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An efficient course recommendation system for higher education students using machine learning techniques

Myla M. Arcinas[1], Meenakshi[2], Pranjali S. Bahalkar[3], Deepali Bhaturkar[4], Sachin Lalar[5], Kantilal Pitambar Rane[6], Shaifali Garg[7], Batyrkhan Omarov[8], Abhishek Raghuvanshi[9]
[1]Department of Sociology and Behavioral Sciences, De La Salle University, Manila, Philippines
[2]School of Journalism and Mass Communication, Apeejay Stya University, Sohna, India
[3]Department of Artificial Intelligence and Data Science, Dr. D Y Patil Institute of Technology, Pune, India
[4]Department of Information Technology, Savitribai Phule University, International Institute of Information Technology, Pune, India
[5]Department of Engineering and Technology, Gurugram University, Gurugram, India
[6]Department of Electronics and Telecommunications Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, India
[7]Amity Business School, Amity University Madhya Pradesh, Gwalior, India
[8]International Information Technology University, Al-Farabi Kazakh National University, Almaty, Kazakhstan
[9]Faculty of Computer Engineering, Mahakal Institute of Technology, Ujjain, India

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ABSTRACT

Education institutions and teachers are in desperate need of automated, non-intrusive means of getting student feedback that would allow them to better understand the learning cycle and assess the success of course design. Students would benefit from a framework that intelligently guides their actions and provides exercises or resources to support and enhance their learning. The recommender system framework is a software agent that learns the user's preferences through a variety of channels and then utilizes that knowledge to provide product suggestions. A recommendation engine considers all potential user interests as background information, uses that knowledge to produce convincing recommendations, and then returns those ideas to the user. This article presents a feature selection and machine learning based course recommendation system for higher education students. principal component analysis (PCA) algorithm is used for feature selection. AdaBoost, k nearest neighbour (KNN), and Naïve Bayes algorithms are used to classify and predict student data. It is found that the AdaBoost algorithm is having better accuracy and F1 score for course recommendation to students. PCA AdaBoost is achieving an accuracy of 99.5%.

Corresponding Author:

Abhishek Raghuvanshi
Faculty of Computer Engineering, Mahakal Institute of Technology
Ujjain, Madhya Pradesh, India
Email: abhishek14482@gmail.com

1. INTRODUCTION

When deciding on a degree programmed, students at both the undergraduate and graduate levels are faced with a crucial decision. If a student is not given the appropriate guidance in picking a curriculum, it is possible that they may lose motivation, and as a result, they will not be able to realize their full academic potential [1]. When it comes to choosing a major in college, a student's parents, teachers, and other students will almost always be the ones that prove to be the most beneficial. It is imperative that instruction be given to the students at this point. The direction that a student is given may either be beneficial or detrimental to their efforts to develop successful professions in the future [2]. It is impossible to provide objective guidance in every circumstance due to the fact that humans are fallible and have their own boundaries. Because new

software is being developed at such a breakneck speed, it is becoming harder for human advisors to keep up with the latest developments. It is essential that human counsellors have access to a digital system that can aid them in their work since there is a significant possibility of making an error when depending just on human judgement. The purpose of programmed advisory systems is not to take the role of human counsellors but rather to assist human advisers in making better decisions based on more information [3].

In the past, course recommendation systems [4] were built with the assistance of databases. The database is comprised entirely of everlasting information. Later on, object-oriented database systems were developed, which improved databases by making it easier to store objects. After some time, there was a rise in the number of AI-inspired initiatives made inside the industry to develop some kind of expert system. However, since more courses were added on the fly, the expert system has not been able to keep up with all that has happened. Methodologies that are based on fuzzy logic and neural networks were included into the creation of course advisory systems because of their ability to more properly represent the complexities of real-world scenarios [5].

The challenge associated with such systems is in their inability to precisely assess a student's true capability. Analytics has become ubiquitous across various sectors in contemporary society [6]. This suggests that the application of analytics to student data can result in the development of a curriculum that is effective and efficient in enhancing academic achievement [7]. Therefore, it is imperative to implement a student programmed advising system that facilitates the guidance of students towards the most suitable course options [8]. Historically, questionnaires and surveys have been employed as means of ascertaining the most suitable pedagogical technique to be implemented within the classroom setting. Develop a comprehensive digital record for every student who utilizes this resource by establishing a digital footprint [9]. There is a potential for the collection of big data along this vast trajectory. The software industry has witnessed significant progress, enabling the execution of novel processing techniques on educational data. These techniques include educational data mining (EDM), learning analytics (LA), and personalized recommender systems. These sectors represent a limited selection of the most recent ones [10], [11].

This article introduces a course recommendation system for higher education students that utilizes feature selection and machine learning techniques. The principal component analysis (PCA) technique is employed for target selection of features. The algorithms AdaBoost, k nearest neighbour (KNN), and Naïve Bayes are commonly employed for the purpose of classifying and predicting student data. The AdaBoost algorithm has been observed to exhibit superior accuracy and F1 score in the context of course suggestion for students.

2. LITERATURE SURVEY

Gopi *et al.* [12] focused their attention on data management (DM) and data analytics in order to find out the most effective approach to put the information that was obtained to use in the field of education (DA). These systems may be beneficial to organizations that are either for-profit or not-for-profit, depending on the circumstances. EDM and LA provide a comprehensive examination of the ramifications of the findings, including a discussion of how such implications relate to the responsibilities of shareholders in academic institutions. In this part, we will take a cursory look at the possible applications of these models, including their utility in analyzing the learning processes of students and giving detailed feedback to those processes. In conclusion, these models are having an impact on the administrative ideas that have the potential to bring together all of the stakeholders in the education system at a single table.

It is now possible to use R to access an implementation of a dropout prediction model that was developed [13] utilizing the Naïve Bayes classification. The next stage is to investigate the factors that contribute to a student's success or failure in their first year of college, or even to their expulsion. To review, being kicked out of school may be a consequence of a wide variety of offences. It is of the utmost importance for business owners to have the capacity to anticipate a child's decision on whether or not they will continue their education.

A variety of techniques for data preparation were used to the vast amounts of student data. This is due to the fact that it is very necessary for the grades of the students to be computed in a manner that is suitable for the assessment modules. During the step of data preparation, we cleaned up the students' grades so that we could use them to extract data about the categories. This allowed us to utilize the grades as a source of information. This indicates that grades have not been kept track of in a manner that is distinct for each course [13].

After that, we went back and looked at everything that had been done to be ready to analyses the EDM data. It is generally accepted that educational data preservation requires a unique approach compared to that used with regard to other types of information. This is due to the fact that there are a great deal of unknowns, such as the large variety of applications that may be used and the possibility of human mistake. In view of this, the coursework estimate ratio has been used not only to give transcribing information for course

participants, but also to investigate numerous techniques of module assessment. This was done in light of the fact that the coursework estimation ratio has been utilized. It has been shown that the ratios used in the grading of classes via the utilization of radio-frequency technology have an influence on the accuracy of the classifiers [14].

The use of EDM in such a broad and productive way allows for the evaluation of students' potential academic performance as "excellent," "very good," "good," and "moderate". This kind of foresight into the future might potentially be used by a variety of educational institutions in order to choose the students who would be the finest recipients of financial aid in the form of scholarships. In order to determine whether or not the quality in issue is significant, multivariate modelling techniques were used to a representative sample of the trait in question. Multiple pieces of research have pointed to the positive relationship between a student's family life and their level of ambition and drive to excel academically. The method that was used to compute the findings makes it quite evident that the content being taught to the students is of little relevance, regardless of whether or not the students are interested in the subject matter [14].

Work done in [15] examined the academic performance of 210 undergraduate students as part of their research to discover how well people do academically. One may make inferences about the student's potential academic performance based on these characteristics. According to the findings of the research, it is possible to generate a more accurate prediction. Researchers in [16] examined the data that was collected from a group of students who had chosen technology as their area of study in order to make a prediction on the total rate of students who did not finish their bachelor's degree programmers. Users have the option of using WEKA's attribute selection algorithms, which are one of the program's primary functions, in order to lessen the tool's dependency on a limited number of qualities. It is a well-known belief that the factors that come into play after enrollment, such as attendance, concentration, and grades, are the ones that are the most significant to take into consideration while choosing a university.

It has been shown that automatic machine learning is a very helpful way for estimating the level of success that a student will have in a setting that involves distance education. Both rule-based and tree-based methods are used, and both are used in order to offer search results that are intelligible and clear. In conclusion, it is important to point out that a number of research have shown the extraordinary potential of auto machine learning systems. It has been shown that the DM model is capable of doing academic data analysis [17], [18]. Since the 1970s, high school seniors who are applying to colleges for the first time have had unfettered access to information that can be independently validated on their previous academic performance. When working with non-normal data, it is necessary to do pre-processing on the raw data.

Putting in place a data security standard (DSS) is one of the most important elements in enterprise resource management (ERM). Making decisions is facilitated more easily by many applications, which is one of the key tasks of each programmed. Work of this kind includes things like making comments and cautions, organizing events, coming up with new ideas, and revising course materials, among other things. Despite the broad acceptance of DSS in the academic community, a significant number of its users, including students, managers, and researchers, do not possess the skills required to fully benefit from using it.

As a direct result of the most recent study that has been done, many novel ways of thinking have been proposed. However, the focus of these hypotheses is on the persons who were engaged in the event. Students may get direction and instruction from teachers in a variety of settings, including but not limited to classes. Hybrid systems, association rules, and associative or content-based filtering are a few examples of typical remote sensing (RS) approaches. When discovery techniques are used to create ideas, there is an additional advantage that may be realized. Researcher in [19] provided an example using a performance forecasting tool. When we use this technique, we are able to forecast how well a student will do in each unit, and we can adjust the courses that we propose for them appropriately.

Pardos and Jiang [20] presented three different models as a component of the approach that they took to suggest classes for college students. The initial model utilized a simulated enrollment time series as its primary data source. The authors then made use of a bag-of-words concept that was generated from the description of the course catalogue. This concept relied on the subsequent model's reliance on the course's explicitly available aspects. Both locally and remotely, these models were put through their paces so that they could be evaluated alongside the recurrent neural network–based suggestion that was already present in their system. Guruge *et al.* [21] created a Markov chain by using the sequential classes that the students took over the course of their education. The writers conduct an analysis of the student's prior coursework using a method based on random walking in order to provide recommendations for the student's future studies.

3. METHOD

This section presents a feature selection and machine learning based course recommendation system for higher education students. PCA algorithm is used for feature selection. AdaBoost, KNN, and Naïve Bayes algorithms are used to classify and predict student data. This proposed framework is shown in Figure 1.

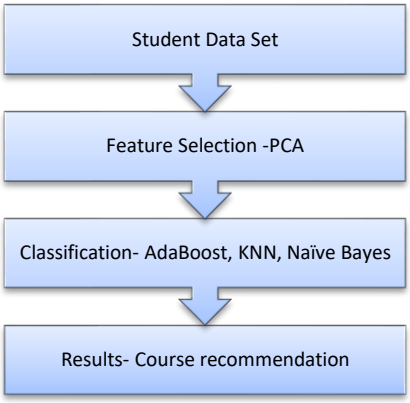

Figure 1. Course recommendation system using AdaBoost and PCA methods

PCA [22] is used in situations when a considerable number of variables within a dataset are found to be associated with one another. This makes it possible to cut down on the total number of variables while yet preserving the highest possible level of data integrity. In order to decrease the number of dimensions that make up a dataset, it is possible to make use of a collection of independent variables known as principle components. The PCA is a useful method that may be used in order to locate these essential building elements.

Researchers at the University of Michigan developed an algorithm named AdaBoost for binary classification as an additional tool for gradient boosting. The procedure starts with the construction of a decision tree, which is then evaluated against each training instance to assess its efficacy. It is feasible to construct a singular reliable classification strategy by amalgamating many less reliable strategies to address the classification problem. A preliminary model is constructed using the collected training data. To rectify identified differences, further models are constructed. Model development is considered complete when all potential models have been constructed or when the training set data can be accurately predicted. The optimal categorization model emerged from the synthesis of all preceding models. Many drivers choose to install the AdaBoost sensor to enhance their capacity to detect pedestrians. The photos are segmented into rectangular forms, and the feature values are computed for each rectangle individually. Pedestrians and other road users may be recognized by marking the windows in any order. All procedures are executed as before, with the only exception that the windows in the illustrative image are chosen in a different order. For instance, if an initial model eliminates windows that obviously do not pertain to pedestrians, the subsequent model may exclude windows that are less apparent, continuing this process until the final model retains only the windows that remain unaltered [23]. This is due to the fact that, ultimately, the model will consider only those windows that were not previously rejected.

The KNN classifier has been extensively studied for data classification. Pattern recognition employs many approaches to organize and categories data. KNN is a data classification approach that relies on the distances between training samples as its basis. The KNN algorithm exemplifies an event-driven learning application. The calculation is postponed until the classification step is completed when using a locally estimated function [24]. KNN is the most straightforward strategy for categorizing objects when there is little information about the data distribution. A multitude of individuals choose for the KNN method when tasked with organizing pattern data. The KNN algorithm has shown exceptional performance in several trials using diverse data sources. The Naive Bayes methodology is an effective method for selecting labels for classes of problem occurrences based on feature value vectors. This strategy is used while constructing classifier models. Various approaches are used to train these classifiers, all grounded on a common principle. Prioritizing characteristics is challenging when just the class variable is considered [25]. Naïve Bayes classifiers may be taught in a supervised learning context for certain sorts of probability models. This is feasible. In several real-world situations, one may forgo Bayesian probability and other Bayesian techniques while working with Naïve Bayes models by using the maximum likelihood approach for parameter

estimation. This is enabled by the model's capacity to use maximum likelihood for parameter estimation. The Naïve Bayes classifier is a supervised learning method that employs Bayes' theorem and the assumption of independence among all pairs of features.

4. RESULTS AND DISCUSSION

Five hundred students' academic records [26], [27] have been compiled into a dataset with 18 different attributes, including: age, sex, family size, health status, commute time, family relationship, study hours, extracurricular activities, course name, course description, names of the students' universities skills, difficulty level, results, and attendance. Different parameters used for performance comparison are presented in (1) to (4). The performance of machine learning algorithms is shown in Table 1 and Figure 2.

$$accuracy = (tp + tn)/N \quad (1)$$

$$precision = tp/(tp + fp) \quad (2)$$

$$recall = \frac{tp}{tp+fn} \quad (3)$$

$$f\_measure = 2 * ((precision * recall)/(precision + recall)) \quad (4)$$

Table 1. Result comparison for course recommendation

Algorithm	Accuracy	Precision	Recall	F1
Random forest (RF)	91.6	93.5	94.6	92.3
KNN	95.5	94.5	95.5	95.6
AdaBoost	99.5	98.5	99	99.5

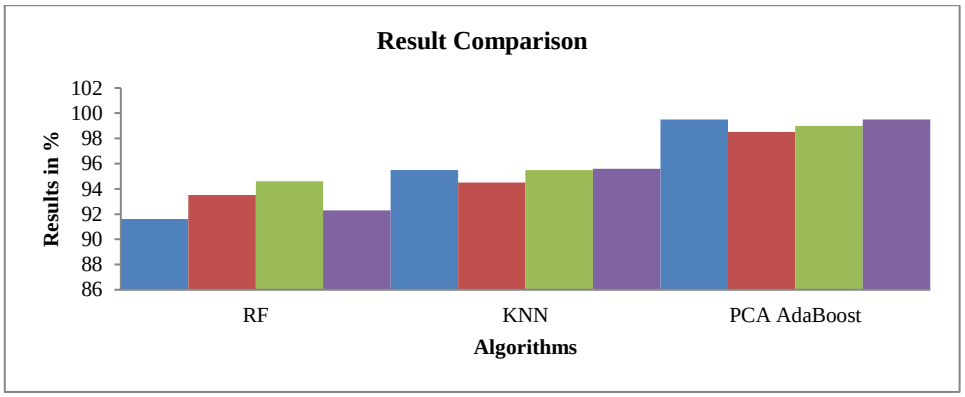

Figure 2. Results for course recommendation system using machine learning and feature selection

Results are presented in Figure 2. PCA AdaBoost is having an accuracy of 99.5%. It is 4% more than the accuracy of KNN algorithm. It is 7.9% higher than the accuracy of RF algorithm. Precision, recall, and F1 score of PCA based AdaBoost is better than that of KNN and RF algorithm.

5. CONCLUSION

In the past, databases have been used as a helpful tool in the process of developing course recommendation systems. The expert system has, sadly, been unable to keep up with the tremendous rise in the number of classes that are offered. The issue with these approaches is that they do not evaluate a student's genuine potential in a fair and accurate manner. In today's world, analytics can be found in almost every sector of the economy. This article provides an introduction to a course recommendation system that makes use of feature selection and machine learning for usage by college students. PCA is what's utilised to decide which characteristics to employ. The methods AdaBoost, KNN, and Naive Bayes are used in the process of using student data to classify and make predictions about those data. It has been shown that AdaBoost has a better F1 score as well as a greater accuracy when it comes to proposing classes to students.

In future research, online course recommendation system can be developed. Optimization techniques can also be used to select appropriate features for course recommendation. More detailed data set can also be prepared on the basis of region, country, socio economic factors and availability of job or business opportunities for the courses.

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BIOGRAPHIES OF AUTHORS

Dr. Myla M. Arcinas is an Associate Professor of the Behavioral Sciences Department of De La Salle University and an SDRC research fellow. She does research on gender, overseas Filipino workers and their left-behind family members, and health. She obtained her Ph.D. in sociology from of De La Salle University-Manila. She can be contacted at email: myla.arcinas@dlsu.edu.ph.

Dr. Meenakshi is an expert in Media and International Relations, Intercultural Communication, Event Management, Radio and TV Journalism and has a background in continental philosophy. She has taught these subjects for nearly 11 years at universities such as the Kurukshetra University (Haryana, India), LLDIMS, GGSIP University (Delhi, India), Lovely Professional University (Punjab, India), GD Goenka University (India) and at Apeejay University, India. She can be contacted at email: mt6458@gmail.com.

Mrs. Pranjali S. Bahalkar working as an Assistant Professor in the Department of Artificial Intelligence and Data Science at D. Y. Patil College of Engineering, Akurdi, Pune, India. She graduated in bachelor of engineering in computer engineering in JSPM, RSCOE, Tathawade, Savitribai Phule Pune University, Maharashtra, India. She secured master of computer engineering at Bharati VidyapeethDeemed University, Pune, India. She is in teaching profession for more than 5 years and have 4 month of industrial experience. She can be contacted at email: pranjali85bahalkar@gmail.com.

Prof. Deepali Bhaturkar working as an Assistant Professor in the Department of Information Technology at International Institute of Information Technology, Pune, India. She graduated in bachelor of engineering in information technology at Nagpur University (RTMU), Nagupr, Maharashtra, India. She secured master of engineering in computer engineering at Pune University, Pune, India. She can be contacted at email: deepali.bhaturkar11@gmail.com.

Dr. Sachin Lalar is working as Assistant Professor in Kurukshetra University in Department of Computer Science and Applications. He has received his Ph.D. in computer science and engineering. He has more than 15 years' experience in teaching and research. His research interests are computer networks, data structure, and programming. He has visited many universities for presenting the research papers. Several research papers of his work published in the leading National and International Journals. He can be contacted at email: sachin509@gmail.com.

Dr. Kantilal Pitambar Rane received B.E. degree in electronics and telecommunication engineering from North Maharashtra University, Jalgaon in 1996. M.E. degree in electronics engineering from Shivaji University, Kolhapur in 2005. Ph.D. degree in electronics engineering from North Maharashtra University, Jalgaon in 2013. He is currently working as Professor at Bharati Vidyapeeth College of Engineering Navi Mumbai, India. His research interests include image processing, IoT, AI, and machine learning. He can be contacted at email: kantiprane@rediffmail.com.

Dr. Shaifali Garg Associate Professor, Amity Business School, Amity University, Madhya Pradesh (Gwalior) having 14 years of experience in area of Human Resource management, earlier she was working with a GLA University, Mathura and associated with Galgotias Educational Institute, Greater Noida, so far she got 11 papers published in Scopus indexed journal and presented research papers in various National and International Conferences and also published papers in renowned UGC Care journals. Teaching students effectively and innovative ways is her strength. She believe in work out for mutual support and cooperation in building the students path of success. She can be contacted at email: sgarg1@gwa.amity.edu.

Batyrkhan Omarov received his bachelor's and master's degrees from Al-Farabi Kazakh National University, Almaty, Kazakhstan in 2008 and 2010, respectively. In 2019, he received his Ph.D. from Tenaga National University, Kuala Lumpur, Malaysia. His research interests include machine learning, deep learning, data science, image processing, medical image analysis, and artificial intelligence in medicine. He can be contacted at email: batyahan@gmail.com.

Abhishek Raghuvanshi is working as head of Department in Department of Computer Science and Engineering in Mahakal Institute of Technology in Ujjain in India. He is having teaching experience of 19 years, research experience of 15 years and administrative experience of 10 years. His research areas include machine learning, internet of things security, and health care analytics. He is having many publications in SCI and Scopus indexed journals. He has also worked on many governments of India funded research projects. He can be contacted at email: abhishek14482@gmail.com.