

1. Introduction

Organisations invest significant sums of money and time into training its staff [1]. This project aims to study the impact of learning and development activities on attrition and promotion using machine learning algorithms accompanied by XAI.

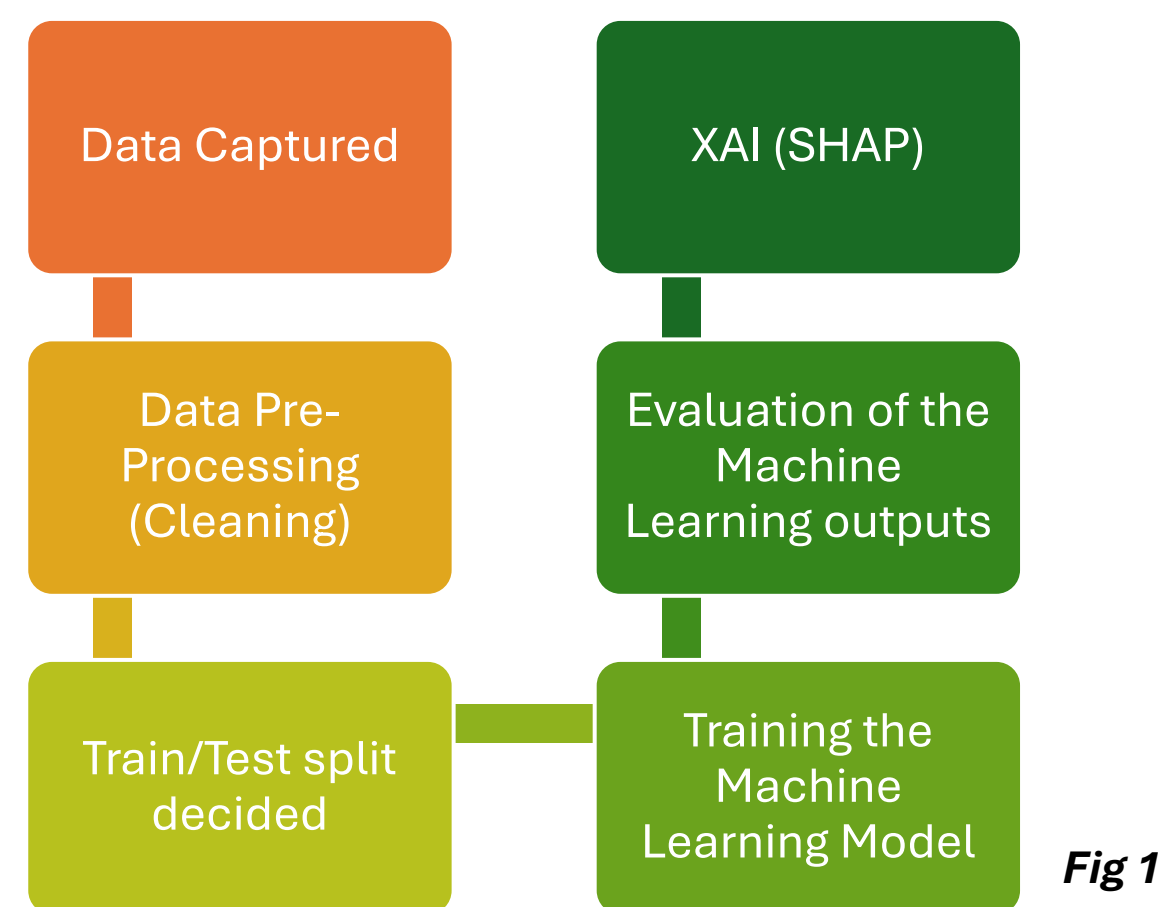


Fig 1

2. Aim and Objectives

Aim: Investigate how machine learning and XAI can predict the impact of employee learning and development on attrition and promotion

Objectives:

- 1 – Review research on attrition, promotion prediction, and the use of machine learning and XAI in HR analytics to identify gaps and trends
- 2 – Develop a machine learning pipeline using learning and development data to predict attrition and promotion outcomes
- 3 – Evaluate model performance and analyse feature importance to assess the influence of learning and development on employee outcomes
- 4 – Produce recommendations and assess model limitations, ethical considerations and future research opportunities.

3. Literature Review

Research highlights that there are many studies on attrition and employee retention and the application of machine learning in this context due to a high level of organisational concern[1]. There is limited research on promotion and XAI within these contexts[2].

Existing evidence has suggested that ensemble models like Random Forest and Gradient Boosting performed well, but there is no single algorithm that consistently outperforms the others. Literature also highlight the importance of XAI [3] in a HR context, but a research gap remains in understanding how learning and development activities influence both attrition and promotion using real world data and not the IBM case study upon which most of the research was performed.

4. Design and Implementation

The high level design is shown in **Fig1** above. The machine learning pipeline developed used multiple datasets, with extensive cleaning undertaken in both Excel and Python to standardise the records, remove any errors and ensure that no personal information was used in the study. The pipeline created binary values for promotion and attrition and used one-hot encoding to convert any categorical information into numerical so that it could be used by the machine learning models. Gradient Boosting, Logistic Regression and Random Forest were chosen to allow comparison of performance across them all.

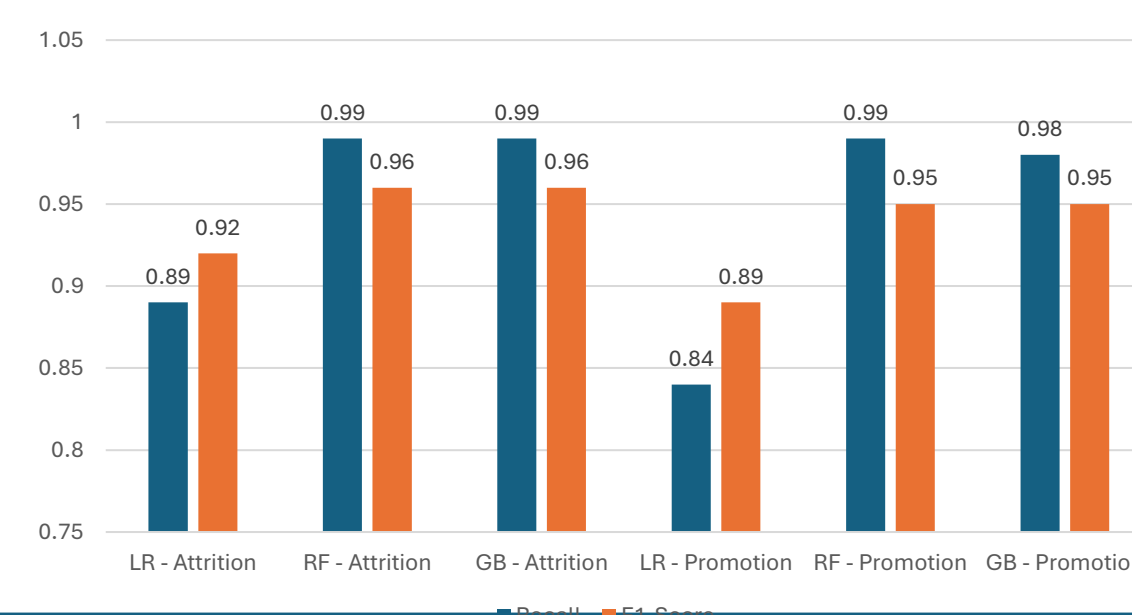


Fig 2: RF SHAP Bee swarm
Attrition

5. Evaluation

Model performance was assessed using Accuracy, Precision, Recall, F1-Score, ROC-AUC and Confusion Matrices. SHAP was incorporated in order to provide explainability.

Promotion predictions achieved the higher ROC-AUC scores (0.74) which suggests a stronger relationship than with attrition (0.69), though both were strongly linked. Feature importance also showed learning and development related variables as key predictors across all models.

SHAP confirmed feature importance and showed chow decisions were made on an individual staff level basis.

6. Conclusion

This study has shown that machine learning and XAI can provide insight into the relationship between learning and development, attrition and promotion. All models were able to successfully identify patterns and training related variables consistently were the most influential factors.

Overall, the findings suggest that employee development is associated with both career progression and retention, which supports the use of these methods within a HR context.

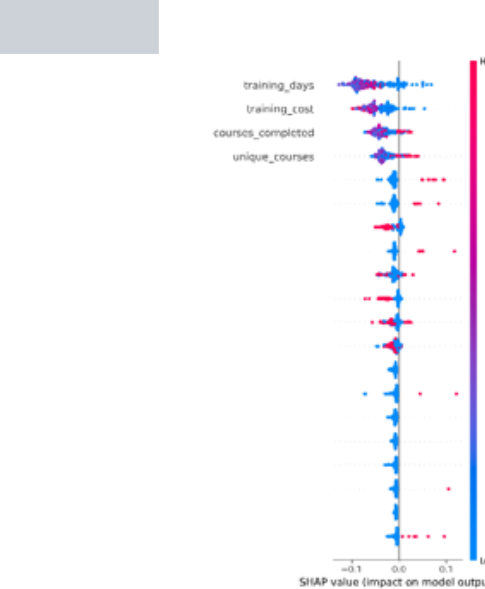


Fig 3: RF SHAP Bee swarm
Promotion

References

- [1] A.Cavescu, "A general investigation of attrition and retention factors in organisations", *Springer Nature*, Vol. 5, p.99, 2025.
- [2] J.Miller, "Explanation in Artificial Intelligence: Insights from the Social Sciences," *Journal of artificial intelligence research* Vol.78, pp. 217-220, 2023.
- [3] I.T. Basar and B.T.Tilmaz, "Predicting Employee Attrition: XAI-powered Models for Manegerial Decision-Making," *Systems*, Vol. 13, no.7 p.583, 2025.