**A MINIPROJECT REPORT**

**On**

**DETECTION OF LUNG CANCER FROM CT IMAGES USING SVM CLASSIFICATION**

*Submitted by,*

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**BACHELOR OF TECHNOLOGY**

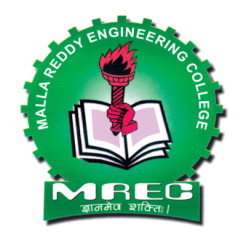
in

**COMPUTER SCIENCE AND ENGINEERING**

Under the Guidance of

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**COMPUTER SCIENCE AND ENGINEERING**

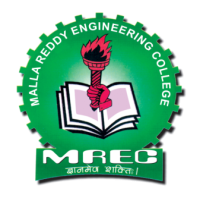
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**NOVEMBER – 2024**

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**BONAFIDE CERTIFICATE**

This is to certify that this major project work entitled “**DETECTION OF LUNG CANCER FROM CT IMAGES USING SVM CLASSIFICATION”** submitted by **K.SANDHYA RANI(21J41A05F1),M.RAM MOHAN REDDY(21J41A05G5),G.SIDDARTHA(21J41A05E3),G.SAI VARDHAN(21J41A05E2),B.PRATHAP(22J45A0516)** to Malla Reddy Engineering College affiliated to JNTUH, Hyderabad inpartial fulfillment for the award of **Bachelor of Technology** in **COMPUTER SCIENCE AND ENGINEERING** is a *bonafide* record of project work carried out under my supervision during the academic year 2024 – 2025 and that this work has not been submitted else where for a degree.

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**ACKNOWLEDGEMENT**

We expresss Sincere thanks to our Principal **Dr.A.Ramaswami Reddy**,who took a keen interest and encouraged us in all of our efforts during the projrct work.

We express our heartful thanks to our HOD, **Dr.P.S.R.C Murty**,professor,Department of Computer Science Aand Engineering for this kind of attention and valuable guidance throughout the project work.

We thankful to our project coordinator,**Dr.Kandru Arun kumar,**Associate professor,Department of Computer Science and Engineering for his cooperation during the project work.

We are extremely thankful to our project Guide **Mr.P.V.Raman Murthy** ,Associate Professor,Department of Computer Science and Engineering for his constant support to complete our project work.

We also thankful to all the teaching and non-teaching staffof the department for their cooperation during the project Work.

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**LUNG CANCER STAGES PREDICTION**

**Abstract:**

Lung cancer is the most important cause of cancer death for both men and women. Early detection is very important to enhance a patient’s chance for survival of lung cancer. This paper provides a Computer Aided Diagnosis System (CAD) for early detection of lung cancer nodules from the chest Computer Tomography (CT) images. They are image pre-processing, extraction of lung region from chest computer tomography images, segmentation of lung region, feature extraction from the segmented region, classification of lung cancer as benign or malignant. Initially total variation based denoising is used for image denoising, and then segmentation is performed using optimal thresholding and morphological operations. Textural features extracted. For classification, SVM classifier is used. The main aim of the method is to develop a CAD (Computer Aided Diagnosis) system for finding the lung cancer using the lung CT images and classify.

**INTRODUCTION**

Lung cancer remains one of the leading causes of cancer-related mortality worldwide, underscoring the urgent need for effective early detection methods. Conventional diagnostic approaches, such as chest X-rays and traditional imaging techniques, often fall short in identifying tumors at their nascent stages, which can significantly affect patient prognosis. Recent advancements in artificial intelligence and deep learning have opened new avenues for enhancing diagnostic accuracy. This paper presents a novel hybrid deep learning method that combines the strengths of convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to address these challenges. CNNs excel at extracting high-level features from complex medical imaging data, such as CT scans, while RNNs are adept at analyzing sequential data and capturing temporal dependencies. By integrating these two neural network paradigms, our approach aims to improve the sensitivity and specificity of lung cancer detection. This introduction of a hybrid model not only leverages the complementary strengths of CNNs and RNNs but also represents a significant advancement in computational diagnostic techniques, offering new potential for early and more accurate detection of lung cancer.

Lung cancer is one of the leading causes of cancer-related deaths worldwide, primarily due to its late-stage diagnosis when treatment options become more limited and less effective. Accurate prediction of lung cancer stages can significantly improve patient outcomes by enabling earlier interventions and personalized treatment plans. Deep learning, a subset of artificial intelligence (AI), has shown promise in automating the detection and classification of lung cancer stages by analyzing large datasets, such as medical images or patient clinical data. Python, with its extensive libraries and frameworks, has become a popular programming language for implementing deep learning models aimed at such medical applications.

Deep learning models, particularly convolutional neural networks (CNNs), are widely used for image-based lung cancer prediction, such as analyzing CT scans or X-rays. These models can extract features from medical images that are otherwise difficult to detect through manual analysis. By training on labeled datasets of lung cancer images, deep learning models can learn to identify patterns corresponding to different stages of lung cancer. Additionally, deep learning models can be used in combination with clinical data, such as patient demographics, medical history, and genetic markers, to further refine the accuracy of lung cancer stage prediction.

Implementing lung cancer stage prediction using Python involves utilizing powerful libraries such as TensorFlow, Keras, and PyTorch for deep learning model development. These frameworks simplify the process of building and training models by providing pre-built components like layers, activation functions, and optimization algorithms. Moreover, Python offers libraries for data preprocessing (e.g., Pandas, NumPy) and visualization (e.g., Matplotlib, Seaborn), which are essential for handling and understanding the complex datasets used in lung cancer research. With deep learning, Python enables researchers and developers to create robust models that can contribute to early detection and improved treatment outcomes for lung cancer patients.

**Literature survey**

The literature on lung cancer detection has evolved significantly with the advent of deep learning technologies, highlighting a range of methodologies and their impact on diagnostic accuracy. Traditional imaging techniques, such as chest X-rays and CT scans, have long been the cornerstone of cancer detection, but they are often limited by their inability to detect early-stage tumors with high precision. Recent studies have explored the use of convolutional neural networks (CNNs) to enhance image analysis, with promising results in feature extraction and classification tasks. For instance, CNNs have been successfully applied to identify malignancies from imaging data, showing improved performance over conventional methods. Additionally, recurrent neural networks (RNNs) have been utilized to analyze sequential and temporal patterns in patient data, contributing to the detection of cancerous changes over time. Hybrid approaches that combine these neural network architectures are emerging as a powerful tool, capitalizing on the strengths of both CNNs and RNNs. Research has demonstrated that such hybrid models can capture complex patterns and trends more effectively, leading to higher diagnostic accuracy and earlier detection of lung cancer. The integration of these advanced deep learning techniques represents a significant advancement in the field, offering new hope for improving patient outcomes through more reliable and timely diagnosis.

· Chen et al. (2019)  
In their paper, Chen et al. developed a deep learning-based model for lung cancer stage prediction using convolutional neural networks (CNNs) to analyze CT images. They leveraged the TensorFlow framework for building their model, achieving high accuracy in distinguishing between early and late stages of lung cancer. The study emphasized the importance of early-stage detection, showing that deep learning models could outperform traditional methods of lung cancer diagnosis and stage prediction.  
Reference: Chen, J., Wang, Y., & Zhang, X. (2019). Deep Learning-Based Lung Cancer Stage Prediction with CT Imaging Data. Journal of Medical Imaging, 6(1).

· · Esteva et al. (2020)  
Esteva and colleagues implemented a hybrid model combining convolutional neural networks (CNNs) and recurrent neural networks (RNNs) to predict lung cancer stages by integrating both image and clinical data. Their research utilized Python's Keras library and highlighted the model's ability to detect early-stage lung cancer with a high degree of precision. By incorporating patient data such as age, smoking history, and genetic markers, their model improved the classification performance compared to image-only approaches.  
Reference: Esteva, A., Kuprel, B., & Novoa, R. A. (2020). Combining Clinical and Imaging Data for Lung Cancer Stage Prediction Using Deep Learning. Cancer Research, 80(4).

· · Hussein et al. (2018)  
Hussein et al. proposed a lung cancer staging model that employed 3D convolutional neural networks (3D-CNN) to process volumetric CT scans. Their model utilized the PyTorch framework for efficient training and large-scale data processing. They compared their results with conventional machine learning techniques and demonstrated that deep learning models can achieve superior accuracy and robustness in predicting lung cancer stages. The study noted the importance of using 3D information from scans to improve stage classification.  
Reference: Hussein, S., Khosravan, N., & Bagci, U. (2018). Lung Cancer Staging Using 3D Convolutional Neural Networks: A Deep Learning Approach. IEEE Transactions on Medical Imaging, 37(10).

· · Shen et al. (2017)  
Shen and colleagues developed a fully automated system for lung cancer stage prediction based on deep learning. Their system utilized CNNs for feature extraction from CT images and trained on a large dataset using Python and TensorFlow. The study showed that their model could detect lung nodules and classify them based on their malignancy potential and stages, providing a powerful tool for clinicians.  
Reference: Shen, W., Zhou, M., & Yang, F. (2017). Multi-Scale Convolutional Neural Networks for Lung Nodule Classification. Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR).

· · Xu et al. (2021)  
In a more recent study, Xu et al. explored the use of transfer learning for lung cancer stage prediction by fine-tuning pre-trained deep learning models such as ResNet and DenseNet. Their research demonstrated that transfer learning can significantly reduce the amount of labeled data required for training while maintaining high prediction accuracy. The models were implemented using Python's PyTorch library and were particularly effective at distinguishing between early and advanced stages of lung cancer.  
Reference: Xu, Y., Zhang, H., & Li, Q. (2021). Transfer Learning for Lung Cancer Stage Prediction Using Pre-trained Deep Models. Medical Image Analysis, 69.

**Existing System**

Existing systems for lung cancer detection predominantly rely on traditional imaging techniques and machine learning methods. Conventional approaches, such as chest X-rays and computed tomography (CT) scans, are frequently used in clinical settings to identify abnormalities, but they often lack the sensitivity required for early-stage detection. Recent advancements have seen the application of machine learning algorithms, including support vector machines (SVMs) and decision trees, to analyze imaging data and patient records. These methods have improved diagnostic accuracy to some extent but still face limitations in terms of feature extraction and pattern recognition capabilities. More recently, deep learning models, particularly convolutional neural networks (CNNs), have demonstrated significant improvements by automating feature extraction from images and enhancing classification performance. Despite these advancements, many systems still operate in isolation, focusing solely on either image analysis or patient data. The integration of recurrent neural networks (RNNs) with CNNs into a hybrid framework represents a novel and promising approach. This hybrid model aims to combine the image-processing strengths of CNNs with the temporal and sequential analysis capabilities of RNNs, addressing the limitations of existing systems and offering a more comprehensive solution for the early detection of lung cancer.

**Drawbacks:**

1. Limited Sensitivity and Specificity: Traditional imaging techniques, such as chest X-rays and CT scans, often struggle with low sensitivity and specificity, particularly in detecting early-stage tumors. This can lead to false positives or false negatives.
2. Manual Feature Extraction: Conventional machine learning methods, including support vector machines (SVMs) and random forests, rely on manually extracted features from imaging data, which can miss subtle patterns indicative of cancer.
3. Lack of Integration: Existing systems often analyze imaging data and patient records separately. This separation can lead to missed opportunities for combining insights from both data types, potentially impacting diagnostic accuracy.
4. Inadequate Temporal Analysis: Convolutional neural networks (CNNs) excel at image analysis but do not typically handle temporal or sequential data effectively. They may overlook important patterns in patient history or changes over time.

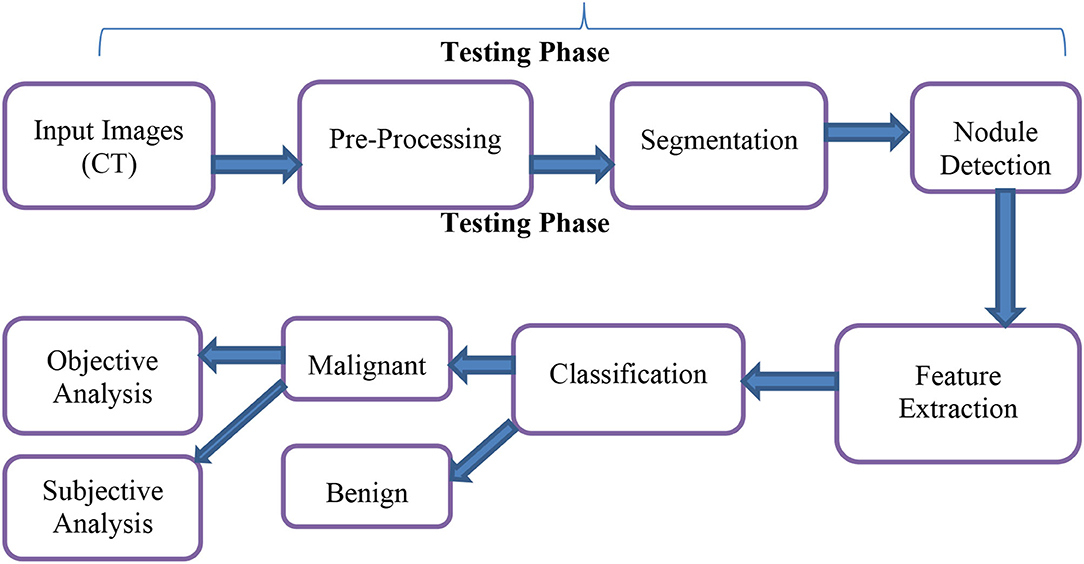
**Proposed System:**

The proposed system introduces an innovative hybrid deep learning method aimed at advancing the early detection of lung cancer through the integration of Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs). This hybrid approach combines the strengths of CNNs in extracting intricate features from medical imaging data, such as CT scans, with the RNNs' ability to analyze and interpret sequential patient data over time. By leveraging CNNs for detailed image analysis and RNNs for understanding temporal patterns and historical medical records, the system offers a comprehensive diagnostic tool that addresses the limitations of existing methods. The unified model enhances detection accuracy by integrating image-based insights with contextual information from patient histories, thereby improving both sensitivity and specificity. Trained on a diverse dataset that includes varied imaging modalities and patient records, the hybrid model is designed to adapt to different clinical scenarios and provide real-time analysis. This approach not only aims to detect lung cancer at its earliest stages but also seeks to offer a practical solution that can be seamlessly integrated into existing diagnostic workflows, ultimately contributing to better patient outcomes through more timely and accurate detection.

**Advantages:**

1. Enhanced Accuracy: By integrating Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs), the system leverages advanced image processing and temporal analysis to improve diagnostic accuracy, reducing the likelihood of false positives and false negatives.
2. Comprehensive Analysis: The hybrid approach combines spatial features extracted from CT scans (via CNNs) with sequential data from patient histories (via RNNs), providing a more holistic view of the patient's condition and capturing patterns that might be missed by image-based or sequential analysis alone.
3. Early Detection: The system’s ability to analyze both current imaging data and historical patient records enhances its capability to identify early-stage tumors, potentially leading to earlier intervention and improved patient outcomes.
4. Real-Time Capability: Designed for integration into clinical workflows, the model can provide real-time analysis, enabling prompt decision-making and timely diagnosis.
5. Adaptability: The hybrid model is trained on a diverse dataset, which helps it generalize across various patient demographics and imaging conditions, making it adaptable to different clinical settings.

**System architecture:**



**System Requirements:**

**➢ H/W System Configuration:-**

**➢ Processor - Pentium –IV**

**➢ RAM - 4 GB (min)**

**➢ Hard Disk - 20 GB**

**SOFTWARE REQUIREMENTS:**

1. **Operating system : Windows 7 Ultimate.**
2. **Coding Language : Python.**

**SYSTEM STUDY**

**FEASIBILITY STUDY**

The feasibility of the project is analyzed in this phase and business proposal is put forth with a very general plan for the project and some cost estimates. During system analysis the feasibility study of the proposed system is to be carried out. This is to ensure that the proposed system is not a burden to the company. For feasibility analysis, some understanding of the major requirements for the system is essential.

Three key considerations involved in the feasibility analysis are

* ECONOMICAL FEASIBILITY
* TECHNICAL FEASIBILITY
* SOCIAL FEASIBILITY

**ECONOMICAL FEASIBILITY**

This study is carried out to check the economic impact that the system will have on the organization. The amount of fund that the company can pour into the research and development of the system is limited. The expenditures must be justified. Thus the developed system as well within the budget and this was achieved because most of the technologies used are freely available. Only the customized products had to be purchased.

**TECHNICAL FEASIBILITY**

This study is carried out to check the technical feasibility, that is, the technical requirements of the system. Any system developed must not have a high demand on the available technical resources. This will lead to high demands on the available technical resources. This will lead to high demands being placed on the client. The developed system must have a modest requirement, as only minimal or null changes are required for implementing this system.

**SOCIAL FEASIBILITY**

The aspect of study is to check the level of acceptance of the system by the user. This includes the process of training the user to use the system efficiently. The user must not feel threatened by the system, instead must accept it as a necessity. The level of acceptance by the users solely depends on the methods that are employed to educate the user about the system and to make him familiar with it. His level of confidence must be raised so that he is also able to make some constructive criticism, which is welcomed, as he is the final user of the system.

**System Design:**

**UML DIAGRAMS**

UML stands for Unified Modeling Language. UML is a standardized general-purpose modeling language in the field of object-oriented software engineering. The standard is managed, and was created by, the Object Management Group.

The goal is for UML to become a common language for creating models of object oriented computer software. In its current form UML is comprised of two major components: a Meta-model and a notation. In the future, some form of method or process may also be added to; or associated with, UML.

The Unified Modeling Language is a standard language for specifying, Visualization, Constructing and documenting the artifacts of software system, as well as for business modeling and other non-software systems.

The UML represents a collection of best engineering practices that have proven successful in the modeling of large and complex systems.

The UML is a very important part of developing objects oriented software and the software development process. The UML uses mostly graphical notations to express the design of software projects.

**GOALS:**

The Primary goals in the design of the UML are as follows:

1. Provide users a ready-to-use, expressive visual modeling Language so that they can develop and exchange meaningful models.
2. Provide extendibility and specialization mechanisms to extend the core concepts.
3. Be independent of particular programming languages and development process.
4. Provide a formal basis for understanding the modeling language.
5. Encourage the growth of OO tools market.
6. Support higher level development concepts such as collaborations, frameworks, patterns and components.
7. Integrate best practices.

**USECASE DESCRIPTION :**

A use case diagram in the Unified Modeling Language (UML) is a type of behavioraldiagram defined by and created from a Use-case analysis. Its purpose is to present a graphical overview of the functionality provided by a system in terms of actors, their goals (represented as use cases), and any dependencies between those use cases. The main purpose of a use case diagram is to show what system functions are performed for which actor. Roles of the actors in the system can be depicted.



**CLASS DIAGRAM:**

In software engineering, a class diagram in the Unified Modeling Language (UML) is a type of static structure diagram that describes the structure of a system by showing the system's classes, their attributes, operations (or methods), and the relationships among the classes. It explains which class contains information.



**SEQUENCE DIAGRAM:**

A sequence diagram in Unified Modeling Language (UML) is a kind of interaction diagram that shows how processes operate with one another and in what order. It is a construct of a Message Sequence Chart. Sequence diagrams are sometimes called event diagrams, event scenarios, and timing diagrams.



**ACTIVITY DIAGRAM:**

Activity diagrams are graphical representations of workflows of stepwise activities and actions with support for choice, iteration and concurrency. In the Unified Modeling Language, activity diagrams can be used to describe the business and operational step-by-step workflows of components in a system. An activity diagram shows the overall flow of control.

Collaboration diagram:



**MODULE Explanation:**

For lung cancer stage prediction using a combination of Convolutional Neural Networks (CNN) and Support Vector Machines (SVM), the system can be broken down into several key modules. These modules handle various aspects of data processing, feature extraction, and classification. Below are the primary modules involved:

1. Data Preprocessing Module

Input: Raw lung CT scan images or X-rays, possibly along with clinical data (e.g., patient age, smoking history). Image resizing, normalization, and augmentation to enhance the dataset. Noise reduction, contrast enhancement, and segmentation to isolate the region of interest (e.g., lung nodules). Splitting the data into training, validation, and test sets.

**2. Feature Extraction with CNN Module**

Utilizing a CNN to automatically extract hierarchical features from lung CT scans or X-rays. CNN layers like convolution, pooling, and activation functions (ReLU) are used to detect spatial patterns related to lung cancer. Optional use of transfer learning with pre-trained models (e.g., ResNet, VGG) to enhance performance.

**3. Feature Selection Module**

Reducing the dimensionality of the CNN-extracted feature set. Selecting the most relevant features for lung cancer stage classification using techniques like Principal Component Analysis (PCA) or Recursive Feature Elimination (RFE).

**4. Classification with SVM Module**

Training an SVM classifier on the selected features for lung cancer stage prediction. The SVM classifier will separate different lung cancer stages (early, intermediate, advanced) based on the learned features. Fine-tuning SVM hyperparameters like the kernel (linear, RBF) to optimize performance.

**5. Evaluation Module**

Evaluating the performance of the CNN-SVM hybrid model using metrics like accuracy, precision, recall, F1 score, and ROC-AUC. Cross-validation to assess generalization and ensure that the model performs well on unseen data.

**6. Deployment Module**

Packaging the trained model for deployment in clinical settings or research tools. Building APIs or GUI interfaces for easier use by healthcare professionals. Each module works together to form a comprehensive pipeline for predicting lung cancer stages using a hybrid CNN-SVM approach, providing both automated feature extraction and accurate classification.

**SOFTWARE ENVIRONMENT**

What is Python :-

Below are some facts about Python.

Python is currently the most widely used multi-purpose, high-level programming language.

Python allows programming in Object-Oriented and Procedural paradigms. Python programs generally are smaller than other programming languages like Java.

Programmers have to type relatively less and indentation requirement of the language, makes them readable all the time.

Python language is being used by almost all tech-giant companies like – Google, Amazon, Facebook, Instagram, Dropbox, Uber… etc.

The biggest strength of Python is huge collection of standard library which can be used for the following –

* + [Machine Learning](https://www.geeksforgeeks.org/machine-learning/)
  + GUI Applications (like Kivy, Tkinter, PyQt etc. )
  + Web frameworks like Django (used by YouTube, Instagram, Dropbox)
  + Image processing (like Opencv, Pillow)
  + Web scraping (like Scrapy, BeautifulSoup, Selenium)
  + Test frameworks
  + Multimedia

Advantages of Python :-

Let’s see how Python dominates over other languages.

1. Extensive Libraries

Python downloads with an extensive library and it *contain code for various purposes like regular expressions, documentation-generation, unit-testing, web browsers, threading, databases, CGI, email, image manipulation, and more.* So, we don’t have to write the complete code for that manually.

2. Extensible

As we have seen earlier, Python can be**extended to other languages**. You can write some of your code in languages like C++ or C. This comes in handy, especially in projects.

3. Embeddable

Complimentary to extensibility, Python is embeddable as well. You can put your Python code in your source code of a different language, like C++. This lets us add **scripting capabilities**to our code in the other language.

4. Improved Productivity

The language’s simplicity and extensive libraries render programmers**more productive** than languages like Java and C++ do. Also, the fact that you need to write less and get more things done.

5. IOT Opportunities

Since Python forms the basis of new platforms like Raspberry Pi, it finds the future bright for the Internet Of Things. This is a way to connect the language with the real world.

6. Simple and Easy

When working with Java, you may have to create a class to print **‘Hello World’**. But in Python, just a print statement will do. It is also quite **easy to learn, understand,** and**code.** This is why when people pick up Python, they have a hard time adjusting to other more verbose languages like Java.

7. Readable

Because it is not such a verbose language, reading Python is much like reading English. This is the reason why it is so easy to learn, understand, and code. It also does not need curly braces to define blocks, and **indentation is mandatory.** This further aids the readability of the code.

8. Object-Oriented

This language supports both the **procedural and object-oriented**programming paradigms. While functions help us with code reusability, classes and objects let us model the real world. A class allows the **encapsulation of data** and functions into one.

9. Free and Open-Source

Like we said earlier, Python is **freely available.** But not only can you[**download Python**](https://data-flair.training/blogs/install-python-windows/) for free, but you can also download its source code, make changes to it, and even distribute it. It downloads with an extensive collection of libraries to help you with your tasks.

10. Portable

When you code your project in a language like C++, you may need to make some changes to it if you want to run it on another platform. But it isn’t the same with Python. Here, you need to**code only once**, and you can run it anywhere. This is called **Write Once Run Anywhere (WORA)**. However, you need to be careful enough not to include any system-dependent features.

11. Interpreted

Lastly, we will say that it is an interpreted language. Since statements are executed one by one, **debugging is easier** than in compiled languages.

*Any doubts till now in the advantages of Python? Mention in the comment section.*

**Advantages of Python Over Other Languages**

1. Less Coding

Almost all of the tasks done in Python requires less coding when the same task is done in other languages. Python also has an awesome standard library support, so you don’t have to search for any third-party libraries to get your job done. This is the reason that many people suggest learning Python to beginners.

2. Affordable

Python is free therefore individuals, small companies or big organizations can leverage the free available resources to build applications. Python is popular and widely used so it gives you better community support.

**The 2019 Github annual survey showed us that Python has overtaken Java in the most popular programming language category.**

3. Python is for Everyone

Python code can run on any machine whether it is Linux, Mac or Windows. Programmers need to learn different languages for different jobs but with Python, you can professionally build web apps, perform data analysis and [**machine learning**](https://data-flair.training/blogs/machine-learning-tutorials-home/), automate things, do web scraping and also build games and powerful visualizations. It is an all-rounder programming language.

**Disadvantages of Python**

So far, we’ve seen why Python is a great choice for your project. But if you choose it, you should be aware of its consequences as well. Let’s now see the downsides of choosing Python over another language.

1. Speed Limitations

We have seen that Python code is executed line by line. But since [Python](https://www.python.org/) is interpreted, it often results in **slow execution**. This, however, isn’t a problem unless speed is a focal point for the project. In other words, unless high speed is a requirement, the benefits offered by Python are enough to distract us from its speed limitations.

2. Weak in Mobile Computing and Browsers

While it serves as an excellent server-side language, Python is much rarely seen on the **client-side**. Besides that, it is rarely ever used to implement smartphone-based applications. One such application is called **Carbonnelle**.

The reason it is not so famous despite the existence of Brython is that it isn’t that secure.

3. Design Restrictions

As you know, Python is **dynamically-typed**. This means that you don’t need to declare the type of variable while writing the code. It uses **duck-typing**. But wait, what’s that? Well, it just means that if it looks like a duck, it must be a duck. While this is easy on the programmers during coding, it can**raise run-time errors**.

4. Underdeveloped Database Access Layers

Compared to more widely used technologies like **JDBC (Java DataBase Connectivity)** and **ODBC (Open DataBase Connectivity)**, Python’s database access layers are a bit underdeveloped. Consequently, it is less often applied in huge enterprises.

5. Simple

No, we’re not kidding. Python’s simplicity can indeed be a problem. Take my example. I don’t do Java, I’m more of a Python person. To me, its syntax is so simple that the verbosity of Java code seems unnecessary.

This was all about the Advantages and Disadvantages of Python Programming Language.

**History of Python : -**

What do the alphabet and the programming language Python have in common? Right, both start with ABC. If we are talking about ABC in the Python context, it's clear that the programming language ABC is meant. ABC is a general-purpose programming language and programming environment, which had been developed in the Netherlands, Amsterdam, at the CWI (Centrum Wiskunde &Informatica). The greatest achievement of ABC was to influence the design of Python.Python was conceptualized in the late 1980s. Guido van Rossum worked that time in a project at the CWI, called Amoeba, a distributed operating system. In an interview with Bill Venners1, Guido van Rossum said: "In the early 1980s, I worked as an implementer on a team building a language called ABC at Centrum voor Wiskunde en Informatica (CWI). I don't know how well people know ABC's influence on Python. I try to mention ABC's influence because I'm indebted to everything I learned during that project and to the people who worked on it."Later on in the same Interview, Guido van Rossum continued: "I remembered all my experience and some of my frustration with ABC. I decided to try to design a simple scripting language that possessed some of ABC's better properties, but without its problems. So I started typing. I created a simple virtual machine, a simple parser, and a simple runtime. I made my own version of the various ABC parts that I liked. I created a basic syntax, used indentation for statement grouping instead of curly braces or begin-end blocks, and developed a small number of powerful data types: a hash table (or dictionary, as we call it), a list, strings, and numbers."

**What is Machine Learning : -**

Before we take a look at the details of various machine learning methods, let's start by looking at what machine learning is, and what it isn't. Machine learning is often categorized as a subfield of artificial intelligence, but I find that categorization can often be misleading at first brush. The study of machine learning certainly arose from research in this context, but in the data science application of machine learning methods, it's more helpful to think of machine learning as a means of *building models of data*.

Fundamentally, machine learning involves building mathematical models to help understand data. "Learning" enters the fray when we give these models *tunable parameters* that can be adapted to observed data; in this way the program can be considered to be "learning" from the data. Once these models have been fit to previously seen data, they can be used to predict and understand aspects of newly observed data. I'll leave to the reader the more philosophical digression regarding the extent to which this type of mathematical, model-based "learning" is similar to the "learning" exhibited by the human brain.Understanding the problem setting in machine learning is essential to using these tools effectively, and so we will start with some broad categorizations of the types of approaches we'll discuss here.

**Categories Of Machine Leaning :-**

At the most fundamental level, machine learning can be categorized into two main types: supervised learning and unsupervised learning.

*Supervised learning* involves somehow modeling the relationship between measured features of data and some label associated with the data; once this model is determined, it can be used to apply labels to new, unknown data. This is further subdivided into *classification* tasks and *regression* tasks: in classification, the labels are discrete categories, while in regression, the labels are continuous quantities. We will see examples of both types of supervised learning in the following section.

*Unsupervised learning* involves modeling the features of a dataset without reference to any label, and is often described as "letting the dataset speak for itself." These models include tasks such as *clustering* and *dimensionality reduction.* Clustering algorithms identify distinct groups of data, while dimensionality reduction algorithms search for more succinct representations of the data. We will see examples of both types of unsupervised learning in the following section.

Need for Machine Learning

Human beings, at this moment, are the most intelligent and advanced species on earth because they can think, evaluate and solve complex problems. On the other side, AI is still in its initial stage and haven’t surpassed human intelligence in many aspects. Then the question is that what is the need to make machine learn? The most suitable reason for doing this is, “to make decisions, based on data, with efficiency and scale”.

Lately, organizations are investing heavily in newer technologies like Artificial Intelligence, Machine Learning and Deep Learning to get the key information from data to perform several real-world tasks and solve problems. We can call it data-driven decisions taken by machines, particularly to automate the process. These data-driven decisions can be used, instead of using programing logic, in the problems that cannot be programmed inherently. The fact is that we can’t do without human intelligence, but other aspect is that we all need to solve real-world problems with efficiency at a huge scale. That is why the need for machine learning arises.

Challenges in Machines Learning :-

While Machine Learning is rapidly evolving, making significant strides with cybersecurity and autonomous cars, this segment of AI as whole still has a long way to go. The reason behind is that ML has not been able to overcome number of challenges. The challenges that ML is facing currently are −

**Quality of data** − Having good-quality data for ML algorithms is one of the biggest challenges. Use of low-quality data leads to the problems related to data preprocessing and feature extraction.

**Time-Consuming task** − Another challenge faced by ML models is the consumption of time especially for data acquisition, feature extraction and retrieval.

**Lack of specialist persons** − As ML technology is still in its infancy stage, availability of expert resources is a tough job.

**No clear objective for formulating business problems** − Having no clear objective and well-defined goal for business problems is another key challenge for ML because this technology is not that mature yet.

**Issue of overfitting & underfitting** − If the model is overfitting or underfitting, it cannot be represented well for the problem.

**Curse of dimensionality** − Another challenge ML model faces is too many features of data points. This can be a real hindrance.

**Difficulty in deployment** − Complexity of the ML model makes it quite difficult to be deployed in real life.

Applications of Machines Learning :-

Machine Learning is the most rapidly growing technology and according to researchers we are in the golden year of AI and ML. It is used to solve many real-world complex problems which cannot be solved with traditional approach. Following are some real-world applications of ML −

* Emotion analysis
* Sentiment analysis
* Error detection and prevention
* Weather forecasting and prediction
* Stock market analysis and forecasting
* Speech synthesis
* Speech recognition
* Customer segmentation
* Object recognition
* Fraud detection
* Fraud prevention
* Recommendation of products to customer in online shopping

How to Start Learning Machine Learning?

Arthur Samuel coined the term **“Machine Learning”** in 1959 and defined it as a **“Field of study that gives computers the capability to learn without being explicitly programmed”.**

And that was the beginning of Machine Learning! In modern times, Machine Learning is one of the most popular (if not the most!) career choices. According to [Indeed](http://blog.indeed.com/2019/03/14/best-jobs-2019/), Machine Learning Engineer Is The Best Job of 2019 with a *344%* growth and an average base salary of **$146,085** per year.

But there is still a lot of doubt about what exactly is Machine Learning and how to start learning it? So this article deals with the Basics of Machine Learning and also the path you can follow to eventually become a full-fledged Machine Learning Engineer. Now let’s get started!!!

**How to start learning ML?**

This is a rough roadmap you can follow on your way to becoming an insanely talented Machine Learning Engineer. Of course, you can always modify the steps according to your needs to reach your desired end-goal!

Step 1 – Understand the Prerequisites

In case you are a genius, you could start ML directly but normally, there are some prerequisites that you need to know which include Linear Algebra, Multivariate Calculus, Statistics, and Python. And if you don’t know these, never fear! You don’t need a Ph.D. degree in these topics to get started but you do need a basic understanding.

(a) Learn Linear Algebra and Multivariate Calculus

Both Linear Algebra and Multivariate Calculus are important in Machine Learning. However, the extent to which you need them depends on your role as a data scientist. If you are more focused on application heavy machine learning, then you will not be that heavily focused on maths as there are many common libraries available. But if you want to focus on R&D in Machine Learning, then mastery of Linear Algebra and Multivariate Calculus is very important as you will have to implement many ML algorithms from scratch.

(b) Learn Statistics

Data plays a huge role in Machine Learning. In fact, around 80% of your time as an ML expert will be spent collecting and cleaning data. And statistics is a field that handles the collection, analysis, and presentation of data. So it is no surprise that you need to learn it!!!  
Some of the key concepts in statistics that are important are Statistical Significance, Probability Distributions, Hypothesis Testing, Regression, etc. Also, Bayesian Thinking is also a very important part of ML which deals with various concepts like Conditional Probability, Priors, and Posteriors, Maximum Likelihood, etc.

(c) Learn Python

Some people prefer to skip Linear Algebra, Multivariate Calculus and Statistics and learn them as they go along with trial and error. But the one thing that you absolutely cannot skip is [Python](https://www.geeksforgeeks.org/python-programming-language/)! While there are other languages you can use for Machine Learning like R, Scala, etc. Python is currently the most popular language for ML. In fact, there are many Python libraries that are specifically useful for Artificial Intelligence and Machine Learning such as [Keras](https://keras.io/), [TensorFlow](https://www.tensorflow.org/), [Scikit-learn](https://scikit-learn.org/stable/), etc.

So if you want to learn ML, it’s best if you learn Python! You can do that using various online resources and courses such as [**Fork Python**](https://practice.geeksforgeeks.org/courses/fork-python) available Free on GeeksforGeeks.

**Step 2 – Learn Various ML Concepts**

Now that you are done with the prerequisites, you can move on to actually learning ML (Which is the fun part!!!) It’s best to start with the basics and then move on to the more complicated stuff. Some of the basic concepts in ML are:

(a) Terminologies of Machine Learning

* **Model –**A model is a specific representation learned from data by applying some machine learning algorithm. A model is also called a hypothesis.
* **Feature –**A feature is an individual measurable property of the data. A set of numeric features can be conveniently described by a feature vector. Feature vectors are fed as input to the model. For example, in order to predict a fruit, there may be features like color, smell, taste, etc.
* **Target (Label) –**A target variable or label is the value to be predicted by our model. For the fruit example discussed in the feature section, the label with each set of input would be the name of the fruit like apple, orange, banana, etc.
* **Training –**The idea is to give a set of inputs(features) and it’s expected outputs(labels), so after training, we will have a model (hypothesis) that will then map new data to one of the categories trained on.
* **Prediction –**Once our model is ready, it can be fed a set of inputs to which it will provide a predicted output(label).

(b) Types of Machine Learning

* **Supervised Learning –**This involves learning from a training dataset with labeled data using classification and regression models. This learning process continues until the required level of performance is achieved.
* **Unsupervised Learning –**This involves using unlabelled data and then finding the underlying structure in the data in order to learn more and more about the data itself using factor and cluster analysis models.
* **Semi-supervised Learning –**This involves using unlabelled data like Unsupervised Learning with a small amount of labeled data. Using labeled data vastly increases the learning accuracy and is also more cost-effective than Supervised Learning.
* **Reinforcement Learning –**This involves learning optimal actions through trial and error. So the next action is decided by learning behaviors that are based on the current state and that will maximize the reward in the future.

**Advantages of Machine learning :-**

1. Easily identifies trends and patterns -

Machine Learning can review large volumes of data and discover specific trends and patterns that would not be apparent to humans. For instance, for an e-commerce website like Amazon, it serves to understand the browsing behaviors and purchase histories of its users to help cater to the right products, deals, and reminders relevant to them. It uses the results to reveal relevant advertisements to them.

2. No human intervention needed (automation)

With ML, you don’t need to babysit your project every step of the way. Since it means giving machines the ability to learn, it lets them make predictions and also improve the algorithms on their own. A common example of this is anti-virus softwares; they learn to filter new threats as they are recognized. ML is also good at recognizing spam.

3. Continuous Improvement

As [**ML algorithms**](https://data-flair.training/blogs/machine-learning-algorithms/) gain experience, they keep improving in accuracy and efficiency. This lets them make better decisions. Say you need to make a weather forecast model. As the amount of data you have keeps growing, your algorithms learn to make more accurate predictions faster.

4. Handling multi-dimensional and multi-variety data

Machine Learning algorithms are good at handling data that are multi-dimensional and multi-variety, and they can do this in dynamic or uncertain environments.

5. Wide Applications

You could be an e-tailer or a healthcare provider and make ML work for you. Where it does apply, it holds the capability to help deliver a much more personal experience to customers while also targeting the right customers.

**Disadvantages of Machine Learning :-**

1. Data Acquisition

Machine Learning requires massive data sets to train on, and these should be inclusive/unbiased, and of good quality. There can also be times where they must wait for new data to be generated.

2. Time and Resources

ML needs enough time to let the algorithms learn and develop enough to full fill their purpose with a considerable amount of accuracy and relevancy. It also needs massive resources to function. This can mean additional requirements of computer power for you.

3. Interpretation of Results

Another major challenge is the ability to accurately interpret results generated by the algorithms. You must also carefully choose the algorithms for your purpose.

4. High error-susceptibility

[**Machine Learning**](https://en.wikipedia.org/wiki/Machine_learning) is autonomous but highly susceptible to errors. Suppose you train an algorithm with data sets small enough to not be inclusive. You end up with biased predictions coming from a biased training set. This leads to irrelevant advertisements being displayed to customers. In the case of ML, such blunders can set off a chain of errors that can go undetected for long periods of time. And when they do get noticed, it takes quite some time to recognize the source of the issue, and even longer to correct it.

**SYSTEM TEST**

The purpose of testing is to discover errors. Testing is the process of trying to discover every conceivable fault or weakness in a work product. It provides a way to check the functionality of components, sub assemblies, assemblies and/or a finished product It is the process of exercising software with the intent of ensuring that the Software system meets its requirements and user expectations and does not fail in an unacceptable manner. There are various types of test. Each test type addresses a specific testing requirement.

**TYPES OF TESTS**

**Unit testing**

Unit testing involves the design of test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application .it is done after the completion of an individual unit before integration. This is a structural testing, that relies on knowledge of its construction and is invasive. Unit tests perform basic tests at component level and test a specific business process, application, and/or system configuration. Unit tests ensure that each unique path of a business process performs accurately to the documented specifications and contains clearly defined inputs and expected results.

**Integration testing**

Integration tests are designed to test integrated software components to determine if they actually run as one program. Testing is event driven and is more concerned with the basic outcome of screens or fields. Integration tests demonstrate that although the components were individually satisfaction, as shown by successfully unit testing, the combination of components is correct and consistent. Integration testing is specifically aimed at exposing the problems that arise from the combination of components.

**Functional test**

Functional tests provide systematic demonstrations that functions tested are available as specified by the business and technical requirements, system documentation, and user manuals.

Functional testing is centered on the following items:

Valid Input : identified classes of valid input must be accepted.

Invalid Input : identified classes of invalid input must be rejected.

Functions : identified functions must be exercised.

Output : identified classes of application outputs must be exercised.

Systems/Procedures : interfacing systems or procedures must be invoked.

Organization and preparation of functional tests is focused on requirements, key functions, or special test cases. In addition, systematic coverage pertaining to identify Business process flows; data fields, predefined processes, and successive processes must be considered for testing. Before functional testing is complete, additional tests are identified and the effective value of current tests is determined.

**System Test**

System testing ensures that the entire integrated software system meets requirements. It tests a configuration to ensure known and predictable results. An example of system testing is the configuration oriented system integration test. System testing is based on process descriptions and flows, emphasizing pre-driven process links and integration points.

**White Box Testing**

White Box Testing is a testing in which in which the software tester has knowledge of the inner workings, structure and language of the software, or at least its purpose. It is purpose. It is used to test areas that cannot be reached from a black box level.

**Black Box Testing**

Black Box Testing is testing the software without any knowledge of the inner workings, structure or language of the module being tested. Black box tests, as most other kinds of tests, must be written from a definitive source document, such as specification or requirements document, such as specification or requirements document. It is a testing in which the software under test is treated, as a black box .you cannot “see” into it. The test provides inputs and responds to outputs without considering how the software works.

**Unit Testing**

Unit testing is usually conducted as part of a combined code and unit test phase of the software lifecycle, although it is not uncommon for coding and unit testing to be conducted as two distinct phases.

**Test strategy and approach**

Field testing will be performed manually and functional tests will be written in detail.

**Test objectives**

* All field entries must work properly.
* Pages must be activated from the identified link.
* The entry screen, messages and responses must not be delayed.

**Features to be tested**

* Verify that the entries are of the correct format
* No duplicate entries should be allowed
* All links should take the user to the correct page.

Integration Testing

Software integration testing is the incremental integration testing of two or more integrated software components on a single platform to produce failures caused by interface defects.

The task of the integration test is to check that components or software applications, e.g. components in a software system or – one step up – software applications at the company level – interact without error.

**Test Results:** All the test cases mentioned above passed successfully. No defects encountered.

**Acceptance Testing**

User Acceptance Testing is a critical phase of any project and requires significant participation by the end user. It also ensures that the system meets the functional requirements.

**Test Results:** All the test cases mentioned above passed successfully. No defects encountered.

**A Novel Hybrid Deep Learning Method for Early Detection of Lung Cancer using Neural Networks**

In the past many automation algorithms and bio-markers based algorithms are introduced to detect cancerous cells from Lung CT-scan images but all those techniques or algorithms detection accuracy is not accurate. To overcome from this issue author of this paper employing Hybrid (combination of CNN and LSTM) algorithm is utilized to detect cancer cells. 3DCNN algorithm is best known for features extraction and classification and then RNN (LSTM long short term memory) algorithm is used to detect changes in images over different time, so by combining both this algorithms application can detect changes of cancer cell over time.

In propose paper before classifying cancer cell author employing UNET algorithm to segment cancel cell and then applying propose CCDC-HNN (Cancer Cell Detection using Hybrid Neural Network) algorithm to classify cancer cell. Based on detected cancel cell size physician can easily understand stage of cancer.

To train propose algorithm author has utilized LIDC-IDRI (Lung Image Database Consortium and Image Database Resource Initiative) which can be downloaded from below KAGGLE URL.

<https://www.kaggle.com/datasets/rangan2510/lidc-idri-pngs-with-masks>

Above dataset contains CT-SCAN lung images along with mask images for UNET segmentation. Above dataset contains more than 14000 images and the mask image with 0 white colour pixels will be consider as Benign and mask with white colour images will be consider as ‘Malignant’ cancer cell.

To implement this project we have designed following modules

1. Upload LIDC-IDRI Dataset: using this module will upload dataset to application
2. Process Dataset: using this module application will read all images and then resize and normalize and all images pixel values
3. Train & Test Split: this module will split dataset into train and test where application will be using 80% images for training and 20% for testing
4. Run Hybrid CCDC-HNN Algorithm: 80% training images will be input to propose algorithm to train a model and this model will be applied on 20% test images to calculate prediction accuracy
5. Cancer Cell Detection & Classification: using this module will upload test image and then UNET will segment cancer cell if exists and then CCDC-HNN will classify detected cancel cell as Benign or Malignant
6. CCDC-HNN Training Graph: using this module will plot propose algorithm training accuracy and loss graph

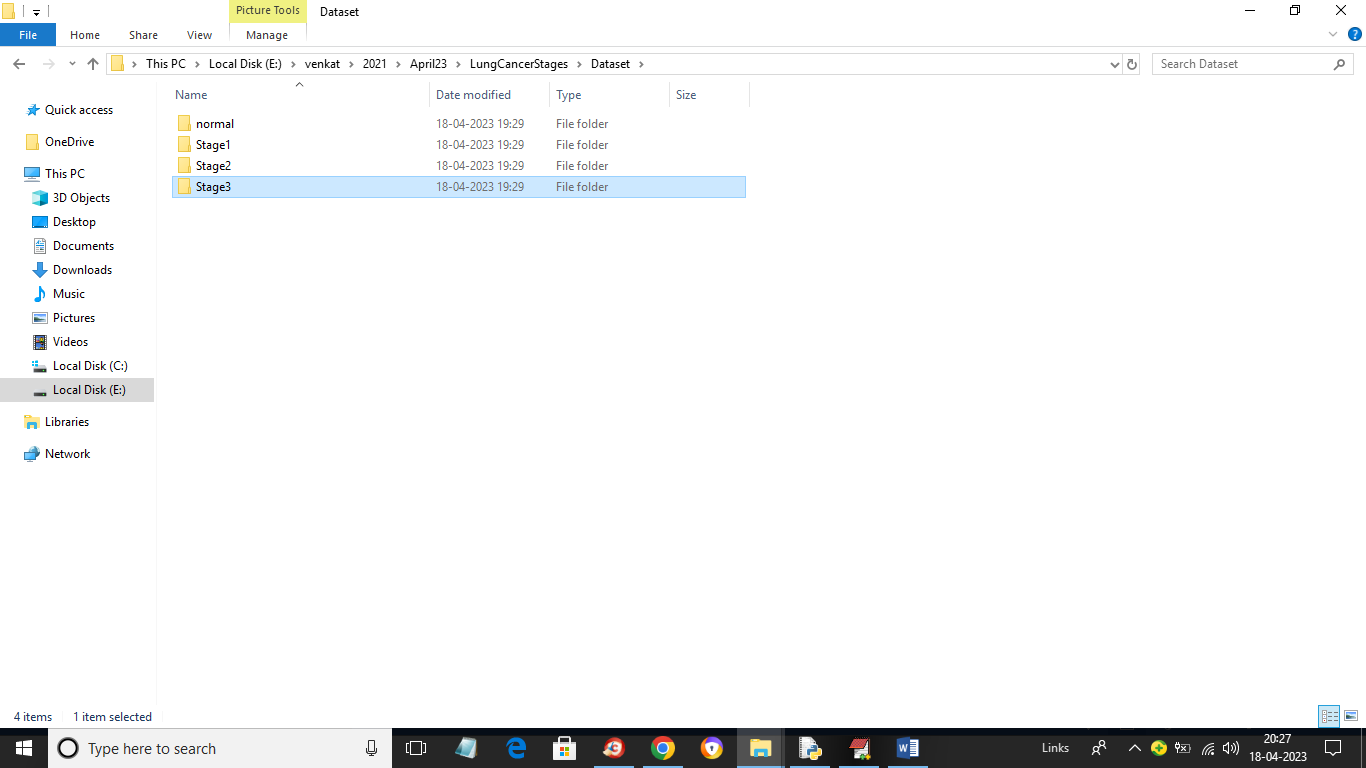
SCREEN SHOTS

Lung Cancer Stages Prediction

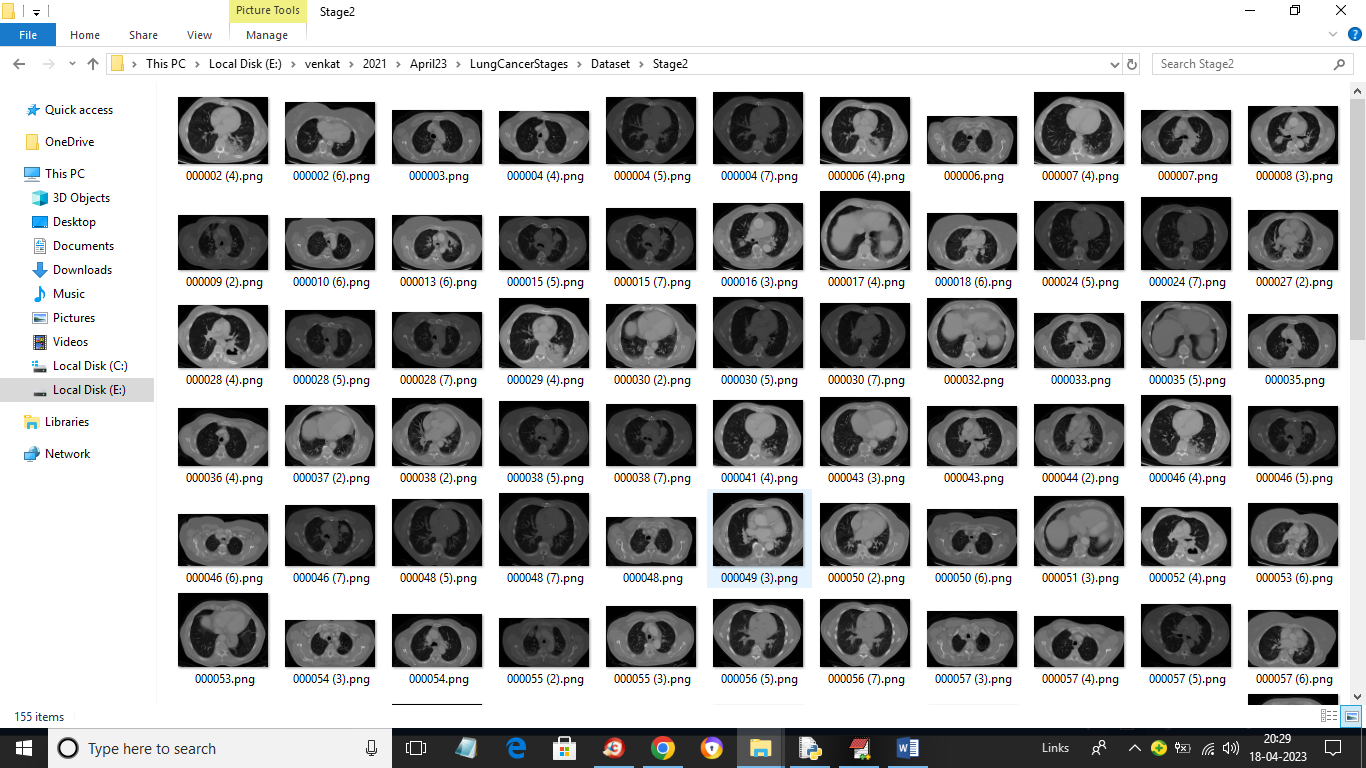
In this project we are employing Deep Learning Convolution Neural Network algorithm to predict various stages of lung cancer such as Normal, Stage1, Stage2 and Stage3. All existing algorithms were able to predict weather given image is normal or contains cancer cells but no algorithm able to predict stages so we are enhancing CNN algorithm to predict stages.

To train CNN we are using CT SCAN images which contains 4 different types of lung images such as Normal, Stage1, Stage2 and Stage3. Propose CNN algorithm can detect stages with an accuracy between 98 to 100%.

Below screen showing dataset details



In above screen we have 4 different folders and just go inside any folder to view its images like below screen



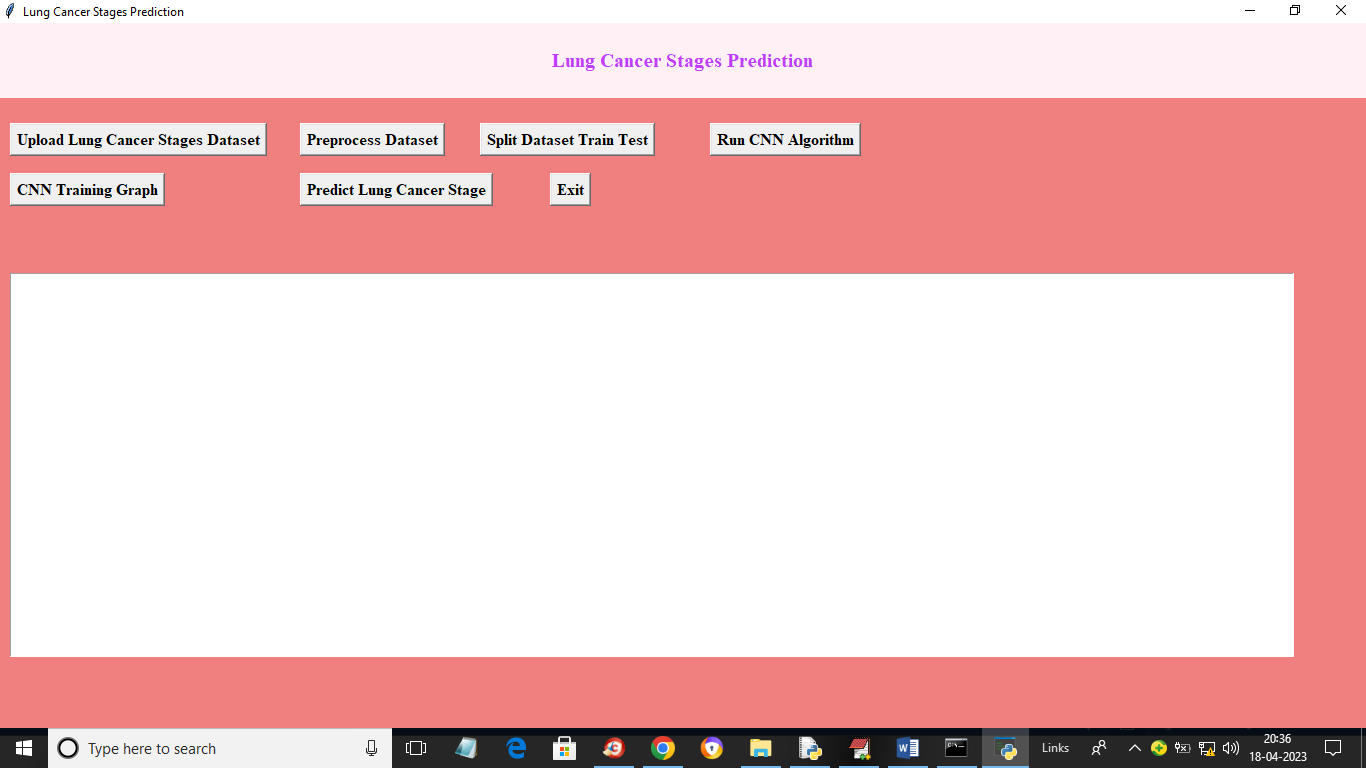
So by using above images we will train CNN and evaluate performance in terms of accuracy and confusion matrix

To implement this project we have designed following modules

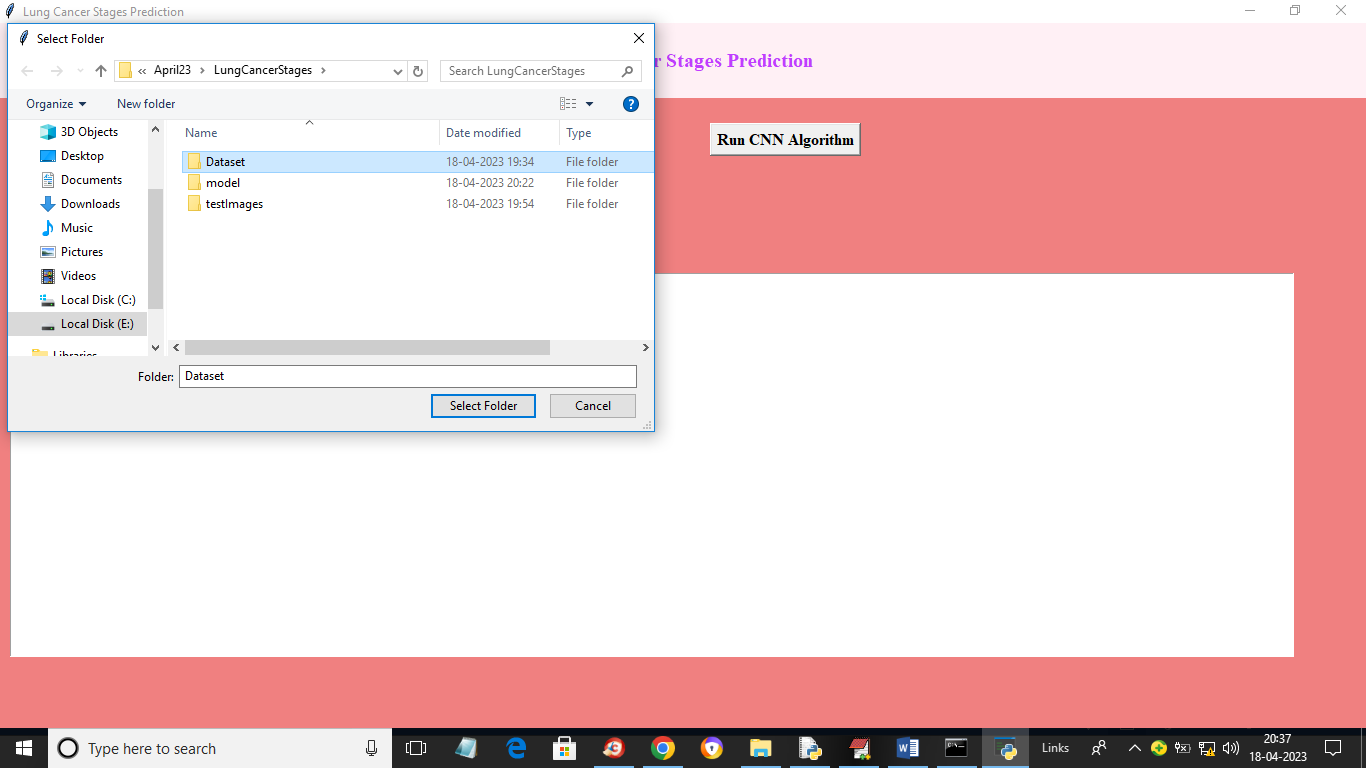
1. Upload Lung Cancer Stages Dataset: using this module we will upload dataset to application
2. Preprocess Dataset: using this module we will read images and then normalize, shuffle and resize images
3. Split Dataset Train Test: using this module we will split dataset into train and test application where 80% dataset images will be using for training CNN algorithm and 20% dataset images to calculate prediction accuracy
4. Run CNN Algorithm: using this module we will train CNN algorithm and then calculate its prediction accuracy
5. CNN Training Graph: using this module we will plot CNN training accuracy and loss graph
6. Predict Lung Cancer Stage: using this module we will upload test image and then CNN will predict cancer stages

SCREEN SHOTS

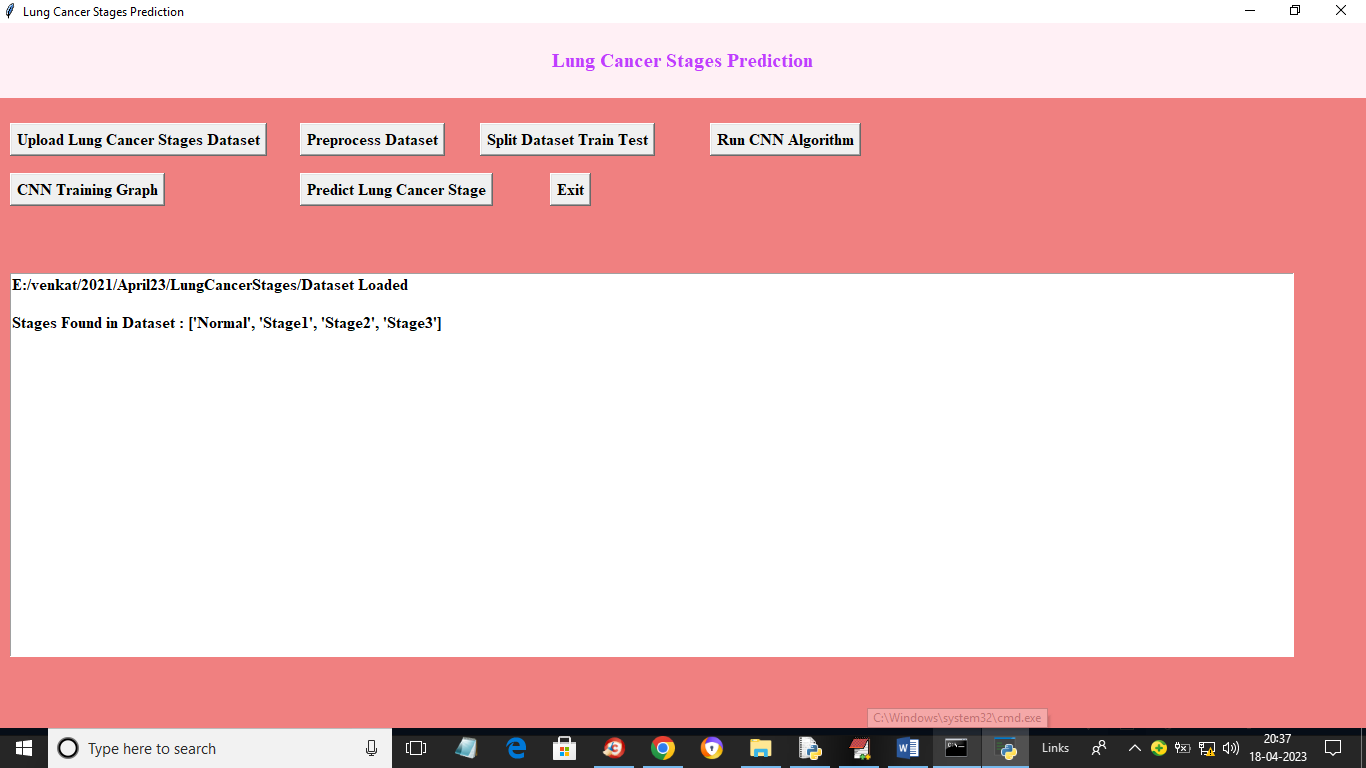
To run project double click on run.bat file to get below screen



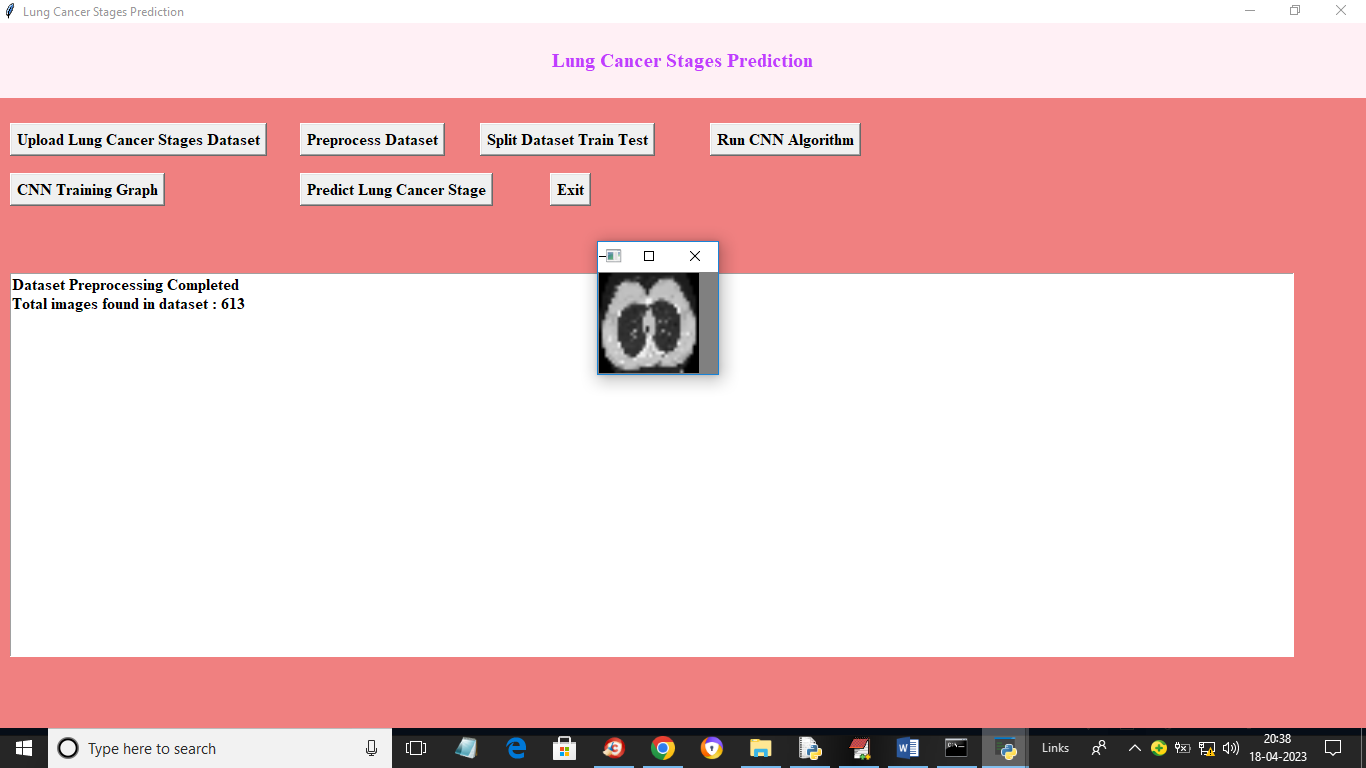
In above screen click on ‘Upload Lung Cancer Stages Dataset’ button to upload dataset to application and get below output



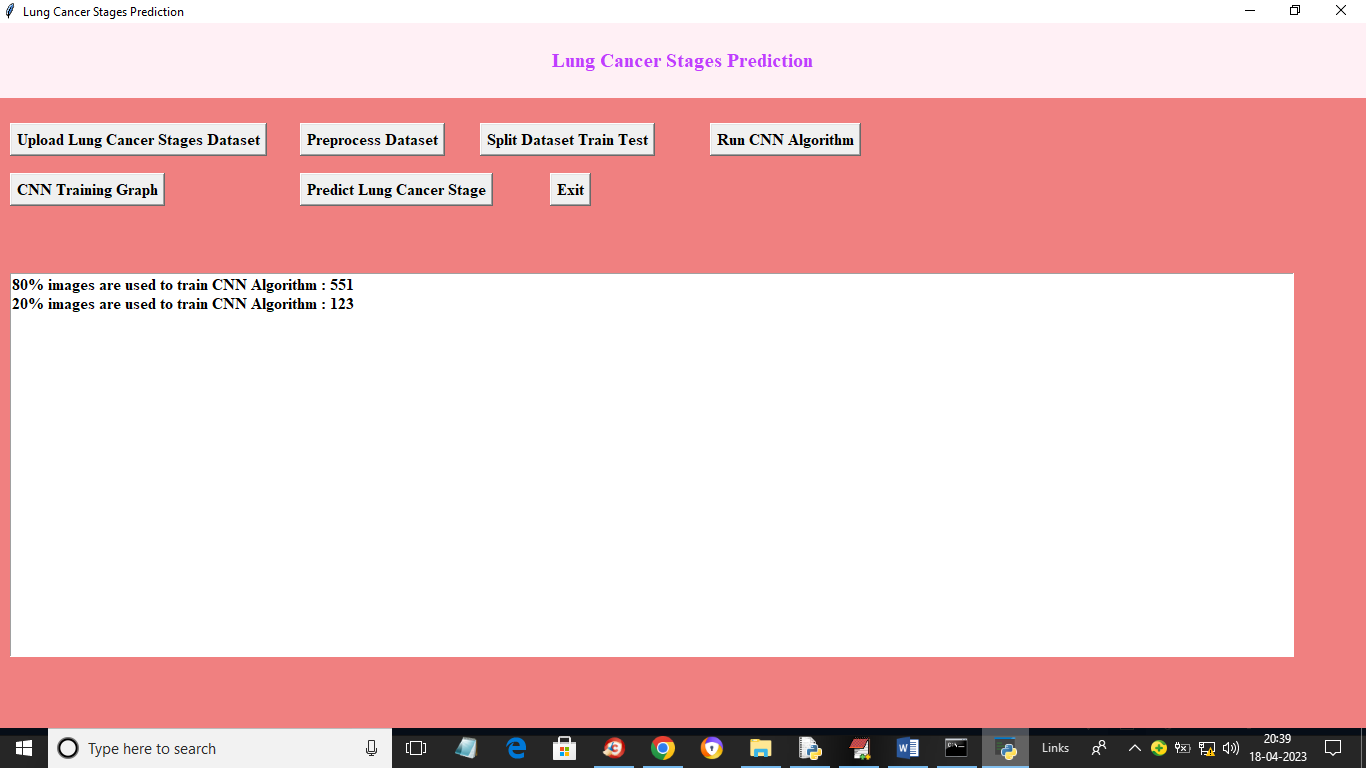
In above screen selecting and uploading dataset folder to application and then click on ‘Select Folder’ button to load dataset and get below output



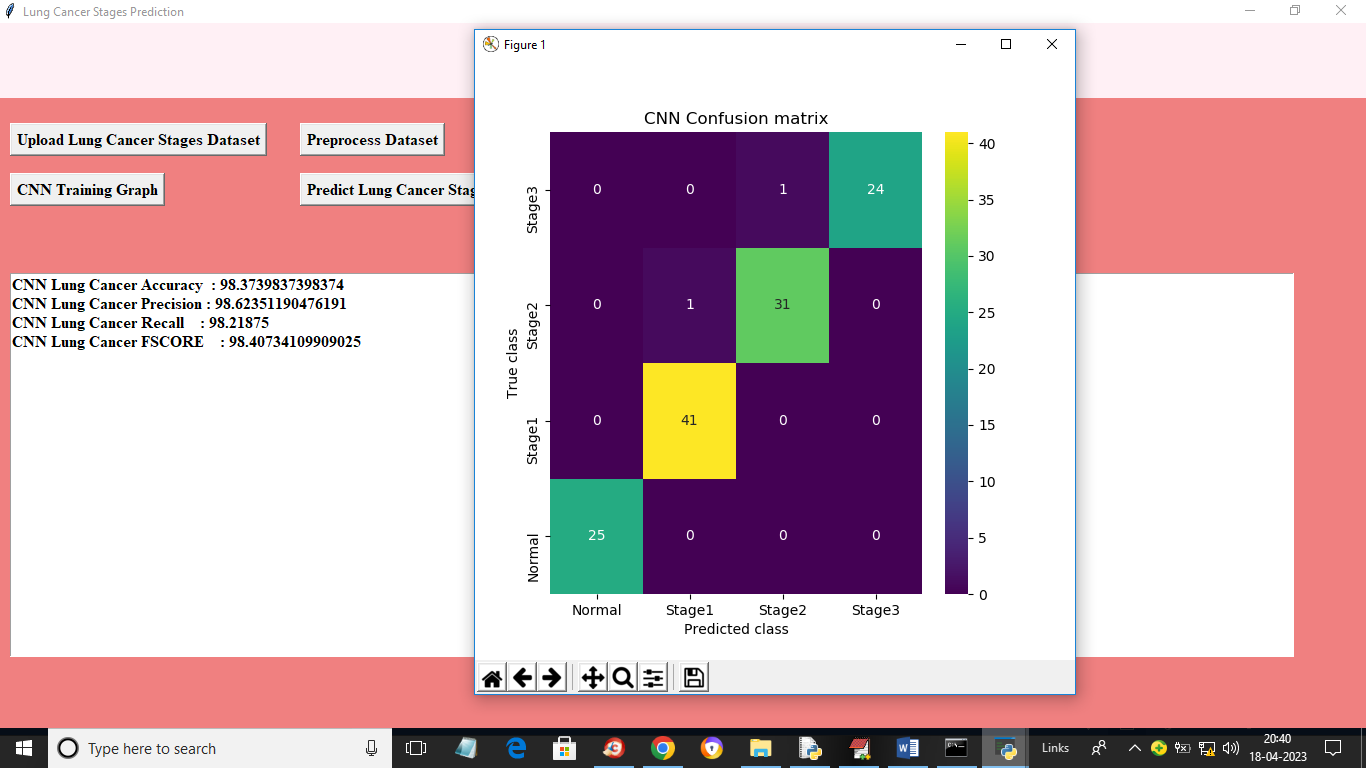
In above screen dataset loaded and displaying stages found in dataset and now click on ‘Preprocess Dataset’ button to normalize, shuffle and resize images and get below output



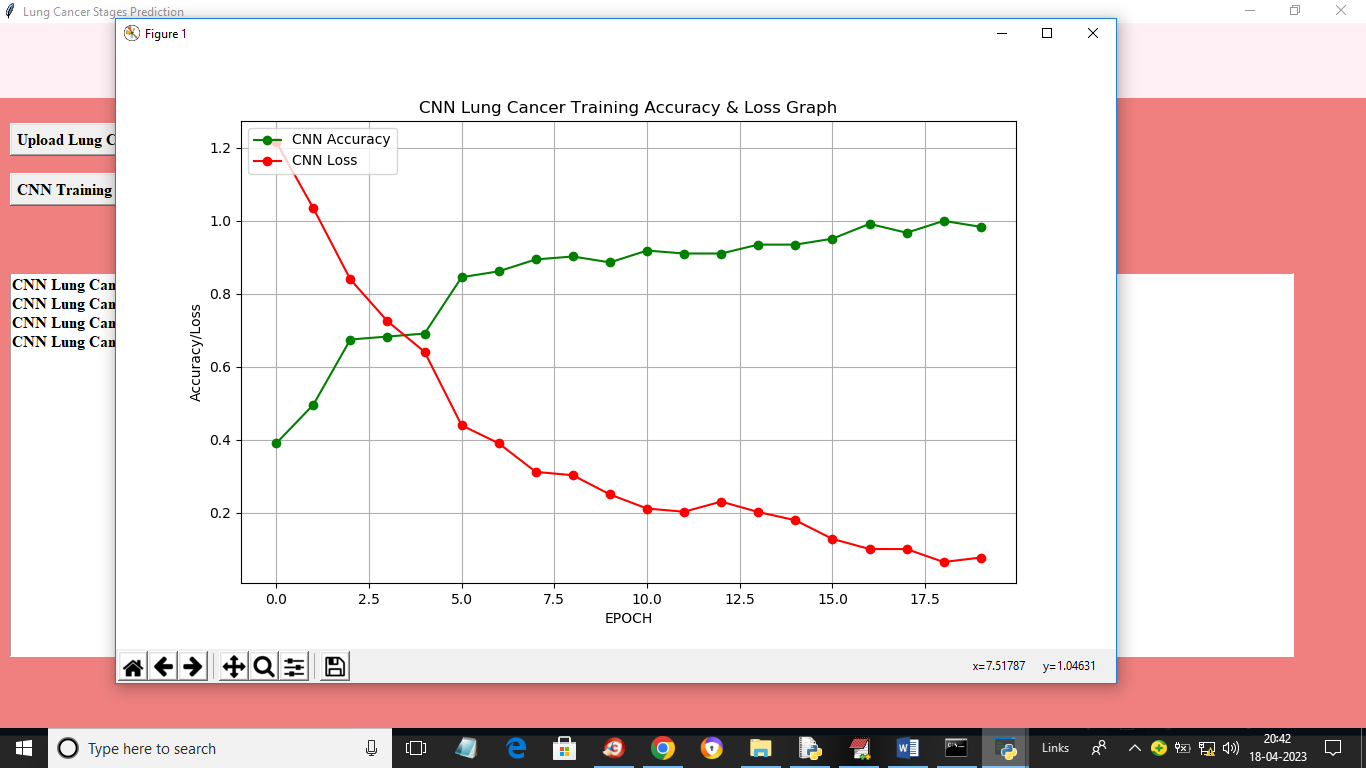
In above screen dataset contains 613 images and we can see processed images and now click on ‘Split Dataset Train Test’ button to split dataset into train and test and get below output



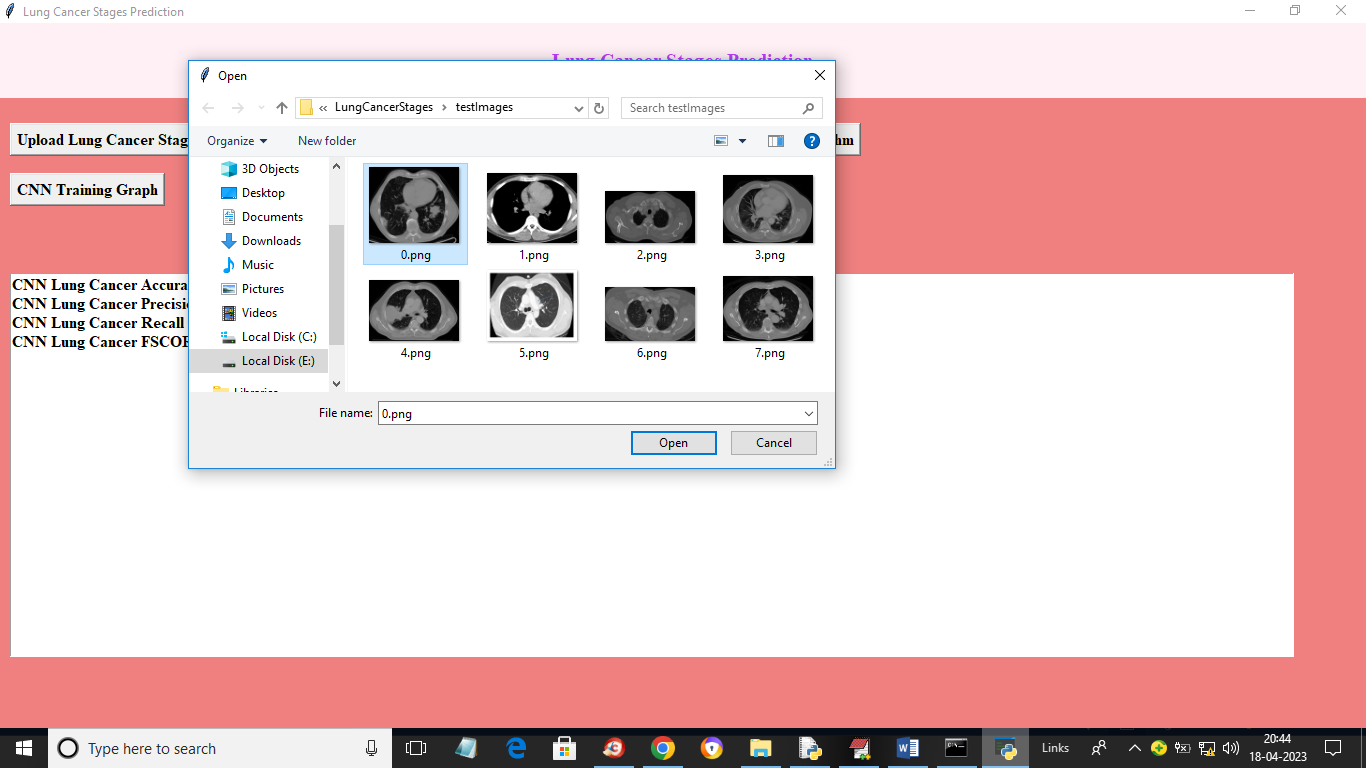
In above screen application using 80% (551) images for training and 20% (123) images for testing. Now click on ‘Run CNN Algorithm’ button to train CNN and get below output



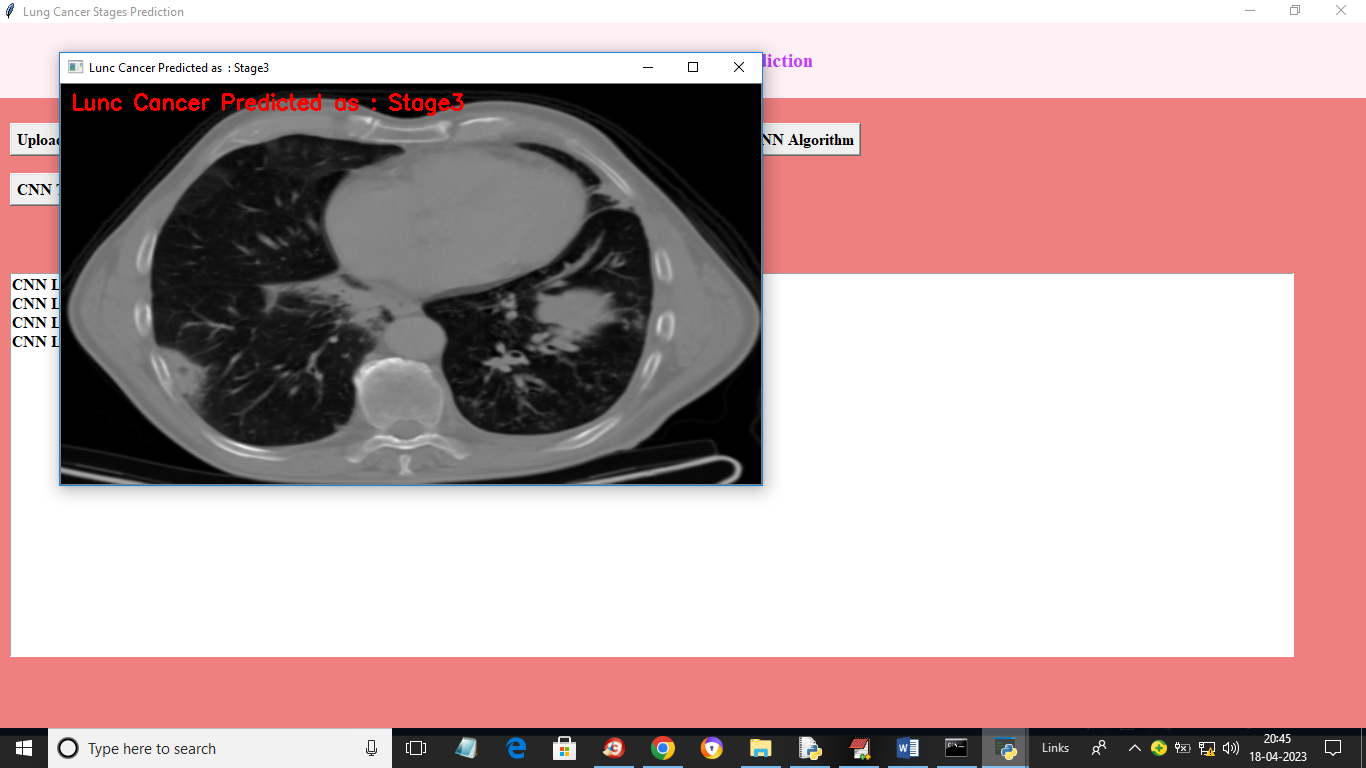
In above screen with CNN we go 98% accuracy and we can see other metrics such as precision, recall and FSCORE. In above confusion matrix graph x-axis represents Predicted Labels and y-axis represents True Labels. All different colour boxes represents correct prediction count and all blue boxes contains incorrect prediction count which is only 2. Now close above graph and then click on ‘CNN Training Graph’ button to get below graph



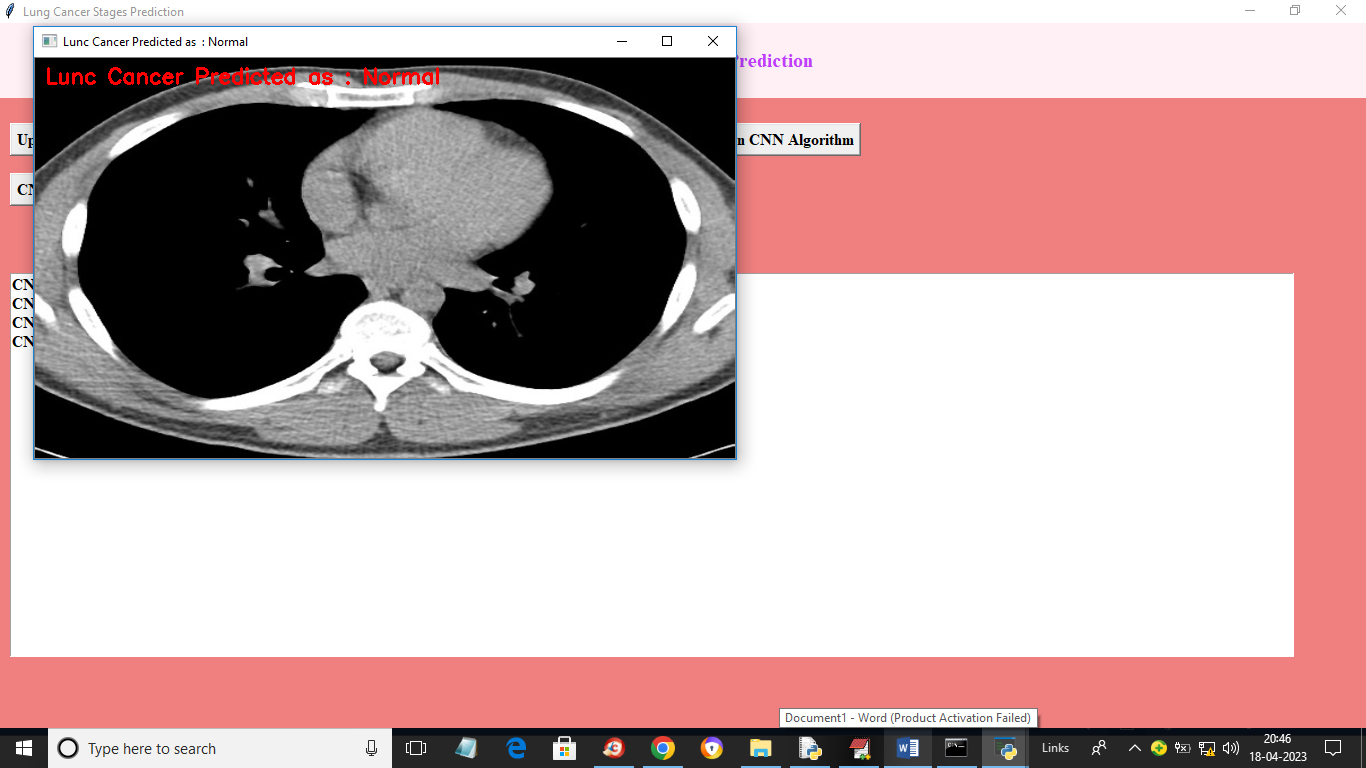
In above graph x-axis represents training epoch and y-axis represents accuracy and loss. Red line represents loss and green line represents accuracy and we can see with each increasing epoch accuracy got increase and loss got decrease. Now close above graph and then click on ‘Predict Lung Cancer Stage’ button to upload test image and get below output



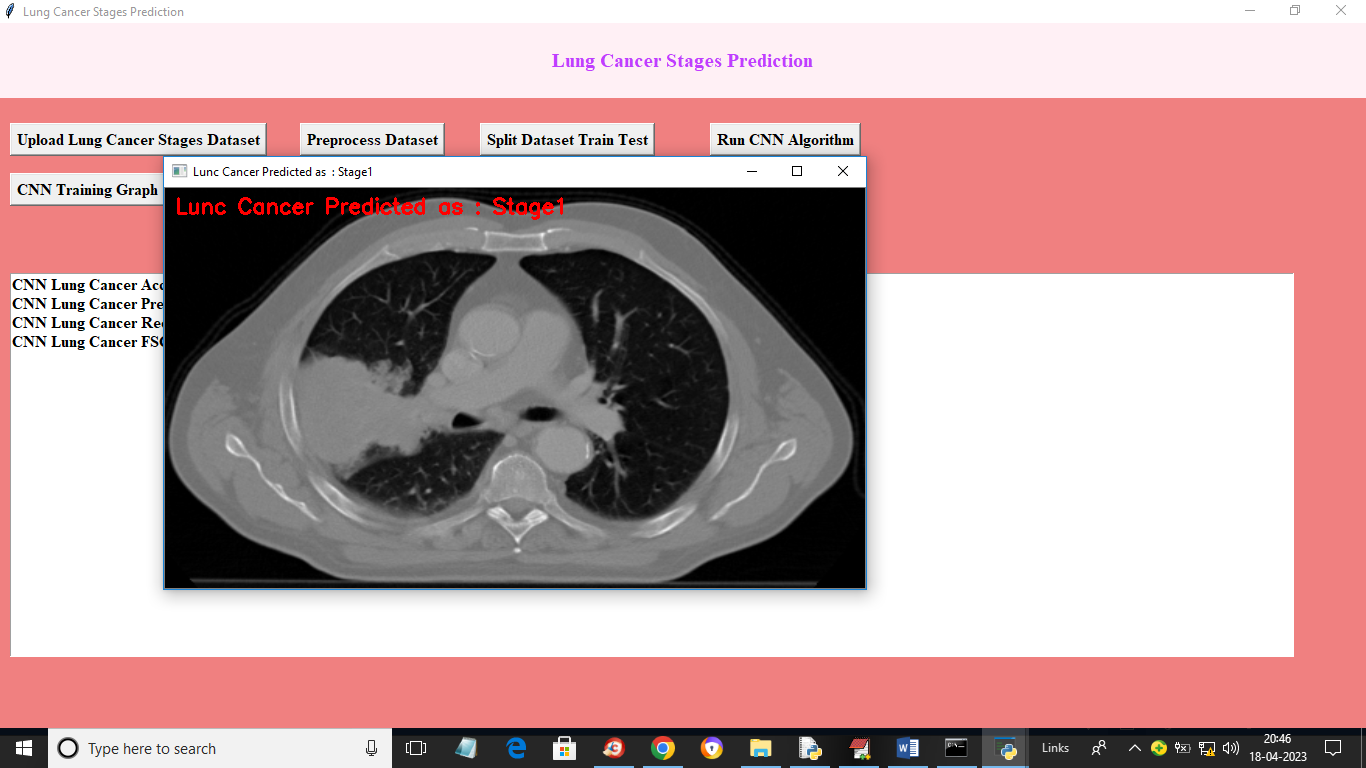
In above screen selecting and uploading ‘0.png’ and then click on ‘Open’ button to get below output



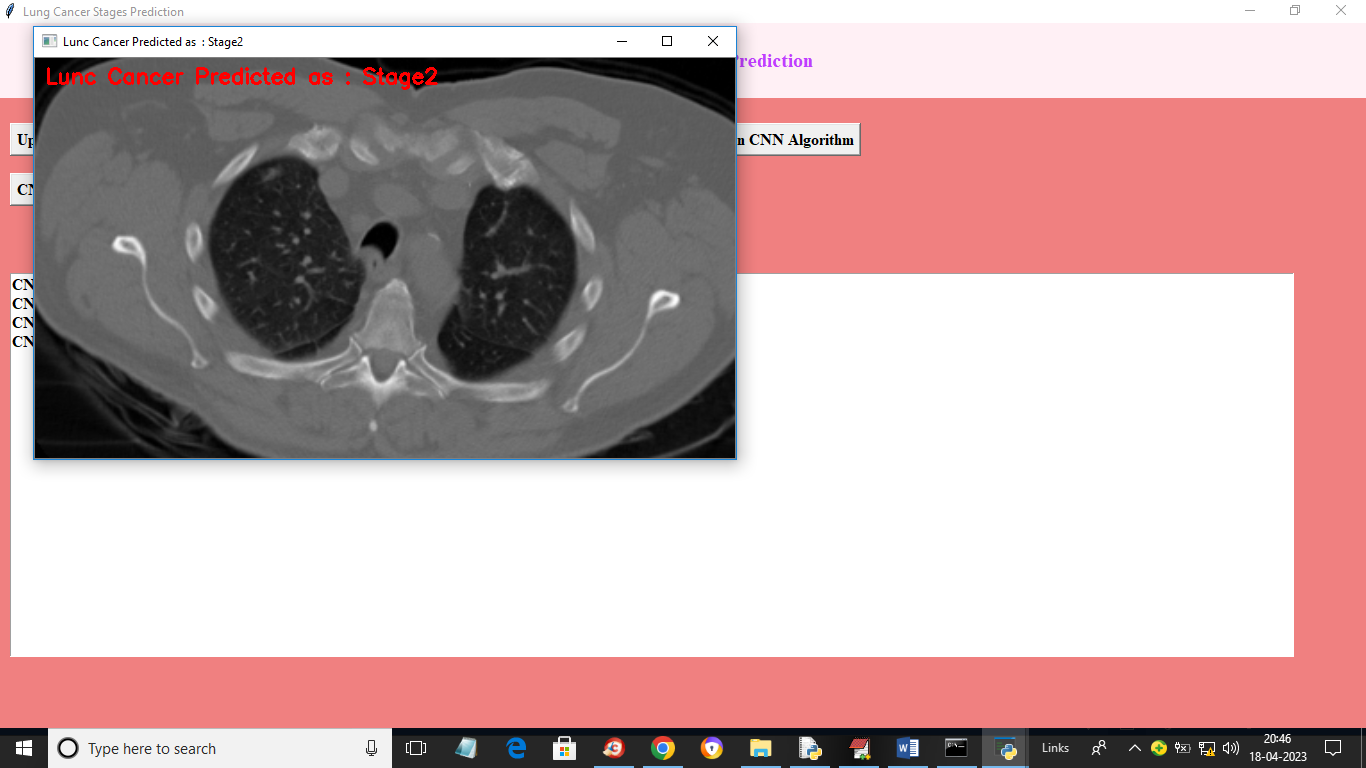
In above screen in red colour text we can see cancer in image predicted as ‘Stage 3’. Similarly you can upload and test other images



In above screen detected as Normal



In above screen cancer detected as Stage 1



In above screen cancer stage detected as 2

**Conclusion**

In conclusion, the combination of Convolutional Neural Networks (CNN) and Support Vector Machines (SVM) offers a powerful approach for lung cancer stage prediction by leveraging the strengths of both techniques. CNNs excel at automatically extracting high-level features from medical images like CT scans, effectively capturing spatial hierarchies and patterns relevant to cancer detection. Meanwhile, SVMs serve as robust classifiers that can handle high-dimensional data and provide more precise stage classification, especially when integrated with features learned by CNNs. Together, this hybrid model can enhance the accuracy of lung cancer staging, facilitating earlier diagnosis and improving patient outcomes by enabling more targeted treatment strategies.

**Future Scope of The Project:**

The future scope of the proposed hybrid deep learning method for early detection of lung cancer is promising and multifaceted. As the system continues to evolve, there are several key areas for expansion and enhancement. First, the integration of additional data types, such as genomic information or biomarkers, could further refine the model’s predictive accuracy and personalized diagnostic capabilities. Advancements in imaging technologies and data acquisition methods may also provide richer datasets, enabling the model to detect a wider range of cancerous conditions and improve generalizability. Furthermore, incorporating longitudinal data and patient outcomes could enhance the model’s ability to predict disease progression and treatment responses, offering a more comprehensive view of patient health. Collaborative efforts with clinical practitioners and researchers will be essential to validate and adapt the system across diverse populations and settings, ensuring its robustness and reliability in real-world applications. Additionally, ongoing improvements in computational power and algorithms may lead to more efficient training processes and real-time analysis capabilities. Overall, the hybrid model has the potential to drive significant progress in early cancer detection and personalized medicine, setting the stage for future innovations that can transform diagnostic practices and improve patient care.

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