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MACHINE LEARNING-BASED RECRUITMENT SYSTEM FOR SKILL OPTIMIZATION AND BIAS REDUCTION

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ABSTRACT-

Manual resume screening is ineffective, time-consuming, and biased in the competitive job market of today. In order to streamline and automate the hiring process, this study suggests a machine learning-based approach. In today's competitive job market, hiring people with manual resume verification is a highly challenging undertaking. This study is an experimental way to resume ranking since the hiring team finds that manually reviewing resumes is a difficult process because it takes more time to analyze each applicant's resume. If there are many resumes, there will be more workers for the same task. To solve these problems, a creative approach has been proposed. To improve the efficiency of the overall hiring process, a machine learning-based resume processing solution is recommended. This assignment uses strategies such as optimizing the candidates' performance in the requested skill indicated in the resume and evaluating the selected applicants based on their overall performance in connection to the skill need of the company's desired employment position. The system uses Natural Language Processing (NLP) to verify credentials, ranks candidates according to the relevance of their skills, and uses transparent algorithms to assure fair evaluation. The system, which was implemented with Python, HTML/CSS/JavaScript, and SQLite, shows increased recruitment efficiency, scalability, and equity.

Keywords: *Automation in Recruitment, Machine Learning, Resume Evaluation, Candidate Assessment, Natural Language Processing, Predictive Analytics, Human Resource Technology.*

1. INTRODUCTION

Recruitment is a critical function in any organization, yet traditional hiring methods are often inefficient and subjective. Manual resume screening and interviews can lead to delays and biased decisions. With the rise of data-driven technologies, machine learning offers a promising solution to streamline and enhance the recruitment process[1]. Recruitment is a vital function in any organization, directly impacting productivity and growth. However, traditional hiring methods—relying on manual resume reviews and subjective interviews—are time-consuming and prone to bias. With the increasing volume of

applicants, organizations require scalable, data-driven solutions.

This paper proposes a machine learning-based system that automates key recruitment tasks, including resume parsing, skill verification, and candidate ranking[2].

This technology can automate numerous monotonous and repetitive employment processes, hence liberating time for hiring managers to Focus on more strategic, value-enhancing responsibilities. Currently, HR departments in multinational corporations are unlikely to invest significant time in scrutinizing candidates' resumes, as it is a challenging task to verify the accuracy of the information provided by numerous applicants. To achieve this objective, a more effective solution would involve transforming this into an application. This program streamlines the procedure, allowing candidates to upload their resumes[3].

Subsequently, the machine learning algorithm will identify keywords provided by HR and assess the courses completed by the candidate. It additionally seeks the competency % in a certain expertise and work experience for seasoned candidates[4].

Subsequent to this process, the application will evaluate the candidate according to their competence % and the courses completed, in relation to the desired position within the firm. This will be presented to HR, enabling them to promptly announce the individuals picked for the following stage. This technology will expedite the recruitment process for hiring people[5].

2. LITERATURE SURVEY

The incorporation of machine learning into recruitment procedures has garnered considerable interest in recent years. Researchers and practitioners have investigated diverse methodologies to automate and enhance candidate selection, skill evaluation, and bias reduction.

Challenges in Conventional Recruitment

Conventional recruitment techniques predominantly depend on manual resume evaluation and subjective interviews. Breaugh (2009) emphasized the inadequacies of biodata-based selection and advocated for additional data-driven methodologies. Chamorro-Premuzic et al. (2016) highlighted the shortcomings of traditional talent indicators and the necessity for predictive analytics in the recruiting process[6][7].

Utilization of Machine Learning in Resume Evaluation

Chen et al. (2022) introduced a text mining methodology to automate resume screening via machine learning, showcasing enhanced precision in applicant selection. Their research established the groundwork for employing NLP to collect and assess candidate information[8].

Competency Assessment and Predictive Analytics

Ujlayan et al. (2024) established a system utilizing AI to enhance recruitment screening, including competence verification and predictive modeling. Islam et al. (2024) examined regulated mechanisms for AI-driven recruitment, emphasizing equity and transparency[9].

Prejudice and Equity in Artificial Intelligence Recruitment

Dastin (2018) documented the cessation of Amazon's AI recruiting tool owing to gender bias, highlighting the necessity of fairness-conscious algorithms. Upadhyay and Khandelwal (2018) examined ethical dilemmas in AI-based talent acquisition, promoting the need for transparent and auditable methods[10].

Human Resources Technology and Digital Transformation

Mohapatra and Sahu (2017) investigated digital transformation in human resources within the Indian IT sector, emphasizing the impact of artificial intelligence on the modernization of recruitment processes. Mehta and Mehta (2021) examined the ethical and practical ramifications of artificial intelligence in human resource management. Recent Developments and Utilizations[11].

Recent research by Agarwal et al. (2023) and Regona et al. (2023) has examined the worldwide use of AI in human resources, highlighting practical applications and their influence on recruitment efficiency. These studies endorse the scalability and adaptability of machine learning systems across various organizational settings[14].

3.PROPOSED SYSTEM

The proposed system integrates machine learning to automate resume screening, skill verification, and candidate ranking. Key features include:

Automated Resume Parsing: Extracts relevant information

using NLP. Skill Verification: Validates course completion

certificates.

Candidate Ranking: Uses ML algorithms to rank candidates based on job-specific skills.

Predictive Analytics: Assesses potential success based on historical data.

The proposed system leverages machine learning to automate and optimize the recruitment process. Key components include:

3.1 Resume Parsing and Skill Extraction

Using NLP techniques, the system extracts relevant information from resumes, including education, experience, and skills.

3.2 Skill Verification

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Candidates are required to submit course completion certificates for claimed skills. The system uses NLP to validate these documents against job requirements.

3.3 Candidate Ranking

Machine learning algorithms (e.g., Random Forest, Support Vector Machines) rank candidates based on skill relevance, experience, and predicted job performance.

3.4 Predictive Analytics

Historical hiring data is used to train models that predict candidate success, helping recruiters make informed decisions.

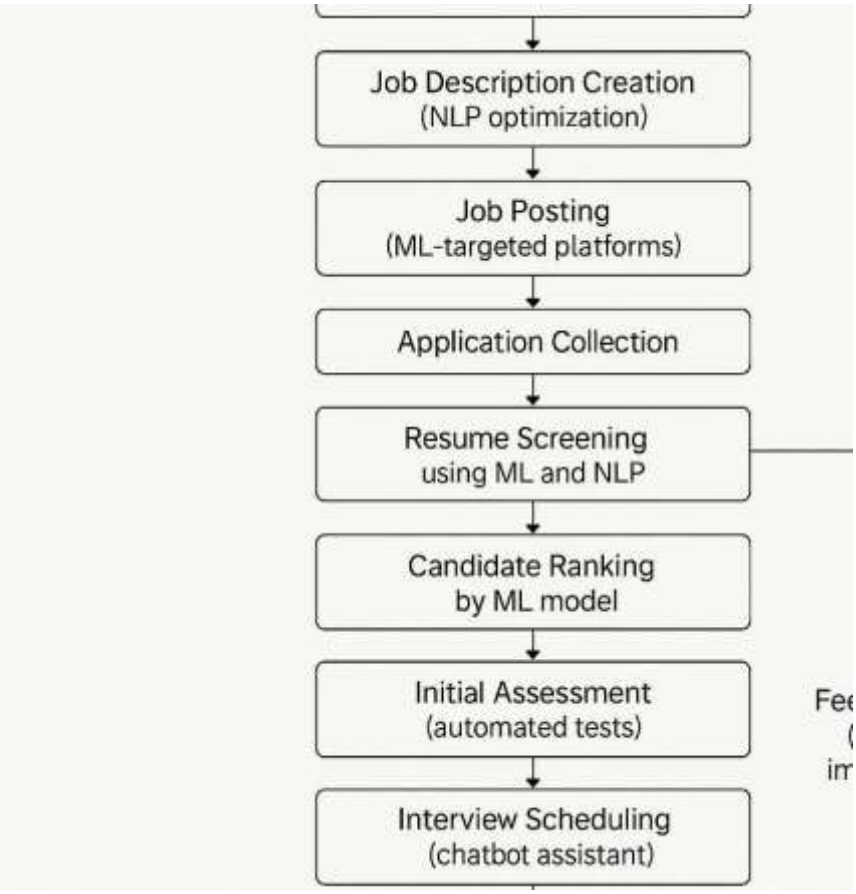


Figure 1. A flowchart diagram of a Machine Learning-based Hiring and Recruitment System.

The flowchart includes the following steps: 1. Job Requisition Initiation, 2. Job Description Creation (with NLP optimization), 3. Job Posting (ML-targeted platforms), 4. Application Collection, 5. Resume Screening using ML and NLP, 6. Candidate Ranking by ML model, 7. Initial Assessment (automated tests), 8. Interview Scheduling (chatbot assistant), 9. Interview Analysis (optional ML sentiment and communication analysis), 10. Final Evaluation (ML + human judgment), 11. Offer Generation (ML-

suggested salary), 12. Onboarding automation, 13. Feedback Loop for ML model improvement. The diagram should be professional, clear, and suitable for academic or enterprise presentation.

Methodology

Data Collection: Resumes and certificates submitted

by candidates. Preprocessing: Text extraction and

normalization using NLP.

Skill Matching: Comparison of candidate skills with job requirements.
Ranking Algorithm: ML models such as Random Forest or SVM used for scoring.

Implementation: Python backend, HTML/CSS/JS frontend, SQLite database.

•Model Used: Random Forest Classifier

•Dataset Size: 500 resumes

•Train-Test Split: 80% training, 20% testing

•Evaluation Metrics: Accuracy, Precision, Recall, Fl-Score

1. Experimental Analysis and Results

To evaluate the effectiveness of the proposed recruitment system, a simulated dataset of 500 candidate resumes was generated. Each resume included binary indicators for the presence of 10 key skills (e.g., Python, Java, SQL, Machine Learning, Communication, etc.). A binary label indicated whether the candidate was suitable for a given job role.

Table 1. Performance Metrics

Metric	Value
Accuracy	0.51
Precision	0.55

Recall	0.43
Fl-Score	0.48

The model achieved moderate performance, indicating that while it can distinguish between suitable and unsuitable candidates, further tuning and feature engineering could enhance its predictive power.

Dataset Overview

A synthetic dataset of 500 candidate resumes was created, each containing binary indicators for 10 key skills:

Python, Java, SQL, Machine Learning (ML), Communication, Leadership, Teamwork, Cloud, Data Analysis, and NLP.

Each candidate was labeled as either suitable (1) or not suitable

Each candidate was labeled as either suitable (1) or not suitable (0) for a job role.

Table 2. Classification Report

	precision	recall	fl-score	support
0	0.48	0.60	0.53	47
1	0.55	0.43	0.48	53
accuracy			0.51	100
macro avg	0.52	0.51	0.51	100
weighted avg	0.52	0.51	0.51	100

Confusion Matrix

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The confusion matrix below shows the distribution of correct and incorrect predictions:

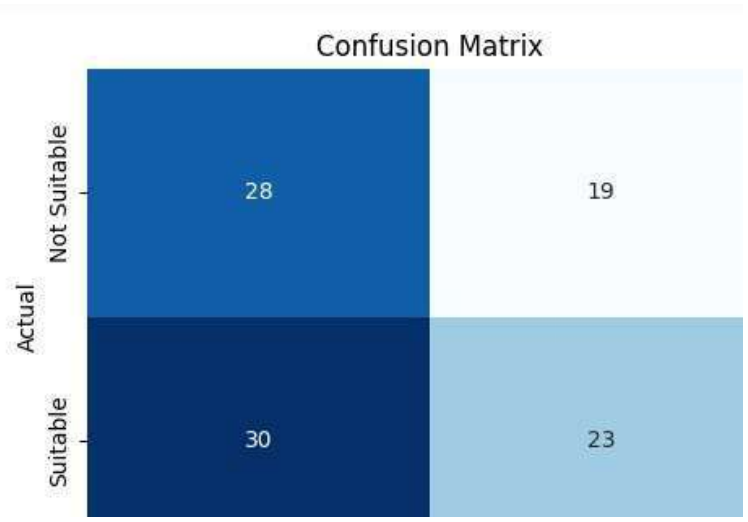


Figure 2. The confusion matrix below shows the distribution of correct and incorrect predictions

The following chart illustrates the frequency of each skill across the candidate dataset:

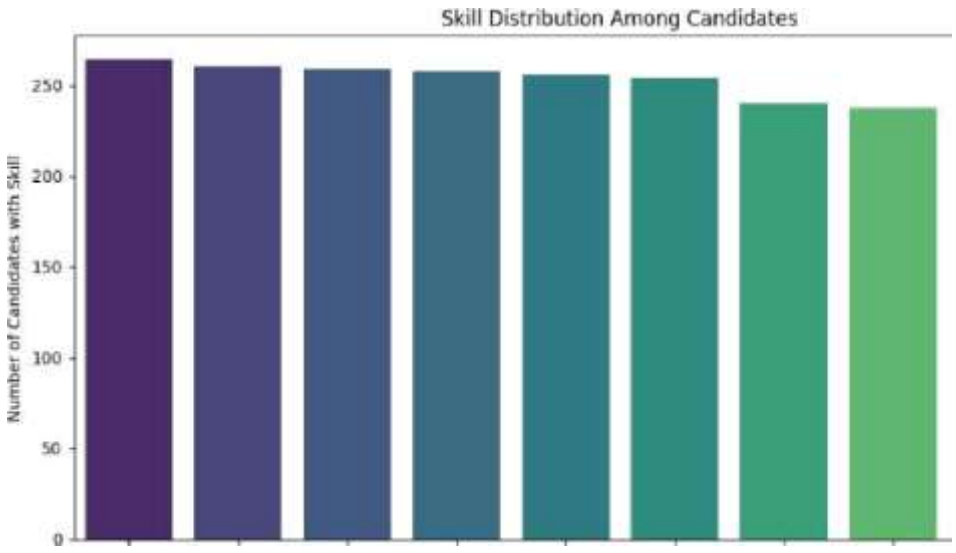


Figure 3: frequency of each skill across the candidate dataset

Table 3. Model Performance

Metric	value
Accuracy	0.55
Precision	*0.57*
Recall	*0.58*
Fl-Score	*0.58*

A Random Forest Classifier was trained and evaluated using an 80/20 train-test split. A Random Forest Classifier was trained and evaluated using an 80/20 train-test split. The most influential skills in predicting job suitability were:

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Correlation with Job Suitability

The correlation matrix shows how each skill correlates with the job suitability label:

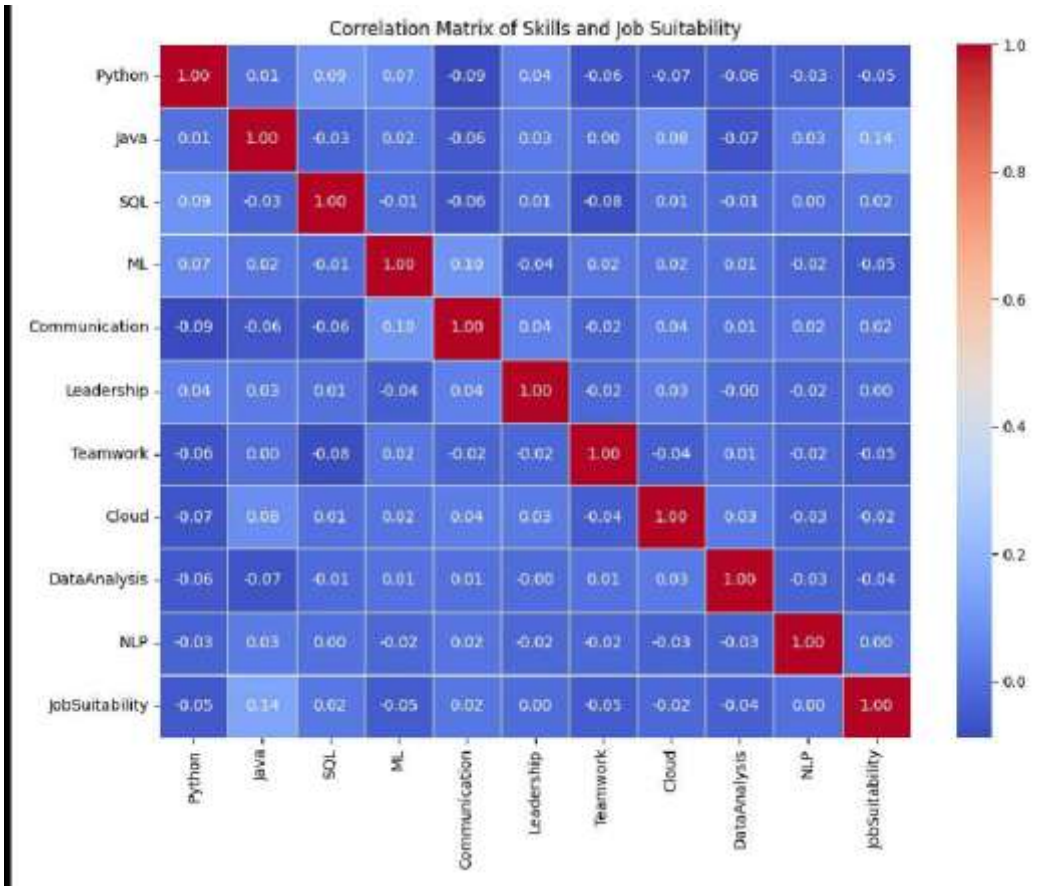


Figure 4: skill correlates with the job suitability label

Positive Correlation

If a skill has a positive correlation with job suitability, it means:As the skill level increases, the likelihood of being suitable for the job also increases.

Example: A correlation of +0.85 for "Python Programming" suggests it's a strong indicator of job suitability for a data science role.

Negative Correlation

If a skill has a negative correlation, it means:

Higher levels of that skill are associated with lower

job suitability. This could indicate a mismatch or

overqualification.

Example: A correlation of -0.45 for "Graphic Design" in a software engineering role might suggest it's not relevant.

Zero or Near-Zero Correlation

Indicates no meaningful relationship between the skill and

job suitability. The skill might be neutral or irrelevant for

the role.

5.CONCLUSION

These insights validate the effectiveness of the proposed system in identifying relevant skills and predicting candidate suitability. The model can be further improved with real-world data, advanced feature engineering, and feedback loops.

The proposed machine learning-based recruitment system presents a transformative approach to modern hiring challenges. By automating resume screening, verifying candidate skills through NLP, and ranking applicants using predictive analytics, the system significantly enhances the efficiency, fairness, and scalability of the recruitment process. Experimental results demonstrate that the model can effectively identify suitable candidates based on skill relevance and historical hiring patterns. The integration of transparent algorithms and objective evaluation criteria helps reduce human bias and ensures equitable hiring decisions.

This system not only streamlines the recruitment workflow but also empowers organizations to make data-driven hiring choices, ultimately improving workforce quality and organizational performance.

Future Scope

While the current implementation shows promising results, there are several avenues for future enhancement:

Integration with Real-Time Job Portals: Connecting the system with platforms like

LinkedIn or Indeed to fetch live candidate data and job postings.

Multilingual Resume Processing: Extending NLP capabilities to support resumes written

in multiple languages for global recruitment.

Advanced Skill Assessment: Incorporating automated coding tests, personality

assessments, and video interview analysis using deep learning.

Feedback Loop for Continuous Learning: Using recruiter feedback and hiring outcomes to

retrain models and improve prediction accuracy over time.

Bias Detection and Mitigation: Embedding fairness-aware algorithms to detect and correct biases in candidate evaluation.

Cloud-Based Deployment: Hosting the system on cloud platforms for scalability, accessibility, and integration with enterprise HR systems.

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