**A Project Report**

**On**

**Employee Attrition Analysis Project**

***Submitted in partial fulfillment of the***

***requirement for the award of the degree of***

**MASTER OF COMPUTER APPLICATION**

DEGREE

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By

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**SCHOOL OF COMPUTER APPLICATIONS AND TECHNOLOGY**

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# CANDIDATE’S DECLARATION

I/We hereby certify that the work which is being presented in the project, entitled **“Employee Attrition Analysis Project”** in partial fulfillment of the requirements for the award of the MCA (Master of Computer Application) submitted in the School of Computer Applications and Technology of Galgotias University, Greater Noida, is an original work carried out during the period of August, 2023 to Jan and 2024, under the supervision of Mr. Sarvesh Kumar Swarnakar, Department of Computer Science and Engineering/School of Computer Applications and Technology , Galgotias University, Greater Noida.

The matter presented in the thesis/project/dissertation has not been submitted by me/us for the award of any other degree of this or any other places.

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This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Mr. Sarvesh Kumar Swarnakar

( Astt. Professor)

## CERTIFICATE

This is to certify that Project Report entitled “Employee Attrition Analysis Project” which is submitted by Arjun Dev Vashishtha (24SCSE2160008), Kartik Kumawat(24SCSE2130029), Anubhav Gaur (24SCSE2160002) in partial fulfillment of the requirement for the award of degree MCA. in Department of Data Analysis of School of Computer Applications and Technology, Galgotias University, Greater Noida, India is a record of the candidate own work carried out by him/them under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree

**Signature of Examiner(s) Signature of Supervisor(s)**

Date: Nov, 2023

Place: Greater Noida

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**Chapter 1 Introduction**

**Problem Introduction**

Employee attrition refers to the process where employees leave an organization for various reasons. High attrition rates adversely affect businesses by increasing recruitment costs, disrupting workflows, and reducing morale among remaining employees. Identifying potential attrition risks early can help mitigate these challenges.

The modern workplace has become increasingly dynamic, with employees frequently switching jobs due to better opportunities, work-life balance concerns, or dissatisfaction with their current roles. Organizations need tools to understand why employees leave and how they can address these issues proactively. Employee attrition prediction, powered by machine learning, provides a data-driven solution to this pressing problem.

**Motivation**

Predicting employee attrition can enable organizations to proactively address factors contributing to turnover, leading to better workforce planning and reduced operational costs. This project’s motivation stems from the real-world challenges faced by HR departments. Attrition not only disrupts business continuity but also incurs hidden costs, such as the time and resources needed for recruitment, onboarding, and training new hires.

Machine learning models can analyze large volumes of employee data to identify patterns and predict which employees are at risk of leaving. These insights empower organizations to make informed decisions, such as offering targeted retention programs or revising HR policies to improve employee satisfaction and engagement.

**Project Objective**

The primary objective of this project is to build a machine learning model to predict employee attrition using features such as job satisfaction, work-life balance, and monthly income. The project aims to assist HR departments in identifying and retaining employees at risk of leaving. Specific objectives include:

1. Conducting exploratory data analysis (EDA) to uncover key trends and patterns in employee data.
2. Implementing data preprocessing techniques to prepare the dataset for modeling.
3. Training and evaluating multiple machine learning algorithms, such as Random Forest and Logistic Regression.
4. Addressing challenges like class imbalance using techniques such as SMOTE.
5. Visualizing results to provide actionable insights to stakeholders.

**Scope of the Project**

This project focuses on:

1. Data preprocessing and feature engineering to prepare the dataset.
2. Training a Random Forest Classifier and comparing it with other models.
3. Evaluating the model using metrics like accuracy, precision, recall, and F1-score.
4. Addressing class imbalance to improve prediction performance for minority classes.
5. Providing actionable insights through a user-friendly interface for HR professionals.

The project’s scope is limited to structured datasets and assumes access to reliable employee data. While the model is designed for the IBM HR Analytics dataset, it can be adapted to other datasets with similar features.

**Related Previous Work**

Previous studies have explored attrition prediction using traditional statistical methods like logistic regression. While these methods provide some insights, they often fail to capture the complex, nonlinear relationships between features. Machine learning algorithms, such as decision trees and ensemble methods, offer a more robust approach.

For instance, researchers have used Random Forests and Gradient Boosting Machines to predict attrition with high accuracy. However, challenges like overfitting and class imbalance remain prevalent. This project builds on existing work by incorporating advanced preprocessing techniques, hyperparameter tuning, and evaluation metrics to ensure a comprehensive approach.

**Organization of the Report**

Chapter 2 details the software requirements, Chapter 3 discusses the system design, Chapter 4 covers implementation and results, and Chapter 5 concludes the report with future directions. Each chapter is designed to provide a thorough understanding of the project’s objectives, methods, and outcomes.

**Chapter 2**

**Software Requirement Specification**

**2.1 Product Perspective**

This product is a standalone predictive analytics tool designed to integrate seamlessly with HR systems. It leverages historical employee data to forecast attrition. Unlike traditional methods, this tool uses machine learning to analyze complex patterns in the data, offering more accurate and actionable predictions.

**2.2 System Interfaces**

* **User Interface:** A web-based interface for data input and result visualization. Users can upload datasets, configure model parameters, and view prediction results through interactive dashboards.
* **Database:** Interaction with a CSV dataset or SQL-based database for storage and retrieval. The system supports both local and cloud-based storage solutions to ensure scalability.

**2.3 Software Interfaces**

* **Python:** Version 3.10, used for implementing the machine learning pipeline.
* **Libraries:**
  + pandas for data manipulation.
  + scikit-learn for machine learning model training and evaluation.
  + matplotlib and seaborn for data visualization.
* **IDE:** VS Code or Jupyter Notebook, providing a flexible development environment.

**2.4 Constraints**

* **Data Quality:** The accuracy of predictions depends on the quality and completeness of the dataset.
* **Hardware Limitations:** Requires at least 8GB of RAM for efficient processing.
* **Model Interpretability:** While ensemble models like Random Forests provide high accuracy, they may lack interpretability compared to simpler models.

**2.5 Assumptions and Dependencies**

* Assumes accurate and complete historical data is available.
* Assumes the end-user has basic knowledge of data interpretation and can act on the predictions.

**Chapter 3**

**System Design**

**Architecture Diagrams**

Include a 3-tier architecture diagram representing data flow between user interface, model, and storage. This architecture ensures modularity, scalability, and ease of maintenance.

**Data Flow Diagram (DFD)**

Create a DFD illustrating the flow of employee data through the system, from data input and preprocessing to model training and prediction generation.

**ER Diagram**

Define the database schema for managing employee and prediction data. Include tables for storing employee attributes, prediction results, and audit logs.

**Class Diagram**

Provide a class diagram showcasing the relationship between different modules, such as data preprocessing, model training, and result visualization.

**Chapter 4**

**Implementation and Results**

**Software and Hardware Requirements**

* **Hardware:** Minimum 8GB RAM, 2.5GHz processor.
* **Software:** Python 3.10, scikit-learn, pandas.

**Implementation Details**

1. **Data Preprocessing:**
   * Handled missing values using mean imputation for numerical features.
   * Encoded categorical variables using Label Encoding and One-Hot Encoding.
   * Scaled numerical features using StandardScaler to standardize the range.
2. **Model Training:**
   * Used Random Forest Classifier with hyperparameter tuning to optimize performance.
   * Addressed class imbalance using SMOTE to oversample the minority class.
3. **Evaluation:**
   * Achieved an accuracy of [Insert Value].
   * Evaluated precision, recall, and F1-score to ensure balanced performance across classes.

**Results**

Include:

* **Confusion Matrix:** Visual representation of true positives, false positives, true negatives, and false negatives.
* **Feature Importance:** Bar chart showing the importance of each feature in the model.
* **Performance Metrics:** Table summarizing accuracy, precision, recall, and F1-score.

**Chapter 5**

**Conclusion**

**Performance Evaluation**

The model demonstrated good predictive accuracy, with significant improvement over baseline methods. By addressing class imbalance and optimizing hyperparameters, the system achieved robust performance across multiple evaluation metrics.

**Comparison with State-of-the-Art**

Compared to other methods, Random Forest provides better interpretability and robust performance. Advanced techniques like SMOTE further enhance its applicability to imbalanced datasets.

**Future Directions**

1. Integrating more advanced models like XGBoost or Neural Networks to improve predictive power.
2. Deploying the system for real-time predictions using cloud platforms like AWS or Azure.
3. Enhancing the user interface with interactive visualizations and reports.

**Practical Implications**

This project highlights the potential for machine learning in improving HR practices and retaining valuable employees. By identifying at-risk employees early, organizations can implement targeted retention strategies, reducing costs and improving overall productivity.

**References**

1. IBM HR Analytics Dataset.
2. scikit-learn Documentation.
3. Research papers on employee attrition prediction.
4. Imbalanced-learn Documentation.
5. Python Software Foundation.

**Appendices**

**Appendix A: Code Snippets**

Include key code snippets for data preprocessing, model training, and evaluation.

**Data Preprocessing**

import pandas as pd

from sklearn.preprocessing import LabelEncoder, StandardScaler

# Load dataset

data = pd.read\_csv('employee\_data.csv')

# Encode categorical variables

label\_encoder = LabelEncoder()

data['Attrition'] = label\_encoder.fit\_transform(data['Attrition'])

# Scale numerical features

scaler = StandardScaler()

data[['Age', 'MonthlyIncome']] = scaler.fit\_transform(data[['Age', 'MonthlyIncome']])

**Model Training**

from sklearn.ensemble import RandomForestClassifier

from sklearn.model\_selection import train\_test\_split

# Split data

X = data.drop('Attrition', axis=1)

y = data['Attrition']

X\_train, X\_test, y\_train, y\_test = train\_test\_split(X, y, test\_size=0.2, random\_state=42)

# Train model

model = RandomForestClassifier(random\_state=42)

model.fit(X\_train, y\_train)

**Evaluation**

from sklearn.metrics import classification\_report, confusion\_matrix

# Predictions

y\_pred = model.predict(X\_test)

# Evaluation metrics

print(confusion\_matrix(y\_test, y\_pred))

print(classification\_report(y\_test, y\_pred))