



Predicting The Academic Performance Of The Students In Classrooms Using Machine Learning Technique

¹Dr Adilakshamma T

¹ Associate Professor

¹ Master of Computer Applications

¹ Koshys Institute of Management Studies, Autonomous, Bengaluru, Karnataka, India

Abstract

Machine Learning is an important technologically advanced technique, which is run on the characteristics of Artificial Intelligence. Use of Machine Learning has several advantages for different industries. Now-a-days, the benefits of Machine Learning technique are highly prominent in the education sector. Educational institutions are trying to forecast the performance of the students in future semesters or future sessions through the help of technologically advanced applications to enhance academic improvements for all the students in the classrooms. Machine Learning technique is one of those technologically advanced applications, which is helping the professionals of schools or colleges to assess the previous performance of all the students in an error-free and time-effective manner. This Machine Learning technique can manage and control large datasets in quick time period. In addition, chances of errors are also almost zero.

This research work has analysed different Machine Learning techniques and their effectiveness in predicting the performance of the students in a classroom. Different images, graphs, tables, and a flowchart are developed in this research to make understand how machine Learning technique helps in predicting the performance of students in educational institutions. A secondary data collection method is considered in this research work to determine how Machine Learning technique can improve the performance of the students in a classroom depending on the prediction system as this Machine Learning technique significantly helps in predicting the failures of the students and scope for the students in the classrooms.

Keywords: Machine Learning; Artificial Intelligence; Prediction; Performance; Algorithm.

Introduction

In this contemporary era, use of advanced technological applications is evident in the area of education to predict the performance of the students in an institution. Prediction of the performance of the students is an important element in modern Machine learning is considered as one of the imperative technological applications, which allows software applications to become perfect at predicting the outcomes without being clearly programmed to do so. Machine learning designs and develops algorithms, which allows the computers in predicting the behaviours depending on the given data. Now-a-days, education or academic performance of students is difficult to predict manually. Therefore, it has become important to consider technologically advanced applications in the prediction of academic performance of the students. Usually Artificial Intelligence allows the organisations to use software applications to predict the academic performance of the students accurately in time effective manner. Machine Learning is a division of Artificial Intelligence and this Machine Learning technology is widely used in forecasting the academic performance of the students in this contemporary era.

Research Aim and Objectives

Major aim of this research is to understand the efficacy of Machine Learning technology in forecasting the performance of the students in an educational institution in this contemporary. Some objectives related to the research topic are needed to be developed for the purpose of this research. The objectives are:

- To investigate the importance of Machine Learning technology in predicting the performance of students in an educational institution.
- To analyse the efficacy of Machine Learning technology in amending any defect in the performance or activities of the students before he or she fails at the academic level.

Literature Review

Education is known to be the most important element, which facilitates the progress or development of the individuals. Therefore, the educational institutions and professionals of those institutions are highly responsible for offering quality education to the students. Quality education ensures better progress and enhanced skill development of the students ([15]). In this present era of technological advancements, renowned educational institutions are adopting different techniques or methods to improve the skill development process of the students. Prediction of the performance of the students can be considered as one of the important elements, which helps the educational institutions to comprehend the capability of the students in a classroom. In addition, this process of prediction of the performance of the students allows the educational institutions to identify the weaknesses of the students in a classroom. This specific method helps the professionals to understand the scope for improvement of specific students. Now, consideration of manual method in predicting the performance of the students can be time taking and it cannot help in predicting the performance of all the students in a classroom ([12]). Therefore, need for modern technological application in this prediction approach is highly realised. Rather than the consideration of mimic human intelligence, contemporary educational institutions are following technologically advanced artificial intelligence in predicting the performance of all the students in a classroom. Machine Learning is a sub-field of Artificial Intelligence, which is supporting the human beings comprehensively.

Characteristics and Types of Machine Learning

Machine Learning platforms are considered as the most important and technologically advanced operation management tools, which are helping the operation management professionals of different organisations in completing the collection of data, preparation of data, classification of data, model development, training processes, and application deployment processes ([8]). Previously human intelligence techniques were used in the Machine Learning process. Now, the evolution of technology has introduced deep learning method in this Machine Learning technique to enhance comprehensive prediction of the performance of the students in an educational institution.

It is already discussed that the data scientists and professionals previously used different kinds of human intelligence techniques to forecast the performance of students in an educational institutes. These are generally time taking approaches. In addition, such approaches are also associated with different drawbacks. The software development scientists have continuously tried to capitalise on the opportunities created by technological evolution. Deep learning system is an example of modern Machine Learning technique. This takes limited time compared to the traditional methods ([10]). In addition, consideration of these technologically advanced Machine Learning techniques also has minimum possibilities of errors.

The Machine Learning technique is also associated with different kinds of important artificial intelligence subfields, such as natural language processing, deep learning, and neural networks. Natural language processing is a section of machine learning that allows the machines to understand the natural languages spoken as well as written by the human beings. On the other hand, neural networks are generally used in the specific Machine Learning algorithms. Basically Artificial Neural Networks are designed on the human brains in which millions of processing nodes are organised into layers. These nodes are also interconnected in the system ([9]). Unlike these two techniques, deep learning system is developed of several neural networks with multiple layers.

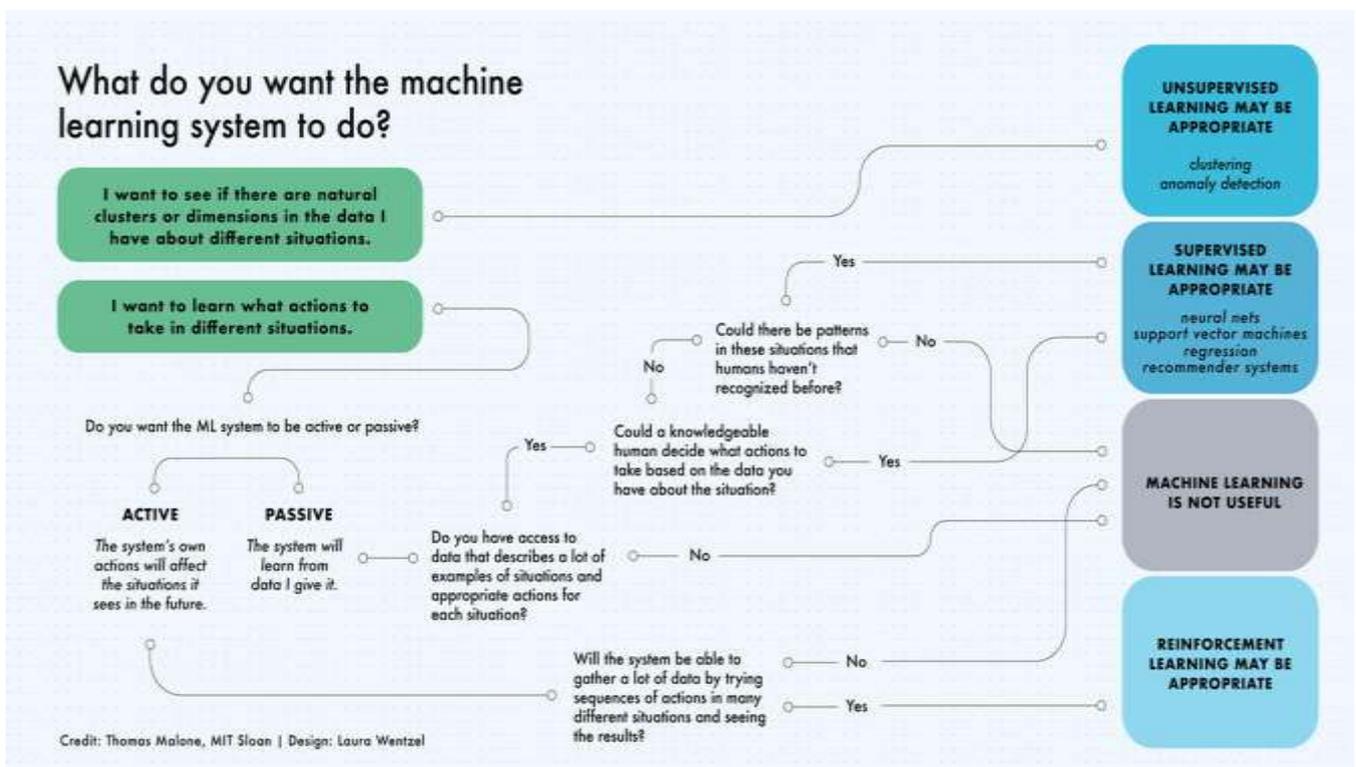


Figure 1: Types of Machine Learning Technique

(Source: [3])

There are different kinds of Machine Learning methods, such as supervised learning, unsupervised learning, semi-supervised learning, and reinforcement learning. In supervised learning, the data scientists usually consider the algorithms with labelled training information. In this Machine Learning technique, the data scientists usually define the variables for assessing the correlations. In unsupervised learning, the data scientists usually consider the algorithms with unlabelled information. In semi-supervised learning method, the data scientists consider algorithm with both labelled and unlabelled information ([4]). In reinforcement learning technique, the data scientists consider reinforcement learning to allow the machines in completing a multi-step process.

Prediction System Steps in Machine Learning

Machine Learning technique helps the users to predict some authentic outputs from a given dataset. This prediction system of machine Learning Technique is completed through some important steps. These important steps are discussed below.

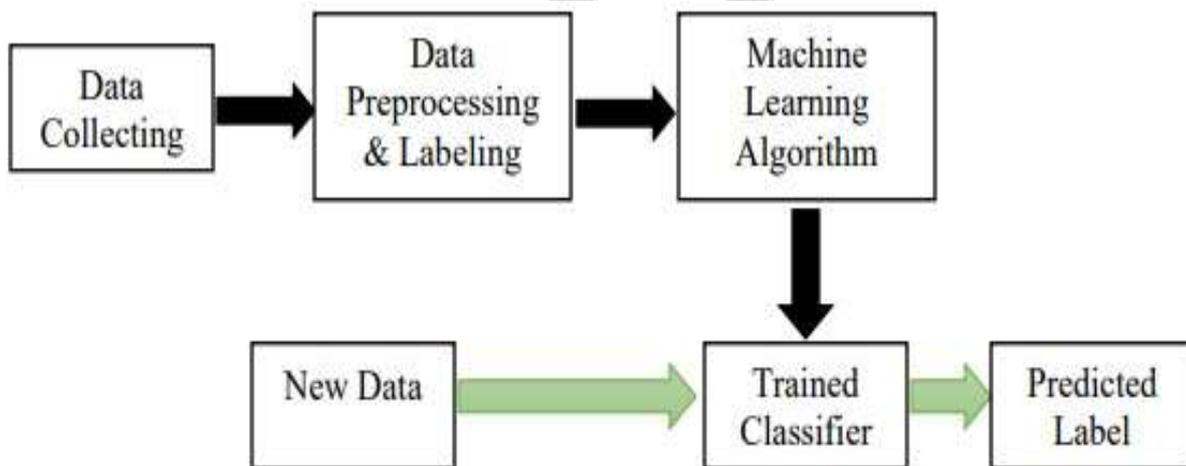


Figure 2: Steps of Prediction System in Machine Learning

(Source: [2])

The first step of this Machine Learning technique is data collecting. Generally, the users collect relevant data by conducting a survey process. Data processing and labelling is the second step of this Machine Learning Technique. In this case, the collected data through the survey procedure are significantly processed in order to obtain a normalise data set ([11]). After obtaining the dataset, the professionals usually label the data rows accordingly. Machine Learning Algorithm is the third step. In this step, the outcome of the second step is fed to the particular Machine Learning algorithm. The fourth step is trained classifier. In this step, some necessary new inputs can be obtained ([7]). This decision is made by the users depending on the demands of the situation. After completion of all of these four steps, the users finally complete this prediction system in Machine Learning technique by predicting the labels.

Academic performance of the students in educational institutions is strongly dependent on the past performance of the students. Use of different kinds of Machine Learning techniques also helps in investigating the past performance of the students in an appropriate way. The example of neural network technique can be considered here, which is used by the data scientists to investigate the previous performance of the staffs. Gradually, Machine Learning has become an effective tool in the academia. However, it is also important to accept that the use of Machine Learning technique can have several kinds of associated challenges. In order to overcome these challenges, it is important for the data scientists to go through appropriate training and reviewing process to overcome the possible challenges in the prediction system ([5]). Apart from the prediction of the performance of students, consideration of Machine Learning technique also helps in scheduling better methods for improving the academic activities of those students.

Research Methodology and Data Collection

Research methodology helps a researcher to explain his or her intentions to conduct a particular research. Research methodology can be divided into two types. One is quantitative research method and the other is qualitative research method. Researchers consider one among these two methods depending on his or her intentions as well as the characteristics of the research work. In qualitative method, feelings, emotions, views, and perceptions of other individuals are considered to conduct a research. In this method, individual knowledge of the researchers is applied. In quantitative method, numerical numbers, figures, and statistics are considered by the researchers. This particular research will investigate the effectiveness of Machine Learning technique in predicting the performance level of the staffs. Now, Machine Learning technique works on the characteristics of Artificial Intelligence as it is a branch of Artificial Intelligence. This Machine Learning technique works on information science technology and deals with different datasets to predict the performance of students. The number of conductions of investigations on the usefulness of Machine Learning Technique in academic sector in the previous research articles is very limited. Therefore, consideration of the quantitative methodology will be ideal for this research work as it will help the researcher to adopt scientific method in determining the actual role of Machine Learning Technique in predicting the academic performance of the students in the classroom. This quantitative method will ensure authentic research outcome, which will help somehow help in closing the research gaps.

Data Collection

Data collection method is also an essential part of any research work. Collection of authentic and appropriate data related to research topic helps the researchers to carry out the research in an appropriate way. There are two kinds of data collection techniques. One is primary data collection method and the other is secondary data collection method. The researchers consider one among these data collection methods depending on the situations. In primary data collection method, researchers gather live and raw information through field works like surveys, interviews or questionnaires. The result of the primary data collection process is authentic in nature. It is one of his advantages. However, it is a time taking approach and can create problems for the researchers during close deadlines. In secondary data collection method, researchers collect ready-to-use data from existing data sources. Authentication of data can be considered as a challenge for the researchers in the secondary data collection method. However, it is time-effective and cost-effective approach for the researchers compared to the primary data collection method. The deadline of this assignment is very close. Therefore, it will be justified for the researcher to consider secondary data collection method. Availability of valuable data presented by expert researchers and authors in this field on this particular research topic is more than sufficient. Different kinds of authentic international or longitudinal analysis of secondary data are also available as data sets, which will significantly help in

achieving the research objectives. In addition, unforeseen discovery can be made through this secondary data collection method as researchers can collect huge amount of data keeping the fact in mind that Machine Learning Technique plays an important role in predicting the performance levels of the students in the classroom. These points easily justify the selection of secondary data collection method.

Authentic websites and relevant scholarly journal articles are considered in this research as the sources of secondary data. The collected data are relevant to the research topic. Most importantly, the selected sources of the secondary data are not older than five years. Hence, the collected information is relevant and very much new. Therefore, ethical angles are also considered in the data collection method.

Research Analysis and Findings

Machine Learning technique helps the data scientists or the professionals in educational institutions to investigate the previous performance of a large number of students. Based on this investigation, this technological tool helps in predicting the performance level of the students in upcoming semesters. Now, a dataset of the students of a university can be considered. For example, a Deep Neural Network under the Machine Learning technique has been used here. A dataset of 400 university students has been considered in this research analysis in which Kalboard 360 System has been considered. This system has 10 different features.

Table 1: Use of Deep Neural Network as Machine Learning Technique

Name	Type of Data	Distinct Values
Nationality	Nominal	16
Gender	Nominal	2
Section ID	Nominal	4
Grades	Nominal	14
Semester	Nominal	3
Raised Hands	Nominal	0-100
Parent Answering	Nominal	3
Parent Satisfaction	Nominal	3
Absent Day for Students	Nominal	3
Visiting of Resources	Nominal	0-100

The above dataset has three classes depending on the numerical interval values. Now, a table of classes on interval values as well as class label can be considered below.

Table 2: Classes on Interval-Values and Class-Label

Classes	
Interval Values	Class Label
0-59	Low
60-79	Medium
80-100	High

The above tables are developed basis on the use of Deep Neural Network of Machine Learning. Now, the pre-processing of data after the overall data collection method needs to be improved. The data scientists or the users can improve this pre-processing by improving the quality of the datasets. The users or the data scientists need to ensure that the data attribute, section of data, cleaning of data, transformation of data, and reduction of data are done by maintaining effective quality. The above table indicates that three labels of class set and three segments of interval values are decided. Based on these class labels and interval values, the performance of the selected 400 students will be promoted predicted by the users of the institution.

Now, Random Forest Algorithm has been applied below to determine how Machine Learning Technique is used in predicting the performance of the students in a classroom.

Table 3: Table for Random Forest Algorithm (First)

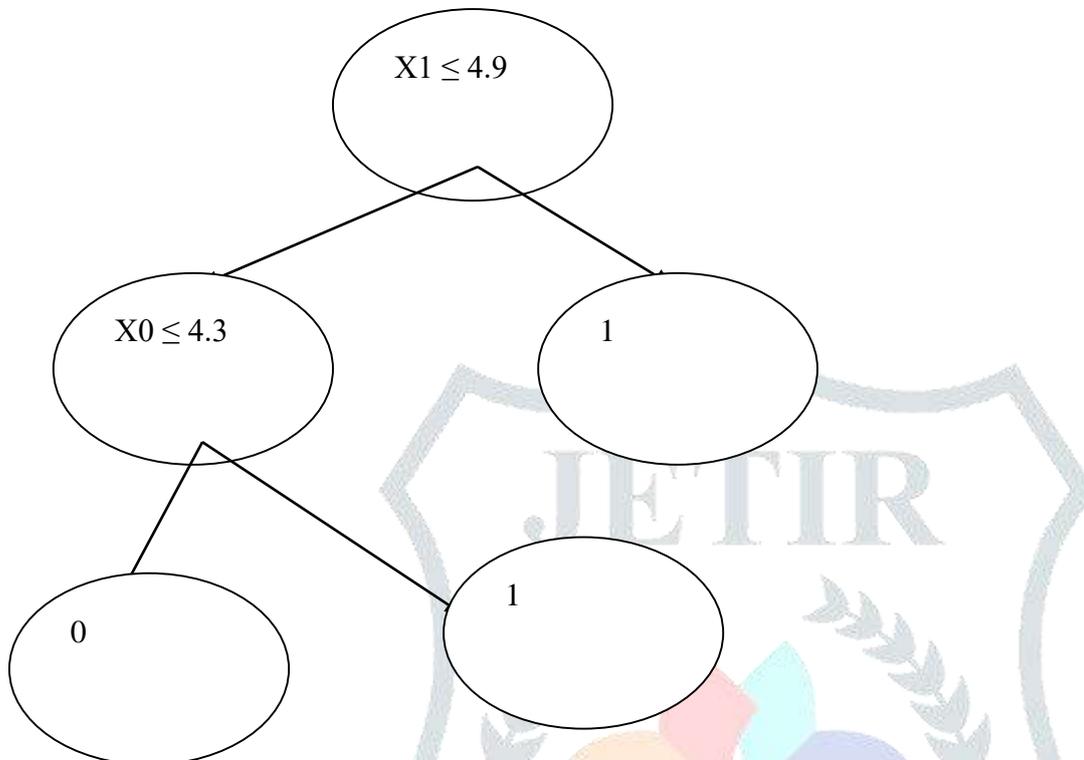
Id	X0	X1	X2	X3	X4	y
0	4.3	4.9	4.1	4.7	5.5	0
1	3.9	6.1	5.9	5.5	5.9	0
2	2.7	4.8	4.1	5.0	5.6	0
3	6.6	4.4	4.5	3.9	5.9	1
4	6.5	2.9	4.7	4.6	6.1	1
5	2.7	6.7	4.2	5.3	4.8	1

Table 4: Table for Random Forest Algorithm (Second)

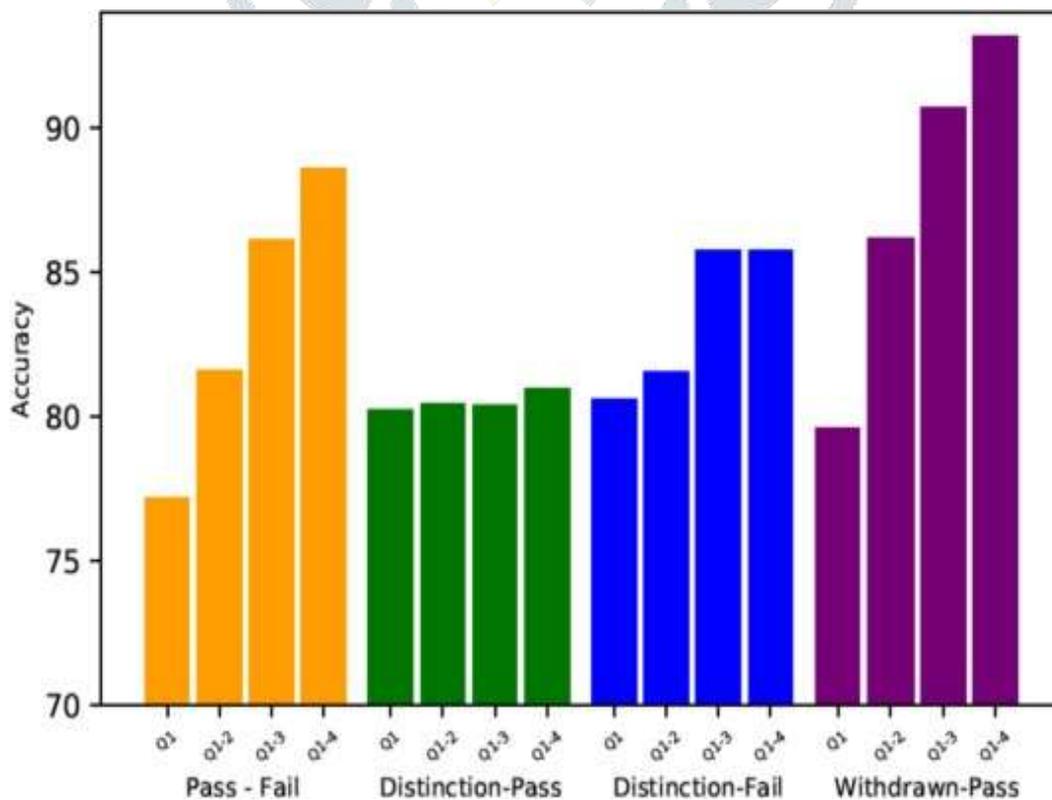
Id (X0-X1)	Id (X2-X3)	Id (X2-X4)	Id (X1-X3)
2	2	4	3
0	1	1	3
2	3	3	2
4	1	0	5

5	4	0	1
5	4	2	2

The algorithm flowchart is developed below based on the above tabular figure.



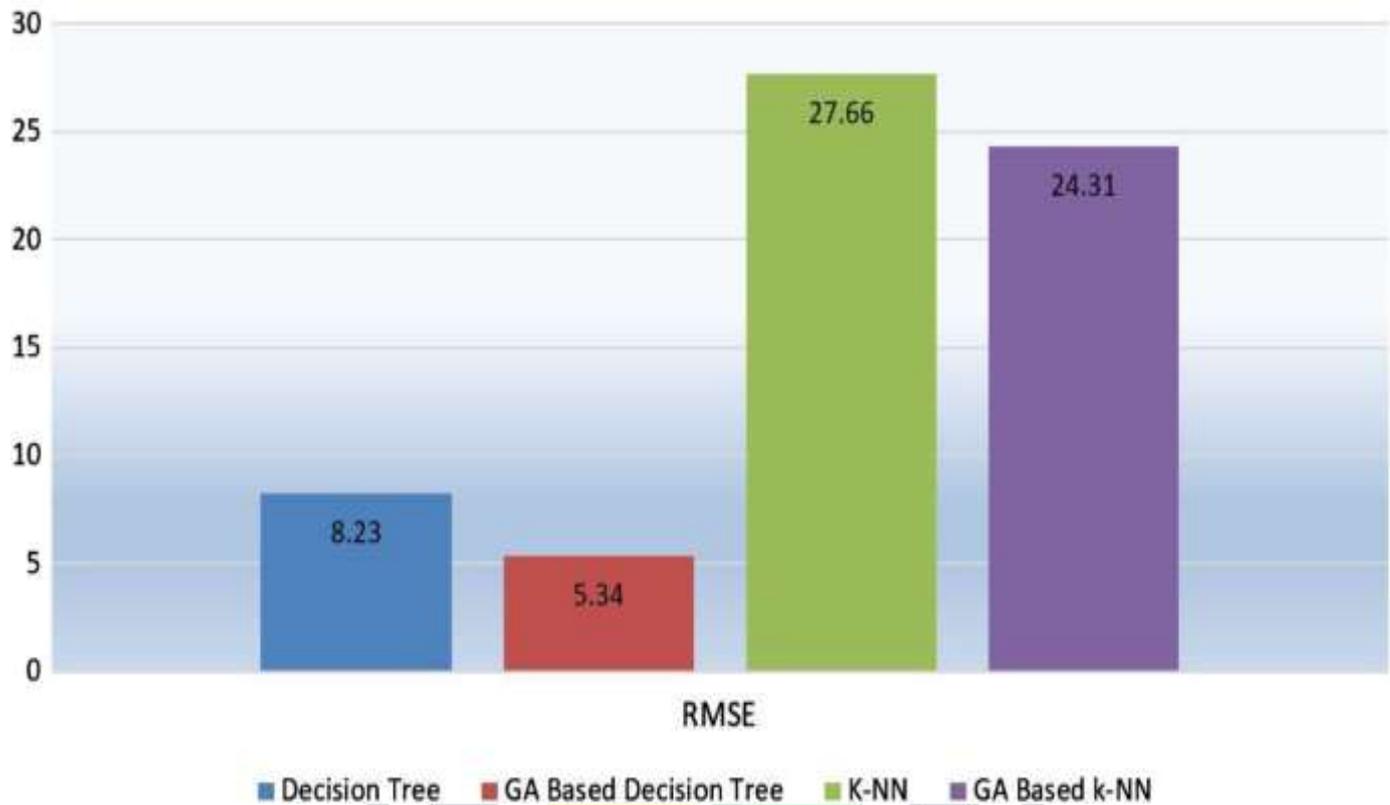
Now, it is also important here to express that consideration of graph algorithm helps in improving the efficacy of the Machine Learning Technique. The below graphical image will demonstrate how the professionals or the data scientists predict the performance of the students in a particular year.



Graph 1: Graphical Prediction of Performance of Students (Source: [13])

The above graphical representation easily indicates how the Machine Learning technique can help the data scientists or the professionals of the institutions to predict how many students pass with different grades and how many students will fail in the year. In this technique, previous performances of the students are considered.

R.M.S.E of Marks-Prediction System

**Graph 2: Different Attributes of Machine Learning Technique in Prediction System**

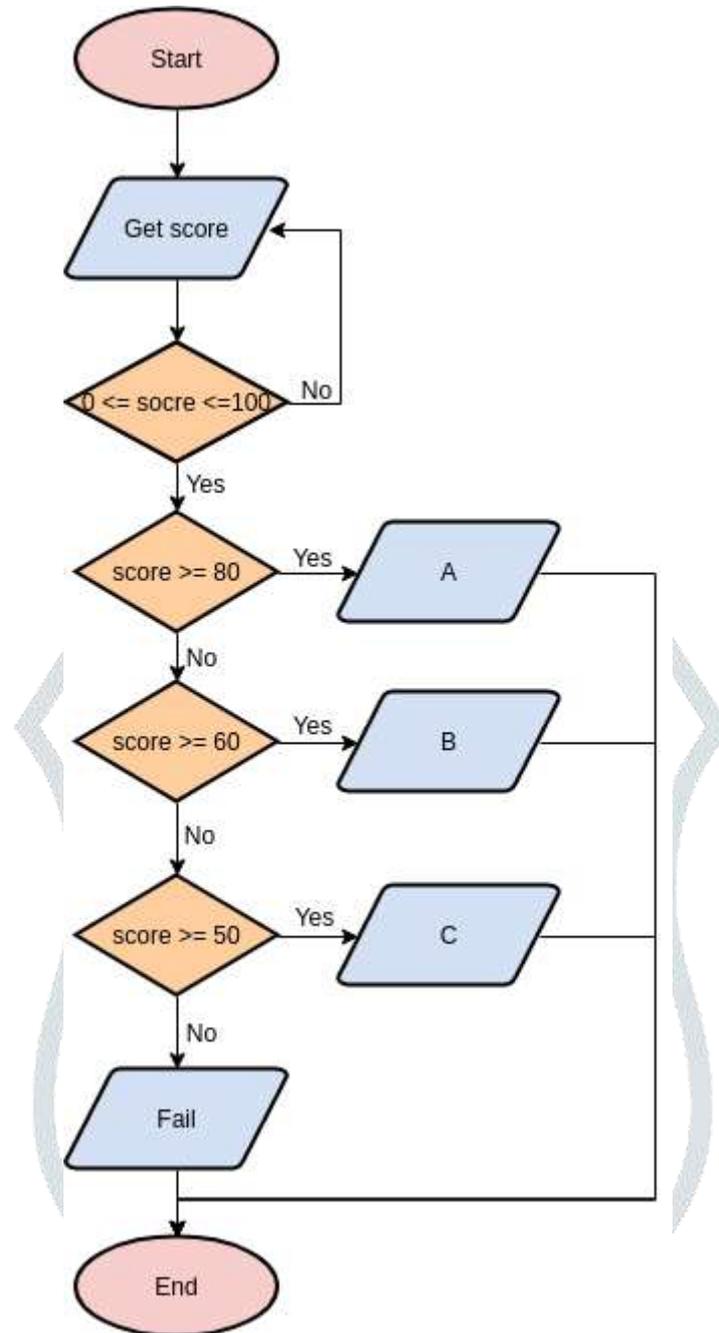
(Source: [6]).

Datasets with different kinds of attributes are considered. In order to predict the performance of the students out of those datasets, different methods of Machine Learning are considered. This prediction process is a time effective process in which the professionals can predict the performance of the students in a time-effective way.

Findings

It is already identified from the analysis part that the Machine Learning technique is generally used in the educational institutions to predict the performance of the students inside the classroom in an entire year. In this prediction process, the data scientists or the professionals generally consider the trends of previous performance of the students ([1]). Basis on the evaluation of the previous performance of the students, the professionals can become successful in improving the future results or the future performance of the professionals. Depending on the evaluation of the previous performance, the professionals can identify the weaknesses of the students. Through this Machine Learning technique, teachers or professors can overcome those weaknesses of

the students. As a result, the performance of the students can be improved in a positive way.



Flowchart 1: Algorithm on Use of Machine Learning

(Source: [14])

The above flowchart is an example of the Machine Learning algorithm, which has predicted the performance of the students in a year. According to the algorithm flowchart, the professionals of the educational institutions have predicted that no student will fail in the class in the upcoming exam. It is also identified that there will be students who will score more than 80. In addition, it is also clear from the prediction that there are student will score more than 60 but less than 80. On the other hand, it is also clear from the algorithm flowchart that there are students who will score more than 50 but less than 60. This flowchart prediction will significantly help the professionals or the teachers to find out the drawbacks of all the students who may score less than 60 and less than 80. As a result, such predictions through the use of Machine Learning technique will significantly assist in improving the performance of the students inside the classroom.

Limitations and Overcome

Lack of quality data can affect the performance of machine learning technique. It is an important limitation. In addition, lack of skilled human resources as well as technical resources also may hamper the performance of machine learning technique. Last but

not the least; poor infrastructure and implication plan can affect the performance of the applied machine learning technique. In order to overcome these problems, following plans need to be considered.

First of all, it is important to ensure the access to the quality data sets. Secondly, effective training sessions should be organised for the employees to apply the Machine Learning Technique. Lastly, it is also important to develop a quality and high-standard infrastructure that can support the application of the technologically advanced Machine Learning Technique.

Conclusion

Artificial Intelligence helps in using software applications to predict the academic performance of the students in an efficient effective manner. Machine Learning is a branch of Artificial Intelligence. This Machine Learning technology is significantly used in the prediction of the academic performance of the students. Instead of considering mimic human intelligence, modern educational institutions are following technologically advanced artificial intelligence in the prediction of the performance of all the students in a classroom. Machine Learning is a sub-section of Artificial Intelligence, which is backing the users comprehensively. Improvement in the academic performance of the students in educational institutions is strongly dependent on the evaluation of the past performance of the students. Use of different Machine Learning techniques helps in investigating the past performance of the students in an appropriate way.

Machine Learning has become an effective educational tool for the professionals in the academic sector. In this prediction process, the data management professionals usually consider the trends of performance of the students in the previous semesters or sessions. Basis on the analysis of these previous performances of the students, the professionals can become successful in improving the future performance of the professionals. Depending on the assessment of the previous performance, the data management experts can identify the weaknesses of all the students. Through different Machine Learning techniques, teachers or professors can overcome the weaknesses of all the students. As a result, the performance of the all the students in a particular classroom can be improved in an effective way.

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