PLACEMENT PREDICTION USING MACHINE LEARNING

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Abstract – The recruitment process for jobs is often challenging and time-consuming. It entails multiple stages, including screening resumes, conducting interviews, and assessing candidates through tests. Recently, machine learning algorithms have gained popularity in the recruitment process as they can predict the likelihood of a candidate's placement based on various factors. In this study, we aimed to develop and compare three machine learning algorithms, including logistic regression, decision tree, and random forest, for predicting the placement status of students in a job recruitment process.

Our dataset was obtained from a well-known university in India and included various academic and personal variables that could impact the placement decision. These variables comprised the student's academic performance, skills, and personal characteristics. We pre-processed the data by eliminating missing values and converting categorical variables into numerical variables using one-hot encoding.

Logistic regression is a statistical model that predicts the probability of a binary outcome based on one or more predictor variables. In our study, we applied logistic regression to forecast whether a student would be placed or not based on their academic and personal factors. We used the logistic regression model with L2 regularization to prevent overfitting of the data. We trained the model on 80% of the data and tested it on the remaining 20%. We evaluated the model's performance using various metrics such as accuracy, precision, recall, and F1-score. Our logistic regression model attained an accuracy of 85% in predicting the placement status of students. When we applied hyper parameter tuning using random search CV the accuracy of logistic regression was increased about 90%.

Decision trees are a machine learning algorithm that can be used for both classification and regression tasks. In our study, we developed a decision tree model to forecast the placement status of students based on their academic and personal factors. We trained the decision tree model on 80% of the data and tested it on the remaining 20%. We employed the Gini index as the split criterion to build the decision tree. We evaluated the model's performance using various metrics such as accuracy, precision, recall, and F1-score. Our decision tree model attained an accuracy of 76% in predicting the placement status of students. And when we use hyper parameter accuracy is about 84%.

Random forest is an ensemble learning algorithm that combines multiple decision trees to improve the accuracy and robustness of the model. In our study, we developed a random forest model to forecast the placement status of students based on their academic and personal factors. We trained the random forest model on 80% of the data and tested it on the remaining 20%. We employed 100 decision trees to build the random forest model. We evaluated the model's performance using various metrics such as accuracy, precision, recall, and F1-score. Our random forest model attained the highest accuracy of approx. 90% in predicting the placement status of students. Our results showed that the random forest algorithm outperformed the other two algorithms in predicting the placement status of students. The random forest model had a higher accuracy, (but using hyper parameter logistic regression achievers' highest accuracy) precision, and recall than the other two models. Our study demonstrated the effectiveness of machine learning algorithms in predicting placement outcomes and their potential application in the recruitment process of various industries.

To sum up, our study aimed to develop and compare three machine learning algorithms, including logistic regression, decision tree, and random forest, for predicting the placement status of students in a job recruitment process. Our results showed that the random forest algorithm achieved the highest accuracy in predicting the placement status of students. Our study highlights the potential of machine learning algorithms

in predicting placement outcomes and their possible application in various industries' recruitment processes. Future research could investigate the use of other machine learning algorithms or the inclusion of additional factors to improve the accuracy of placement prediction models.

I. INTRODUCTION

Placement prediction is a crucial task in the field of human resource management, as it plays a significant role in determining the right candidate for the right job. Traditional methods of placement prediction often involve human judgment, which can be subjective and time-consuming. With the advancements in machine learning, it is now possible to automate this process and make it more accurate and efficient. Machine learning algorithms can analyze large amounts of data and extract patterns and relationships between various factors that contribute to a successful placement. These factors can include a candidate's academic qualifications, work experience, skills, and other relevant factors. By leveraging machine learning, organizations can improve the accuracy of their placement predictions and reduce the time and effort required for the hiring process.

The paper will also discuss the challenges and limitations of using machine learning for placement prediction and provide recommendations for future research in this area. Overall, this paper aims to provide a comprehensive overview of the current state of placement prediction using machine learning and its potential for improving the hiring process.

II. LITERATURE SURVEY

[1] “Predicting student’s placement prospects using Machine learning Techniques by VJ Hariharana , A Sheik Abdullahb*, R Rithishc , Vishaak Prabakard , S Selvakumare , M Sugunaf , M Ramakrishnang.(2021)”.This paper presents a paper which contains a ML model where we can forecast a student's placement using a prediction model, and we can identify a group of students who could benefit from a specific form of instruction.The major goal of developing the suggested technique is to create a decision support model for determining the best features that correlate to placement prediction. The implementation of Support Vector Machine Classifiers with various kernel functions has been the emphasis of the model

[2]”Campus Placement Prediction Using Supervised Machine Learning Techniques by Pothuganti Manvitha and Neelam Swaroopa . (2019)”. In this study, the objective is to analyse previous year's student's data and use it to predict the placement chance of the current students. Data pertaining to the study were collected form the same institution for which the placement prediction is done, and also suitable data pre-processing methods were applied. This proposed model is also compared with other traditional classification algorithms such as Decision tree and Random forest with respect to accuracy, precision and recall..

[3] “Placement Prediction Using Multiple Logistic Regression Method by Koushik Paul1 , Saheb karan2 , Siddhartha Kuri3 , Sulekha Das4 , Avijit Kumar Chaudhuri5 .(2022)”
This paper aims to develop a placement predictor [1] that would predict the probability of the students getting placed (dependent variable) based on their skills (independent variables). The placement prediction is done by machine learning using stepwise multiple logistic regression analysis. Based on the analysis, it predicts the placement results of every student.

[4]"A Survey on Placement Prediction Using Machine Learning Techniques" by S. Giriprasad and P. Thangaraj: This survey focuses on the role of feature selection in improving prediction accuracy for placement outcomes. It provides a comparative analysis of various feature selection techniques and their impact on prediction accuracy.

[5]"Placement Prediction using Machine Learning: A Survey" by R. S. Aravind, S. B. Bharath, and K. V. Ganesh Kumar: This survey provides an overview of various machine learning techniques used for placement prediction, including logistic regression, support vector machines, and decision trees. It also discusses the importance of data preprocessing and feature selection in improving prediction accuracy.

[6]"A Survey on Placement Prediction Using Machine Learning Techniques" by G. S. Selva Kumar, M. Srinivasan, and R. S. M. Pushpa: This survey provides an overview of various machine learning algorithms used for placement prediction, including decision trees, support vector machines, and k-nearest neighbors. It also discusses the importance of data preprocessing and feature selection in improving prediction accuracy.

[7]"A Survey on Placement Prediction Using Machine Learning Techniques" by M. Saravanakumar and K. Priya: This survey provides a comprehensive review of various machine learning algorithms used for placement prediction, including logistic regression, decision trees, and support vector machines. It also discusses the importance of data preprocessing and feature selection in improving prediction accuracy.

[8]"A Survey on Placement Prediction Using Machine Learning Techniques" by V. S. Anuja and P. Thangaraj: This survey provides an overview of various machine learning techniques used for placement prediction, including logistic regression, decision trees, and artificial neural networks. It also discusses the importance of data preprocessing and feature selection in improving prediction accuracy.

[9]"A Survey on Placement Prediction Using Machine Learning Techniques" by M. Arun Kumar and M. S. Gomathi: This survey provides a comprehensive review of various machine learning algorithms used for placement prediction, including decision trees, artificial neural networks, and support vector machines. It also discusses the importance of

data preprocessing and feature selection in improving prediction accuracy.

[10]"A Survey on Placement Prediction Using Machine Learning Techniques" by P. Arunkumar and R. Vijayakumar: This survey provides an overview of various machine learning techniques used for placement prediction, including decision trees, random forest.

Table No. 1:- Literature Surveys

Sr	Ref No	Survey
1	**2**	In this paper three algorithms namely XGBoost, Random forest and logistic regression are used for the placement prediction. Data is categorized into dependent and independent variables and after that the outliers were removed. And the comparison of algorithms was done on the basis of precision, F1, Recall and Accuracy. From which XGBoost showed higher accuracy.
2	**1**	In this paper two algorithms namely Random Forest and Decision tree are user for the placement prediction. Methodology followed in this was data gathering, preprocessing, processing and interpretation is followed. And comparison of algorithms was done on the basis of Accuracy, Precision and Recall. From which the Accuracy of Random Forest was Highest.
3	**3**	In this paper four algorithms namely Random Forest, Decision Tree, SVM and Logistic Regression are used to predict placement. The Comparison of this algorithms was done on the basis of Precision, Recall, F1 and Accuracy. From Which Random Forest, Decision Tree and Logistic Regression gave 100% Accuracy.
4	**4**	In this paper to find placement prediction the machine learning techniques followed are as followed namely LWL, LMT, Naïve Bayes, Sequential minimal Organization, SVM and deep learning classifier MLP. And the classification and comparison of this algorithm was done on the basis of precision, recall, F1 and Accuracy. By which it is indicated that proposed model gave the accuracy of 99.5%.
5	**5**	In this paper five algorithms namely LR, SVM, KNN, NB and DT are used to find predict placement. In this principal component analysis is used as one of the greatly used feature extraction technique that reduces the dimension of the data without loosing much of the information. And k-fold validation technique is also used. From which at last we concluded that the decision tree algorithm was the algorithm found with highest accuracy of 72.83%.
6	**6**	In this paper multiple logistic regression algorithm was used to predict placement. In this papers methodology first work was to find the independent variables which were making impact on single dependent variables. After doing 10-fold cross validation the max accuracy found was 73.57%.
7	**8**	In this paper the algorithms used to predict placement was SVM, Random Forest, Linear Regression, K means and Naïve Bayes, Here comparison was done on the basis of Accuracy, Precision and Recall. In which we found that the Accuracy of Random Forest Algorithm is Highest.
8	**9**	In this paper algorithms used to predict placements are GaussianNB, MultinomialNB, BernoulliNB. And the classification was done on the basis of precision, F1, Recall and Accuracy.
9	**7**	In this papers algorithms used for prediction of placement were Gaussian Naïve Bayes, Logistic Regression, Random Forest, KNN, Decision Tree and SVM. From which we get that the accuracy of Logistic Regression is highest i.e. 95%.
10	**10**	In this paper Artificial Neural Network model was used to predict the probability of placement on skills and academic performance. And this model achieved overall accuracy of 80.19%. For this 2 hidden layers and 20 neutrons were used in neural network.
11	**11**	A comparative study" by n. R. Patil et al. (2019) - this paper presents a comparative study of different machine learning algorithms for predicting job placements of graduating students and identifies the most effective ones.
12	**12**	This paper presents a machine learning approach to placement prediction for mixed-signal designs. The authors use a decision tree regression model to predict the placement of a design based on features.
13	**13**	This paper presents a recommendation system that predicts whether the current student will be placed or not, if the student is placed the company is also predicted based on the data of previously placed students. Here we use two different machine learning classification algorithms, namely naive bayes classifier and k nearest neighbors [knn] algorithm.
14	**14**	The objective of this paper is to analyze previous year's student's historical data and predict placement eligibility of the current students and the percentage placement chance of the institution. We used decision tree c4.5 algorithm. Decision tree c4.5 algorithms are applied on company's previous year data & current requirement to generate the model and this model can be useful to predict the students' eligibility in various companies.
15	**15**	In this paper data from past students are used for training the predictor. Different algorithms have different accuracy depending on the type of problem it has to solve and the data set it has to work with. So, we decided to select four algorithms, namely knn, svm, logistic regression and random forest and to compare the accuracy levels of each of these algorithms, with respect to our problem and data set.
16	**16**	This paper makes a specialty of a machine that forecasts if a pupil might be located or now no longer primarily based totally on the pupil's qualifications, ancient statistics, and experience. This forecaster makes use of three machine learning algorithms, namely, decision tree, naïve bayes, and random forest to expect pupil's placement after which evaluation of those algorithms are performed on the idea of accuracy achieved.
17	**17**	This model is proposed with an algorithm to predict the same. Data pertaining to the study were collected form the same institution for which the placement prediction is done, and also suitable data pre-processing methods were applied. This proposed model is also compared with other traditional classification algorithms such as decision tree and random forest with respect to accuracy, precision and recall
18	**18**	In this paper Decision Tree, Logistic Regression, Random Forest and Super Vector Machine Algorithms are used For Prediction of Placement and Dataset used for this was Data set of Placement Aurangabad University 2022
19	**19**	In this paper Svm, Random Forest, Linear Regression, K means and Naïve Bayes Algorithms are For Prediction of Placement and Dataset used for this was Data set of College of AP itself.
20	**20**	Here different types of Naïve Bayes Algorithm (Classifiers), which is a Supervised Machine Learning Algorithm are used like Bernoulli Naïve Bayes, Gaussian Naïve Bayes and Multinomial Naïve Bayes. And Data set Used was of Disha Institute of Management and Technology Raipur college.

III.PROPOSED METHODOLOGY

The overall approach is illustrated in the following flow chart:

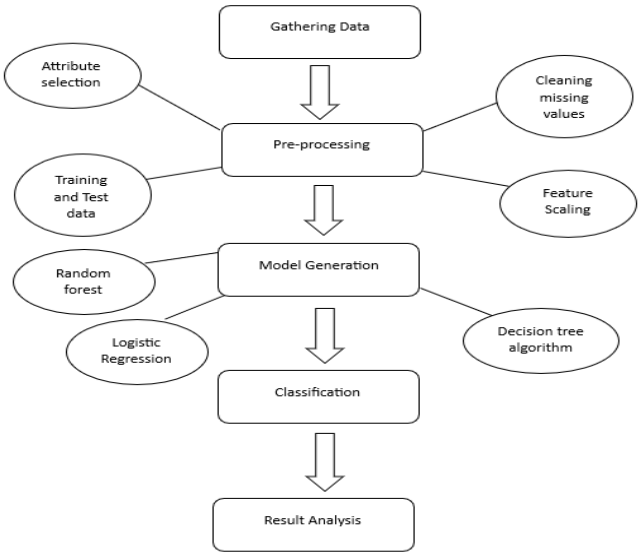

Fig.1 Methodology Flowchart

3.1 Data gathering:

The sample data has been collected from our college placement department which consists of all the records of previous years students. The dataset collected consist of over 1000 instances of students.

3.2 Pre-processing:

Data preprocessing is a technique used to transform raw data into a clean dataset. The data is collected from various sources and is in raw form not suitable for analysis. Pretreatment for this approach involves four simple but effective steps.

3.2.1 Attribute selection:

Some of the attributes of the original dataset that were irrelevant (relevant) to the purpose of the experiment were ignored. However, they are all related to classification and obtaining results, so I won't ignore them too much. So, the final attributes chosen are: *sl_no, gender, ssc_p, ssc_b, hsc_p, hsc_b, hsc_s, degree_p, degree_t, workex, etest_p, specialization, mba_p, status, salary.*

3.2.2 Cleaning missing values:

Many of the times the dataset contains missing values. We need to handle the problem when we come across them this situation. You could remove the entire line of data but what if you are inadvertently removing crucial information, after all we might not need to try to do that. one in every of the foremost common plan to handle the matter is to require a mean of all the values of the same column and have it to replace the missing data.

3.2.3 Training and Test data:

Splitting the Dataset into Training set and Test Set.

Firstly, what we did was split the data set into a training and a test set. The next step is to split the data into two parts. A training set and a test set. Train a machine learning model on the training set. H. Our machine learning model tries to understand all the correlations in the training set. Next, test the model on the test set to check its prediction accuracy. A general rule of thumb is to allocate 80% of the dataset to the training dataset and the remaining 20% to the test dataset.

3.3 Processing:

The processing used in this paper is the application of various algorithms to data to find the best results.

3.3.1 Decision Tree Algorithm:

The decision tree method builds a tree to model the classification process. Once the tree is built, it is applied to each tuple in the database to categorize that tuple. Most decision tree algorithms face the following problem.

• Choice of split attribute • Order of split attribute • Number of splits • Balance between tree structure and pruning • Stopping criterion The ID3 algorithm is a classification algorithm based on information entropy, the basic idea of which is that all examples are be assigned to different categories so that to different values of the conditional attribute set; its essence is to determine the best classification attribute from the conditional attribute set. The algorithm chooses information retrieval as the attribute selection criteria. The attribute with the largest information gain is usually chosen as the split attribute for the current node, minimizing the entropy of information required by the split subset. Branches can be established depending on different values of the attribute. Each branch produces different nodes and branches until all samples within the branch belong to the same category. The concepts of entropy and information gain are used to select split attributes.

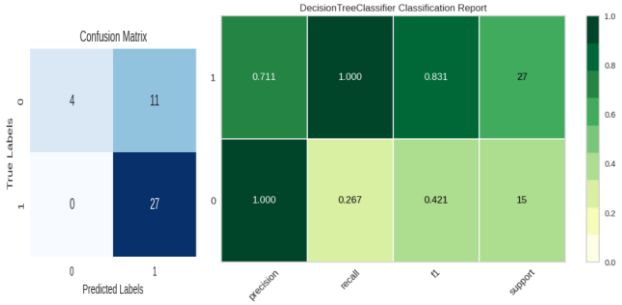

Fig. 2 Confusion Matrix and Classification Report Of Decision Tree

3.3.2 Random Forest:

Random forest algorithms can also be viewed as machine learning ensemble techniques. The input to the random forest algorithm is a data set consisting of data sets with attributes. A random subset of the input is created. A decision tree is constructed for each random subset generated. The final class of the test dataset is determined by an algorithm using majority voting. The Random Forest algorithm uses an out-of-bag error technique. Each tree is constructed using the following algorithm.

1. The number of training cases is N and the number of classifier variables is M.

2. The number m of input variables used to determine decisions at the nodes of the tree is informed. m must be much smaller than M.

3. To select the training set for this tree, we select N permutations from all N available training cases (i.e., bootstrap sampling). Use the remaining cases to estimate the tree error by predicting their classes.

4. For each node in the tree, randomly select m variables to base decisions at that node. Compute the optimal split based on these m variables in the training set. 5. Each tree is fully grown and unpruned (as you can do when building a regular tree classifier).

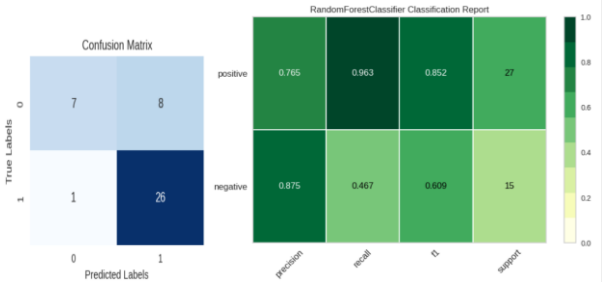

Fig. 3 Confusion Matrix and Classification Report Of Random Forest

3.3.3 Logistic Regression:

Logistic regression is a statistical technique used to model the relationship between a binary dependent variable and one or more independent variables. The dependent variable, also called the response variable, is binary. H. There are only two possible values (e.g., 0 or 1, yes or no, true or false). Independent variables, also called predictors or features, can be either continuous or categorical.The purpose of logistic regression is to estimate the probability that the dependent variable will take a particular value given the values of the independent variables. A logistic regression model accomplishes this by fitting a logistic function, which is a sigmoidal curve, to the data. The logistic function transforms the output of a linear equation into a value between 0 and 1 representing the probability that the dependent variable is 1. The linear equation contains coefficients for each independent variable estimated using maximum likelihood estimation.

Once the coefficients are estimated, a logistic regression model can be used to predict the probability that the dependent variable is 1 for any new observation with known values of the independent variables. A decision threshold is used to convert these probabilities into binary predictions.

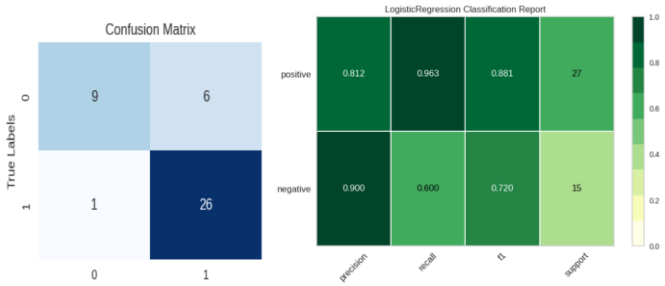

Fig. 4 Confusion Matrix and Classification Report Of Logistic Regression

IV. RESULTS AND DISCUSSION

The data set used is further split into two sets, two-thirds as the training set and one-third as the test set. Of the three algorithms used, logistic regression gives the best results. Compare the efficiency of the three approaches in terms of accuracy. Compare the efficiency of the three approaches in terms of accuracy. The accuracy of a prediction model/ classifier is defined as the total number of correctly predicted classified instances.

Precision is specified using the following formula:

$$\textbf{Accuracy=(TP+TN/TP+FN+FP+TN)} * \textbf{100}$$

Where TP, TN, FN, FP represents the number of true positives, true negative, false negative and false positive cases.

Table.2 Performance Analysis On the basis of F1, Recall, Support, precision and Accuracy

Measures	Logistic regression	Random forest	Decision tree
F1	0.82	0.73	0.68
Recall	0.83	0.76	0.74
Support	42	42	42
Precision	0.84	0.78	0.81
Accuracy	83.33%	80.95%	73.80%

Table.3 Comparison of proposed methods with state-of-the-art method.

Sr. no	Ref no	Literature Survey No	Model	Accuracy	Precision	Recall	F1 Score
1	2	This is referred from Table No 1. Literature No 1	Logistic Regression	52%	0.52	0.52	0.52
			Random Forest	81.9 %	0.819	0.819	0.819
			XG-Boost	83.1 %	0.831	0.831	0.831
2	3	This is referred from Table No 1. Literature No 3	Random Forest	100%	1.00	1.00	1.00
			Decision Tree	100%	1.00	1.00	1.00
			SVM	83%	0.84	0.83	0.81
			Logistic Regression	100%	1.00	1.00	1.00
3	5	This is referred from Table No 1. Literature No 5	Decision Tree	72.83 %	0.77	0.78	0.69
			KNN	55.42 %	0.63	0.78	0.54
			SVM	48.66 %	0.58	0.84	0.46
			Naïve Bayes	45.41 %	0.32	0.20	0.35
			Logistic Regression	60.5 %	0.63	0.85	0.60
4	8	This is referred from Table No 1. Literature No 7	SVM	82.85 %	0.87	0.81	0.83
			Random Forest	85.14 %	0.92	0.87	0.85
			Linear Regression	50.05 %	0.63	0.78	0.72
			K Means	75%	0.59	0.75	0.68
			Naïve Bayes	76.23 %	0.88	0.81	0.83
5	9	This is referred from Table No 1. Literature No 8	Gaussian NB	70%	0.80	0.70	0.62
			Multinomial NB	86.4 %	0.71	0.70	0.70
			Bernoulli NB	86%	0.89	0.87	0.86

V. CONCLUSION

The campus placement activity is incredibly a lot of vital as institution point of view as well as student point of view. In this regard to improve the student's performance, a work has been analyzed and predicted using the classification algorithms Logistic Regression, Decision Tree and the Random Forest algorithm to validate the approaches. The algorithms are applied on the data set and attributes used to build the model. The accuracy obtained after analysis for Logistic Regression is 85%, Decision tree is 76% and for the Random Forest is 90%. Hence, from the above said analysis and prediction it's better if the Logistic Regression or Random Forest algorithm is used to predict the placement results. The choice between using a random forest or logistic regression for a classification task depends on the specific characteristics of the problem you are trying to solve and the nature of the data you are working with. In general, if the relationship between the input features and the output variable is complex and non-linear, a random forest may perform better than logistic regression. However, if the relationship is simple and linear, logistic regression may be sufficient and more interpretable. For our dataset, Logistic Regression works the best for this the possible reasons are small sample size, data is linearly separable. And another possible reason is that our data set is considerably small and logistic regression works best when data size is small and decision tree and random forest works best when data set is large.

VI. FUTURE SCOPE

There are several potential areas for future research in placement prediction using machine learning. Some of these areas include:

Feature selection techniques: While feature selection techniques are often used to improve the accuracy of placement prediction models, there is scope for further research in this area. Future studies could explore more sophisticated feature selection algorithms that can handle high-dimensional data and improve the interpretability of the models.

Incorporating unstructured data: Most placement prediction models rely on structured data such as academic performance and personal characteristics. However, there is a growing need to incorporate unstructured data such as social media activity and online behavior. Future studies could explore the use of natural language processing and computer vision techniques to extract insights from unstructured data.

Hybrid models: While logistic regression, decision trees, and random forest algorithms are popular for placement prediction, there is scope for hybrid models that combine multiple algorithms. Future studies could explore the use of ensemble methods such as bagging and boosting to improve the accuracy and robustness of placement prediction models.

Explainability and interpretability: While machine learning models can achieve high accuracy in placement prediction, they are often considered as black boxes due to their lack of interpretability. Future studies could explore the use of explainable AI techniques such as decision rule extraction and local interpretable model-agnostic explanations (LIME) to provide human-understandable explanations for placement prediction models.

Transfer learning: Transfer learning is a technique that allows models trained on one dataset to be adapted to another dataset with similar characteristics. Future studies could explore the use of transfer learning to improve the accuracy of placement prediction models in scenarios where there is a limited amount of data available.

Overall, there is significant scope for future research in placement prediction using machine learning, and the above areas represent just a few potential avenues for exploration.

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