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Comparative Study of Different Classification Algorithms on ILPD Dataset to Predict Liver Disorder

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Abstract: Data mining techniques can be applied in various fields such as Information Retrieval, Business analytics, Medicine and many more. This paper deals with medical field which mainly focuses on liver disease diagnoses. The aim of this study is to implement different classification algorithms on Indian Liver Patient Dataset (ILPD) using WEKA in order to get proper prediction of liver disorders. Feature selection is carried out on the dataset. Pre-processing is carried out to pre-process and cluster the data. K means clustering algorithm is used for pre-processing the data. The clustered data is further applied to various classification algorithms such as Naive Bayes, Ada Boost, J48, Bagging and Random Forest. A comparison is carried out considering performance measures such as Accuracy, Error rate, Precision, Recall and F measure. On the basis of comparison, the results are concluded. Random Forest algorithm provides best performance among all.

Keywords: ILPD, Pre-processing, Classification algorithms, Performance Measures, WEKA.

I. INTRODUCTION

Data mining uncover patterns from the large amount of information stored and is used to build predictive models. Medical field consist of large amount of data that needs to be processed. Data mining in medical field improves the accuracy of prediction of healthcare patterns. Data mining techniques such as classification and prediction, clustering, association rule mining and various mining methods can be useful to apply on medical data.

Several machine learning algorithms for data mining tasks are included in WEKA. Users can use their own algorithm in the form of java code or use inbuilt algorithms to be applied on data sets. WEKA provides general purpose environment tools for data pre-processing, classification, clustering, regression, association rules, visualization feature and selection. This tool allows us to view and modify the data attributes. Further this data can be passed to any of the algorithms. A detailed result along with summary of all the calculations is generated. The prime focus is to implement the classification algorithms using WEKA to make predictions in order to help physicians, by providing accurate patients pathological status. Pre-processing helps to improve the accuracy of classification algorithms. Pre-processing technique is applied on the dataset to remove noise and cluster the data. The pre-processed data is applied to various classification algorithms and their performance is compared.

II. LITERATURE SURVEY

Medical Diagnosis is a difficult process which requires experience and proficiency to deal with medical data [1]. Various diseases like heart disease, diabetes, breast cancer and liver disorder are diagnosed using various data mining techniques. Data mining provides better results in disease diagnosis when appropriate tools and techniques are applied. Several target values are combined to obtain disease prediction using various clustering and classification methods [1-2].

Data mining deals with large databases that impose on clustering analysis. Clustering deals with grouping of data into clusters. Various clustering methods are introduced for cluster analysis purpose [3-4]. Enhanced K-Means, DB-Scan and Fuzzy C Means algorithms are applied on medical data.

Empirical results are obtained by comparing different clustering algorithms. These results are used to study independence or correlation between diseases and for better insight into medical survey data [5]. Partitional clustering on ILPD dataset is implemented using Kmeans algorithm. The dataset is grouped into two sets- liver and non liver patients [6]. Classification is a major task in disease diagnosis. Various classification algorithms are used to predict liver diseases at early stage [7]. Classification algorithms like Decision Tree, SVM, Naïve Bayes, ANN etc are applied on the dataset. Further these algorithms are compared on the basis of performance measures [8-10].

III. DATASET

The dataset used in this paper is ILPD dataset. This dataset is available on UCI machine learning repository [15]. This dataset contains 583 records with 11 attributes. It contains 416 liver patient records and 167 non liver patient records. Attributes detail is mentioned in Table 1.

Table 1. ILPD Dataset Attributes

Attribute Number	Attribute Name with description
1	Age : Age of the patient
2	Gender : Gender of the patient
3	TB : Total Bilirubin
4	DB : Direct Bilirubin
5	Alkphos : Alkaline Phosphotase
6	SGPT : Almine Aminotransferase
7	SGOT : Aspartate Aminotransferase
8	TP : Total Proteins
9	ALB : Albumin
10	A/G Ratio : Albumin and Globulin Ratio
11	Selector: Field used to split data into two set

IV. METHODOLOGY

The work is divided into three parts: Feature selection, Pre-processing and Classification. The flow diagram of entire work described in this paper is mentioned in the Fig4.1.

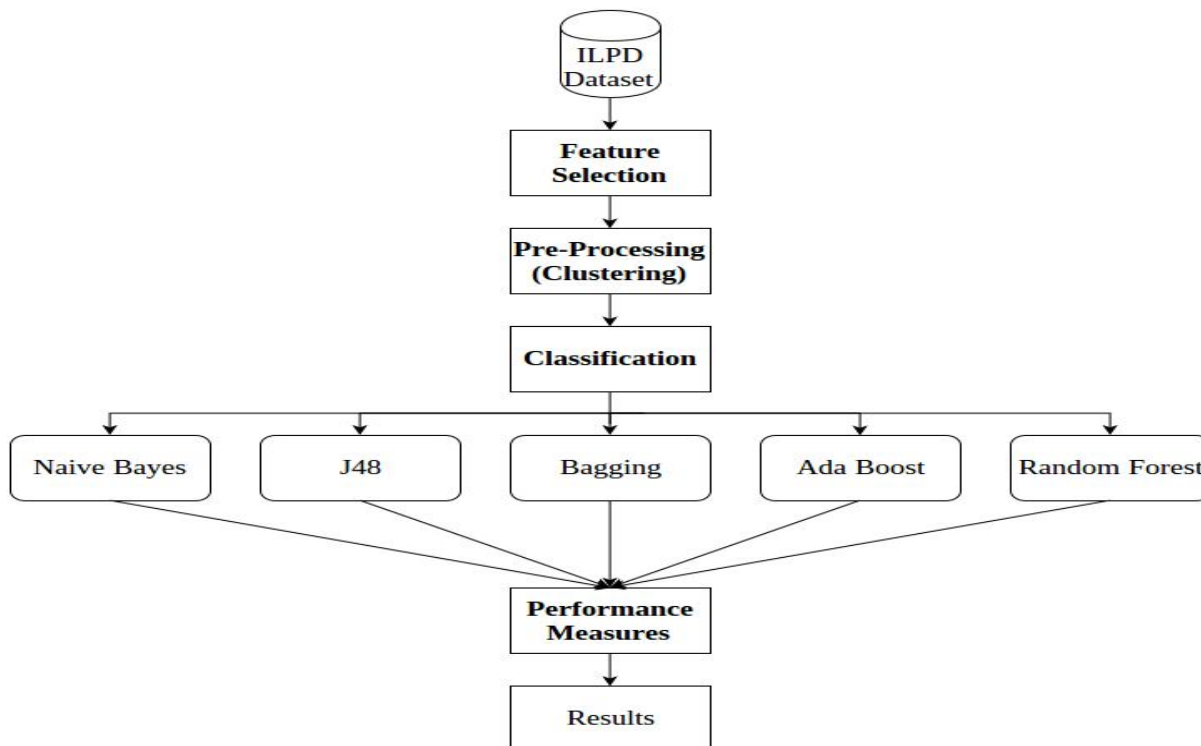


Fig 4.1. Flow Diagram

A. Feature Selection

The dataset contains n number of attributes. Usually data is represented by L dimension vector. L represents the total number of features. All the features are not so useful. Instead of using all the features, we can select the best feature for clustering. This will improve the performance of a clustering task. The process of selecting the best feature is called feature selection. There are many feature selection techniques that can be used to improve the performance. The features selected are selector and age.

B. Pre-processing Technique

The pre-processing technique used in this paper is K means clustering algorithm[6]. K means algorithm is as follows-

1) Input

K – It represents the number of clusters

D – It is the dataset containing N objects

2) Output

A Set of clusters

3) Method

a) Arbitrary choose k objects from D as in initial cluster centre

b) Repeat

c) Reassign each object to the most similar cluster based on the mean value of the objects in the cluster

d) Update the cluster means Until no change This technique clusters the data into two sets - liver data and non-liver data.

C. Classification Techniques

1) *Naive Bayes* [11]: The Naive Bayes algorithm is a simple probabilistic classifier that is used to calculate a collection of probabilities by investigating frequency and combination of values in a given data set. The algorithm is based on applying Bayes theorem with the “naive” assumption of independence between every pair of features. Model of Naive Bayes can be defined by

$$P(C_i|N) = \frac{P(N|C_i) \times P(C_i)}{P(N)} \dots\dots\dots\text{Equation (1)}$$

2) *AdaBoost* [12]: AdaBoost is used to boost the performance of decision trees on binary classification problems. It is also termed as discrete AdaBoost because this algorithm is mostly used for classification rather than regression. Each instance in the training dataset is weighted. The initial weight is set to: $\text{weight}(x_i) = 1/n$, where x_i is the i 'th training instance and n is the number of training instances.

3) *J48* [11]: J48 is an extension of C4.5 algorithm. It allows classification either using decision trees or rules generated from them. This technique is used to construct a tree. It works on categorical as well as continuous values. The nodes of tree denote different attributes. The branches between nodes represent the possible value of attributes and the terminal node represents the final values of the dependent variables.

4) *Bagging* [13]: Bagging is a simple and powerful ensemble method. It randomly generates bootstrap samples from the training set using sampling without replacements. Each sample is used to train a different component of classifier. Classification is carried out by plurality voting.

5) *Random Forest* [14]: Random Forest is an ensemble algorithm with Decision tree model. It builds multiple CART models with different sample and initial variables. This algorithm potentially improves classification accuracy. Random forest is similar to bagging and results in a very powerful classifier

V. RESULTS AND DISCUSSIONS

The above mentioned strategy is tested using WEKA tool. The features that do not affect the cluster formation and are less significant are identified. Feature selection and ranking techniques are applied on the attributes. After feature selection, Pre-processing is done using K means clustering algorithm. Classification is carried out on clustered data using Naive Bayes, AdaBoost, J48, Bagging and Random Forest. A comparative study is performed based on performance measures such as accuracy, error rate, precision, recall and F-measure. Table 2 represents the values of performance measures. From the table, it is observed that Random Forest Algorithm gives best performance.

Table 2. Performance comparison of classification algorithms

	Accuracy	Error Rate	Precision	Recall	Fmeasure
NB	55.84%	44.16%	0.796%	0.558	0.56
AdaBoost	71.31%	28.69%	0.508	0.713	0.594
J48	87.46%	12.54	0.872	0.875	0.872
Bagging	90.38%	9.62%	0.904	0.904	0.901
Random Forest	100.00%	0.00%	1	1	1

Accuracy: It is the ratio of correctly classified observation to the total observations.

$$\text{Accuracy, acc} = \frac{TP+TN}{TP+FN+FP+TN}$$

A comparison on accuracy measure of classification algorithms is given in Fig 5.1.

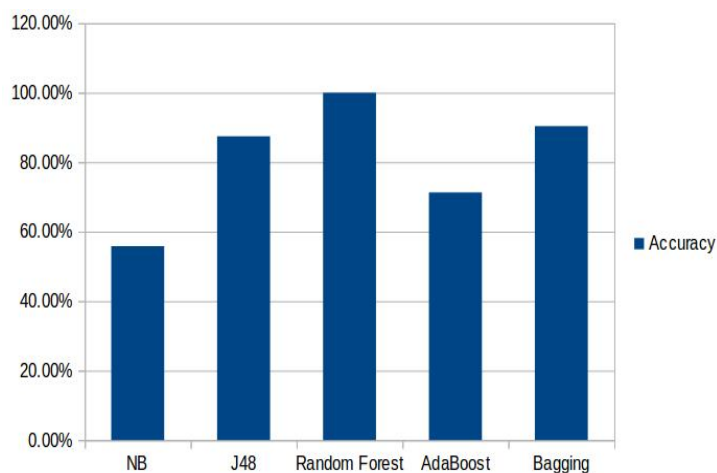


Fig 5.1 Accuracy of classification algorithms

Error Rate : It is the ratio of incorrectly classified observation to the total observations.

$$\text{Error rate, err} = \frac{FN+FP}{TP+FN+FP+TN}$$

A comparison on error rate measure of classification algorithms is given in Fig 5.2.

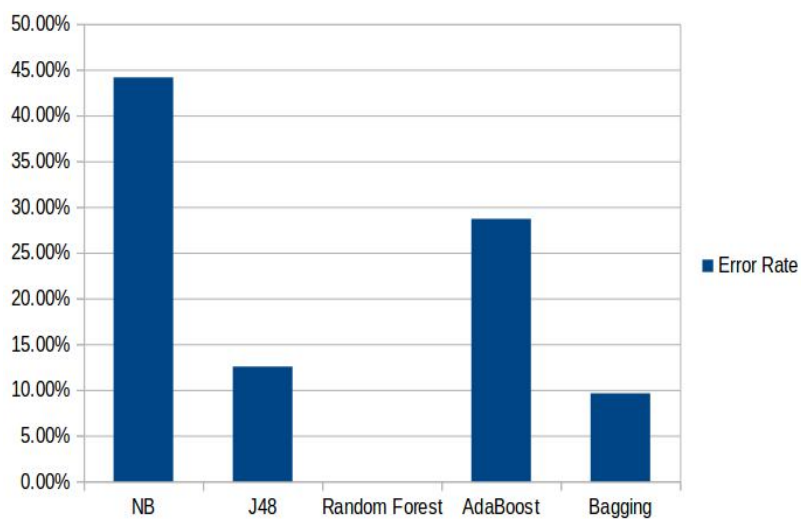


Fig 5.2 Error Rate of classification algorithms

Precision: It is the ratio of correctly classified positive observations to the total classified positive observations.

$$\text{Precision, } p = \frac{TP}{TP+FP}$$

A comparison on precision measure of classification algorithms is given in Fig 5.3.

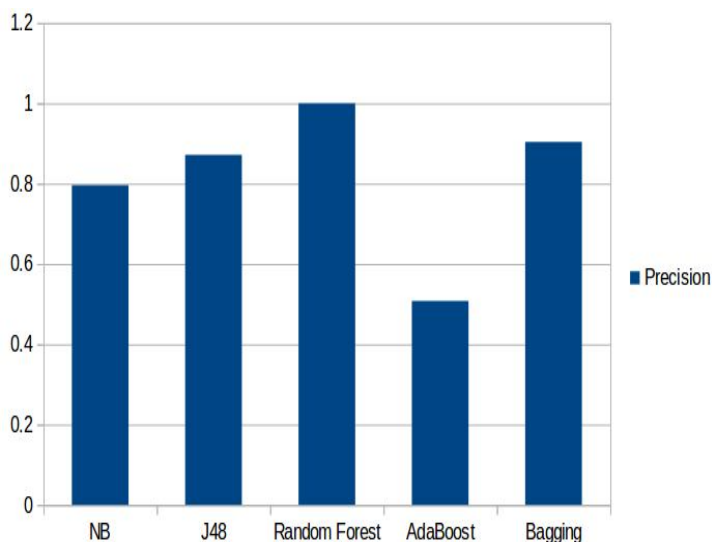


Fig 5.3 Precision of classification algorithms

Recall: It is the ratio of correctly classified positive observations to the all observations in actual class.

$$\text{Recall, } r = \frac{TP}{TP+FN}$$

A comparison on recall measure of classification algorithms is given in Fig 5.4.

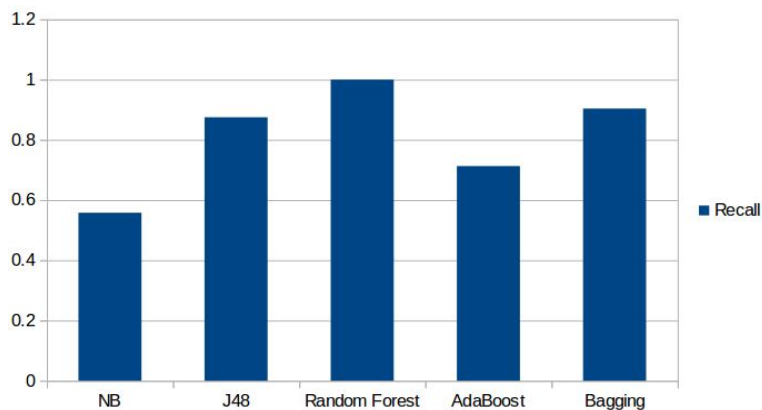


Fig 5.4 Recall of classification algorithms

F measures: It is weighted average of precision and recall.

$$F \text{ measure} = \frac{2rp}{r+p} = \frac{2 \times TP}{2 \times TP + FP + FN}$$

A comparison on F-measure of classification algorithms is given in Fig 5.5.

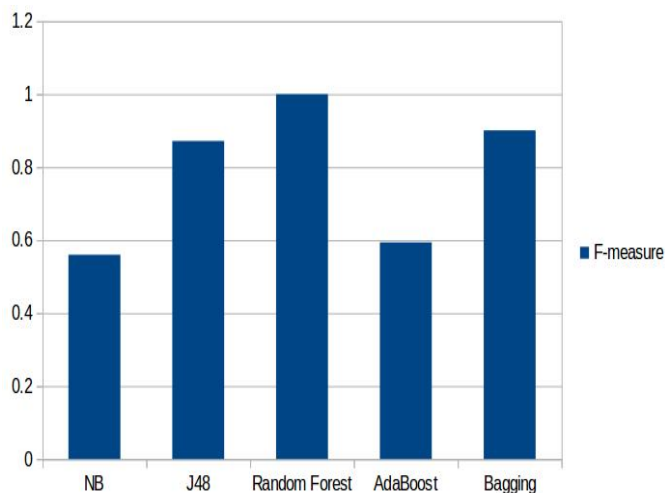


Fig 5.5 Fmeasure of classification algorithms

The overall comparison of performance measures of all classification algorithms is given in Fig 5.6.

Performance comparison of classification algorithms

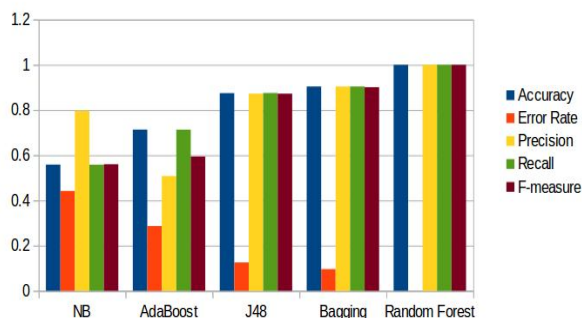


Fig 5.6 Graphical representation of performance comparison

It can be noted from the results that the parameters accuracy, error rate, precision, recall and F-measure are high for Random Forest algorithm.

VI. CONCLUSION

The main aim of this paper is to improve the accuracy of classification of liver disorders. The aim is achieved by performing a comparative study of classification algorithms on the ILPD dataset. Pre-processing technique is used to divide the data into two groups- liver patients and non liver patient. This is done using K means clustering algorithm. Further the clustered dataset is applied to various classification algorithms. The performance of each algorithm is evaluated and a comparative study has been carried out. Based on the performance comparison, it is clear that Random Forest algorithm provides better performance as compared to Naive Bayes, AdaBoost, J48 and Bagging.

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