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Predicting Breast Cancer using Modern Data Science Methodology

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***Abstract*: Breast Cancer is the mass occurring cancer in women according to the World Health Organization(WHO), But the early prediction of breast cancer helps in the recovery for the effected one's. Reasons for breast cancer were Hormone replacement therapy or getting explore to harmful radioactive rays and due to late childbearing. The aim is to diagnose cancer by using a machine learning technique, Random Forest, for accurate solutions. The dataset we used is the Wisconsin Breast Cancer dataset. The output which the error rate was only about "0.0177".**

***Keywords* : Breast Cancer Prediction. Machine Learning, Data Science, Random Forest.**

I. INTRODUCTION

In women, Breast Cancer is the most frequent cause of death. Breast Cancer occurred as cells began to grow out of control, which leads to the emergence of a tumor that can be discerned on an X-ray or felt as a lump. Nearly 21% of women had breast cancer, in which 16% were women for more than 50 years. This cancer develops from the breast tissue. There are mainly two types of classifications in breast cancer that are Benign tumor and Malignant Tumor. Benign tumors are not part of cancer it can be seen anywhere in the body and removes by proper medication and treatment, but Malignant tumors are cancerous, they grow abnormally out of control and can spread to other organs. The typical symptom was the lump on the breast with the chance in breast skin into a reddish color. Machine Learning helps in analyzing the data and helps to extract the information and characteristics from the given data. In cancer, machine learning techniques help in early diagnostics and prognosis of cancer [1]. There are many ML techniques to predict breast cancer like Decision trees, and Naive based Bagging Trees, Random Forest, and many more.

In this paper, we'll be using Random forest for the prediction since in decision tree have the majority of variance when utilization of different training and test sets of same data which leads to overfitting of data and the performance reduced. Whereas in bagging tree it occupies entire feature space by creating splits in the tree, which leads to decreasing variance and increasing bias. However, in the random forest, the correlation issue that occurred in bagging trees reduced along with that it prunes the tree by and de-correlated the tree by setting stopping criteria.

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II. REVIEW CRITERIA

Numerous ML algorithms used for the prediction of breast cancer. In those here are some research reviews. The author Moh'd Rasoul achieved 93.7% accuracy by using DWT tool [2]. The author Ashwaq Qasem achieved 95% accuracy by using marker Controller marker shed [3], and the author Junaid Ahmed achieved 84.21% accuracy by using Adaptive Reasoning Theory [4]. In this, the Wisconsin Breast Cancer data set was used, which acquired from the Machine Learning Repository of UCI, which contains 569 rows of data, and contains 32 attributes [5].

Random Forest R.F extended from Breiman's Bagging [6]. Random Forest based on the trees which group each tree based on a group of random variables. R.F is also the collection of multiple decision trees.

Fernandez-Delgado [7] used 179 ML algorithms on around 121 UCI datasets, and random forest ranked first in all.

III. RESULT AND DISCUSSION

In this paper, we used the Random forest technique for prediction of breast cancer and found that the test error rate is "0.0177". Here we use both GINI Impurity and Entropy, which gives insight to essential variables used for training.

$$\text{GINI Impurity} = 1 - \sum_{r} Ar$$

$$\text{Entropy} = \sum_{r} -Ar * \log Ar$$

Random Forest is the widely used ML technique used for predicting the diagnosis of breast cancer. The training data and the testing data is divided in 7:3 fashion, where the data can train so that the prediction can be made accessible. The confusion matrix for the given data can be seen below in table1.

Table 1: Confusion matrix

Class	B	M	class.error
B	279	7	0.02447552
M	14	156	0.08235294

He bringing out for diagnosis is essential as it brings the class imbalance within ML[8-14]. This occurs when the data is outnumbered by other classes, which leads to deceptive of accuracy. Hence the target class should not be imbalances. Many techniques in Machine Learning requires the preprocessing of the data like neural networks, and Neural networks require the preprocessing of the data for better performance.

However, the random forest doesn't require any preprocessing. We are using Hyperparameter Optimization in this, which helps in creating to create models allows us to do a grid search. Here we used mtry, ntree, nodesize for best accuracy[15-18].

In R.F, not all the attributes are equally used in amount for classification and prediction[19-21]. Here's the visual representation of essential attributes the dataset which can be seen in the Figure1. This graph contains all the essential attributes that were used for predicting, And the scores of each attribute that used are also mentioned in table 2

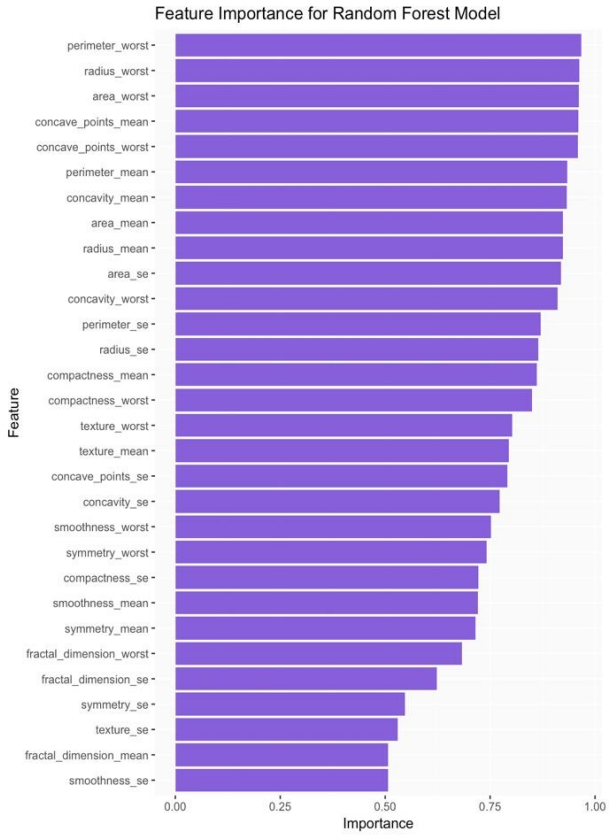

Figure 1: Feature importance of random forest model

Table 2: Attributes Scores

S.No	Names	Var_imp_scores
1	radius_ mean	0.9229638
2	texture_ mean	0.7948272
3	perimeter_ mean	0.9336487
4	area_ mean	0.9239305
5	smoothness_mean	0.7208865
6	compactness_ mean	0.8613534
7	concavity_ mean	0.9328877
8	concave_points_ mean	0.9599548
9	symmetry_ mean	0.7148807
10	fractal_dimension_ mean	0.5073118
11	radius_ se	0.8651584
12	texture_ se	0.5300288
13	perimeter_ se	0.8709070
14	area_ se	0.9187269
15	smoothness_se	0.5070444
16	compactness_ se	0.7222851
17	concavity_ se	0.7726347
18	concave_points_ se	0.7910839
19	symmetry_se	0.5474496
20	fractal_dimension_se	0.6225422
21	radius _worst	0.9622378
22	texture_ worst	0.8026018
23	perimeter_ worst	0.9675339
24	area_ worst	0.9615693
25	smoothness_worst	0.7520053
26	compactness_worst	0.8500103
27	concavity_worst	0.9108700
28	concave_points_ worst	0.9595640
29	symmetry_worst	0.7410325
30	fractal_dimension_worst	0.6824558

There is another useful method in Random Forest that is Out of Bag Error Rate(OBB error rate) [22-24], Usually, in the random forest only 2/3 part of data is used for training, and the rest can utilize for this purpose. The Predicted values of the testing dataset can be seen in table3. If the category of column and row are same, then it says that those are the correctly predicted values, other than those, they were the wrongly predicted values[25-27].

Table 3: Predicted Values

Class	B	M
B	70	1
M	1	41

In this paper, the OOB error rate is checked for across 100 trees using the random forest. These 100 trees contain a different set of training data so that the output prediction will be more accurate; here are the 100 trees OOB error rate, which seen in Figure 2.

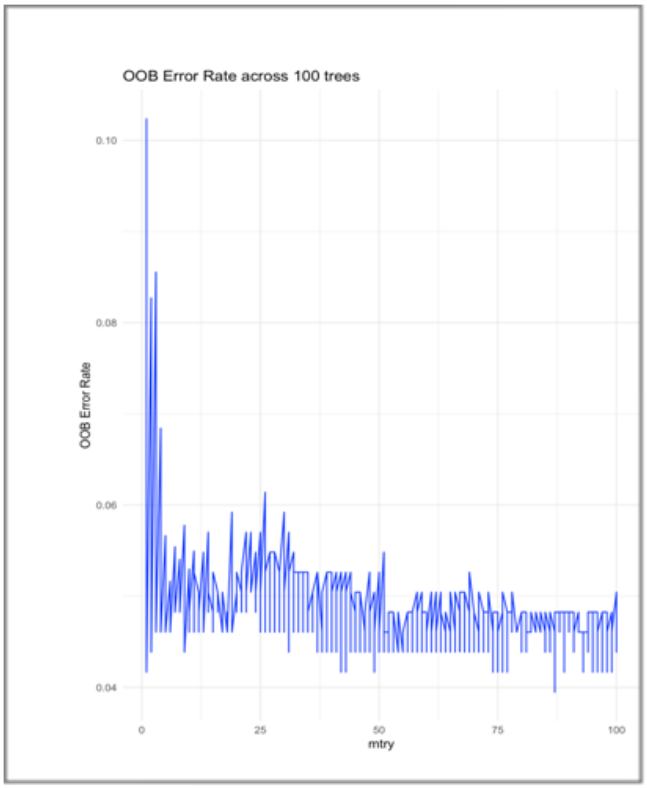

Figure 2: OBB Rate across 100 trees

The importance of OOB is, it gives us the evidence to show that OBB estimate is provided equal accuracy as using a test set of equal size as training data set.

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IV. CONCLUSION

Breast Cancer is the occurring in the mass of women, and early prediction and diagnosis helps in a long and healthy life. In this paper, we discussed the random forest, a machine learning technique for the Wisconsin Breast Cancer.

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