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A Retrospective: Sightseeing Excursion of Threatened Miscarriage Pertaining Ensemble Machine Learning Algorithms

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Abstract -**The manifested invention is associated with a miscarriage/stillbirth prediction using the ensemble learning methodology. The elementary data is congregated from various rural areas of 9 different states in India with 15258 rows and 201 columns. Further, data is processed to acquire useful features such as age, intake of tobacco, alcohol, smoking, diagnosis with any disease, awareness of danger, is currently pregnant, the outcome of the pregnancy and so forth. The outcome signifies that the proposed method has the capability of extracting the chances of miscarriage with preferable accuracy and classifying them in a fruitful way. This research includes the implementation of various machine learning algorithms namely Adaboost, Random forest, bagging, and boosting which are clubbed together by using a voting classifier to obtain accuracy, precision, recall and f1-score based on ensemble methods in order to generate precise results. Raising awareness of the concern which can emerge in pregnancy, and how to spot the symptoms, can help save lives. Therefore, this invention impetus mothers to maintain their health status on the behalf of data prediction set used.**

Keywords: Machine Learning, Ensemble Learning, Voting Classifier, Bagging, Ada-Boost.

I. INTRODUCTION

The spontaneous loss of pregnancy before 20th weak is signifies as miscarriage which is the most threatening pregnancy's consequences. Based on international records of WHO, it has been declared around 40-50 million miscarriages estimated across the world. This turn around 44 pregnancy losses every 59secs, so in order to safeguard women health and their future we must take an initiative The first and foremost way to deal with miscarriage is via prediction and prevention, which has gloomy psychological outcome for women and her better-half. According to few researches approximately 11% of women used to experience endangered miscarriage, which is diagnosed by vaginal bleeding, with 50% of pregnancies end in miscarriage. The collective miscarriage threat is 15·32% (95% CI 12·51-18·72%) among all captured details of pregnant women. The inhabitant ubiquity of women posing single miscarriage is 10·82% (10·31-11·43%), duplet miscarriages is 1·91% (1·83-2·11%), and threefold or many miscarriages is 0·71% (0·50-0·80%). The foremost objective of the research is to bring a prediction framework for miscarriage using machine learning algorithms based on earlier gathered records, which can be availed by doctors in order to make accurate suggestions and better recommendations. Figure 1 The major pillars of introduction of data and its analysis. The well-established threatening factor for abortion contains past details, rise in infertility and increased age of pregnancy. In fact, the amalgamation between daily life schedule and level of stress in pregnant women enhances the chances of miscarriage to happen. In accordance with approximation 2015, demise of 3,030,00 pregnant women leads due to improper care and complicacies. Approximately 99.1% demise of women occurs because of early miscarriage. In research [1], factors that possibly varying the threats of pre-pregnancy are obesity, increase in age and underweight. Nevertheless, increased physical activities leads to massive threat of miscarriage [2]. Therefore, it is prominent to develop an authentic early warning method for threatened miscarriage that could lead to early ministrations and nursing for threatened miscarriage. In early pregnancies, precariousness is correlated with excessive stress and anxieties, explaining requirement of frameworks that precisely forecast the consequences of a miscarriage related to pregnant women. Emotional changes and surroundings also play a vital role in miscarriage [3]. To forecast the threat of miscarriage, several models and multiple algorithms are designed in past decades. The hike of data science and human-made intelligence over past few years have been resulted into more complicated models using machine learning and artificial intelligence that has illustrated the excellent outcome in various appreciative settings. However, previous researches in medical have used ensemble learning to reach a triumphant outcome [4] The target of model is to instruct organizations & healthcare for modifying the gathered details in form of captivating accomplishment. The remaining part of this research is illustrated as mentioned: In Section2, A demonstration of literature survey is put on view which includes a description of several researches based on individual machine learning models and ensemble models.

Fig. 1. The major pillars for introduction of data and its analysis

Section 3 represents the data conceptual modelling and methodology including data collection, data pre-processing, data visualization, applied algorithms and experimental setups. The next Section 4 is enlightened with absolute results. In Section 5, comparative analysis of different model is shown. Finally, In Section 6 a brief conclusion and denouement is be manifested. In section 7 all the relevant references are mentioned.

II. LITERATURE SURVEY

A. Individuals Machine-Learning Models

Lakshmi.B.N et al [5] This research paper oriented towards finding the health and monitoring of pregnant women during the pregnancy period and try to safeguard them from upcoming complications. Researcher proposes a hybrid model using c4.5 decision tree and mentioned rules from decision tree. They use the relevancy score for the justification of feature selection using a scale filled by the judge panel. Then final predicted rule set is used for the prediction with the accuracy of 98.5%. **Hiba Asri et al [6]** This research paper aim to mobile phone and sensors in order to collected huge amount of data for analysis. Basically, research takes benefit of modern technology to gather from mobile sensor and form filled by pregnant women, to reach the consequences researcher has used big data and machine learning techniques. K-means is used for prediction purpose and the predicted result send to mobile phone of women, through which she can take active decisions. All computed tasks are performed on Apache Spark using real data. **Mallu L, Ezhilarasie R. [7]** In this paper researchers have detailed the efficient cum purposeful section of huge data managing equipment and methods implemented in health organization and medicine. The assertion, as combination of medical informatics, facts mining, big feature tools and statistics are an efficacious path to better health sector outcome and healthcare managing cost. **Mastrodima, et al [8]** This research paper aim towards forecast of stillbirth dependent upon maternal features, medicinal old details to describe working of machine learning framework used to implement in a model for better prediction, to ensure categories for prediction of stillbirth using logistic regression data mining method. For prediction of model the most prominent characteristics were considered. **Nizard J, et al [9]** In another research9 authors considered underweight, obesity and maternal to be major factor affiliated with escalated miscarriage. This research approximate that miscarriages could be declined by 25.21% if pregnant women will lessen the mentioned threatening factors to lower level. Moreover, the major consequential factors of miscarriage are excessive use of alcohol, and increase in maternal age**. Rebecca Knowles et al [10]** This research paper projected to use the machine learning and (NLP) Natural processing language to identify the risk factors of pregnancy and automate to identify the patient for referral. Only physicians' notes as (unstructured form) were used to say. Clustering technique can be used in order to gain the label of not risk or risk by calculating the outcome of clustering patients. 15028 records were used by researchers for analysis purpose. **Yu Mu et al [11]** This paper projected towards the implementation of a deep learning technique collaborated with machine learning which avail to search and classify the pregnancy consequences for building a model to find the early detection of pregnancy birth results using healthcare and medicine data which is collected from NFPC. For all the mentioned classes the accuracy of the model is 89.2%. **Han Wu et al [12]** This research paper aim to use of a data mining technique to find the type 2 diabetes in pregnant women. The focus is to find high accuracy performance and model flavorful to one or more dataset. k means and logistic regression are the two machine learning algorithms used in this paper. These techniques applied on PIMA diabetes dataset. The outcome of this model is extremely impressive and working efficiently on other two data set. **Gbenga A. Kayode et al [13]** In This paper researcher works for the silent contribution to prenatal mortality by developing a prediction model using machine learning, by detecting high risk of still birth at early stages. They use both clinical and non-clinical parameters for the prediction at minimal resource. For the early detection of high risk, the researcher uses multivariable logistic regression in order to develop an easily applicable decision, including parameters are parity, place of residence, age, bleeding etc. By considering a bootstrap re-sampling techniques for internal validation to all searched data to build 200 test datasets**.**

B. Ensemble Models

Jafar Abdollahi1 et al [14]. In this proposed research, genetic algorithm is preferred to use based on the methodology of ensemble learning is included for accurate diagnose of miscarriage by prediction. The mentioned research has considered actual and experimental values of diabetes role is displayed on University of California original website. In ICT there are several researches going on,

TABLE I. INDIVIDUAL MACHINE LEARNING ALGORITHM

Research	Hybrid model	Decision tree	K-means clustering	Big data tools	Logistic regression	NLP +ML	DL + ML	Multivariable logistic regression	bootstrap re-sampling	Dataset type	Predicting what?
Lakshmi.B.N et al [3]	✓	✓								Pregnant women	Health and monitoring of pregnant women.
Hiba Asri et al [4]			✓							Mobile phones and sensors	Predicting pregnant women health.
Mallu L, Ezhilarasie R. [5]				✓						Health care centres	Big data tools for health and medicines.
Mastrodima et al [6]					✓					Pregnant Women	Predicting stillbirth on maternal features.
Nizard J et al [7]						✓				PubMed and the Cochrane library	underweight, obesity to be major factor related to escalated miscarriage.
Rebecca Knowles et al [8]			✓			✓				physicians' notes	To identify risk factors and give labels.
Yu Mu et al [9]							✓			Health centres	early detection of pregnancy birth.
Han Wu et al [10]			✓		✓					PIMA diabetes dataset	type 2 diabetes in pregnant women.
Gbenga A. Kayode et al [11]								✓	✓	clinical and non-clinical parameters	prenatal mortality .

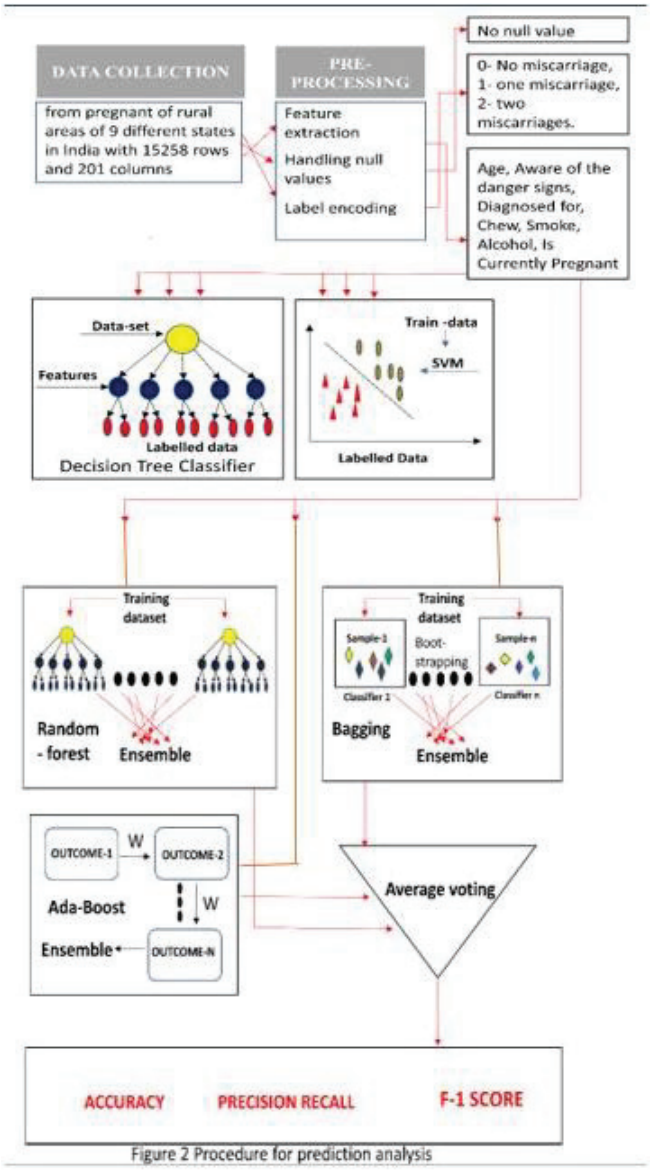


Figure 2 Procedure for prediction analysis

Fig. 2. Procedure for Prediction analysis

namely (IOT) Internet of Things, data science and artificial intelligence, providing use a statistical and analytical data to precisely forecast the consequences of pregnancies based on daily scheduled life by prohibiting the ongoing complicacies in healthcare. Outcome displayed the effective working ofmachine learning framework which is used to predict the accuracy of 98.78 percent and 99 percent. **N. L. Fitriyani, et al [15]** This research came up with a prognosis or DPM for type 2 diabetes forecast and high blood pressure of an individual based on several hazardous aspect. This prophecy involves (ISOLATION FOREST) centered on anomaly observation techniques which cut out anomalous details and data augmentation for minority class, and predictive learning methodology in order to treat diseases. **S. Buyrukoğlu [16],** This research paper aim "Improvement of Machine Learning Models' Performances based on Ensemble Learning for the detection of Alzheimer Disease," In a conference of computer science held on an international level in the year 2021 named (UBMK). 102-106, di.2021.9558994. Major focus of paper in order to modify classification outcome earlier studies for early identification of AD applying ensemble learning methods includes bagging, boosting, and stacking. ADNI clinical dataset used in 3 targets namely: NCN (normal CN), low mental issues and disease of memory loss. The implemented ensemble learning technique provided better classification performance compared to single machine learning methods. Besides, performance from the best ensemble methods is to achieve through the boosting (AdaBoost) ensemble (92.7%). Ibrahim, et al [17] This study intended a model to anticipate diurnal COVID-19 cases in some countries of Africa. Machine learning models over non-linearity and decisive prognostication, including support vector machine (SVM), artificial neural network, robust fuzzy logic and inference system and conventional multiple linear regression models. As linear(continuous) and nonlinear parameters might be accommodated in COVID data. Under aforesaid circumstances, neither non-linear nor linear models employ great change. Henceforth, symbiotic Machine Learning and Multiple Linear

Regression models can construct decisive accuracy. Therefore, to enhance the prognostication of accuracy of the Machine Learning models, peculiar ensemble accessions including ANN E with SVM E were adopted. Ensemble approaches accrue concerted privilege of all the stand-in models, through abbreviating their fragility and improving their prognostication potentiality.

III. METHODOLGY

This proposed machine leaning model undertakes the task for prediction of miscarriage in pregnant women using powerful classification techniques. **Dimple Tiwari[18].** For an instance several machine learning models were proposed to prognose the outcome of covid-19, similarly this research includes multiple forecasting models to predict the consequences of spontaneous miscarriage and enforce the appropriate measures.

There are several features in our dataset which are helpful for predicting the dependent variable (target value). The method, involves steps of applying classification techniques; combining individual classification technique, voting to improve accuracy. Figure 2 The architecture of proposed ensemble model which depict the how data are collected and preprocessed to divide on basis of numerous parameters to apply several classifiers. The consequences of all the proposed models are bind together by voting classifier. It trains on an ensemble of various models to depict a result based on their maximum probability. It basically combines the result of Voting Classifier in which each classifier is passed which forecast consequences based on fittest and maximum voting result.

A. Data Collection

Dataset involved in the study is acquired from rural areas of 9 different states in India with 15258 rows and 201 columns. Only the features dominant for our prophesy were included from the dataset which are as follows: -

1. Age: - Women under 35 years of age has less chances of miscarriage while women between 35-45 have equal likely chances of miscarriage and above 45 years there are high chances of child loss. 2. Aware of the danger signs: - Awareness among mothers related to risk factors during pregnancy. 3. Diagnosed for: - If women are suffering from any other disease or not. 4. Chew: - intake of tobacco. 5. Smoke: - Smoking is very harmful for pregnant women. It can harm tissues of unborn baby. 6. Alcohol: - Alcohol

consumption during pregnancy is risky and an important factor for predicting miscarriage. 7. Is Currently Pregnant: - Present pregnancy status of a woman. 8. Outcome pregnancy: - It is dependent variable which has [0,1,2] as values; 0- No miscarriage, 1- one miscarriage, 2- two miscarriages.

TABLE II. DATA-TYPE OF FEATURES

FEATURES	NULL VALUE	INTEGER	CHARACTER
AGE	✗	✓	✗
AWARE OF DANGER	✗	✓	✗
DIAGNOSED FOR	✗	✓	✗
CHEW	✗	✓	✗
SMOKE	✗	✓	✗
ALCOHOL	✗	✓	✗
IS CURRENTLY PREGNANT	✗	✓	✗
OUTCOME PREGNANCY	✗	✓	✗

DESCRIBING DATASET - Table 2 Manifestation of header elements of used data-frames.

B. *Pre-Processing*

Data preprocessing is an important part which is performed to reduce noise and unwanted data from the dataset before applying it to the model. Here, we do: - 1. Checking for Null values 2. Check for categorical data: -All data is converted to nominal and integer type for better accuracy and processing process. Know the target variable (Outcome of pregnancy), It is dependent variable which has [0,1,2] as values; 0- No miscarriage, 1- one miscarriage, 2- two miscarriages.

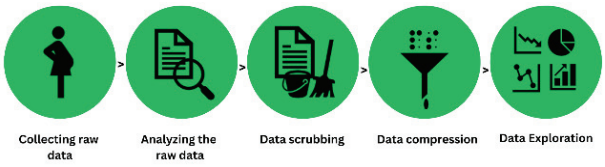


Fig. 3. Data Pre-processing of raw dataset by scrubbing, compression, and exploration.

TABLE III.

	AGE	CHEW	SMOKE	ALCOHOL	OUTCOME PREG
0	FALSE	FALSE	FALSE	FALSE	FALSE
1	FALSE	FALSE	FALSE	FALSE	FALSE
2	FALSE	FALSE	FALSE	FALSE	FALSE
3	FALSE	FALSE	FALSE	FALSE	FALSE
.....	.....	.....	.....	.....	.....
5075	FALSE	FALSE	FALSE	FALSE	FALSE
5076	FALSE	FALSE	FALSE	FALSE	FALSE
5077	FALSE	FALSE	FALSE	FALSE	FALSE

Table 3 The sample information of pregnant women considering their age, chew, smoke, alcohol, together with outcome, checks for null values is shown. The Outcome of pregnancy is tabulated. Data pre-processing signifies the procedure of collecting raw data in order to apply scrubbing and termination of undesirable data. Subsequently these filtered data is sent for data compression and data exploration.

C. *Data-Visualization*

The graphical representation of data and information of pregnant women is considered for displaying the scenario in a coherent manner.

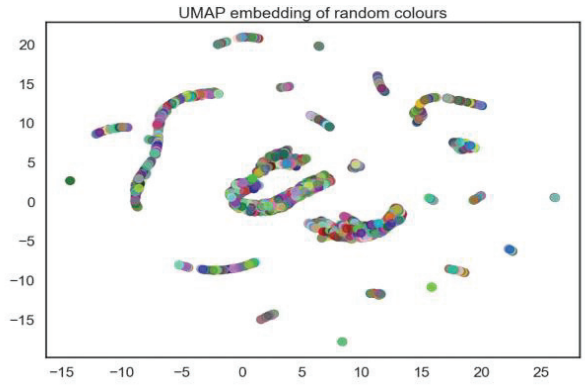


Fig. 4. UMAP Embedding

In Figure 4 Embedded data in random colors using UMAP. Uniform Manifold Approximation and Projection is a data visualization technique which is used for visualization for linear as well as non-linear dimension reduction.

D. *Ensemble Learning*

Indulging into deep concepts of machine learning and artificial intelligence, a method called ensemble learning is mainly used when you need to apply different algorithms to procure enhanced forecasting results comparative to the result gained alone use any constituent or individual machine learning algorithms which ultimately modifies existing model in a better side. Bagging estimator is an ensemble algorithm which is mainly used for classification and regression purpose.

Figure 5 Forecasting of every framework is taken as vote. A popular method termed as max voting is used for classification purpose in which every data point is used to make prediction of several models. Prediction is completed based on typical procedure of methods used in bagging. Adaptive boosting, popularly pronounced as AdaBoost is one of the easiest boosting algorithms. Weight is assigned as an initial step for observation of incorrect prediction to work simultaneously for better prediction of model.

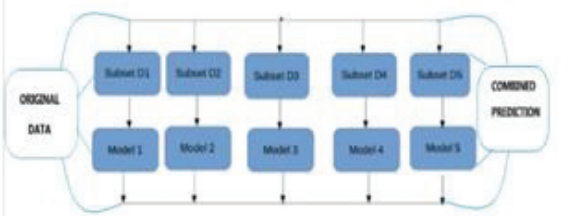


Fig. 5. Ensemble Learning model

Algorithm 1 Pseudocode of the ensemble learning algorithm

1: Input: - Training data frame df = {(x_1, s_1), (x_2, s_2) ……. (x_n, s_n)}
2: Base level classifiers BL_1, …….. BL_r
3: Meta level classifier $\widehat{BL}$
4: Output: Trained Ensemble classifier $\widehat{TM}$
5: Begin
6: Step1: - Train Base learners by applying classifiers BL_i to data frame df
7: For I =1, ……...k; do
8: B_i= BL_i(df)
9: end for
10: Step2: - Construct new dataset of predictions $\widehat{df}$
11: For j=1, ……. n; do
12: For i=1, ……...k; do
13: % use B_i to classify training example xj
14: $W_{ij} = B_i(x_j)$
15: end for
16: $\widehat{df}$ = {W_j, S_j}, where W_j= {w_{ij}, ……w_{nj}}
17: end for
18: step3: - Train a meta level Classifier $\widehat{TM}$
19: $\widehat{TM} = \widehat{BL}(\widehat{df})$
20: Return $\widehat{TM}$
21: END

Algorithm 1 The proposed algorithm of ensemble learning used in the research is jotted down in form of pseudocode. A method for machine learning called an ensemble algorithm mixes numerous models to forecast more precise and trustworthy outcome. The fundamental concept underlying ensemble algorithms is to aggregate predictions from many base models in some way to obtain predictions that are more accurate than those that could be made by any one model alone. In this algorithm we took the data frame for training of base level classifier (BL_1, …….. BL_r) and meta level classifier. The first and foremost step is to train Base learners by applying classifiers BL_i to data frame (df) and then construct a new dataset for prediction further we need to classify training examples (xj) and return meta level classifier after it get trained.

E. Experimental Setup

We have conducted numerous experiments to detect risk factors and threatening cause of early-stage miscarriage. All the experiments are performed on real dataset of healthcare system taken from government site of Maharashtra, to check the authenticity of the proposed model. Experiments were conducted only after the implementation of obligatory scaling and pre-processing steps.

Total 20 features namely, 'age', 'surviving_total',

'Mother_age_when_baby_was_born','outcome_pregnancy','is_currently_pregnant','aware_of_the_danger_signs','occupation_status','disability_status', 'injury_treatment_type','illness_type','treatment_source','symptoms_pertaining_illness','sought_medical_care','diagnosed_for','diagnosis_source','regular_treatment','regular_treatment_source','chew', 'smoke' and 'alcohol' were extracted that holds prominent information regarding miscarriage prediction using machine learning techniques. Thenceforth, we have implemented the ensemble learning algorithm on selected features to optimize the detected results.

IV. RESULTS

This research intends to extol the benefits of applying multiple algorithms of the ensemble approach, which is used based on successful prediction, in order to provide a description of the results. Using the ensemble learning technique, multiple analyzers employed different parameters to diagnose precise and improved outcomes. Based on these findings, the suggested chapter demonstrates the simplicity of various algorithms employed in artificial intelligence models, with the purpose of emphasising risk factors such as smoking, drinking, chew tobacco, stress, and others. Precision, f1score, and recall would be used to better depict the comparison of the developed methods. F1Score is a computed number that combines precision and recall. It is commonly referred to as the harmonic mean of the two. Another way to search an "average" of values is harmonic mean, usually described as most preferable for ratios (such as precision and recall) than the traditional arithmetic mean method. Table 4 A brief outcome of accuracy of implemented algorithms are shown in the resultant table. It includes the diagrammatic representation of results in form of plots and pie rings and bar graphs of every implemented algorithm, displaying their actual summary, accuracy, and percentage.

V. COMPARSION ANALYSIS

A comparative study, which shows the similarities and differences between the utilized attributes is taken to display a confusion matrix of pregnant women on basis of number of child and number of pregnant women's data considered while implementing several models are visualized.

Figure 6 Confusion matrix of pregnant women on behalf of number of children and total number of women's data used to implement different algorithms. The displayed confusion matrix is based on the prognostication of outcomes based on the machine learning algorithms for designing model.

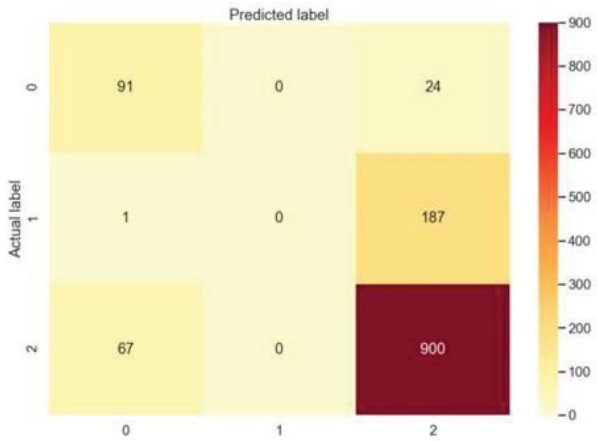
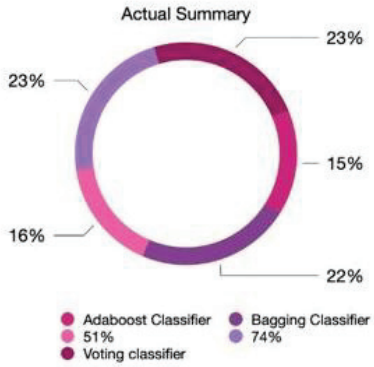


Fig. 6. Confusion Matrix

VI. CONCLUSION

Miscarriage has become a particularly notable communal pain because to its irreversible intricacy and pervasiveness. Over the years that followed, ensemble approaches were considered to provide medical and health care in detecting and avoiding miscarriage, clinching treatment logistics, and

TABLE IV. ACCURACY FOR VOTING



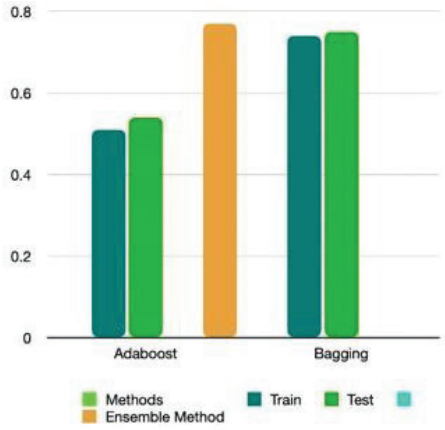


Table 1

	Methods	Train	Test
✓	Adaboost Classifier	51%	54%
✓	Bagging Classifier	74%	75%

Table 2

	Ensemble Method	Accuracy
✓	Voting classifier	77%

determining cessation and regimen expenses. In order to separate data of women based on segregated complications, we developed an ensemble model based on varied algorithms. This discussion is designed to combine machine learning algorithms by voting in order to unify that integrated models may be improved. After this examination, many machine learning techniques for catastrophic miscarriage have been developed.

In contrast to official portals for gathering clinical information, we have foregathered patient information. Unrivalled and authentic elements of the preceding data set were removed from the pool of data set to improve the predicted model's accuracy and precision by removing superfluous characteristics that reduce estimate. Voting administrators operate professionally and cautiously with massive healthcare databases to produce timely result.

Unquestionably, a progressive miscarriage data congregation, accurate aftereffect and prompt prediction has been accomplished. Our endorsed arrangement's absolute performance lies amid 77% and 78%. In the act of conclusion, new healthcare researchers can avail from imminent research and scholastic proceeding, notably for machine learning related prognostication systems.

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