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Performance Analysis of Engineering Students for Recruitment Using Classification Data Mining Techniques

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Abstract **--- Data Mining is a powerful tool for academic intervention. Mining in education environment is called Educational Data Mining. Educational Data Mining is concerned with developing new methods to discover knowledge from educational database and can used for decision making in educational system. In our work, we collected the student's data from engineering institute that have different information about their previous and current academics records like students S.No., Name, Branch, 10th, 12th, B.Tech passing percentage and final grade & then apply different classification algorithm using Data Mining tools (WEKA) for analysis the students academics performance for Training & placement department or company executives. This paper deals with a comparative study of various classification data mining algorithms for the performance analysis of the student's academic records and check which algorithm is optimal for classifying students' based on their final grade. This analysis also classifies the performance of Students into Excellent, Good and Average categories.**

Keywords– **Data Mining, Discover knowledge, Technical Education, Educational Data, Mining, Classification, WEKA, Classifiers.**

I. INTRODUCTION

Data Mining is a process of extracting previously unknown, valid, potentional useful and hidden patterns from large data sets (Connolly, 1999). As the amount of data stored in educational databases is increasing rapidly. In order to get required benefits from such large data and to find hidden relationships between variables using different data mining techniques developed and used (Han and Kamber, 2006).

There are increasing research interests in using data mining in education. This new emerging field, called Educational Data Mining, concerns with developing methods that discover knowledge from data come from educational environments [1]. The data can be collected form historical and operational data reside in the databases of educational institutes. The student data can be personal or academic. Also it can be collected from e-learning systems which have a vast amount of information used by most institutes [2][3]. Educational data mining used many techniques such as decision trees, neural networks, k-nearest Neighbor, Naïve Bayes, support vector machines and many others. Using these methods many kinds of knowledge can be discovered such as association rules, classifications and clustering. The discovered knowledge can be used to better understand students' behavior, to assist instructors, to improve teaching, to evaluate and improve e-learning systems , to improve curriculums and many other benefits [4] [1].

Performance monitoring involves assessments which serve a vital role in providing information that is geared to help students, teachers, administrators, and policy makers take decisions.[5] The changing factors in contemporary education has led to the quest to effectively and efficiently monitor student performance in educational institutions, which is now moving away from the traditional measurement & evaluation techniques to the use of DMT which employs various intrusive data penetration and investigation methods to isolate vital implicit or hidden information. Due to the fact that several new technologies have contributed and generated huge explicit knowledge, causing implicit knowledge to be unobserved and stacked away within huge amounts of data.

The main attribute of data mining is that it subsumes Knowledge Discovery (KD) which according to [6] is a nontrivial process of identifying valid, novel, potentially useful and ultimately understandable Patterns in data processes, thereby contributing to predicting trends of outcomes by profiling performance attributes that supports effective decisions making. This paper deploys theory and practice of data mining as it relates to student's performance in their qualifications.

The main objective of this paper is to use data mining methodologies to study student's performance in their qualifications. Data mining provides many tasks that could be used to study the student performance. In this research, the classification task is used to evaluate student's performance and as there are many approaches that are used for data classification. Information's like student's course Branch, passing % of 10th, passing % of 12th and passing % of B.Tech were collected from the student's database, to classify the performance grade. This paper also investigates the accuracy of different applied classifiers for classification of student performance (Final Grade).

II. EDUCATIONAL DATA MINING

Education is an essential element for the betterment and progress of a country. It enables the people of a country civilized and well mannered. Educational Data Mining is an emerging discipline concerned with developing methods for exploring the unique types of data that come from educational database. Mining in educational environment is called Educational Data Mining, concern with developing new methods to discover knowledge from educational databases (Galit, 2007) (Erdogan and Timor 2005) ,in order to analyze students trends and behaviors toward education(Alaa el-Halees , 2009). Lack of deep and enough knowledge in higher educational system may prevent system management to achieve quality objectives, data mining methodology can help bridging this knowledge gaps in higher education system.

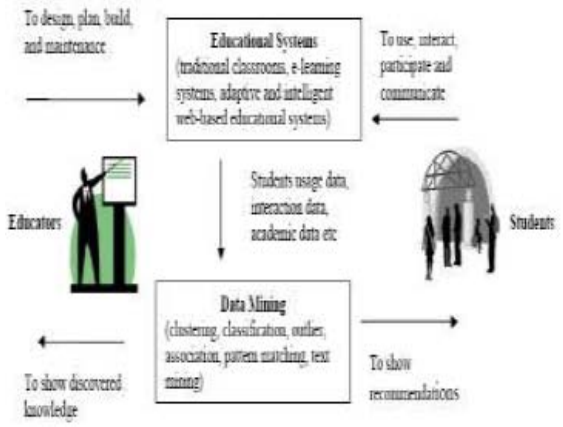

Figure 1 : The cycle of applying data mining in education system [15]

III. DATA MINING DEFINITION & TECHNIQUES

Data mining, also popularly known as Knowledge Discovery in Database, refers to extracting or "mining" knowledge from large amounts of data. Data mining techniques are used to operate on large volumes of data to discover hidden patterns and relationships helpful in decision making. While data mining and knowledge discovery in database are frequently treated as synonyms, data mining is actually part of the knowledge discovery process.

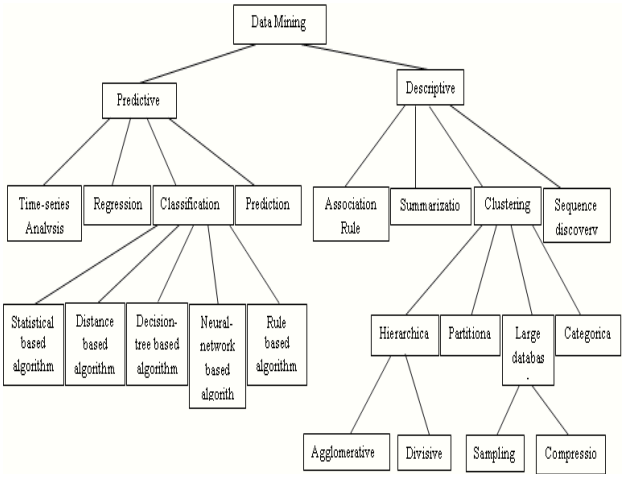

Figure -2 Data Mining Model & Task.

A. *Classification*

Classification is the most commonly applied data mining technique, which employs a set of pre-classified attributes to develop a model that can classify the population of records at large. This approach frequently employs decision tree or neural network-based classification algorithms. The data classification process involves learning and classification .In learning the training data are analyzed by classification algorithm. In classification test data are used to estimate the accuracy of the classification rules. If the accuracy is acceptable the rules can be applied to the new data tuples. The classifier-training algorithm uses these pre-classified attributes to determine the set of parameters required for proper discrimination. The algorithm then encodes these parameters into a model called a classifier. The Classification methods used for the comparative study are discussed in brief.

1) Bayesian Network

Bayesian Classifiers are statistical classifiers which predict class membership probabilities. The probability that a given tuple belongs to a particular class is obtained using this. [17][18]. It is a graphical model that encodes probabilistic relationships among variables of interest [19][20].

2) Navive Bayes

Naive Bayesian classifiers [24] can handle any number of variables, regardless of whether they are qualitative or quantitative. The algorithm works on the assumption, that variables provided to the classifier are independent. Even though this might not always be the case, it greatly simplifies the classification task. Instead of being presented with a multi-dimensional task, the algorithm has to compute only a set of one-dimensional tasks. Furthermore, the regions near decision boundaries do not seem to be greatly affected by doing this, thus leaving the classification task unaffected.

3) Multilayer Perceptron

Multilayer Perceptron (MLP) is a feed forward artificial neural network model that maps sets of input data onto a set of appropriate output. An MLP consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. Their current output depends only on the current input instance. It trains using back propagation [21] [18] [19][23].

4) IB1

IB1 is nearest neighbour classifier. It uses normalized Euclidean distance to find the training instance closest to the given test instance, and predicts the same class as this training instance. If several instances have the smallest distance to the test instance, the first one obtained is used. Nearest neighbour method is one of the effortless and uncomplicated learning/classification algorithms, and has been effectively applied to a broad range of problems [25].

5) Decision Table

Decision tables are classification models induced by machine learning algorithms and are used for making predictions. A decision table consists of a hierarchical table in which each entry in a higher level table gets broken down by the values of a pair of additional attributes to form another table. The structure is similar to dimensional stacking [18][22].

IV. RELATED WORK

Data mining in higher education is a recent research field and this area of research is gaining popularity because of its potentials to educational institutes.

Data Mining can be used in educational field to enhance our understanding of learning process to focus on identifying, extracting and evaluating variables related to the learning process of students as described by Alaa el-Halees [7]. Mining in educational environment is called Educational Data Mining.

Han and Kamber [8] describes data mining software that allow the users to analyze data from different dimensions, categorize it and summarize the relationships which are identified during the mining process.

Pandey and Pal [9] conducted study on the student performance based by selecting 600 students from different colleges of Dr. R.M.L. Awadh University, Faizabad, India. By means of Bayes Classification on category, language and background qualification, it was found that whether new comer students will performer or not.

Al-Radaideh, et al [10] applied a decision tree model to predict the final grade of students who studied the C++ course in Yarmouk University, Jordan in the year 2005. Three different classification methods namely ID3, C4.5 and the Naïve Bayes were used. The outcome of their results indicated that Decision Tree model had better prediction than other models.

Data mining applications in higher education given in [11], they concluded with that the Data mining is a powerful analytical tool that enables educational institutions to better allocate resources and staff to proactively manage student outcomes and improve the effectiveness of alumni development.

Varsha, Anuj, Divakar, R.C Jain [13] applied four classification methods on student academic data i.e Decision tree (ID3), Multilayers perceptron, Decision table & Naïve Bayes classification method.

Brijesh kumar & Saurabh Pal [14] study the data set of 50 students from VBS Purvanchal University, Jaunpur (U.P). As there are many approaches that are used for data Classification, the decision tree method is used here. Information's like Attendance, Class test, Seminar and Assignment marks were collected from the student's previous database, to predict the performance at the end of the semester.

Sunita B Aher, Mr. LOBO L.M.R.J [16] defines the Data Mining in Educational System Using WEKA. They classify the student performance using WEKA (Data Mining Tool).

Tongshan Chang, & Ed.D [26] introduces a real project to assist higher education institutions in achieving enrollment goals using data mining techniques Furthermore, the results also provide evidence that data mining is an effective technology for college recruitment. It can help higher education institutions mange enrollment more effectively.

R. R. Kabra & R. S. Bichkar [27] shows that students past academic performance can be used to create the model using decision tree algorithm that can be used for prediction of student's performance in First Year of engineering exam.

Neelam Naik & Seema Purohit [28] created classification trees for MCA result prediction and placement prediction of students are tested for validation data.

P.K.Srimani & Annapurna S Kamath [29] define a comparative study of the application of various data mining algorithms for the performance analysis of the learning model. Performance analysis is the analysis of the data stored by the learning model in the mathematical pathway database which is used to track the progress of each student. The analysis classifies the performance of a student into average, below average and above average categories.

Samrat Singh & Dr. Vikesh Kumar [30] introduce the use of data mining process in a student's database using classification data mining techniques (decision tree method etc). The information generated after the analysis of data mining techniques on student's data base is helpful for executives for training & placement department of engineering colleges. This work classifies the categories of student's performance in their academic qualifications.

Sudheep Elayidom , Sumam Mary Idikkula & Joseph Alexander [31] proved that the technology named data mining can be very effectively applied to the domain called employment prediction, which helps the students to choose a good branch that may fetch them placement. A generalized framework for similar problems has been proposed.

V.Ramesh, P.Parkavi & P.Yasodha [32] defines an attempt to use classification algorithms for predicting the student performance and comparing the performance of NaiveBayes Simple, MultiLayer Perception, SMO, J48, and REP Tree.

S. Anupama Kumar and Dr. Vijayalakshmi M.N [33] classification techniques can be applied on educational data for predicting the student's outcome and improve their results. The efficiency of various decision tree algorithms can be analyzed based on their accuracy and time taken to derive the tree. The predictions obtained from the system have helped the tutor to identify the weak students and improve their Performance.

V. PROPOSED WORK

A. Data Collection & Preparations

The data set used in this study was obtained from the different branches of Engineering College. Initially size of the data is 50. The data sets have six attributes like student's Name, Branch, passing percentage (%) of 10^{th} class, passing percentage (%) of 12^{th} class and passing percentage (%) and Final Grade for analysis.

We discretized the numerical attributes to categorical ones. For example, variable X ($X = x_0, x_1, x_2$ Where $x_{0=}10^{th}$ %, $x_{1=}12^{th}$ %, $x_{2=}$B.Tech %) is common variable of student's passing percentage (%) in 10^{th}, 12^{th} & B.Tech. We grouped all grades into three groups Excellent, Good, Average as described in table below.

TABLE-I
VALUES OF FINAL GRADE

Final_Percentage	**Final_Grade**
$X \geq 60\%$	Excellent
$X \geq 45\%$	Good
$X \geq 35\%$	Average

In the same way, we descretized other attributes such as student's course Branch, passing % of 10^{th}, passing % of 12^{th}, passing % of B.Tech. Finally the most significant attributes presented in following table:-

TABLE- II
THE SYMBOLIC ATTRIBUTE DESCRIPTION

Attribute	Description	Possible Values
Student_Name	Student's name in B.Tech course.	{alphabets Characters}
Branch	Student's branch in B.Tech course.	{CS, IT, EC, EN}
HighSchool_ Percentage (10^{th} %)	Percentage of marks obtained in 10^{th} class exam.	{ First > 60% Second > 45 & < 60 % Third > 35 & < 45 % }
Intermediate_ Percentage(12^{th} %)	Percentage of marks obtained in 12^{th} class exam.	{ First > 60% Second > 50 & < 60 % }
B.Tech_ Percentage(B.Tech %)	Percentage of marks obtained in B.Tech course.	{ First > 60% Second > 50 & < 60 % }
Final_ Grade	Final Grade obtained after analysis the passing percentage of 10^{th},12^{th} , B.Tech	{ Excellent, Good, Average }

The domain values for some of the variables were defined for the present investigation as follows:

- **Branch** – Student's branch in they are enrolled in B.Tech Course. Branch split in four classes: *CS, IT, EC, EN, ME*.
- **HighSchool_Percentage (10^{th}%)** -- Student's passing Percentage (%) in 10^{th} class. 10^{th} % is split into three classes: First- >60% Second - >45% and <60%, Third - >35% and < 45%.
- **Intermediate_Percentage (12^{th} %)** --Student's passing Percentage (%) in 12^{th} class. For admission in B.Tech course minimum 50% marks are needed in 12^{th} class. So 12^{th} % is split into two classes:First- >60% Secon>50% and <60%.
- **B.Tech_Percentage (B.Tech%)** --Student's passing percentage (%) in B.Tech Course. In B.Tech course Minimum 50 marks is compulsory for passing. So B.Tech % is split into two classes: First- >60% Second - >50% and <60%.
- Final_Grade –The value of final grade (X) will be finding after analysis of rule sets of Student's passing percentage (%) in 10^{th} (x_0), 12^{th} (x_1), B.Tech (x_2). The final grade is divided into three categories: *Excellent, Good, Average.*

VI. WEKA TOOL

The Weka workbench contains a collection of visualization tools and algorithms for data analysis and predictive modeling, together with graphical user interfaces for easy access to this functionality. It is freely available software. It is portable & platform independent because it is fully implemented in the Java programming language and thus runs on almost any modern computing platform. Weka has several standard data mining tasks, data preprocessing, clustering, classification, association, visualization, and feature selection. The WEKA GUI chooser launches the WEKA's graphical environment which has six buttons: Simple CLI, Explorer, Experimenter, Knowledge Flow, ARFF-Viewer, & Log.

The *Explorer* interface has several panels that give access to the main components of the workbench:

1. The *Preprocess* panel imports the data from a database, a CSV file, ARFF etc., and preprocesses this data using *filtering* algorithm which can be used to transform the data from one format to other e.g. numeric attributes into discrete ones. It is also possible to delete instances and attributes according to specific criteria on the preprocess screen. It is also possible to view the graph for particular attribute.
2. The *Classify* panel allows the user to apply classification and regression algorithms (e.g. NaiveBays algorithm, ADTree, ID3 Tree , J48 Tree, ZeroR rules etc) to the dataset estimate the accuracy of the resulting model. It is also possible to visualize erroneous predictions, ROC curves, etc. Result of classification can be seen in classifier output area .
3. The *Cluster* panel is used to access the clustering techniques in Weka, e.g., the simple k-means, EM, DBScan, XMeans algorithm. Sometimes it is necessary to ignore some attribute while using the clustering algorithm, so it is possible with Ignore Attribute button.
4. The *Associate* panel gives access to association rule e.g. Apriori, PredictiveApriori algorithm. Once the appropriate parameter for association rule is chosen then result list allows the result set to viewed or saved.
5. The *Select attributes* panel allows to search among all possible combination of attribute in dataset, which subset of attribute is best for making prediction.
6. The *Visualize* panel visualizes 2D plots of current relation.

VII. RESULT AND DISCUSSION

The data set of 50 students used in this study was obtained from the Engineering College of B.Tech course.

TABLE –III
RULE SET FOR STUDENT'S FINAL GRADE

IF 10^{th} % ="First" AND 12^{th} % ="First" AND B.Tech % = "First" THEN Final_Grade = "Excellent"
IF 10^{th} % ="Second" AND 12^{th} % ="First" AND B.Tech % = "First" THEN Final_Grade = "Good"
IF 10^{th} % ="Third" AND 12^{th} % ="First" AND B.Tech % = "First" THEN Final_Grade = "Average"
IF 10^{th} % ="First" AND 12^{th} % ="Second" AND B.Tech % = "First" THEN Final_Grade = "Good"
IF 10^{th} % ="Second" AND 12^{th} % ="Second"AND B.Tech % = "First" THEN Final_Grade = "Average"
IF 10^{th} % ="Third" AND 12^{th} % ="Second" AND B.Tech % = "First" THEN Final_Grade = "Average"
IF 10^{th} % ="First" AND 12^{th} % ="First" AND B.Tech % = "Second" THEN Final_Grade = "Average"
IF 10^{th} % ="Second" AND 12^{th} % ="First" AND B.Tech % = "Second" THEN Final_Grade = "Average"
IF 10^{th} % ="Third" AND 12^{th} % ="First" AND B.Tech % = "Second" THEN Final_Grade = "Average"
IF 10^{th} % ="First" AND 12^{th} % ="Second" AND B.Tech % = "Second" THEN Final_Grade = "Average"
IF 10^{th} % ="Second" AND 12^{th} % ="Second"AND B.Tech % = "Second" THEN Final_Grade = "Average"
IF 10^{th} % ="Third" AND 12^{th} % ="Second" AND B.Tech % = "Second" THEN Final_Grade = "Average"

TABLE –IV
STUDENT'S DATA FOR ANALYSIS ON WEKA

S. N	Student_Name	Branch	10th %	12th %	B.Tech %	Final Grade
1.	ANKIT	CS	61	70	65	Excellent
2.	ANKUL	CS	68	57	68	Good
3.	ANOOP	CS	69	72	71	Excellent
4.	DHEERAJ	CS	61	57	64	Good
5.	DIVYA	CS	69	69	70	Excellent
6.	FIROJ	CS	66	63	71	Excellent
7.	GOVIND	CS	67	52	65	Good
8.	JITENDRA	CS	65	57	65	Good
9.	KANIKA	CS	65	75	73	Excellent
10	MAHENDRA	CS	53	61	67	Good
11	ABHINAV	IT	66	65	70	Excellent
12	ANMOL	IT	54	71	64	Good
13	ANUJ	IT	68	70	73	Excellent
14	MUKESH	IT	86	85	80	Excellent
15	NAVEEN	IT	74	67	71	Excellent
16	NIPUN	IT	75	60	62	Excellent
17	PRITHBI RAJ	IT	67	65	63	Excellent
18	PRIYA	IT	76	58	68	Good
19	RAVINDRA	IT	59	57	68	Average
20	RAVINDRA	IT	63	64	67	Excellent
21	ABHISHEK	EC	67	63	64	Excellent
22	ANKIT	EC	73	62	68	Excellent
23	ANKUR	EC	54	52	65	Average
24	ASHWINI	EC	49	64	60	Good
25	AVANEESH	EC	64	58	63	Good
26	AVINASH	EC	52	67	56	Average
27	FAZAL	EC	61	64	69	Excellent
28	GAURAV	EC	69	63	74	Excellent
29	HEMANT	EC	80	80	77	Excellent
30	JATIN	EC	48	55	67	Average
31	ANUP	EN	76	58	68	Good
32	ASHISH	EN	59	57	68	Average
33	ASHUTOSH	EN	63	64	67	Excellent
34	KRISHNA	EN	63	65	64	Excellent
35	KRISHNA	EN	67	60	58	Average
36	PRANJAL	EN	62	60	65	Excellent
37	ROHIT	EN	72	63	66	Excellent
38	VINAY	EN	73	53	57	Average
39	VIPUL	EN	58	58	63	Average
40	ANKUSH	EN	60	67	61	Good
41	ABDULLA	ME	69	63	74	Excellent
42	ADITYA	ME	76	58	68	Good
43	AJAJ	ME	63	65	64	Excellent
44	AKHIL	ME	67	60	58	Average
45	AMIT	ME	65	75	73	Excellent
46	ANOOP	ME	53	61	67	Good
47	ARVIND	ME	66	65	70	Excellent
48	ANIL	ME	67	65	63	Excellent
49	ATUL	ME	76	58	68	Good
50	VIPIN	ME	59	57	68	Average

TABLE- V
BRANCHWISE STUDENT'S FINAL GRADE DETAILS

S. N	Branch	No. of Students	No. of students Excellent	No. of students Good	No. of students Average
1.	CS	10	5	5	0
2.	IT	10	7	2	1
3.	EC	10	5	2	3
4.	EN	10	4	2	4
5.	ME	10	5	3	2
Total→		50	26	14	10
Grade Percentage (%) →			52%	28%	20%

TABLE VI
RESULT FROM DIFFERENT CLASSIFIER USING WEKA

Classifier Name→	BayesNet	Navive Bayes	Multilayers Perceptron	IB1	Decision Table	PART
Total No.of Instances	50	50	50	50	50	50
Correctly Classified Instances	48 (96%)	45 (90%)	50 (100%)	50 (100%)	45 (90%)	50 (100%)
Incorrectly Classified Instances	2 (4%)	5 (10%)	0 (0%)	0 (0%)	5 (10%)	0 (0%)
Time Taken to build the Model	0 Second	0 Second	2.49 Second	0 Second	0.01 Second	0.01 Second
Confusion Matrix	24 1 1 0 14 0 0 0 10	24 0 2 0 12 2 0 1 9	26 0 0 0 14 0 0 0 10	26 0 0 0 14 0 0 0 10	24 1 1 0 14 0 0 0 10	26 0 0 0 14 0 0 0 10
Kappa Statistic	.93	.84	1	1	.83	1
ROC value	1	.98	1	1	.96	1

TABLE VII
BEST CLASSIFIERS OF DIFFERENT MEASUREMENTS

Classifier Name→	BayesNet	Navive Bayes	Multilayers Perceptron	IB1	Decision Table	PART
Correctly Classified Instances	--	--	Multilayers Perceptron	IB1	--	PART
Time Taken to build the Model	BayesNet	Navive Bayes	--	IB1	--	--
Confusion Matrix	--	--	Multilayers Perceptron	IB1	--	PART
Kappa Statistic	--	--	Multilayers Perceptron	IB1	--	PART
ROC value	BayesNet	--	Multilayers Perceptron	IB1	--	PART
Total points (5) →	2	1	4	5	0	4

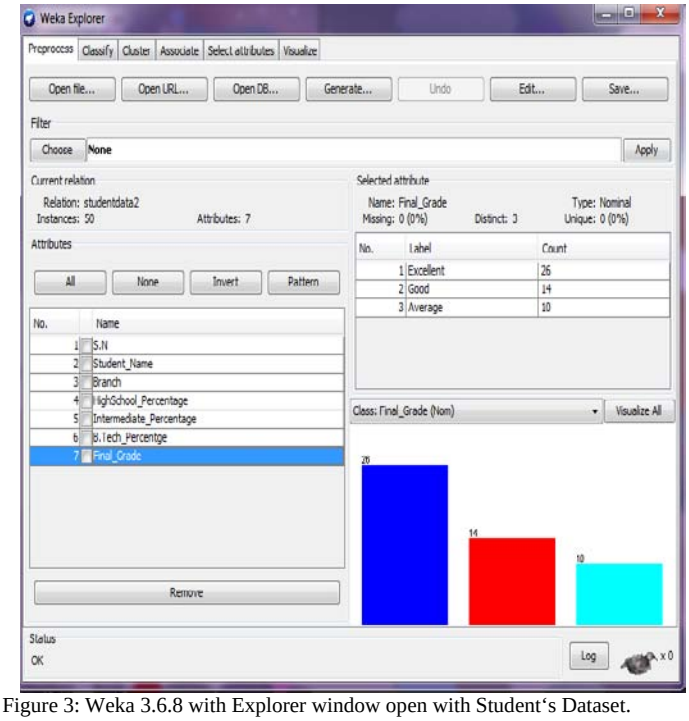

Figure 3: Weka 3.6.8 with Explorer window open with Student's Dataset.

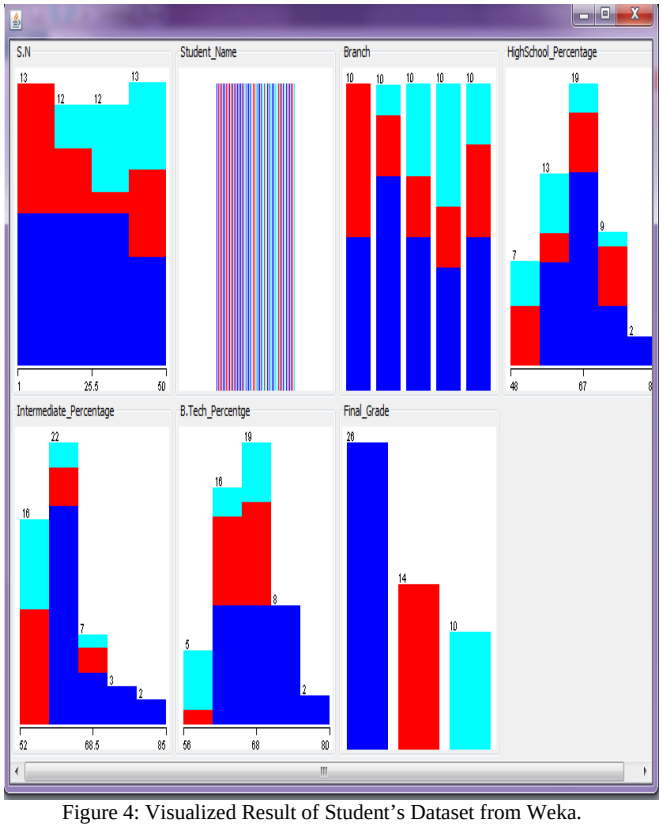

Figure 4: Visualized Result of Student's Dataset from Weka.

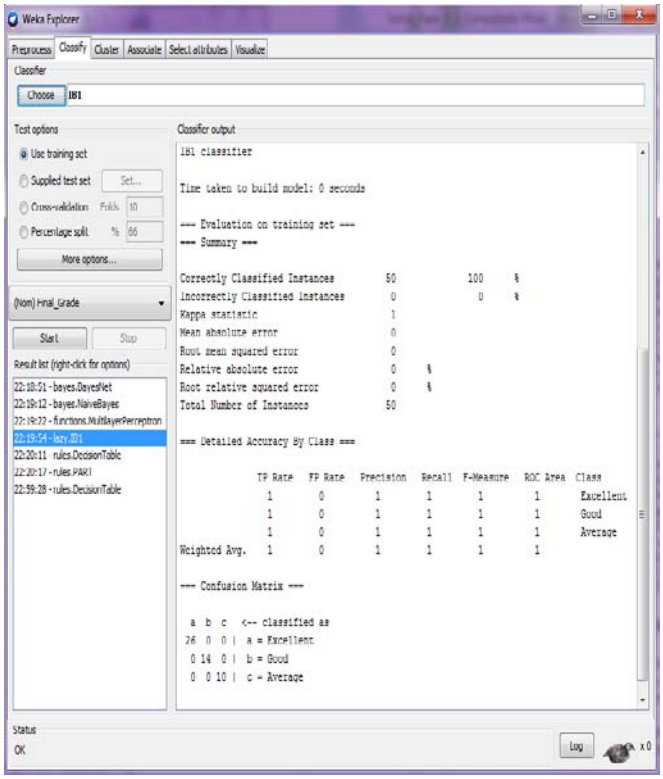

Figure 5: IB1 Classifier Result of Student's Dataset from Weka.

The results obtained from the various data mining algorithms viz, BayesNet , Navive Bayes, Multilayers Perceptron, IB1, Decision Table and PART on the data set for different branches of students are tabulated and the performance analyzed Comparison table gives the total no. of instances, Correctly classified and Incorrectly classified instances, Time taken to build a model, Confusion matrix, Kappa statistics and ROC value. The interpretations of the results based on these parameters are as follows:

In Table V, Branchwise student's details of Final Grade are given. According to different branches have 26 (52%) Excellent students, 14 (28%) Good students and 10 (20%) Average students.

In Table VI, reveals that (i) the classifiers Multilayers Perceptron, IB1 and PART algorithm are found to be very efficient and accurate. In this case the correctly classified instances are 100%, (ii) The Time taken by BayesNet , Navive Bayes and IB1 are 0 Second to build the model but IB1 Algorithm is found 100% correctly classified instances. (iii) The classifiers Multilayers Perceptron, IB1 and PART algorithm are found the accurate diagonal elements of the confusion matrix predicts the correctly classified instances but with regard to time complexity IB1 is found to be efficient to learning model. (iv) with respect to Kappa Statistic the classifiers Multilayers Perceptron, IB1 and PART algorithm are preferred. (v) Classifiers BayesNet, Multilayers

Perceptron, IB1 and PART are found the accurate value of the area (ROC Value). So according to these classifiers performance analysis IB1 secure total 5 points out of 5 points and generates the efficient and accurate results on this type of data set.

VIII. CONCLUSION & FUTURE WORK

This work is an attempt to use Data Mining techniques to analyze students' academic data and to enhance the quality of technical educational system. In this work we applied six classification methods on student data i.e. BayesNet, Naïve Bayes , Multilayer Perceptron, IB1,Decision Table and PART Classification method .We notice that according to experimental result IB1 Classifier is most suitable method for this type of student dataset. The Higher management's executives for training & placement department of engineering colleges or Company Executives can use such classification model to measures or visualized the students' performance according to the extracted knowledge.

For future work, this study will be helpful for institutions and industries. We can be generating the information after implementing the others data mining techniques like clustering, Predication and Association rules etc with help of Data Mining tools on different eligibility criteria of industry recruitment for students.

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