PREDICTION OF EMPLOYEE ATTRITION USING MACHINE LEARNING

A project report submitted in the partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING

Submitted by

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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PEO4: Pursue higher studies and develop their career in software industry.

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3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

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Project Course Outcomes (CO'S):

CO425.1: Analyse the System of Examinations and identify the problem.

CO425.2: Identify and classify the requirements.

CO425.3: Review the Related Literature

CO425.4: Design and Modularize the project

CO425.5: Construct, Integrate, Test and Implement the Project.

CO425.6: Prepare the project Documentation and present the Report using appropriate method.

Course Outcomes – Program Outcomes mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1		√											√		
C425.2	√		√		√								√		
C425.3				√		√	√	√					√		
C425.4			√			√	√	√					√	√	
C425.5					√	√	√	√	√	√	√	√	√	√	√
C425.6									√	√	√		√	√	

Course Outcomes – Program Outcome correlation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C425.1	2	3											2		
C425.2			2		3								2		
C425.3				2		2	3	3					2		
C425.4			2			1	1	2					3	2	
C425.5					3	3	3	2	3	2	2	1	3	2	1
C425.6									3	2	1		2	3	

Note: The values in the above table represent the level of correlation between CO’s and PO’s:

1. Low level

2. Medium level

3. High level

Project mapping with various courses of Curriculum with Attained PO’s:

Name of the course from which principles are applied in this project	**Description of the device**	**Attained PO**
C3.2.4, C3.2.5	Gathering the requirements and defining the problem, plan to develop a **smart bottle for health care using sensors.**	PO1, PO3
CC4.2.5	Each and every requirement is critically analyzed, the process model is identified and divided into **five modules**	PO2, PO3
CC4.2.5	Logical design is done by using the unified modelling language which involves individual team work	PO3, PO5, PO9
CC4.2.5	Each and every module is tested, integrated, and evaluated in our project	PO1, PO5
CC4.2.5	Documentation is done by all our four members in the form of a group	PO10
CC4.2.5	Each and every phase of the work in group is presented periodically	PO10, PO11
CC4.2.5	Implementation is done and the project will be handled by the **hospital management and in future updates in our project can be done based on air bubbles occurring in liquid insaline.**	PO4, PO7
CC4.2.8 CC4.2.	**The physical design includes hardware components like sensors, gsm module, softwareand Arduino.**	PO5, PO6

ABSTRACT

The term Attrition refers to the voluntary or involuntary discontinuation of employees in an organization. This document focuses on discussing a systematic flow for predicting Attrition using Data Analysis and Machine Learning techniques. The steps include Data Collection, Data Preprocessing, and Classification by applying the following Classification Models: Support Vector Machine, Decision Tree, Logistic Regression, Random Forest, algorithms in the Python environment. The resulting predictions of classification were evaluated using three performance metrics: Accuracy Score, Confusion Matrix. Based on the obtained results, we inferred that Random Forest classifier delivered the highest accuracy being 88.3% compared to decision tree. This project intends to be of great use to the organizations aiming at detecting the key causes of Attrition and minimizing them using the power of data.

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1. INTRODUCTION

1.1 INTRODUCTION

In today’s world data is being created at an ever-increasing rate. The analysis of this stored data has proved to be beneficial in gaining insights and creating general awareness about any business or organization. Data analysis is the process of collecting, inspecting, cleansing, transforming, and modeling raw data with the aim of deriving valuable insights and retrieving relevant information to reach a conclusion for good decision making. Machine Learning is the process of using algorithms to train a machine to predict accurately using the existing data[1]. Employees are a crucial resource for any organization, and hence withdrawal of productive employees might affect an organization with respect to various aspects. Some of the consequences of Employee Attrition are: Investing in staffing and training new employees[3], increased burden on existing employees and a decline in the performance[14] of the organization. In this work, we intend to classify employees with respect to previous ‘Attrition’ patterns and other relevant attributes. The outcome of many research shows that the most valuable asset and important resource in organizations are their employees.

Now a day due to increased competition and improved requirement in employees’ proficiency determines the attrition rate. The employee attrition is considered to be a serious issue for organizations. The cost of searching and training employees is very high. Organizations need to search, hire and train new employees. Loss of experienced workers especially high performers is difficult to manage and is negatively related to the success and performance of organizations. The study focuses on the variables that may lead to control the attrition rate of the employee. The problem of employee turnover has turn to eminence in organizations because of its pessimistic impacts on issues on work place self-esteem and efficiency. The organizations deal with this problem is by predicting the risk of attrition of employees using machine learning techniques thus giving organizations to take proactive action for retention.

1.2 EXISTING SYSTEM

Employee attrition is defined as employees leaving their organizations for unpredictable or uncontrollable reasons. Many terms make up attrition, the most common being termination, resignation, planned or voluntary retirement, structural changes, long-term illness, layoffs. In the traditional methods, all the activities inside an organization are carried out manually. The employee records are maintained manually and if any employee wants to leave an organization, they are maintained manually. All this requires a lot of human effort and time and they are prone to a lot of errors. There are many factors involved which may cause a potential employee to leave an organization.?

For example, an employee may leave an organization due to poor salary, lack of proper infrastructure, and many other factors. All these things can’t be predicted manually. To overcome these shortcomings, an employee attrition model is designed by using various machine learning techniques. The model is trained properly by providing the proper data so that the model makes good predictions. The performance of the model is evaluated by calculating the proper accuracy score.

DISADVANTAGES

- Prediction accuracy is not good when compared to other methods.
- Less efficient and less robust when compared to other methods

1.3 PROPOSED SYSTEM

Initially the data is downloaded from Kaggle is pre-processed first so that we can extract important features like Monthly Income, Last Promotion Year, Salary Hike and etc. that are quite natural for employee attrition. Dependent variables or Predicted variable are the one that helps to get the factors that mostly dependent on employee related variables[7]. For example the employee ID or employee count has nothing to do with the attrition rate. Exploratory Data Analysis is an initial process of analysis, in which you can summarize characteristics of data to can predict who, and when an employee will terminate the service. The system builds a prediction model by using random forest technique. It is one of the ensembles learning technique which consists of several decision trees rather than a single decision tree for classification. The techniques perform dependent variable analysis and word formation vector to evaluate the employee churn. Hence, by improving employee assurance and providing a desirable working environment, we can certainly reduce this problem significantly

To deal with the problem, we developed automatic employee attrition prediction using machine learning techniques. We will train the machine with previous dataset. so, machine can analyse and understand the process. Then machine will check for employee to get attrition and give us result.

ADVANTAGES

- More robust and reliable when compared to all the previous methods.
- Prediction accuracy is good and it consumes less time in order to make predictions.
- Whole process will be automated, so human error will be avoided.
- Eligible applicant will be sanctioned loan without any delay.

1.4 SYSTEM REQUIREMENTS

1.4.1 HARDWARE REQUIREMENTS

Processor	:	Intel Core i5
Cache Memory	:	4MB
Hard Disk	:	30GB or more
RAM	:	8GB

1.4.2 SOFTWARE REQUIREMENTS

Coding Language	:	Python
Python Distribution	:	Anaconda, Flask
Browser	:	Any Latest Browser Like Chrome

2. LITERATURE

2.1 LITERATURE SURVEY

In this paper, modified approaches using various data mining techniques are collected to analyzethe employee attrition rate at various levels. The study related to data mining for extracting the employee's attrition rate used in various models and the comprehensive literature review of various researcher's works are stated below;

Qasem A, A.Radaideh and Eman A Nagi, has applied data mining techniques to build a classification model to predict the performance of employees. They adopted CRISP-DM data mining methodology in their work. The Decision tree was the main data mining tool used to build the classification model, where several classification rules were generated. They validated the generated model; several experiments were conducted using real data collected from several companies. The model is intended to be used for predicting new applicants' performance.

Amir Mohammad Esmaieeli Sikaroudi, Rouzbeh Ghousi and Ali Esmaieeli Sikaroudi et al, implemented knowledge discovery steps on real data of a manufacturing plant. They chew over many characteristics of employees such as age, technical skills and work experience. They usedto find out importance of data features is measured by Pearson Chi-Square test.

John M. Kirimi and Christopher Moturi et al, proposed a prediction model for employee performance forecasting that enables the human resource professionals to refocus on human capability criteria and thereby enhance the performance appraisal process of its human capital.

RohitPunnoose and PankajAjit et al, explored the application of Extreme Gradient Boosting (XGBoost) technique which is more robust because of its regularization formulation. Data from the HRIS of a global retailer is used to compare XGBoost against six historically used supervised classifiers and demonstrate its significantly higher accuracy for predicting employee turnover.

Kagmar et al. (2006) argues that some employee turnover can be beneficial for an organization but that turnover in most cases are very costly and can disrupt the workflow. As an example how costly employee turnover could be we turn our eyes towards the U.S. fast food industry. This is an industry which is exposed to high employee turnover, and only retraining costs of new employees per year is as high as $4.3 billion (Kagmar et al, 2006). The first step of being able to reduce employee turnover is to understand why the phenomenon is happening in the first place, and that is extremely important. This is because, knowing what causes the problem, gives organizations the chance to take action.

Batty Dorance Jeen (2014), mentioned that many organizations have the concern of employee turnover. It is highly destructive to both the organization as well as the employees. The research was conducted for the retail industry in Bangalore. Despite the incentives, motivational techniques and old practices of HRM there is still high attrition rate so study show cases ways to reduce the intentions of employee leaving the organization. This is performed by distributing questionnaires to retail outlets in Bangalore. The study concluded that turnover intention has influence on attrition factors such as QWL, career growth, working hours, personal/family reasons, and relation with internal co – worker, welfare, working condition, and salary.

Venkata Naga Manjula, Ruchita Ramani, Swati John (2013), articulated that the objective of the study is to understand the growth of ITES sector in India. The study in the BPO Industry is to understand and gauge the attrition rate, its intensity and make a causal analysis, to design strategy to stabilise the sector by suggesting mitigating the attrition.

Shivani Mishra, Deepa Mishra (2013), articulated that the study carried out is for shipping industry of Kutch, Gujarat. The purpose of the study is to analyse the turnover and the commitment to identify several domains of organization, human resource practices and other like employee characteristic and environmental factors, which may have a positive or negative impact on employees‘ intention to stay with an organization.

Vibha Gupta (2013), stated that in recent years the turnover is high in BPO sectors either by absenteeism or employees absconding without any prior notice. Turnover rates for permanent Agents/Executives were 15.6% in 2009 and 35% in 2012. Department of Human Resources which also tracks attrition of temporary employees measured the turnover rate for temporary employees to be 77% in 2012. Therefore study is focused on recruitment and retention challenges that the IT/BPO industry currently faces and to examine ways to reduce high turnover rates among first year Employees in the leading Domestic Call Center based in Indore.

3. SYSTEM ANALYSIS

3.1 SOME MACHINE LEARNING METHODS

Machine learning uses two techniques: supervised learning, which trains a model on known input and output data to predict future outputs, and unsupervised learning, which uses hidden patterns or internal structures in the input data.

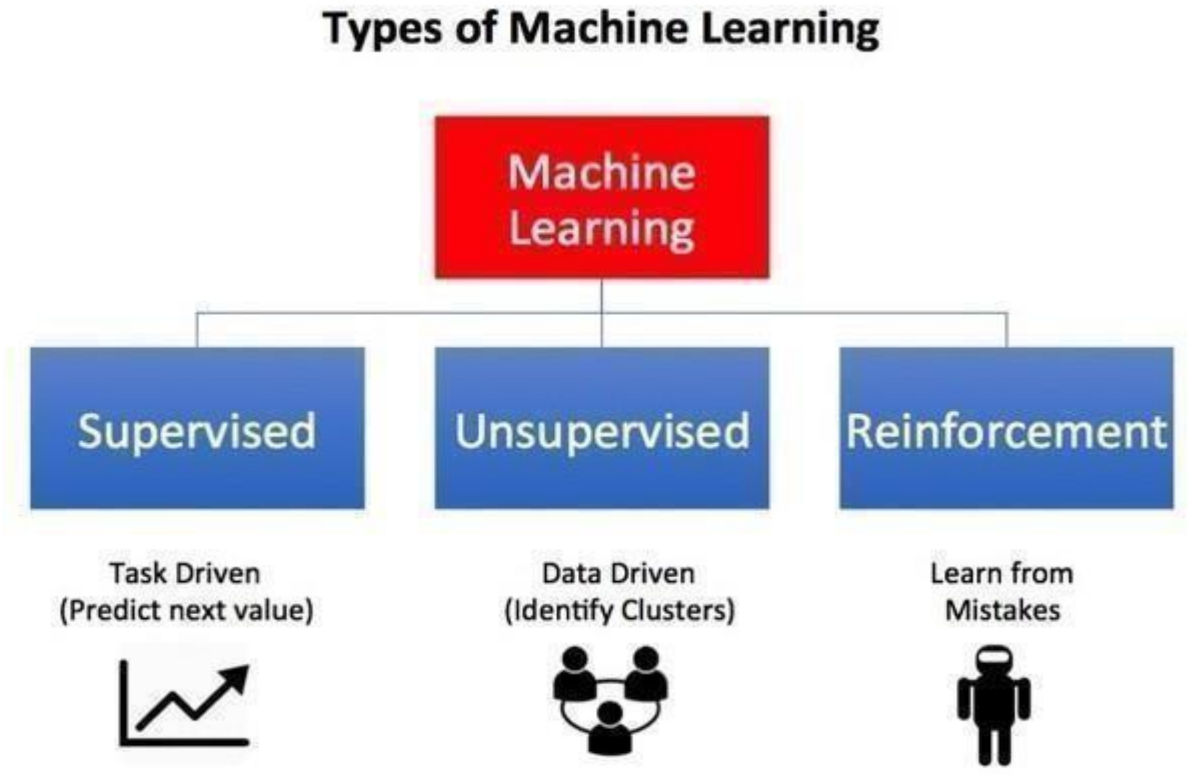

Types of Machine Learning
Machine Learning
Supervised
Unsupervised
Reinforcement
Task Driven (Predict next value)
Data Driven (Identify Clusters)
Learn from Mistakes

Figure: 3.1 Types of Machine Learning

Machine learning algorithms are often categorized as supervised and unsupervised.

Supervised machine learning algorithms:

Supervised machine learning creates a model that makes predictions based on evidence in the presence of uncertainty. A supervised learning algorithm takes a known set of input data and known responses to the data (**output**) and trains a model to generate reasonable predictions for the response to the new data. Use supervised learning if you have known data for the output you are trying to estimate. Supervised learning uses classification and regression techniques to develop machine learning models.

Unsupervised machine learning algorithms:

Detects hidden patterns or internal structures in unsupervised learning data. It is used to eliminate datasets containing input data without labeled responses. Clustering is a common unsupervised learning technique. It is used for exploratory data analysis to find hidden patterns and clusters in the data. Applications for cluster analysis include gene sequence analysis, market research, and commodity identification.

.

Reinforcement machine learning algorithms:

Reinforcement learning is an area of Machine Learning. It is about taking suitable action to maximize reward in a particular situation. It is employed by various software and machines to find the best possible behavior or path it should take in a specific situation. Reinforcement learning differs from supervised learning in a way that in supervised learning the training data has the answer key with it so the model is trained with the correct answer itself whereas in reinforcement learning, there is no answer but the reinforcement agent decides what to do to perform the given task. In the absence of a training dataset, it is bound to learn from its experience.

3.2 APPLICATIONS OF MACHINE LEARNING

1. Virtual Personal Assistants
2. Predictions while Commuting
3. Videos Surveillance
4. Social Media Services
5. Email Spam and Malware Filtering
6. Online Customer Support
7. Search Engine Result Refining
8. Product Recommendations
9. Online Fraud Detection

3.3 IMPORTANCE OF MACHINE LEARNING IN EMPLOYEE ATTRITION

The use of machine learning classification models to predict whether an employee is likely to quit could greatly increase the human resource department's ability to intervene on time and possibly provide a remedy to the situation to prevent attrition.

3.4 IMPLEMENTATION OF MACHINE LEARNING USING PYTHON

Python is a popular programming language. It was created in 1991 by Guido van Rossum.
It is used for:

1.web development (server-side),

2.software development,

3.mathematics,

4.system scripting.

The most recent major version of Python is Python 3. However, Python 2, although not being updated with anything other than security updates, is still quite popular. It is possible to write Python in an Integrated Development Environment, such as Thonny, PyCharm, NetBeans or Eclipse, Anaconda which are particularly useful when managing larger collections of Python files. Python was designed for its readability. Python uses new lines to complete a command, as opposedto other programming languages which often use semicolons or parentheses.

Python relies on indentation, using whitespace, to define scope; such as the scope of loops, functions and classes. Other programming languages often use curly-brackets for this purpose. In the older days, people used to perform Machine Learning tasks manually by coding all the algorithms and mathematical and statistical formula. This made the process time consuming, tedious and inefficient. But in the modern days, it is become very much easy and efficient compared to the olden days by various python libraries, frameworks, and modules. Today, Python is one of the most popular programming languages for this task and it has replaced many languages in the industry, one of the reasons is its vast collection of libraries.

Python libraries that used in Machine Learning are:

1.Numpy

2. Scipy

3.Scikit-learn

4.Pandas

5.Matplotlib

NumPy is a very popular python library for large multi-dimensional array and matrix processing, with the help of a large collection of high-level mathematical functions. It is very useful for fundamental scientific computations in Machine Learning. It is particularly useful for linear algebra, Fourier transform, and random number capabilities. High-end libraries like TensorFlow uses NumPy internally for manipulation of Tensors.

SciPy is a very popular library among Machine Learning enthusiasts as it contains different modules for optimization, linear algebra, integration and statistics. There is a difference between the SciPy library and the SciPy stack. The SciPy is one of the core packages that make up the SciPy stack. SciPy is also very useful for image manipulation.

Skikit-learn is one of the most popular Machine Learning libraries for classical Machine Learning algorithms. It is built on top of two basic Python libraries, NumPy and SciPy. Scikit-learn supports most of the supervised and unsupervised learning algorithms. Scikit learn can also be used for data-mining and data-analysis, which makes it a great tool who is starting out with Machine Learning.

Pandas is a popular Python library for data analysis. It is not directly related to Machine Learning. As we know that the dataset must be prepared before training. In this case, Pandas comes handy as it was developed specifically for data extraction and preparation. It provides high-level data structures and wide variety tools for data analysis. It provides many inbuilt methods for groping, combining and filtering data.

Matpoltlib is a very popular Python library for data visualization. Like Pandas, it is not directly related to Machine Learning. It particularly comes in handy when a programmer wants to visualize the patterns in the data. It is a 2D plotting library used for creating 2D graphs and plots. A module named pyplot makes it easy for programmers for plotting as it provides features to control line styles, font properties, formatting axes, etc. It provides various kinds of graphs and plots for data visualization, histogram, error charts, bar chats, etc.

3.5 SCOPE OF THE PROJECT

The scope of this system is to maintain employee details in datasets, train the model using the large quantity of data present in datasets and predict whether the employee will continue or not in the organization.

4. METHODOLOGY

There are various steps involved in a machine learning project. The standard steps that you've to follow for a machine learning project. For any project, first, we have to collect the data according to our needs. The next step is to clean the data like removing values, removing outliers, handling imbalanced datasets, changing categorical variables to numerical values, etc.

After that training of a model, use various machine learning and deep learning algorithms. Next, is model evaluation using different metrics like recall, f1 score, accuracy, etc.

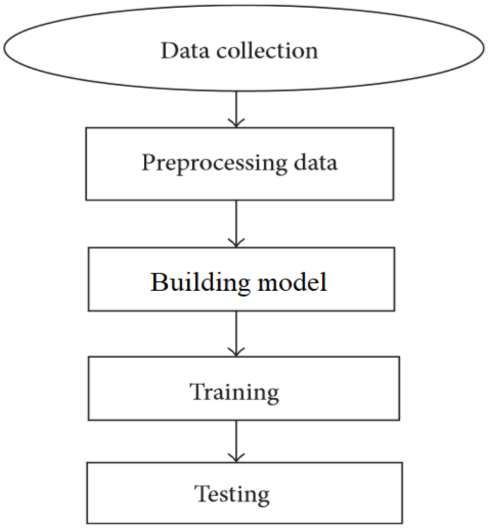


Figure: 4.1 Methodology

4.1 DATA SET

Dataset is a group of data. Most commonly a dataset agrees to the contents of a single database, where every column of the table signifies a particular variable, and each row agrees to a member of the dataset. For our project we take employee statistics from IBM which contains 1470 records and 35 fields including categorical and numeric features. Each record in the employee dataset signifies a single employee information and each field in the record signifies a feature of that particular employee[13].

Some of the attributes are:

Age- Numeric Discrete

Attrition-Categorical

Business Travel- Categorical

Daily Rate- Numeric Discrete

Department- Categorical

DistanceFromHome- Numeric

Education- Categorical

Education Field- Categorical

Employee Count- Numeric Discrete

Employee Number- Numeric Discrete

Environment Satisfaction- Categorical

Gender- Categorical

Hourly Rate- Numeric Discrete

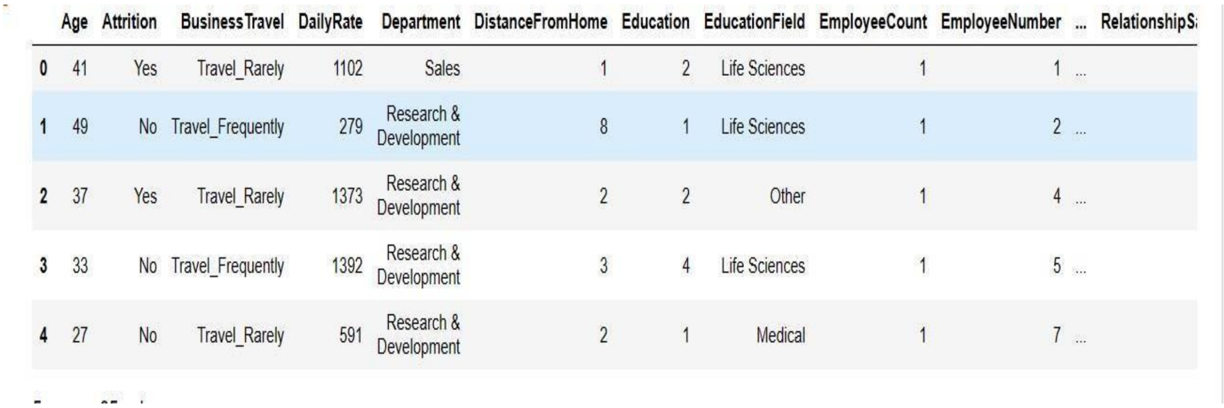
Job Involvement- Categorical

JobLevel-Categorical

JobRole-Categorical

Data Set Link:

https://www.kaggle.com/datasets/pavansubhasht/ibm-hr-analytics-attrition-dataset?select=WA_Fn-UseC_-HR-Employee-Attrition.csv



	Age	Attrition	BusinessTravel	DailyRate	Department	DistanceFromHome	Education	EducationField	EmployeeCount	EmployeeNumber	...	RelationshipS
0	41	Yes	Travel_Rarely	1102	Sales	1	2	Life Sciences	1	1	...	
1	49	No	Travel_Frequently	279	Research & Development	8	1	Life Sciences	1	2	...	
2	37	Yes	Travel_Rarely	1373	Research & Development	2	2	Other	1	4	...	
3	33	No	Travel_Frequently	1392	Research & Development	3	4	Life Sciences	1	5	...	
4	27	No	Travel_Rarely	591	Research & Development	2	1	Medical	1	7	...	

Figure:4.2 Employee dataset attribute names and information

The above figure is the part of employee dataset . There are 1470 rows and 35 attributes in dataset. ‘Attrition’ is the target variable to predict and values for it are ‘YES’ and ‘No’.

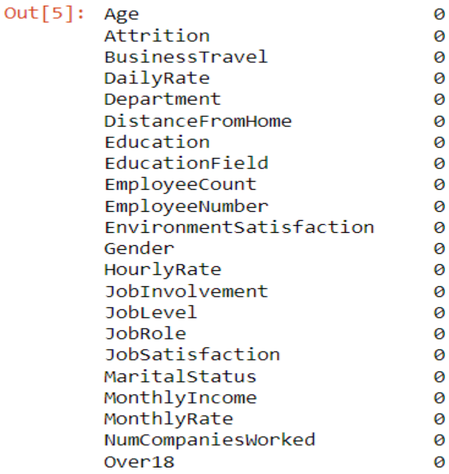
4.2 DATA PREPROCESSING

Data preprocessing is a process of preparing the raw data and making it suitable for a machine learning model. It is the first and crucial step while creating a machine learning model. When creating a machine learning project, it is not always a case that we come across the clean and formatted data. And while doing any operation with data, it is mandatory to clean it and put in a formatted way. So for this, we use data preprocessing task. A real-world data generally contains noises, missing values, and maybe in an unusable format which cannot be directly used for machine learning models. Data preprocessing is required tasks for cleaning the data and making it suitable for a machine learning model which also increases the accuracy and efficiency of a machine learning model.

4.2.1 Verifying NULL values

An easy way to check for missing values is to use the method *isnull*. We will get a data frame with true (1) and false (0) values, so we will sum the values and we can see in which column we have missing values.

```
df=pd.read_csv('employee.csv')
df.isna().sum()
```

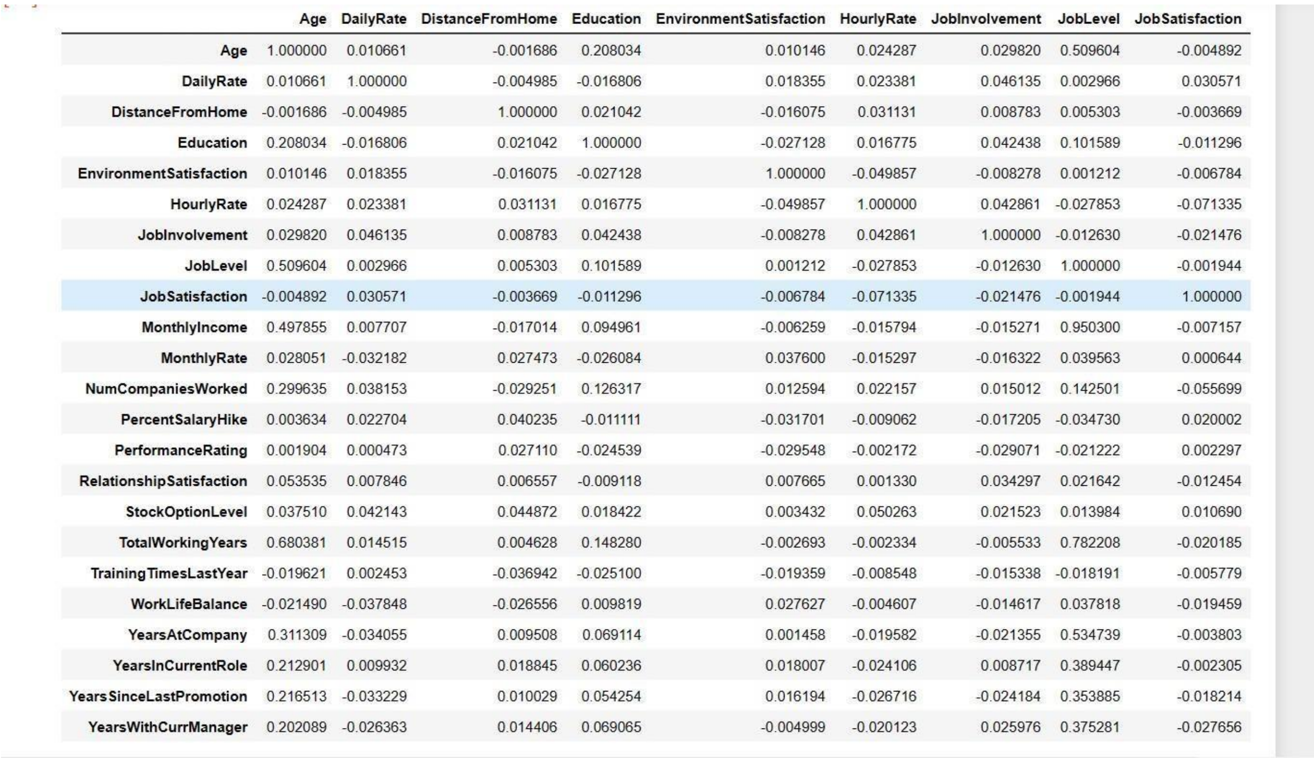


```
Out[5]: Age                         0
        Attrition                   0
        BusinessTravel              0
        DailyRate                   0
        Department                  0
        DistanceFromHome            0
        Education                   0
        EducationField              0
        EmployeeCount               0
        EmployeeNumber              0
        EnvironmentSatisfaction     0
        Gender                      0
        HourlyRate                  0
        JobInvolvement              0
        JobLevel                    0
        JobRole                     0
        JobSatisfaction             0
        MaritalStatus               0
        MonthlyIncome               0
        MonthlyRate                 0
        NumCompaniesWorked          0
        Over18                      0
```

Figure 4.3 Null values info

4.2.2 Correlation of attributes

Correlation is the statistical measure of the relationship between two variables. There are different types of correlation coefficients like Pearson coefficient (linear) and Spearman coefficient (non-linear) which capture different degrees of probabilistic dependence but not necessarily causation. We can find dependency between two attributes p and q using Correlation coefficient method using the formula. rp,q= ∑(pi-p) (qi-q)/nσpσq =∑ (pi qi)-np q/ nσpσq n is the total number of patterns, pi and qi are respective values of p and q attributes in patterns i, p and q are respective mean values of p and q attributes, σp , σq are respective standarddeviations values of p and q attributes. Generally, -1≤ rp,q ≤ +1. If rp,q < 0, then p and q are negatively correlated. If rp,q =0, then p and q are independent attributes and there is no correlationbetween them. If rp,q > 0, then p and q are positively correlated. We can drop the attributes that are having correlation coefficient value as 0 as it indicates that the variables are independent with respect to the prediction attribute.



	Age	DailyRate	DistanceFromHome	Education	EnvironmentSatisfaction	HourlyRate	JobInvolvement	JobLevel	JobSatisfaction
Age	1.000000	0.010661	-0.001686	0.208034	0.010146	0.024287	0.029820	0.509604	-0.004892
DailyRate	0.010661	1.000000	-0.004985	-0.016806	0.018355	0.023381	0.046135	0.002966	0.030571
DistanceFromHome	-0.001686	-0.004985	1.000000	0.021042	-0.016075	0.031131	0.008783	0.005303	-0.003669
Education	0.208034	-0.016806	0.021042	1.000000	-0.027128	0.016775	0.042438	0.101589	-0.011296
EnvironmentSatisfaction	0.010146	0.018355	-0.016075	-0.027128	1.000000	-0.049857	-0.008278	0.001212	-0.006784
HourlyRate	0.024287	0.023381	0.031131	0.016775	-0.049857	1.000000	0.042861	-0.027853	-0.071335
JobInvolvement	0.029820	0.046135	0.008783	0.042438	-0.008278	0.042861	1.000000	-0.012630	-0.021476
JobLevel	0.509604	0.002966	0.005303	0.101589	0.001212	-0.027853	-0.012630	1.000000	-0.001944
JobSatisfaction	-0.004892	0.030571	-0.003669	-0.011296	-0.006784	-0.071335	-0.021476	-0.001944	1.000000
MonthlyIncome	0.497855	0.007707	-0.017014	0.094961	-0.006259	-0.015794	-0.015271	0.950300	-0.007157
MonthlyRate	0.028051	-0.032182	0.027473	-0.026084	0.037600	-0.015297	-0.016322	0.039563	0.000644
NumCompaniesWorked	0.299635	0.038153	-0.029251	0.126317	0.012594	0.022157	0.015012	0.142501	-0.055699
PercentSalaryHike	0.003634	0.022704	0.040235	-0.011111	-0.031701	-0.009062	-0.017205	-0.034730	0.020002
PerformanceRating	0.001904	0.000473	0.027110	-0.024539	-0.029548	-0.002172	-0.029071	-0.021222	0.002297
RelationshipSatisfaction	0.053535	0.007846	0.006557	-0.009118	0.007665	0.001330	0.034297	0.021642	-0.012454
StockOptionLevel	0.037510	0.042143	0.044872	0.018422	0.003432	0.050263	0.021523	0.013984	0.010690
TotalWorkingYears	0.680381	0.014515	0.004628	0.148280	-0.002693	-0.002334	-0.005533	0.782208	-0.020185
TrainingTimesLastYear	-0.019621	0.002453	-0.036942	-0.025100	-0.019359	-0.008548	-0.015338	-0.018191	-0.005779
WorkLifeBalance	-0.021490	-0.037848	-0.026556	0.009819	0.027627	-0.004607	-0.014617	0.037818	-0.019459
YearsAtCompany	0.311309	-0.034055	0.009508	0.069114	0.001458	-0.019582	-0.021355	0.534739	-0.003803
YearsInCurrentRole	0.212901	0.009932	0.018845	0.060236	0.018007	-0.024106	0.008717	0.389447	-0.002305
YearsSinceLastPromotion	0.216513	-0.033229	0.010029	0.054254	0.016194	-0.026716	-0.024184	0.353885	-0.018214
YearsWithCurrManager	0.202089	-0.026363	0.014406	0.069065	-0.004999	-0.020123	0.025976	0.375281	-0.027656

Figure:4.4 Correlation

The data that we have had a large number of attributes, but we have used some major attributes in finding out the turnover rate. We have found out many interesting relationships from figure 3.4.1 among these attributes that led us to our goal of finding the turnover rate and in which year the turnover rate touched its peak. In our data, we have shown a correlation between attributes such as how many years an employee spent in a company, how many years an employee spent in a company with current manager and how many years spent in the company since the last promotion. We have also shown the correlation between the level of job or service an employee is doing and monthly income of the employee. We have also considered the relation between the attributes like percent hike and the performance rating of an employee. We have also found out the correlation between attributes such as number of years spent by an employee under the current manager, the level of the job and percentage of hike in salary. So, we have used a number of attributes and correlations among them to find out the turnover rate of a company in a certain period of time.

4.2.3 Feature Selection

Feature Selection is considered as the most crucial theory in the fields of machine learning which has a significant amount of impact on the actual performance of the model your building. These features can be simply used to coach your model and have an enormous influence on the performance. Trivial and unrelated features can have a negative impact on the performance of the model. Feature selection and Data cleaning should be the first and most significant step of your model designing. Feature Selection is the process where you automatically or manually select those features on the basis of some various techniques like Univariate Selection Feature Importance Correlation Matrix which contribute most to your dependent variable or output variable in which you are interested in. After analysing the dataset manually we came to a conclusion that these features Employee Count, Employee Number, Over18 have no direct impact on our output variable Arttrition. Therefore, these features have been completely neglected before applying any feature selection methods[8].

Feature Importance

Feature importance gives you a score for each feature of your data, the higher the score more important or relevant is the feature towards your output variable. Feature importance is an inbuilt class that comes with Tree Based Classifiers, we will be using Extra Tree Classifier for extracting the top features for the dataset.

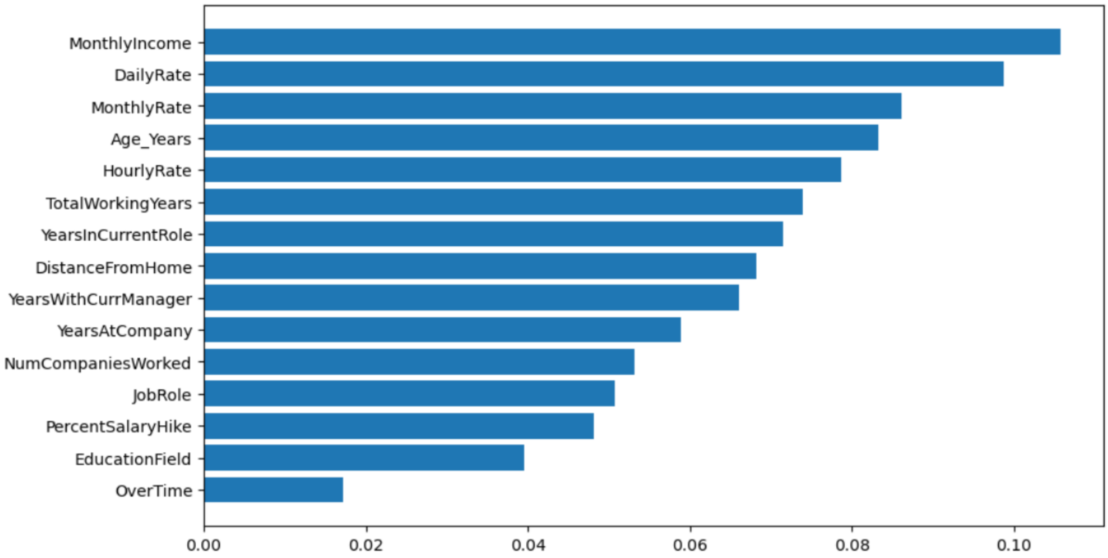


Figure 4.5 Feature Importance

The diagram above represents the feature importance of each feature of our dataset with the help of this feature importance method we could analyse that the features like Monthly income, Age , Daily rate , Hourly rate etc are some of the significant attributes . Along with that we came to conclusion that the features like Business travel Gender, Department, Performance rating are having least impact on our output variable Atrrition. Therefore we can neglect these features beforehand.

4.2.4 Imbalanced Dataset

In the dataset 90% records are labelled with class YES and remaining 10% records are labelled with class NO. This type of datasets are called as imbalanced datasets and can have adverse effect on the performance of the model it makes the model biased towards majority class of output variable. Therefore handling imbalanced dataset becomes a necessary task for this type of problem statement.

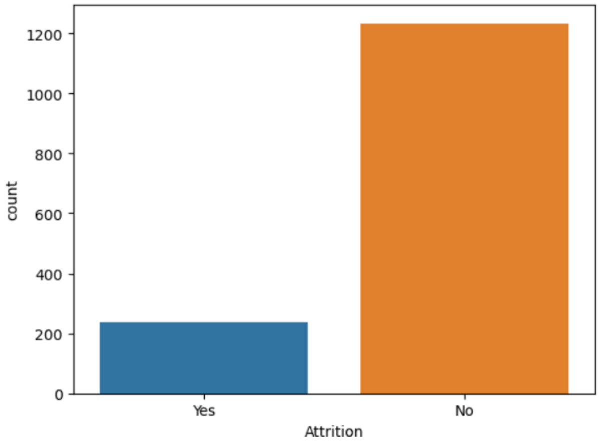


Figure 4.6 Imbalanced data

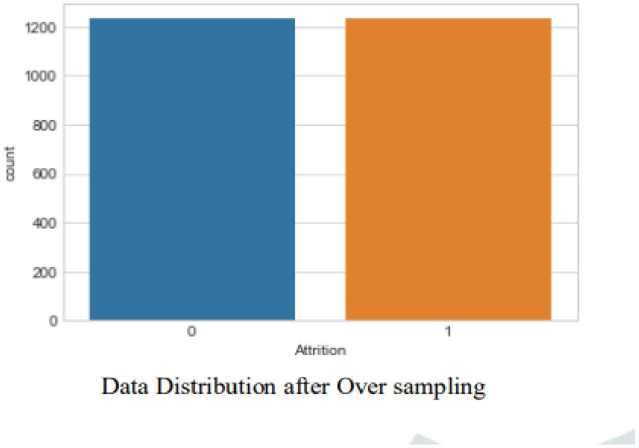
Following are some of the methods to handle imbalanceness of dataset

1.Random Under Sampling

2. Random Over Sampling

3.Custer Based Over Sampling

For our dataset we are using over sampling[12] method to handel the imbalanceness of the dataset. Before over sampling 1233 records were labelled with class NO and only 237 records were labelled with class YES. After performing over sampling we similaried the number of records of both classes to 1233 records as shown in the diagram below



Data Distribution after Over sampling

Figure 4.7 Balanced data

4.3 IMPLEMENTATION OF MACHINE LEARNING ALGORITHM ON TRAINING DATA

Data was gathered from Kaggle, one of the most providers of data sources for the purposeof learning, and hence the data is collected from the Kaggle, which had two sets of details, one of which was for the preparation and the supplementary tests. The dataset for training is the model in which datasets are further divided into datasets was used to train the model train and the minor dataset. For the measuring of the value of attrition, many regression models are applied during this study. The dataset is split into 2 sections.

One half for model training and also the other part for model analysis or testing. During this study, the info set is separated into two-part the first half is termed coaching knowledge and also the second called take a look at data, training data makes up for eighty percent of the whole data used, and the rest for test data. all of those models are trained with the training data part and so evaluated with the test data. The accuracy is checked with the assistance of f1 score.

In this process we use Decision Tree Algorithm and Random Forest Algorithm.

Random Forest Algorithm:

The random forest algorithm improves the flexibility and decision-making capacity of individual trees. It is another machine learning algorithm incorporating the ensemble learning theorem as its foundation, combining results from various decision trees to optimize training. In some use cases of loan and credit risk prediction, some features are more important than the rest or, more specifically, some features whose removal would improve the overall performance. Sincewe know the fundamentals of decision trees and how they choose features based on information gain, random forests would incorporate these benefits to give superior performance[9].

It uses a tree-like graph to show the possible consequences. If you input a training dataset with targets and features into the decision tree, it will formulate some set of rules. These Rules can be used to perform predictions. There are two stages in Random Forest algorithm, one is random forest creation, and the other is to make a prediction from the random forest classifier created in the first stage.

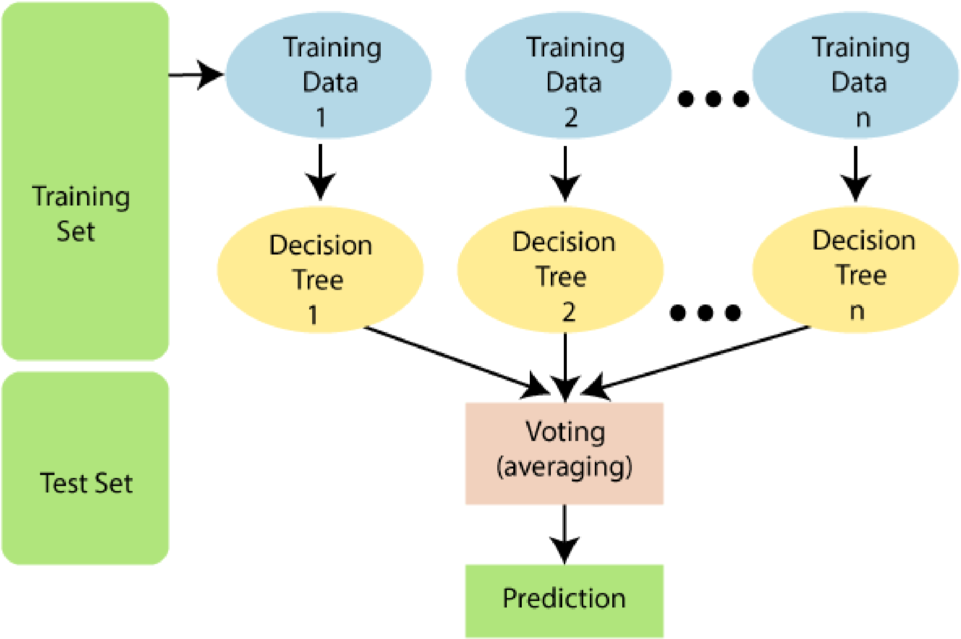


Figure 4.8: Random Forest Algorithm

Random Forest works in two-phase first is to create the random forest by combining N decision tree, and second is to make predictions for each tree created in the first phase.

The Working process can be explained in the below steps and diagram:

Step-1: Select random K data points from the training set.

Step-2: Build the decision trees associated with the selected data points (Subsets).

Step-3: Choose the number N for decision trees that you want to build.

Step-4: Repeat Step 1 & 2.

Step-5: For new data points, find the predictions of each decision tree, and assign the new data points to the category that wins the majority votes.

Decision Tree Algorithm

A decision tree is a type of supervised machine learning used to categorize or make predictions based on how a previous set of questions were answered. The model is a form of supervised learning, meaning that the model is trained and tested on a set of data that contains the desired categorization. In a decision tree, for predicting the class of the given dataset, the algorithm starts from the root node of the tree. This algorithm compares the values of root attribute with the record (real dataset) attribute and, based on the comparison, follows the branch and jumps to the next node[2][3].

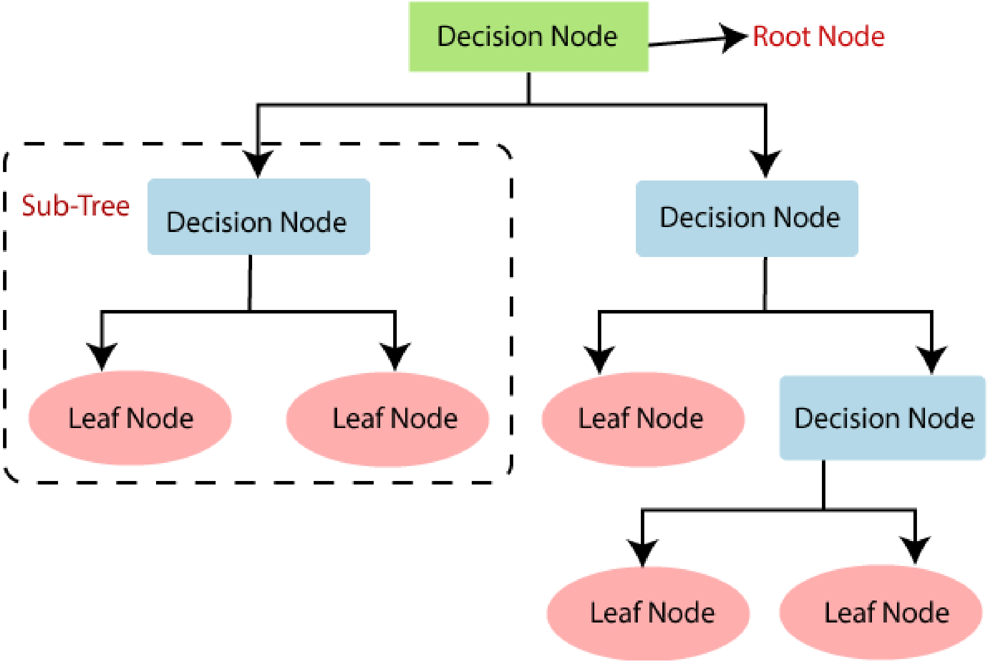


Figure 4.9: Decision tree classifier

For the next node, the algorithm again compares the attribute value with the other sub-nodes and move further. It continues the process until it reaches the leaf node of the tree. The complete process can be better understood using the below algorithm:

Step-1: Begin the tree with the root node, says S, which contains the complete dataset.

Step-2: Find the best attribute in the dataset using Attribute Selection Measure (ASM).

Step-3: Divide the S into subsets that contains possible values for the best attributes.

Step-4: Generate the decision tree node, which contains the best attribute.

Step-5: Recursively make new decision trees using the subsets of the dataset created in step -3. Continue this process until a stage is reached where you cannot further classify the nodes and called the final node as a leaf node.

Logistic Regression

Logistic regression is a statistical method used to predict the outcome of a dependent variable based on previous observations. It's a type of regression analysis and is a commonly used algorithm for solving binary classification problems[5][6].

Logistic regression predicts the output of a categorical dependent variable. Therefore the outcome must be a categorical or discrete value. It can be either Yes or No, 0 or 1, true or False, etc. but instead of giving the exact value as 0 and 1, it gives the probabilistic values which lie between 0 and 1.

Logistic Regression is much similar to the Linear Regression except that how they are used. Linear Regression is used for solving Regression problems, whereas Logistic regression is used for solving the classification problems[14].

In Logistic regression, instead of fitting a regression line, we fit an "S" shaped logistic function, which predicts two maximum values (0 or 1).

The curve from the logistic function indicates the likelihood of something such as whether the cells are cancerous or not, a mouse is obese or not based on its weight, etc.

Logistic Regression is a significant machine learning algorithm because it has the ability to provide probabilities and classify new data using continuous and discrete datasets[14].

5. IMPLEMENTATION CODE

5.1 BACKEND

Employee Prediction .py

```
import  numpy  as  np
import  pandas  as  pd
import seaborn as sns
import matplotlib.pyplot as plt
df=pd.read_csv('employee.csv')
df.head()
df.shape
df.dtypes
df.isna().sum()
df.isnull().values.any()
df.describe()
df['Attrition'].value_counts()
sns.countplot(df['Attrition'])
import matplotlib.pyplot as plt
plt.subplots(figsize=(12,4))
sns.countplot(x='Age',hue='Attrition',data=df,palette='colorblind')
for column in df.columns:
  if df[column].dtype==object:
    print(str(column)+':'+str(df[column].unique()))
print(df[column].value_counts())
    print('------------------------------------------------------------')
df['StandardHours'].unique()
df=df.drop('Over18',axis=1)
df=df.drop('EmployeeNumber',axis=1)
df=df.drop('StandardHours',axis=1)
df=df.drop('EmployeeCount',axis=1)
df.corr()
plt.figure(figsize=(14,14))
sns.heatmap(df.corr(),annot=True,fmt='.0%')
from sklearn.preprocessing import LabelEncoder
for column in df.columns:
  if df[column].dtype==np.number:
    continue
df[column]=LabelEncoder().fit_transform(df[column])
df['Age_Years']=df['Age']
df=df.drop('Age',axis=1)
df=df.drop(['Gender','PerformanceRating','EnvironmentSatisfaction','Department','RelationshipSatisfaction','WorkLifeBalance','BusinessTravel','Education','StockOptionLevel','YearsSinceLastPromotion','JobInvolvement','MaritalStatus','JobSatisfaction','JobLevel','TrainingTimesLastYear'], axis=1)
X=df.iloc[:,1:df.shape[1]].values
Y=df.iloc[:,0].values
pip install imblearn
from sklearn.ensemble import RandomForestClassifier
from sklearn.model_selection import KFold
```

```
forest=RandomForestClassifier(n_estimators=10,criterion='entropy',random_state=0)
from imblearn.over_sampling import SMOTE
oversampler=SMOTE()
# X=pd.DataFrame(X)
# Y=pd.DataFrame(Y)
x_smote,y_smote=oversampler.fit_resample(X,Y)
x_smote=pd.DataFrame(x_smote)
y_smote=pd.DataFrame(y_smote)
kfold = KFold(n_splits=10, shuffle=True,random_state=0)
model=RandomForestClassifier()
kfold = KFold(n_splits=10, shuffle=True,random_state=42)
    # Evaluate the model using K-fold cross-validation
 scores = []
for train_index, test_index in kfold.split(x_smote,y_smote):
    X_train, X_test = x_smote.iloc[train_index], x_smote.iloc[test_index]
    y_train, y_test = y_smote.iloc[train_index], y_smote.iloc[test_index]
    forest.fit(X_train, y_train)
    score = forest.score(X_test, y_test)
    scores.append(score)
print("Mean accuracy:", np.mean(scores))
print(scores)
from sklearn.model_selection import train_test_split
X_train,X_test,Y_train,Y_test=train_test_split(x_smote,y_smote,test_size=0.15,random_state=0)
plt.figure(figsize=(10,6))
 sort=forest.feature_importances_.argsort()
 plt.barh(df.columns[1:31][sort],forest.feature_importances_[sort]
 )forest.fit(X_train,Y_train)
forest.score(X_train,Y_train)
from sklearn.metrics import confusion_matrix,accuracy_score,ConfusionMatrixDisplay
pred=forest.predict(X_test)
accuracy_score(Y_test,pred)
cm=confusion_matrix(Y_test,pred)
dis=ConfusionMatrixDisplay(confusion_matrix=cm,display_labels=forest.classes_)
dis.plot()
import pickle
with open('Employee_attrition.pkl','wb') as f:
    pickle.dump(forest,f)
```

5.2 FRONTEND

index.html

```
<!DOCTYPE html>
<html lang="en">
<head>
    <meta charset="UTF-8">
    <meta name="viewport" content="width=device-width, initial-scale=1.0">
    <title>Employee Attrition</title>
    <!-- Include any required CSS files -->

    <style>
        body{
 background-image: url('https://www.employeecycle.com/wp-
content/uploads/2022/11/PeopleAnalytics-403x224.jpg');
background-repeat: no-repeat;
 background-size: cover;
 text-decoration: solid;

 }
 h1{
    margin-left:20%;
    color:black;
 }
 label{
    color:black;
    font-size: medium;
 }
 button{
    width:80px;
    height:40px;
    background-color: green;
    font-size: medium;
    margin-bottom: 1%;
 }
</style>
</head>
<body>
    <header>
        <h1>Employee Attrition Predictor</h1><br><br>
    </header>
    <main>
        <form action="/employeePredict" id="form1" method="POST">
            <table>
                    <th>
            <div style="float:left;margin-left: 200px; text-align: center;">
            <!-- Include input fields to gather student information -->
            <label for="DailyRate">Daily Rate</label>&nbsp&nbsp
            <input type="number" min="0" max="1499" name="DailyRate" required><br><br>

            <label for="dfh">Distance From Home</label>
            <input type="number" id="dfh" min="0" max="28" name="dfh" required><br><br>

            <label for="EducationField">Education Field</label>
            <select name="EducationField" class="first" required="required">
              <option value="1">Life Sciences</option>
              <option value="3">Medical</option>
              <option value="4">other</option>
              <option value="5">Technical Degree</option>
              <option value="2">Marketing</option>
              <option value="0">Human Resources </option>
              </select><br><br>

            <label for="HourlyRate">Hourly Rate</label>
            <input type="number" id="HourlyRate" min="0" max="100" name="HourlyRate"
required></input><br><br>

            <label for="JobRole">Job Role</label>

            <select name="JobRole" class="first" required="required">
              <option value="7">Sales Executive</option>
              <option value="6">Research Scientist</option>
              <option value="2">Laboratory Technician</option>
              <option value="0">Healthcare Representative</option>
              <option value="4">Manufacturing Director</option>
              <option value="1">Human Resources</option>
              <option value="3">Manager</option>
              <option value="5">Research Director</option>
              <option value="8">Sales Representative</option>
              </select><br><br>
            <label for="MonthlyIncome">Monthly Income</label>
            <input type="number" id="MonthlyIncome" min="0" max="5993"
name="MonthlyIncome" required><br><br>
            <label for="MonthlyRate">Monthly Rate</label>
            <input type="number" id="MonthlyRate" min="0" max="20000" name="MonthlyRate"
required><br><br>

            <label for="ncw">Number of companies Worked</label>
            <input type="number" id="ncw" name="ncw" min="0" max="18" required><br><br>
            </div>
            </th>
            <th>

            <div style="float:right;margin-top:20%;margin-right: 100px; text-align: center;">

            <label for="OverTime">Over Time</label>
            <select name="OverTime" class="first" required="required">
```

```
             <option value="0">No</option>
       <option value="1">Yes</option>
         </select><br><br>
           <label for="psh">Percent salary Hike</label>
           <input type="number" id="psh" min="0" max="14" name="psh" required><br><br>
           <label for="twy">Total Working Years</label>
           <input type="number" id="twy" min="0" max="40" name="twy" required><br><br>
           <label for="yac">Years At Company</label><br>
           <input type="number" id="yac" min="0" max="40"name="yac" required><br><br>
           <label for="ycr">Years In Current Role</label><br>
           <input type="number" id="ycr" min="0" max="18" name="ycr" required><br><br>
           <label for="ycm">Years With Current Manager</label><br>
           <input type="number" id="ycm" min="0" max="17" name="ycm" required><br><br>
           <label for="age">Age</label>
           <input type="number" id="age" min='18' max='60'name="age" required><br><br><br>

           <button type="submit" value="Predict">Submit</button>
           </div>
           </th>
           </table>
           <p>{{res}}</p>
        </form>
    </main>

</body>
</html>
```

5.3 CONNECTION

App.py

```
from flask import Flask, render_template, request
import pickle
import numpy as np
app = Flask(_name_)
model = pickle.load(open('Employee_attrition.pkl', 'rb'))

@app.route("/")
def Home():
 return render_template('index.html')

@app.route("/employeePredict",methods=['POST','GET']

def employeePredict():

  if request.method=='POST':

      print(" ............................................")
   age= int(request.form['age'])
   dfh= int(request.form['dfh'])
   mi=int(request.form['MonthlyIncome'])
   hr= int(request.form['HourlyRate'])
   mr =int( request.form['MonthlyRate'])
   dr =int( request.form['DailyRate'])
   ycm = int(request.form['ycm'])
   ycr = int(request.form['ycr'])
   yac=int(request.form['yac'])
   psh=int(request.form['psh'])
   ncw=int(request.form['ncw'])
   twy=int(request.form['twy'])
   ov=(request.form['OverTime'])
   if ov=="1":
    v=1
   else:
    v=0
   ef=(request.form['EducationField'])
   ef=int(ef)
   jr=(request.form['JobRole'])
   jr=int(jr)
   x=[dr,dfh,ef,hr,jr,mi,mr,ncw,v,psh,twy,yac,ycr,ycm,age]
   print(x)
   result=model.predict([[dr,dfh,ef,hr,jr,mi,mr,ncw,v,psh,twy,yac,ycr,ycm,age]])[0]
   print(result)
  if result==1:
    return render_template('index.html',res="Employee discontinued.")
  else:
    return render_template('index.html',res="employee continued")
if__name_=="_main_":
 app.run(debug=True)
```

6. RESULT ANALYSIS

Employee attrition prediction problem, statement comes under the classification type of machine learning. To solve such a classification problem there are multiple choices available. Comparative analysis is a study of choosing the best algorithm for the problem statement in this section we illustrate the results of models based on their accuracy, precision, recall, and F1 score. Here we are comparing between multiple classification algorithms like Random forest(RFA) , Decision tree ,Logistic regression(LR), over evaluation metrics like Accuracy, Precision, Recall, and F1 score.

This phase evaluated the qualities of the adopted models. The results of the decisions made in the prediction phase were collected, for each algorithm, in the relative “confusion matrix”. This is a matrix where the values predicted by the classifier are shown in the columns and the real values of each instance of the test-set are shown in rows. To proceed with the performance evaluation, we used the confusion matrix to derive a series of fundamental metrics to quantitatively express the efficiency of each algorithm

By comparative analysis of below 3 algorithms we came to a firm conclusion that Random Forest Algorithm has the best accuracy. Therefore RFA is used for model building for our system.

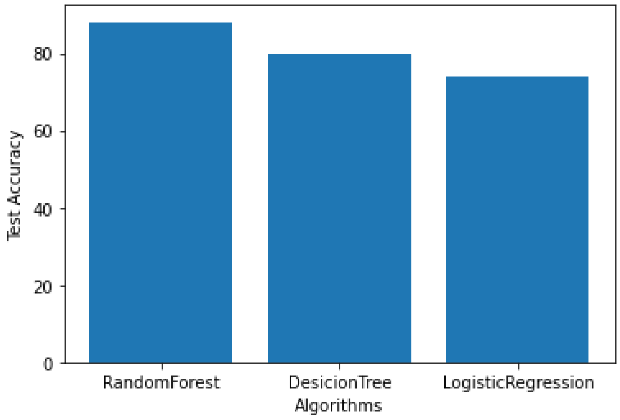


Figure:6.1 Result Analysis

Performance Evaluation:
All trained models were evaluated by measuring their accuracy, precision, recall and F1 score which are described below :

- Accuracy = TP+TN $TP+TN+FP+FN$
- Precision = TP $TP+FP$
- Recall = TP $TP+FN$
- F1 Score = 2 ∗ Precision∗ Recall /Precision+ Recall

CONFUSION MATRIX

The confusion matrix is a matrix used to determine the performance of the classification models for a given set of test data. It can only be determined if the true values for test data are known[10][11].

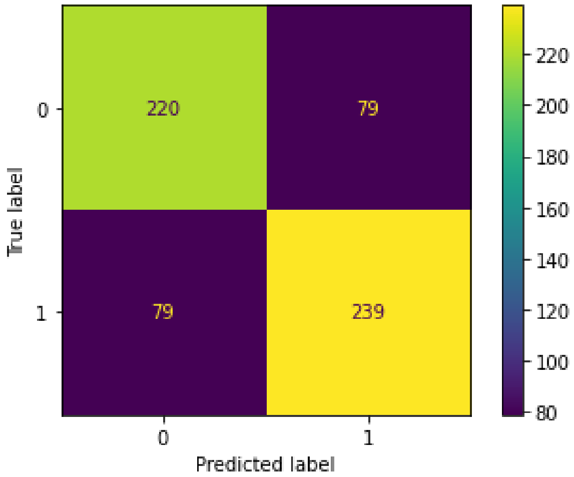


Figure 6.2: Logistic Regression

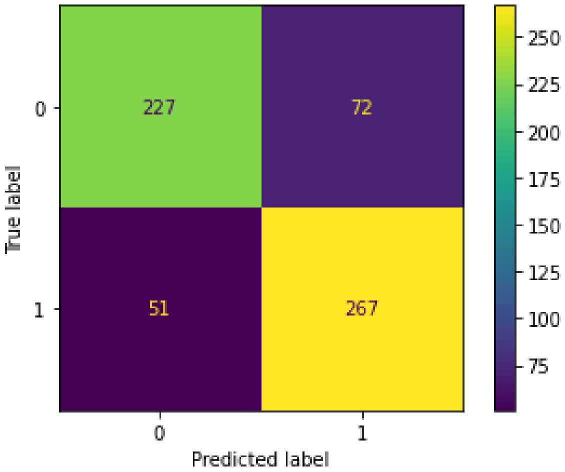


Figure 6.3: Decision Tree

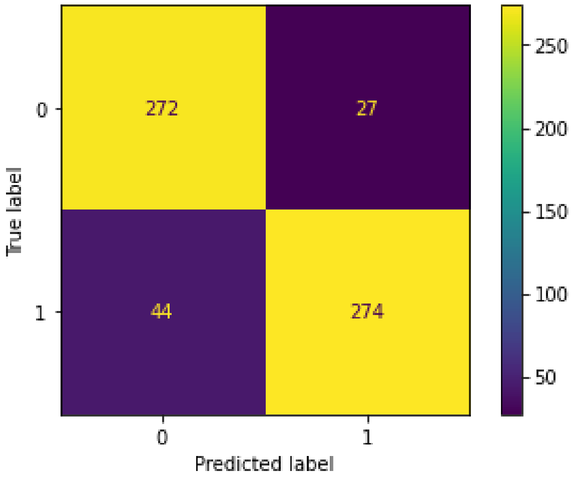
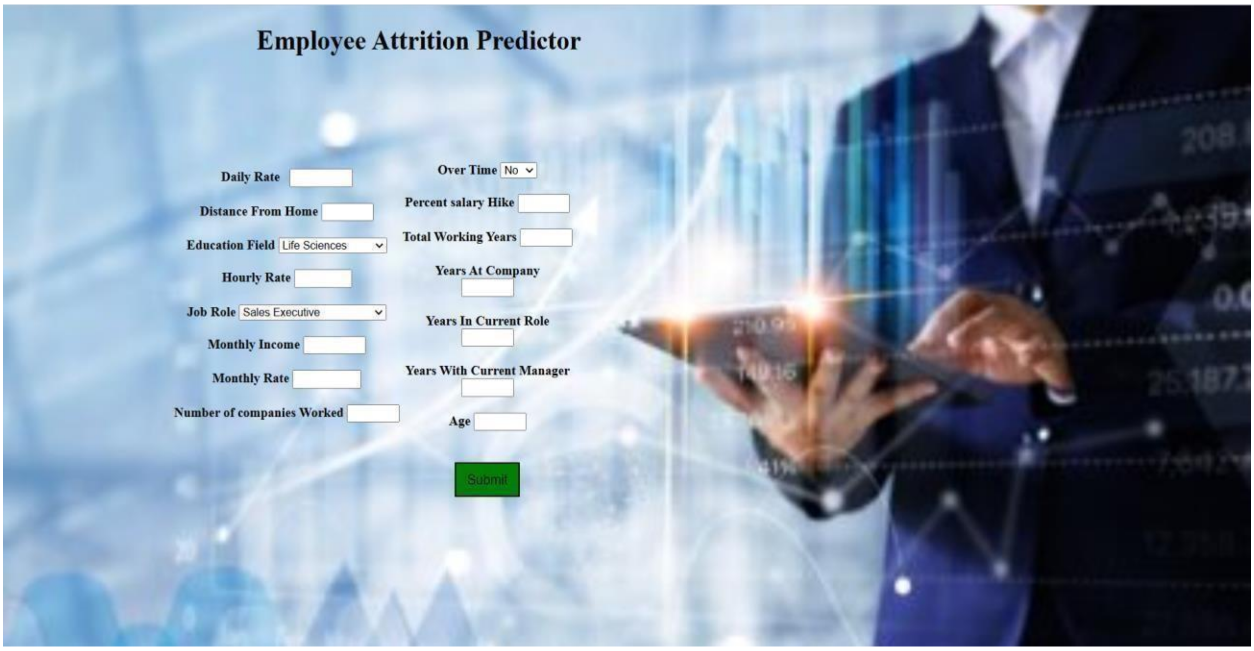


Figure 6.4: Random Forest

Figure 6.2 is the confusion matrix for Logistic Regression, this algorithm gives 74% accuracy means it correctly predicting the 74% of test data. Figure 6.3 is confusion matrix for decision tree classifier it predicting the true negatives and true positives correctly compare to Logistic Regression. Figure 6.4 is the confusion matrix for Random Forest, It gives highest accuracy i.e 88% compared to other. It correctly predicting the TN and TP values.

7. OUTPUT SCREENS

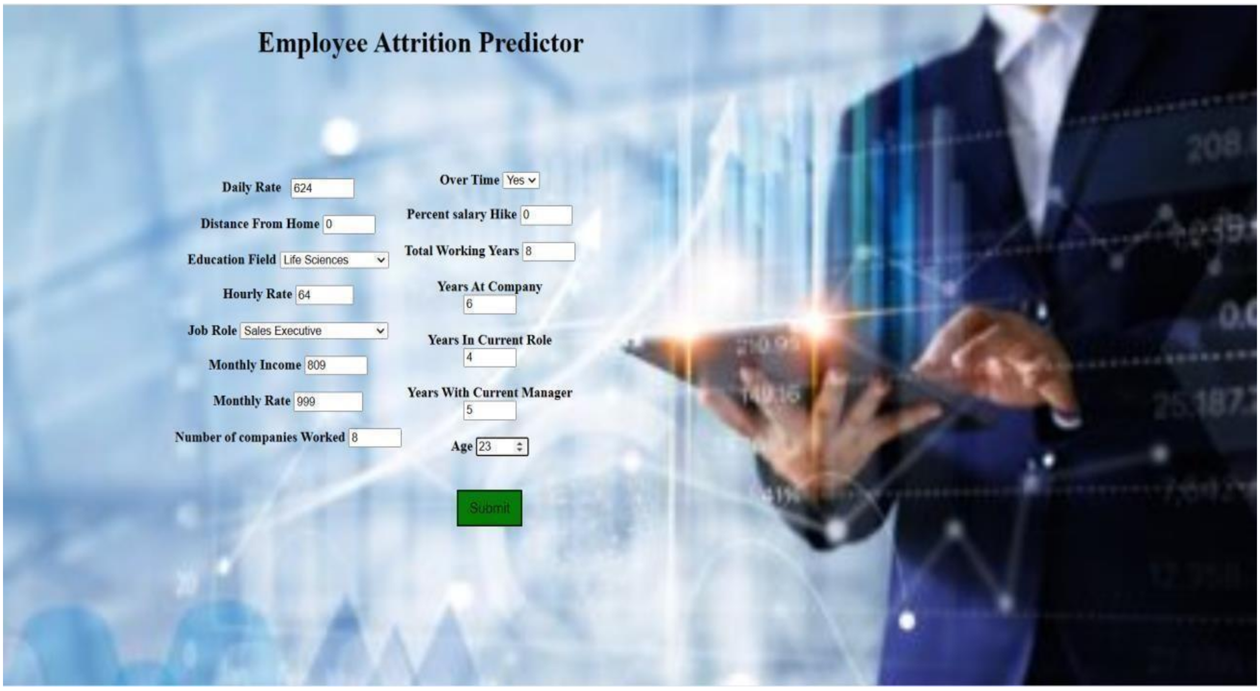


Employee Attrition Predictor

Daily Rate
Distance From Home
Education Field: Life Sciences
Hourly Rate
Job Role: Sales Executive
Monthly Income
Monthly Rate
Number of companies Worked
Over Time: No
Percent salary Hike
Total Working Years
Years At Company
Years In Current Role
Years With Current Manager
Age

Figure:7.1 Home Screen

Figure 7.1 is the home screen of our project where we have to give values for the attributes in the above image.

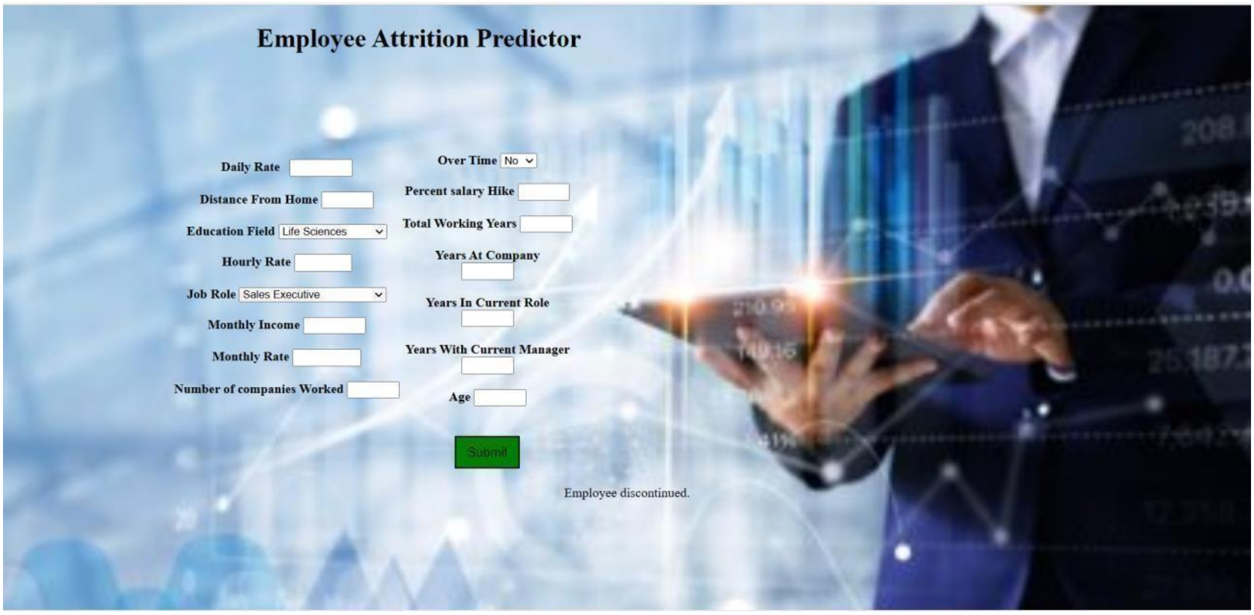


Employee Attrition Predictor

Daily Rate: 624
Distance From Home: 0
Education Field: Life Sciences
Hourly Rate: 64
Job Role: Sales Executive
Monthly Income: 809
Monthly Rate: 999
Number of companies Worked: 8
Over Time: Yes
Percent salary Hike: 0
Total Working Years: 8
Years At Company: 6
Years In Current Role: 4
Years With Current Manager: 5
Age: 23

Figure:7.2 After giving input

Figure 7.2, this is screen appears after giving input to fields in home screen



Employee Attrition Predictor

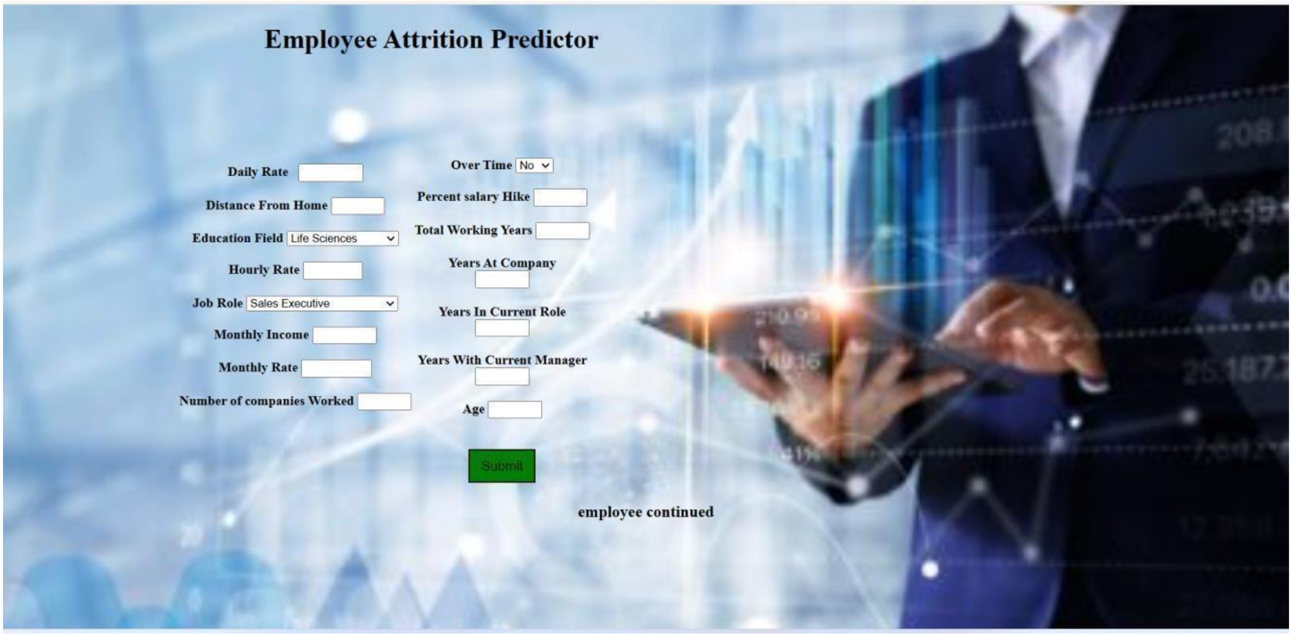
Daily Rate
Distance From Home
Education Field Life Sciences
Hourly Rate
Job Role Sales Executive
Monthly Income
Monthly Rate
Number of companies Worked

Over Time No
Percent salary Hike
Total Working Years
Years At Company
Years In Current Role
Years With Current Manager
Age

Employee discontinued.

Figure:7.3 Evaluation of employee attrition for discontinuation

Figure 7.3 is the prediction of employee attrition. The value of result is ‘1’ which is labeled as ‘YES’ for attrition variable.



Employee Attrition Predictor

Daily Rate
Distance From Home
Education Field Life Sciences
Hourly Rate
Job Role Sales Executive
Monthly Income
Monthly Rate
Number of companies Worked

Over Time No
Percent salary Hike
Total Working Years
Years At Company
Years In Current Role
Years With Current Manager
Age

employee continued

Figure:7.4 Evaluation of employee for continuation

Figure 7.4 is the prediction of employee attrition. The value of result is ‘0’ which is labeled as ‘No’ for attrition variable.

8. CONCLUSION AND FUTURE SCOPE

8.1 CONCLUSION

After assessing the execution of four classification models, a significant finding was that if feature reduction for prediction is appropriately conducted, the accuracy rate of the classification models always be better compared to classification with feature selection. In particular, the Random Forest classifier with feature reduction achieved an accuracy score of 85.3%, while the Decision tree classifier achieved 83%. Random Forest model giving best classification for True positives and True negatives data. The methods described in the paper for analyzing and categorizing data can form a basis for improving data-driven decision-making processes. These techniques can unlock new insights from data and help organizations improve their operations. Implementation of these methods can also contribute to a positive work culture and improve an organization's reputation in their respective industry.

8.2 FUTURE SCOPE

To develop more accuracy using machine learning algorithms and advanced techniques. The work can extend and improved for the automation of employee attrition prediction by using advanced techniques.

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PREDICTION OF EMPLOYEE ATTRITION USING MACHINE LEARNING

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***Abstract*- In today's IT world, the major concern is employee attrition rate. Attrition rate can be defined as the percentage of employees who left from the organization. The aim of this project is to analyse a particular employee will continue in the organization or not. The discontinuous of an employee can be done by either up to the individual or due to organization force. To predict attrition rate we have used different machine learning techniques. The steps are dataset collection, pre-processing the data, training model using machine learning classification models like Random Forest, decision tree classifier etc and result analysis . The results are evaluated using accuracy score and confusion matrix. Random forest algorithm giving the best accuracy i.e 85% compared to decision tree. This work will help organizations to better understand the attrition causes.**

Keywords- Attrition, classification models, random forest, SVM, decision tree classifier

I. INTRODUCTION

In these days, data produced at an exponential pace. This data has been useful in gaining knowledge and spreading awareness about any company or group. Before modelling data we have to pre-process the data with the goal of gaining insightful conclusions, recovering pertinent data to make wise decisions. It is a way of making a computer to make correct predictions using historical information.

Employees are playing major role for any company, so losing effective employees could have a negative impact on the business in a number of ways. Employee attrition has a number of negative effects, including increased costs for hiring and training new workers[1]. This will effect the well being of existing employees in the organization. This paper consists of 3 sections. Dataset collection is the first step and it is discussed in next step. section II discuss the data pre-processing steps. This step is crucial for any machine learning project before building model[9]. Dataset consists of inconsistent data , imbalanced class labels and unwanted attributes[8]. All these problems lead to poor model construct. We are supposed to find important attributes which impacts target attribute. For doing this step we do feature importance on all attributes. Third section will discuss on model training here we pass more consistent data to different classification models.

II. LITERATURE SURVEY

A lot of studies have been made on attrition prediction analysis in the literature. The major focus was on predicting employee attrition. Researchers have applied machine learning classification models like logistic regression, random forests, support vector machine, and others to analyze the attributes that impact the attrition rate. For instance, Srivastava[1] et al presented a framework that predicts employee churn by analyzing the behaviors of employees and attributes with the help of machine learning techniques. Setiawan[5] et al through their work found variables that have a major impact on employee attrition. Qasem A, A.Radaideh, and Eman A Nagi have utilized data mining techniques to construct a classification model that can anticipate employees' performance. They implemented the CRISP-DM data mining methodology in their research and employed the decision tree as the primary data mining tool to build the classification model. Multiple classification rules were created as a result of this. The generated model was validated through a series of experiments using actual data obtained from various businesses. The purpose of the model is to forecast the performance of new job applicants.

III. DATASET COLLECTION

The "IBM HR Employee Analytics Attrition and Performance" dataset was acquired from Kaggle, a website that provides datasets and serves as a venue for data science-related contests [13]. There are 35 attributes and 1470 entries in this collection. The data categories include independent factors like "Age," "Daily Rate," "Education Field," "Number of companies worked," etc.; however, in this study, "Attrition" is regarded as the dependent variable. Two class names, "Yes" or "No," make up the "Attrition" data field.

IV. DATA PRE-PROCESSING

A).LIBRARIES USED:

1) Libraries for Import: We take into consideration the following potent and useful tools for the analysis and prediction of attrition rate. The libraries are:

a) Numpy: It ranks among the most significant Python tools for computational mathematics and science.

b) Pandas: A tool made for quick and simple data frame processing.

c) Matplotlib: A Python package that produces complex graphs and charts like bar charts, pie charts, and more.

d) Scikit-Learn: The SciKit-Learn package provides a variety of supervised and unsupervised machine learning methods. The main goal of machine learning tools is data modeling.

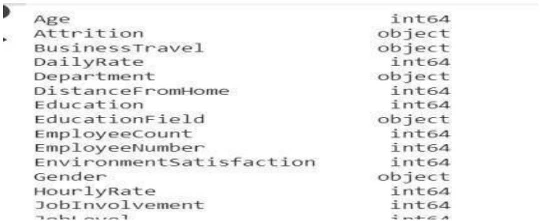
2) Read Dataset: Read the dataset of .csv format using pandas function read_csv().

3) Create dataset as Data Frame: Now create data frame using read dataset object. This data frame will be used in further pre-processing steps.

B) DATA PREPROCESSING

Pre-processing means cleaning data, normalizing datasets and operate the changes in the data. These steps are performed to get the datasets into a state that enables analysis in further phases [1]. In Data preprocessing the following steps were performed:

1) Investigate Dataset Properties: The goal of data research was to comprehend the connections between the factors and to examine the issue at hand [1]. This research step is useful for spotting common dataset problems like Null values, Outliers, Redundancies, etc. Below figure 1 picture depicts the columns of dataset and its datatype.



```
Age                              int64
Attrition                       object
BusinessTravel                  object
DailyRate                        int64
Department                      object
DistanceFromHome                 int64
Education                        int64
EducationField                  object
EmployeeCount                    int64
EmployeeNumber                   int64
EnvironmentSatisfaction          int64
Gender                          object
HourlyRate                       int64
JobInvolvement                   int64
JobLevel                         int64
```

FIG: 1 ATTRIBUTES AND DATA TYPES

2)Data preparation: This includes the procedures for exploring, pre-processing, and configuring data before data modeling. It was carried out in order to familiarize ourselves with our information and learn more about it. It required converting the data into a structure that would make further research easier. This is usually the stage in the analytics lifecycle that requires the most effort and iterations [1]. The following are the main processes taken for data preparation:

a) Feature Reduction: This phase was important in deciding which features in the dataset should be kept and which features should be transformed or removed in order to make decisions about which attributes in the data will be helpful for analysis in the later stages. The decision as to which trait is important and which is not for attrition forecast was made. Following are some examples of characteristics based on which elements were excluded from further analysis:

i) Attributes with numbers that are not unique: There are non-unique numbers for the following attributes:

The number of the property "Employee count," which is "1" for each employee, is given by the employee count attribute.

"Standard working hours" is an attribute that provides the number of an employee's standard working hours, which is "80" for each entry. "Over 18 yrs of age" is an attribute that confirms whether an employee meets the age requirement (to be over 18), which is "Yes" for every entry.

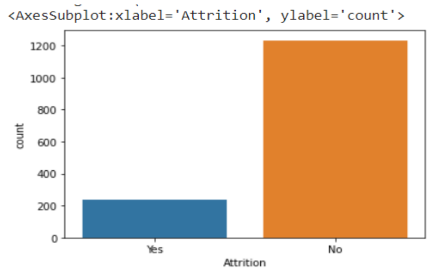
All the above mentioned attributes having only one unique value .So, we are ignoring these attributes from dataset.

ii) Data cleaning: To guarantee better data quality, abnormalities, usually missing values, duplicate data, and outliers are removed. In our dataset there are no missing values and outliers.

iii) Categorical to Numerical: Since categorical variables are not accepted as input by normal libraries, these values must be transformed into numeric form. As seen in Figure 2, this was accomplished by using the Label Encoder Method to convert nominal category variables or categorical data into numerical labels. The range of a numerical identifier is always 0 to n_classes-1.

Attrition	Attrition
Yes	1
No	0
Yes	1

FIG: 2 ATTRITION ATTRIBUTE LABEL ENCODING *iv) Dataset balancing:* In given dataset, there are more records with the label "Attrition" set to "0" than there are records with the label "Attrition" set to "1," causing an unbalance. Figure 3 is a bar graph that displays the number of labels in the collection for each label.



```
<AxesSubplot:xlabel='Attrition', ylabel='count'>
```

FIG: 3 BAR PLOT FOR TARGET ATTRIBUTE DISTRIBUTION

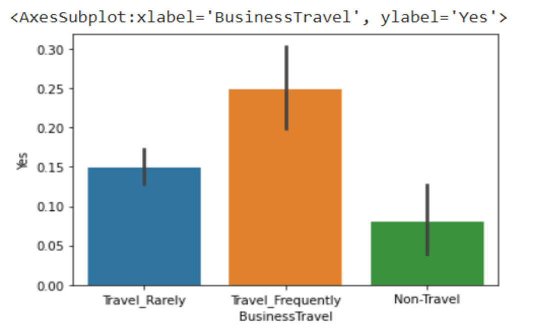
Using the Synthetic Minority Oversampling Technique (SMOTE), entries for the class with a lower total were artificially generated. SMOTE, a method for oversampling the minority class, was chosen over under sampling because the latter could lead to the removal of important data[12].

C) VISUALIZATION

This process provides valuable insights into the dataset and helps to distinguish important features from irrelevant ones. Overall, visualization is a crucial step in data analysis that enables us to quickly gain a high-level understanding of the data and make informed decisions about feature selection.

1) Attrition vs Business Travel:

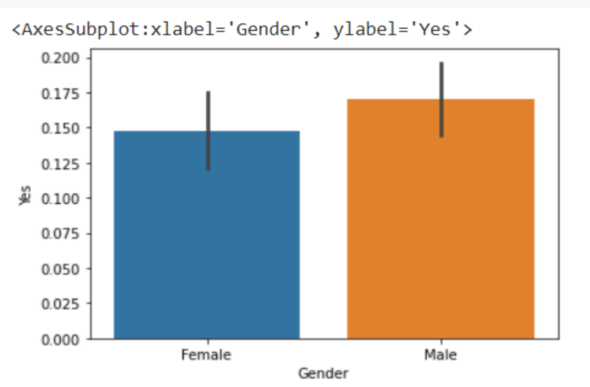
From Figure 4, we can clearly knowing that Non-Travel employees having low attrition rate. In other way, employees who travel from one place to other place on business purpose, having high attrition rate.



```
<AxesSubplot:xlabel='BusinessTravel', ylabel='Yes'>
```

FIG: 4 BAR PLOT REPRESENTATION FOR BUSINESS TRAVEL

2) Attrition on basis of gender:



```
<AxesSubplot:xlabel='Gender', ylabel='Yes'>
```

FIG: 5 BAR CHART REPRESENTATION FOR 'GENDER'

Figure 5 shows that the turnover rate is not significantly influenced by the employee's gender. In each instance, the turnover rate stays about the same. This demonstrates that Gender is not a characteristic that should be considered for inclusion in future attrition forecast methods. These graphic representations make feature selection and reduction much more understandable and simple.

V. FEATURE IMPORTANCE AND TRAIN MODEL

A).Divide dataset into Train and Test: To prepare the data for machine learning, the 'DataFrame' was divided into two subsets: Train and Test. The Train set was used to train the machine learning algorithm, and the knowledge gained was used to predict the required attribute for the Test set. It is important to have a larger Train set than Test set as this helps the machine learn better from the dataset. Typically, the train data should be around 70-85% of the entire dataset. In particular case, the train data consists of 75% of the 'DataFrame', i.e 1249 rows, where other 15% or 221 rows are from test data.

B) Feature Importance: In machine learning, feature importance refers to the process of determining the relative importance of different input variables[7], or features, in predicting the output of a model.

Feature importance is useful because it helps to identify which features are most relevant to the problem being solved, and which features can be ignored or removed to simplify the model without sacrificing accuracy. This information can be used to optimize the performance of the model by focusing on the most important features and reducing the dimensionality of the data.

C) *Machine Learning Models for prediction:*

After preparing the data, the next step in using machine learning models for prediction involves an loop process that aims to improve the accuracy of the models. There are several classification models that can be used for this purpose:

1).Decision Tree Classifier: This method is suitable for multistage decision-making and breaks down complex decisions into elementary ones for easy interpretation[2][3].

2).Support Vector Machine (SVM): This approach can be utilized for both classification and regression tasks, and it involves constructing a hyperplane with maximum margin in a transformed input space to separate different classes of examples. The goal is to ensure that the hyperplane is as far as possible from the nearest correctly classified examples, which results in a well-separated and accurately classified dataset[4].

3).Logistic Regression: It is one of the simplest supervised machine learning algorithms. The logistic regression technique employs a linear model to convert the predictor variables into a probability value between 0 and 1. The logistic function parameters are estimated by the model using a technique known as maximum likelihood estimation, that involves determining the parameter values that affect the probability of observing the data. [14][6]

4).Random Forest: This method is an ensemble learning algorithm that generates multiple sub decision trees and merges them to generate better accurate and stable prediction[9].

In this project we train model using Random Forest algorithm , logistic regression[6], SVM and Decision tree.In these algorithms random forest gives best accuracy when compared to other classification models.

D) *Result Analysis:*

When evaluating a machine learning model, it is important to use appropriate metrics to measure its performance. Three commonly used metrics in machine learning are:

1).Accuracy: This metric used to measure the proportion of correct predictions made by the model over the total number of predictions. It is calculated by dividing the number of correct predictions by the total number of predictions made.

2) Confusion Matrix: It is a matrix representation of TP,TN,FP and FN values. Using this matrix we can also find out the accuracy score by (TP+TN)/(TN+TP+FN+FP)[10][11]

Among all classification algorithms, we observe that Random Forest algorithm giving best accuracy score and also predicting accurately on unknown data.

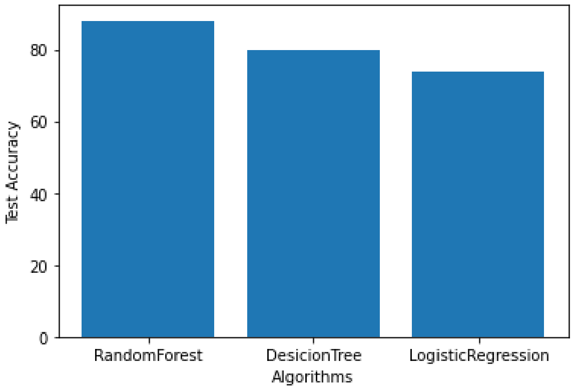


FIG:6 BAR GRAPH FOR TEST ACCURACIES

Figure 6 represents test accuracies of algorithms . from above figure we clearly observe that random forest algorithm gives best accuracy compared to other.

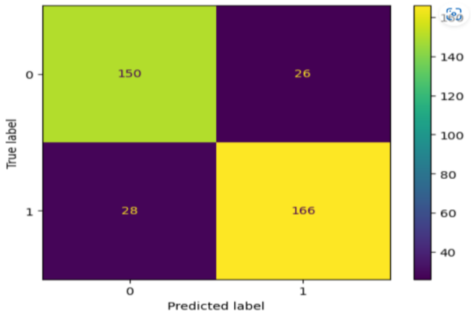


FIG:7 CONFUSION MATRIX FOR RANDOM FOREST

Figure 7, shows how currectly the random forest algorithm predict the target class.

VI. CONCLUSION

After assessing the execution of four classification models, a significant finding was that if feature reduction for prediction is appropriately conducted, the accuracy rate of the classification models always be better compared to classification with feature selection. In particular, the Random Forest classifier with feature reduction achieved an accuracy score of 85.3%, while the Decision tree classifier achieved 83%. Random Forest model giving best classification for True positives and True negatives data. The methods described in the paper for analyzing and categorizing data can form a basis for improving data-driven decision-making processes. These techniques can unlock new insights from data and help organizations improve their operations. Implementation of these methods can also contribute to a positive work culture and improve an organization's reputation in their respective industry.

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AG-2

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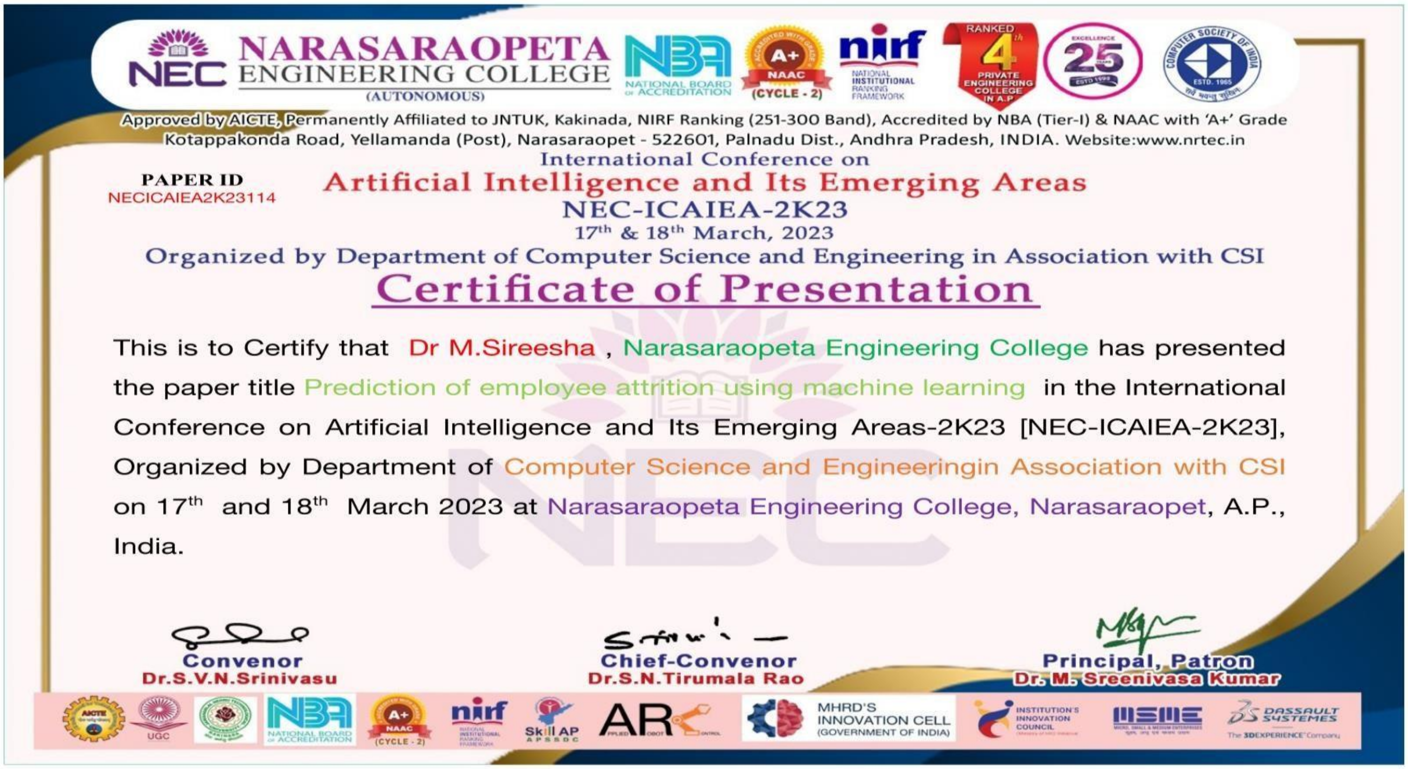

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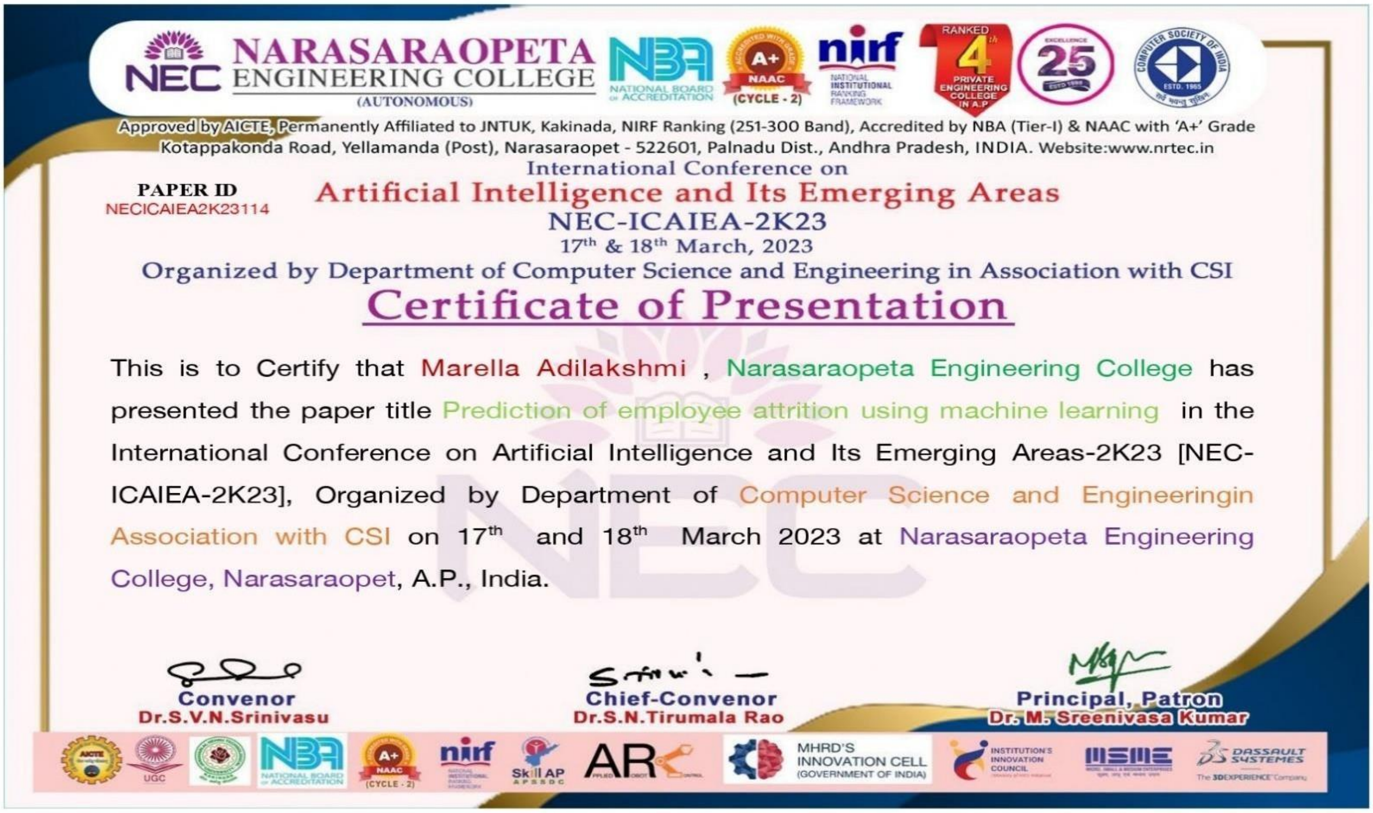

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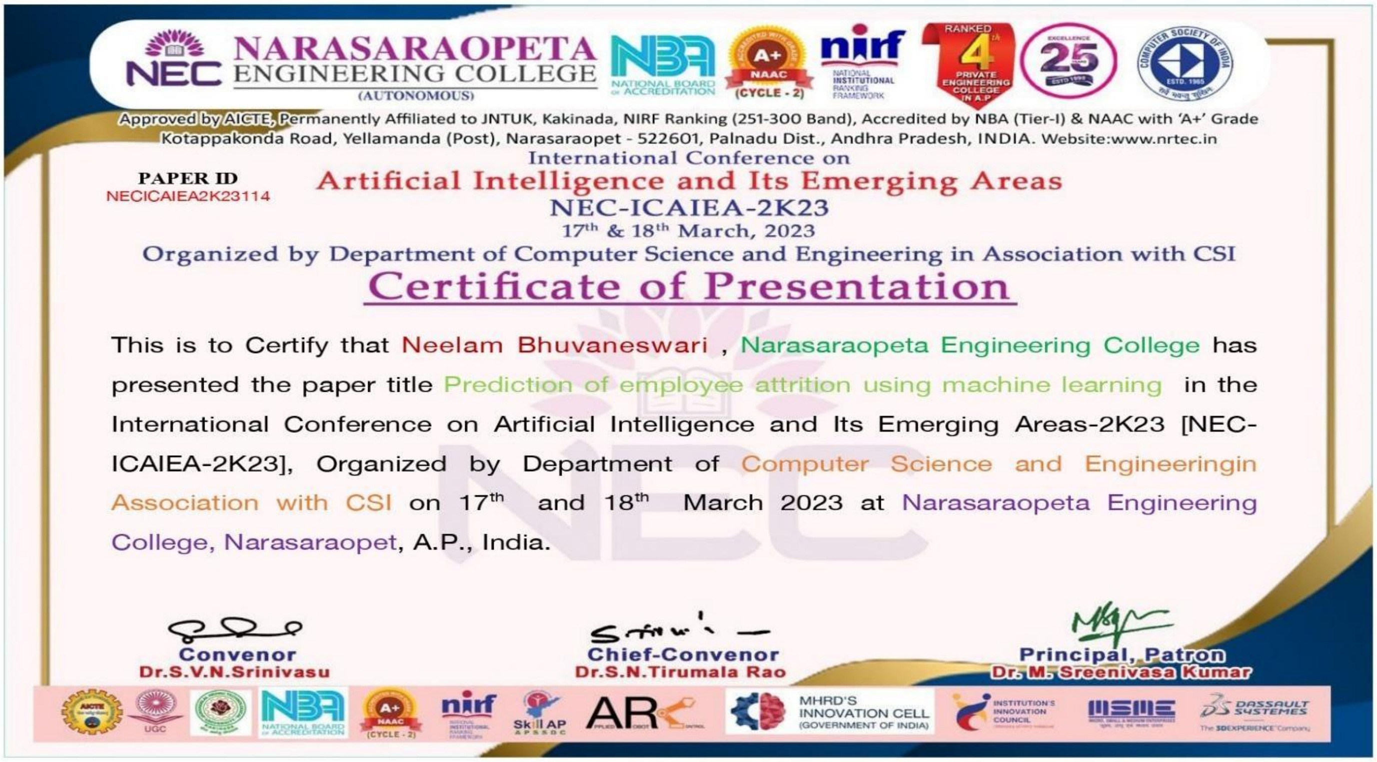

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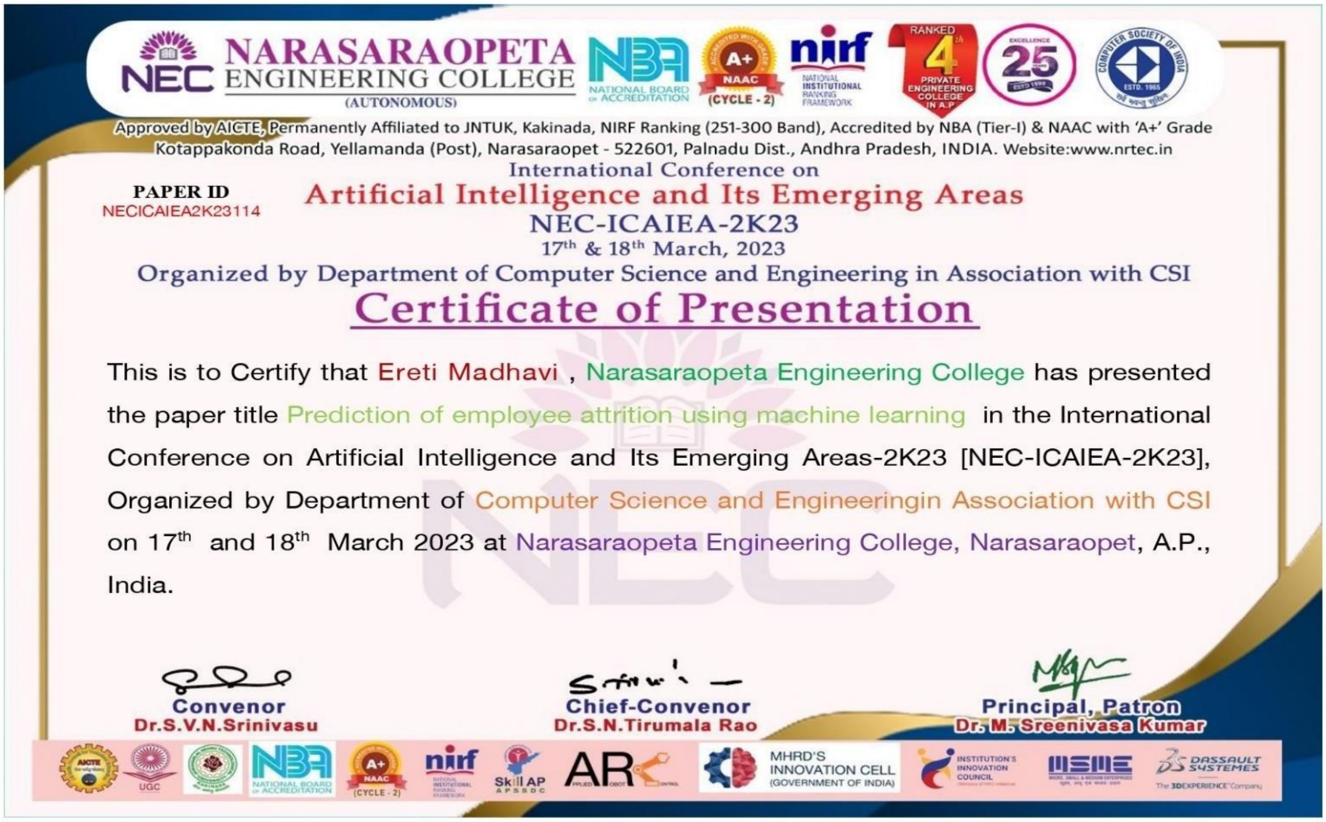

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