Early Prediction and Detection of Lung Cancer using Data Mining

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Abstract –

As there is a big growth in large volume of data now days, this will create a need for extracting meaningful data from the information. Data mining has contributed various type of applications domains related to information technology, stock, marketing, healthcare and banking among them.With the increase in population growth has increased in coupled of disease and has increased the necessity of inclusion data mining in diagnosis medical datasets. From the various biomedical datasets, cancer is the widest disease that has killed human life over 7 million every year and lung cancer among them is nearly 17% of moralities.Previous research works show that survival rate of patients affected with cancer is larger and higher, when compared to the diagnosed at the initial stage, Lung cancer is the most historic data and dependent disease in for early diagnosis. This has created the researcher to use data mining technique for early diagnosis of lung cancer in stage 1.There has been an increase in survival rate to about 70% at the early stage of detection, when tumor is not spread. Pre- existing techniques The five year survival rate increases to 70% with the early detection at stage 1, when the tumor has not yet spread. Existing medical techniques like X-Ray, Computed Tomography (CT) scan, sputum cytology analysis and other imaging techniques not only require complex equipment and high cost but is also proven to be efficient only in stage 4, when the tumor has metastasized to other parts of the body.Our proposed work involves the uses of data mining technique used in classification of lung cancer patients and the categorization of stage to which it belong positive. The work is based on early diagnosis of prediction of lung cancer which suggest the doctors in treating the patients for increasing the survival rate of the human.

Keywords—ANN, Data Mining, classification , CT scan

I. Introduction

Lung cancer is the most rapidly increase disease which is causing human death world-wide due to respiratory problems; this cancer disease has exceeded the death rate compared to breast cancer. This disease has characterized based on growth of uncontrolled cells. If this disease is not diagonised at the early stages and cured before the second stage, it will increase the death percentage in human. This tissue will be spread rapidly to other parts of the body like brain , heart, bones, glands and liver.

As from early research, there is no such tool for early detection of lung cancer disease in human. We come across two types of lung cancers, one is SCLS and NSCLS There are two major types of lung cancer, non-small cell lung cancer (NSCLC) and small cell lung cancer (SCLC). Over 85 percent of all lung cancers are non-small cell lung cancers, while about 13 percent contribute small cell lung cancers **[2]**. Staging lung cancer is based on whether the cancer islocal or has spread from the lungs to the lymph nodes or other organs. Because the lungs are big, tumors can grow in them for a long time before they are found. Even when symptoms like coughing and fatigue occurs, people think that they are due to other causes. Because of this reason, early-stage of lung cancer (stages I and II) is difficult to detect. Most people with NSCLC are diagnosed only at stages III and IV.

Existing techniques like the chest X-Ray**[3]**, Computed Tomography (CT) scan**[4]**, sputum cytology, biopsy, bronchoscopy, needle aspirations, electronic nose**[5]** and others, not only require complex equipment and high cost but is also proven to be efficient only in stage 4, when the tumor has metastasized to other parts of the body. Also, it has been found that 0.4% of current cancers in US are due to the CT scans performed in the past and this may increase to as high as 1.5-2% as per the 2007 report **[6]**. The ionizing radiation emitted by the CT scan has the capability to damage the DNA which cannot be corrected by the cellular repair mechanism. Biomarker test is available for diagnosing cancers but there is no specific biomarker found so far for lung cancer **[7]** and researchers are still working on that. In spite of the available existing techniques, most of the time lung cancer is detected only after crossing stage 1.

The lung cancer five-year survival rate (16.3%) is lower than many other leading cancer sites **[8]**.The five-year survival rate for lung cancer is 52.6% for cases detected early, when the disease is still localized (within lungs). However, only 15% of lung cancer is diagnosed at this early stage. For distant tumors, the five-year survival rate reducessignificantly to 3.5%. So, over half of the people with lung cancer die within one year of being diagnosed.

As the volume of data is growing proportionally with the increase in population, there is a greater need to extract the knowledge from the data. Data mining contributes much towards this and finds its application in various diverse fields including the healthcare industry. Data mining is the process of sifting through historical data thus providing an insight into the patterns from large dataset and helps to incorporate the pattern in everyday activity. Data mining helps in medical diagnosis to extract the underlying pattern of the disease. Researchers are suggesting that applying data mining techniques in identifying effective pre-diagnosis of the disease can improve practitioner performance **[9]**. Lung cancer being a disease which is highly dependent on historical data can make use of data mining for its early detection .Researchers have been investigating on applying various data mining techniques on lung cancer dataset for early diagnosis of lung cancer.

This paper proposes a model for measuring if applying data mining techniques to lung cancer dataset can provide reliable performance in the detection of lung cancer at Stage I. The rest of the paper is organized as follows: Section 2 provides a literature survey on using data mining techniques which help health care professionals in the early diagnosis of lung cancer. Section 3 provides an overview of data mining and the various steps involved in data mining for the classification process. Section 4 discusses the proposed research model which is followed by a summary section.

II. Literature Survey

Over the last decade, many interesting techniques of data mining were proposed to detect various types of cancers. Few of the techniques are described below with their significance and limitations. In **[10]**, Ahmed et al, implemented a model to diagnose lung cancer risk at an early stage using k-means clustering. The significant patterns are then discovered using Apriori Tid and Decision Tree algorithm. Apriori Tid, which is an extension of Apriori algorithm is one of the most influential algorithms to mine frequent item sets**[11]**. Apriori algorithm called two sub-processes which are Apriori-gen() and subset(), Apriori-gen() process produces a candidate for lung cancer, then use the Apriori property to delete those candidates of the non-frequent subsets. Once all the candidates gets generated, the database will be scanned and for each transaction, the Subset() sub procedure is used toidentify all the candidate subsets, and make cumulative count for each of these candidates. Finally, all candidates met the minimum support form frequent item set L . The major drawback of this system is that it requires lot of database scans as the number of attributes increases. Also, it takes lot of time, space and memory for the candidate generation.

Oh et al. **[12]** proposed a method for predicting local failure in lung cancer post radiation therapy using Bayesian network. Bayesian networks encode the relations between variables using probability theory. They are used to predict an outcome and also to interpret the predictions based on the encoded relations. The attributes of the patient records are assigned to the nodes of the graph. The joint probability distribution function is then encoded by the network as per Equation 1.

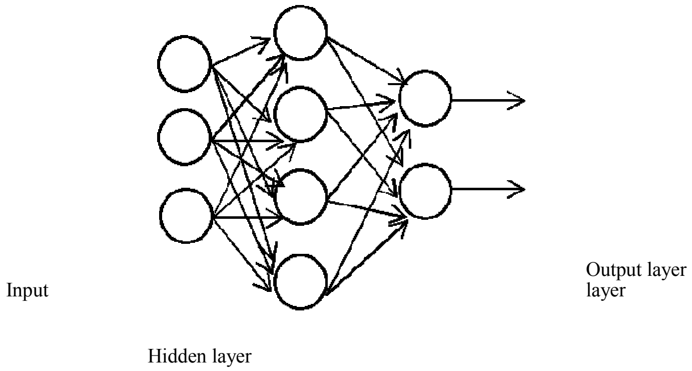
$$P(X) = \prod_{i=1}^{n} P\left(X_i | par(X_i)\right) \qquad (1)$$

This Bayesian model makes use of both the physical attributes and the biological attribute, i.e, the blood biomarkers, for predicting the local failure. This method has outperformed **[10]** by including the biological parameters.

A novel approached was proposed by Palanisamy et al. in **[13]** for selecting the significant genes of leukemia cancer using k-means clustering algorithm. Clustering was basically carried out on the gene expression data. Here, the k value is fixed as 5, 10 and 15 and the classification is done for every k value separately and the accuracy is calculated. The k-means clustering always converges to a local minima. Classification accuracy depends on the starting cluster centroid selection which was one difficulty faced with the k-means algorithm. Bayesian method as proposed byOh et al. gave a better accuracy **[12]** because of the inclusion of physical parameters in combination with the biological parameters.

In 2011, Liu et al. implemented a classifier using Discrete Particle Swam Optimization(DPSO) **[14]** with new rule pruning procedure for detecting lung cancer and breast cancer. This is a slight modification of the Particle Swarm Optimization where DPSO does not make use of the velocity and the initial weight. With this new procedure, the average accuracy rates have improved. Also, the impact is more noteworthy on lung cancer data than it is on the breast cancer one. The major limitation of PSO and DPSO is that the algorithm has a limit on the number of iterations and in most situation it is not possible to know that the program has found an optimal solution.

Artificial neural networks (ANN) provide a powerful tool to help doctors to analyze, then model and make sense of complex clinical data across a wide range of medical applications **[15]**. It is a mathematical model developed on the basis of biological neural networks. Each neuron / node in the input layer represents each attribute of the patient dataset. The values from the input layer are then send to the nodes in the hidden layer along with the weight values where the learning actually takes place. After the learning process, the classification is done in the output layer. Figure 1 shows the structure of the basic network used for classification.



Economou et al. has proposed a model that diagnoses pulmonary diseases such as tuberculosis, lung cancer , asthma, occupational disorders of lungs and others **[16]**. They also proved that feed forward networks, especially the back propagation network and the Kalman filter could give a better performance.

III. Proposed Method

In the last few years, the digital revolution has provided relatively inexpensive and available means to collect and store large amounts of patient data in databases containing rich medical information and made available through the Internet for Health services globally. Data mining techniques applied on these databases discover relationships and patterns that are helpful in studying the progression of disease**[17]**. The steps involved in data mining are :

1) Data Integration
   Heterogeneous data from various health organizations which are in different forms are collected from multiple sources and made into a common source.
2) Data Selection
   The dataset collected from various sources contain all sorts of data. Some of the data may be irrelevant for the mining process and also, some data contain a lot of missing information. Such data are discareded. Only those data relevant to the mining process are considered.
3) Data cleaning
   Some patient record contain errors, noise or missing information. Certain data are corrected and those that cannot be corrected are discarded. Fuzzy Self Organising Maps can also be used to filling the missing values **[17]**. Table 2 presents some of the attributes identified.

Table 2 Some of Lung Cancer Causes Attributes

Attribute	Type
Age	Numeric
Gender	Nominal
Height	Numeric
Weight	Numeric
Smoking habit	Nominal
Secondhand smoke	Nominal
Radon gas	Nominal
Asbestos	Nominal
Air pollution	Nominal
Radiation therapy to lungs	Nominal
HIV or AIDS	Nominal
Organ Transplant	Nominal
Women with HRT	Nominal

Table 3 and Table 4 represent some of the primary and secondary symptoms identified.

Table 3 Some of Lung Cancer Primary Symptoms Attributes

Attribute	Type
Chest pain	Nominal
Cough	Nominal
Coughing of blood	Nominal
Fatigue	Nominal
Losing weight without trying	Nominal
Loss of appetite	Nominal
Shortness of breathe	Nominal
Wheezing	Nominal

Table 4 Some of Lung Cancer Secondary Symptoms Attributes

Attributes	Type
Bone pain or tenderness	Nominal
Eyelid drooping	Nominal
Facial Paralysis	Nominal
Hoarseness or changing voice	Nominal
Joint pain	Nominal
Nail problems	Nominal
Shoulder pain	Nominal
Swallowing difficulty	Nominal
Swelling of face or arms	Nominal
Weakness	Nominal
Fever	Nominal

4) Data Transformation

The acquired data from the process of cleaning will not be ready for mining. This data has to be converted into suitable form for data mining. Larger values have to be normalized for fast calculation. This is achieved by using the formula.

$$x_{new} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

From the process of normalization and data acquired using discretization, the patients records are produced in a matrix form.

5) Data Classification

Different type of patterns is discovered in this phase. Various types of techniques are studied in the survey of literature. It is been identify that ANN will give better results when compared to other methods. In **[16]**, Economou et al made use of the supervised learningmethods but in **[18],** it has been proves that the unsupervised learning, to be more specific, Kohonen Self Organising Map (SOM) could yield better performance even in the case of missing data. A ‘learnt’ SOM can be used as an important visualization aid because it gives a complete picture of the data ,i.e, similar data items are automatically grouped together**[19]**.

For this reason, this method can be used for the diagnoses of lung cancer at an early stage. With modification done to the learning rate and the neighborhood distance and the weight updation formula, the model can yield a better performance result.

IV. RESULTS AND DISCUSSIONS

The aim of this survey is to evaluate the effective technique for extracting knowledge and notify the existing lung cancer data profile. Various types of techniques of data mining are applied on the cancer data. A survey work has been done in this area related to data mining algorithms applied on lung cancer data. Data cleaning is the major challenging processed involved in this area, because of data extracting from various sources base done required attributes. Fuzzy model is used to fill the missing values. As there is an increase in training data, performance is also increase and improved

V. CONCLUSION

Our paper presents early detection of lung cancer based on survey using data mining techniques. The work of survey aims in detection and diagnosis of cancer disease and related areas. The work done in this paper will compare various techniques of data mining based on efficiency in classification of lung cancer for various classes.

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