

Enhanced Constructive Decision Tree Classification Model for Engineering Students Data

A.S. Arunachalam, A. Thirumurthi Raja, S.Perumal

Abstract: Educational Data Mining (EDM) explains the exploration involved with the application of data mining, machine learning and statistical analysis to the enormous amount of data generated from educational institutions. At a high level, the sector seeks to develop and improve strategies for exploring this information, which frequently has multiple levels of significant hierarchy, so as to find new insights regarding the learning process of individuals in the context of such settings. Therefore, the EDM has contributed to theories of learning investigated by researchers in educational psychological science and the learning methodology. This sector is closely tied with the learning analytics, which are compared and contrasted. This work is a comparative analysis of various decision tree classification algorithms using Engineering students' academic performance data. Educational Data Mining is the process which extracts knowledge through interesting patterns recognized from large amount of data from educational field. Learning related datasets with the performance of students obtained from educational institutions and processed before actual data mining or data analytics process. Data mining is one of the information discovering regions which is broadly used in the field of computer science. Furthermore is an inter-disciplinary area which has great impact on various other fields such as data analytics in prediction of risk factors in business organizations, medical forecasting and diagnosis, market basket analysis, statistical analysis and forecasting, predictive analysis in various other fields. Data mining has multiple forms such as text data mining, web data mining, visual data mining, spatial data mining and Educational data mining. As educational institutions is the source of generating quality students in order to tune them to become an eminent personality. All the educational institutions must be aware of the competency and academic level of every student in order to upgrade their performance. The implementation work is performed in Weka tool to compare the performance accuracy between the different types of decision tree classification algorithms namely J48, Entree and Enhanced Random Tree. These three classifier algorithms which are widely working with the Weka tool are used to classify this learning dataset and the result are obtained and has been evaluated & compared to identify the best decision tree classifier among them.

Index Terms: Educational Data mining; Weka, decision tree, classifier, Learning dataset, J48, RepTree, Enhanced Random Tree.

I. INTRODUCTION

Educational Data Mining is an imminent trend in the higher education. The quality of the student's utilization and enhancement of variety of learning techniques used in Educational Institutions may be improved through discovering hidden knowledge from the large amount of data stored in student databases/ data warehouses. In general the process of data mining has many tasks from pre-processing. The actual task of data mining starts after the pre-processing task obtained raw data in to a processed one so as to apply the data mining techniques [1]. Sturdy patterns if found can doubtless generalize to create correct predictions on future knowledge. The amount of data in the medical field has increased tremendously. Although, such a large volume of information is valuable and need to be analyzed for further forecast perceive and predict the complexities that may arise in future. Data mining gives the methodology and technology to recognize the valuable information of data for higher cognitive process. Machine learning algorithms are widely used to analyses and process various kinds of data [2]. There are various tool available to apply the machine learning algorithms to different kinds of data set. These tools allow performing various kinds of tasks from pre-processing till visualization of the obtained result [3]. In this work the Weka tool is used for implementing and evaluating the machine learning algorithms using the medical dataset.

II. REVIEW OF LITERATURE

Educational data mining is a major area mainly focus for predicting the students' academic performance in learning aspects. The extraction of necessary information from collected educational record set and analyzing the information are known as educational data mining. The evaluation of research field and recent improvement in educational filed leads to produce a challenging task in evaluating students' performance in academics. The necessary steps for educational data mining starts from pre-processing following feature extraction process and ends with analysing stage with necessary clustering and classification algorithms [23]. Data mining techniques are broadly divided into: supervised and unsupervised learning [24,29]. Data mining techniques are pertained to forecast students' academic performance based on some of the attributes like socioeconomic condition, earlier academic performances and so on.

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Classification is one type of data mining technique of the predictive types that classifies data based on the training set. It then uses the generated pattern to classify a new data (testing set) [25].

S.R. Garner et al, made a survey, a travelogue (2002- 2014) towards educational data mining and its scope in future [11]. In last decade, the number of higher education universities/institutions have proliferated manifolds. Large numbers of graduates/post graduates are produced by them every year., Universities could identify the factors for low performance earlier and is able to predict students' behavior, this knowledge can help them in taking pro-active actions, so as to improve the performance of such students.

The paper discusses briefly about communications between different analyzing tools presented in educational data mining. Association rule based clustering and classification based clustering techniques are discussed with various problems solutions [10]. The simulations of the results are carried out with the usage of WEKA tool, which makes feature extraction process very easy and carrying the dataset to next analyzing process. One of the key problems of educational data mining is to design student models that would predict the student performance [11]. Once we have a reliable performance prediction, it can be used in many contexts: for identifying weak students for guiding the adaptive behavior in intelligent tutoring systems or for providing a feedback to students.

III. METHODOLOGY

A. DECISION TREE CLASSIFICATION MODEL

The dataset contained in all the information aggregated during a survey it needs to be analyzed. Studying how to interpret the results is a major part of the survey process. It is collection of interconnected data with user defined parameters. Student learning data set are most helpful in analyzing and finding their performance with respect to the learning methodology.

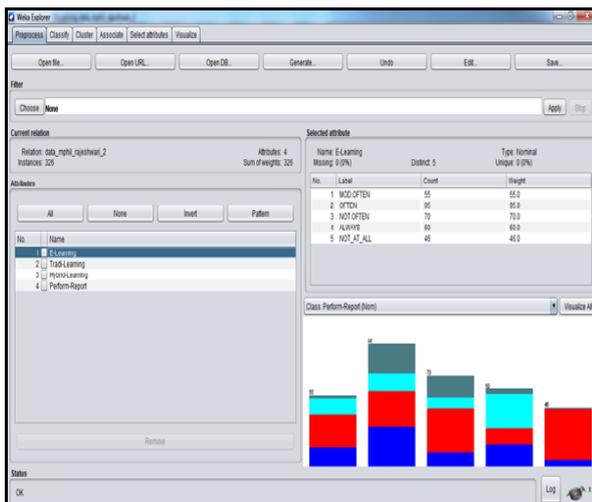


Figure 1: the dataset and its attributes with 326 instances.

This work, have used students learning dataset. This data set consists of four attributes namely E-Learning, Tradi-Learning, Hybrid-Learning and Perform-Report. All the attributes are categorical types of data. The raw dataset is collected, processed and stored in .csv file format. The Figure 1 explains the dataset and its attribute with 326 instances.

B. CLASSIFICATION APPROACHES APPLIED IN PREDICTION OF STUDENTS PERFORMANCE

Students' academic evolutionary process basically begins with the classification of the student's record following the basic data mining process of preprocessing and feature extraction process. The classification techniques is mainly considered as an important techniques followed in data mining process. The terminology behind the classification process predicts grouping combination and data instances carried out in machine learning process. Classification process plays a major role in documentation and analyzing process. Some of classification algorithms such as Rep Tree and ERTree and J48 mainly used in grouping and clustering concepts.

C. EVALUATION OF DECISION TREE CLASSIFICATION ALGORITHMS

The inner node representation of an attributes are represented with decision tree and edge representation testing strategy. Mostly other attributes are also follows the same techniques for inner node representation and leaf representation. The classes are also followed the decision tree classification techniques with top down approach and constructed based on the data trained. It Processes both numerical and categorical type of values [27]. The reason why decision trees are very much preferred for classification is as they are fast, Robust and requires very little experimentation.

The following decision tree classification algorithms are applied and Performance accuracy of the classifiers evaluated in this work.

D. J48 DECISION TREE CLASSIFICATION

Decision tree J48 is the implementation of algorithm ID3 (Iterative Dichotomiser 3) developed by the WEKA project team. Behind the idea of a decision tree we should find what it is called information gain, a concept that measures the amount of information contained in a set of data [30]. It gives the idea of importance of an attribute in a dataset.

The table 1 describe the detailed accuracy by class of J48 Tree by using the student learning data set. The accuracy of true positive rate is 0.825, false positive rate is 0.075, precision value is 0.828, recall is 0.825 and accuracy of F-measure is 0.826.

Table 1: J48 tree classification - Describes the detailed accuracy by class

CLASS	TP RATE	FP RATE	PRECISION	RECALL	F-MEASURE
AVG	0.823	0.028	0.903	0.823	0.861
BETTER	0.835	0.123	0.835	0.835	0.835
B.AVG	0.904	0.038	0.846	0.904	0.873

BEST	0.702	0.061	0.660	0.702	0.680
WEIGHTED AVG	0.825	0.075	0.828	0.825	0.826

The Figure 2 describe the detailed accuracy by class of J48 Tree. It shows average comparison of True Positive Rate, False Positive Rate, Recall, Precision, F-measure.



Figure 2: J48 TREE- Comparison of Detailed Accuracy by Class

E. REP TREE CLASSIFICATION

REPTree is a rapid decision tree learner which builds a decision/regression tree using information gain as the splitting principle and prunes it using reduced-error pruning. It only sorts values for numeric attributes once. Missing values are dealt with using C4.5’s method of using fractional instances [30]. The table 2 describe the detailed accuracy by class of Rep Tree by using the student learning data set. The weighted average of true positive rate is 0.801, false positive rate is 0.095, precision value is 0.801, recall is 0.801 and accuracy of F- measure is 0.800.

Table 2: Rep Tree classification -Describes the detailed accuracy by class

CLASS	TP RATE	FP RATE	PRECISION	RECALL	F-MEASURE
AVG	0.810	0.036	0.877	0.810	0.842
BETTER	0.842	0.166	0.791	0.842	0.815
B.AVG	0.803	0.045	0.803	0.803	0.803
BEST	0.660	0.047	0.705	0.660	0.681
WEIGHTED AVG	0.801	0.095	0.801	0.801	0.800

The Figure 3 describe the detailed accuracy by class of Rep Tree. It shows average comparison of True Positive Rate, False Positive Rate, Recall, Precision, and F-measure.

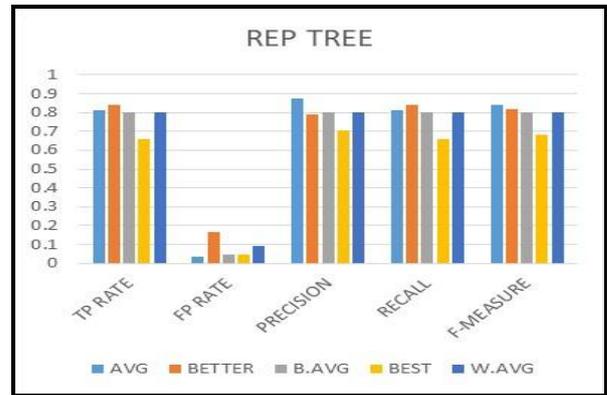


Figure 3: REP TREE- Comparison of Detailed Accuracy by Class

F. ENHANCED CONSTRUCTIVE DECISION TREE CLASSIFICATION MODEL

The proposed methodology is an enhanced approach to evaluate the best classification algorithm among various decision tree classification algorithm classifiers through analysis and experimentation. The main objective and scope of this research work is to improve data mining methods available for predicting the performance analysis of the students by knowing their way of combinational hybrid learning which can be used in to enhance their academic performance. The figure 4 shows the over view of enhanced constructive decision tree classification model.

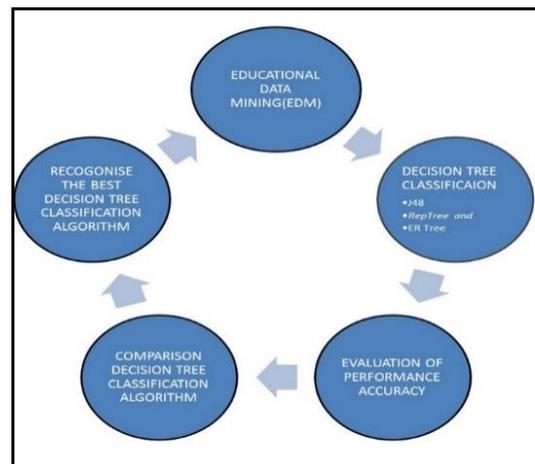


Figure 4: Enhanced Constructive Decision Tree Classification Model

G. ER TREE CLASSIFICATION

Random Trees With k random features at each node, a random tree is a tree drawn at random from a set of potential trees. In this framework each tree in the set of trees holds an equal possibility of being sampled [9]. Another way of saying this is that the distribution of trees is “uniform”. “Random Trees can be generated efficiently and the combination of large sets of random trees generally leads to accurate Models. Random tree models have been extensively developed in the field of Machine Learning in the recent Years [28]”. The table 3 describe the detailed accuracy by class of Enhanced Random Tree. The accuracy of true positive rate is 0.847, false positive rate is 0.058, precision value is 0.850, recall is 0.847 and accuracy of F- measure is 0.847.

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Table 3: Enhanced Random tree classification - Describes the detailed accuracy by class

CLASS	TP RATE	FP RATE	PRECISION	RECALL	F-MEASURE
AVG	0.899	0.032	0.899	0.899	0.899
BETTER	0.820	0.080	0.884	0.820	0.851
B.AVG	0.934	0.038	0.851	0.934	0.891
BEST	0.723	0.061	0.667	0.723	0.694
WEIGHTED AVG	0.847	0.058	0.850	0.847	0.847

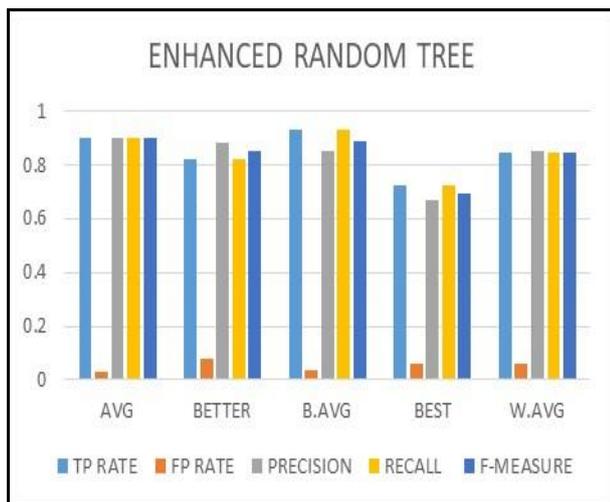


Figure 5: ENHANCED RANDOM TREE- Comparison of Detailed Accuracy by Class

The Figure 5 describe the detailed accuracy by class of Rep Tree. It shows average comparison of True Positive Rate, False Positive Rate, Recall, Precision, and F-measure.

IV. RESULTS AND DISCUSSION

This work experiments various decision tree classification algorithms and analyses its performance and accuracy. Main aim of this work is to analyses the classification algorithms' performance and accuracy as shown in the chart and screen shots of the experimental page and result obtained. The result of this work shows that the hybrid learning is better than either only traditional learning or E-learning process.

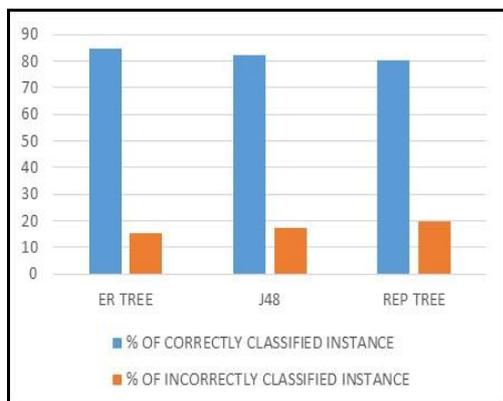


Figure 6: Performance Comparison of Classifiers

The performance of the students is better when the hybrid learning is followed in their academics than following any one of the other two types of learning. The WEKA application is used for the performance evaluation. All the three classifiers namely J48, RepTree and ERTree algorithms are experimented and evaluated with 10 fold cross validation and shows more than 80% of performance accuracy. Among these ER Tree algorithm shows the highest performance accuracy comparatively as shown in the graph below. The graph describes both the percentage of correctly classified instances and the percentage of incorrectly classified instances for all the three algorithms for this student learning dataset.

PERFORMANCE ACCURACY TABLE: The experimental screen shots which depicts the time taken to build the model, the number of correctly classified instances which is 82.5%, the detailed accuracy by class and the confusion matrix .The decision tree of J48 algorithm is shown in figure below. The table 4 illustrates that the highest accuracy is established by ER Tree of 84.7%.

Table 4: Performance result of different algorithm

CLASSIFIER	CORRECTLY CLASSIFIED INSTANCE	INCORRECTLY CLASSIFIED INSTANCE
ER TREE	84.7	15.3
J48	82.5	17.5
REP TREE	80.1	19.9

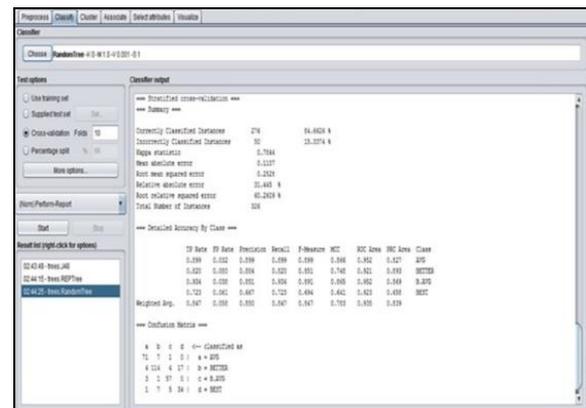


Figure 7: Enhanced Random tree classification that describes the detailed accuracy by class and confusion matrix.

ER Tree: Enhanced Random Trees With k random features at each node, an enhanced random tree is a tree drawn at random from a set of potential trees. In this framework each tree in the set of trees holds an equal possibility of being sampled. "Another way of saying this is that the distribution of trees is "uniform". Enhanced Random Trees can be generated efficiently and the combination of large sets of random trees generally leads to accurate Models". Random tree models have been extensively developed in the field of Machine Learning in the recent Years [9].

The Figure 7 shows the experimental screen shots which depicts the time taken to build the model and the correctly classified instances which is 84.7%.

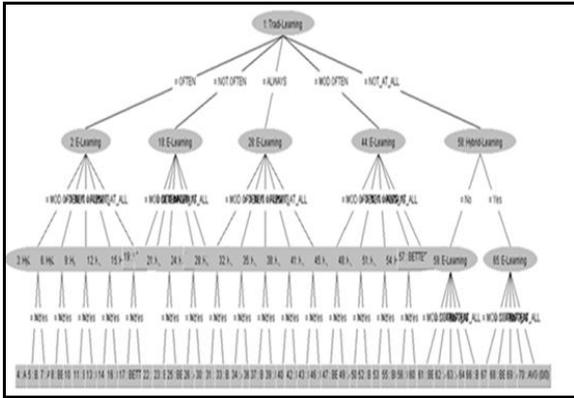


Figure 8: Decision tree of the Enhanced Random tree classification.

The confusion matrix and the detailed accuracy by class show comparatively higher performance accuracy than the accuracy and performance of the J48 and RepTree classifiers. The figure 8 shows the visualization of decision tree of the Enhanced Random tree classification.

J48 Decision tree: Decision tree J48 is the implementation of algorithm ID3 (Iterative Dichotomiser 3) developed by the WEKA project team. Behind the idea of a decision tree we should find what it is called information gain, a concept that measures the amount of information contained in a set of data.[8] It gives the idea of importance of an attribute in a dataset.

The Figure 9 below shows the experimental screen shots which depict the time taken to build the model, the number of correctly classified instances which is 82.5%, the detailed accuracy by class and the confusion matrix .The decision tree of J48 algorithm is shown in figure 9.

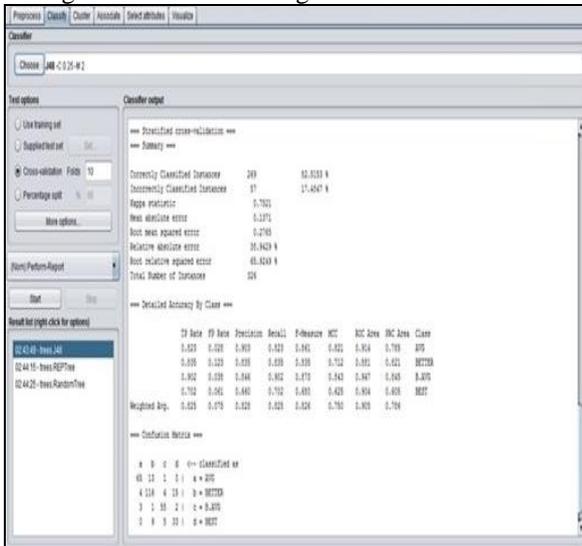


Figure 9: J48 Decision tree classification that describes the detailed accuracy by class and confusion matrix.

The Figure 9 depicts the time taken to build the model, the number of correctly classified instances which is 82.5%, the detailed accuracy by class and the confusion matrix of J48 algorithm. The decision tree of J48 algorithm is shown in figure 10.

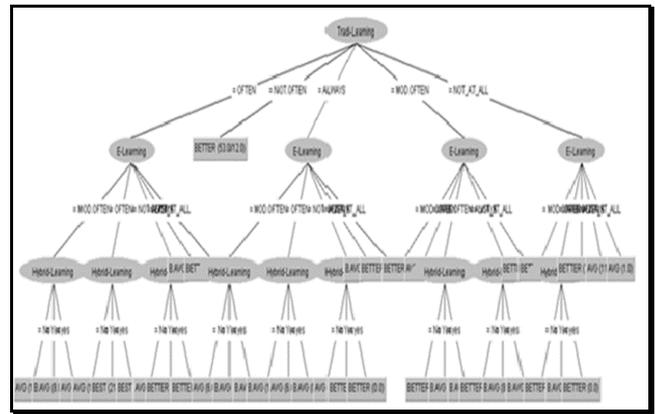


Figure 10: The decision tree of J48 algorithm is shown.

REPTree: It is a rapid decision tree learner which builds a decision/regression tree using information gain as the splitting principle and prunes it using reduced-error pruning. It only sorts values for numeric attributes once. Missing values are dealt with using C4.5's method of using fractional instances. [10].

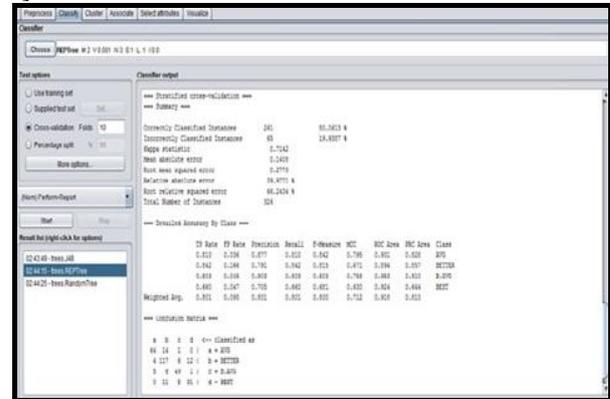


Figure 11: Rep tree classification that describes the detailed accuracy by class and confusion matrix.

The Figure 11 shows the experimental screen shots which depicts the time taken to build the model and the correctly classified instances which is 84.7%. The confusion matrix and the detailed accuracy by class show comparatively lower than the performance accuracy than the accuracy and performance of the J48 and Enhanced Random Tree classifiers. Figure12 shows the visualization of decision tree of the random tree classification.

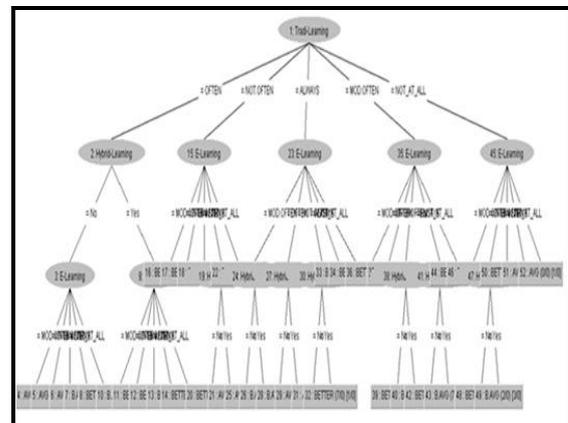


Figure 12: Decision tree for RepTree classification

COMPARISON OF ACCURACY BY CLASS: The table describe the comparison of accuracy by class for three different algorithm of J48 Tree, Rep Tree and Enhanced Random Tree. In detailed accuracy of Enhanced Random Tree by class of True positive rate, Precision, Recall and F-measure are comparatively higher than J48 Tree and Rep Tree. False Positive Rate of Enhanced Random Tree is comparatively lower than J48 Tree and Rep Tree.

Table5: Accuracy by class for different types of decision tree classification algorithm

CLASS	TP RATE	FP RATE	PRECISION	RECALL	F-MEASURE
ER TREE	0.847	0.058	0.850	0.847	0.847
J48	0.825	0.075	0.828	0.825	0.826
REP TREE	0.801	0.095	0.801	0.801	0.800

The figure13 shows the comparison of accuracy by class of three different algorithm of J48 Tree, Rep Tree and Enhanced Random Tree. In detailed accuracy of Enhanced Random Tree by class of True positive rate, Precision, Recall and F-measure are comparatively higher than J48 Tree and Rep Tree.

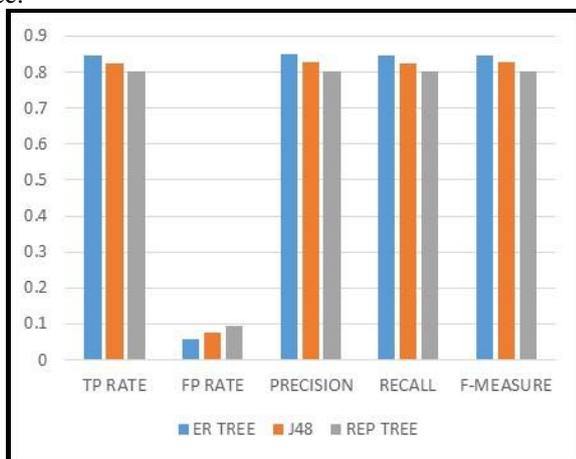


Figure 13: Comparison of Accuracy by Class

V. CONCLUSION

The engineering student's academic performance evaluation process are tested with classification techniques for understanding the best decision tree support. The Classification process is followed from the process of pre-processing of engineering students academic data and feature selection process. The basic features necessary for analyzing academic performance of the engineering students are carried out with the decision tree support. The classification algorithms are tested with various similar decision algorithms with various constrains such as sensitivity, specificity and accuracy. The decision tree algorithms such as J48, ER tree and Reptree are considered for testing the performance of the engineering students. The result shown that the ER tree decision algorithms outfits the working of J48 and Reptree algorithm.

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