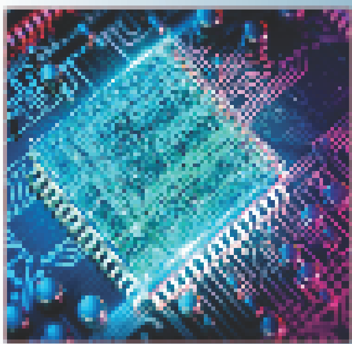

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Lung Cancer Detection using Supervised Machine Learning Techniques

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ABSTRACT:

In recent times, Lung cancer has been the most common cause of mortality in both men and women worldwide. Lung cancer is the second most well-known disease after heart disease. Although lung cancer prevention is impossible, early detection of lung cancer can effectively treat lung cancer at an early stage. A patient's survival rate may increase if lung cancer is identified early. Various data analysis and machine learning techniques have been applied to detect and diagnose lung cancer in its early stages. In this paper, we used supervised machine learning algorithms like SVM (Support vector machine), ANN (Artificial neural networks), MLR (Multiple linear regression), and RF (random forest) to detect the early stages of lung tumours. The primary purpose of this study is to examine the success of machine learning algorithms in detecting lung cancer at an early stage. Compared to all other supervised machine learning algorithms, the Random forest model produces a high result, with a 99.99% accuracy rate.

KEYWORDS: Machine Learning, Healthcare, Lung Cancer Detection, SVM, ANN, MLR, Random Forest

1. INTRODUCTION

Cancer is a broad term and the most complex disease in people's life. Cancer can cause by the development of uncontrollable cells, which can be spread anywhere in the human body. General cancer symptoms are fatigue, weight loss, pain, cough, fever, lumps, etc. Cancer is also called a tumour. Save the lives of humans; it is essential to detect quickly and correctly the initial stage of cancer. Many kinds of cancer include breast, brain, lung, liver, skin cancer, etc. [1]. Lung cancer is a form that starts the abnormal cells cluster together. Lung cancer is the main reason for death among both men and women worldwide. Worldwide after heart disease, Lung cancer is the second most frequent disease. Uncontrollable cell growth may be the reason for the death of the cancer patient [2].

Early examination of lung tumours is critical in decreasing the risk of death from lung tumour disease. Lung cancer can spread very quickly to the brain, liver, bones, and adrenal glands; therefore, the initial diagnosis of lung cancer is essential. Every year, almost 1.3 million people die due to lung cancer worldwide. In 2018, approximately 234,030 Americans will be diagnosed, 121,480 males and 112,350 females. Due to lung cancer, about 121,680 deaths will occur, of which 83,550 males and 70,500 females [2][3]. Common ways to diagnose lung cancer include Magnetic Resonance Imaging (MRI), CT (Computed Tomography) scan, and Positron Emission Tomography (PET)[4]. Lung carcinoma is another name for lung cancer. Lung cancer has two categories: SCLC(Small Cell Lung Cancer) and NSCLC(Non-Small Cell Lung Cancer)[5]. SCLC: It's a generally rare

lung cancer. Around 15% of lung cancer cases have a small cell lung cancer history. Small lung cancer spreads very quickly.
NSCLC: It's a pretty frequent kind of lung cancer. Around 85% of lung cancer cases have a non-small cell lung cancer history. This type of lung cancer is more dangerous than SCLC because it spreads slowly. NSCLC is further divided into three categories:
NSCLC has four stages: Stage I, Stage II, Stage III, and Stage IV [6].
In Stage I, cancer produces 60 to 80% in a single lung and doesn't develop in lymph nodes or distant organs.
In Stage II, 30 to 50% of cancer grows in lymph nodes rather than distant organs.
In stage III, the tumour expands 10 to 15% in nodes and builds in the centre of the chest.
In stage IV, the tumour spreads throughout the body.
Many studies have been undertaken on the causes of lung cancer, concluding that smoking is the primary cause. Smoking harms the lungs. In the United States, cigarette smoking contributes to 80 to 90% of deaths due to lung cancer. Other tobacco products such as cigars, pipes, or snuff (a powdered form of tobacco) raise the risk of lung cancer and different kinds of cancer, such as mouth cancer. The use of tobacco smoking for a long time begins with lung cancer. According to the survey, smoking caused lung cancer in 90% of males and 75 to 80% of females. It is a reality that 10 to 15% of people who never smoke cause lung cancer. Lung cancer may be passive smoking, air pollution, asbestos, and radon gas [7].
Machine Learning is an artificial intelligence field that applies computer algorithms to conclude various outcomes from data sets. Machine learning provides guidance to execute complex tasks more creatively and efficiently. Many machine learning algorithms are used in the data set to measure the accuracy of a lung cancer diagnosis. In the past survey, many machine learning techniques have been tried to detect and predict lung tumours [3][8][9] Support Vector Machine (SVM), Artificial Neural Network (ANN), Naive Bayes (NB), Convolutional Neural network (CNN), Recurrent Neural network, Decision Tree, k-nearest neighbours.
The innovation of this study is too early diagnoses of lung cancer from the data set. This research works on four well-known machine learning classifiers: SVM, ANN, MLR, and RF, to detect lung cancer. In the end, we compared the accuracy and find out the best classifier to detect lung cancer. Figure 1 shows the workflow of our study.
This research article consists of a literature review and methodology in sections two and three. The fourth section analyzes the experiment's results. The last section is about the conclusion and future work. Finally, we determined the goals of our proposed research and compared model findings to determine which model works best.

2. LITERATURE REVIEW

Machine learning is a method of diagnosing lung cancer, the leading cause of death worldwide. In previous work, many researchers have used image processing methods, machine learning approaches, or hybrid techniques to diagnose lung cancer. Many machine-learning applications are already used in the field of Lung cancer detection.
In this paper [8] Author used the clinical images dataset for the image processing methodology. The image processing approach is divided into five different steps:
1) collect images
2) image processing and segmentation
3) extraction of features
4) classification of images
5) performance evaluation.
Seven classifiers as KNN(k-nearest neighbours), SVM(support vector machine), DT(Decision tree), MNB(Multinomial naïve Bayes), SGD(Stochastic gradient descent), RF(Random forest), and MLP(Multi-layer perceptron) was used to evaluate the performance based on the following parameters: accuracy, F1 score, precision, recall and then calculated using a confusion matrix. Conversely, MLP obtains higher accuracy with a value of 88.55% compared to other classifiers.
The primary goal of this paper[10] is to use image transformation and machine learning methods to identify lung cancer and its phases. Many steps are involved in the image processing approach. First, 200 CT scan reports and blood samples with CT scan images were used as input for image processing. Secondly, make a Grayscale image out of an RGB image. To convert the RGB image to a Grayscale image, we find the colour image's average and then replace the RGB pixel using that average. The formula of average [average = R+G+B/3]. In the third step, a median filter was used to extract the noise from a grayscale picture. The grayscale picture is converted to a binary image in the fourth step. The grayscale image has(From 0 to 255)pixel range, and the binary image has (0,1). When converting a grayscale picture to a binary image, the threshold value 175 is occupied.
In the fifth segmentation step, decrease the irrelevant information from the image and convert the duplicate CT scan image into an informative, easily examined detail. In the feature extraction step, the segmented output is used as an input for the feature extraction. Feature extraction uses algorithms to extract a pattern from a duplicate image. These features, such as Area, Perimeter, and Eccentricity, are provided by feature extraction. In the last step, the Support vector machine (SVM) arranges data and manages the pattern. SVM was used for classification and regression problems and categorized positive and negative samples of lung cancer images. This paper uses the SVM classifier compared to other classifiers like Decision trees, Naïve Bayes, and Random forest because SVM is less time-consuming.
In this study [3], access the Standard Digital Image Database dataset to identify the lung tumour. The dataset consists of 247 CT images, 154 images labelled with a nodule, and 93 images labelled without a nodule. The dataset was divided into two parts: training and testing. Notably, 70% of the dataset was employed for the training set, while 30% was used for the testing set. PCA(Principal component analysis), KNN(k-nearest neighbours), SVM(Support vector machine), NB(Naïve Bayes), DT(Decision tree), and ANN(Artificial Neural Network)

are among the machine learning techniques used to detect lung cancer. Then compare all the classifier's accuracy before and after preprocessing. In the end, ANN has higher accuracy of 82,43% than other classifiers after image processing, and the Decision tree has higher accuracy of 93,24% than different algorithms without image processing.

This paper [11] uses machine learning algorithms to save human lives by analyzing lung cancer's initial stage. Lung cancer datasets are sourced from the UCI Machine Learning Repository and Data. World. The K-fold cross-validation method splits datasets into two parts: training and testing. Many classification methods are used to attain accuracy, including Logistic Regression, Decision Tree, Naïve Bayes, and Support Vector Machine, and then compared each classifier's accuracy with another classifier. SVM has a higher accuracy of 99.2% than all other classifiers.

In this study [7], the Author primarily focused on the segmentation and classification method. An Unsharp mask filter is used to sharpen the image. An unsharp mask is used in image processing to convert blurred images into original images. Many thresholding methods are used for calculating the image's background and foreground color intensity level, but here we use the OTSU'S thresholding. The mean of OTSU'S thresholding to estimate the following parameters (weight, mean, variance) of the background and foreground of all levels. We used an Adaptive Canny algorithm to detect the cancer region and actual affected area, which was estimated over Otsu's global thresholding method. For the segmentation process, the k-nearest neighbour classification method is used. The KNN method has effective applications like machine learning, pattern recognition, data mining, object recognition, etc. To calculate the classification results from Bayesian Regularization neural network (BRNN) attains high accuracy with a value of 99.5%.

The Author [5] has proposed a CAD (Computer-aided diagnosis) system using the SVM to categorize abnormal or normal images using the CT images dataset. The CAD system has four phases to detect lung cancer from CT images. These stages are preprocessing images, extraction of features, selection, and categorization. In this study, a Gray level co-occurrence matrix was applied to extract image information such as colour, shape, texture, etc., and ANT Colony Optimization was employed as a feature selection method for better outcomes. Two machine learning classifiers, ANN and SVM, were applied to categorize the normal and abnormal photos. ANN achieves a high accuracy of 98.40% compared to SVM's accuracy of 93.2%.

Furthermore,[12] Deep Learning Approach is employed to diagnose lung cancer at the initial stages, which are very important to decrease the possibility of death. In this study, the TensorFlow library is used to diagnose lung cancer. SPIE-AAPM dataset used consists of 70 CT images. The training set is made up of 40 photographs, while the test set is made up of 30 images. 3D Convolutional Neural Network is utilized to classify the lung nodules, which can be benign or cancerous. While calculating the model's performance, 30 CT images are used, resulting in 17 malignant and 13 benign patients. Several metrics are used to assess the performance of the classification method, but in this work, a confusion matrix is employed to evaluate the achievement of binary classification. The Confusion Matrix shows 70% accuracy of 3D CNN.

This work [13] has proposed the deep residual network to detect lung cancer using the CT scan images dataset in DICOM (digital imaging and communication in medicine) image format. First, perform the preprocessing method on the dataset. In preprocessing, to determine and split lung nodules, perform growing regions and morphological operations, using the UNet and ResNet models for feature extraction. In segmentation, analyze the distinctive features from the CT scan images.

In this work, XGBoost and RandomForest are used for cancer detection. In the end, we compared the accuracy of the proposed models. UNet+RandoomForest individually achieved 74% accuracy, ResNet+XSBoost completed 76% accuracy, and the combination of UNet+RandoomForest and ResNet+XSBoost obtained 84% accuracy.

The Multi-class SVM classifier is used in work [14] to detect and predict lung cancer. This work used MATLAB to build an algorithm to detect and predict lung cancer. In each phase of classification, image enhancement and segmentation were done separately. Image enhancement is an approach for improving the quality and information of a data image. Many methods, such as image scaling, spatial transformation, and contrast enhancement, have been promoted to enhance images. Watershed transformed is used for segmentation to achieve a better resolution in CT images, and Gray Level Co-Occurance method is used for feature extraction. An SVM classifier is used for classification and relapse purposes to classify cancer nodules. Our proposed method achieves higher accuracy.

This research work [15] addressed various segmentation approaches such as Hopfield Neural Network (HNN) and Fuzzy C-Mean (FCM) clustering algorithms methods. To diagnose the early stage of lung cancer used, Sputum color images. In this study, a thresholding classifier was used to handle the problem of extreme fluctuation in the grey level and the related contrast between the pictures with 98% accuracy. The results of HNN Segmentation exceed the results of FCM because FCM failed in extracting the nucleus and cytoplasm areas.

[16]Developed a computer-assisted detection approach to distinguish between malignant and non-cancerous tissue in DICOM images.CNN was used for feature extraction.

Many machine learning classifiers were used to classify the cancerous and normal images and compare their accuracy to determine which is best for diagnosing lung and pancreatic tumours.

An Artificial Neural Network [17] was developed to identify the presence and absence of lung cancer. ANN uses the symptoms dataset to perform two layers of training and validation.ANN attains the highest 96.67% accuracy, which shows that ANN can detect lung cancer.

A group of Authors [18] proposed a new system to improve the current model's accuracy. The current model has 88.4% accuracy to increase the accuracy of the existing model. A median filter is employed in the proposed system's preprocessing stage to remove salt and paper noise from CT pictures, which causes challenges in accurate lung cancer identification. The gaussian filter is then applied to smooth the images and remove the speckle noise from CT images. In the segmentation step, a watershed technique was utilized to divide the image into areas to examine the meaningful information. In the feature extraction step, extracting features such as area, perimeter, centroid, diameter, eccentricity, and Mean intensity were employed as training features to build the classifier. The SVM classifier was utilized to identify the nodule as malignant or beginning in CT scan images. The proposed model has higher accuracy of 92% than the current model.

In this paper [19] image processing technique was used to classify the cancerous and non-cancerous nodules using MRI, CT, and Ultrasound images. In the experiment section, 6 CT scans and 15 MRI images of the lung are used. The image processing method decreases the image's noise and distortion, which is very beneficial for the segmentation step. The Gabor filter was applied to improve the pictures for both CT and MRI pictures. In the image enhancement step, smoothing of the image, blurring, and elimination of noise are involved. For the next step, picture filtering is highly effective. After image processing, a canny filter is used for edge detection—morphological processing techniques like Erosion and dilation decrease images' unnecessary detail. For image segmentation, Superpixel Segmentation was used. Feature extraction is a critical stage and uses many algorithms to produce the final output in which we conclude the normality and abnormality of the image. For feature selection and feature classification through GUI (Graphical user interface) in MATLAB are used different algorithms such as Particle swarm optimization (PSO), Genetic Optimization, and SVM(support vector machine) give result as a regular or abnormal nodule and attains 89.5% accuracy.

[20] Proposed five steps of image processing technique for the analysis of lung images. In the 1st step, collected data contain the CT scan images of patients with cancer and non-cancer. In the 2nd step, the image preprocessing technique is applied, which is very important and beneficial for the segmentation of images. In image preprocessing, two steps involve using the median filter to remove the noise from the images dataset and the contrast adjustment technique to enhance the refined images. In the 3rd step, an input image is segmented into several parts, and morphological operations are utilized to select the appropriate area of interest (ROI) based on the structuring element. After this, masked it to extract the tumour region from the CT scan image. In the 4th step, after the segmentation step, to gain the tumour region calculate the features of the tumour-like area, perimeter, and eccentricity and then send them to the classifier. In the 5th step, an SVM classifier is employed to classify the picture dataset as cancerous or benign.

3. METHODOLOGY

Nowadays, detecting lung cancer is a more challenging task for radiologists, but an intelligent computer-aided system helps the radiologist to detect and predict lung cancer very well. Machine learning is fundamental in detecting lung cancer [14]. Many image analyses and machine learning techniques are used in literature to diagnose lung cancer. This section describes our proposed model using different Supervised machine-learning methods to diagnose the early stage of lung cancer. Our proposed system is divided into two sections which are as follows:

- Description of data
- A detailed description of the proposed architecture

3.1 Description of data

The dataset we used in this study was obtained from the data—world The obtained in CSV format.

There are 1000 instances in this dataset and 25 data columns, 24 of which are predictive and one of which is a class label. 25 column is a class label containing high, medium, and low text data. We used the LabelEncoder of the SciKit Learn library in Python to convert the text data of class labels into numbers (0,1,2). Many attributes are used as a symptom to classify lung cancer detection in this dataset. This dataset employs many variables as a symptom to classify lung cancer detection. The name of a property is Occupational Hazards, Dust Allergy, Chronic Lung Disease, Balanced Diet, Genetic Risk, Age, Gender, Air Pollution, Alcohol Use, Occupational Hazards, Genetic Risk, Chronic Lung Disease, Balanced Diet. Obesity is a disease that affects both men and women. Smoking, chest discomfort, bloody cough, fatigue, passive smoking, weight loss, shortness of breath, finger clubbing, frequent colds, wheezing, difficulty swallowing, dry coughs, and snoring are all symptoms that can indicate lung cancer. In the class label, the '2' value signifies "Malignant cancer", the '1' value signifies "Benign cancer", and the value '0' signifies " No cancer".

3.2 A detailed description of the proposed architecture:

In this proposed architecture, in figure 2, we describe our proposed work's workflow. First, we insert the dataset in the form of CSV. Then, we performed the preprocessing on the dataset to remove the noise. After this, we divided the dataset into training and testing sections. Then, using models like ANN, SVM, Random Forest, and Multiple Linear Regression, we classified our dataset into three categories: malignant tumour, benign tumour, and healthy person with no tumour. If the class label value '2' means malignant cancer, the class label value '1' indicates Benign cancer, and the class label value '0' signifies No tumour. And results are discussed in Result Section, and we compared the results of our models and found out which is best for diagnosing lung cancer.

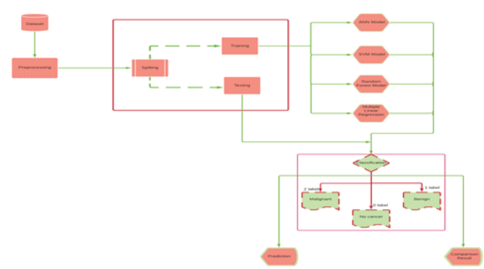

Figure 1. Proposed Methodology of Lung Cancer Detection using Machine Learning TechniquesANALYSIS AND RESULTS

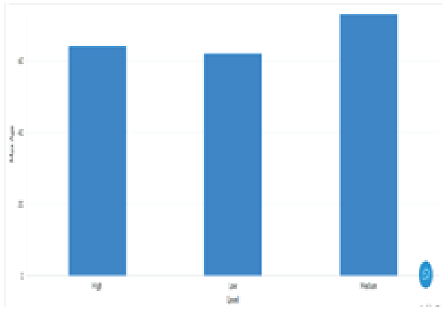

Figure 2a: Level VS max-age

Previously, we described the dataset and model used in our research work. In this part, we visualize the original data using the Bar graphs. These bar graphs show the level Vs attributes of the dataset. Fig 2a shows the level vs max-age. According to this fig High level has a max-age of 64, the Low level has a max-age of 62, and the Medium level has a max-age of 73.
Level (High, Low, Medium) Vs age, air pollution, and alcohol use of data visualization is shown in figure 2b.

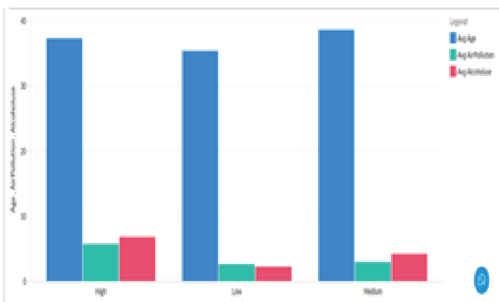

Figure 2 b: Level VS Age, Air Pollution & Alcohol Use

Level (High, Low, Medium) Vs dust allergy, occupational hazards, and genetic risk of data visualization is shown in figure 2 c.

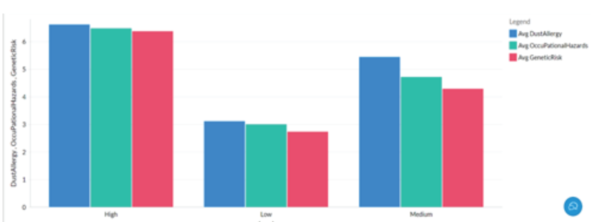

Figure 2c: Level VS dust allergy, occupational hazards, genetic risk

Level (High, Low, Medium) Vs chronic Lung disease, balanced diet, and obesity of data visualization are shown in figure 2 d.

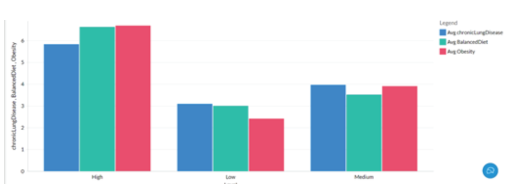

Figure 2d: Level Vs genetic risk & occupational hazards

Level (High, Low, Medium) Vs smoking, Passive smoker and chest pain of data visualization shown in figure 2 e.

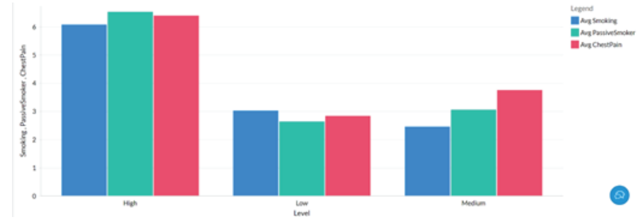

Figure 2 e: Level VS chronic lung disease & balanced diet

Level (High, Low, Medium) Vs coughing Up blood, fatigue, and weight loss of data visualization shown in figure 2 f.

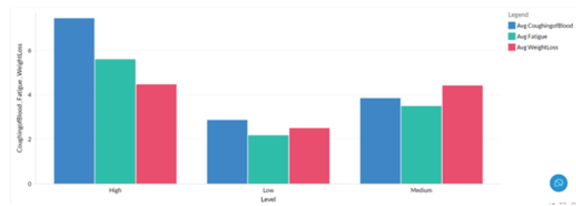

Figure 2 f: Level VS obesity & smoking

Level (High, Low, Medium) Vs shortness of breath, wheezing and swallowing difficulty of data visualization shown in figure 2 g.

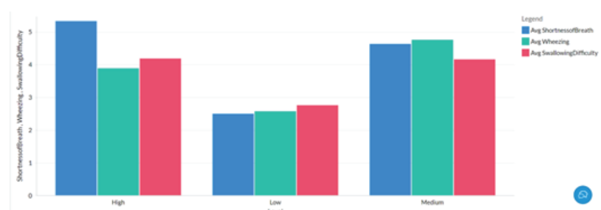

Figure 2 g: Level Vs passive smoker & chest pain

Level (High, Low, Medium) Vs clubbing of fingernails, a frequent cloud, dry cough, and data visualization snoring are shown in figure 2 h.

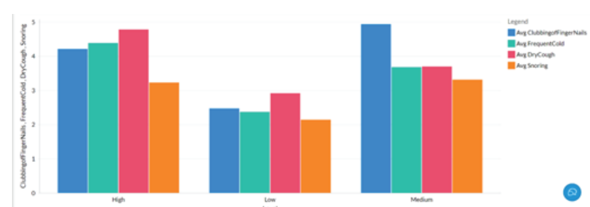

Figure 2 h: Level VS coughing up blood & fatigue

3.1 Performance Evaluation Table:

Random forest beats all other supervised machine learning methods, including multiple linear regression, artificial neural networks, and Support vector machines, as shown in Table 1. For this dataset, the Random forest outperforms other classification algorithms in terms of accuracy. This section will create a table that compares the performance of the various machine learning algorithms employed in this study.

Table 1. Performance evaluation table of supervised machine learning algorithms

Machine Learning Algorithms	Accuracy (%)
ANN (Artificial neural network)	65.75
MLR (Multiple linear regression)	77.54
RF (Random Forest)	99.99
SVM (Support vector machine)	98.91

4. RESULT VISUALIZATION

The outcomes of the proposed models, such as Artificial neural networks, Multiple linear regression, Random Forest, and Support vector machines, are visualized in this part. In this dataset, the ANN model performs poorly. This is because ANN is a simple neural network only with limited connected layers. Multiple linear regression model performance is better than the ANN model result. But the Random Forest model has the highest performance on this dataset of all other machine learning algorithms.

Result visualization is done on the lining graph using the excel sheet. Figure 3-6, graphs show the prediction results of previously mentioned models in the Lung Cancer dataset.

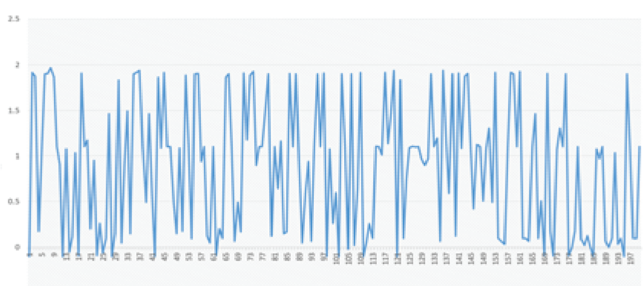

Figure 3: Prediction result of the ANN model

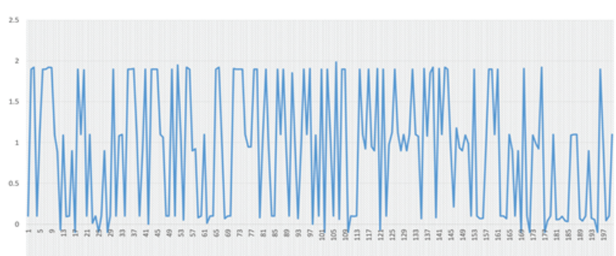

Figure 4: Prediction result of Multiple linear regression

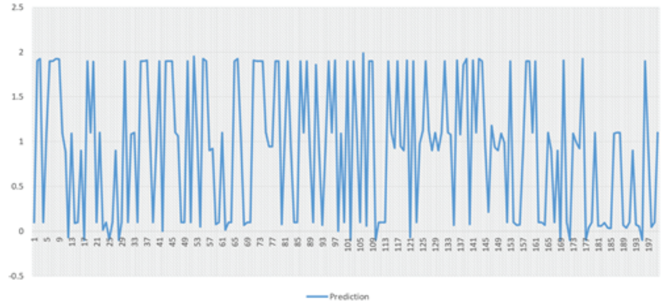

Figure 5: Prediction result of Random forest model

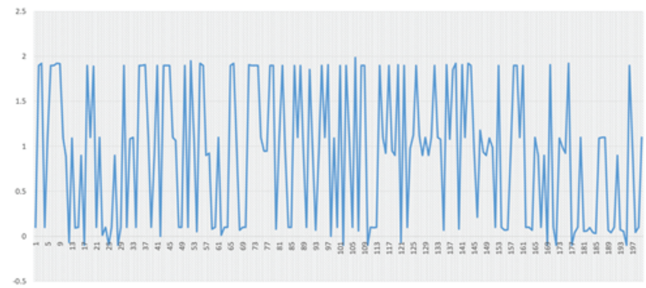

Figure 6: Prediction result of Support vector machine model

5. CONCLUSION AND FUTURE WORK

In previous times, Lung cancer detection was challenging and time-consuming because a doctor has done multiple tests on a patient to confirm whether the patient has lung cancer. Many machine learning classifiers have become more critical for diagnosing and detecting lung cancer. The main goal of this work is to find a way to detect lung cancer early. Lung nodule classification is benign, malignant, and has no cancer. This study's supervised machine learning methods are the Artificial Neural Network, Support Vector Machine, Random Forest, and Multiple Linear Regression. The performance chart shows that each machine learning classifier delivers different outcomes on the same lung cancer dataset. Compared to other supervised machine learning algorithms, the Random Forest model gives the best result with an accuracy of 99.99 per cent, according to the proper classification and confusion matrices.

For future work, Additional preprocessing improve the accuracy rate of other supervised machine learning algorithms.

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