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Predicting Students Adaptability Levels in Online Classes

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Abstract: *The shift in the education sector in which learning was being done in the traditional classroom setting to digital platforms has also changed the academic world greatly. Online education is flexible, accessible and convenient in that, students will be able to continue learning despite geographical barriers. Nonetheless, the success of online learning mostly relies on the capacity of learners to adjust to online learning conditions. Poor access to technology, unreliable internet connectivity, technical incompetence, and a tendency to lose motivation when attending online classes are among some of the challenges confronting many students. These are some of the factors that affect their participation in virtual learning environments. In this study, it is proposed to propose a machine learning-based system that predicts the level of adaptability of a student to online education. The level of adaptability is categorized into three namely Low, moderate, and High. The demographic and socioeconomic variables used by the model to come up with predictions are age, sex, level of education, type of institution, financial status, connectivity to the internet, and availability of devices. To identify the best machine learning algorithm in terms of predicting the levels of adaptability, different machine learning algorithms, such as Logistic Regression, Decision Tree, Support Vector Machine, and Random Forest, were tested. The best of these algorithms was the Random Forest classifier with an accuracy of around 89% and so it was the most appropriate in this case. The given system has been implemented as a web-based application with Flask as a backend and a responsive HTML/CSS interface to make interaction with the users. The system will allow an educator or an administrator to enter the student data and get real time predictions of adaptability. The findings of this study confirm that machine learning methods can be efficiently used to reveal learners who have difficulty in online learning conditions. These predictions will be able to help educational institutions to offer early assistance and enhance the general performance of digital education.*

Keywords: *education sector*

I. INTRODUCTION

The development of digital technologies and accessibility of the internet have transformed most sectors including education. Over the past few years, institutions of higher learning have been embracing internet based learning platforms in an effort to provide academic content. Online classes, video teachings, digital work and online testing are all becoming part and parcel of these contemporary systems of education. Online education has numerous benefits, but also it poses new difficulties to students. Unlike in the traditional classroom learning where students interact with the teachers and classmates in real sense, online learning enforces students to manage their time efficiently, maintain self discipline and be technology dependent. Such demands might be an obstacle to certain students, especially those who do not have the proper technological access or who are not familiar with digital learning systems. Flexibility of students is very important in the success of online learning. Adaptability is a faculty enabling the students to change their learning behavior, the use of technology, and the patterns of learning to adapt to the needs of online learning. Those students who adjust well to

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online learning are also likely to be active, finish their assignments in time, and have improved academic results. Conversely, lowly adaptive students can have problems with course material comprehension, interaction with lecturers, or regular participation. Educators and institutions should identify students who have problems adjusting to online learning environments. Early detection enables teachers to carry out facilitating interventions like offering technical education, offering more scholarly support, or enhancing internet infrastructure. Machine learning methods offer effective means of processing vast amounts of data and identifying trends that may be used in predicting actions and academic performance of students. Using the machine learning algorithms on the data related to students, one will be able to predict the level of adaptability and identify particular students who might need further assistance. The major aim of the research is to come up with a prediction system using machine learning that is able to identify the student adaptability level in online learning. Through demographic and socioeconomic analysis, the system can give the right predictions, which can guide the educators to work on the teaching strategies and to advance thelearning process in general.

Fig:1 Introduction to adaptability learning

II. RELATED WORK

The issue of data analytics and machine learning in relation to educational settings has been previously examined by a number of researchers who are interested in enhancing student performance and engagement. Educational data mining has emerged as a key research field, which is dedicated to useful knowledge extraction in educational datasets. The use of classification algorithms to predict the academic performance of students in online courses has been studied before. Decision Trees and Naive Bayes algorithms, among others like Support Vector Machines, have been extensively utilized in the examination of factors that impact on the learning performance of students. These works prove that machine learning models are quite effective at detecting trends concerning student success and learning challenges. Other scholars have been interested in forecasting the rates of student dropouts within the online learning forums. Such variables are examined in these studies including the records of attendance, patterns of submission of assignments, and the degree of interactions with online learning systems. The use of ensemble learning approaches, such as Random Forest and Gradient Boosting, has proven to be promising since they can deal with complex data and minimize the error of prediction. Other studies have also investigated how socioeconomic and technological issues influence the online education participation of students. Research shows that students who are securely connected to the internet, have good equipment and are in conducive environments to study are able to achieve better in online learning systems. Even with these developments, the literature on how to forecast the level of flexibility of the students to online education within the demographic and socioeconomic factors has been minimal. Most of the current works focus on the academic performance and not on the ability to adapt to online learning atmosphere. The study will fill this gap through the development of a predictive system that will assess the adaptation capabilities of students to online learning environments.

III. BACKGROUND AND PURPOSE

Online education has become a part of the contemporary school system. Schools have extensively depended on the technological platforms to teach their students, to administer tests, and communication between students and teachers. But the success of these platforms is determined by whether the students will be able to adjust to the technological and behavioral requirements of online studies. Adaptability to online learning entails a variety of elements, such as navigation

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in the digital learning environments, accessibility to educational materials online, control of study time on an individual basis, and socializing in the virtual learning world. All students with a high adaptability skill find it easy to go through the traditional learning methods to the digital arena.Nonetheless, there are numerous barriers which limit adaptability among students. As an illustration, financially disadvantaged students might not be able to afford the services of a stable internet or have an appropriate device to attend online classes.In the same way, students who lack familiarity with digital technology might also face problems with access to learning management systems or the ability to engage in online discussion.It is imperative to understand what factors affect adaptability to enhance quality of online education. Learning institutions should have dependable ways of determining the students who are in need of extra assistance. With the assistance of machine learning models to predict the degree of adaptability, institutions will be able to make sound decisions about how to allocate resources, counsel students, and offer them academic support options. This research aims at designing and instituting a predictive system to assess student adaptability to online education on the basis of demographic and socioeconomic characteristics. The system will give precise forecasts that may guide the educators in pinpointing students that might not be at ease in digital learning platforms.

IV. PROPOSED METHODOLOGY

The suggested methodology is systematic in the construction and deployment of a machine learning-based prediction model. Overall process consists of collection of data, preprocessing, training of the model, evaluation and deployment of systems. First, a dataset with the information on the students and their conditions of learning was gathered. Age, Gender, education level, type of institution, financial condition, internet connectivity and device usage are some of the attribute in the dataset. These features are significant determinants that affect the capability of a student to engage in online learning. After the acquisition of the dataset, a data preprocessing phase was carried out so that the quality and consistency of the data could be achieved. The values were also missing, and their absence was recognized and managed. Encoding techniques were used to convert categorical variables into numerical values to enable the machine learning algorithms to work on them. The dataset was preprocessed then it was split into training and testing parts. Training dataset was applied to the training of various machine learning models and a testing dataset was applied to test the performance of the models.

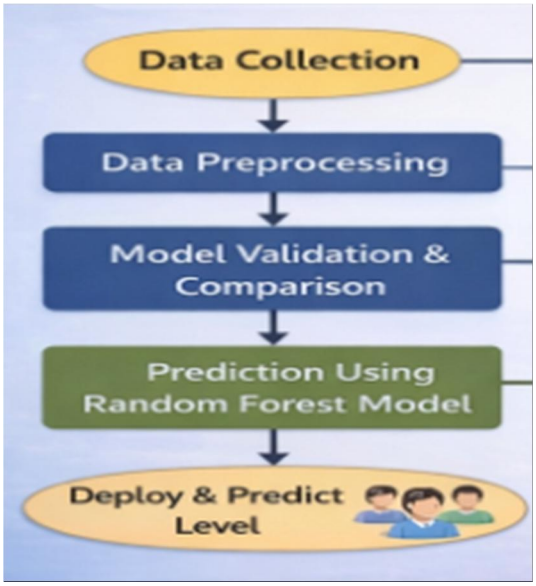

Fig:2 Proposed Methodology

The implementation of several classification algorithms has been done, namely; Logistic Regression, Decision Tree, Support Vector Machine, and Random Forest. The algorithms were trained and tested using the performance metrics of accuracy, precision, recall, and F1-score. Random Forest model showed better performance in comparison to the other models. Random Forest is an ensemble learning algorithm, which is a combination of several decision trees in order to

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obtain more reliable and consistent predictions. It had the best prediction accuracy of about 89 per cent because of its capability of reducing overfitting and its capability to work with complex datasets. The selected high-performing model was then embedded in an online application with the use of the trained Random Forest classifier. The application back-end was created with the help of the Flask framework, which allows connecting the machine learning model and the user interface. Frontend was developed with the help of HTML and CSS to establish a lightweight and responsive interface in which the user can input the attributes of the students and get the predictions of the adaptability in real time.

V. SYSTEM ARCHITECTURE

The suggested system architecture will help to efficiently gather information about students, run it through a machine learning model and make predictions of adaptability via a web-based interface. The architecture is composed of a number of interrelated parts, which collaborate to accomplish data processing, model prediction, and result visualization. The user interface layer is the first constituent of the system and it will enable the educators or administrators to communicate with the system. This interface is created on the basis of HTML and CSS and is offered as a simple form in which the user is supposed to input information about the student like the age, gender, level of education, financial status, type of internet, and the presence of the device. The interface should be user friendly and responsive to enable predictions to be made fast without necessarily having to be technical. The second element is the Flask server which is the communication interface between the user interface and the machine learning model. After the user key-in the student data using the web form, the data is forwarded to the Flask server to be processed. The backend server does input validation and transforms the data to the format necessary to the trained machine learning model. The third one is the machine learning prediction module. The trained Random Forest classifier is contained in this module and had been developed in the model training phase. After the Flask server receives the input data, the data is sent to the prediction module where the trained model processes the features and identifies the category of adaptability of the student. The model gives three possible results, which are Low Adaptability, Moderate Adaptability and High Adaptability. The second critical element is the data preprocessing module that will make sure the input data is correctly encoded, and formatted in a manner that it can be processed by the model. Categorical attributes like gender, education level and type of device are encoded with the help of machine learning algorithms, since their input needs to be in the form of numbers. Lastly, the prediction output module passes the results to the user interface. There is a prediction of the level of adaptability that is presented to the user and a short explanation of the outcome. This will help teachers to quickly figure out whether the student needs extra help in studying online. The modular architecture makes the system scalable and easily extendable in future to support other features like tracking the performance of students, recommendation system or the ability to connect the system to educational databases.

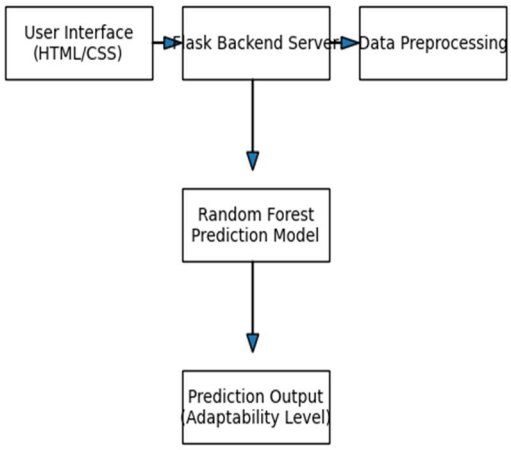

Fig:3 System Architecture

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VI. ADVANTAGES

The suggested system of predicting the adaptability based on the machine learning has a number of benefits that render it helpful to educational facilities and teachers. Early detection of students who might have problems with online education is one of the major benefits. Foreseeing the level of adaptability, institutions will be able to anticipate the needs of students that will struggle with digital learning settings. The use of data-driven decision making is also another advantage. Predictive analytics can help educators to determine patterns and trends in the behavior of students instead of relying on subjective observations alone. Another feature of the system is a high level of prediction accuracy, which is achieved with the help of the Random Forest algorithm. By using ensemble learning techniques like the Random Forest, several decision trees are used to enhance better prediction and minimize errors. Moreover, it has a user-friendly interface and is available via a web interface.

Fig:4 Algorithm Selection

The application is user friendly and does not require high level of technical skills of the educators hence making it applicable in the real world educational setting. The suggested solution can also be scaled and flexible, with more features or data attributes being added to the system in the future.

VII. LIMITATIONS

Despite the excellent outcomes of the proposed system, some limitations have to be recognized. The reliance on the quality and size of the dataset is one of the shortcomings. Unless there is complete and unbiased information in the dataset, the predictions of the model might not be a true indication of actual student behavior in the real world. The other limitation is that the model takes into account a minimal number of factors including demographic and socioeconomic attributes. Nonetheless, flexibility to online learning also can be determined by psychological parameters, the level of motivation, and learning styles, academic background, which are not provided in the present dataset. Also, the system presupposes the accuracy of the input data that users can give. Wrong or unsuitable data entries can have consequences on the reliability of prediction. Lastly, the model might need to be retrained on a regular basis as the education environment and technological circumstances change with time.

VIII. FUTURE WORK

The proposed system can be improved in functionality and accuracy in future. The first potential direction is the incorporation of more behavioral and academic elements like attendance data, pattern of submitting assignments, and the interaction of the students on online sites. The other way in which it can be improved is by incorporating deep learning or advanced ensemble models in order to further maximize the accuracy of prediction and to be able to capture more

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complex relationships in the data. Real-time educational analytics may also be added to the system, which involves the automated collection and analysis of data related to learning management systems (LMS) used to develop predictions regarding the adaptability. Moreover, a recommendation module might be created and it may give individualized recommendations to the students depending on the predicted adaptability. As an example, the low-adaptability students may be offered time management or technical preparation recommendations, or even the extra academic support. The other possible enhancement is making the system available as a mobile application, so the educators and administrators could retrieve the predictions and analytics on smartphones or tablets. Results and Discussion To test the efficacy of the proposed system, several machine learning algorithms were implemented and compared in terms of their accuracy in prediction. To achieve credible assessment of the dataset, it was separated into training and testing sets. A number of classification models were tried which comprised of Logistic Regression, Decision Tree, Support Vector Machine and the Random Forest. All the models were trained on the same dataset and performance measured based on standard measures. Random Forest classifier has shown best results as it had highest prediction accuracy rate compared to the algorithms tested. It had an ensemble form that enabled it to store elaborate associations among the input characteristics and flexibility degrees.

IX. RESULTS AND DISCUSSION

The proposed system was tested in terms of the performance of various machine learning algorithms and their quality of prediction. To be sure that the evaluation was reliable, the dataset was split into training and testing sets. A number of the classification models were tried, which were Logistic Regression, Decision Tree, Support Vector Machine and random forest. All the models were trained on the same data and assessed by the traditional performance measures.

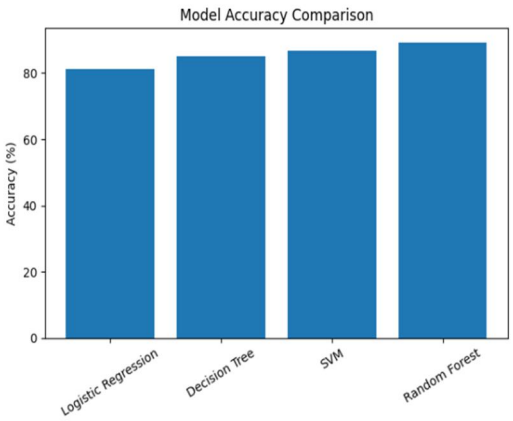

Fig:5 Result Graph

The Random Forest classifier gave the best performance, as it demonstrated the highest accuracy of the prediction when compared to the other tested algorithms. It was ensemble and this enabled it to learn intricate relationships among input features and adaptability levels. The findings show that the random forest model beats the other algorithms by a large margin in relation to the accuracy of prediction and the performance as a whole.

Comparison of Performance (Sample Results)

Table 1: System Performance Metrics

ALGORITHM	Accuracy (%)	Precision (%)	Recall (%)	F-1 SCORE (%)
Logistic Regression	81.3	80.5	79.8	80.1
Decision Tree	85.2	84.6	83.9	84.2
SVM	86.7	86.1	85.8	85.9
Random Forest	89.1	88.5	88.2	88.3

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X. CONCLUSION

Online education has brought new issues to students and learning institutions. It is important to learn the extent of student-acclimatization to digital learning environments to enhance the quality of an online learning system. This study introduced a machine learning-based model of forecasting the level of student adaptability based on demographic and socioeconomic characteristics. A number of machine learning algorithms have been compared and the best one is the Random Forest classifier that was chosen because of its excellent results and prediction accuracy. It was a web-based system, in which the backend was done in flask, and the frontend interface was done in HTML/CSS. Such implementation enables teachers to make predictions of adaptability in real time by typing in information concerning students. The experimental findings indicate that machine learning methods can be able to detect students who might have difficulties in on-line learning platforms efficiently. Predictive analytics will help an educational institution intervene early and give specific support to enhance student performance. Comprehensively, the suggested system leads to the development of the overall educational data mining domain and presents the prospects of the machine learning in the improvement of the digital educational systems.

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