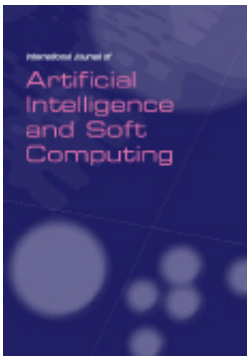

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Machine learning classification models for student placement prediction based on skills

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Machine learning classification models for student placement prediction based on skills

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Abstract: Placement plays a vital role for engineering students in their career planning. Placement is also important for engineering institutions to maintain the ranking in university. In this paper, we have proposed a few supervised machine learning classification models, which may be used to predict the placement of a student based on skills like aptitude, coding, communication and technical. We also compare the results of different proposed classification models. The classification algorithms support vector machine, Gaussian naive Bayes, K-nearest neighbour, random forest, decision tree, stochastic gradient descent and logistic regression were used.

Keywords: supervised learning; classification model; skill level; placement decision.

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1 Introduction

Every engineering student wants to get placed in reputed company during the campus placement. In the present era, campus placement activity has a great importance among all college activities. It helps to build a strong foundation for professionals to start a career in MNCs without facing problems in the real world jobs. Campus placement provides great opportunity to the students in order to achieve a great job in the companies as well as to establish a carrier in academics and research. Placement is also important for institutions, which helps them to maintain a good ranking in the university as well as in other national and international ranking agencies. In campus recruitment process there are many challenges.

- Technological transformations: In the recent era, the technology is changing in every sector day by day. Due to advancement of technology in every sector, there are some new emerging technologies that are on boom, such as artificial intelligence, machine learning, robotics, deep learning, data science, internet of things, etc. and taking over the traditional educational module.
- Reduction of gap between skill set and Industry requirement: Education system should be developed according to the recent trends, which is missing. To reduce the gap between skill set and industry requirement, institutions should create different models which helps them to take decision whether their students are fit for the industry or not?

To understand the gap between the skill set and industry requirement we have analysed some studies.

In their paper authors had described a placement prediction system for the students who are going to be placed in various IT companies, the prediction system based on the various skills of the students such as programming, communication etc. By using machine learning algorithm, the result is compared with some other machine learning algorithms such as LR, SVM etc. The prediction helps the placement officer and the students to evaluate themselves. This also indicates that, not all the companies look for the similar talent. It also helps the placement officers to identify the weaker students and devise the strategies so as to make the students fit for the industries (Giri, et al., 2016).

Authors had performed a survey on student placement prediction using supervised learning algorithms and concluded that the placement activity is very important for any educational institution. Placement of any students depends upon various aspects such as academic and non-academic activities, say communicational skill, soft skill, etc. Placement prediction of students is a tough task for the training placement officer (TPO).To solve this, data mining is performed. This proposed system is used to identify,

whether the student is placed or not. It is based on some machine learning model say SVM and Random Forest (Shejwal et al., 2019).

In this paper, the prediction of campus placement was done using data mining algorithms, i.e., fuzzy logic and k-nearest neighbour. Data mining was used in order to extract the information from large datasets. Placement of the student is most important part of any organisation. Placement not only depends on the academics, but it also depends upon some more features. In this paper, K-Nearest neighbour and fuzzy logic algorithm are used on the dataset in order to get the predictions and then the result is compared with respect to accuracy and performance. The algorithm is applied and the obtained accuracy for K-nearest neighbour is 97.33 % and for fuzzy logic it is 92.67%. Hence, K-nearest neighbour is better for prediction (Mangasuli and Bakare, 2016).

In their paper, authors had discussed about campus placement prediction using supervised machine learning technique. Placement is the most important activity in any institution. Placement always helps the institutions as well as the students. The dataset of the student was taken. The main objective was to predict the placement data with some model. Then the model was compared with the traditional classification model. Here, the dataset is applied on random forest which gives 86% result and the decision tree gives 84% accuracy. Hence, random forest is better for prediction of placement dataset (Manvitha and Swaroopa, 2019).

1.1 Machine learning

In this section, define the machine learning by different computer scientist and machine learning pioneer.

According to the Samuel, 'The field of study that gives computer the ability to learn without being explicitly programmed', this is an older definition of machine learning.

Other definition is given by Tom Mitchell 'A computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if it's performance at task in T, as measured by P, improves with expertise E.'

Example: Playing checkers.

E the expertise of playing games

T the task of playing checkers

P the probability of winning next game.

Machine learning is the science of obtaining computers to find out, while not being expressly programmed. When you would like your email and a spam filter saves you from having to struggle through heaps of spams, again, that is a result of your pc has learned to tell apart spam from non-spam email, thus that is machine learning.

In our research proposal, we seek answers to the following research questions:

1 Which input feature out of the four selected in the study have the highest impact on the placement of the student?

2 How do seven classification algorithms used in proposed classification models compare in terms of accuracy?

3 How do seven classification algorithms used in proposed classification models compare in terms of performance?

The rest of the paper is as follows. Section 2 shows related work on supervised learning and classification. Section 3 describes materials and methods used in our research work, whereas Section 4 addresses the results and discussions. Finally, Section 5 draws conclusions from results and outlines the future work.

2 Related work

In this section, there is a brief summary of the previous work conducted by researchers in the context of supervised machine learning particularly classification.

Authors had described a model based on data mining for student placement prediction using machine learning algorithms. To extract the meaningful information of datasets, this process is called as data mining by using machine learning algorithms. Authors also used education data mining tool, which is to be considered as more powerful tool in educational domain. It presents an effective method for extracting the student's performance based on various parameters and predict as well as analyses whether the students were recruited or not during the campus placement. Predictions are performed using machine learning algorithm J48, naive Bayes, random forest and random tree in weka tool and multiple linear regression. Based on the result, higher education organisation can offer superior training to their students (Rao et al., 2018).

Authors had discussed about the student placement analyser. Higher learning institutions are facing bigger challenges in performance evaluation of students for placements. In this era, the competition is increasing among the institutions. Therefore, there is a need of defining a new efficient system which is used for assessment and for providing the better management and take decision support system to assist new strategies. Authors present a recommendation system which is used to predict the student's placement (Thangavel et al., 2017).

In their paper, author's wants to tell about the data mining methodology which can be used to extract meaningful information from data and that can be used in formatical evaluation in assisting educators to taking important decisions. Data mining is used to discover the knowledge from education database, and able to take decisions for educational system. Authors collect the data of students such as previous and current academic records and apply different classification algorithms by using WEKA tool and analyses the student's performance for training and placement. Here, three classifications algorithms are used. The best algorithm based on the placement data is Naive Bayes and its accuracy is 86.15% (Pal and Pal, 2013).

In their paper, authors had proposed a model to solve the student placement prediction problem using linear regression model, K-neighbour regression model, decision tree regression model, XGBoostRegression model, random tree classifier model, Gradient boost regression model and light GBM regression model. This work was divided in two phases. The phase 1 was done on a simple dataset and the phase 2 was done with an extended dataset with added additional features about the students. The performance measurements considered in this study were prediction accuracy and the root mean square error (RMSE) (Aravind et al., 2019).

In their paper, authors had given a harmony, a deep learning-driven cubic centimeter cluster computer hardware that places coaching jobs in a very manner that minimises interference and maximises performance (i.e., coaching completion time). Harmony was supported a rigorously designed deep reinforcement learning (DRL) framework increased

with reward modelling. The DRL employs progressive techniques to stabilise coaching and improve convergence, together with actor-critic algorithmic program, job-aware action house exploration and knowledge replay (Bao et al., 2019).

In their paper, authors had presented a recommendation system that predicts the students to have one of the five placement statuses, viz., dream company, core company, mass recruiters, not eligible and not interested in placement. Furthermore, the students in pre-final and final years of their under graduate engineering program. With this they can put in more hard work for getting placed in to the companies that belong to higher hierarchies (Thangavel et al., 2017).

Authors had used an outsized and have made dataset from education transition system in Turkey and developed models to predict education placement check results. Mistreatment sensitivity analysis on those prediction models they known the foremost necessary predictors. The results showed that C5 call tree algorithmic rule is that the best predictor with ninety fifth accuracy on hold-out sample, followed by support vector machines (with associate accuracy of 91%) associated artificial neural networks (with an accuracy of 89%). provision regression models came intent on be the smallest amount correct of the four with and overall accuracy of eighty two. The sensitivity analysis unconcealed that previous check expertise, whether or not a student encompasses a scholarship, student's range of siblings, and former years' grade average is among the foremost necessary predictors of the location check scores (Sen et al., 2012).

Author had given the event of placement predictor system (PPS) mistreatment logistical regression model, supported the scholar scores in matric, senior secondary, and subjects in numerous semesters of technical education and demographics. PPS predicts the location of a student in coming achievement session. The steps concerned in planning and building logistical regression model was explicit mistreatment the past educational and in-house placement information of Guru Nanak Dev Engineering School (GNDEC), Ludhiana. Machine learning parameterised approach was accustomed support analysis and analyse the student's performance in previous sessions. The results were generated from AN open supply wildebeest Octave programming tool. The developed model had been applied to predict the location of scholars at coaching and placement centre (TPO). The testing of PPS brings concerning promising 83, 83.33% accuracy. (Sharma et al., 2014).

Author had planned the scholar prediction system being most important approach which can be wont to differentiate the scholar data/information on the idea of the scholar performance. Managing placement and coaching records in any larger organisation is kind of tough because the student's variety area unit high. Planned fuzzy reasoning system classified the scholar knowledge with ease and useful to several instructional organisations. There are a unit several classification algorithms and applied math base technique which can be taken pretty much as good assets for classifying the scholar knowledge set within the education field. During this paper, fuzzy reasoning system has been applied to predict student performance that helps to spot performance of the scholars and conjointly provides a chance to enhance the performance (Rathore and Jayanthi, 2017).

In their paper, authors investigated the accuracy of data mining techniques. The first step of the study was to gather the student's data. They collected records of 300 Under Graduate students of computer science course, from a private educational institution. In second step cleaning of data was done. In the third step, Naive Bayes simple, MultiLayerPerception, SMO, J48, REPTree algorithms were constructed and their

performances were evaluated. The study revealed that the MultiLayer perception is more accurate than the other algorithms. This work will help the institute to accurately predict the performance of the students (Ramesh et al., 2011).

Author had proposed a system using the knowledge discovery and data mining (KDD), which is the placement class process using the classification method. In the first experiment classified instances 84.2%. The second experiment uses the same data and attributes, give the best percentage of accuracy as 92.1%. The best results are using Naive Bayes and SMO (Pratiwi, 2013).

3 Materials and methods

This section describes various materials used in our research work and the entire steps in research methodology.

3.1 Dataset

The dataset used in the study is collected from the students of the final year BTech CSE and IT branch of Shri Ram MurtiSmarak college of engineering and technology (SRMSCET), Bareilly, Uttar Pradesh (India). These students have undergone through the various placement drives in the current academic session of 2019-20. The four input features selected in the dataset are Aptitude, technical, coding and communication skills of the students. The output/target class is whether the student is placed in any of the placement drives or not. All four input features and the target class are categorical in nature. The students were self- evaluated on all input features on a scale of 1 to 5 as follows: 1 is poor, 2 is average, 3 is good, 4 is very good and 5 is excellent. The target class interprets 1 as Placed and 0 as unplaced student. The total numbers of rows in the dataset are 170.A Google form with appropriate instructions was designed and sent to the students for data collection.

3.2 Tools used

All the seven classification algorithms used to build classification models are implemented using following libraries of Python:

Scikit learn

Pandas

Matplotlib

Seaborn

Numpy

Google Colab, a free cloud service is used to write and execute codes in Python.

3.3 Research methodology

Various steps that we follow to accomplish our research work is broadly consist of 12 steps:

Step1 Problem formulation

Step2 Feature selection

Step3 Data collection

Step 4 Data cleansing

Step 5 Classification algorithm identification

Step 6 Identification of tools for implementation

Step 7 Implementation of algorithm and development of classification models through training

Step 8 Testing the models

Step 9 Evaluating the accuracy of the models

Step 10 Evaluating the performance of the models

Step11 Prioritising the input feature through result analysis

Step 12 Comparing the accuracy and performance of the models

4 Results and discussion

The results of our work are summarised in three tables and two figures, i.e., Table 1, Table 2, Table 3, Figure 1 and Figure 2.

Table 1 represents Accuracy_scoreandits percentage of different classification models. Other fields of Table 1 are algorithm, input features, target class, training data, test data and Random_State. It is observed from Table 1 that Gaussian Naive Bayes,K-nearest neighbour, Support Vector machine and logistic regression have the highestAccuracy_score of 0.9411. Stochastic gradient descent has the Accuracy_score of 0.8529. Random forest and decision tree classifiers have the lowest Accuracy_score of 0.8235.

Table 2 depicts Confusion_matrix and Heatmapgenerated from different classification models. Both of them consist of Actual label and predicted label. Further, these actual and predicted labels are divided into true positive, false positive, false negative and true negative values. Accuracy_score in Table 1 is calculated on the basis of the values of Confusion_matrix.

Table 3 elaborates the Classification_report of different classification models. The various parameters used in Classification_report are precision, recall, f1-score and support.

Figure 1 represents the decision tree generated by the decision tree classifier. Its root node is the input feature communication. So, this classifier assumes communication on the top priority among all the four input features. Aptitude and coding are almost at same label on the second priority and technical on the last priority. The depth of the decision tree is 9.

Table 1 Accuracy_score of different classification models

	Algorithm	*Input features*	*Target class*	*Training data*	*Test data*	*Random_State*	*Accuracy_score*	*% Accuracy_score*
1	Gaussian Naïve Bayes	Aptitude Technical Coding Communication	80%	20%	20%	13	0.9411	94.11
2	K-Nearest neighbour (k = 13)	Aptitude Technical Coding Communication	Placed	80%	20%	13	0.9411	94.11
3	Support Vector machine (kernel ='linear')	Aptitude Technical Coding Communication	Placed	80%	20%	13	0.9411	94.11
4	Stochastic gradient descent	Aptitude Technical Coding Communication	Placed	80%	20%	08	0.8529	85.29
5	Random forest classifier	Aptitude Technical Coding Communication	Placed	80%	20%	13	0.8235	82.35
6	Decision tree classifier	Aptitude Technical Coding Communication	Placed	80%	20%	33	0.8235	82.35
7	Logistic regression	Aptitude Technical Coding Communication	Placed	80%	20%	13	0.9411	94.11

Table 2 Confusion_matrix and Heat map of different classification models (see online version for colours)

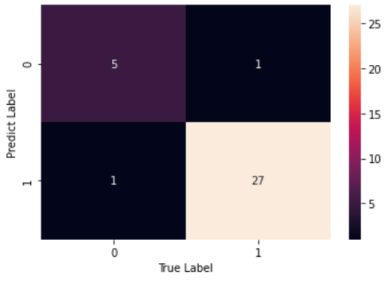
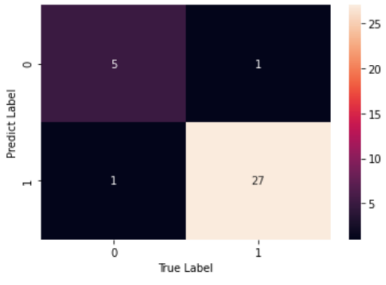
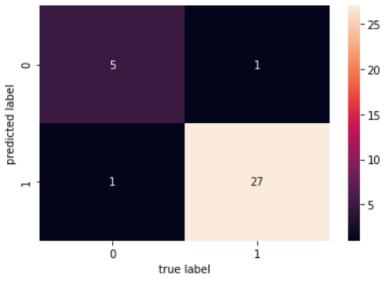
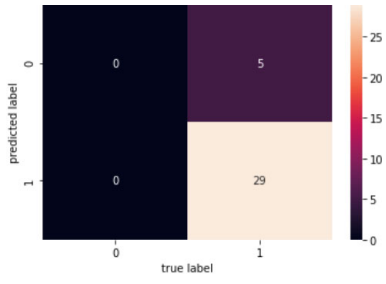
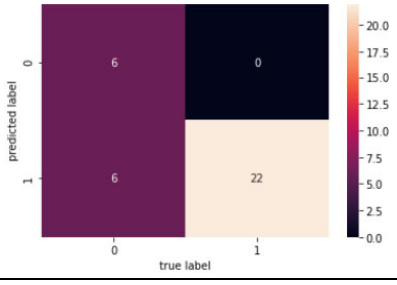
Models		*Confusion matrix*	*Heat map*
1	Gaussian Naive Bayes	[5, 1], [1,27]	
2	K-Nearest neighbour	[5, 1], [1,27]	
3	Support vector machine	[5, 1], [1,27]	
4	Stochastic gradient descent	[0, 5], [0,29]	
5	Random forest classifier	[6, 0], [6,22]	

Table 2 Confusion_matrix and Heat map of different classification models (continued) (see online version for colours)

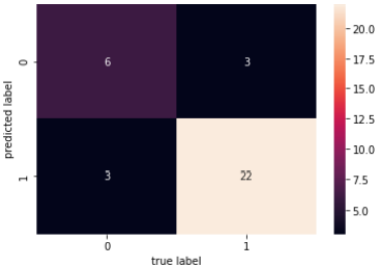
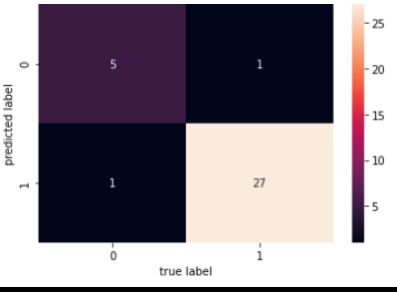
Models		*Confusion matrix*	*Heat map*
6	Decision tree classifier	[6, 3], [3,22]	
7	Logistic regression	[5, 1], [1,27]	

Table 3 Classification_report of different classification models

Model		*Classification report*				
1	Gaussian Naive Bayes	precision	recall	f1-score	support	
		0	0.83	0.83	0.83	6
		1	0.96	0.96	0.96	28
		accuracy			0.94	34
		macro avg	0.90	0.90	0.90	34
		weighted avg	0.94	0.94	0.94	34
2	K-Nearest neighbour	precision recall	recall	f1-score	support	
		0	0.83	0.83	0.83	6
		1	0.96	0.96	0.96	28
		accuracy			0.94	34
3	Support Vector machine	precision	recall	f1-score	support	
		0	0.83	0.83	0.83	6
		1	0.96	0.96	0.96	28
		accuracy			0.94	34
		macro avg	0.90	0.90	0.90	34
		weighted avg	0.94	0.944	0.94	34

Table 3 Classification_report of different classification models (continued)

Model		*Classification report*				
4	Stochastic gradient descent		precision	recall	f1-score	support
		0	0.00	0.00	0.00	5
		1	0.85	1.00	0.92	29
		accuracy			0.85	34
		macro avg	0.43	0.504	0.46	34
		weighted avg	0.73	0.85	0.79	34
5	Random forest classifier		precision	recall	f1-score	support
		0	0.50	1.00	0.67	6
		1	1.00	0.79	0.88	28
		accuracy			0.82	34
		macro avg	0.75	0.89	0.77	34
		weighted avg	0.91	0.82	0.84	34
6	Decision tree classifier		precision	recall	f1-score	support
		0	0.67	0.67	0.67	9
		1	0.88	0.88	0.88	25
		accuracy			0.82	34
		macro avg	0.77	0.77	0.77	34
		weighted avg	0.82	0.82	0.82	34
7	logistic regression	precision	recall	f1-score	support	
		0	0.83	0.83	0.83	6
		1	0.96	0.96	0.96	28
		accuracy			0.94	34
		macro avg	0.90	0.90	0.90	34
		weighted avg	0.94	0.94	0.94	34

Figure 1 Decision tree (depth = 9) (see online version for colours)

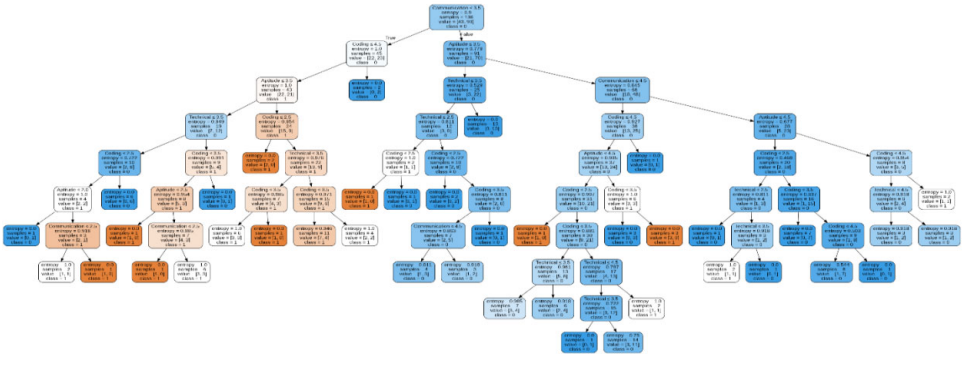
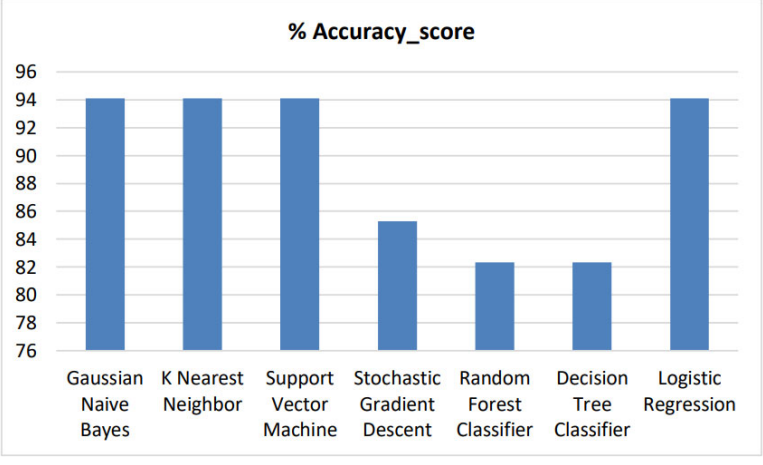


Figure 2 shows a 2D column chart to compare the %Accuracy_score predicted by seven different classifiers. From this figure, it is obvious that that Gaussian Naive Bayes, K

nearest neighbour, Support Vector machine and logistic regression have the highest Accuracy_score of 0.9411, Stochastic gradient descent has the Accuracy_score of 0.8529, random forest and decision tree classifiers have the lowest Accuracy_score of 0.8235.

Figure 2 2 d column chart to compare the % Accuracy_score (see online version for colours)



5 Conclusions and future work

This paper proposes seven classification models. The results of all seven proposed classification models in terms of metrics Accuracy_score, Confusion_matrix, Heatmapand Classification_report are exhaustively discussed and explained in Section 4. Fundamentally there were three research questions in our mind and we want to find the answer of these three research questions through our research work as mentioned in Section 1 also.

From the results and discussions of Section 4, firstly, we conclude that Communication is on the top priority among all the four input features. Aptitude and Coding are almost at the same label and on the second priority and Technical on the last priority. This conclusion is also validated by applying new data sample (not included in the dataset) and observing the target class as output of all classification models. The analysis of Decision Tree in Figure 1 also validates the above conclusion. From the results and discussions of Section 4, secondly, we conclude that classification models using Gaussian Naive Bayes,K-Nearest Neighbour, Support Vector machine and logistic regression have the highest Accuracy_score of 0.9411, Stochastic gradient descent has the Accuracy_score of 0.8529, random forest and decision tree classifiers have the lowest Accuracy_score of 0.8235. Table 1 and Figure 2 also validate the above conclusion.

In this paper, we have selected the student skills, i.e., aptitude, coding, communication and technical for our research work. In future, we will select entirely different characteristics of the student, i.e., academic performance and try to correlate its impact on their placement.

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