

# Machine Learning Based Employee Attrition Prediction and Layoff Prediction System

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## ABSTRACT:

Now a days Employee attrition is a major issue faced by many organizations, as it leads to increased costs and loss of experienced employees. When employees leave a company frequently, it affects productivity and overall organizational growth. Therefore, predicting employee attrition in advance is important for companies to take preventive actions and improve employee retention. This project focuses on predicting employee attrition using machine learning techniques. Employee data such as age, job role, salary, experience, job satisfaction, and working conditions are analyzed to understand the factors influencing attrition. Before building the model, data preprocessing techniques are applied to clean and prepare the dataset. Machine learning algorithms such as Logistic Regression, Decision Tree, and Random Forest are used to build an effective attrition prediction system. The proposed machine learning-based employee attrition prediction system helps organizations identify employees who are at risk of leaving the company. By predicting attrition in advance, HR departments can take timely actions such as improving work conditions, offering incentives, and providing career growth opportunities. This system supports data-driven decision making and helps organizations improve employee retention and long-term performance.

**Keywords:** Employee Attrition, Layoff Prediction, Machine Learning, HR Analytics, Classification Models, Predictive Analysis, Random Forest Algorithm.

## INTRODUCTION

Employee attrition is one of the major challenges faced by organizations, especially in the software industry where skilled employees play a critical role in business success. When employees leave an organization frequently, it results in increased recruitment and training costs, loss of experience, and reduced productivity. Understanding the reasons behind employee attrition is essential for organizations to maintain a stable workforce and ensure long-term growth. With the availability of large amounts of employee data, organizations are increasingly using data analysis techniques to study employee behavior and workplace factors. Traditional methods of analyzing employee attrition are often time-consuming and less effective when dealing with complex and large datasets. Machine learning techniques provide an efficient way to analyze employee-related data, identify hidden patterns, and predict the likelihood of an employee leaving the organization.

This project focuses on developing a machine learning-based employee attrition prediction system to help organizations make informed decisions. By analyzing factors such as employee age, job role, salary,

work experience, and job satisfaction, the proposed system aims to predict employee attrition accurately. The results of this study can assist HR departments in taking timely preventive measures to improve employee retention and create a better working environment.

Today, organizations collect a large amount of data about their employees. People analytics helps organizations understand employee behavior and reduce attrition. Instead of using only large datasets, Deep Data focuses on finding hidden patterns and relationships. This helps organizations predict employee attrition more accurately and make better retention decisions.

Employee attrition and student dropout are serious problems for companies and educational institutions. Machine learning and deep learning techniques help analyze complex data to find the reasons behind attrition. These methods can identify employees or students who are likely to leave early, which supports timely actions to improve retention. Predictive models use historical data to forecast employee attrition and study the key factors that influence it. Different machine learning models can be compared to find the most accurate one. Understanding both prediction results and influencing factors helps organizations reduce turnover, control costs, and improve productivity.

## LITERATURE REVIEW

In [1] paper by N. B. Yahia, J. Hlel and R. Colomo-Palacios used feature selection algorithms in From Big Data to Deep Data to Support People Analytics for Employee Attrition Prediction. They propose the people analytics model predicts employee attrition with 99% accuracy. [2] D. Uliyan, A. S. Aljaloud, A. Alkhalil, H. S. A. Amer, M. A. E. A. Mohamed and A. F. M. Alogali used Conditional Random Field in Deep Learning Model to Predict Students Retention Using BLSTM and CRF. They BLSTM and CRF predicted student retention with 90% accuracy.[3] Doohee Chung, Jinseop Yun, Jeha Lee, Yeram Jeon used Random Forest Algorithm in Predictive model of employee attrition based on stacking ensemble learning. In This work Ensemble model best overall performance with 97% accuracy.

In [4] Paper by Rajkumar Govindarajan, N. Komal Kumar, Sudhakar Reddy P, Sai Pravallika E et al used Hybrid Model (RF, SVM, Decision Tree, Grad. Boosting) in Predicting Employee Attrition: A Comparative Analysis of Machine Learning Models Using the IBM Human Resource Analytics Dataset. In This Work Hybrid model outperformed individual models with 95% accuracy.[5] Shahin Manafi Varkiani, Francesco Pattarin, Tommaso Fabbri, Gualtiero Fantoni used Random Forest Algorithm in Predicting employee attrition and explaining its determinants. It's Work Random Forest top predictive performance with feature direction insights with 95% accuracy. [6] Hojat Talebi, Amid Khatibi Bardsiri, Vahid Khatibi Bardsiri used Feature selection Algorithm in eveloping a hybrid machine learning model for employee turnover prediction. In This works GA+LightGBM outperformed conventional models with 80% accuracy.

In [7] Paper by Ghita Regasse, Francesco Venier used Support Vector Classifier in Implementing machine learning for predictive analytics: An empirical study of employee turnover. In This works SVC had strongest discriminative capability with 89% accuracy.[8] Mohammad Reza Shafie, Hamed Khosravi, Sarah Farhadpour, Srinjoy Das, Imtiaz Ahmed used Cluster-based ANN with data augmentation in A cluster-based human resources analytics for predicting employee turnover using optimized Artificial Neural Networks and data augmentation .In This works Enhanced ANN models improved prediction compared to baseline ML with 85%accuracy.[9] M. Saqib Nawaz, M. Zohaib Nawaz, Philippe Fournier-Viger, José María Luna used Sequential Pattern Classifier in Analysis and classification of employee attrition and absenteeism in industry A sequential pattern mining-based

methodology. In This Works E(3A)CSPM pattern mining + classifiers outperformed state-of-the-art classification on multiple datasets with 85% accuracy.

In [10] Paper by Ali Raza, Kashif Munir, Mubarak Almutairi, Faizan Younas, Mian Muhammad Sadiq Fareed used Extra Trees Classifier in Predicting Employee Attrition Using Machine Learning Approaches. In This Works ETC achieved the best performance among tested ML models with 93% accuracy.[11] Zaiyong Tang, James Gu, Mayuresh Kelkar used Random Forest Algorithm in Enhancing Employee Retention: Predicting Attrition Using Machine Learning Models. In This Works Random Forest (with SMOTE) outperformed others in model comparison with 80% accuracy.[12] Akintunde Adetoye Fadare used Random Forest Algorithm in Prediction of HR Employee Attrition with Machine Learning: Bagging and Random Forest Application. They Works ML framework enabled targeted retention insights with 87% accuracy.

In [13] Paper by Md Shakir Khan, Manas Kumar, Keshab Das, Monish Mukul Das, Sayan Chakraborty used ML classification in Employee Attrition Prediction using Machine Learning. In This Works Showed predictive analytics utility for HR planning with 89% accuracy.[14] Intan Susilawati, Oktavianti, Rizki Eka Putra used Comparative ML methods in Predictive Analytics for Employee Turnover: A Comparative Study Between Industries. In This Works Different models work best by industry with 86% accuracy.[15] Dino Michael Quinteros used Deep Learning optimized model in Predictive Modelling of Employee Attrition Using Deep Learning. In This works Demonstrated deep learning's potential for attrition linked factors & outcomes with 87% accuracy.

## PROPOSED METHODOLOGY

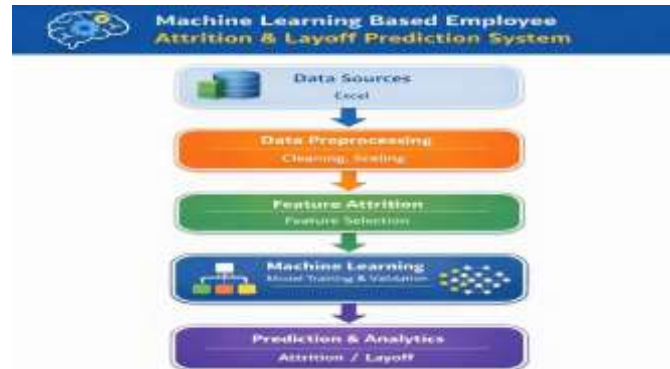
The proposed methodology for predicting employee attrition starts with collecting employee data such as age, job role, tenure, salary, performance, and engagement levels. This data is then cleaned and prepared by handling missing values, converting categories into numbers, and scaling numeric data so that it is consistent. Important features that most affect attrition are selected using a Genetic Algorithm, which helps the model focus on the factors that really matter. These features are then used to train a LightGBM machine learning model, which is fast and accurate for prediction. The model's performance is checked using metrics like Accuracy, Precision, Recall, F1-score, and AUC, and techniques like cross-validation and hyperparameter tuning are applied to make the predictions more reliable. Overall, this approach helps identify employees who might leave, giving HR teams useful insights to take early action.

**Random Forest Algorithm:** In our project, the Random Forest algorithm is used to predict whether an employee is likely to leave the company or not. Random Forest works by creating many decision trees from the employee data, where each tree looks at different features like age, job role, salary, and performance. Each tree makes its own prediction, and the algorithm then combines all these predictions to give a final result. This approach helps to make the prediction more accurate and reduces mistakes because it does not rely on just one decision tree. By using Random Forest, we can identify which employees are at risk of leaving and understand the main factors that affect attrition.

**Decision Tree Algorithm:** In our project, the Decision Tree algorithm is used to predict if an employee might leave the company. It works like a flowchart, where the data is split step by step based on important features like age, job role, salary, or performance. At each step, the algorithm asks a question about a feature and divides the data into smaller groups. By following these steps down the tree, it finally predicts whether an employee is likely to stay or leave. Decision Trees are easy to understand and

help us see which factors have the biggest impact on employee attrition.

## SYSTEM ARCHITECTURE



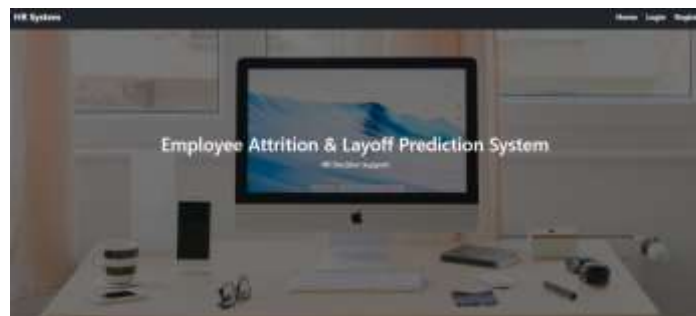
**FIG 1.SYSTEM ARCHITECTURE**

The system architecture explains how the complete system works step by step. First, employee data is collected from the company database. This data includes details like age, salary, experience, working hours, performance, and job role. Next, the collected data is cleaned to remove missing and wrong values. After that, the data is sent to the machine learning module. In this module, different algorithms analyze the employee data and find patterns related to attrition and layoffs. Then, the trained model predicts whether an employee may leave the company or not. The prediction results are stored in the database. Finally, the results are shown to HR managers in the form of reports and graphs. This system helps the company to understand employee behavior and take early actions to reduce Terminations.

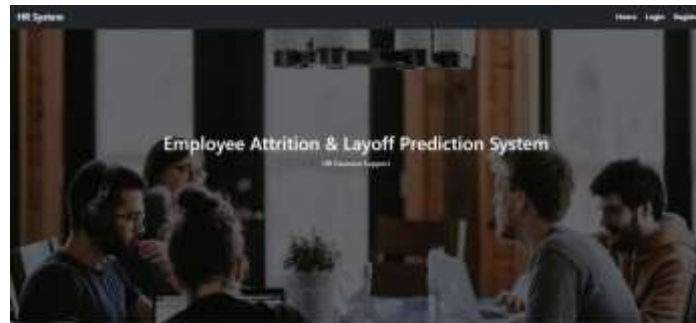
## RESULT AND DISCUSSION

The model used Random Forest and Decision Tree to predict which employees might leave the company. Important factors like job role, salary, years at the company, overtime, and job satisfaction helped the model make predictions. Random Forest worked better than Decision Tree, giving more accurate and consistent results. The findings show that pay, workload, and satisfaction are key reasons employees leave. By knowing this, companies can support employees who might be at risk, such as offering better incentives or improving work conditions. The model depends on having good data, and adding more information or combining different approaches could make predictions even stronger.

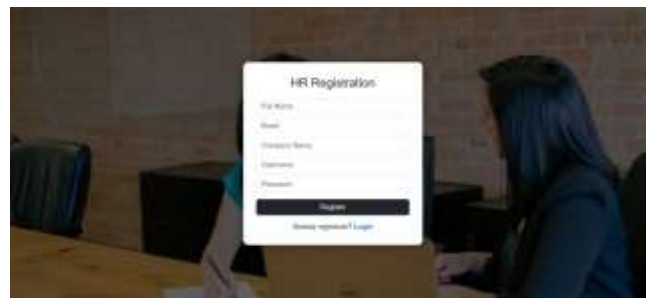
## SCREEN SHOTS



**FIG 2.INDEX PAGE**



**FIG 3. INDEX PAGE**



**FIG 4. REGISTER PAGE**



**FIG 5. LOGIN PAGE**



**FIG 6. DASHBOARD**

**FIG 7. PREDICTION PAGE****FIG 8. RESULT PAGE****FIG 9. PERFORMANCE PAGE**

## CONCLUSION

In this project, a machine learning–based system for predicting employee attrition and layoffs is studied. By observing previous research, it is understood that machine learning algorithms like Logistic Regression, Decision Tree, SVM, and Random Forest can be used to predict employee behavior effectively. Factors such as employee experience, job satisfaction, salary, performance, and working hours play an important role in prediction. This system helps organizations to identify employees who are at risk at an early stage, so that necessary actions can be taken in advance. Though the approach gives good results, issues like limited data and imbalance in datasets still need improvement. Overall, this system is useful for better workforce planning and decision-making in organizations. Enhance models with real-time data streams and multimodal inputs like sentiment analysis from emails or performance reviews. Explore hybrid deep learning architectures, such as transformers, for better handling of sequential workforce trends and economic indicators. Integrate with enterprise tools for automated alerts and conduct longitudinal studies across industries to validate generalizability. Finally, address ethical concerns like bias mitigation through fairness-aware algorithms.

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