

Ensemble Bagging Classifiers for Student Course Selection

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Abstract

By examining the relevant literature, it is found that many students and parents always faced confusion while selecting appropriate course. Available Study focused on student's academic performance, placement area but there is a lack of study which focused course selection among multiple graduation courses considering on all demographic, personal, academic and social factors. So, to fill this gap, authors have identified influencing factor by using **feature selection** technique **mutual information gain** on collected data. Study focused on comparison of accuracy of naive bayse, SVM classifiers without ensemble bagging classifier with accuracy of naive bayse, SVM classifiers with ensemble bagging classifier. Descriptive research method using a survey was used for the present study. The online questionnaires were used to collect data from the students who are perusing course from various streams such as medical, engineering and commerce and management. Convenience sampling method was used to determine the participants of the study. A total of 91 student's data from all stream were collected for the study. Google colab was used for the study. The results show that that the performance accuracy of classifiers has increased after applying Ensemble bagging classifier. The naïve bayse classifier showed the best performance with an accuracy of 96% which increased from 89% after applying Ensemble bagging classifier. SVM also showed increase in accuracy from 67% to 78%.

Keywords: *ensemble, influencing factors, bagging, classifier, feature selection*

Introduction

The usefulness of data mining tools has been demonstrated in numerous fields such as Financial Analysis, Telecommunication Industry, retail Industry, health care etc. They play an important role in the decision-making process. One of these areas is e-learning where it has become extremely important to analyses and predicts students' performance statistics [1]. A novel Veracity Scanning Model (VSM) was put forth in [2] to identify false material in the field of health care. Many researchers

around the globe are interested in the growing amount of data that the Increased use of technology in education is producing on a daily basis [3]. The selection of an academic programme by students is influenced by various variables [4]. Ensemble methods are learning algorithms that build a group of classifiers and then classify new data points by weighing the forecasts of those classifiers [5]. To categories various kinds of data, many classification models have also been put forth, including K-nearest-neighbor, Random Forest, XGBoost, Neural Networks, etc. **Bagging** and boosting are two common ensemble ideas. Bagging aggregates the findings across multiple models, whereas boosting builds a stronger model out of multiple weak models [6]. In [7] Bagging ensemble technique Data from the training dataset is taken at random and placed into a bag. There are created a number of bags, each containing a portion of the training data collection. Next, a classification algorithm is taught on each bag to provide a model. In the boosting ensemble technique, the first model is trained using the entire training set, and the second model is trained using the results of the first model. It initially assigns each instance of the dataset identical weights. If an instance's class is incorrect, the subsequent model will give it more weight and concentrate on this instance. This procedure is repeated until the desired accuracy or quantity of additional models is obtained. The Random Forest algorithm is a sizable group of unrelated Decision Tree algorithms. From the training dataset's segments, which each contain a decision tree, Random Forest generates a large number of decision trees. Now, an instance was placed in a class by each Decision Tree model. The class that received the most votes will then be used as the instance's class. About 40% of students are unsure of their career choices, according to a survey by the Council for Scientific and Industrial Research (CSIR). This could lead to the wrong career choice and subsequent employment in an area that is not a good fit for them, decreasing the human resource's productivity [8].

Following are the research objectives:

- 1) To developed predictive model which suggest courses such as Medial, Engineering and Commerce & Management after 12th?
- 2) To compare model accuracy between traditional machine learning algorithms and ensembles algorithms.

The remaining section of the paper is structured as follows: Section II discusses the literature; Section III explains the methodology and Section IV highlights the results and discussion followed by Section V conclusion and future enhancements

Literature Survey

This section discusses various techniques used in the literature to tackle above mentioned challenges. Section A describes and focus on factors, techniques and area were consisted for the study; section B elaborates research gap. `

Previous Studies

Compared data mining algorithms such as J-48, Random Forest, Naive Bayes, Naive Bayes Multinomial, K-Star, and IBK for mark predictions. According to the results, random forest algorithms outperform the competition [9]. In [10] the decision tree method and the probabilistic classification method were used to create the model that forecasts the student's performance in end semester examination. Used educational data mining to predict where students would be placed in software businesses. Students' personal, pre-university, and operational traits were taken into account for the prediction. According to the study, the J48 Decision Tree Algorithm has an accuracy rate of 76.41%, making it the top algorithm overall. According to the research, students who use both Internet-based (Facebook, Twitter) and mobile-based (WhatsApp, WeChat, Line) networking methods perform better than those who use just one or the other [11]. In [12] use artificial neural networks to forecast students' graduation. Utilizing the psychological state of the student, the proposed system forecasts a career option. The accuracy of data mining algorithms like C4.5, Naive Bayes, K Star, and simple cart was examined and contrasted. The study reveals that C4.5 works superior to others [13]. In [14] proposed a model to find extremely favorable association rules from student enrollment data. In [15], a new attribute selection measurement function (heuristic) was applied to the C4.5 DT algorithm to create a knowledge-based decision method for choosing the appropriate engineering branch. Using big data hadoop-hive software, a model was created to compare the performance of colleges based on placements, the student-staff ratio, affiliations, students' performance, and student rating [16]. Developed an expert system using CLIPS in [17] to assist new students in choosing a faculty at Gomal University based on the student's aptitudes, including intelligence, understanding, comprehension, and mathematical concepts, as well as his or her prior academic performance. In [18] Based on the student's abilities and capabilities as determined by the test module results, the developed expert system uses rules to determine the faculty or major that is the most appropriate for him. On the data collection, various data mining algorithms including ID3, K-Means, Naive Bayes, and Random Forest were used. The study found that Random Forest provides improved results or accuracy as data size increases. Focused on the use of data mining methods for student enrollment in higher education. Identify additional places where data mining can be used [19]. In [20] revealed that Parents' professions, the media, and students' own preferences all interact to influence students' career

choices. A proposed system for predicting people's career choices based on their personality traits, interests, and capacity to enroll in courses is implemented in [21], and it demonstrated 94% accuracy, which is better than 5.0 without an adaptive boosting algorithm. In [22] created the K-Nearest Neighbor and Certainty Factor algorithms-based Student Career Prediction System. The certainty factor technique and the K nearest neighbor approach both have excellent accuracy. create a fuzzy logic-based decision support system to assist university applicants who are faced with the admissions choice issue [23]. In [24] predicted student's estimated career using ID3, Classification and Regression Tree, Random Forest, Support Vector Machines, Neural Networks CART and Multi-Layer Perceptron (MLP). In [25] created a web-based Expert System for Career Guidance using Rule based knowledge-base. Designed Cognitive model which investigate and find an appropriate job related to software career(s) in the software industry for the students [26]. In [27] Developed recommendation system using Feed-forward back propagation probabilistic neural network and Classification using Fuzzy Logic and Rough Set for students to select course engineering Stream. Developed an Intuitive Career System to predict the career using Binary classification, Logistic Regression, K-Nearest Neighbors and Stochastic Gradient Descent, random forest [28]. In [29] proposed an expert system using a machine learning approach for assessing student's career using Artificial Neural Network. Designed a framework of expert system using ID3, J48, IB1 fuzzy logic for career selection [30]. In [31] used Apriori and Naïve Bayes algorithm to predict Student's Branch Prediction and second is Stream Analysis of engineering course. Developed Model based on Naive Bayes algorithm to predict whether the student will enroll to university or not [31]. In [32] Designed Recommendation System using VM, Random Forest decision tree, One Hot encoding, XG boost Logistic Regression and Linear Discriminate Analysis for choosing a right field in CSE/IT stream. Developed Intelligent Career Counseling Bot artificial intelligence algorithms [33]. In [34] created framework for Multilevel Expert System to advice Career path Nearest Neighbor (NN). created a framework using Clustering and Apriori Association Rule Algorithm for e-learning Course Recommendation System [35]. In [36] used REP Tree algorithm, neural network to designed a model for branch selection while taking the admission in the engineering. Proposed algorithm used to predict the career choice of a student accurately based on Naïve Bayes, K-Star and SVM using the majority voting methodology worked together in incremental ensemble [37]. In [38] designed a fuzzy logic-based career recommendation system for UiTM Perlis Students. Online Career Counselor System based on Artificial Intelligence [39]. According to the study, EDM can be applied in a variety of contexts, including identifying at-risk students, prioritizing the educational needs of different student groups, increasing graduation rates, accurately assessing institutional performance, allocating resources on campus, and enhancing topic curriculum renewal [40]. In [41] concluded that Subset Evaluator did better than the other three feature selection algorithms, and IBK demonstrated high accuracy of 99.680%. Compared to using only Naive Bayes, the proposed system's accuracy of 86.66% was achieved using an improved Naive

Bayesian mining method [42]. In [43] to predict the student's success, construct the classification model using Support Vector Machines, Decision Trees, and Gradient Boosting algorithms. Researchers come to the conclusion that the Boosting algorithm outperforms other classifications. In [44, 46, 47] proposed 'Content Similarity Measure (CSM)' algorithm in the healthcare domain. In [45] using a classification algorithm in data mining, predicted student success in a distributed environment.

Potential Research Gaps

Following is the summarized list of potential research gaps identified through extensive literature from section A

- 1) The issue of identifying influencing variables from all demographic, personal, academic, and social factors while choosing a course is not addressed by the prior study work.
- 2) The authors found that the Identifying and implementing Ensemble Bagging Classifier plays a significant role in the classification of course stream.

Methodology

Study is a descriptive study for the purpose of comparing accuracy of predictive model of course selection using bagging ensemble algorithm and traditional algorithms. Descriptive research method using a survey was used for the present study. The online questionnaires were used to collect data from the students who are perusing course from various stream such as medical, engineering & commerce and management. Convenience sampling method was used to determine the participants of the study. A total of 91 student's data from all stream were collected for the study. On the basis of the factors identified from the literature, a questionnaire was prepared and delivered on a convenience base to who are perusing graduation.

Experimental Results and Discussion

Study limitations. The four confusion matrices each contain 27 evaluation cases, although the survey collected 91 responses. The procedure selecting those cases, class mapping and feature-selection validation protocol are not specified. The plotted classifier label GB differs from the Naïve Bayes name used in the text and captions. The matrices support the rounded accuracy percentages, but the classifier identity and generalizability of the results remain unresolved.

To describe the factors affected to the students while course selection, data file generated from

online Google form is converted to comma separated file. Factors such as SSC score, HSC board, HSC scored, Entrance examination, Entrance score, birth order, mothers' occupation, father occupation, no of siblings, time spent with friend, time for study, category, parents' occupation field, family income, personality features, parent occupation, area of living, thing like to do most, tempted factors were considered in the analyses. In the current study we have applied machine learning feature selection technique mutual information gain. Analysis is based on python code using Google colab. From Figure 1 to Figure 3 shows the 10 influencing factors while course selection which received after performing feature selection using mutual information gain. Study revealed that 10 factors namely SSC Score, Entrance Examination name, Entrance examination score, category, Mother's Qualification, Father's job, personality feature, HSC/diploma stream mostly considered by students while course selection. While other factors such as birth order, family income, area of living and HSC score were not considered while course selection. The current study compared accuracy of predictive models using Machine learning classifier such as naïve bayse, SVM with Ensemble bagging techniques and without Ensemble bagging technique.

The performance evaluation of various classifiers is measured through accuracy, precision, recall, and F1-score and presented graphically through Figure. 2 to Figure 8.

Figure 8 shows accuracy of Machine learning classifier such as naïve bayse, SVM with Ensemble bagging techniques and without Ensemble bagging technique. It can be seen that the performance accuracy of classifiers has increased after applying Ensemble bagging technique. The naïve bayse classifier showed the best performance with an accuracy of 96% which increased from 89% after applying Ensemble bagging classifier. SVM also showed increase in accuracy from 67% to 78%.

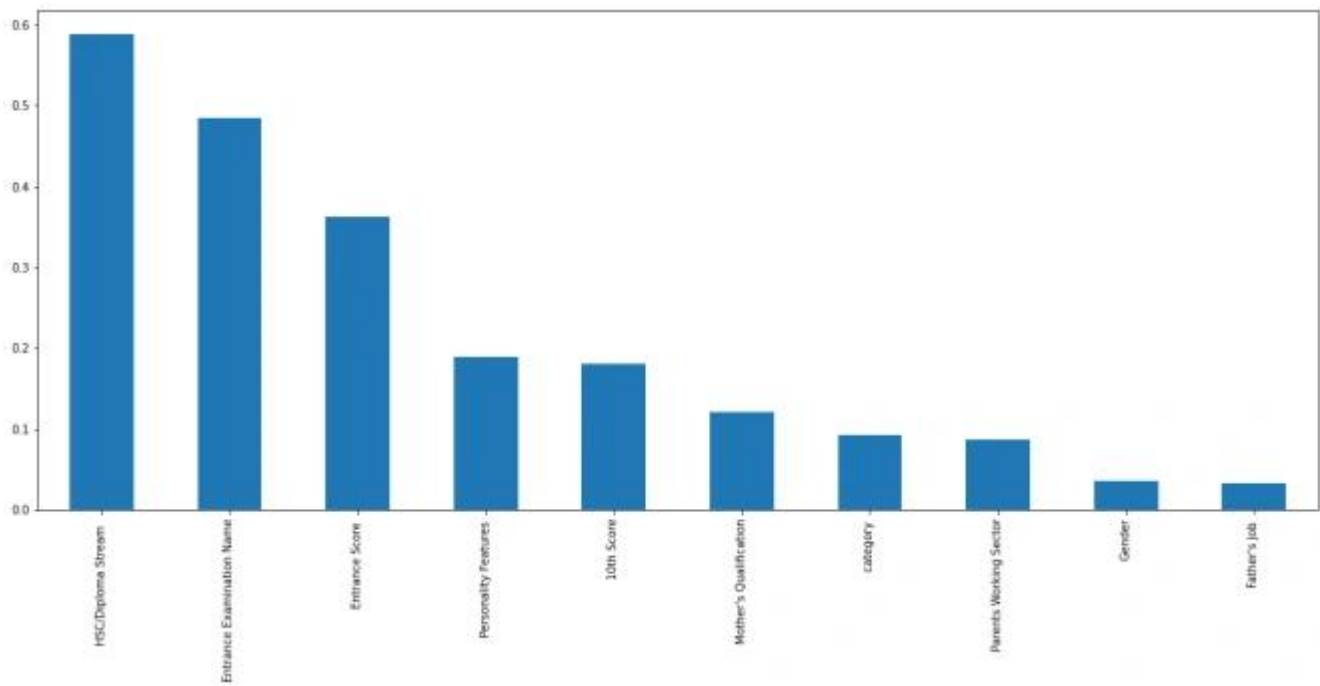


Figure 1: Feature Selection-mutual information gain

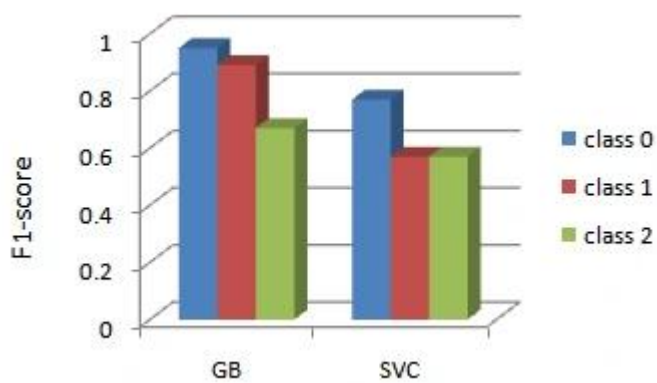


Figure 2: F1-score without bagging algorithm

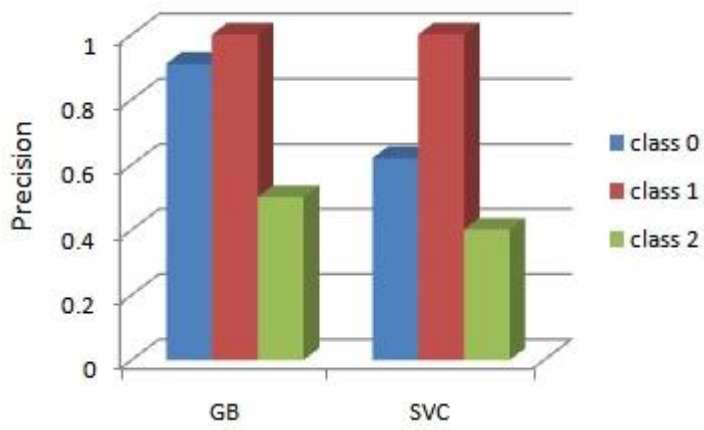


Figure 3: Precision without bagging algorithm

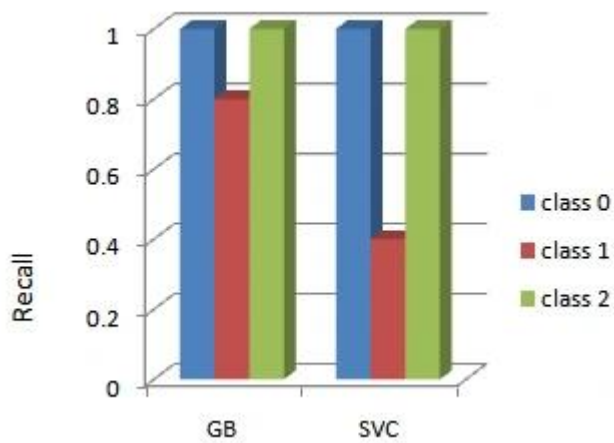


Figure 4: Recall without bagging algorithm

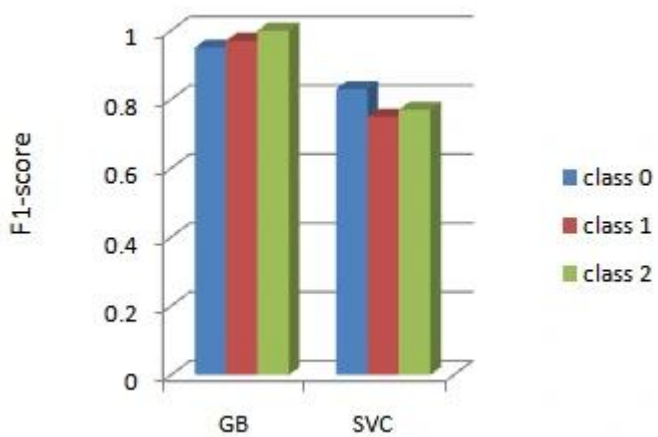


Figure 5: F1-score with bagging algorithm

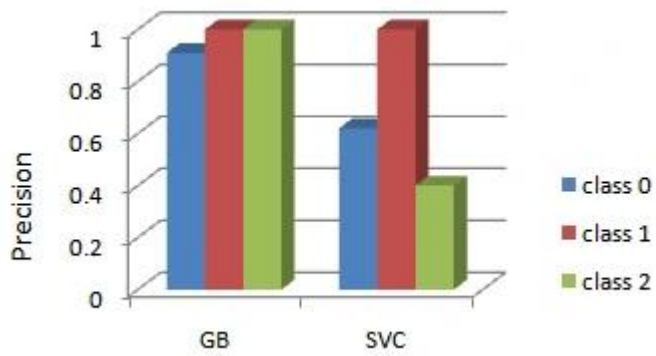


Figure 6: Precision with bagging algorithm

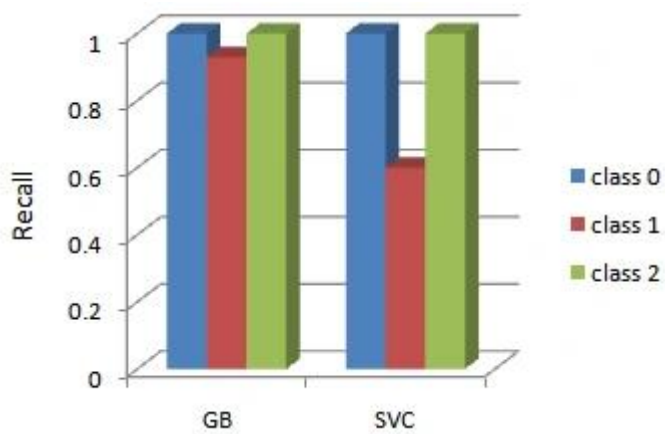


Figure: 7 Recall with bagging algorithm

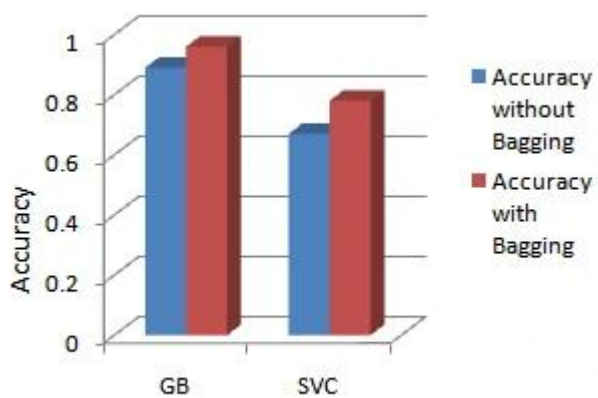


Figure 8: Accuracy of algorithms

From Figure. 9. to Figure. 12. shows the confusion matrix of Naive bayse, SVM classifier with and without Ensemble bagging classifier respectively.

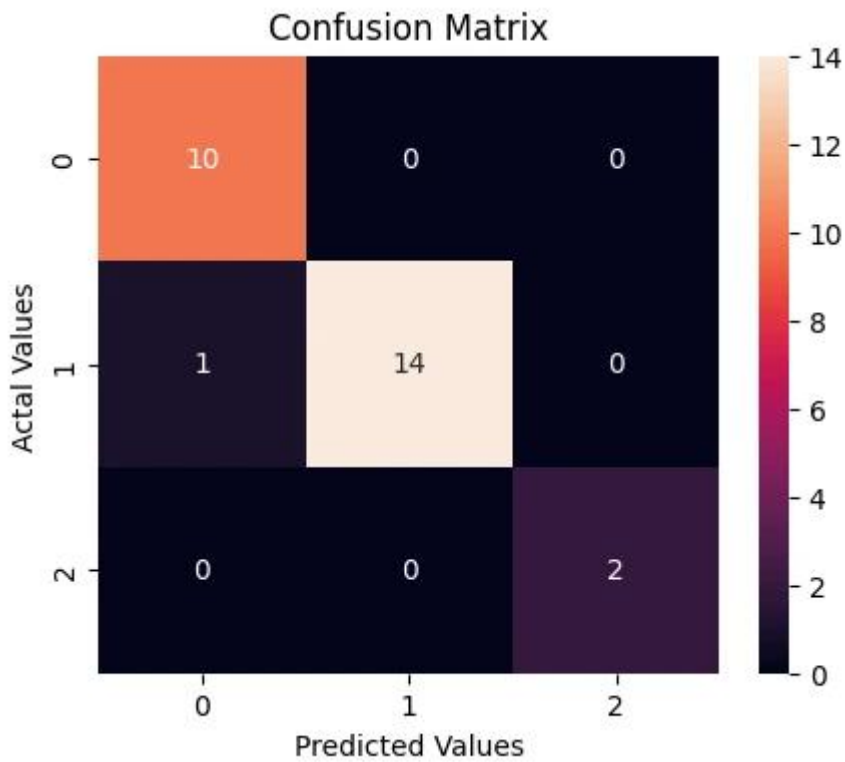


Figure 9: Confusion matrix of Naïve Bayse classifier with bagging classifier

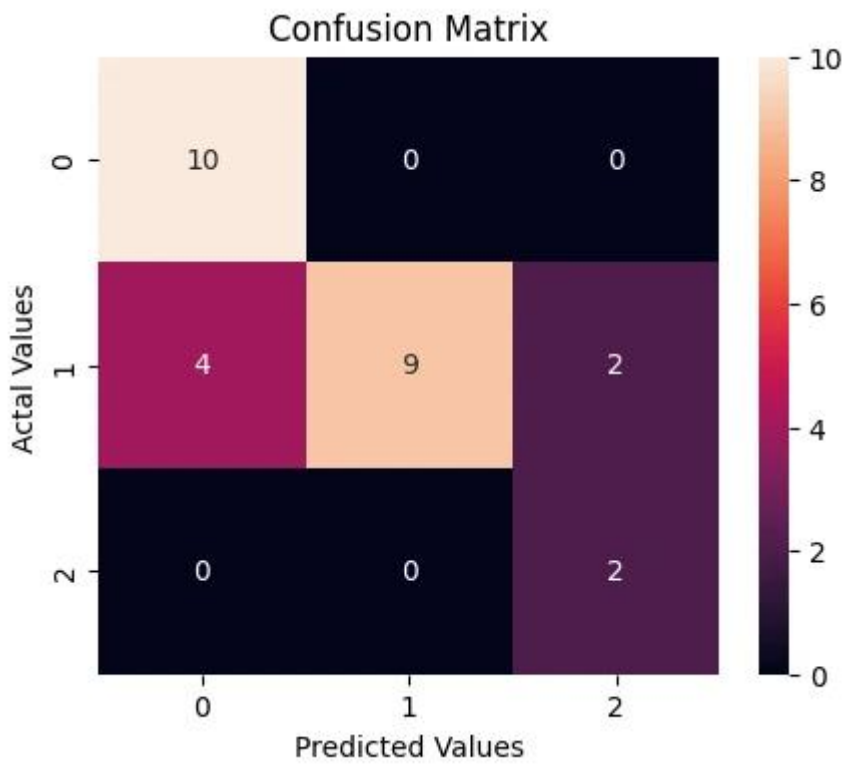


Figure 10: Confusion matrix of SVM classifier with bagging classifier

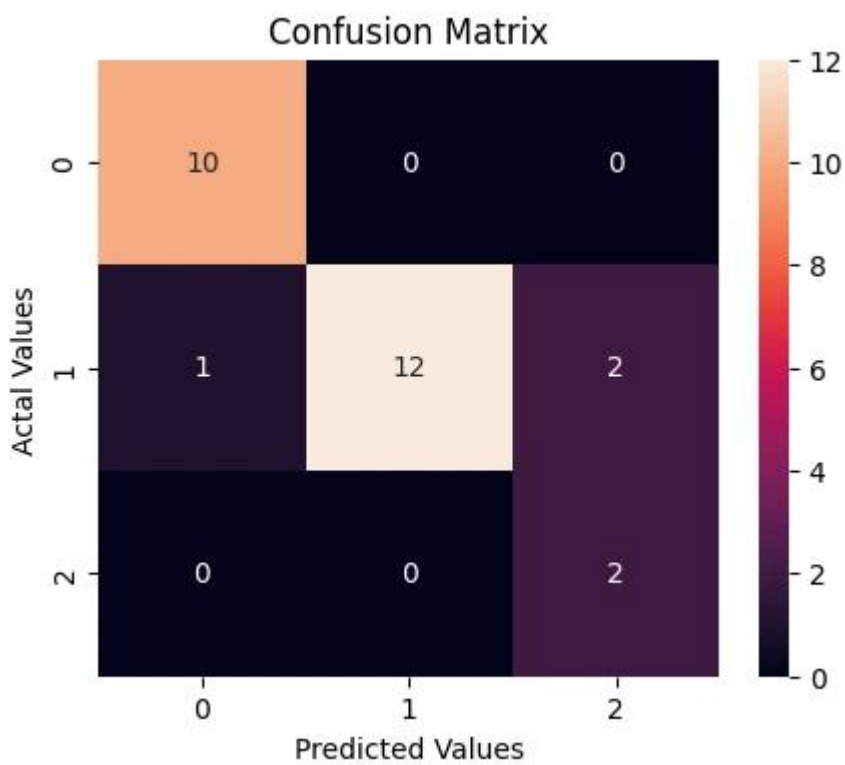


Figure.11: Confusion matrix of Naïve Bayse classifier without bagging classifier

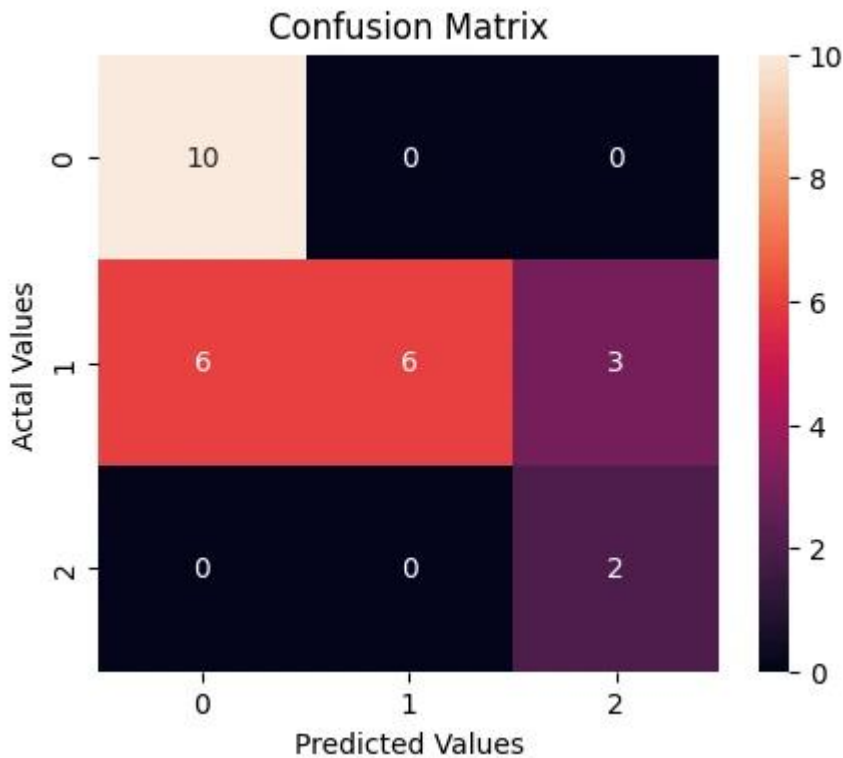


Figure.12: Confusion matrix of SVM classifier without bagging classifier.

Conclusion and Future Enhancements

In this study, survey conducted on the students who are perusing graduation course from Medical, Engineering and Commerce & Management streams has aimed to identify influencing factors of students while course choice decision. Machine learning features selection methods such as Mutual information gain was applied on the collected data to find out the important features which were considered by the students while course selection. According to the analysis 10 factors namely SSC score, Entrance Exam name, Entrance score, personality, Father's occupation, mother's qualification, hobby, category, HSC/Diploma stream are mostly considered by students while course selection. While other factors such as family income, area of living, father's qualification, HSC board, time spent for study, time set with friends, number of siblings birth order, family income were not considered while course selection. The experimental results show that the performance accuracy of classifiers has increased after applying Ensemble bagging classifier. The naïve bayse classifier showed the best performance with an accuracy of 96% which increased from 89% after applying Ensemble bagging classifier. SVM also showed increase in accuracy from 67% to 78%.

Research results will help students and parents in decision-making process while course selection.

In the future, the author wants to compare the accuracy of models by applying other Ensemble classifiers.

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