

Factor Scoring and Machine Learning algorithm to Predict Student Counselling

Nusrat Jahan, Saiful Islam, Rezwana Sultana

Abstract: Personal realization is one of the best things for a successful life. Sometimes, one needs help to realize about bad habits, career goals and accomplish mental health as well as to overcome other problems. This help is generally known as “Counselling”. To ensure effectiveness of counselling service, prime concern is to find out the target group of instances. Many researchers worked with student performance prediction based on academic attributes moreover students’ counselling is also needed to increase their performance. We addressed this issue for this paper work. Here, a model is proposed to predict a student who needs counselling. This study was mainly motivated by two main steps. The first was to investigate university students who feels an urge about having counselling for psychological help from their circumstances and second was to predict efficiently which group of students really needs counselling. This paper work was established with 498 instances and each comprised of 6 attributes. In the case of evaluate the result, paper shows superiority over state-of-the-art methods to predict student counselling through machine learning and factor scoring method. We applied 10 fold cross-validation and 66% dataset splits evaluation method to find out better algorithm among selected 5 algorithms which are Ibk, Naive Bayes, Multilayer, SMO and Random Forest. Weka 3.8.0 have been used for machine learning algorithms where Ibk (Instance Based Learning) was found best for our approach with 95.38% accuracy.

Keywords: Student Counselling, Factor Scoring, Machine Learning, Ibk, Weka

I. INTRODUCTION

Throughout the world education is one of the basic needs. However, the route of education sometimes create acute problem among the students. According to police headquarters in Bangladesh, over 10,000 people committed for suicide every year for various reasons where, Dr. Mohammad Jahangirul Alam, a physician at Bangabandhu Sheikh Mujib Medical University (BSMMU), Bangladesh said that “The most common underlying disorder of a human being is depression and 30-70 percent of suicide victims suffer from major depression or bipolar (manic depressive) disorder” [1]. Although students are highly ambitious about their academia and career yet they rarely have ideas how to achieve their ambitions as well. Very small proportion of the students completed their graduation according to their plan. In the same time, huge number of

students enters into a university with a specific career goal but from the beginning of their university life they become procrastinated in many ways, e.g. social networking, bad influence, drug addiction, de-motivation to study etc. Most of the time in our country, parents are occasionally consider their children’s interest over education, as a result it creates distance among parents and child and have a long term negative effects on their future. As a student they suffer for the rest of their life, even if they choose a way to become successful and due to frustration some of them may become devastated. To minimize this damage, a preplanned subject specific motivation and counselling can bring them in the right track within right time. Throughout the world, it has become a prime concern to enhance personal development of a student. To ensure the worldwide development of a country, nurturing the students based on their career choice is getting highest priority with each passing day. In our country, many universities provides student counselling zone but the quality and the process of this facility is still not considerable. Thaleia Deniozou, June 2015 conducted a survey where 1189 University students were participated. However, 993 of them were undergraduate, and around 84% of them made proper response. Here, a question was for self-evaluate undergrad students based on their general mental health issues. The result was 35% of students were mentally very good, 24% students good, 20% felt excellent, 16% fair, and finally 5% were mentally poor [2].

“Counselling” is now a considerable word. We found different algorithms for predicting counselling (career) status and other related task. Most of the research focused on students’ academic performance analysis rather than students’ counselling issues based on academic performances. Nikita Gorad, Ishani Zalte, Aishwarya Nandi, and Deepali Nayak explored the efficient use of data mining in career counselling. In their paper, they considered Introvert vs. Extrovert, Sensing vs. Intuitive, Thinking vs. Feeling, and Judging vs. Perceiving as factors to predict the career counselling of a student who needs help for selecting the career path. According to the survey which was conducted by the Council of Scientific and Industrial Research (CSIR) and the finding was about 40% students are confused about their career planning [3]. Meanwhile, Pooja Thakar, Anil Mehta and Manisha discussed about educational data mining that was based on different survey results like, survey on weak students, determining student’s satisfaction for a particular path, Faculty Evaluation, Comprehensive student evaluation, Class room teaching language selection, Predicting students’ dropout, course registration planning, evaluation of collaborative activities etc. [4]. Modo and F. N. defined counselling is a helping relationship between the counselor and the counselee.

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Counselling is a way for helping the counselee to adjust properly to family, school, peer association, and society as well [5]. Social networking site is one of the biggest platform where students spend their maximum time rather than their personal development or study as a result it affect their academic performances. However, social-networking can helps us if the way of usage is focused on personal skill development [6]. Shruthi P. and Chaitra B. P., explored the academic performance prediction of the students in the next semester. This approach also helpful for finding weak students besides for giving proper study guide line. In this paper, they used data mining techniques to predict the performance and found that naive bayes algorithm provided the highest accuracy [7]. In this recent era many researcher also talked about e- counselling. Emmanuel A. K. and et al. explored the e- counselling system which was based on students' historical data. In this paper author's demonstrated the e- counselling platform for students of high school. Their study also focused the uses of ICT to provide online counselling services to the students [8]. Zamani and Shiller identified that email, chat, video- conferencing and text messaging as well as short message system (SMS) are widely used e-counselling tools [9]. N. Banu Priya and I. Juvanna also talked about an android application which was implemented for university online counselling. Here, they provided an e-counselling platform among the students and a counselling staff, where student's academic and personal success, drawbacks, problems and feedbacks were main focus for counselling [10].

On the contrary, in recent era machine learning is a technique which helps us to solve different mode of problems by machine knowledge. There are many algorithms and some of them was proved as a best algorithm for various purposes. Machine learning algorithms are divided into many categories according to their purpose [11]. Decision tree (Random Forest), Support vector machine, Naive bayes, Neural network and Instance based learning were applied for classifying our dataset by using Weka (version 3.8.0) machine learning tool. All these are supervised learning algorithms. Decision Tree is one of the supervised machine learning approaches where the data is continuously categories according to a certain parameter. The tree can be explained with the help of two entities: decision nodes and leaves [12]. Artificial Neural Networks (ANNs) also called Neural Networks, it is a computational structure which is followed the biological neural networks. Learning ability is the main characteristics of ANNs. The learning process is achieved by adjusting the weights of the internal layers according to some applied learning algorithms [13]. Support Vector machine (SVM) is a popular supervised machine learning approach. SVM can be applied for classification as well as for regression purposes. SVM just creates a hyper plane that can divide a dataset into two different classes [14]. On the other hand, the naive bayes classifier requires a small number of training data to estimate the effective parameters (means and variances of the variables) that is necessary for classifying the dataset [15]. In this study, naive bayes algorithm did not work well as like other four algorithms. Instances Based learning (Ibk) is an algorithm that is calculated nearest neighbors' distances and then classify the dataset based on that distances. The number of nearest neighbors can be changed if needed. Solomon Mwanjele and et al. showed that the Ibk classifier generates

the least error to predict and the least root relative squared error. They used it to predict precipitation in advance with greater accuracy compared to the other two classifiers namely discretization and isotonic regression classifier algorithm [16]. As we observed from the current situation, it is obvious that if we find out the target group of students who needs proper counselling in early stage that would be better for their academic life as well as in future life. Contemplating all those, we integrated factor scoring with machine learning algorithm for classifying student dataset to predict counselling requirement. To develop and enhance student's personal strength and awareness we need to properly guide our students as early as possible. In this paper we worked for predicting student counselling for guiding their academic life and for achieving this we performed following 3 steps:

- Select features according to our aim then collect data from undergraduate students
- Set a score against each feature for getting more precise class level
- Model selection then evaluate model with 10 fold cross-validation and 66% data splits techniques

II. MATERIALS AND METHODS

In this section we are going to explore our proposed approach to predict a student who needs counselling. Here, we discussed about data collection procedure, data analysis for factor scoring as well as a flow chart to present whole working procedure. It is also would be supportive for any further extension of this work as well as implement any application.

A. Data Collection and Scoring

Quality data, quantity of data and data classification are major parts to get better accuracy for any machine learning approaches. For this study, we were collected 498 responses from student by using google form. It was a survey based approach that plotted students condition based on counselling area and all of the data belonged to undergraduate level students. Data were collected from the department of computer science and engineering at Daffodil International University, Dhaka, Bangladesh [17]. We considered six attributes or factors to predict counselling for a specific student, described in Table I. In the case of data processing we cleaned some errors like null, data imbalance etc. then set a score against each factor to set a class/decision level according to counselling needed. Evaluated this score based class/decision by comparing with student's given class and student's counsellor given class and finally considered a new dataset with a class value as a final class value to predict class.

After feature selection we organized Table II, which was prepared for representing the attributes with score namely SGPA, CGPA, SGPA vs. CGPA, Friendliness, Favorite Area, Weakness and Two Class Type (YES and NO), which were considered for making initial dataset as we described in Table I and that was the second step of this paper work because first step was to select attribute and we also found most effective feature using information gain ranking method.

Table- I: Attribute Description

No.	Attribute	Description
1.	SGPA	Semester Grade Points Average
2.	CGPA	Cumulative Grade Points Average
3.	Friendliness	A single line question “Yes or No”
4.	Favorite Area	A single line question with some course related topic/area as like- <ul style="list-style-type: none"> • Programming • Web developing • Research • Gaming • Other
5.	Weakness	A single line question with some area- <ul style="list-style-type: none"> • Communication Problem • Arrogance • Not punctual • Language Problem • Irresponsible
6.	SGPA vs. CGPA	To observe current improve according to academic performance

Here, we set high score against CGPA and SGPA because our aim was to focus on academic counselling more rather than others. For scoring each attribute, we analysed the feedback from teachers’ as a student counsellor as well. We collected data from students’ counsellor where they gave decision on class level according to our collected data from undergraduate students. This factor scoring approach was used to propose our model to predict student counselling. Here, we set prediction class (Yes or No) as follows:

- If the summation of all attributes value is greater than zero then there is no need to give counselling that specific student (No Class).
- If the value is less than or equal to zero then the student needs counselling (YES Class).

Now, we can define the formal definition of student counselling prediction approach as follows:

Given, m = total number of training samples (X_1, X_2, \dots, X_m), $n=6$, that is the total number of features here we considered and $f(z_i)$ is the counselling status. We showed this function in equation 1.

$$f(z_i) = \sum_n \quad \text{If, } \begin{cases} \leq 0; & \text{Yes} \\ > 0; & \text{No} \end{cases} \quad (1)$$

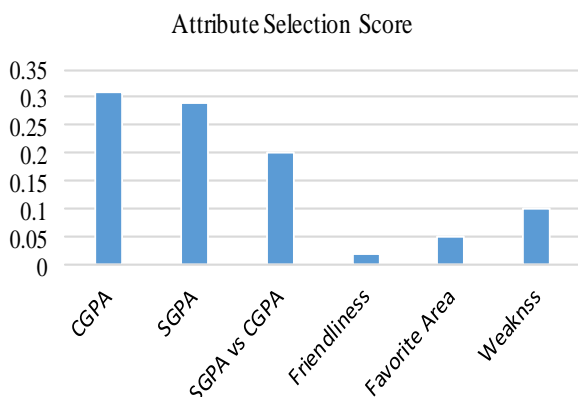


Fig. 1. Attribute Selection with Score

When the attribute selection procedure was applied then we got CGPA as the strong attribute which contribution was more than other 5 attributes for predicting student counselling status as we focused on academic counselling. Fig. 1 for showing the attribute selection results by using information gain by ranking method. This is a method to select the best attribute based on information gain value and in this way we were also able to know which one provide more effects on class level.

Table- II: Factor Scoring According to Attribute

Attributes/ Factors	Scoring	Counselling Status/Class
SGPA	if less than 2.5 then - 2	Yes
	if 2.5 to 3.0 then -1	Yes
	if 3.0 to 3.5 then 0	Yes
	if 3.5 to 4 then 1	No
CGPA	if less than 2.5 then - 2	Yes
	if 2.5 to 3.0 then -1	Yes
	if 3.0 to 3.5 then 0	Yes
	if 3.5 to 4 then 1	No
SGPA vs. CGPA	SGPA > CGPA = 0	No
	SGPA < CGPA = -1	Yes
Friendliness	Yes=0	Yes
	No=1	No
Favorite Area	Related = 1	No
	Other = 0	Yes
	Nothing = -1	Yes
Weakness	Yes = -1	Yes
	No = 0	No
Class Type	Total value <=0	Yes
	Total value > 0	No

B. Algorithm Analysis

In this subsection we demonstrated the results where we applied five popular algorithms and at the same time all of their performance comparisons according to our dataset. In the part of model evaluation, we followed two ways to find out the optimum model. On the other hand, we considered 5 teacher’s feedback on class level as a counsellor and picked average value to set score for finding class level to make our dataset. Here, every teacher gave their decision against each student’s counselling requirements based on 6 attributes. They focused on academic counselling as we set first priority on SGPA as well as CGPA for classifying students. After that we got the best model (algorithm) to predict counselling necessity. Meanwhile, 10 fold cross validation and 66% dataset splits method was used here for choosing the best model among 5 classifier algorithms. Table III is going to present the results of two observations among 498 instances. All 5 teachers given feedback is added here.



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Although there is not much difference between them. We considered their average output. All these faculty members were chosen from Daffodil International University on the basis that they are counselling their students for at least a year using a particular platform specially designed for Daffodil International University's all Faculties, so that they can monitor all the students and guide them to shape their futures. So, we can consider their output as standard.

Table- III: Attribute Scoring vs. Average Teacher's Feedback

Considered Parameter (Student Counselling Class)	Factor Scoring	Student Counsellor (SC = (T1 + T2 + T3 + T4 + T5) / 5)
YES	294	325
NO	204	173

Here, Fig. 2 prepared for illustrating the workflow of our proposed model. There are two observable facts namely- the student's counsellor and scoring method that was considered to propose our final model.

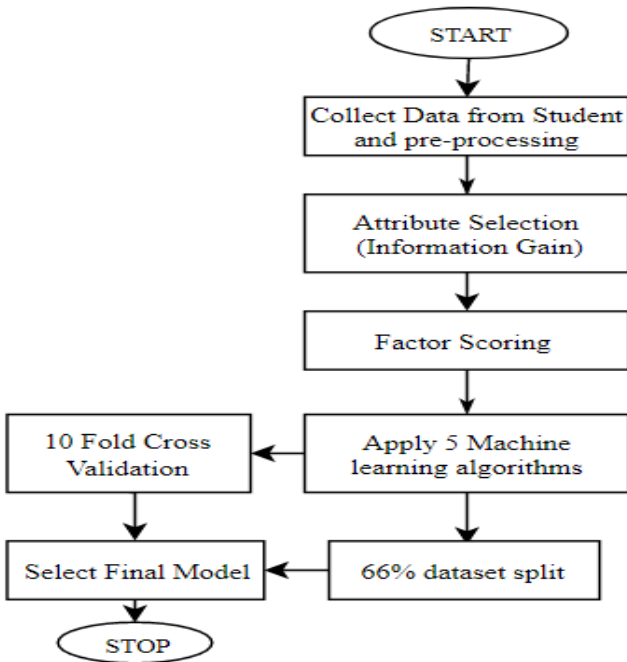


Fig. 2. Model Selection Procedure

We compared 5 algorithms and we have found one algorithm which is Ibk - "Instance Based Knowledge/Learning" is more fit for our approach. Here, the procedure is also described for implementing this model in future. In the case of implementation, factor scoring method will be introduced when a new instance will arrive in the system after that comparing with threshold value then the system could predict the final result for student counselling as like our proposal. In this paper, we have chosen only five most popular machine learning classification algorithms where all of these algorithms provided almost similar results for our proposed approach.

As we mentioned, Ibk follows the nearest neighbor algorithm where the distance function $D(X_i, X_j)$ is used to decide which neighbors (n) are closest to an input instance

according to weighted-distance calculation and also have an intense effect on an instance-based learning system. Equation (2) for calculating distance of two points.

$$D(X_i, X_j) = \sqrt{\sum_{r=0}^n (a_r(X_i) - a_r(X_j))^2} \quad (2)$$

So, $D(X_i, X_j)$ = Distance between X_i and X_j .

And then considered a weighted function is as follows,

$$f(X_i) \leftarrow \frac{\sum_{j=1}^n w_j f(x_j)}{\sum_{j=1}^n w_j} \quad (3)$$

$$\text{Where, } W_j \equiv \frac{1}{D(X_i, X_j)}$$

C. Results

In this section we will discuss about the result. In previous section we found Ibk is better for our approach. Ibk provides 95.38% accuracy based on 10 fold cross- validation method. The two basic performance metric sensitivity and specificity helped us to understand the effectiveness of our proposed method. Sensitivity (Sn) and Specificity (Sp), and total accuracy defined as follows:

$$\text{Sensitivity (Sn)} = TP / (TP+FN)$$

$$\text{Specificity (Sp)} = TN / (TN+FP)$$

$$\text{So, Total Accuracy} = (TP+TN) / N$$

Here, N is the total number of instances. TP, FP, TN and FN are the number of True Positive, False Positive, True Negative and False Negative regulations respectively [18]. True Positive (TP) is the case where true event was correctly predicted. True Negative (TN), where false event was correctly predicted. False Positive (FP) is the case where incorrectly true event was predicted and finally False Negative (FN) where prediction of false event occurred [19]. To detect more effective algorithm we used two ways to analysis dataset which is described in Table IV. Here we present accuracy of five algorithms based on 10 fold cross-validation and 66% dataset splits technique. It is obvious that, Ibk generated the best result to predict counselling for our factor scoring approach.

Table- IV: Accuracy Comparison

Classifier Algorithm	10 fold cross Validation (Accuracy %)	66% data split (Accuracy %)
Ibk	95.38	94.08
Naive Bayes	85.14	94.08
Multilayer	94.97	93.49
SMO	95.38	93.49
Random Forest	95.18	93.49

10 fold cross-validation which is a way where dataset divided into 10 folds and every time total 9 folds tested by remaining 1 fold. Cross validation used in three cases: performance measurement, model selection and tuning model parameter. Meanwhile, 66% dataset splits is an another way to data analysis where total dataset is divided into 2 parts, one part holds 66% data for training and remaining 33% for model testing. Although 66% dataset splits generated almost the same results as 10 fold cross validation for selected 5 algorithms but it helped us to differentiate between Ibk and SMO as both of these algorithms generated same result according to 10 fold cross-validation. After using 66% data splits technique we found Ibk performs slightly better than SMO.

Table V was also created for presenting selected 5 algorithms by TP, TN, FP, FN value to clear the best model.

Table- V: Confusion Matrix of five algorithms according to two category

Classifier	10 Fold Cross-Validation		66% Data split	
	Ibk	TP=293	FN=1	TP=106
	FP=22	TN=182	FP=10	TN=53
Naive Bayes	TP=242	FN=52	TP=106	FN=0
	FP=22	TN=182	FP=10	TN=53
Multilayer	TP=291	FN=3	TP=105	FN=1
	FP=22	TN=182	FP=10	TN=53
SMO	TP=293	FN=1	TP=105	FN=1
	FP=22	TN=182	FP=10	TN=53
Random Forest	TP=292	FN=2	TP=105	FN=1
	FP=22	TN=182	FP=10	TN=53

D. Discussion

In this paper, we used our own created dataset as well as did not find any similar study. Although, many researchers predict students’ performance based on academic activities or features but counselling was rare. Some study was based on career counselling but our aim was to provide the necessity of academic counselling based on selected 6 attributes. In previous section we compared 5 classifier algorithms for realizing which one is the right model for predicting the necessity of counselling. In this paper, we analyzed our dataset according to different algorithms where students’ counselling was the focused point.

Table- VI: Five classifiers’ performance using five evaluation metrics

Classifier	Specificity	FPR	Precision	Recall/Sensitivity	F-measure
Ibk	0.89	0.1	0.93	0.99	0.95
Naive Bayes	0.89	0.1	0.91	0.82	0.86
Multilayer	0.89	0.1	0.92	0.98	0.94
SMO	0.89	0.1	0.93	0.99	0.95
Random Forest	0.89	0.1	0.92	0.99	0.95

Nowadays, the students are busier with their social life/media and other activities rather than study that we found from many research papers. Furthermore, student’s dropout ratio have been increasing day by day. For this purpose, our study was to find out attributes that are related to students’ academic counselling. Though, Ibk achieved better results in our proposed study also we described all those 5 classifier algorithms which are Ibk, Naive Bayes, Multilayer, SMO and Random Forest with 5 metrics showed in Table VI. Furthermore, five metrics also worked as a comparison parameters in our presented study.

ROC (Receiver Operating Characteristics) is a well-known performance evaluator. ROC area was also illustrated in Fig. 3. In this figure, we presented 5 ROC areas according to 5 algorithms as we mentioned the data in Table 6. Roc area provided the ratio of True Positive Rate (TPR) that is actually follow the equation of Sensitivity (Sn) and False Positive Rate (FPR). Where, $FPR = 1 - Specificity (Sp)$. ROC is an easiest way to visualize the performance of working algorithms.

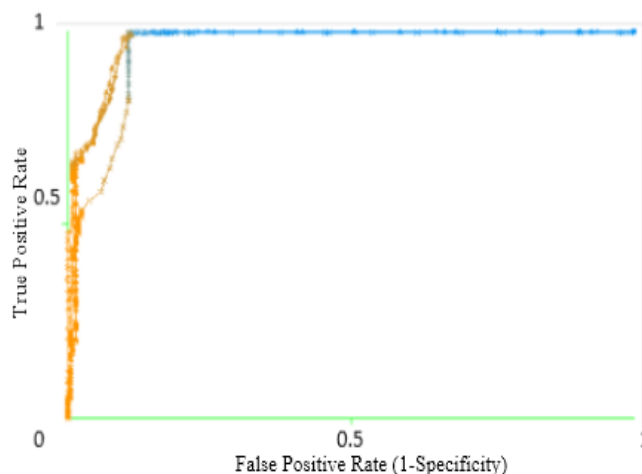


Fig. 3. ROC Area Comparison of Five Algorithms

Finally, this paper study is supportive for us to know about student’s study life and when it is helpful to provide counselling with better guidance and motivation for their successful life. Meanwhile, students will be more conscious about their life and parents if we also share this information with them.

III. CONCLUSION

Frustration of the students in university life cannot be removed entirely from all over the world but the level can be minimized if it is possible to predict in the early stage. In this paper, one of the most crucial focuses was to identify the procrastinated students in the classroom who needs proper counselling for a better student life. Although, the attributes those are considered here possibly not the only attributes to conduct this work. Some of the other attributes and pre-processing steps can be revised and improved to achieve more accuracy. The result from the students’ counsellor and the opinion from the students, both are considered to generate dataset for this model. The conclusion is justified that the Ibk algorithm is the strongest predictor among 5 algorithms those were considered for this experiment.



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In the contrast, finding the appropriate category of counselling for a specific student might be considered as a challenging future work for extending our research work.

Besides, implementing this method and applying it in real life is also our next study purpose. While, more features and instances will be needed for more accurate model creation.

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