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Mining Educational Data using Filter based Feature Selection Method

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Abstract: Today, the tremendous growth in electronic data of universities creates the need to have some meaningful information extracted from these large volumes of educational data. The advancement in the data mining field makes it possible to mine educational data in order to improve the quality of the educational processes and teaching methods. All these improvement leads to enhance the performance and overall institution output, is known as education mining. This study thus, uses data mining methods to study the performance of students. Educational data set is taken and filter method applied for best feature selection using WEKA an Open Source Tool. Filter based feature selection method used is Relief attribute selection which helps to know the most significant and least valuable features among the set of features. Then removal of the least valuable features is done and applies the classification algorithms such as Multilayer perceptron along with Adaboost. Therefore, this outperforms better prediction results into the three class levels such low, medium and high with improved accuracy in order to achieve the quality of education organizations. These prediction results would help to make policy decisions for the administration of educational organizations. The obtained results reveal that the removed feature somehow affects performance of students. Therefore, this study showcases the importance of Prediction and Classification based data mining algorithms with the help of feature selection method in the field of education and also presents some promising future lines.
Keywords: Relief Attribute Selection, Adaboost, Multilayer perceptron, Education mining, Weka tool.

I. INTRODUCTION

Currently, information plays important role for taking decisions. Any organisation can make policy using collected data from various sources such as Medical science, Education, Business, Agriculture and so on. Today, education institutions accumulate and store bulk of data, such as student enrolment and attendances records, as well as their examination results. Furthermore, educational institutions are beginning to use the data analytics for improving the quality of educational environments. One of the primary goals of any educational system is to equip students with the knowledge and skills needed to transition into successful careers within a specified period. How effectively global educational systems meet this goal is a major determinant of both economic and social progress ? The educational system is presently facing several issues such as identifying students need, demonstration of training and predicting quality of student interactions.

This issue led to the emergence of the field of education data mining (EDM). Traditional data mining algorithms cannot be directly applied to education problems, as they may have a specific objective and function. This implies that a pre-processing algorithm has to be enforced first and only the some specific data mining methods can be applied to the problems. Educational data mining (EDM) specify a set of techniques which may have help educational system to overcome this issue in order to enhance learning experience of students and increase their profits.

Manual data analysis has been a difficult task now; it also creates bottle-neck for large data analysis. The large amount of data currently in student databases exceeds the human ability to analyze and extract the most useful information without help from automated analysis techniques. The analysis task requires certain automated analysis techniques in this case; there is a need of data mining. Data mining software allow user to analyze data from different dimensions, categorized it and summarized the relationship, identified during mining process. Educational mining support distinct tools and algorithms for analyze the data patterns. In EM, data is acquired during learning process and then analysis work can be done with the techniques from statistics, machine learning and other data mining concepts. To extract the hidden knowledge from data came from educational system, the various data mining techniques like classification, clustering, rule mining etc. have been discussed for generating better decisions in educational system.[15]

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II. LITERATURE REVIEW

D. Krpan and S. Stankov [1] this paper show practical experience with specific e-learning system and applied data mining technique for the analysis which served as a tool for grouping students with similar characteristics.

S. Lakshmi Prabha and Dr. A.R. Mohamed Shanavas [2] this paper explains how the data mining tasks classification, prediction, and clustering can be applied to data taken from an e-learning system. The performance of sixth grade school students are taken for the analysis and present the results achieved with WEKA tool.

L. Calvet Liñán and Á. Alejandro Juan Pérez [3] in this paper, researchers review the similarities and differences between Educational Data Mining and Learning Analytics, two relatively new and increasingly popular fields of research concerned with the collection, analysis, and interpretation of educational data. Their origins, goals, differences, similarities, time evolution, and challenges are addressed, as are their relationship with Big Data and MOOCs.

A. Satyanarayana and G. Ravichandran [4] this paper presents a hybrid procedure based on ensemble classification and clustering that enables academicians to firstly predict students' academic performance and then place each student in a well-defined cluster for further advising. Additionally, it endows instructors an anticipated estimation of their students' capabilities during team forming and in-class participation. For ensemble classification, use multiple classifiers (Decision Trees-J48, Naïve Bayes and Random Forest) to improve the quality of student data by eliminating noisy instances, and hence improving predictive accuracy. Then use the approach of bootstrap (sampling with replacement) averaging, which consists of running k-means clustering algorithm to convergence of the training data and averaging similar cluster centroids to obtain a single model. The researchers empirically compare technique with other ensemble techniques on real world education datasets. H. Mousal and A. Maghari [5] this paper proposes a students' performance prediction model based on DM classification algorithms (Naïve Bayes, Decision Tree and K-NN). The dataset was collected from a preparatory male school in Gaza strip, includes over 1100 records. Obtained results show that Decision Tree gives the best results. Moreover, the results indicates that social case has little impact on the students' performance, while the academic features such as previous year and first term results have more impacts on the performance. These results can be used in improving students' performance by predication their retention early to minimize students' failure. B. Sachin and S. Vijay [6] this paper surveys the history and applications of data mining techniques in the educational field. The objective is to introduce data mining to traditional educational system, web-based educational system, intelligent tutoring system, and e-learning. This paper describes how to apply the main data mining techniques such as prediction, classification, relationship mining, clustering, and social area networking to educational data. S. Nikam [7] has done the comparative study of classification algorithms. Analysis of classification algorithm says each algorithm has its own merits and demerits and the techniques have to be selected based on the situation. O. Shahiri et al. [8] have done a review on predicting students' performance in data mining techniques and found classification algorithms predicts the performance better than other techniques in data mining and C4.5 is highly used to by the researchers for predicting student's performance. P. Thakar et al. [9], broadly analysed many papers on educational mining which compared the data mining technique predicts student's performance and found the attributes which are highly correlated with the student's performance. S. Agarwal et al. [10] describes the implementation by applying classification algorithms on educational data and found SVM classifier LIBSVM with Radial Basis Kernel has been taken as a best choice for data classification in her studies. S. Kumar and B. Bharadwaj [11] have done comparative analysis on the decision tree classification algorithms and found CART algorithm is classifying the First, Second, Third class and Fail students with high accuracy. Abeer et al. [12] conducted a similar research that mainly focuses on generating classification rules and predicting students' performance in a selected course program based previously recorded students' performance and activities. Abeer and Elaraby processed and analysed previously enrolled students' data in a specific course program across 6 years (2005–10), with multiple attributes collected from the university database. As a result, this study was able to predict, to a certain extent, the students' final grades in the selected course program, as well as, "help the student's to improve the student's performance, to identify those students which needed special attention to reduce failing ration and taking appropriate action at right time". Pandey et al. [13] conducted a data mining research using Naïve Bayes classification to analyse, classify, and predict students as performers or underperformers. The research was able to classify and predict to a certain extent the students' grades in their upcoming year, based on their grades in the previous year. Their findings can be employed to help students in their future education in many ways. Arockiam et al. [14] implemented FP Tree and K-means clustering technique for finding the similarity between urban and rural students programming skills. FP Tree mining was applied to sieve the patterns from the dataset. K-means clustering was used to determine the programming skills of the students. The study clearly indicates that the rural and the urban students differ in their programming skills and found that huge proportions of urban students were good in programming skill compared to rural students. It divulges that academicians provide extra training to urban students in the programming subject.

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III. PROPOSED METHODOLOGY

This section describes the proposed methodology used in this research.

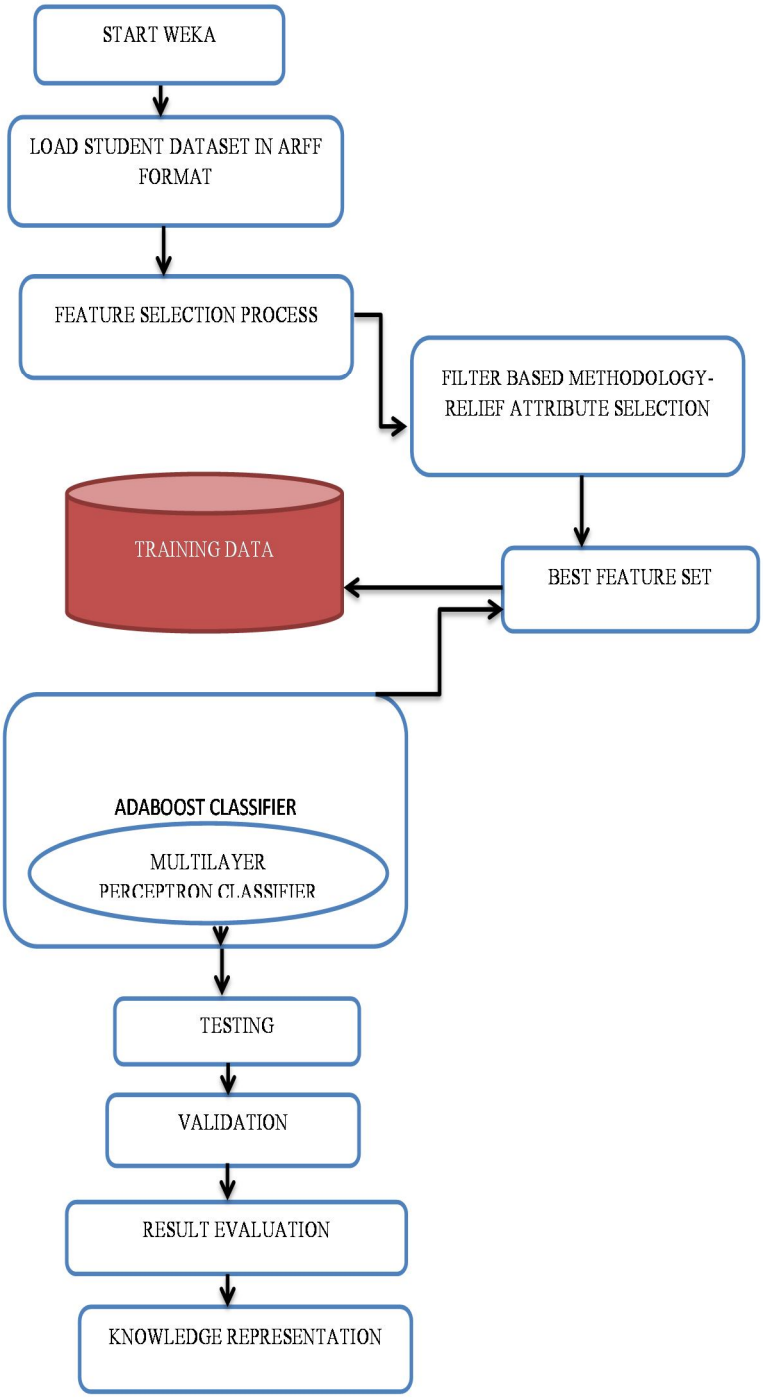

Fig 1 : Block diagram of Proposed Methodology

The dataset used in the experimental work consists of 17 attributes and record of 480 students belongs to the University of Jordan and collected from kaggle.com. The table shown below contains student's features and their description.

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TABLE 1: Student Feature (Attributes) And Their Description

Attribute	Description
Nationality	Student nationality
Gender	The gender of the student (female or male)
Place of birth	Place of birth for the student(Jordan, Kuwait, Iran)
Parent responsible for student	Student's parent as(father or mother)
Educational stages(school level)	Stage student belongs such as (primary, middle and high school levels)
Grade levels	Grade student belongs as(G-01,G-02,G-03,G-04,G-05,G-06,G-06,G-07,G-08,G-09,G-10,G-11,G-12)
Section id	Classroom student belongs to as(A,B,C)
Semester	School year semester as(First or second)
Topic	Course topic as(Math, English ,IT,Arabic,Science)
Student absence days	Student absence days (Above-7, Under-7)
Parent answering survey	Parent is answering the surveys that provided from school or not.
Parent school satisfaction	This feature obtains the degree of satisfaction from school as follow(Good, Bad)
Discussion groups	Student's behaviour during interaction.
Visited resources	
Raised hands on class	
Viewing announcements	

A. Data Pre-Processing

This section will intensively talks about the data pre-processing. Data pre-processing is the step before applying the data mining algorithm, it transforms the original data into a suitable shape to be used by a particular mining algorithm. Data pre-processing includes different tasks as data cleaning feature selection etc.

1) *Feature Selection Using Relief Evaluator:* Feature subset selection is a way for diminishing the attribute space of a feature set. In other words, it is identifying a subset of features by removing irrelevant or redundant features. Relief is a feature selection algorithm for random selection of instances for feature weight calculation is used here. The Relief algorithm was first described by Kira and Rendell as a simple, fast, and effective approach to attribute weighing. The result of the Relief algorithm is a value between −1 and 1 for each attribute, with more positive value indicating more predictive attributes. The value of an attribute is updated iteratively. A sample is selected from the data, and the nearest neighbouring sample that belongs to the same class (nearest hit) and the nearest neighbouring sample that belongs to the opposite class (nearest miss) are identified. A change in attribute value accompanied by a change in class leads up to weighting of the attribute based on the intuition that the attribute change could be responsible for the class change. On the other hand, a change in attribute value accompanied by no change in class leads to down weighting of the attribute based on the observation that the attribute change had no effect on the class.

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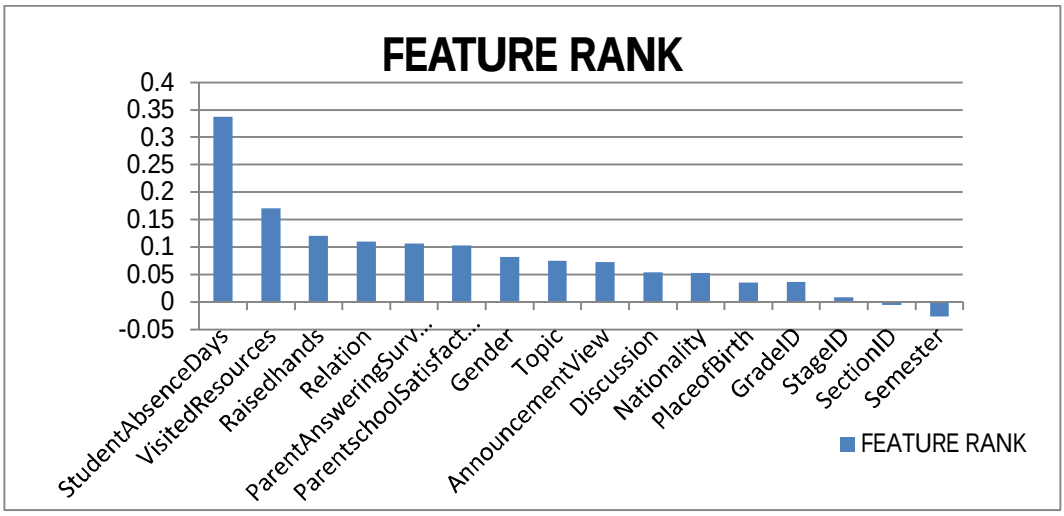

Fig. 2 : Relief Based Feature Selection Evaluation

As shown in Fig. 2, student absence days feature got the higher rank, then followed by visited resources, raised hands, relation, parent answering survey, parent school satisfaction, gender, topic and announcement view, discussion, nationality, place of birth, grade Id stage ID and other features section ID and semester got low rank .As seen in the Fig.. low rank features are excluded and obtained a subset of 15 feature. In summary, the features that are related to student and parent progress during the teaching and learning process got highest ranks which means learner's behaviour during the educational process have an impact on their academic success.`

B. Method used in Education mining

This section defines the classification method used in the experimental work of the research:-

1) *Adaboost :* Boosting belongs to the family of algorithms that are capable of converting weak learners to strong learners. It is an example of dependent ensemble method. The general procedure is to train a set of learners sequentially and combine them for prediction, then focus more on the errors of the previous learner by editing the weights or weak learner. A specific limitation of boosting that is used to solve binary classification problems. The limitation is eliminated with the Adaboost algorithm. Adaboost is an example of boosting algorithm, which stands for Adaptive boost. The make idea behind this algorithm is to pay more attention to patterns that are hard to classify. The amount of attention is measured by a weight that is assigned to every subset in the training set. All the subsets are assigned equal weights. In each iteration, the weights of misclassified instances are increased while the weights or truly classified instances are decreased. Then the Adaboost ensemble combines the learners to generate a strong learner from weak classifiers through a voting process.

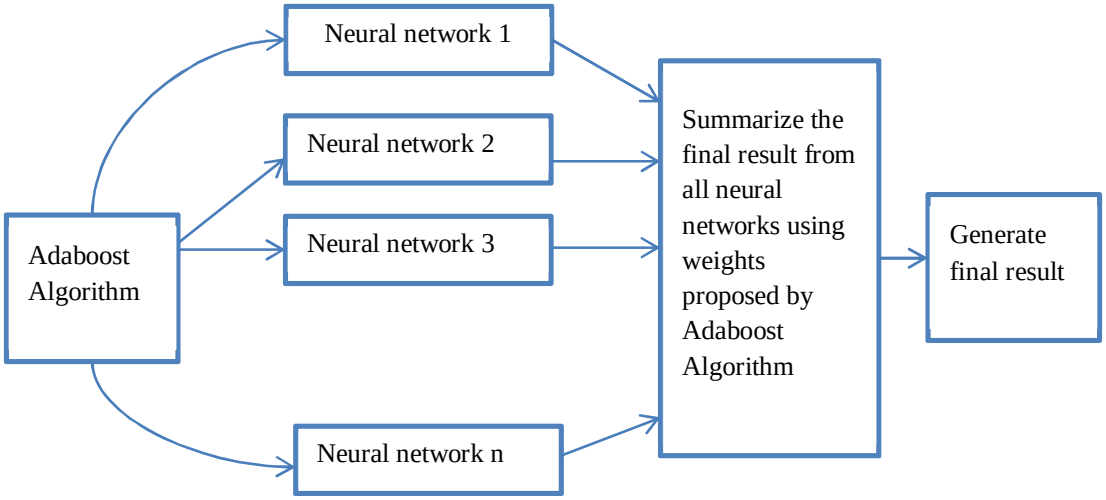

Fig. 3 : Structure of Adaboost

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2) *Multi-Layer Perceptron :* This method of classification is a class of feed forward artificial neural network model known as multi-layer perceptron that maps sets of input data onto a set of appropriate output data. As its name suggests, it consists of multiple layers of nodes in a directed graph, with each layer fully connected to the next one. The schematic architecture of this class of networks, besides having the input and the output layers, also have one or more additional layers also called the hidden layers. The hidden layer that means, the middle layer performs intermediate computation before giving the input layer to output layer.

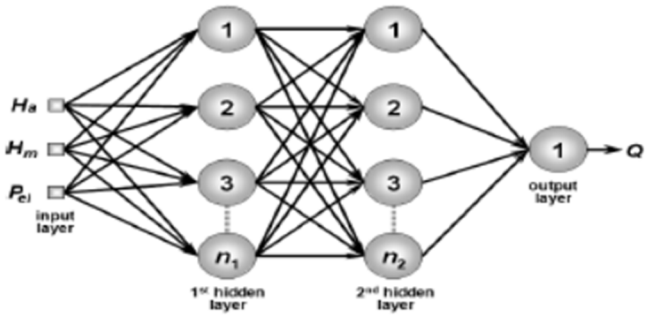

Fig. 4 : Multilayer Perceptron

Algorithm: For Proposed Work

a) Step 1: Start the weka.
b) Step 2: Load x-API-Edu dataset in arff format.
c) Step 3: Apply ReliefF feature selection algo and get output.
d) Step 4: Remove low-valued attribute from dataset and save.
e) Step 5: Load final dataset.
f) Step 6: Choose Adaboost classifier and applied MultiLayer Perceptron classifier.
g) Step 7 : Run the algo.
h) Step 8 : Obtain classification result.
i) Step 9: supply test data.
j) Step 10: Obtain prediction result.

IV. EXPERIMENTAL RESULT ANALYSIS

This section describes the evaluation results of the research and their comparative analysis using different performance measures :-

A. Evaluation Result On Weka Screen

There are various feature used in evaluating student's performances. Based on the modified filter based methodology the result of classification applying Adaboost with ANN is shown in Fig. 4. 80.2% accuracy is achieved as a result of classification and out of 480 records of students 385 students are correctly classified with respect to their class levels (low, Medium and High) and 95 students is incorrectly classified.

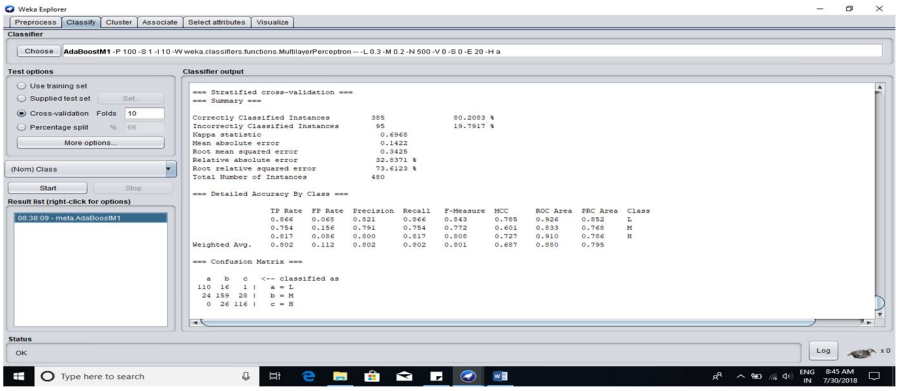

Fig. 5 : Classification Result

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B. Performance Measures

To characterize the effectiveness of the EDM techniques applied in this experiment, we decided to adopt the F-Measure (Han et al., 2011), which is widely used in domains such as information retrieval, machine learning and other domains that involve binary classification. In short, F-Measure (Eq. (1)) is the harmonic mean between Precision (Eq. (2)) and Recall (Eq. (2)), as described below:

$$\text{F-measure} = 2x\frac{\text{Precision}*\text{Recall}}{\text{Precision}+\text{Recall}} \ldots\ldots\ldots (1)$$

$$\text{Precision} = \frac{TP}{FP+TP} \ldots\ldots\ldots (2)$$

$$\text{Recall (TPR)} = \frac{TP}{FN+TP} \ldots\ldots\ldots (3)$$

$$\text{Accuracy} = \frac{TP+TN}{TP+FP+FN+TN} \ldots\ldots\ldots (4)$$

Where:

1) (True Positives - TP) TP is the number of positive instances correctly classified as positive.
2) (False Positives - FP) FP is the number of negative instances incorrectly classified as positive.
3) (False Negatives - FN) FN is the number of positive instances incorrectly classified as negative.
4) (True Negative - TN) TN is the number of negative instances correctly classified as negative.

C. Confusion Matrix

A confusion matrix is a table that is often used to describe the performance of classification model on the set of the test data for which the true values are known. Measures calculate the classification confusion matrix using the following equations 1, 2, 3 and 4 respectively.

TABLE 2 : CONFUSION MATRIX

		Predicted class		
		Low	Medium	High
Actual class	Low	110	16	1
	Medium	24	159	28
	High	0	26	16

Total no. of instances = 480
True positives (TP) =110
True negatives (TN) =229
False positives (FP) =24
False negative (FP) =187

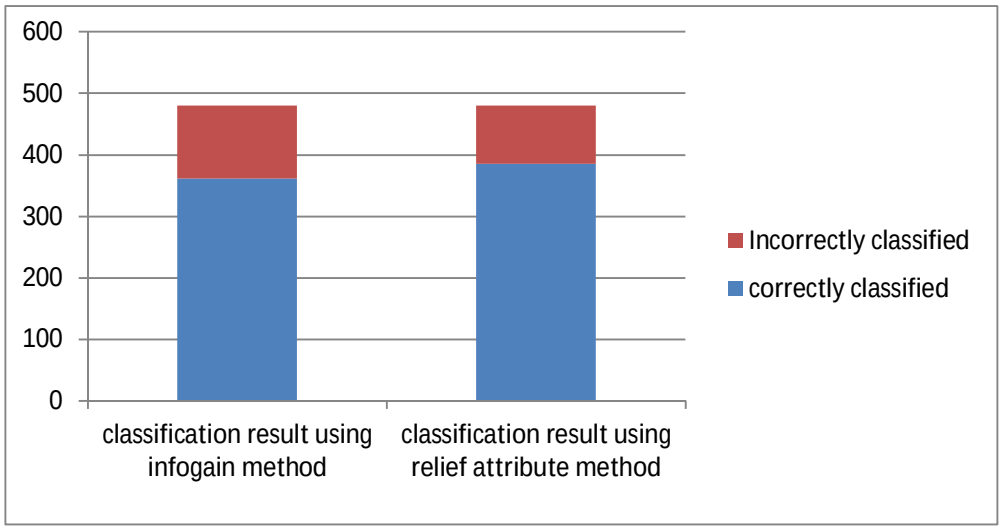

Fig. 6 : Chart Showing Classification Result

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Fig. 6 shows comparison of correctly and incorrectly classified data between existing classification results with information gain attribute selection applied with ranker Method & Proposed classification result with Relief attribute selection with ranker method. In existing classification result, 361 instances are correctly classified and 119 are incorrectly classified. In Proposed classification result, 385 instances are correctly classified and 95 are incorrectly classified.

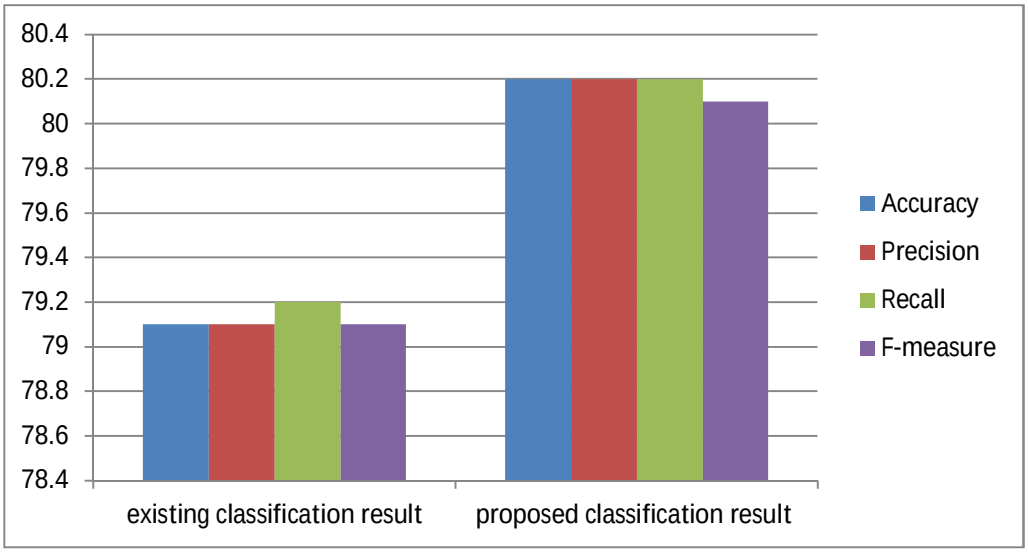

Fig. 7 : Graphical Representation Of Performance Evaluation Measures

Fig. 7 shows comparison of evaluation measures accuracy, precision, recall and f-measure between previous result and current result. For accuracy current result achieved 80.2 accuracy after the removal of irrelevant attributes and 79.1 with attributes. This 80.2 improved accuracy means 385 students out of 480 are correctly classified to the right class levels (high, medium and low) and 95 are incorrectly classified.

For precision current result achieved 80.2 precision after the removal of irrelevant attributes and 79.1 with attributes. This 80.2 improved precision means 385 students out of 480 are correctly classified and 95 are misclassified.

For recall current result achieved 80.2 recall after the removal of irrelevant attributes and 79.2 with attributes. This 80.2 improved recall means 385 students out of 480 are correctly classified to the total no. of unclassified and correctly classified cases.

For f-measure current result achieved 80.1 accuracy after the removal of irrelevant attributes and 79.1 with attributes.

Table 3 : Tabulation Form Of Result Analysis Of Existing Result And Proposed Result

Evaluating Measure	Existing Result	Proposed Result
Classifier Type	ANN(MLP)	ANN(MLP)
Accuracy	79.1	80.2
Precision	79.1	80.2
Recall	79.2	80.2
f-measure	79.1	80.1

.As shown in the table 2, we can notice that ANN model performances with new feature selection method. Proposed results achieved 80.2 accuracy with ANN model using new feature selection process after the removal of irrelevant attributes and 79.1 with attributes. This 80.2 improved accuracy means 385 students out of 480 are correctly classified to the right class levels (high, medium and low) and 95 are incorrectly classified.

For precision measure, results achieved 80.2 precision after the removal of irrelevant attributes and 79.1 with attributes. This 80.2 improved precision means 385 students out of 480 are correctly classified and 95 are misclassified.

For recall measure, results achieved 80.2 recall after the removal of irrelevant attributes and 79.2 with attributes. This 80.2 improved recall means 385 students out of 480 are correctly classified to the total no. of unclassified and correctly classified cases.

For f-measure, result achieved 80.1 accuracy after the removal of irrelevant attributes and 79.1 with attributes.

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The new experiment results prove the strong effect of attribute removal on learner behaviour on students' academic achievement. We get more accurate results with different feature selection process with ensemble method.

V. CONCLUSION AND FUTURE WORK

This study represents analysis of how the use of data mining techniques on educational data can be proved a useful strategic tool for the administration of educational institutions addressing the very ambitious and problematic challenge of enhancing the quality of educational processes. Informed decisions can be made based on knowledge previously unknown and hidden inside the institutional resources. On this basis, decisions can be proved more accurate and correct for the benefit of all stakeholders involved in the educational setting. Furthermore, we presented the results of experiments conducted on educational data, as a first step of the application of data mining technology in the institution. The study results allow us to draw one important conclusion, indicating that the analysis of EDM techniques are sufficiently effective to early identify students' academic failures, and then they are useful to provide educators or teachers with relevant information to help your decisions.

In future work relates to this research area could be utilizing the same dataset; it would be desirable to do more data mining tasks on it, as well as, apply more algorithms. As long as time being, it would be appealing to apply association rules mining to find out interesting rules in the students data. Similarly, clustering would be another data mining task that could be interesting to apply. Moreover, if the data was collected as part of the admission process of the university, that way, it would be easier to collect the data, as well as, the dataset would have been much larger, and the university could run these data mining tasks frequently on their students to find out interesting patterns and maybe improve their performance.

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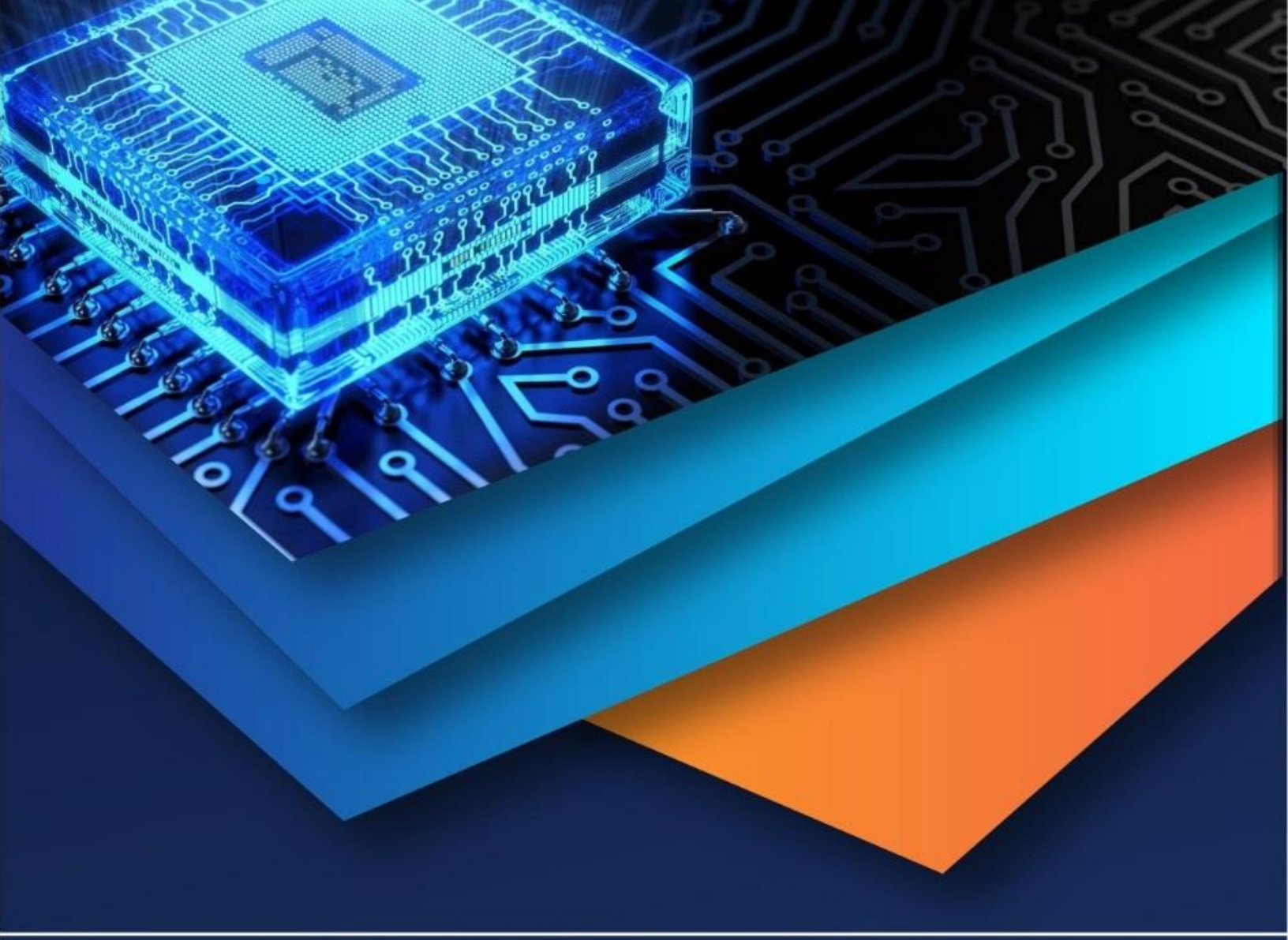

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