: center;
    justify-content: space-evenly;
    .form-main-container{
```

```
display: flex;
        align-items: center;
        justify-content: space-between;
        gap: 2rem;
    }
    .form-container{
        display: flex;
        flex-direction: column;
        align-items: center;
        justify-content: space-evenly;
        gap: 1rem;
        & input[type="text"]{
            background-color: var(--bgColor2);
            border: 2px solid var(--bgColor);
            color: var(--headerColor);
        }
        & #age {
            width: auto;
            padding: 0.25rem;
            border-radius: 5px;
        }
    }
    .image-container{
```

```
display: flex;
        flex-direction: column;
        gap: 1rem;
        & input{
            display: none;
        }
        & label{
            padding: 1rem;
            background-color: var(--btnColor);
            border-radius: 5px;
            text-align: center;
            cursor: pointer;
        }
        #new-image{
        box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
            border-radius: 5px;
            height: 190px;
            width: 190px;
        }
    }
}
.submit{
    cursor: pointer;
```

```
 height: 2.5rem;
    width: 6rem;
    background-color: var(--btnColor);
    border: none;
    border-radius: 7px;
    color: var(--btnText);
}
.radio-container{
    display: flex;
    align-items: center;
    gap: 1rem;
    & input {
        display: none;
    }
    & label {
        padding: 5px 20px;
        border: 2px solid var(--btnColor);
        cursor: pointer;
        border-radius: 5px;
    }
    & input:checked + label {
        background-color: var(--btnColor);
    }
```

```
}
.response-text{
    display: flex;
    flex-direction: column;
    gap: 1rem;
    background-color: var(--bgColor2);
    border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    width: 40vw;
    padding: 1rem;
    text-align: center;
}
```

**index.css**

```
:root{
    --bgColor: #16161a;
    --bgColor2: #242629;
    --headerColor: #fffffe;
    --paraColor: #94a1b2;
    --btnColor: #7f5af0;
    --btnText: #fffffe;
    --secondary: #72757e;
    --tertiary: #2cb67d;
}
```

```
@font-face {
    font-family: 'Product Sans Regular';
    src: url('../fonts/product-sans/Product Sans Regular.ttf');
}
html::-webkit-scrollbar{
    width: 7px;
}
html::-webkit-scrollbar-thumb{
    background-color: var(--btnColor);
}
html::-webkit-scrollbar-track{
    background-color: var(--bgColor);
}
html{
    scroll-behavior: smooth;
}
* {
    font-family: 'Product Sans Regular';
    box-sizing: border-box;
    margin: 0;
    padding: 0;
}
.main {
```

```
height: 90vh;
    padding: 5% 10%;
    display: flex;
    align-items: center;
    justify-content: space-between;
    background-color: var(--bgColor);
    color: var(--headerColor);
    font-size: 45px;
}
.main-text{
    width: 50%;
    text-align: justify;
    & span{
        color: var(--btnColor);
    }
}
.tryBtn{
    font-size: 25px;
    padding: 0.8rem 1.5rem;
    text-decoration: none;
    color: var(--btnText);
    background: var(--btnColor);
```

```
 border-radius: 7px;
}
.lung-inner{
    animation: lungsAnimation 1.5s linear infinite alternate;
}
@keyframes lungsAnimation {
    from{
        filter: drop-shadow(0 0 0px #7f5af0);
    }
    to{
        filter: drop-shadow(0 0 2px #7f5af0);
    }
}
.about{
    height: 130vh;
    padding: 5% 10%;
    background-color: var(--bgColor);
    display: flex;
    flex-direction: column;
    align-items: center;
    gap: 4rem;
}
```

```
.about-heading{
    text-align: center;
    color: var(--headerColor);
}
.about-heading h1{
    font-size: 35px;
}
.about-heading p{
    font-size: 20px;
}
.about-content{
    gap: 2rem;
    display: flex;
    flex-wrap: wrap;
    align-items: center;
    justify-content: space-between;
}
.about-cards{
    /* margin: 2em; */
    height: 30vh;
    width: 38.7vw;
    background-color: var(--bgColor2);
```

```
border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    transition: 0.2s;
    color: var(--paraColor);
    display: flex;
    flex-direction: column;
    justify-content: center;
    align-items: center;
    gap: 3rem;
    text-align: justify;
    padding: 0 1rem;
    & h2{
        color: var(--headerColor);
    }
}
.about-cards:hover{
    transition: 0.2s;
    box-shadow: 0px 2px 20px 0.5px rgba(99, 99, 99, 0.2);
}
.tech{
    padding: 5% 10%;
    background-color: var(--bgColor);
    display: flex;
```

```
flex-direction: column;
    align-items: center;
    gap: 4rem;
    & h1{
        color: var(--headerColor);
        font-size: 35px;
    }
}
.tech-content{
    display: flex;
    flex-direction: column;
    gap: 2rem;
}
.tech-cards{
    display: flex;
    gap: 2rem;
    align-items: center;
    & p{
        color: var(--paraColor);
        text-align: justify;
        font-size: 18px;
    }
    .tech-text{
```

```
padding: 2rem;
        height: 100%;
        width: 100%;
        background-color: var(--bgColor2);
        border-radius: 10px;
        box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
        transition: 0.2s;
        display: flex;
        align-items: center;
        justify-content: center;
    }
}
.tech-icon{
    height: 100%;
    width: 20%;
    padding: 2rem;
    background-color: var(--bgColor2);
    border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    transition: 0.2s;
    display: flex;
    gap: 1rem;
    flex-direction: column;
```

```
align-items: center;
    justify-content: center;
    & h2{
        color: var(--headerColor);
    }
    & img{
        height: 50px;
        width: 50px;
    }
    .matplot{
        height: 60px;
        width: 60px;
    }
    .scikit{
        height: 80px;
        width: 80px;
    }
    .pandas{
        height: 150px;
        width: 150px;
    }
    .opencv{
        height: 70px;
```

```
 width: 70px;
    }
}
.tech-icon:hover{
    transition: 0.2s;
    box-shadow: 0px 2px 20px 0.5px rgba(99, 99, 99, 0.2);
}
.tech-text:hover{
    transition: 0.2s;
    box-shadow: 0px 2px 20px 0.5px rgba(99, 99, 99, 0.2);
}
header {
    padding: 0% 10%;
    height: 10vh;
    background-color: var(--bgColor);
    display: flex;
    align-items: center;
    justify-content: space-between;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    position:sticky;
    /* top: 0; */
}
```

```
.right{
    display: flex;
    align-items: center;
    justify-content: space-between;
    gap: 1em;
}
.links{
    display: flex;
}
.links li{
    padding: 0em 1em;
    list-style: none;
}
.links li a {
    color: var(--headerColor);
    text-decoration: none;
}
.try-now{
    padding: 1rem 2rem;
    background-color: var(--btnColor);
    text-decoration: none;
    color: var(--headerColor);
    border-radius: 7px;
```

```
}
::placeholder{
    color: var(--paraColor);
}
.contact{
    height: 100%;
    padding: 5% 10%;
    background-color: var(--bgColor);
    display: flex;
    align-items: center;
    flex-direction: column;
    gap: 4em;
    & h1{
        color: var(--headerColor);
        font-size: 35px;
    }
}
.contact-container{
    height: 100%;
    width: 100%;
    display: flex;
    justify-content: center;
    gap: 2rem;
```

```
}
.contact-form-container{
    background-color: var(--bgColor2);
    border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    padding: 0vh 3vw;
    height: 45vh;
    width: 50vw;
    display: flex;
    flex-direction: column;
    justify-content: space-evenly;
    text-align: center;
    & h3{
        color: var(--headerColor);
    }
}
.contact-form{
    display: flex;
    flex-direction: column;
    align-items: center;
    gap: 0.5rem;
    & input{
        height: 2rem;
```

```
width: 100%;
        background-color: var(--bgColor2);
        border: 3px solid var(--bgColor);
        color: var(--paraColor);
        border-radius: 10px;
    }
    & textarea{
        color: var(--paraColor);
        height: 6rem;
        width: 100%;
        background-color: var(--bgColor2);
        border: 3px solid var(--bgColor);
        border-radius: 10px;
        resize: none;
    }
    & button{
        cursor: pointer;
        height: 3rem;
        width: 6rem;
        background-color: var(--btnColor);
        border: none;
        border-radius: 7px;
        color: var(--btnText);
```

```
font-size: 20px;
    }
}
.contact-detail-container{
    display: flex;
}
.contact-info{
    width: 35vw;
    background-color: var(--bgColor2);
    border-radius: 10px;
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    padding: 3vh 3vw;
    display: flex;
    align-items: center;
    justify-content: space-evenly;
    flex-direction: column;
    color: var(--headerColor);
}
.contact-labels{
    width: 50%;
    display: flex;
    flex-direction: column;
    justify-content: space-evenly;
```

```
gap: 1rem;
}
.contact-details{
    width: 50%;
    display: flex;
    flex-direction: column;
    justify-content: space-evenly;
    gap: 0.5rem;
    & a{
        color: var(--headerColor);
    }
}
footer{
    padding: 5% 10%;
    height: 35vh;
    background-color: var(--bgColor);
    box-shadow: 0px 2px 20px 0.5px rgba(0, 0, 0, 0.2);
    display: flex;
    justify-content: space-between;
}
.useful-container{
    display: flex;
    flex-direction: column;
```

```
gap: 0.5rem;
    & h3{
        color: var(--headerColor);
    }
    & div ul{
        list-style: none;
        & li a{
            text-decoration: none;
            color: var(--paraColor);
        }
        & li {
            margin: 0.5em 0em;
        }
    }
}
.socials{
    display: flex;
    align-items: center;
    flex-direction: column;
    gap: 0.5rem;
    & h3{
        color: var(--headerColor);
    }
```

```
& a {
    text-decoration: none;
    & svg{
        height: 40px;
        width: 40px;
    }
  }
  & div{
    display: flex;
    justify-content: space-evenly;
    gap: 0.5rem;
  }
}
```

## 7. System Testing

System testing is a critical phase in the development of the Lung Cancer Detection System. It ensures that the system functions as intended, meets its requirements, and is free from critical defects before deployment. This section outlines the comprehensive testing approach employed in the development of the system.

### Testing Objectives

The primary objectives of system testing for the Lung Cancer Detection System are as follows:

**Functionality Testing:** To verify that all system functionalities, including image analysis, reporting, and user interaction, work correctly.

**Accuracy Testing:** To assess the accuracy of lung cancer lesion detection and classification against a set of benchmark cases.

**Performance Testing:** To evaluate the system's response time, scalability, and resource utilization under different workloads.

**Usability Testing:** To ensure that the user interface is intuitive, user-friendly, and accessible to healthcare professionals.

**Security Testing:** To identify and mitigate potential security vulnerabilities and protect patient data.

### Testing Phases

- **Unit Testing**

  Objective: Validate the correctness of individual components and functions within the system, including data preprocessing, machine learning models, and database operations.

  Methods: White-box testing techniques are applied to ensure code-level correctness.

  Tools: Python unit testing for component-level testing.

- **Integration Testing**

Objective: Validate the interaction between system components, ensuring that they work together as intended.

Methods: Black-box testing techniques focus on inputs, outputs, and interfaces between components.

Tools: Tools like Postman or custom scripts to simulate different interactions.

- **Functional Testing**

Objective: Verify that the system functions correctly according to its requirements and specifications.

Methods: Black-box testing to evaluate functional aspects such as image analysis, report generation, and user interactions.

Tools: Custom test scripts, sample datasets, and test cases.

- **Performance Testing**

Objective: Evaluate system performance under varying loads, assess response times, and identify potential bottlenecks.

Methods: Load testing, stress testing, and benchmarking using simulated user traffic.

Tools: Built in web browser tools and using python logger.

- **Usability Testing**

Objective: Assess the user interface's intuitiveness and user-friendliness through user feedback.

Methods: Real healthcare professionals interact with the system, and their feedback is collected.

Tools: Usability testing platforms and surveys.

## Test Cases

Each testing phase involves the creation of detailed test cases that specify input data, expected outcomes, and pass/fail criteria. Test cases should cover various scenarios, including normal operation, edge cases, and potential error conditions.

## Test Environment

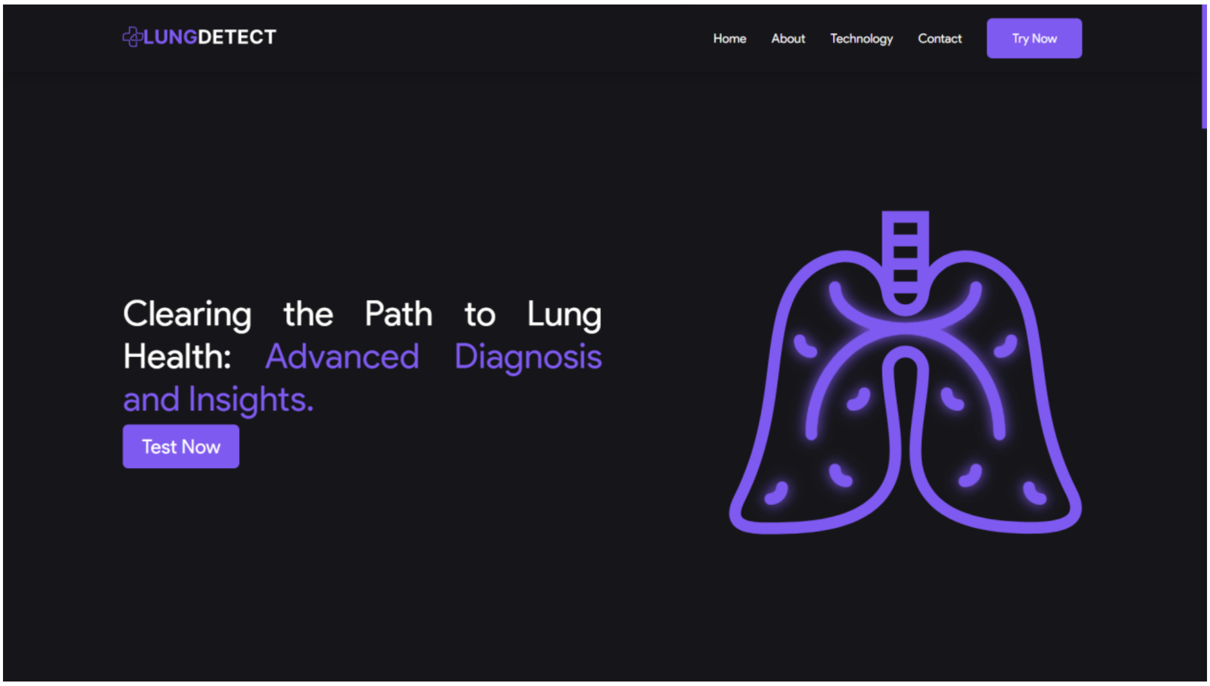
A dedicated test environment is set up to mimic the production environment as closely as possible. It includes a replica of the database, server infrastructure, and network configurations.

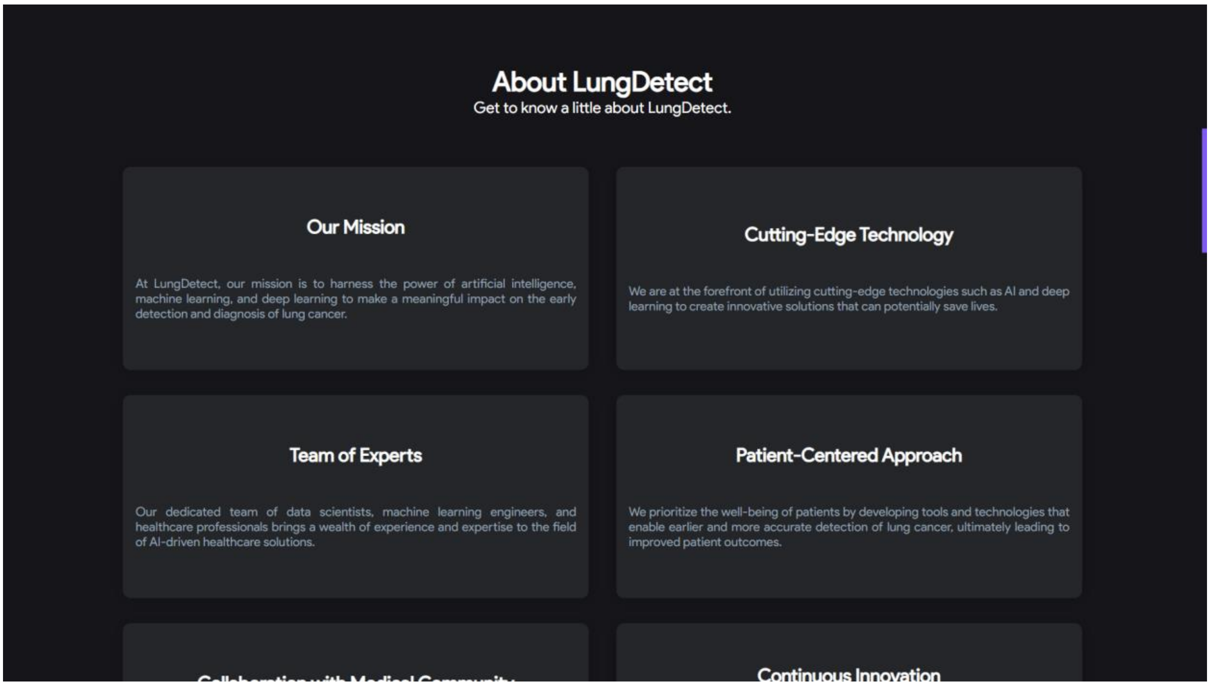
## Conclusion

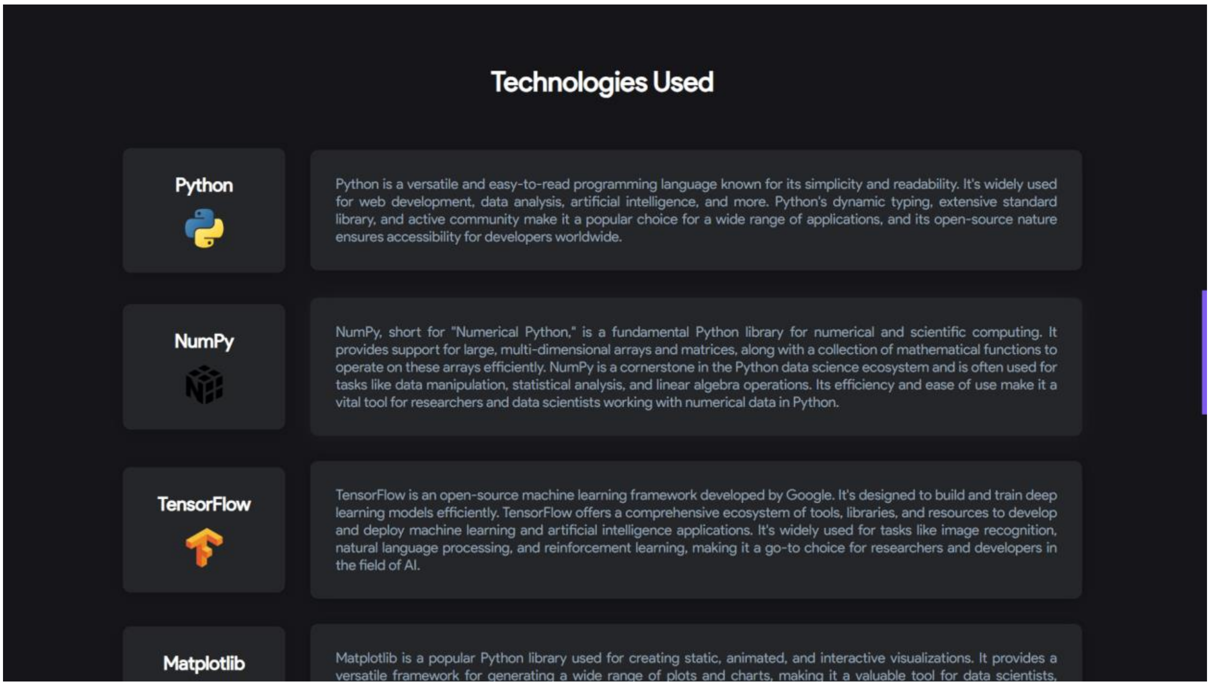
System testing is an integral part of the development process for the Lung Cancer Detection System. It ensures that the system meets its objectives in terms of functionality, accuracy, performance, usability, and security. Thorough testing is crucial to deliver a reliable and effective tool for healthcare professionals in the early detection of lung cancer.

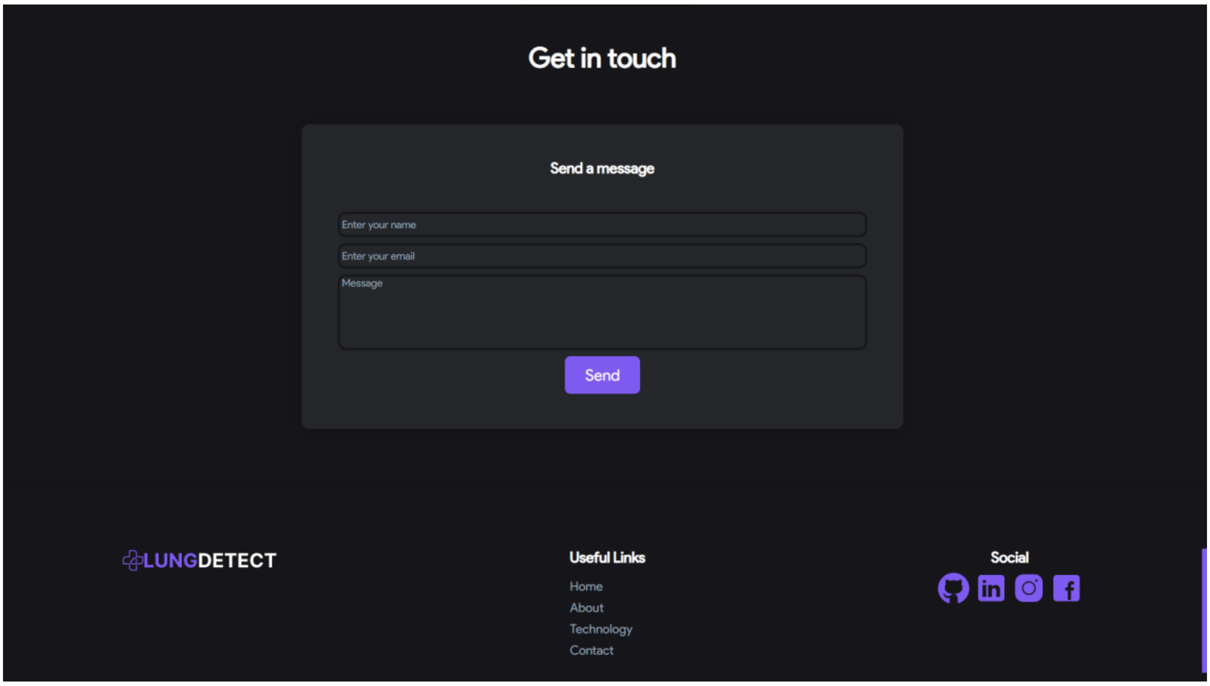
## 8. Snapshots

### Index page

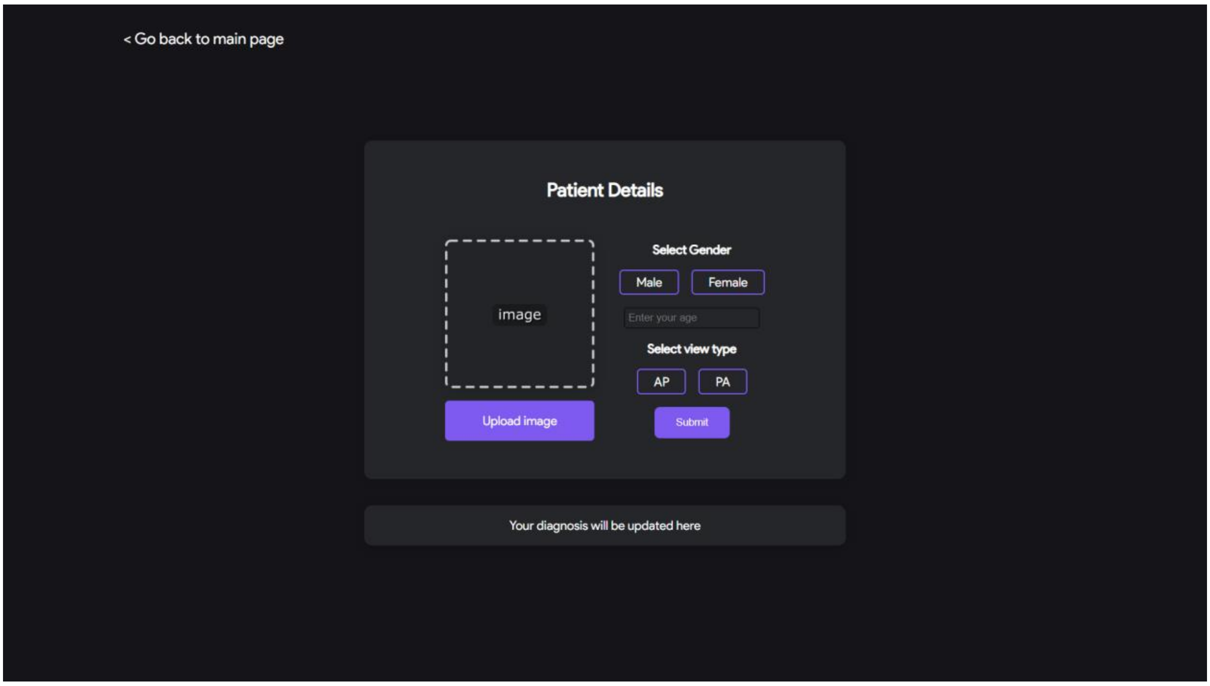


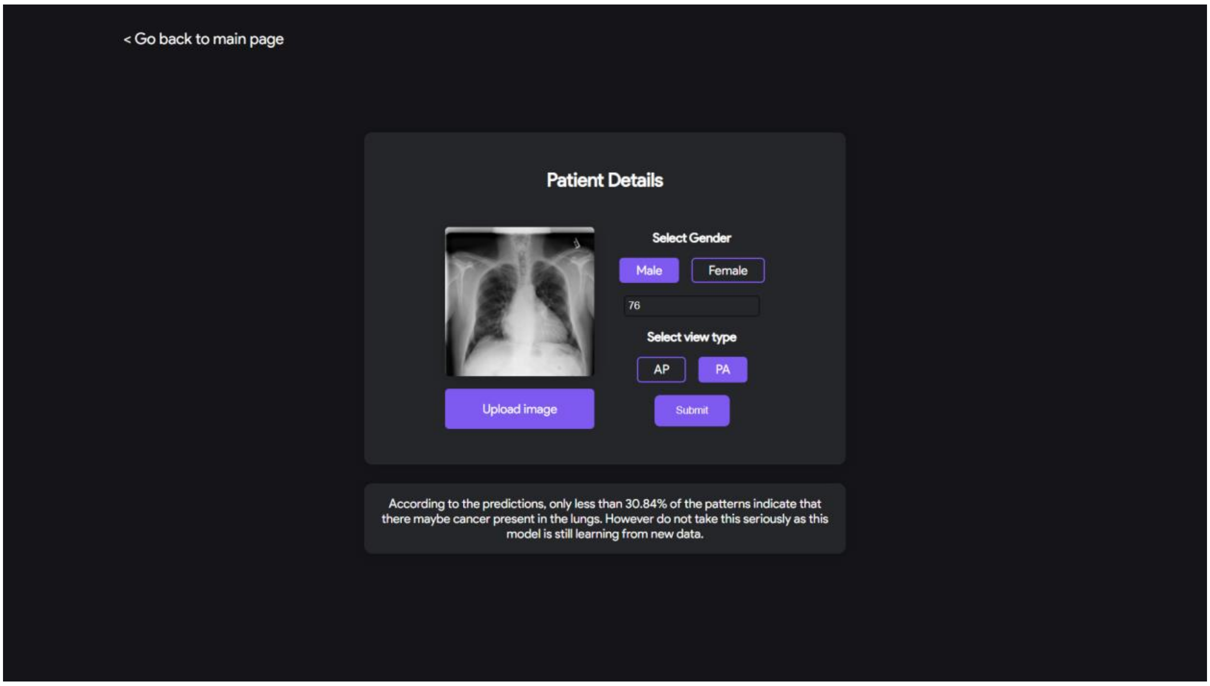




Technologies Used
Python
Python is a versatile and easy-to-read programming language known for its simplicity and readability. It's widely used for web development, data analysis, artificial intelligence, and more. Python's dynamic typing, extensive standard library, and active community make it a popular choice for a wide range of applications, and its open-source nature ensures accessibility for developers worldwide.
NumPy
NumPy, short for "Numerical Python," is a fundamental Python library for numerical and scientific computing. It provides support for large, multi-dimensional arrays and matrices, along with a collection of mathematical functions to operate on these arrays efficiently. NumPy is a cornerstone in the Python data science ecosystem and is often used for tasks like data manipulation, statistical analysis, and linear algebra operations. Its efficiency and ease of use make it a vital tool for researchers and data scientists working with numerical data in Python.
TensorFlow
TensorFlow is an open-source machine learning framework developed by Google. It's designed to build and train deep learning models efficiently. TensorFlow offers a comprehensive ecosystem of tools, libraries, and resources to develop and deploy machine learning and artificial intelligence applications. It's widely used for tasks like image recognition, natural language processing, and reinforcement learning, making it a go-to choice for researchers and developers in the field of AI.
Matplotlib
Matplotlib is a popular Python library used for creating static, animated, and interactive visualizations. It provides a


Get in touch
Send a message
Enter your name
Enter your email
Message
Send
LUNGDETECT
Useful Links
Home
About
Technology
Contact
Social

## Predictions page



# 9. Future Enhancements

As technology continues to evolve, and as we gain more insights into the field of lung cancer detection, the Lung Cancer Detection System can be enhanced and expanded to provide even more value to healthcare professionals and patients. Here are some promising directions for future development:

- **Integration with Multiple Imaging Modalities:** While the system currently focuses on X-ray image analysis, future enhancements could involve the integration of other imaging modalities such as CT scans, MRIs, or PET scans. This broader range of data sources would provide a more comprehensive view for diagnosis.

- **Continuous Learning:** Incorporate mechanisms for continuous learning of the machine learning models. Frequent updates and retraining on new data can improve accuracy and adapt to evolving patterns of lung cancer.

- **Multilingual Support:** Extend the user interface to support multiple languages, making the system accessible to a broader audience of healthcare professionals globally.

- **Telemedicine Integration:** Integrate the Lung Cancer Detection System with telemedicine platforms, enabling remote consultations and diagnostics. This can enhance healthcare access, especially in underserved areas.

- **Mobile Application:** Develop a mobile application that allows healthcare professionals to capture and upload images directly from mobile devices, making it easier to use the system in various clinical settings.

- **Enhanced Reporting:** Enhance the diagnostic reports with more detailed information, including lesion size, growth rate, and treatment recommendations. Interactive visualizations can aid in data interpretation.

- **Cloud-based Deployment:** Consider a cloud-based deployment model, which can offer scalability, redundancy, and accessibility from anywhere with an internet connection.

- **Collaboration and Second Opinions:** Enable collaboration features that allow multiple healthcare professionals to review and discuss cases within the system. Second-opinion capabilities can improve diagnostic accuracy.

- **Regulatory Compliance:** Stay updated with regulatory requirements in the healthcare and medical software domain. Comply with standards such as HIPAA and FDA regulations, ensuring data security and patient safety.

- **Research Collaboration:** Collaborate with research institutions and medical experts to continually refine and validate the system's algorithms and performance against a broader dataset.

- **AI Explainability:** Implement AI explainability features to provide insights into how the machine learning model arrives at its conclusions. This can increase trust and transparency in the system.

- **Education and Training:** Develop educational resources and training materials to help healthcare professionals make the most of the system's capabilities. This can include online courses or webinars.

- **User Feedback Mechanism:** Incorporate a feedback mechanism within the user interface to gather suggestions and insights from healthcare professionals, aiding in iterative improvements.

These future enhancements demonstrate your commitment to ongoing development and innovation in the field of lung cancer detection. They also highlight your dedication to improving patient care and the effectiveness of healthcare providers in combatting this critical health issue.

## 10. Conclusion

In conclusion, the Lung Cancer Detection System represents a pivotal milestone in the realm of healthcare technology. This innovative project, developed with unwavering dedication, brings forth a powerful tool designed to transform the early detection of lung cancer. As this documentation encapsulates the journey, purpose, and capabilities of the system, it is imperative to reflect on the significance of this endeavor.

Our system leverages cutting-edge technologies, including machine learning and medical image analysis, to analyze medical images such as X-rays and aid healthcare professionals in the timely identification of potential lung cancer lesions. With a user-friendly interface and rigorous testing, it is poised to become an invaluable asset in clinical practice.

Throughout the development process, we have adhered to the highest standards of accuracy, functionality, and security. The system's performance has been rigorously tested, ensuring that it meets and surpasses its defined objectives.

The journey does not end here; it merely signifies the beginning of a commitment to continuous improvement and advancement. Future enhancements, such as integration with multiple imaging modalities, real-time analysis, and cloud-based deployment, demonstrate our dedication to staying at the forefront of healthcare technology.

We extend our gratitude to the healthcare professionals, researchers, and experts who have contributed their insights and expertise to make this project a reality. Together, we endeavor to make a meaningful impact in the fight against lung cancer, improving patient outcomes and enhancing the quality of care.

As we move forward, this Lung Cancer Detection System stands as a testament to the potential of technology to revolutionize healthcare. It is not merely a system but a beacon of hope, embodying our collective commitment to the well-being of patients and the pursuit of excellence in medical science.

In the spirit of innovation and dedication to human health, we invite you to explore, utilize, and contribute to this system's ongoing evolution. Together, we can forge a brighter future in the early detection and treatment of lung cancer, saving lives and making a profound difference in the world of healthcare.

## 11. Bibliography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