Mesopotamian journal of Computer Science
Vol. **(2023)**, 2023, **pp**. 100-114
DOI: https://doi.org/10.58496/MJCSC/2023/013 ; ISSN: 2958-6631
https://mesopotamian.press/journals/index.php/cs

Research Article

Machine Learning Application on Employee Promotion

Muhannad Ilwani[1], Ghalia Nassreddine[1, *], Joumana Younis[1]

[1] *Faculty of Business, Jinan University, Tripoli, Lebanon*

ARTICLE INFO

Article History
Received 05 Mar 2023
Accepted 15 May 2023
Published 07 Jun 2023

Keywords
Employee promotion
Machine learning
Support vector machine
Logistic regression
Confusion matrix
Random forest
Performance
Engagement
Accuracy

ABSTRACT

Any company's most valuable asset, its workforce, is its employees. As a result, the company's primary goal should be to develop an excellent strategy for supporting and investing in its employees and staff by providing the best training and development. Employee Promotion denotes the advancement of an employee's rank. It raises the salary, position, duties, and benefits. It is a part of the job that propels employees to the highest commitment and loyalty to their organizations. Employee morale and loyalty are two critical components of any successful business. Employee promotion is the key to improving employee performance and engagement. It is a complex process that may require effort and time from the human resource department. However, artificial intelligence is a recent science that has proven effective in many sectors, including healthcare and finance. Thus, this study used artificial intelligence techniques to automate employee promo. A new promotion approach based on machine learning techniques was proposed. Three machine learning techniques were applied: Logistic regression, support vector machine, and random forest. The result shows the efficacy of these techniques on the employee promotion problem.

1. INTRODUCTION

The most valuable asset of any company is its employees, considered its workforce. Therefore, the company's primary goal should be to find an excellent strategy to support and invest in its employees and staff by providing them with the best training and development. Employee Promotion represents the rising of an employee's rank. It increases salary, position, duties, position, and benefits. It is a part of the job that moves employees to the most fantastic prize for commitment and loyalty regarding their organizations. Employee morale and loyalty are two critical elements in a successful company. Employee promotion is considered one of the main challenges of any organization or company. Indeed, employees come with different educational degrees, training, skills, perspective, and ethic that may influence the organization's performance. Usually, all institutions, including the government, adopt a promotion system to enhance their performance [1].

The human resources department is responsible for employee promotion. It uses a systematic process to choose which employees should be promoted. The main goal of this process is to find the right employee for the promotion. Usually, this process is done manually, which is time-consuming for the HR department. Nowadays, with the enormous development of information technology tools, there are a lot of new technologies that the HR department can use to simplify the process of employee promotion. Artificial intelligence (AI) is a recent science that concentrates on designing and building systems or machines that emulate human intelligence. These systems can complete jobs and learn from their experience and the information they gather [2].

Machine learning (ML) is a branch of AI based on the concept that systems can learn, recognize patterns, and make decisions without human intervention [3]. In this paper, ML techniques will be used to help the HR department in selecting the most suitable employee for promotion tasks. Four main ML techniques will be used: Support vector machine, Logistic regression, Artificial Neural Network, and Random Forest.

This paper is composed of six sections. First, the employee promotion will be described briefly in Section II. Machine learning will be presented in Section III. In Section IV, existing work will be presented. the proposed method will be described in section V. The result of a real dataset will be discussed in Section VI. This paper will end with a conclusion in Section VII.

*Corresponding author. Email: gh.nassreddine@gmail.com

2. EMPLOYEE PROMOTION

Human resources are the core of any organization to support the development and progress of companies. Without a good team, the company cannot be improved. Therefore, the main reason for any organization is a good team of employees. Promotion is an accomplishment desired by employees within an organization according to a set of criteria fixed by the Human resources department [4]. From the viewpoint of the organizations, the goal of employee promotion is to choose an appropriate workforce from different positions and give them new positions with higher titles, capabilities, and salaries. This step may improve their contribution to the organization. Thus, the "outcome" and "validity" of employee promotion are keys to an organization's development and success [5].

2.1. Types

Employee Promotion represents the ascension of an employee to higher ranks and titles. It produces growth in salary, responsibilities, status, and benefits. There are four different types of promotions:

a. Horizontal promotion: in this type, employees' salaries increase with no change or slight change of responsibilities. An employee's upgrading in the educational sector is an example of this promotion type - the promotion of a teacher from lecturer to senior lecturer [6].

b. Vertical promotion: in this type, the employee improves and changes his skills and experience. This type changes to salary, title, duties, and benefits. An example of this type is the promotion of a marketing supervisor to the marketing manager. In addition, in this type, the nature of work may change. For example, it may change from functional head to chief executive (these jobs are entirely different) [7].

c. Dry promotion: this type of promotion has the worst reputation. In this type, the duties and responsibilities of the employee increase without any change of benefits.

d. Open/closed promotion: these two terms refer to the eligibility criteria for the position. An open promotion would be one in which applying to the position is free and open to all company members. In contrast, a closed promotion would only accept a curated list of employees as applicants [8].

2.2. CRITICAL ASPECT OF PROMOTING EMPLOYEE

An employee promotion plan has many essential points [9], as summarized in Table 1 [10].

TABLE I. MAIN POINTS FOR EMPLOYEE PROMATION

Point	Description
Evaluate the current responsibility of the employee	HR staff should check how employees perform their current duties and responsibilities: work quality, work schedule, and work description outline.
Appraise the ability	HR tries to quantify the employee's skills and abilities. The performance level of employees is defined by their operational ability, emotional intelligence, and life experience.
Review the performance	HR staff should use all available resources that provide definitive evidence of an employee's above-average performance. These resources can be a weekly performance review or chat log detailing the sociability and problem-solving skills of the candidate.

The model in Figure 1 shows the main steps of the employee promotion process [11]. It is composed of three main steps, helping in employee retention strategy.

Indeed, it proves to the employee that the organization is checking and investing in their success. Furthermore, it guarantees that the recently promoted employee obtains all the necessary support during every step to succeed in the new position. The HR department should guide and survey the promoted employee during all the steps. Promotion is necessary to overcome employee turnover, maintain a sound retention strategy, and increase employee success.

Step 1: Before the promotion

a. Target interested employees: In this step, the manager should detect the employee interested in getting promoted or those who show the required talent and skills. After that, he can start the preparation procedure by training, teaching, and exposing them to experiences that can qualify them for the next step ahead. Early attention allows us to train and support them.

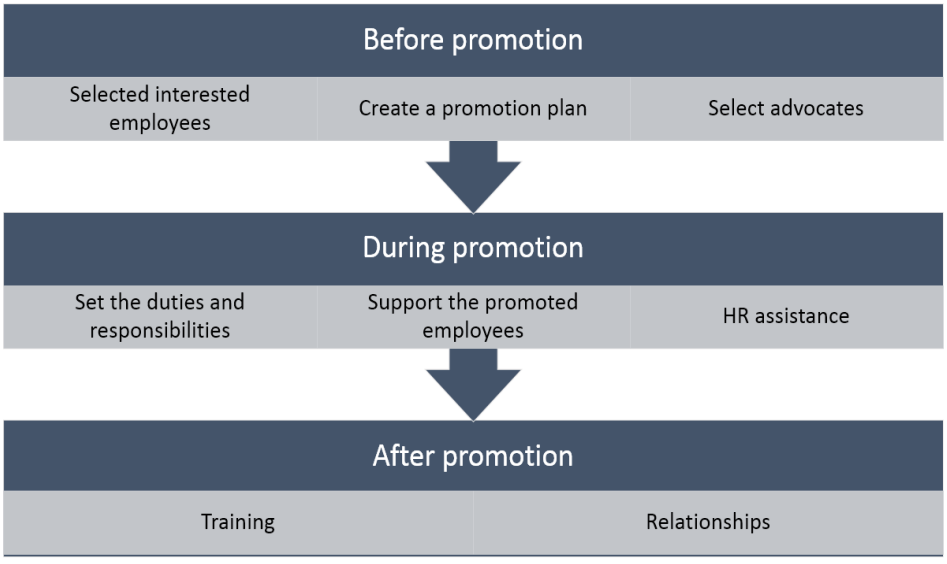

Fig.1. steps for employee promotion

b. Design a detailed promotion plan: in this step, the manager should specify the knowledge and skills needed in a new position. The promotion plan should also contain the required steps, sufficient resources, responsibility for completion, and potential problems that must be addressed.

c. Recruit advocates ready to campaign on the employee's behalf, support their cause and help improve others' perceptions. This step can be critical to individuals who are unsatisfied and comfortable with signing a new contract.

Step 2: During the promotion

a. Set duties and responsibilities: The managers should help the promoted employees understand the new duties and responsibilities. In addition, they should help him set his junior employees' duties.

b. Newly promoted employees may be confident because they have achieved their prior roles. However, they need support to transition smoothly and plan new positions.

c. Human Resources assistance: Recently promoted employees should not wait for Human Resources to reach out. They should take the initiative and immediately contact them to find out how they can be a resource. Indeed, the HR department can deliver training or answer questions concerning many work issues.

Step 3: After the promotion

a. Relationship: The most crucial step is to help the promoted employee select equivalents, such as new assistants and new managers, who can define the new circle of influence for this position. He should also be advised to set a one-on-one meeting to build a supportive and collaborative relationship. This step may assist in creating a network with the organization's leading significant players and decision-makers.

b. Seek appropriate training: This step is essential as the new pieces of training furnish shared knowledge, understood best practices, and networking.

3. MACHINE LEARNING

Artificial Intelligence (AI) represents the capability of a machine to mimic intelligent human and human behavior. Recently, AI systems have been employed widely to execute complicated tasks like humans. AI aims to develop computer systems that demonstrate "intelligent behaviors" such as humans [12]. Machine learning (ML) is a subpart of AI that creates systems that can learn from experience without human intervention. ML allows computer systems to learn to program themselves via experience. ML systems work with data types, such as numbers, photos, or text, including bank transactions, human photos, or sensor values. After collection, the data is trained using machine learning methods and tested later [13]. ML learning techniques are used to resolve different problems, as illustrated in Figure 2 [14].

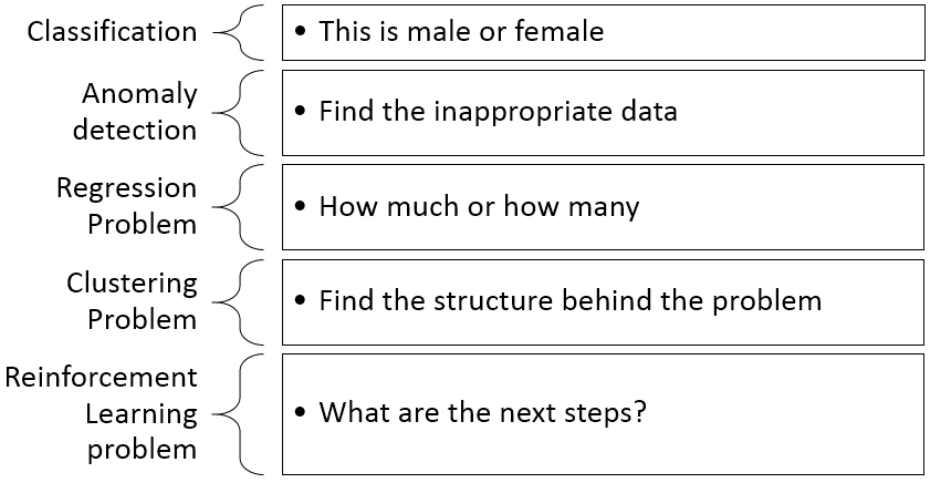

Fig.2. Problems solved by ML techniques.

- Classification represents the problems in which the outcomes can take one value from a set of possible values, such as Male/Female or True/False. The classification can be a binary or multi-class according to the number of outcome classes [15].

- Anomaly Detection represents the problems that explore a specific pattern to catch differences or anomalies in the pattern that falls within this type. For example, credit card companies use anomaly detection algorithms to find unusual transaction conduct of their client [16].

- Regression techniques are used to resolve problems with continuous and numerical outcomes. These are usually used for problems with questions like, 'How much' or 'How many.' [17].

- Clustering techniques are used to build systems that learn structures within the data and try to make groups according to the similarity in the arrangement of the data. The distinct groups or clusters are labeled. After training, unseen data are represented in one of the present clusters [18].

- Reinforcement techniques are used to choose what to do next based on learning gathered from experience. The machine agent maintains the behavior by interacting with the constantly changing environment through trial and error. It allows program agents to use rewards and penalties without specifying how the task will be completed. Some popular applications of reinforcement learning include game-playing programs and temperature control programs [19].

3.1. Machine Learning Process

Figure 3 presents the general process of the ML system [20]. The data from the environment representing the problem's natural world should be selected. The selected data will be stored in a dataset. The machine learning system will be used this dataset from training the model.

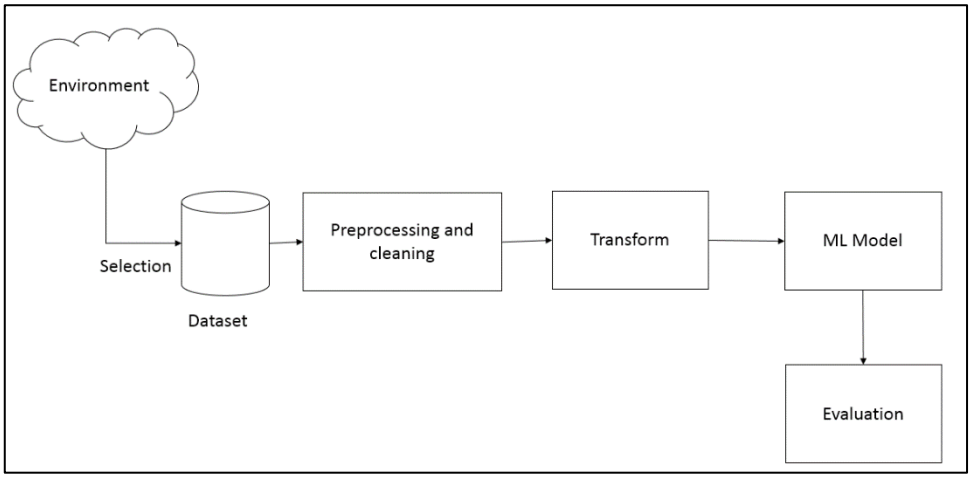

Fig.3. ML process.

Each part of the ML process has a specific mission to complete, as described next:

- Selection of data: Data that should be used in the ML system can be gathered from different sources such as sensors, databases, or surveys.

- Preprocessing and cleaning of Data: This is the main task of the machine learning process. It consists of preparing data in a format that can be given as input to the algorithm. Collected data may contain noises and inappropriate values. These values should be removed before moving to the next step.

- Transform The data received from the previous step may include numerous features. Some of these features could be relevant to the learning process. The other features must be removed, and a subset of the most critical features must be selected.

- ML model: Not all ML algorithms can be used for all problems. Indeed, specific algorithms are more appropriate for a classification problem. The best ML technique should be selected in this step to get the best result.

- Evaluation: Before implementing the system in real-time, the model must be tested against unseen data to determine how much has been learned using performance parameters such as accuracy, precision, and recall.

3.2. ALGORITHMS

This section describes three ML algorithms: logistic regression, support vector machine, and Random Forest. They will be used in the next later to select the best employee for promotion based on available data.

Logistic Regression

Logistic Regression (LR) is a type of supervised learning. It is employed to predict the probability of binary outcomes. A binary outcome can take one of two possible values Yes/No, True/False, or 0/1. For example, this technique can be applied to detect if COVID-19 infects a patient based on his test. Since we have two possible outcomes to this question – yes/no for infected/not infected. A problem with only two possible answers is usually called binary classification [21].

Support Vector Machine

Support vector machine (SVM) is a straightforward machine learning algorithm widely used for classification and regression purposes. Many researchers highly desire it as it delivers essential accuracy with minor calculation power [22]. The central concept of SVM is to discover a hyperplane in N-dimensional space that distinctly classifies the data points. N is the number of features associated with the classification problem.

Random Forest

Random forest is a decision tree-based collective learning technique (Figure 4). It entails the generation of multiple decision trees from preliminary datasets derived from the original data. Because of classification tasks, the random forest selects the class most trees select. For regression tasks, however, the mean or average prediction of the individual trees is computed (Biau & Scornet, 2016).

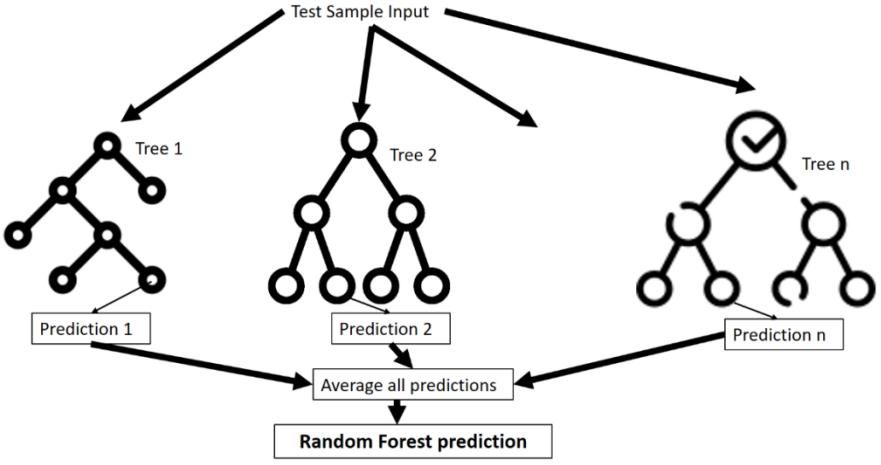

Fig.4. Random forest technique.

4. LITERATURE REVIEW

Many researchers consider the problem of employee promotion. Y Long et al. work on the prediction of employee promotion based on personal characteristics "[23]. They work on the data of a Chinese state-owned enterprise with several features. They applied machine learning methods to predict employee promotion. Firstly, they designed personal fundamental and post characteristics based on five techniques. Then, a correlation analysis examines the associations between features and promotion. After that, the ML model is trained and tested. The results indicate that the random forest

model performs best, confirming the features' validity. In addition, the Gini importance of each characteristic was calculated for more analysis of its influence on staff promotion. It is found that the post characteristics significantly influence promotion compared with essential personal characteristics. The working years, the number of different positions, and the highest department level significantly affect employee promotion. R. Jain et al. built a system that predicts employee attrition using the XGBoost machine learning approach [24]. The primary objective of this study was to predict employee attrition. The authors in this paper have proposed a novel model for predicting employee Attrition based on Machine Learning techniques. They used XGBoost, which is considered a robust technique. To validate the performance of the proposed system, an online dataset was used. The results have shown the efficiency and precision of the proposed technique.

P. Ajit et al. built an approach to predict employee turnover in organizations using machine learning algorithms [25]. The importance of predicting employee turnover in organizations and the application of machine learning in building turnover models were studied in this research. The authors used data from HRIS that suffers from noise that may affect the accuracy of these predictive models. The XGBoost classifier was compared to six other supervised classifiers historically used to make turnover models. The results have demonstrated that the XGBoost classifier is a superior algorithm in terms of significantly higher accuracy, relatively low runtimes, and efficient memory utilization for predicting turnover. J. LIU et al. titled proposed a Data-driven Analysis of Employee Promotion [5]. This paper tried to show the importance of using the data-driven solution to upgrade the Human resource management (HRM) model. The authors have focused on the impact of the work of HRM on the status of an organization. They used data collected from several enterprises in China. In addition, they used the features of organizational position to analyze employee promotion and forecast employee prospects. Finally, they analyzed data using statistics and networks. However, the prediction model was built based on machine learning techniques. They concluded that structural position had an essential role than geographic position. The experimental results showed the efficiency of this model.

Kaewwiset et al. built a promotion Classification model Using Decision Tree and Principal Component Analysis [26]. This paper proposed a new promotion system based on Principle Component Analysis (PCA) and machine learning classification techniques like the decision tree. This paper used an online dataset from Kaggle to compare the promotion classification result. A complete comparison of classification performance for all features, personal features, and performance features was performed. The results showed that the classification with PCA provides the highest accuracy at 91.25%.

5. PROPOSED APPROACH

Employee promotion is an essential task of the HR department. Many criteria should be considered to choose the best employee to be promoted, such as training, performance evaluations, and others. It is a complicated task that may require a massive effort from HR employees. This section will present an employee promotion method based on machine learning. In this method, a classification technique will be applied. Three classification algorithms will be compared according to their performance to select the most appropriate one. The dataset used in this thesis is downloaded from Kaggle.com. It is a real dataset.

5.1. Dataset

A large multinational corporation has nine broad verticals spread across its organization. One issue is identifying and preparing the right people for promotion (only for manager positions and below).

Final promotions are not announced until after the evaluation, which causes a delay in transitioning to new roles. As a result, the company requires assistance in identifying qualified candidates at a specific checkpoint to accelerate the promotion cycle.

Multiple attributes have been provided around employees' past and current performance and demographics. Figure 5 shows the other features represented in the dataset.

```
data1 <- read.csv('train.csv')
head(data1, 5)
```

[3]

	employee_id	department	region	education	gender	recruitment_channel	no_of_trainings
1	65438	Sales & Marketing	region_7	Master's & above	f	sourcing	1
2	65141	Operations	region_22	Bachelor's	m	other	1
3	7513	Sales & Marketing	region_19	Bachelor's	m	sourcing	1
4	2542	Sales & Marketing	region_23	Bachelor's	m	other	2
5	48945	Technology	region_26	Bachelor's	m	other	1

(a)

```
ead.csv('train.csv')
, 5)
```

[3]

age	previous_year_rating	length_of_service	awards_won.	avg_training_score	is_promoted
35	5	8	0	49	0
30	5	4	0	60	0
34	3	7	0	50	0
39	1	10	0	50	0
45	3	2	0	73	0

(a)

Fig.5. The other features in the dataset

This study aims to create a system to help the HR department choose the most suitable employee for a promotion. The proposed approach is divided into five main steps, as illustrated in Figure 6.

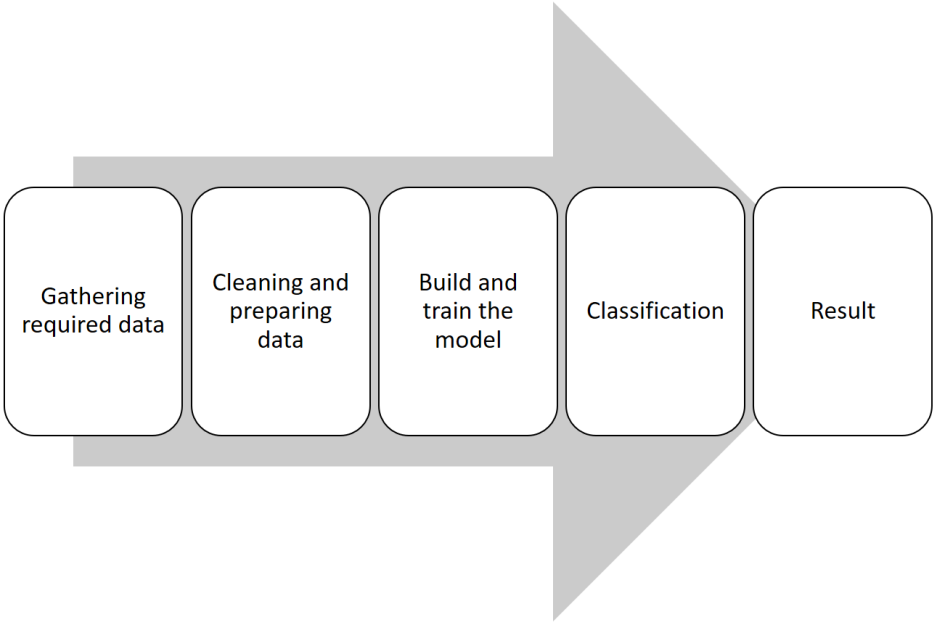

Fig.6. Steps of the proposed approach

5.2 Gathering Data

Machine learning systems learn from available data. Therefore, collecting data is an essential step of such a system. To find the correct pattern, it is essential to gather reliable data. Indeed, the accuracy of the model is highly dependent on the quality of the collected data. The data used in this study is accurate data collected from kaggle.com[1]. It is reliable and tested.

Preparing Data

After collecting data, a processing step should be performed before using it in the ML model :

- Combine data and randomize it. This step should be taken to ensure that the data is distributed evenly and that the ordering does not affect the learning process.
- Clean the data by removing unwanted, missing, and duplicate records. In some cases, it is necessary to restructure the dataset and modify the rows and columns and the index of rows and columns.

Visualize the data to understand its structure and the relationships between variables and classes.

Splitting Data

In this step, the data should be divided into two sets:

- A training set consisting of 80% of the whole dataset was used to train this study model.
- A testing set consisting of 20% was used to test the performance of this study model.

Classifying

The machine learning algorithm will be applied to the training dataset to train the classifier in this step. These steps will apply and compare three classifiers: SVM, Logistic regression, and random forest.

The good of the classifier is to predict the class of the dependent variable Y based on the values of the dependent variable X. In this study, the independent variable Y is "Is_promoted". There are two classes:

- Yes, the employee can be promoted. The associated value is 1.
- No, the employee can not be promoted. The associated value is 0.

[1] www.kaggle.com

The dependent variable X consists of:

Employee_ID	Department	Region
Education Level	Gender	recruitment_channel
Age	no_ of_ trainings	previous_year_rating
length_ of_ service	awards_ won	avg_ training_ score

Before applying the classifier, the authors study the correlations between the dependent and independent variables (see Figure 7).

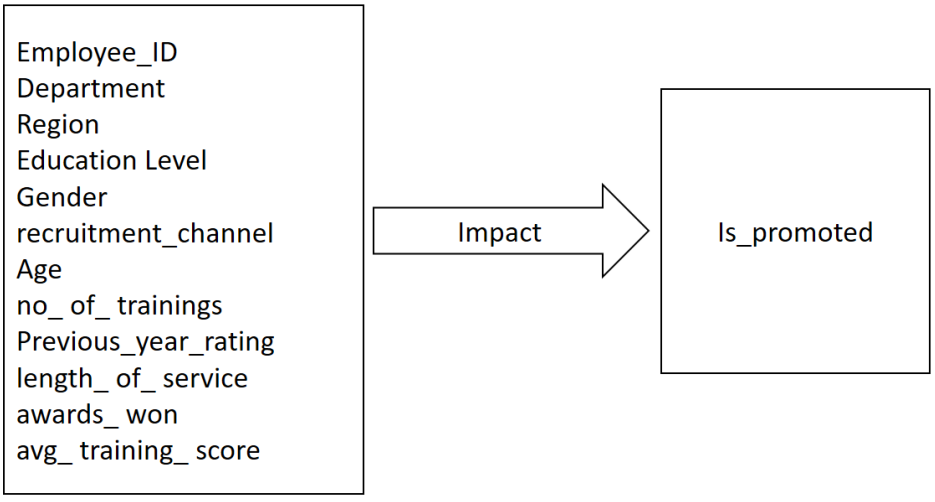

Fig.7. Impact between dependent and independent variables

For accurate results, the least influential dependent variables should be removed. The asterisk (*) sign denotes variables with significant impacts. However, studying the relationships between qualitative variables is not permitted; only quantitative variables are permitted in studying the relationships between variables. It is accomplished by instructing (correlation) and studying the correlation between each pair of variables.

All dependent variables are taken to task at their significant level. The model is considered a binomial model; its results are shown in Figure 8.

```
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)             -4.220566   0.292730 -14.418  < 2e-16 ***
department               0.251074   0.176452   1.423 0.154764
gender                  -0.007215   0.043910  -0.164 0.869491
recruitment_channel      0.007722   0.041255   0.187 0.851529
previous_year_rating     0.539391   0.018840  28.630  < 2e-16 ***
education                0.610213   0.218500   2.793 0.005226 **
no_of_trainings         -0.178841   0.040666  -4.398 1.09e-05 ***
age                     -0.024216   0.003781  -6.404 1.51e-10 ***
length_of_service        0.014191   0.006263   2.266 0.023446 *
awards_won.              2.350582   0.079824  29.447  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Fig.8. Significant Results

As illustrated in Figure 8, department, recruitment_channel, and gender variables are insignificant. Therefore, they can be eliminated and not used in the classifier.

6. RESULTS AND DISCUSSION

The previous step's classifier results are evaluated in this step. Many metrics are used to compute and evaluate an ML technique's performance and efficiency. The following metrics were used in this study:

A confusion matrix (CM) visually represents. This matrix categorizes outputs into two or more groups (See Table 2).

TABLE II. CONFUSION MATRIX FOR CLASSIFICATION ACTUAL VS PREDICATED

	Predicted YES	**Predicted NO**
Actual YES	True Positive (TP)	False Negative (FN)
Actual NO	False Positive (FP)	True Negative (TN)

- The actual class represents the real class of any element (relevant vs non-relevant candidate). However, the predicted class represents the class resulting from an ML model.
- Positive (1) represents a relevant candidate, whereas, Negative (0) represents an irrelevant candidate.

- True Positive (TP) represents the number of relevant predicted elements that should be relevant, whereas, True Negative (TN) represents the number of irrelevant predicted elements that should be irrelevant.

- False Positive (FP) represents the number of relevant predicted elements that should be irrelevant, whereas False Negative (FN) represents the number of irrelevant predicted elements that should be relevant.

The classification performance is measured as follows:

- The precision represents the value of TP elements over TP and FP, computed based on CM as follows:

$$Precision = \frac{TP}{TP + FP} \quad (1)$$

- The recall represents the value of TP elements over TP and FN, computed based on CM as follows:

$$Recall = \frac{TP}{TP + FN} \quad (2)$$

- The f-measure balances the precision and recall values, computed based on CM as follows:

$$F - measure = 2 \times \frac{Recall \times Precision}{Recall + Precision} \quad (3)$$

- The accuracy represents the ratio of correct predictions to the sample size, computed based on CM as follows:

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN} \quad (4)$$

In this section, a comparison between the three ML algorithms will be made using the testing part of the dataset. Table 3 shows the accuracy, recall, precision, and F-measure of these algorithms:

TABLE III. COMPARISION BETWEEN LR, RF, AND SVM

Method	Recall (%)	Precision (%)	F-measure (%)	Accuracy (%)
LR	8.69	72.8	15.5	91.7
SVM	17.3	100	30.3	92.6
RF	58.2	100	73.6	91.7

The recall value only reflects how positive employee promotions are classified. The precision describes the accuracy of the model's optimistic prediction. The f-measure represents a harmonious relationship between precision and recall by assigning equal weighting to each. It aids in model evaluation by combining the precision and recall values into a single value. When describing model performance and comparing models, the f-measure comes in handy. The accuracy value describes the model's performance when all possible solutions are considered. It is the proportion of correct predictions to total predictions. As illustrated in Table 3:

- The recall of LR and SVM algorithms is weak. A machine learning model correctly identifies the percentage of data sample belonging to a class of interest—the "positive class"—out of the total samples for that class. Therefore, LR and SVM cannot detect correctly appropriate employees for a promotion.

- The precision of SVM and RF is equal to 1. Therefore, the quality of an optimistic prediction made by these models is excellent. However, LR has a precision of 72.8%. Thus, LR has a quality of optimistic prediction at 72.8%.

- The accuracy of all models is good. Thus, the fraction of predictions of all models are suitable.

We can conclude that RF is the best algorithm in this study.

7. CONCLUSION

If any employee is asked: "What motivates and inspires them to do their best?" They would answer: "Employee promotion. It is human nature. Any human likes to grow and improve in his life and work."

Employee Promotion denotes an employee's advancement to a higher position, which includes salary, title, responsibilities, rate, and benefit growth. This aspect of the job is the most motivating for employees—the ultimate reward for dedication and loyalty to an organization.

The employee promotion process is complicated and may take enormous effort and time from the human resource department. However, with the considerable development of information technology tools and computer science, the HR department may use advanced tools and science to perform this process more simply and quickly.

Machine learning is a part of Artificial Intelligence that proves its efficacy in many areas like healthcare, navigation, power systems, and finance.

In this study, ML was used in the employee promotion process. A new approach was proposed to classify the employees into two classes: Appropriate to the promotion and not appropriate to promotion. This approach is composed of four main steps: Collecting and cleaning data, splitting data, applying of ML algorithm, and testing the accuracy.

The proposed approach was tested on actual data collected from kaggle.com. This data contains 11 attributes (ID, education, department, number of training, and others.). It is composed of 54808 rows. This data was cleaned (all missing data was removed) and splitter (80% training and 20% testing).

After that, the ML algorithms were applied. Three algorithms were used: Logistic regression, Support vector machine, and random forest. All these algorithms show high accuracy (around 92%). This result proves the efficacy of using ML in employee promotion; the RF shows the best result according to recall and precision. However, it requires more time than the others; the Logistic regression was faster than the support vector machine and random forest. However, the recall value is the worst. The SVM shows an acceptable running time; however, the recall value is lower than the random forest algorithm.

After performing this study, the following recommendations can be proposed:

1. Companies in Arabic countries, especially in Iraq, should spend more money on the Human resource department

2. Using more Information technology tools in companies, especially in the Human resource department

3. Choose a suitable promotion method. Indeed, promotion may enhance the productivity and engagement of the employees.

4. Performing more research on the effect of integration of ML tools and Artificial Intelligence techniques in human resource tasks like recruitment, promotion, and development

5. Testing more ML algorithms in the employee promotion process

Funding

No funding was received for this study. All expenses associated with this research were covered by the authors

Conflict of interest

The authors declare that they have no conflicts of interest related to this study. All authors have disclosed any financial or personal relationships with organizations or individuals that could potentially bias this work.

Acknowledgments

We would like to express our deepest appreciation to our academic institutions for their support.

REFERENCES

[1] M. Husnain, B. Rehman, F. Syed and M. khtar, "Personal and in-store factors influencing impulse buying behavior among generation Y consumers of small cities," *Business Perspectives and Research,* vol. 7, no. 1, pp. 92-107, 2019.
[2] R. Akerkar, "Introduction to artificial intelligence," in *Artificial Intelligence for Business*, Springer, Cham, 2019, pp. 1-18.
[3] N. A. Lafta , Tran., “A Comprehensive Analysis of Keras: Enhancing Deep Learning Applications in Network Engineering”, BJN, vol. 2023, pp. 94–100, Nov. 2023, doi: 10.58496/BJN/2023/012.
[4] H. H. Lai, "Study on the influence of employee promotion system on organizational performance," *International Journal of Organizational Innovation (Online),* vol. 5, no. 1, p. 231, 2012.
[5] J. Liu, T. Wang, J. Li, J. Huang, F. Yao and H. He, "A data-driven analysis of employee promotion: the role of the position of organization," in *IEEE international conference on systems, man and cybernetics*, 2019.
[6] L. Lipych, I. Volynets, O. Khilukha, I. Matviichuk and Z. Semchuk, "Model of management of the employees' innovative behavior at the industrial enterprises," *Problems and Perspectives in Management,* vol. 16, no. 3, p. 197, 2018.
[7] S. Feng, R. Suri, M. C. H. Chao and U. Koc, "Presenting comparative price promotions vertically or horizontally: Does it matter?," *Journal of Business Research,* vol. 76, pp. 209-218, 2017.
[8] M. Alawamleh, L. B. Ismail, K. Aladwan and A. Saleh, "The influence of open/closed innovation on employees' performance," *International Journal of Organizational Analysis,* 2018.
[9] Y. T. Alzubaidi and S. H. Oleiwi , Trans., “Integrating IoT Technologies with Open Educational Resources (OER) for Enhanced Learning Experiences During the COVID-19 Pandemic”, BJIoT, vol. 2023, pp. 92–101, Nov. 2023, doi: 10.58496/BJIoT/2023/012.
[10] M. Ibrahim and V. A. Brobbey, "Impact of motivation on employee performance," *International Journal of Economics, Commerce and Management,* vol. 3, no. 11, pp. 1218-1237, 2015.
[11] O. Cloutier, L. Felusiak, C. Hill and E. J. Pemberton-Jones, "The importance of developing strategies for employee retention," *Journal of Leadership, Accountability & Ethics,* vol. 12, no. 2, 2015.
[12] V. C. Müller and N. Bostrom, "Future progress in artificial intelligence: A survey of expert opinion," in *Fundamental issues of artificial intelligence* , Cham, Springer, 2016, pp. 555-572.
[13] B. Liu, M. Ding, S. Shaham, W. Rahayu, F. Farokhi and Z. Lin, "When machine learning meets privacy: A survey and outlook," *ACM Computing Surveys (CSUR),* vol. 54, no. 2, pp. 1-36, 2021.
[14] H. Alkattan , Trans., “Employing Data Mining Techniques and Machine Learning Models in Classification of Students’ Academic Performance”, Babylonian Journal of Artificial Intelligence, vol. 2023, pp. 43–54, Aug. 2023, doi: 10.58496/BJAI/2023/008.
[15] P. Sen, M. Hajra and M. Ghosh, " Supervised classification algorithms in machine learning: A survey and review," *Emerging Technology in Modelling and Graphics: Proceedings of IEM Graph. Springer Singapore.,* pp. 99-111, 2020.
[16] G. Pang, C. Shen, L. Cao and A. Hengel, " Deep learning for anomaly detection: A review," *ACM computing surveys (CSUR),* vol. 54, no. 2, pp. 1-38, 2021.

[17] D. Maulud and A. Abdulazeez, " A review on linear regression comprehensive in machine learning.," *Journal of Applied Science and Technology Trends,* vol. 1, no. 4, pp. 140-147, 2020.
[18] M. karim, O. Beyan, A. Zappa, I. Costa, D. Rebholz-Schuhmann, M. Cochez and S. Decker, "Deep learning-based clustering approaches for bioinformatics," *Briefings in Bioinformatics,* vol. 22, no. 1, pp. 393-415, 2021.
[19] S. M. Khazaal and H. Maarouf , Trans., "Predicting Coronary Artery Disease Utilizing Support Vector Machines: Optimizing Predictive Model ", MJAIH , vol. 2023, pp. 21–26, Mar. 2023, doi: 10.58496/MJAIH/2023/004.
[20] J. Hüffmeier, J. Lundman and F. Elern, " Trim and ballast optimization for a tnaker based on machine learning," 2020.
[21] E. Y. Boateng and D. A. Abaye, "A review of the logistic regression model with emphasis on medical research," *Journal of data analysis and information processing,* vol. 7, no. 4, pp. 190-207, 2019.
[22] J. Nalepa and M. Kawulok, "Selecting training sets for support vector machines: a review," *Artificial Intelligence Review,* vol. 52, no. 2, pp. 857-900, 2019.
[23] Y. Long, J. Liu, M. Fang, T. Wang and W. Jiang, "Prediction of employee promotion based on personal basic features and post features," in *in International Conference on Data Processing and Applications*, 2018.
[24] Samar Hazim Hammed and A.S. Albahri , Trans., "Unlocking the Potential of Autism Detection: Integrating Traditional Feature Selection and Machine Learning Techniques", Applied Data Science and Analysis, vol. 2023, pp. 42–58, May 2023, doi: 10.58496/ADSA/2023/003.
[25] P. Ajit, "Prediction of employee turnover in organizations using machine learning algorithms," *Algorithms,* 2016.
[26] T. Kaewwiset and P. Temdee, "Promotion Classification Using DecisionTree and Principal Component Analysis," in *Joint International Conference on Digital Arts, Media and Technology with ECTI Northern Section Conference on Electrical, Elctronics, Computer and Telecommunications Engineering (ECTI DAMT & NCON)*, 2022.