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Predicting Diagnosis and Prognosis stages of Breast Cancer through Artificial Neural Network

Mohammad Tanzil Idrisi

Rani Laxmi Bai Memorial School, Lucknow, India

Abstract: Nowadays, breast cancer is a common problem appearing in women. According to statistics, by the end of 2020, there were 7.8 million women alive, who were diagnosed with breast cancer in the past 5 years. Making it the world's most prevalent cancer. Although, predicting diagnosis & prognosis in breast cancer are two clinical applications that have represented a test to the scientists. But the utilization of AI and data mining strategies has changed the entire course of breast malignancy Diagnosis and Prognosis. Breast Cancer Diagnosis recognizes harmless from dangerous breast lumps and Breast Cancer Prognosis predicts when Breast Cancer is probably going to repeat in patients that have had their malignancies existed. Accordingly, these two issues are primarily in the extent of the grouping issues. Most data mining strategies that are regularly utilized in this space are considered as order classification and applied expectation methods allocate patients to either a harmless gathering that is non-cancerous or a" malignant" group that is cancerous. Consequently the breast malignancy demonstrative issues are fundamentally in the extent of the generally examined grouping issues. In this review, amazing order calculations to be an Artificial Neural Network has been applied for breast cancer prediction. Experiment results show that the previously mentioned calculations have a promising outcome for this reason with the general expectation precision of 96%, individually. A model can be built for each stage reflecting effect due to patient characteristics.

Keywords: Predicting Breast Cancer, Diagnosis Breast Cancer, Prognosis Breast Cancer, Artificial Neural Network, Machine Learning, Data Mining.

I. INTRODUCTION

Breast malignant growth has turned into a typical sickness among ladies all throughout the planet and is considered the second biggest pervasive sort of disease which causes passings among ladies [1]. In any case, it is likewise considered as the most reparable malignant growth type as long as it very well may be analyzed early. A gathering of quickly separating cells might shape a knot or mass of additional tissue which are known as Tumors [2]. Breast screening is performed in women without any signs or symptoms of breast cancer so that the disease can be detected as early as possible. The components of a breast screening evaluation depend on patient age and other factors, such as medical and family history, and can include breast awareness (i.e., patient familiarity with her breasts), physical examination, risk assessment, screening mammography, and, in selected cases, screening MRI.

Tumors can be sorted either as destructive (malignant) or non-malignant (harmless). Threatening tumors, which are considered a risky gathering, can infiltrate and annihilate sound body tissues. The term, breast cancer, alludes to threatening cancer that has been created from the breast cells. In view of the World Health Organization insights, there are more than 1.2 billion women all throughout the planet who are determined to have breast cancer. In any case, lately, this pattern has been decreased because of the powerful symptomatic methods which can fix the cancer growth in case it is analyzed in a proper time. As of late, the progression of data-driven methods has clinical issues, yet additionally, they have broadly utilized in other industrial applications [3][4][5]. To name a portion of the amazing master and data-driven strategies: Artificial Neural Network, fluffy frameworks, decision tree, Support Vector Machine (SVM), Bayesian Network, and so forth [6][7][8]. It's a given that information assessment that has been achieved from patients can be considered as a significant component to foster an effective and exact demonstrative technique. To this end, order calculations have been used to limit the blunder of human mistakes which might occur during the treatment.

Breast cancer forecast dependent on AI(Machine Learning) algorithm has drawn in the consideration of numerous specialists as of late. For instance, Lunin et al. [9] assessed the exactness of Neural Network in 5, 10, and 15-year breast malignant growth explicit endurance. They utilize an informational collection with 951 patients. The region under the ROC bend was utilized as an estimation of precision and the AUC esteems for neural networks are 0.909, 0.886, and 0.833 for 5, 10, and 15-year breast cancer growth explicit endurance, individually. They likewise utilize calculated regression in their paper and the AUC esteems for strategic regression are 0.897, 0.862, and 0.858, individually. In [10], the authors present an examination of the pace of survivability with three information mining strategies: Naive Bayes, the back-proliferated neural network, and the C4.5 decision tree algorithm. SEER dataset has been utilized for their

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research. The precision of prediction for these procedures Naive Bayes, the back-propagated neural network, and C4.5 decision tree are 84.5%, 86.5%, and 86.7% individually. They additionally show that the C 4.5 has the best presentation for this situation. One of the methodologies toward breast cancer prediction is analysis through mammography pictures which is considered as image processing and classification. In [11], the author proposed a technique for programmed division of the mammogram pictures and afterward arranged them as dangerous, harmless, or ordinary depending on the choice tree J48 algorithm. The exactness of their strategy for bosom disease determination through mammography pictures for positive expectation and the negative prediction is 94% and 98.5%, separately.

The author in [12] proposes a strategy that uses Support Vector Machines (SVMs) and decision trees for grouping 100 breast disease patients into two classes: Benign and Malignant. They reasoned that based on the exactness the SVM (with the precision of 98%) is superior to the choice tree (96% of exactness). In the second phase of their strategy, the k-mean clustering method has been utilized to parcel the over two classes of patients into three classifications: Poor, Intermediate, and Good to decide if the patient is in earnest need of chemotherapy concerning the endurance season of the patient. The objective of this paper is to utilize machines to anticipate whether a has a harmless disease or a threatening one. Decision trees and Neural Networks are incredible data mining strategies instruments that can be utilized to accomplish that. The two algorithms build their models utilizing preparing informational index then, at that point, test the got models on test data. The decision tree algorithm depends on developing a tree that comprises nodes in which every node mirrors a test on a characteristic until you arrive at a leaf node. In a neural network, the dataset ascribes are isolated into three layers: Input, Hidden, and yield layer. Then, at that point, the initial two layers are utilized to show the yield layer. In this review, the two calculations will be tried utilizing breast cancer growth Wisconsin informational data set [13], and afterward contrasted with one another dependent on their capacity to anticipate dangerous cancers.

II. RELATION OF MAMMOGRAPHY WITH BREAST CANCER

Breast Cancer survivors remain at high risk of second breast cancer for many years after initial diagnosis. Surveillance mammography aims to detect second breast cancer at an early stage to decrease morbidity and ultimately improve survival. Annual surveillance mammograms and clinical breast examination are recommended for women starting 1 year after initial diagnosis and no earlier than 6-months after radiation therapy is completed [4]. There are demonstrated benefits of surveillance mammography in reducing breast cancer mortality [5–7]. In a recent study, surveillance mammography reduced breast cancer mortality only for women with local recurrences and did not affect regional or distant recurrences; this provides compelling evidence that early detection of local recurrences drives mortality benefits[6]. We examined factors associated with surveillance mammography among survivors of early-stage breast cancer in the Breast Cancer Surveillance Consortium (BCSC). We describe time to recurrence and second primary breast cancers by initial tumor characteristics, risk factors(including breast density), and mode of initial and subsequent detection

III. DESCRIPTION OF ANALYZE DATA-SET

With regards to the arrangement, there is a need for a dataset to characterize. Dataset is a measurable lattice that addresses various highlights. It is a network where all the data about various highlights is given. Each section of the dataset addresses the component of the tumorous tissue and each line addresses the number of examples. There are principally three sorts of datasets that are for the most part utilized in distinguishing breast cancer.

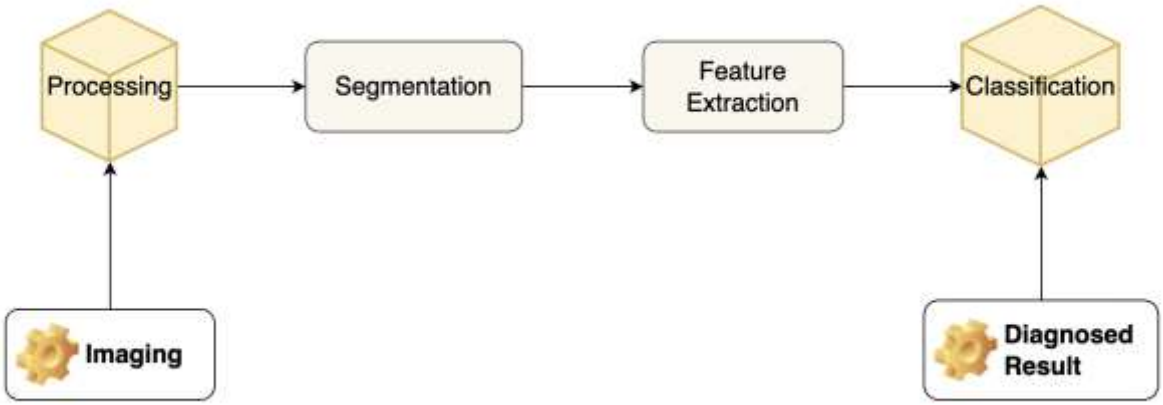

Figure: 1 Flow Chart of Classifying

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3.2.1. Image preprocessing: The task of image preprocessing is to enhance the image and to reduce speckle without destroying the important features of BUS images for diagnosis.

3.2.2. Image segmentation: Image segmentation divides the image into non-overlapping regions and separates the objects (lesions) from the background. The boundaries of the lesions are delineated for feature extraction.

3.2.3. Feature extraction and selection: This step is to find a feature set of breast cancer lesions that can accurately distinguish between lesion and non-lesion or benign and malignant. The feature space could be very large and complex, so extracting and selecting the most effective features is very important.

3.2.4. Classification: Based on the selected features, the suspicious regions will be
classified into different categories, such as benign findings and malignancy.
Many machine learning techniques such as linear discriminant analysis (LDA), support vector machine (SVM), and artificial neural network (ANN) have been studied for lesion classification.

Tests show up occasionally as Dr. Wolberg reports his clinical cases. The information base hence mirrors this sequential gathering of the information. Table 1. summed up the qualities which are utilized for breast cancer growth diagnostics.

Table 1. Data-set information

No.	Quality	Information
1.	Sample of Code Number	Unique Key
2.	Clump Thickness	Cancerous cells are grouped often in multilayers, while benign cells are grouped in monolayers
3.	Class	Indication of tumor category
4.	Uniformity of cell size	Cancer cells varies in size
5.	Uniformity of cell shape	Cancer cells varies in shape
6.	Marginal Adhesion	Normal cells tend to stick together, while cancer cells fail to do that.
7.	Single epithelial cell size	Epithelial cells that are enlarged may be the rest of the cell.
8.	Bare Nuclei	In benign tumors, nuclei are often not surrounded by the rest of the cell.
9.	Bland Chromatin	The texture of the nucleus in benign cells.
10.	Normal nuclei	The nucleus is a small structure that is barely visible in normal cells.
11.	Mitoses	The process of cell division.

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The underlying information preprocessing brought about utilizing just 10 credits from the picked dataset, which are (clump thickness, consistency of cell size, consistency of cell shape, peripheral attachment, single epithelial cell size, bare nuclei, bland chromatin, ordinary nucleoli, mitoses, class). Removing the (Sample code number) characteristic since it won't be valuable for our motivation. The picked calculations will be carried out utilizing Weka3 [14] which is a Data mining programming written in Java.

The assessment of the predicting information through a given data-set is the resulting factor of all the quality of constraints used in grouping the data. The efficacy of the model is primarily interrelated with the attributes or quality we are using in generating the model.

IV. EXPERIENCE OF AI CLASSIFIER

AI is utilized in the scope of figuring undertakings were planning and programming unequivocal, rule-based calculations are infeasible portrayed in Fig. 2. AI calculations distinguish to which of a set of classifications a groundbreaking perception has a place based on a preparation set of information containing perception whose classification enrollment is known.

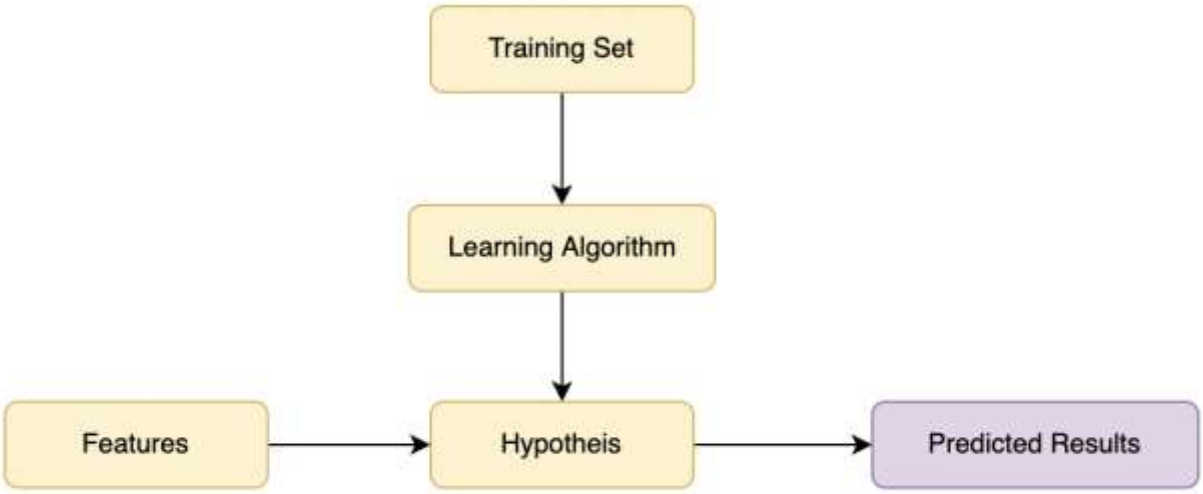

Figure 2

It investigates the development and investigation of calculations that can gain from and make forecasts on the information. Such calculations work by building a model from model contributions to request to make information-driven forecasts or choices, rather than following rigorously static program directions. Utilizing the dataset in the classifier, the harm and benignancy of tumorous cells are distinguished. A few generally utilized classifiers are recorded beneath:

- Naive Bayes
- Logistic Regression
- Support Vector Machines (SVM)
- Decision Tree
- Reinforcement learning
- Neural Network
- k-Nearest Neighbors calculation (KNN,IBK)

Here, we have used Neural Network and Decision Tree technique.

V. DECISION TREE ALGORITHM

The decision trees algorithm is a type of supervised Machine Learning(that explains, what the input is and what the corresponding output is in the training data). It comprises two sections: nodes and rules (tests). The essential thought of this algorithm is to draw a flowchart graph that contains a root node on top. Any remaining (non-leaf) nodes address a test to solitary or numerous properties until you arrive at a leaf node (eventual outcome). Decision tree algorithms have been broadly utilized in data mining applications because of the way that they are amazing order devices [15]. The following are some significant reasons that why decision trees are utilized in the space of information mining and

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characterization:

- **Decision trees make justifiable guidelines:** They are viewed as probably the most amiable algorithm to the end client in information mining. They start connections among the dataset credits in a straightforward structure.

- **Decision trees give an obvious sign to significant qualities:** a significant piece of setting up rules between ascribes is showing the significance level of everyone.

- **Decision trees require less calculation:** They require less calculation contrasted with other characterization algorithms like numerical formulae.

While executing a decision trees algorithm to identify breast disease, leaf nodes are isolated into two classes: Benign or Malignant. Rules will be set up among the picked informational collection credits to decide whether the growth is harmless or threatening. Figure 3. shows an instance of utilizing the decision tree approach for breast malignant growth identification.

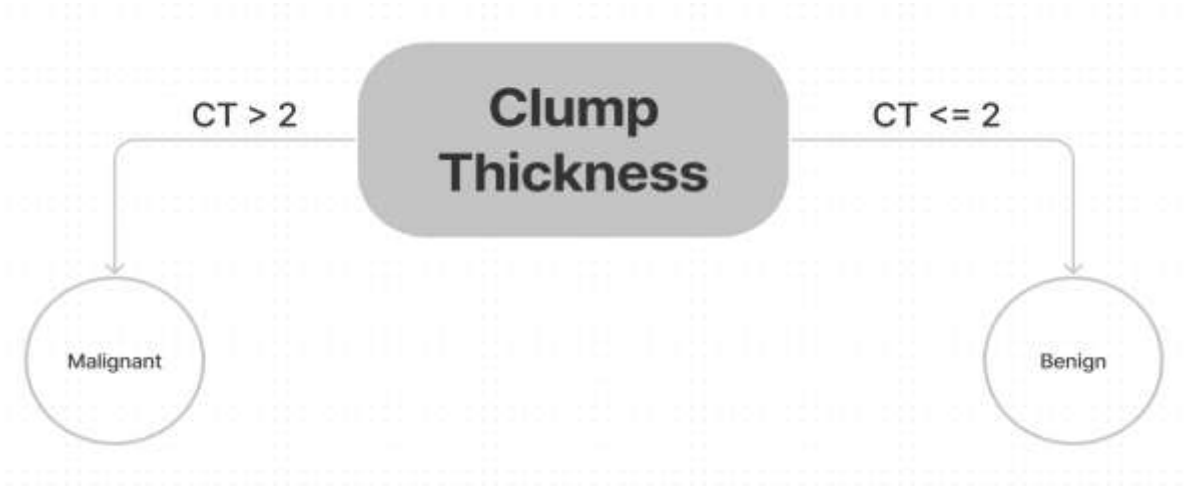

Figure 3: Decision tree examples for Breast Cancer Detection

This figure shows a decision trees algorithm on a solitary quality. Our data set contains different characteristics that should be incorporated. Subsequently, a confounded outline that depicts various connections (rules) among these traits will be conveyed utilizing the Weka application. The decision trees algorithm will be judged and assessed dependent on its capacity to anticipate cancerous cells. A significant stage in the classification is to have a test set that is not quite the same as the pre-owned preparing set. In any case, the assessment results won't be dependable. In this review, the Pareto guideline is utilized [16] as a usually utilized proportion to part a dataset into 80% preparing set and 20% test set. The following stage is to conclude which decision tree algorithm ought to be utilized for a given issue. Weka offers different decision tree algorithms, for example, J48, Random woodland, and Decision stump. J48 is the execution of decision tree algorithm ID3 that makes a parallel tree [17].

The tree is applied to each line in the data set after it is built. In the wake of performing beginning testing on all decision tree algorithms utilizing our dataset, we discovered that the J48 algorithm is moderately quicker than other decision tree algorithms. What's more, straightforwardness is one of its interesting highlights, the yield of this algorithm can be effectively perceived by the end client and it fulfills the presentation measure. Accordingly, the J48 decision tree algorithm has been utilized in this review, and beneath is the classifier yield subsequent to running in Weka.

Classifier output:
=== Run information ===
Scheme: weka.classifiers.trees.J48 -C 0.25 -M 2 Relation: breast-cancer- weka.filters.unsupervised.attribute.Remove-R1
Instances: 1799
Attributes: 10 Clump_Thickness
Uniformity_of_Cell_Size Uniformity_of_Cell_Shape Marginal_Adhesion Single_Epithelial_Cell_Size Bare_Nuclei
Bland_Chromatin Normal_Nucleoli Mitoses
Class
Test mode: split 80.0% train, remainder test
=== Classifier model (full training set) ===
J48 pruned tree

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Test mode: split 80.0% train, remainder test
=== Classifier model (full training set) ===
J48 pruned tree ------------------ Uniformity_of_Cell_Size <= 2
| Bare_Nuclei <= 3: 2 (405.39/2.0)
| Bare_Nuclei > 3
| | Clump_Thickness <=3:2 (405.39/2.0)
| | Clump_Thickness > 3
| | | Bland_Chromatin <= 3
| | | | Marginal_Adhesion <= 3:4 (2.0)
| | | | Marginal_Adhesion > 3.2 (2.0)
Uniformity_of_Cell_Size > 2
| Uniformity_of_Cell_Shape <=2
| | Clump_Thickness <= 5: 2 (19.0/1.0)
| | Clump_Thickness > 5: 4 (4.0)
| Uniformity_of_Cell_Shape > 2
| | Uniformity_of_Cell_Size <= 4
| | | Bare_Nuclei <= 2
| | | | Marginal_Adhesion <= 3: 2 (11.41/1.21)
| | | | Marginal_Adhesion > 3: 4 (3.0)
| | | Bare_Nuclei > 2
| | | | Clump_Thickness <= 6
| | | | | Uniformity_of_Cell_Size <= 3: 4 (13.0/2.0)
| | | | | Uniformity_of_Cell_Size > 3
| | | | | | Marginal_Adhesion < 5:2 (5.79/1.0)
| | | | | | Marginal_Adhesion > 5.4 (5.0)
| | | Clump_Thickness > 6:4 (31.79/1.0)
| | Uniformity_of_Cell_Size > 4.4 (177.0/5.0)

Number of Leaves :                  14
Size of the tree :   27
Time taken to build model: 0.01 seconds
=== Evaluation on test split ===
Time taken to test model on training split: 0 seconds
=== Summary ===
Correctly Classified Instances 130 92.8571 %
Incorrectly Classified Instances 10 7.1429 %
Kappa statistic                  0.8485
Mean absolute error              0.092
Root mean squared error          0.2429
Relative absolute error          20.2164 %
Root relative squared error      50.6609 %
Coverage of cases (0.95 level)              98.5714 %
Mean rel. region size (0.95 level)    70 %
Total Number of Instances 140
=== Detailed Accuracy By Class ===
TP Rate FP Rate Precision Recall F-Measure MCC ROC Area PRC Area Class
0.911    0.040    0.976     0.911   0.943      0.852 0.955     0.962     2
0.960   0.089    0.857     0.960 0.906      0.852 0.955     0.893     4
Weighted Avg. 0.929 0.057 0.934 0.852 0.955 0.937
=== Confusion Matrix ===
a b <-- classified as
82 8| a=2
248| b=4
```

Taking a gander at the confusion matrix, we can see that the algorithm effectively anticipated 82 harmless and 48 threatening cases with a prescient exactness rate equivalent to 92.8571 %. To enhance the outcomes, we ran 10 tests utilizing diverse preparing and test sets without fail, the algorithm effectively anticipated 94 % cases all things considered. More subtleties are accessible in Figure 3.

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VI. ARTIFICIAL NEURAL NETWORK

A neural network is a series of algorithms that endeavors to recognize underlying relationships in a set of data through a process that mimics the way the human brain operates. In this sense, neural networks refer to systems of neurons, either organic or artificial in nature. Neural networks can adapt to changing input; so the network generates the best possible result without needing to redesign the output criteria. Neural networks (NNs) have been broadly utilized in various fields as a canny device as of late. As of late, utilizing a neural network in order of breast cancer datasets has turned into a well-known smart instrument [18]. As a rule, NNs are the transmission capacity of planning from input to output. If each unique information is viewed as a type of information mode, the planning to the yield is considered as yield reaction model, the planning from contribution to yield is without a doubt the issue of example arrangement. Any neural network should be prepared before it tends to be viewed as astute and prepared to utilize. Neural networks are prepared to utilize preparing sets, and afterward, they can foresee the arrangement in the test set. The following are two central points that make Artificial Neural Network (ANN) an incredible classification algorithm:

- **Neural networks are versatile:** A neural network is made out of living units or neurons. It can take in or retain data from information. Learning is the most captivating element of neural networks.

- **Neural networks are normally enormously equal:** This is the primary similitude of ANNs to natural ones. However sometimes neural network models are carried out in programming on customary computerized PCs, they are normally reasonable for equal executions.

The utilization of a neural network to arrange breast cancer data is outlined in Fig. 4. In this review, the information nodes are Clump Thickness, Uniformity of Cell Size, Uniformity of Cell Shape, Marginal Adhesion, Single Epithelial Cell Size, Bare Nuclei, Bland Chromatin, Normal Nucleoli, and Mitoses. The intermediate cell is known as the secret layer unit, whose yield is just in the interior network, not a piece of all the network yield. The yield of the secret layer is considered as the contribution of two yield units, compared to a consequence of the determination of breast cancer benign or malignant tumor.

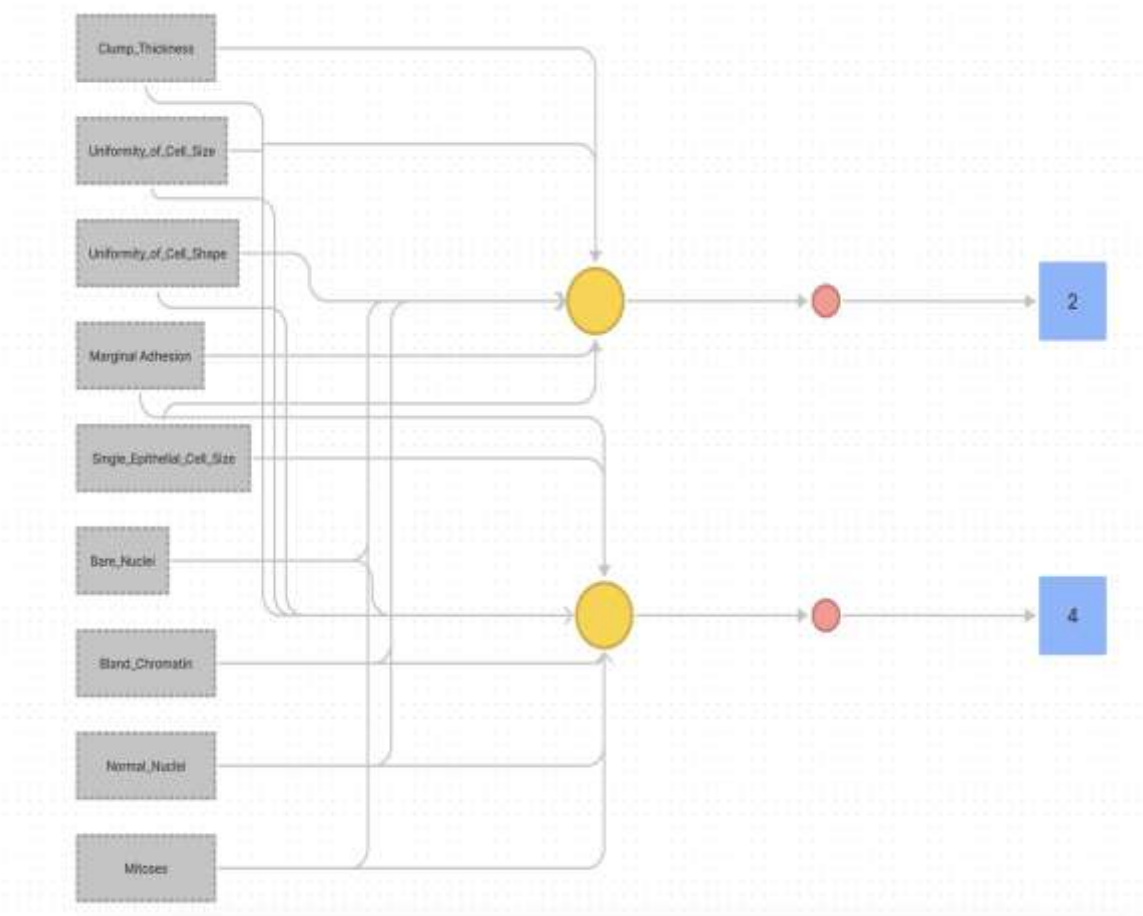

Figure 4. Artificial Neural Network for breast cancer prediction

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Rather than utilizing Conventional approval to separate the dataset into a training set and test set, we utilize 10-overlap cross-validation. One of the fundamental justification behind utilizing cross-validation is to evaluate how the aftereffect of the network will sum up to free information and how precisely a prescient model will act practically speaking. Subsequently, cross-validation is a reasonable method for summing up the presentation of the neural network. In 10-fold cross-validation, the first example is haphazardly parceled into 10 equivalent estimated subsamples. Of the 10 subsamples, a solitary sub-example is held as the approval information for testing the model, and the excess 10-1 subsamples are utilized as training data. The cross-validation process is then rehashed multiple times (the folds), with every one of the 10 subsamples utilized precisely once as the validation data. The 10 outcomes from the folds would then be able to be found the middle value of (or in any case consolidated) to create a solitary assessment.

ANNs is applied with various boundaries like diverse no. of hidden layers, learning rate, and momentum, and the best outcome is 97.42% of accurately characterized cases with the accompanying neural network design: (No. of the information layer, hidden layer, and yield layer are: 9,2,2 individually, learning rate:0.2, and energy: 0.7). Table 2 shows the disarray network, and the precision of the algorithm is given in Table 3.

Table 2: Confusion matrix for ANN

	Benign	Malignant
Benign	1441(a)	117(b)
malignant	18(c)	233(b)

The passages in the confusion matrix have the accompanying importance with regards to this review: various right predictions that a case is negative, b: number of inaccurate predictions that an occasion is positive, c: number of wrong predictions that an example is negative, and d: number of right predictions that a case is positive. The Breast disease information with 1799 tuples and 9 unique credits was dissected to recognize the blunder rates and exactness. Table 3 shows the exactness proportions of the outcome.

Table 3: ANN performance Measurement

	Instance	Percentage
Correctly Classified Instances	1674	97.42%
Wrongly Classified Instances	46	2.57%

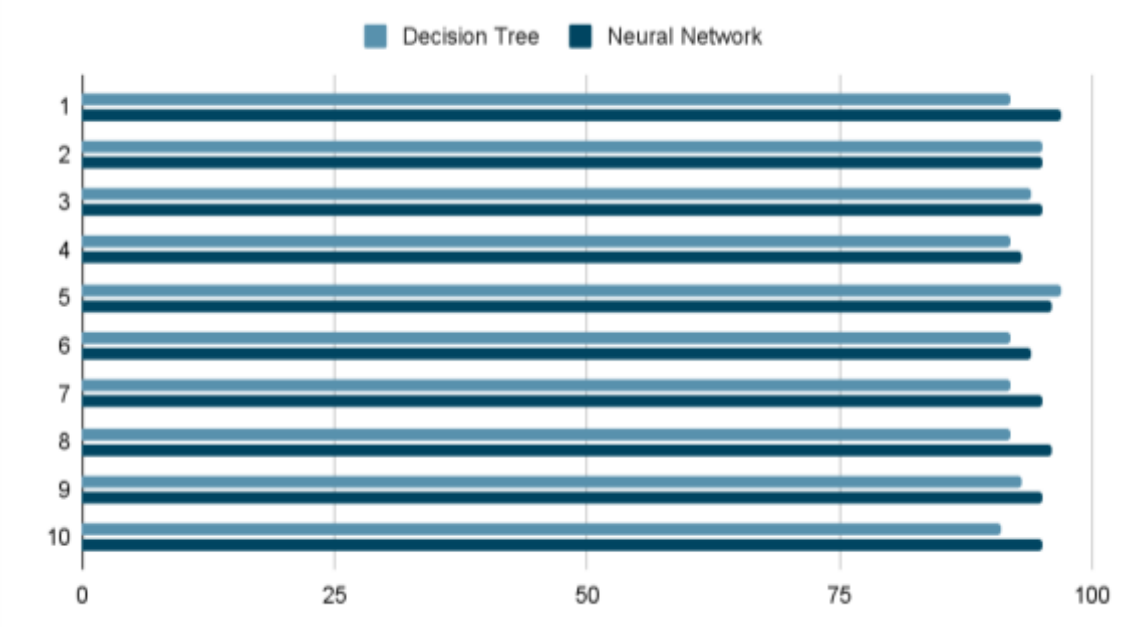

Figure 5: A performance Comparison chart of decision tree and ANN Algorithm

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10 distinct tests have been directed on the equivalent dataset utilizing the decision tree algorithm J48 and the Multi-layer insight model for the neural networks. In J48, the dataset was parted utilizing Pareto guideline proportion, 80% preparing set, and 20% test information. Concerning Multi-layer discernment, the information was parted into 10 folds utilizing cross approval. The two algorithms anticipated basically 92% cases each test. Be that as it may, the Multi-layer discernment model had the option to accurately characterize more cases on normal as displayed in Figure 5.

VII. CONCLUSION AND FUTURE ENHANCEMENT

Decision trees and Neural Networks are amazing information mining procedures that can be utilized to characterize malignant cancers. The decision tree algorithm makes justifiable standards, demonstrates significant traits, and requires less calculation contrasted with different algorithms like Neural Networks. Then again, the Neural Network algorithm is versatile and normally reasonable for equal executions. In this review, the two algorithms have been utilized as clever techniques for breast disease indicative. The two algorithms were effective in accurately grouping over 92% of cases in the 10 investigations. Notwithstanding, the Neural Network algorithm had a superior prescient exactness rate by and large (pace of right arrangement is 95.9%).

Future work with respect to looking through the rule of the brute force search algorithm should likewise be possible that would lessen the calculation intricacy. If the specific relationship with the information size can be observed then the intricacy of the inquiry algorithm can be diminished essentially by instating the load with the ideal esteem so the algorithm doesn't need to look pointlessly through the loads that don't appear to work on the exhibition. In request to decrease the highlights or upgrade it assuming there are less fewer highlights, a strategy for regularization could likewise be embraced in order to work on the precision of our proposed framework.

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BIOGRAPHY

Mohammad Tanzil Idrisi has been graduated from Rani Laxmi Bai Memorial School in 2020. He is an author, researcher, and entrepreneur. In each domain, he has contributed a hefty amount of works. He has also worked as a Full Stack Developer and Software developer in a few companies. From his school to now he has published four research works. He has a keen interest in the healthcare industry, IoT, and FPGA(Field Programmable Gate Array). This research paper is the final work of the light paper which he started in grade 12th. In this, he managed to increase the accuracy rate of the classifier model.

Recently, he sold his product FRACTXR(VR-based online meeting) to Box Ally - (a Co-working space company). Now, he is working on QuiteHabit (a Health and wellness company) which will work on IoT-based integration of wearable devices and mobile devices.