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Prediction of Breast Cancer using different Machine Learning Techniques- A Review

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ABSTRACT

Breast cancer is a type of tumor that occurs in the tissue of breast. It is most common type of disease in the women around the world and leading cause of the death also. Due to the rapid development of population the prediction of breast cancer recurrence is crucial for improving the survival rate of breast cancer patients. Machine learning-based image processing techniques are frequently utilized in the medical field to improve the early diagnosis of breast malignant tumors. From the typical mammography images, malignant images are sorted out and classified using supervised learning algorithms. The accuracy of cancer diagnosis and detection has increased because to technological advancements and machine learning approaches. In this paper we compare supervised machine learning technique namely Support Vector Machine, K-nearest neighbors, random forest, logistic regression, naïve Bayes, decision tree. Every technique has different accuracy rate and varies from different situations. The UCI machine learning database is mostly used in research which is a well-known machine learning database where the Wisconsin Breast Cancer dataset was found.

Keyword:— *Support Vector Machine, K-nearest Neighbor, Random forest, Logistic Regression, Decision Tree,*

I. INTRODUCTION

Breast cancer is the development of a cancerous tumor from cells in the breast. Depending on where in the breast the cancer begins, it will develop specific characteristics that are used to sub-classify breast cancer into kinds. The malignant cells either originate in the lining of the milk glands or ducts of the breast. The tumor first develops in the breast, but as soon as it becomes invasive, it may move to the local lymph nodes or metastasis to other organ systems, becoming widespread in nature [12]. Breast lumps, skin dimpling, fluid coming from the nipple, changing breast shapes, a newly inverted nipple, or a dry area of skin can all be indicators of breast cancer[40]. Normal, benign, in-situ carcinoma, and invasive carcinoma are the four basic kinds of breast cancer. A benign tumor entails a slight change in the breast anatomy. It is not dangerous and is not a dangerous malignancy. When in-situ carcinoma occurs, no other organs are affected and the cancer only affects the mammary duct lobule system. If detected early, this variety is not harmful and can be treated. Because it can spread to all other

organs, invasive carcinoma is regarded as the most serious type of breast cancer[47]. To detect cancer at an early stage before symptoms appear, researchers used a variety of procedures, including screening. Experts have also created fresh methods for predicting the outcome of cancer treatments early on. One of the most difficult and interesting problems for doctors today, as a result of the development of new techniques, is making an accurate cancer prediction [35]. In the field of medicine, disease diagnosis is a challenging task. A large amount of medical diagnosis information is accessible in multiple diagnostic facilities, hospitals, and research facilities, as well as on a number of websites [34]. Machine learning is the main model to train machines and to create predictive model to make decisions successfully. Machine learning helps in early diagnosis of breast cancer and on the basis of tumor size we can analyze the nature of cancer. Machine learning are the leading approach to obtain favorable outcome among classification and prediction problem [46]. Due to the intrinsic difficulties related with image like contrast, noise and lack of appreciation by the eye instruments have been made to prepare and improve images but now days Artificial Intelligence (AI), Machine Learning (ML) and Convolutional Neural Network (CNN) are the quickest rising filed of healthcare domain.AI and ML are found that in the research field which deals and improves the technological system for the complex task and reducing the necessity of human intelligence [23].

II. Related Work

For the prediction and detection of breast cancer, there are numerous machine learning methods available. Support Vector Machine (SVM), Random Forest, Logistic Regression, Decision tree and K-Nearest Neighbors (KNN Network) are a few examples of machine learning algorithms. A lot of researchers have used Wisconsin Data Set from various hospitals. Authors can complete their research by extracting and choosing different features from this datasets. The authors Md. Milon Islam, Md. Rizwanul Haque [34] worked on Breast Cancer Prediction-A comparative study using Machine Learning Techniques and authors used WBCD data set and the evaluation is done by confusion matrix for each technique in which authors have found that ANNs have the maximum accuracy of 98.57 percent, while RFs and LR have the lowest accuracy of 95.7 percent. On the other side the authors Madhuri Gupta and Bharat Gupta [35]worked on "A comparative study of Breast Cancer Diagnosis using Supervised Machine Learning Techniques" in which they have done the comparative analysis between four machine learning techniques Multilayer Perception (MLP), Support Vector Machine (SVM), K-Nearest Neighbors (KNN) and Decision- Tree(DT) and the accuracy of Multilayer Perception is higher than other techniques when cross validation metrics used in breast cancer prediction. The author Mohammed Amine Naji, Sanaa Filali[45] taken WBDC data set and demonstrated that Support Vector Machine (SVM) achieved a higher accuracy of 97.2% and precision is 97.5%.The authors Ali BonuNasif[47] worked on Breast cancer detection using Artificial Intelligence Techniques-A systematic literate review in which the author taken the Gene Sequencing Data and found the accuracy rate by applying different models, classes and performance in which author found that CNN algorithm is widely used for the gene expressions and MRI images data and obtained good result in comparison of other algorithms. On the other hand the authors Siham A. Mohammed [48] demonstrated the "Analysis of Breast Cancer Detection using Machine Learning Techniques" in which

they have focused on three classifiers such as Decision Tree (J48), Naïve-Bayes and Sequential Minimal Optimization (SMO) and used two different datasets found that SMO with accuracy 99.56% outperforms others in WBC dataset J48 with accuracy 98.20% is superior to others in Breast cancer database. Dhanya R [49] proposed a comparative study for Breast Cancer Prediction using Machine Learning and features selection and taken two dataset Wisconsin Dataset and WBDC dataset with feature selection f-test, RFE, SFS in which found that the Random forest classifier gives the higher accuracy when taken Wisconsin dataset it given 97.85%accuracy and when taking WDBC dataset it gives 94.73% accuracy. The author Dana Bazazeh [50] demonstrated the Comparative study of machine learning algorithms for Breast cancer Detection and Diagnosis and focused on three classifier Support Vector Machine (SVM), Random Forest (RF) and Bayesian Network (BN) taken Wisconsin Breast cancer dataset in which found that SVM have the highest performance in terms of accuracy, specify and precision. Author Anusha Pooja Bharat[51] worked on "Using machine learning algorithm for breast cancer risk prediction and diagnose" in which again they have taken Wisconsin breast cancer dataset and compared the accuracy of each machine learning algorithm and found SVM is a strong technique for predictive analysis.

III. METHODOLOGY

The most common disease in the field of medical diagnostics, which rises every year, is breast cancer. On the Wisconsin Breast Cancer Database (WBCD), a comparative analysis of popular machine learning approaches is carried out to predict the recurrence of breast cancer:

3.1 Support Vector Machine

One of the supervised machine learning (ML) classification methods that is frequently used in the field of cancer diagnosis and prognosis is SVM. SVM separates the classes by creating a linear function that divides them as broadly as feasible using these key samples from all classes, which are known as support vectors. As a result, it can be said that SVM is used to map an input vector to a high-dimensional space with the intention of finding the best hyper plane for classifying the data set[50].The Support Vector Machine is useful for both classification and regression, It uses mathematical and theoretical functions to address the regression issue. When making predictions using a huge dataset, it offers the highest accuracy rate. Based on 3D and 2Dmodelling, it is a powerful machine learning technique [44]. The method produces an optimal separation hyperplane that categorizes new samples after using trained labelled data (Supervised Learning). The hyper plane divides a 2-D plane into segments in 2D space, where each segment represents a different class in accordance with the labelled data [18].

3.2 K-Nearest Neighbors

A non-parametric method for classification and regression analysis is the K-Nearest Neighbor methodology. The input consists of the small, positive integer k, which is the number of classes in the dataset. The bulk of its neighbors categories and distinguish any input data. Therefore, the class that scores higher among its K nearest neighbors is given the input data. If the value of K=2 then the input data will be assigned to a class of two nearest neighbors. Since the dataset contain only dataset of 2 classes cancerous or non-cancerous [35]. A supervised classification algorithm is called k-Nearest Neighbors (K-NN). It uses a large

number of labelled points to learn how to label new ones. In order to label a new point, it considers the labelled points that are nearby, or its nearest neighbors, and asks those neighbors to cast their votes [45]

3.3 Random Forest

The supervised learning-based Random Forest technique is used to resolve classification and regression problems. It is a machine learning building component that is utilized for the prediction of new data based on past datasets [44]. An ensemble method of classification, regression and other tasks, random decision forests build a large number of decision trees during the training phase and output the class that represents the mean of the classes (classification) or mean prediction of the individual trees [45]. From a random selection portion of the training data, it generates a group of decision trees. The target class of the test instance is then predicted by combining the findings from various decision trees. It works well because while a single decision tree may be subject to noise, the combined outputs of several decision trees limit the impact of noise, producing superior outcomes. Controlling over-fitting contributes to improved predictive accuracy [49].

3.4 Naïve Bayes

The assumption of a large training dataset is made using this approach. The Bayesian method is used by the algorithm to calculate probability [44]. When calculating the probability of noisy data being utilized as input, it delivers the best level of accuracy [43]. A supervised machine learning technique called Naive Bayes is based on the Bayes theorem. Given the value of the target variable, it assumes functional dependencies between each pair of features [49].Naive Bayes is a classification algorithm for binary (two classes) and multiclass classification problem. The technique is easiest to understand when it is described using binary or categorical input values [51].

3.5 Logistic Regression

The chance of a disease or health condition as a function of a risk factor is evaluated using logistic regression. Assessing the relationship between independent variable (s) (Xi), also known as exposure or predictor variables, and a binary dependent variable (Y), also known as the outcome or response variable, is done using both simple and multiple logistic regression. Prediction of binary or multiclass dependent variables is its main use [45]. It is a supervised machine learning model widely used for the binary classification and the main ensemble algorithms which combines the output of many decision tress for the better performance [49].

3.6 Decision Tree

A supervised machine learning (ML) technique called a decision tree (DT) is used for regression and classification. The divide and conquer strategy is the foundation of decision trees. It uses two techniques to divide the partition: partitions in numbers: Typically, divisions are created using discrete values under certain restrictions and Nominal partition: Nominal attributes are used to create the partitions. It causes the tree to be divided based on the values of the attributes [35]. A predictive modelling tool with many different applications is Decision Tree C4.5. It can be created using an algorithmic method that can divide the dataset in many ways based on various criteria [45].

Table 1: Comparative analysis of Machine Learning Techniques for Breast Cancer Prediction

Algorithm	Tool	Data Set	No. of Attributes	Data Processing method	Evaluation method	Limitations	Validation Technique	Accuracy
Logistic Regression [28]	Matlab	WBC	32	Discrete Value	Cross validation	It was only managed to find the dependency of the weight factor with the size of the data set and the optimization technique	2 fold cross validation	96.83%
Artificial Neural Network[52]	Weka	WBC	10	Mixed values	Cross Validation		10 fold cross validation	98.24%
SVM(Linear Kernal) SVM(RBF-kernal) SVM(Polynomial Kernal)SVM (Sigmoid Kernal)[53]	Jupyter	WDBC	10	Discrete Value	Cross Validation		10 fold cross validation	90.57%
Random Forest [54]		WBCD	10		Cost matrix		10 fold cross validation	97.51%
K-Nearest Neighbor Algorithm [55]		WBC	10	Mixed Value	Confusion Metrix			99.42%
Naïve Bayes(NB) K Nearest Neighbor (Knn) J48 [56]	Weka	Collected from Doctors and Cancer Experts	61	Discrete Values	Confusion Matrix	Testing time is slow and also take too much time. Difficult to choose require K value. To predict about henew K nearest only find the nearest neighbor	10 fold cross validation	98.2% 98.8% 98.5%
K Nearest Neighbor (Knn) and Naïve ayes(NB) [9]		BCD	10	Discrete Value	Confusion Matrix	The running time of the Knn algorithm is very high for the large dataset.	Hold Out Cross Validation	Knn - 97.15% NB 96.19%
Support Vector Machine(SVM) and K Nearest Neighbor (KNN) [12]	Matlab	DDSM	13	Two Classes	React Native Framework			SVM - 95% Knn-97%
Tree Augmented Naïve Bayes(TAN) Boosted Augmented Naïve Bayes(BAN) Bayes Belief Network(BNN) [14]		WDBC	10	Discrete Values	Average Suuare Error	All the three classifiers produces minimum accuracy without applying Gradient Boosting (GB) Technique.	Gradient Boosting	90.1%
Artificial Neural Network and Support Vector Machine[57]	Weka	Wisconsin Hospital	11	Discrete Values	Performance matrix	Expected Probabilities of occurrences and non -occurrences	Minimal Optimization(SMO) Lib SVM	95.4% 96.9%
Support Vector Machnie(SVM) algorithm Decision Tree Random Forest [58]	Weka Spark	University of California Irvine repository WDBC	254 Values	Mixed Values	Gene Expression and DNA Methylation Techniques for dataset evaluation	To achieve the good result of accuracy, precision and accuracy of data large number of samples was needed for computation	10 Fold cross Validation	99.68% 98.80% 98.09%

Table 2: Comparative analysis of Machine learning techniques on the basis of accuracy level

SVM	NN	LR	NB	ANN	DT	RF	J48	Ref.
N/A	97.15%	N/A	96.19%	N/A	N/A	N/A	N/A	[9]
95%	97%	N/A	N/A	N/A	N/A	N/A	N/A	[12]
								[14]
N/A	N/A	96.83%	N/A	N/A	N/A	N/A	N/A	[28]
N/A	N/A	N/A	N/A	98.24%	N/A	N/A	N/A	[52]
90.57%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	[53]
N/A	N/A	N/A	N/A	N/A	N/A	97.51%	N/A	[54]
N/A	99.42%	N/A	N/A	N/A	N/A	N/A	N/A	[55]
N/A	98.8%	N/A	98.2%	N/A	N/A	N/A	98.5%	[56]
96.9%	N/A	98.2%	N/A	95.4%	N/A	98.2%	N/A	[57]
99.68%					98.80%	98.09%		[58]

IV. Discussion

This paper summarized different Machine learning algorithms for the prediction of breast cancer. Table 1 shows the comparative summary of machine learning algorithm for the breast cancer prediction on the basis of different tools, data sets, attributes, data processing methods, evaluation methods, limitations, validations techniques whereas the table 2showing the accuracy level of machine learning algorithms.

After reviewing all the machine learning techniques analyzed that each technique is suitable for different conditions and on different types of data sets and on different number of attributes. After analyzing all the techniques it is observed that the Support Vector Machine (SVM) gives the higher accuracy for the breast cancer prediction by using the data set from Wisconsin Diagnostic Breast Cancer by using different tools like Jupyter, Matlab and Weka and Weka tools it gives the highest accuracy i.e. 99.68%

V. Conclusion

In this paper reviewed different machine learning algorithms for the detection of breast cancer. The main focus is to find out the most suitable algorithm which can predict the breast occurrences more effectively. The purpose of this study is to show or highlight the previous studies of machine learning algorithms. The review of this paper started from the introduction of breast cancer and its types and 58 research papers have been reviewed to achieve the knowledge about the types, symptoms and causes of breast cancer in which found that the Support Vector Machine (SVM) technique is best for the breast cancer prediction among all other techniques and gives highest accuracy 99.68%

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