ISSN:0975-9646

Predictive Machine Learning Techniques for Breast Cancer Detection

S.Kharya[#] , D. Dubey[*] , and S. Soni[#]

[#]*Department of Computer Applications, Bhilai Institute of Technology, Bhilai House Durg(C.G.) - INDIA*
[*] *Department of Computer Science & Engineering, CSIT, Durg (C.G.) – INDIA*

Abstract **-Machine learning is a branch of artificial intelligence that incorporate a variety of statistical, probabilistic and optimization techniques that allow computers to "learn" from past examples and to detect hard-to-diagnosed patterns from massive , noisy or complex data sets. This features are particularly well-suited to medical applications, especially those that depend on complex proteomic and genomic measurements. Machine learning techniques like support vector machine , Bayesian belief network, Artificial neural network are frequently used in cancer diagnosis and detection. More recently machine learning has been applied to cancer prognosis and prediction. The survey has shown that there are lots of best performing algorithms for the analysis of features of data sets.**

Keywords: Bayesian Networks, Breast cancer. Decision trees,Machine learning, Diagnosis, Prognosis,Support Vector Machine.

I. INTRODUCTION

Today machine learning methods are being used in a extensive range of medical applications including detecting and classifying tumors. It has been used first and foremost as an aid to cancer diagnosis and detection (McCarthy et al. 2004). Cancer researchers have recently attempt to pertain machine learning towards cancer prediction and prognosis. Machine learning still draws from statistics and probability, but it is deeply more powerful because it allows inferences or decisions to be made that could not otherwise be made using conventional statistical methodologies[1].Given the budding importance of predictive medicine and the growing reliance on machine learning to make predictions, we believed it would be of interest to conduct a detailed review of published studies employing machine learning methods in cancer prediction and prognosis. If a machine learning experiment is properly deliberate, correctly implemented and the results robustly validated, then one usually has a superior chance of success.

Interestingly, almost all machine learning algorithms used in cancer prediction and prognosis utilize supervised learning. Furthermore, most of these supervised learning algorithms belong to a specific category of classifiers that classify on the basis of conditional probabilities or conditional decisions. The major types of conditional algorithms include: 1) artificial neural networks 2) decision trees 3) genetic algorithms 4) linear discriminant analysis 5) *k*-nearest neighbor algorithms prognosis 6) Naïve Bayesian.

Predicting the result of a disease is one of the most interesting and exigent tasks where to develop data mining applications. As the use of computers powered with automated tools, large volumes of medical data are being collected and made available to the medical research groups. As a result, Knowledge Discovery in Databases (KDD), which includes data mining techniques, has become a popular research tool for medical researchers to identify and exploit patterns and relationships among large number of variables and made them able to predict the outcome of a disease using the historical cases stored within datasets.

The objective of this paper is to summaries various review and technical articles on diagnosis and prognosis of breast cancer. It gives an overview of the current research being carried out on various breast cancer datasets using the data mining techniques to enhance the breast cancer diagnosis and prognosis.

II . BREAST CANCER:AN OVERVIEW

Breast cancer is the most common cancer in women worldwide. It is also the principle cause of death from cancer among women globally. The most effective way to reduce breast cancer deaths is detect it earlier. Early diagnosis requires an accurate and reliable diagnosis procedure that allows physicians to distinguish benign breast tumors from malignant ones without going for surgical biopsy.

Breast cancer is the most frequently diagnosed cancer and is the leading cause of cancer death among women worldwide [2].

- Every 19 seconds, somewhere around the world a case of breast cancer is diagnosed among women.
- Every 74 seconds, somewhere in the world, someone dies from breast cancer.

A. Breast Cancer Types

We can distinguish three types of breast tumors: benign breast tumors, in situ cancers, and invasive cancers. The majority of breast tumors detected by mammography are benign. They are non-cancerous growths and cannot spread outside of the breast to other organs. In some cases it is difficult to distinguish certain benign masses from malignant lesions with mammography. If the malignant cells have not gone through the basal membrane but is completely contained in the lobule or the ducts, the cancer is called in situ or noninvasive .If the cancer has broken through the basal membrane and spread into the surrounding tissue, it is called invasive. Therefore, early detection of breast cancer is essential. In our study, we are

focusing on the differentiation between benign and malignant tumors. The objective of these predictions is to assign patients to either a *"benign"* group that is non cancerous or a *"malignant"* group that is cancerous.

III. PREDICTIVE MODELLING APPROCHES

Predictive data mining is becoming an essential instrument for researchers and clinical practitioners in medicine. Understanding the main issues underlying these methods and the application of agreed and uniform procedures is mandatory for their deployment and the broadcasting of results. Predictive models can be used to conjecture explicit values, based on patterns determined from known results. This technique is becoming an essential appliance for researchers and clinical practitioners in medical . These methods may be applied to the edifice of decision models for procedures such as prognosis, diagnosis and treatment planning, which – once evaluated and verified –may be embedded within clinical information systems. *Classification* and *prediction* are major predictive data mining task.

A. Predictive Data Mining in Breast Cancer

Most data mining methods universally used for this review are of classification category as the applied prediction techniques assign patients to either a "benign" group that is non- cancerous or a "malignant" group that is cancerous. The endeavor of the classification is to build a classifier based on some cases with some attributes to portray the objects or one attribute to describe the group of the objects. Then, the classifier is used to predict the group attributes of new cases from the domain based on the values of other attributes.

IV.DATA MINING MODELLING APPROACHES

A Classification Tree

Decision trees are authoritative classification algorithms that are becoming very admired with the advancement of data mining in the field of information systems. As it implies, this technique recursively separates observations in branches to construct a tree for the purpose of improving the prediction accuracy. A decision tree structure consists of root, internal and leaf nodes. The tree structure is used in classifying unknown data records. A number of algorithms have been anticipated for decision tree induction. Following are the decision tree methods commonly used in most practical applications.

Following are the advantages and disadvantages of this method.

+ In this method, learned trees can be represented as a set of if-then rules that improve human readability.
+ This offers an easy approach to understand representation of clinical knowledge.
+ Decision tree methods are simple to understand and interpret by domain experts.
− Tree building is very task loaded and computationally intensive as the training data set is traversed repeatedly.
− Over-fitting in decision tree algorithm results in misclassification error.

1) ***Classification tree in diagnosis & prognosis of Breast cancer:*** Decision Tree has been applied in medical for many purpose like diagnosis of various chronic disease, Predicting Risk of Mortality, feature selection to improve classification accuracy, for reduction of the diagnosis cost[30].

In [4] authors analyzed the prediction of survivability rate of breast cancer patients using data mining techniques. The data used is the SEER Public-Use Data. The preprocessed data set consists of 151,886 records, which have all the available 16 fields from the SEER database .Authors investigated three data mining techniques: the Naïve Bayes, the back-propagated neural network, and the C4.5 decision tree algorithms. They found out , C4.5 algorithm has a much better performance than the other two techniques.

In [31], explored the applicability of decision trees for detection of high-risk breast cancer groups over the dataset produced by Department of Genetics of faculty of Medical Sciences of Universidade Nova de Lisboa with 164 controls and 94 cases in WEKA machine learning tool. To statistically validate the association found, permutation tests were used. They found a high-risk breast cancer group composed of 13 cases and only 1 control, with a Fisher Exact Test(for validation) value of 9.7*10-6 and a p-value of 0.017. These results showed that it is possible to find statistically significant associations with breast cancer by deriving a decision tree and selecting the best leaf.

In [5] Decision tree has been successfully applied for feature selection to analyze the performance of classifier. The analysis of CART Classifier is performed with and without feature selection in terms of accuracy, time to build a model and size of the tree on various Breast Cancer Datasets. The results show that a particular feature selection using CART has enhanced the classification accuracy of a particular dataset.

In [6] the Decision Trees model has been proposed to solve specific problems that commonly use Logistic Regression as a solution, especially to predict risk of death. From experiments the conclusion is that Logistic Regression and Decision Trees are both effective means of constructing models to predict risk of mortality. Both methods provide reasonable discrimination but Decision Trees considering the advantages of human interpretability can be seen as a worthy alternative to Logistic Regression in the area of Data Mining.

B. Neural Networks

Neural Network (NN) is a prevailing AI techniques that has the capability to learn a set of data and constructs weight matrixes to represent the learning patterns. Neural networks are a parallel distributed processing models, are computer-based, self-adaptive models that were first developed in the 1960s, but they reached great esteem only in the mid-1980s after the development of the back propagation algorithm by Rumelhart et al. [1986]. A neural network is a computational representation that takes as input a sequence of numbers, for example, encoded patient features, and outputs another sequence of numbers that is interpreted as,

for example, survival probability of that patient . Computational nodes are connected in several layers (input, hidden and output) via weights that are typically adapted during the training phase to achieve high performance.

+ Implementation using data instead of possibly ill defined rules.
+ Noise and novel situations are handled automatically via data generalization.
+ Predictability of future indicator values based on past data and trend recognition.
+ Automated real-time analysis and diagnosis.
+ Allows rapid identification and classification of input data.
+ Reduces error associated with human fatigue and habituation.
− Neural networks are very powerful at learning complicated, non-linear patterns in data.
− They have a tendency of adapting themselves too much to the data, resulting a phenomenon known as over fitting. This may give rise to the discovery of spurious patterns.
− They belong to back-box methods, *i.e.,* the relation between a neural network and the problem it represents is not easy to understand.

1) Neural Network in diagnosis & prognosis of breast cancer: Artificial neural networks have featured in a wide range of medical journals, often with promising results. The software development exploits the potential of human intelligence such as reasoning, making decision, learning by experiencing and many others areas.

In [7] the authors have successfully applied neural network methods to medical problems and proved that human diagnostic capabilities are significantly worse than the neural diagnostic systems.

In [8] The author reports on a systematic review conducted to assess the benefit of artificial neural networks (ANNs) as decision making tools in the field of cancer. The number of clinical trials (CTs) and randomized controlled trials (RCTs) involving the use of ANNs in diagnosis and prognosis increased from 1 to 38. In this study out of 396 studies involving the use of ANNs in cancer, only 27 were either CTs or RCTs. Out of these trials, 21 showed an increase in benefit to healthcare provision and only 6 did not. The artificial neural networks has been used as decision making tools in the field of medical for diagnosis of various chronic disease. It is found to play a vital role in the medical field in solving various health problems like acute diseases and even other mild diseases.

In [9] an approach for early breast cancer diagnostic by employing combination of artificial neuralnetworks (ANN) and multiwavelet packet based subband image decomposition.In their work Intelligent system has been developed for the identification of microcalcification clusters in digitized mammograms, aiding the radiologists for breast cancer prognosis.

In [11] an automatic diagnosis system for detecting breast cancer based on association rules (AR) and neural network (NN). In this study, AR is used for reducing the dimension of breast cancer database and NN is used for intelligent classification. The proposed AR + NN system performance is compared with NN model. This study was performed using Wisconsin breast cancer database with 9 attributes and 699 records. Their proposed AR + NN model can be used to obtain efficient automatic diagnostic systems for other diseases.

In [12] the aim of study is to propose an approach for breast cancer distinguishing between different classes of breast cancer. This approach is based on the Wisconsin Diagnostic and Prognostic Breast Cancer datasets for feature selection, and the classification of different types of breast cancer using neural network approach, and especially the multi layer perceptron MLP and the radial basis function RBF. The data set consists of nine features that represent the input layer to the neural network. The neural network will classify the input features into two classes of cancer type (benign and malignant). The proposed approach tested on the database, resulted in 97 % succession rate of classification using RBF neural network.

C. Support Vector Machine

Support vector machines (SVM**)** are today's most powerful classification algorithm in terms of predictive accuracy [13]. The SVM algorithm as a relatively new classification or prediction method, has been developed in the [14] as a result of the collaboration between the statistical and the machine learning research community. The methods are based on strong mathematical foundations and statistical learning theory [15]. Basically the method is to finds a hyper plane that separates the examples of different outcomes. Being primarily designed for two-class problems, SVMs find a hyper plane with a maximum distance to the closest point of the two classes; such a hyper plane is called the optimal hyper plane. A set of instances that is closest to the optimal hyper plane is called a support vector.

Support vector machines are becoming increasingly popular, in bioinformatics. It uses a formalism that is often unsuitable for interpretation by human experts. If we are only interested in predictive accuracy, support vector machines are a strong contender to artificial neural networks, especially since their performance may be more robust and less depends on the specific selection of method's parameters.

+ Support vector machines are powerful pattern recognizers.
+ The development of SVMs involved sound theory first, and then implementation and experiments assumed to belong to the same family of methods.
+ The solution to an SVM is global and unique
+ Two more advantages of SVMs are that they have a simple geometric interpretation and give a sparse solution
+ SVMs use structural risk minimization.
− They yield black-box models.

1) Support Vector machine in diagnosis & prognosis of breast cancer: In [16] authors have used neural networks Support Vector Machine method for

diagnosis of breast cancer. SVMs can only be used for classification, not for function approximation. The Support Vector Machine (SVM) is implemented using the kernel Adatron algorithm. Support Vector Machine method was used on the set of 683 samples of actual data. Additional set of data of 117 samples is generated using Neural Network. Using Support Vector Machine ANN, the prediction of diagnosis and detection of breast cancer is comparably accurate than the human being. The efficiency of manual detection of breast cancer is 85% and the efficiency of the Support Vector machine recognition obtained is nearly 97%. This high rate of accuracy can be utilized to support the Doctor's decision to avoid Biopsy.

In [17] authors proposed a Support Vector Machines (SVMs) based classifier in comparison with Bayesian classifiers and Artificial Neural Networks for the prognosis and diagnosis of breast cancer disease. The paper provides the implementation details along with the corresponding results for all the assessed classifiers. A SVM model is implemented for the breast cancer diagnosis and prognosis problem using the Wisconsin Diagnostic Breast Cancer (WDBC) as well as the Wisconsin Prognostic Breast Cancer (WPBC) datasets. The optimized SVM algorithm performed excellently, exhibiting high values of accuracy (up to 96.91%), specificity (up 97,67%) and sensitivity (up to 97,84%).

D. Bayesian Network

A Bayesian network (also referred to as *Bayesian belief network, belief network, probabilistic network*, or *causal network*) consists of a qualitative part, encoding existence of probabilistic influences among a domain's variables in a directed graph, and a quantitative part, encoding the joint probability distribution over these variables.

Bayesian networks are very attractive for medical diagnostic systems because as they can be applied to make inferences in case where the input data is incomplete .Each node of the graph represents a random variable and each arc represents a direct dependence between two variables. The directed graph is a representation of a factorization of the joint probability distribution. The graph reflect the causal structure of the domain they normally reflect expert's understanding of the domain, enhance interaction with a human expert at the model building stage and are readily extendible with new information. Finally, causal models facilitate user insight once a model is employed. This is important in all those systems that aid decisions and fulfill in part a training role, like most diagnostic systems. Quantification of a Bayesian network consists of prior probability distributions over those variables that have no predecessors in the network and conditional probability distributions over those variables that have predecessors. These probabilities can easily incorporate available statistics and, where no data are available, for expert judgment. A probabilistic graph represents explicitly independencies among model variables and allows for representing a full joint probability distribution by a fraction of numbers that would be required if no independencies were known.

1) Bayesian belief networks: A Bayesian Network is a directed acyclic graph consisting of (i) Nodes (circles), which represent random variables; arcs (arrows), which represent probabilistic relationships among these variables and (ii) for each node, there exists a local probability distribution attached to it, which depends on the state of its parents[18]. A Bayesian Network is a graphical model that represents relationships of probabilistic nature among the input variables of interest. Such networks consist of a qualitative part (structural model), which provides a visual representation of the interactions amid variables, and a quantitative part (set of local probability distributions), which permits probabilistic inference and numerically measures the impact of a variable or sets of variables on others. Both the qualitative and quantitative parts determine a unique joint probability distribution over the variables in a specific problem. In other words, many of the early Bayesian networks developed for real-life applications in biomedicine and health-care have been constructed by hand, ie, they are based on medical background knowledge. Manual constructions of a Bayesian network requires access to the knowledge of human experts and, are quite time consuming. With the increasing availability of clinical and biologic data, machine learning is clearly the more feasible alternative for developing a Bayesian network. Integrating background knowledge and evidence derived from past data is also supported by Bayesian networks. Missing data can be handled both in the construction process and in using a Bayesian network model.

+ The Bayesian network is a powerful tool to describe the uncertainty and complexity of many problems in the real world having rigorously justified mathematical basis.
+ They deal in a natural way with uncertainty (modeled as a joint probability distribution).
+ They are easy to understandable because of their graphical representation.
+ BNs can be used both as predictive and descriptive models. In prediction they constitute an efficient tool for solving different inference tasks (posterior probability, adductive or diagnostic reasoning, relevance analysis, classification). As a descriptive tool they possess the ability to efficiently represent the dependence/independence relationships among the random variables
+ That compose the problem domain we desire to model.
+ It is possible to represent a large instance in a Bayesian network using little space, and it is possible to perform probabilistic inference among the features in an acceptable amount of time.
+ The graphical nature of Bayesian network gives us a much better intuitive grasp of the relationships among the features.

2) *Comparison with Neural Networks:* Compared to artificial neural networks, Bayesian belief networks have certain unique advantages, in addition to their ability to work with incomplete information, mentioned above. One such advantage is that they can provide explanations of their decisions [19]. Because they provide a flexible capability for specifying dependence and independence of

variables, in a natural way through the network topology, their structure tends to reflect the logical structure inherent in a decision task. In contrast, neural networks can be viewed, to a large extent, as a black box whose 'machine learned' internal decision structure is generally incomprehensible to human observers.

3) *Suitability in Medical Prediction:* Medical Prediction is special Domain where symptoms have certain degree of dependency among them. For example if the Obesity will increase it will also increase Blood Pressure, blood sugar level etc. In BN's the probability values for links between nodes in Bayesian networks reflect degrees of dependence between variables. This makes it possible for the structure of these networks to be examined by human experts to uncover relationships between the variables, hence, enabling the assessment of the reasonableness of the decision process. The other prediction Model discussed so far does not consider the dependency among the input parameter rather the model is built considering the independency of input parameter and this is an important factor in their gaining acceptance in the field of medical diagnosis.

4) Characteristics of BBN:

- BBN provides an approach for capturing the prior knowledge of a particular domain using a graphical model. The network also be used to encode casual dependencies among the variables.
- BBN are well suited to dealing with incomplete data.
- Because the data is combined probabilistically with prior knowledge, the method is quite robust to model over fitting [28].

5) Bayesian networks diagnosis & prognosis of breast cancer: The main advantages of Bayesian networks from a (bio) medical point of view are its flexibility and strong links with how biomedical people think about problems.

In [20] an automated breast cancer detection support tool is designed using Bayesian Belief Network. Bayesian networks are suitable technique for computer-aided detection by representing the relationships between diagnoses, physical findings, laboratory test results and imaging study findings. This work brings together the Radiologists, Image Processing Scientists, Data Base Specialists and Applied Mathematicians on a common platform.

In [21] Bayesian networks are used in Predicting the prognosis of breast cancer by integrating the clinical and microarray data. The main advantage of this probabilistic model is that it allows integrating these data sources in several ways and that it allows investigating and understanding the model structure and parameters.

In [22] temporal Bayesian classifiers has been used for Computer-aided detection of lesions in digital mammograms.

In [23] the author have demonstrated that when the BI-RADS lexicon, coupled with Bayesian model, has great potential to communicate quantitative probabilistic information beyond teaching cases to actual patients.

In [25] this study evaluated two different Bayesian classifiers; tree augmented Naive Bayes and Markov blanket estimation networks to build an ensemble model for prediction the severity of breast masses. The objective of the proposed algorithm was to help physicians in their decisions to perform a breast biopsy on a suspicious lesion seen in a mammogram image results. The authors have found the Bayesian network classifiers to be a competitive alternative to other techniques in medical applications.

In [26] Bayesian network (BN) applied in the domain of emergency medicine where BN are found to be an appropriate technique because of their symbolic representation, handling of uncertainty, where different scenarios are possible by given evidences.

In [27] a simple Bayesian belief network for the diagnosis of breast cancer, and specifically addresses the question of whether integrating image and non-image based features into a single network can yield better performance than hybrid combinations of independent networks

E. Comparisions Between Different Machine Learning Algorithms

In Table 1,benefits and limitations of various machine learning techniques are listed in summarized form.

TABLE I
BENEFITS AND LIMITATIONS OF MACHINE LEARNING TECHNIQUES

Machine Learning Algorithm	Benefits	Assumptions and /or Limitations
Decision Tree	Easy to understand.	Classes must be mutually exclusive.
	Efficient training algorithm.	Decision tree depend upon order of attribute selection.
	Order of instances has no effect on training.	Missing values of an attribute create confusion.
Naive Bayes	Based on statistical modeling.	Assumes attributes to be statistically independent.
	Easy to understand.	Assumes normal distribution on numeric attributes.
	Efficient training algorithm.	Classes must be mutually exclusive.
	Order of instances has no effect on training.	Redundant attributes mislead classification.
	Useful across multiple domains.	Attribute & class frequencies affect accuracy.
Neural Network	Used for classification or regression	Difficult to understand structure of algorithm.
	Able to represent boolean functions.	Too many attributes can result in over fitting.
	Tolerate noisy inputs.	Network structure can be determined by experiment.
Support Vector Machine	Models non linear class boundaries.	Training is slow compared to Bayes & Decision tree.
	Easy to control complexity of decision rule.	Difficult to understand structure of algorithm

V. CONCLUSIONS AND FINDINGS

The paper provides a comprehensive review of the state of the art of predictive data field. From the exhaustive review of work carried out during last 10 years, **ANN** is found to be most widely used predictive technique in medical prediction as compare to traditional methods like Decision Tree, Regression Tree etc. Owing to the fact that ANN technique provides Robust solution to real time prediction problem till date they have invaded almost all the realm of medical prediction process. **SVM** has been mainly used in the computational biology such as microarray data analysis, protein secondary structure prediction, prediction of human signal peptide cleavage sites, translational initiation site recognition in DNA, protein fold recognition, prediction of protein–protein interactions, prediction of protein sub-cellular localization, and peptide identification from mass-spectrometry derived data. Like ANN, SVM is also Black Box method have not yet seen widespread adoption in the communities working with very large datasets due to the high computational in the training phase [29].

Bayesian network is recently developed technique suitable to perform prediction under uncertainty with incomplete data. It offers a very attractive formalism for representing uncertain knowledge, have so far only been used in medicine essentially to assist in the diagnosis of disorders and to predict the natural course of disease after treatment (prognosis). The graphical nature of Bayesian networks gives a much better intuitive grasp of the relationships among the features. BBN is found to be a technique for medical prediction for breast cancer prognosis & diagnosis .In future we intend to design and implement such system for web applications.

REFERENCES

[1]Applications of Machine Learning in Cancer Prediction and Prognosis,Joseph A. Cruz, David S. Wishart Departments of Biological Science and Computing Science, University of Alberta Edmonton,AB, Canada.

[2] www.komen.org

[3]McCarthy et al. 2004,Applications of Machine Learning and High□Dimensional Visualization in Cancer Detection, Diagnosis, and Management

[4]Bellaachia, Erhan Guven,Predicting Breast cancer survivability using data mining techniques,Department of computer science,George Washington university.

[5] Lavanya, D. , Dr.K.Usha Rani (2011), ANALYSIS OF FEATURE SELECTION WITH CLASSFICATION: BREAST CANCER DATASETS, *Indian Journal of Computer Science and Engineering* (IJCSE) ISSN : 0976-5166 Vol. 2 No. 5, pp 756-763.

[6] Badriyah, T., Jim S. Briggs, and Dave R. Prytherch (2012), Decision Trees for Predicting Risk of Mortality using Routinely Collected Data, *International Journal of Social and Human Sciences* 6.

[7]Brause, R. W. (2001), Medical Analysis and Diagnosis by Neural Networks, Margarita Sordo, Introduction to Neural Networks in Healthcare, *knowledge Management for Health Care, Lecture Notes in Computer Science*.

[8]Paulo J, et al, 2006, Paulo, J. Lisboa , Azzam F.G. Taktak(2006), The use of artificial neural networks in decision support in cancer: A systematic review, *Neural Networks* 19 (2006) 408–415@ Elsevier.

[9]Sepehr M.H.Jamarani,Intelligent System for breast cancer prognosis using Multi wavelet packets & Neural Network,Transaction on Engineering ,computing & technology V7,August 2005,ISSN 1305-5313.

[10]Delen, D., Walker Glenn and Kadam Amit (2005), Predicting breast cancer survivability: a comparison of three data mining methods, *Artificial Intelligence in Medicine* ,vol. 34, pp. 113-127.

[11]Murat Karabatak a, M. Cevdet Ince,Expert system with applications,2009,Elsevier.

[12]Ali Raad*, Ali Kalakech**,Mohammad Ayache,Breast cancer classification using neural network approach ;MLP & RBF,13th International Arab Conference on Information Technology ,ACIT'2012 Dec.10-13,ISSN.182-0857.

[13] Delen, D. (2009), Analysis of cancer data: a data mining approach , *Expert Systems*, Vol. 26, No. 1.

[14] Vapnik ,V.N. (1998), Statistical Learning Theory, *Wiley, New York.*

[15]Yanmin ,S., Andrew K. C. Wong, Yang Wang(2006) , An Overview of Associative Classifier, *DMIN* : 138-143.

[16]SUDHIR D. SAWARKAR,GHATOL,Neural network aided Breast Cancer Detection & diagnosis using Support Vector Machine,Proceeding of 7th WSEAS International conference on Neural Network,June 12-14,2006(pp 158-163)

[17]Ilias Maglogiannis · Elias Zafiropoulos · Ioannis Anagnostopoulos,an Intelligent system for automated breast cancer diagnosis & prognosis using SVM based classifiers,july-2007,Springer.

[18]Cooper, 1999, An overview of the representation and discovery of causal relationships using Bayesian networks.

[19]HECKERMAN D 1997). HECKERMAN, D.(1997), Bayesian Networks for Data Mining, *Data Mining and Knowledge Discovery* 1, 79–11.

[20]Gadewadikar J et al 2010),Exploring Bayesian Network for medical decision support in breast cancer detection.,AJMCSR,vol 3(10),pp-225-231.

[21]Olivier G et al 2006, Olivier, G., Frank De Smet, Dirk Timmerman, Yves Moreau and Bart De Moor (2006), Predicting the prognosis of breast cancer by integrating clinical and microarray data with Bayesian networks, BIOINFORMATICS Vol. 22 no. 14 pages e184–e190.

[22]Maurice S, 2005) Computer aided detection of lesions in digital mammograms uing temporal Bayesian classifiers, Radboud University Nijmegen.

[23]Elizabeth S et al, 2004) Elizabeth, S. Burnside, Daniel L. Rubin, Ross D.

[24]Shachter(2004),Using a Bayesian Network to Predict the Probability and Type of Breast Cancer, *MEDINFO* 2004, IMIA.,

[25]Alaa M. Elsayad,,Predicting the severity of breast masses with ensemble of Bayesian classifiers,Journal of computer science 6(5);576-584,2010.

[26] Miljenko, K., Matej Mertik(2008), Application of Bayesian networks in emergency medicine.

[27](Wang, Bin Zheng, Walter F. Good,1998),Computer assisted diagnosis of breast cancer using a data driven Bayesian belief network,IJMI 54(1998)115-126.

[28]Shweta Kharya ,Sunita soni ,Using Bayesian Belief Network of breast cancer detection.,AICON-13,paper no-50,April 2013.

[29]Shweta Kharya, Using Data Mining Techniques for diagnosis & prognosis of cancer disease,ijcseit,vol-2,Issue no-2,april 2012.

[30]Camelia, V. B, Cristina Savin & Rodica Potolea (2007), A Hybrid Algorithm for Medical Diagnosis, *The International Conference on "Computer as a Tool" EUROCON, ;Page(s): 668 – 673.*

[31]A Data Mining Approach for the Detection of High-Risk Breast Cancer Groups,2010,springer.