ISSN 2616-5902 Vol. 7, Issue 12: 82-86, DOI: 10.25236/AJBM.2025.071211

Artificial Intelligence in Human Resource Management: Frontier Advances and Challenges of Machine Learning Algorithms

Tianyu Zhao

Business School, University of Shanghai for Science and Technology, Shanghai, 200082, China
17344806930@163.com

Abstract: *This paper reviews the current status and research progress of machine learning (ML) applications in human resource management (HRM). It specifically focuses on algorithmic applications in employee turnover prediction, recruitment and talent screening, and performance evaluation. The paper highlights ML's significant role in enhancing HRM efficiency and accuracy through innovations in algorithms and data processing. It also identifies challenges such as the complexity of HR phenomena, limitations of small datasets, ethical issues (including fairness and legal compliance), and employee reactions to algorithmic decisions. Finally, it outlines future directions, emphasizing algorithmic transparency, cross-domain data fusion, and in-depth ethical and legal research to promote innovative ML applications in HRM.*

Keywords: *Artificial Intelligence; Human Resource Management; Machine Learning*

1. Introduction

In modern enterprises, human resource management (HRM) is not only central to business operations but also a key factor in achieving corporate strategic goals. Efficient HRM is crucial for enhancing corporate competitiveness. Through effective HR management, enterprises can attract and retain top talent, improve employee satisfaction and work efficiency, thereby strengthening their market position and profitability. However, with accelerating globalization and technological advancements, enterprises face increasingly complex and diverse challenges, and traditional HR management methods can no longer meet the demands of modern enterprises.

In the field of human resource management, enterprises are facing a series of complex challenges. Firstly, the increasing employee turnover rate brings significant financial burdens and knowledge loss to organizations. Secondly, traditional recruitment processes are often inefficient, making it difficult to quickly find suitable talent. Furthermore, performance evaluation methods often rely on subjective judgment, which can lead to unfair outcomes[1]. These issues not only affect the operational efficiency of enterprises but also may weaken their market competitiveness. Against the backdrop of globalization and rapid technological development, enterprises urgently need innovative solutions to improve the effectiveness of human resource management.

Machine learning (ML) technology provides powerful tools for human resource management (HRM). By processing and analyzing large amounts of HR data, ML can automatically identify complex patterns and make data-driven judgments[2]. For example, enterprises can use ML models to predict which employees are at risk of turnover, thereby enabling proactive retention measures. Additionally, ML can optimize recruitment processes by analyzing applicant data to identify the most suitable candidates. Concurrently, ML can also be applied to employee performance evaluation schemes, helping enterprises improve the accuracy and efficiency of assessments.

The objective of this paper is to review the latest research progress of machine learning in human resource management, systematically analyze the technical challenges in current applications, and anticipate future development trends. By summarizing existing literature, we aim to provide valuable insights for both academia and industry, promoting innovative applications of machine learning in human resource management.

ISSN 2616-5902 Vol. 7, Issue 12: 82-86, DOI: 10.25236/AJBM.2025.071211

2. Literature Review

2.1. Employee Turnover Prediction

In employee turnover prediction, machine learning algorithms are crucial. XGBoost models are widely used due to their ability to handle imbalanced datasets and high predictive accuracy. Random Forest models are favored for their advantages in handling complex data relationships. Support Vector Machines (SVMs) are widely adopted for their excellent predictive performance. Logistic Regression algorithms also play an important role, helping identify key features through simple and effective linear models. Furthermore, emerging algorithms like LightGBM and WRF show potential, enhancing predictive accuracy by optimizing parameters and improving data processing efficiency.

Li proposed an employee turnover prediction method based on SMOTE and AdaBoost, innovatively improving the SMOTE algorithm by introducing new distance metrics and sample generation strategies to balance data, which significantly enhanced the prediction effect for departing employees[3]. Yan constructed a PCC model integrating Principal Component Analysis, large-scale data clustering, and Classification and Regression Tree algorithms, successfully delineating profiles of departing employees and proposing targeted employee retention strategies [4]. Zheng developed a Random Forest algorithm based on interval variables, demonstrating its higher predictive accuracy in handling imbalanced data, while also identifying important features affecting turnover, providing a basis for corporate decision-making[5]. Wang used the MV method and LASSO for high-dimensional data variable screening and employed multiple machine learning models for prediction. The results showed that the Random Forest model under the MV method performed best in multiple experiments, demonstrating excellent robustness[6]. These studies collectively provide diverse and effective solutions for employee turnover prediction.

2.2. Recruitment and Talent Screening

Modern algorithms significantly improve information acquisition in recruitment and talent screening. Beyond traditional ML models (such as XGBoost, Random Forest, and SVM), deep learning models like BERT and BERT-Bi-LSTM-CRF automatically extract key details from job postings. Clustering analysis further extracts capability requirements and responsibilities for specific roles, such as data scientists, from these announcements. These technologies boost recruitment efficiency and decision-making accuracy.

Firstly, Yuan proposed an "industry-position-knowledge-discipline" analysis framework, utilizing models such as CRF, BiLSTM-CRF, and BERT-BiLSTM-CRF to extract entities from AI recruitment texts. This framework constructs relationship networks and precisely locates the relationship between talent demand and discipline cultivation, providing support for national strategies and higher education decisions [7]. Xu obtained AI job information through web crawling, used K-means clustering analysis to identify job clusters such as software engineers and algorithm engineers, and employed the LDA model to analyze skill requirements. This process constructed a demand matrix to reveal specific skill requirements for each position, helping universities and enterprises perceive market demand in real-time[8]. Xue, based on big data technology, analyzed the talent demand characteristics for data-related positions, used text analysis and clustering methods to distinguish demand differences between social recruitment and campus recruitment, and found that demand is concentrated in specific cities in industries such as internet and finance, providing guidance for talent cultivation and recruitment strategies[9]. These studies enhance the efficiency of recruitment and talent screening through advanced algorithms, accurately extract job and skill requirements, and provide important support for optimizing talent cultivation and decision-making.

2.3. Performance Evaluation

In performance management, Random Forests identify key performance drivers, improving evaluation accuracy. CART decision trees provide interpretable models of factor impact. Logistic regression predicts performance level probabilities, highlighting influential factors. Bayesian networks uncover causal relationships, aiding decision optimization. These algorithms significantly enhance the scientific and effective nature of performance management.

Zhu analyzed the importance of competitive network features for corporate financial performance using an interpretable Random Forest model, finding that individual network size and other features

ISSN 2616-5902 Vol. 7, Issue 12: 82-86, DOI: 10.25236/AJBM.2025.071211

significantly impact performance[10]. Xu used machine learning methods such as Logistic Regression, Random Forest, Elastic Net, and Support Vector Machines to investigate the satisfaction of medical staff with performance distribution in Guangxi Traditional Chinese Medicine hospitals. The study found that salary gaps and other factors affect satisfaction, and suggested improvements to salary schemes[11]. Cheng utilized the CART decision tree algorithm to study enterprise R&D project performance evaluation, finding that project process management has the greatest impact[12]. Huang identified key factors influencing performance differentiation in China's manufacturing industry through Ridge Regression and LASSO algorithms, pointing out that capital productivity is the most important factor[13]. These studies provide new insights and methods for relevant fields. The aforementioned scholars deeply analyzed performance influencing factors in different domains using various algorithms, improving the scientific and effective nature of performance evaluation, and providing an important basis for improving management decisions.

3. Technological Advances

3.1. Application of Emerging Algorithms

Emerging algorithms such as deep learning and self-supervised learning are transforming human resource management (HRM). Deep learning, by handling complex unstructured data like natural language and images, enhances the accuracy of resume screening; for instance, the BERT model automatically extracts key resume information. Self-supervised learning, even without labeled data, learns internal data structures and features through pseudo-labels or pre-training tasks, which can then be used to predict employee turnover risks. The application of these algorithms boosts HR process efficiency and decision-making precision.

3.2. Innovations in Data Processing

Data processing technology has also made significant strides in HR. Beyond traditional methods like Principal Component Analysis (PCA) and cluster analysis, deep learning, Natural Language Processing (NLP), and Graph Neural Networks (GNNs) show immense potential. Deep learning can predict employee turnover, evaluate performance, and automate resume screening. NLP analyzes employee text feedback to generate satisfaction reports. GNNs identify key individuals and team structures by analyzing employee relationship networks. These innovative technologies not only improve data processing quality but also bring new analytical dimensions and insights to HR management.

4. Current Challenges

In modern human resource management, artificial intelligence faces multiple challenges, including the complexity of HR phenomena, limitations of small datasets, ethical issues related to fairness and legal compliance, and employee reactions to algorithmic decisions[14].

4.1. Complexity of HR Phenomena

In human resource management, the complexity of individual attributes and organizational behaviors poses significant challenges to the application of artificial intelligence algorithms. For individual attributes, in addition to quantifiable indicators such as years of service and performance ratings, there are also factors that are difficult to quantify, such as employee personality, communication skills, and teamwork spirit. These factors have a significant impact on employee performance and satisfaction but are often vague and difficult to quantify, increasing the difficulty of algorithm design. For organizational behavior, complexity is reflected in factors such as organizational culture, leadership style, and communication channels, which are dynamic and difficult to quantify. Algorithms need to process complex networks and unstructured data to accurately analyze and predict organizational behavior.

4.2. Limitations of Small Datasets

In human resource management, due to privacy protection and data sensitivity, datasets are usually small, which limits the training effect and generalization ability of machine learning models. Small datasets struggle to fully capture the complexity of individual attributes and organizational behaviors, leading to models that are prone to overfitting, meaning they perform well on training data but poorly on

ISSN 2616-5902 Vol. 7, Issue 12: 82-86, DOI: 10.25236/AJBM.2025.071211

new data. Furthermore, insufficient data diversity and representativeness make it difficult for models to accurately reflect dynamic factors such as employee personality, communication skills, organizational culture, and leadership style, further increasing the challenges of algorithmic application.

4.3. Ethical Issues Related to Fairness and Legal Compliance

Artificial intelligence faces numerous ethical and legal challenges in human resource management. Firstly, the lack of transparency in deep learning models, often seen as "black boxes," can lead to distrust from employees and management. Secondly, algorithms used in recruitment and performance evaluation may amplify biases present in data, leading to unfair treatment of certain groups. Additionally, privacy rights and data protection are crucial, and enterprises must comply with relevant laws and regulations to ensure the security of employee information. In terms of legal liability, improper algorithmic decisions may lead to legal disputes, and enterprises need to clarify responsibilities. Finally, enterprises should bear moral responsibility to ensure that algorithmic use aligns with social ethics and public expectations.

4.4. Employee Reactions to Algorithmic Decisions

Employee reactions to algorithmic decisions are influenced by multiple factors, including their understanding of the algorithm, the transparency of the decision-making process, and the extent to which algorithms replace human judgment in recruitment. While algorithms are generally accurate in predicting employee performance, they may lead to decreased commitment due to a lack of employee involvement. Furthermore, complex algorithms can cause distrust, affecting work efficiency and organizational atmosphere. Therefore, improving the transparency and interpretability of algorithms is crucial for enhancing employee acceptance.

5. Future Development Directions

5.1. Enhancing Algorithmic Transparency and Interpretability

As artificial intelligence becomes more widely applied in human resource management, algorithmic transparency and interpretability become key issues[15]. Future research should focus on developing more interpretable models to make decision-making processes more transparent to employees and management. For example, explainable machine learning techniques (such as SHAP values, LIME, etc.) can be introduced to explain model prediction results, helping employees understand the basis of algorithmic decisions, thereby enhancing trust and acceptance

5.2. Cross-Domain Data Fusion

One of the future research trends is the fusion and application of cross-domain data. By integrating data from different sources (e.g., social media, employee behavioral data, external market data, etc.), a more comprehensive understanding of employee behavior and needs can be obtained. Cross-domain data fusion can not only improve the accuracy and comprehensiveness of data analysis but also help enterprises better understand market trends and industry dynamics, thereby formulating more effective recruitment and talent management strategies.

5.3. In-depth Research on Ethical and Legal Issues

As artificial intelligence applications in human resource management continue to expand, ethical and legal issues will become an important direction for future research. Future research should deeply explore how to ensure fairness and transparency in algorithm design and application, avoiding data bias and discrimination. Additionally, research should focus on data privacy and security issues, ensuring that employee information protection complies with laws and regulations.

6. Conclusion

This paper reviews machine learning's progress in human resource management, analyzing current technical challenges and future trends. We found machine learning to be crucial for employee turnover prediction, recruitment, and performance evaluation, with deep learning and self-supervised learning significantly improving efficiency. However, challenges remain, including HR complexity, limitations of

ISSN 2616-5902 Vol. 7, Issue 12: 82-86, DOI: 10.25236/AJBM.2025.071211

small datasets, ethical concerns, and employee reactions to AI. Future research will focus on algorithmic transparency, cross-domain data fusion, and ethical/legal issues to advance machine learning in HR, offering valuable insights for both academia and industry.

References

[1] Xie, X. Y., Zuo, Y. H., & Hu, Q. J. (2021). Human resource management in the digital era: A perspective based on human-technology interaction. Management World, 37(01), 200-216+13.
[2] Luo, W. H., Huo, W. W., Zhao, Y. X., et al. (2022). Artificial intelligence-driven organizational and human resource management transformation: Practical insights and research directions. China Human Resource Development, 39(01), 4-16.
[3] Li, A. D., Huang, J., Yu, Y., et al. (2024). Employee turnover prediction method based on improved SMOTE and AdaBoost for enterprises. Computer Applications and Software, 1-8.
[4] Yan, H. X., & Yu, S. K. (2024). Research on employee turnover prediction model based on profiles. Chinese Management Science, 32(09), 303-312.
[5] Zheng, J., & Liu, R. J. (2022). Employee turnover prediction of Qinghai Electric Power Company based on interval variable RF algorithm. Operations Research and Management Science, 31(09), 210-216.
[6] Wang, G. P., Qin, S. Y., & Cui, H. J. (2022). Analysis and prediction of influencing factors of employee turnover. System Sciences and Mathematics, 42(06), 1616-1632.
[7] Yuan, Y., Tao, X. Q., Li, J. X., et al. (2022). Analysis of talent supply and demand based on recruitment text entity mining—Taking the field of artificial intelligence as an example. Library and Information Service, 66(14), 101-118.
[8] Xu, Z. L., Wen, B. X., Xie, M. Y., et al. (2021). Research on AI job demand analysis based on big data technology. Guangxi Sciences, 28(03), 321-329.
[9] Xue, J., Wang, X., & Ji, Y. L. (2022). Analysis of talent demand characteristics for data-related positions in the big data era. Heilongjiang Higher Education Research, 40(10), 119-124.
[10] Zhu, J. X., Liu, K. X., Zeng, N. M., et al. (2025). Competitive networks and corporate financial performance—Empirical evidence based on interpretable random forests. Chinese Management Science, 33(08), 75-89.
[11] Xu, X. Y., Zhu, P. H., Mo, Y. J., et al. (2024). Analysis of influencing factors of medical staff performance distribution satisfaction in Guangxi Traditional Chinese Medicine Hospital. Chinese Hospital, 28(03), 10-14.
[12] Cheng, P., & Yan, L. (2022). Research on enterprise R&D project performance evaluation based on CART decision tree algorithm. Accounting Monthly, (24), 30-37.
[13] Huang, B. J., & Zhang, T. B. (2022). Identification of key influencing factors and transmission network diagram of performance differentiation in Chinese manufacturing enterprises—A study based on machine learning combined algorithms. Operations Research and Management Science, 31(04), 224-231.
[14] Tambe P ,Cappelli P , & Yakubovich V (2019).Artificial Intelligence in Human Resources Management: Challenges and a Path Forward.California Management Review, 61(4):15-42.
[15] He, W., Wang, L., & Wu, X. Y. (2024). A review of the impact of artificial intelligence technology on human resource management research. Science Foundation in China, 38(05), 831-840.