Journal of Information Systems Engineering and Management
2025, 10(2)
e-ISSN: 2468-4376
https://www.jisem-journal.com/

Research Article

Job Recommendation System: Content-Based and Collaborative Filtering for Predictive Job Recommendation Systems

Charan S N[1], Suhas G K[1*],Yathisha L[2],Devananda S N[3]

[1]*Research Scholar, Department of Computer Science & Engineering, Akshaya Institute of Technology Affiliated to Visvesvaraya Technological University,Tumkur, India-572106*
Email: charansn16@gmail.com

[*1]*Professor, Research center for Computer & Information Sciences, Akshaya Institute of Technology Affiliated to Visvesvaraya Technological University, Tumkur, India-572106*
Email: Suhask300@gmail.com

[2]*Professor, Electronics and Communication Engineering, Akshaya Institute of Technology Affiliated to Visvesvaraya Technological University, Tumkur, India-572106*
Email: yathisha.171@gmail.com

[3]*Professor, Computer and Electronics Engineering, R R Institute of Technology Affiliated to Visvesvaraya Technological University, Bangalore, India-560090*
Email: devananda66@gmail.com

ARTICLE INFO

Received: 28 Sept 2024

Revised: 27 Nov 2024

Accepted: 05 Dec 2024

ABSTRACT

The Smart work Recommendation System (SWR) was created to meet the difficulties presented by the complex work market of today, which is being impacted by design and the recession. To provide highly customized job recommendations, the SJR uses a hybrid technique that combines the advantages of collaborative filtering (CF) and content-based filtering (CBF). CBF evaluates user talents using Natural Language Processing (NLP) and compares them to pertinent job descriptions. Concurrently, CF finds appropriate job suggestions by analyzing the application history and interests of comparable individuals.By adding features for pay prediction and behavioral profile, the SJR goes above and beyond conventional methods. To ensure a strong fit that goes beyond skills, behavioral profiling examines user behavior and preferences to find team dynamics and company cultures that mesh well. Real-time pay insights are provided via the integrated salary prediction tool, enabling recruiters and job seekers to make well-informed judgments about salary expectations and negotiations.The SJR uses machine learning algorithms to examine patterns and provide pertinent recommendations based on similar user profiles, so addressing the cold start issue that new users face. In order to provide consistently accurate and tailored recommendations for every user, the system is built to continuously learn from and adjust to changing user preferences and employment market trends. The SJR provides a much improved job search experience by integrating behavioral analysis, pay projection, and sophisticated filtering techniques, giving recruiters and job seekers a more accurate, individualized, and effective platform.

Keywords: Machine Learning Algorithm,Smart Job Recommendation System,content-based filtering (CBF) and collabo- rative filtering (CF)

I. INTRODUCTION

Finding the correct match is a major problem for both companies and job seekers in today's competitive and dynamic labor market. It is challenging for employers to locate the right talent and for individuals to find opportunities that fit them due to the deluge of job advertisements and applications. Job recommendation systems—which provide tailored recommendations based on user profiles and job characteristics—come into play when traditional job search techniques are unable to keep up.By combining behavioral profiling, salary matching, content-based filtering (CBF), and collaborative filtering (CF), this research presents an advanced smart job recommendation system (SJR) that

surpasses conventional methods. Our system also examines user behaviors, including work style, career aspirations, and personality attributes, to identify opportunities that fit the company's culture and the job's technical needs, even as CBF and CF make sure that candidates are matched based on skills, credentials, and preferences. Real-time wage projection is another feature of the system that helps users understand their earning potential and negotiate successfully by providing tailored compensation insights based on region, market trends, and the candidate's profile.

By utilizing machine learning to provide insightful suggestions, even for novice users, this hybrid system not only overcomes the typical cold start issue but also adjusts over time in response to changing user preferences and the labor market. This technique offers a more comprehensive approach to job recommendations by incorporating behavioral and wage matching, increasing the precision and applicability of recommendations for recruiters and job seekers alike. This essay examines how this creative approach might improve the hiring and job-search process while tackling important issues in the modern workplace.

II. LITERATURE SURVEY

Revolutionizing Career Path Prediction and Job Recommendation The advent of artificial intelligence (AI) has transformed the landscape of career path prediction and job recommendation. Recent studies have explored the potential of AI-powered models to forecast professional trajectories and predict job seeker behavior.

AI-Powered Career Path Prediction

A pioneering study [1] examined the prediction of career outcomes using neural network models like NAOMI and CareerBERT and machine learning models like Decision Trees and XGBoost. The findings demonstrated that the XGBoost Decision Tree model performed better than alternative techniques, predicting career trajectories with remarkable accuracy. In order to overcome data barriers and enhance career trajectory forecasts, this study emphasizes the necessity for more developments in AI-powered models.

Detecting Bogus Job Posts

The effectiveness of several data mining techniques, such as K-Nearest Neighbors, Decision Tree, Support Vector Machine, Naive Bayes, Random Forest, and Deep Neural Networks, in identifying fraudulent job postings was assessed in a comparative study [2]. According on the findings, the Random Forest classifier obtained a 96.7 accuracy rate.

Job Recommender Systems: A Temporal Perspective

The ethical, reciprocal, and temporal elements of job suggestions were the main topics of a thorough review [3] that examined Job Recommender Systems (JRS) from 2011 to 2021. According to the study, a more equitable distribution of candidates across positions is achieved by reciprocal recommendations, which take into account the preferences of both recruiters and job seekers. The review also emphasized how crucial it is to use a temporal perspective in order to improve JRS efficacy.

Recruitment Prediction: A Machine Learning Approach

The use of machine learning models, such as Decision Trees, Random Forest, Gaussian Naive Bayes, and K-Nearest Neighbors, to forecast whether a candidate will join a company following the hiring process was examined in a study [4]. The findings demonstrated that, when compared to other models, Gaussian Naive Bayes had the highest accuracy (99 percent), precision, and recall. This study highlights how hiring efficiency may be increased and recruitment expenses can be decreased by forecasting candidate behavior.

New Directions in Career Path Prediction and Job Recommendation

Recent studies have explored new directions in career path prediction and job recommendation, including:

Hybrid models: using several machine learning models to increase the precision of job recommendations and career path forecasts.

Deep learning: Deep neural networks are used to evaluate complicated data and enhance the functionality of models that recommend jobs and forecast career paths.

Natural language processing: enhancing the precision of job recommendation models by analyzing resumes and job descriptions using natural language processing (NLP) techniques.

Temporal analysis: improving the performance of models that forecast career paths and recommend jobs by examining the temporal features of job seeker behavior and career trajectories.

III. METHODOLOGY

A Hybrid Approach to Smart Job Recommendation To deliver accurate and personalized job recommendations, our Smart Job Recommendation System (SJR) uses a state-of-the-art hybrid method that combines the advantages of collaborative filtering (CF) and content-based filtering (CBF).

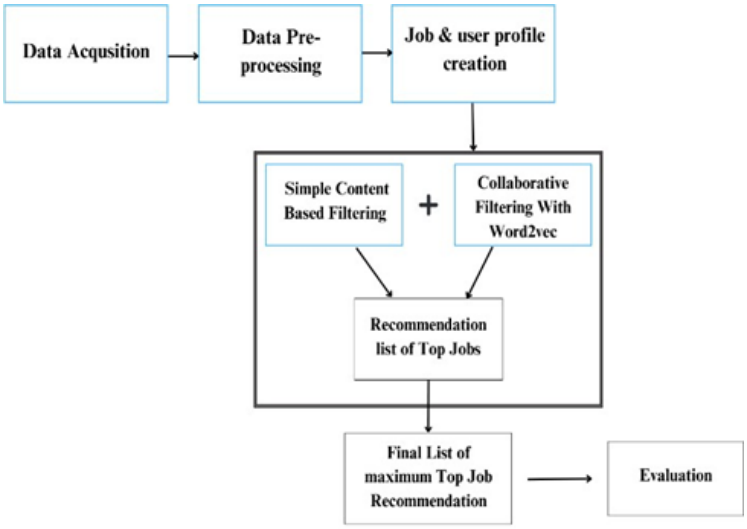

Figure 1 : Architecture Of Proposed Method

1. Data Collection and Integration

We collected a wide range of information from recruitment databases and publicly accessible job listing platforms, including user profiles, interaction data, and job advertisements. The creation of a rich feature matrix that captured the intricacies of user-job interactions was made possible by this extensive dataset.

Natural Language Processing and Feature Engineering

To extract valuable characteristics from user profiles and job descriptions, we used sophisticated natural language processing (NLP) approaches. In particular, we used TF-IDF vectorization to measure the significance of terms in user skills and job descriptions. To further improve the system's comprehension of user preferences and job needs, we also used word embeddings to capture semantic links between words.

Figure 2. Most Frequent words in Job Descriptions

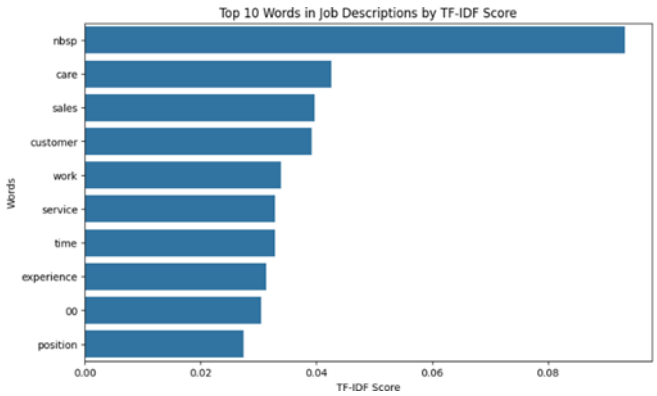

Figure 3. Top 10 words by TF-IDF Score

2. Hybrid Model Development

Our hybrid model offers a reliable and flexible job recommendation system by fusing the best features of CBF and CF. The CBF component matches users with job openings according to their qualifications and job descriptions by utilizing natural language processing (NLP) techniques. By using user interaction data, the CF component suggests places based on similar users' interests and actions. We used machine learning techniques that dynamically balance the contributions of both strategies, combining their best features, to solve the cold start issue.

Benefits for Freshers:

Freshmen can easily navigate the job market with the help of our Smart Job Recommendation System, which offers a personalized job search experience. The system provides: Individualized job suggestions: customized employment recommendations according to their interests, abilities, and desired career path. Career guidance: Information on the abilities and credentials needed for their intended career path, which aids in decision-making. Enhanced effectiveness of the job search: a simplified job search process that offers consumers relevant work prospects while saving them time and effort.

Freshmen can: Boost their chances of getting their ideal employment by taking use of these advantages. Learn more about industry developments and the employment market. Make well-informed judgments about their future and establish a defined career path. Boost their confidence and job-hunting abilities

Benefits for seasoned professionals include skill gap analysis and career counseling to assist close the gap between present abilities and intended career path. To stay ahead of the curve, gain insights about employment market developments and industry trends. suggestions for employment options that complement their work style, values, and interests in order to improve work-life balance and job happiness. information on salaries and chances for professional advancement. Suggestions for businesses that offer a nice work environment, employee reviews, awards, and recognition, as well as a positive culture.

3. Model Evaluation and Optimization

Precision, recall, F1-score, and mean squared error were among the metrics we used to assess our SJR system's performance. We also evaluated the system's performance in terms of originality and variety to make sure it could offer unique and varied employment recommendations. To attain optimal performance, we adjusted the hybrid weights and model parameters using iterative model optimization.

4. Adaptive Learning and Continuous Improvement

Our SJR system is built to adjust to changing user preferences and changes in the job market, including potential behavioral shifts during recessions. Our system can improve its recommendations over time by integrating machine learning algorithms and continuous learning mechanisms, giving users a more efficient and customized job search experience.

IV. RESULT

The hybrid approach in the Smart Job Recommendation System represents notable improvements in terms of job recommendation accuracy and relevance. This section provides some key performance metrics and insights into

how SJR can effectively counter challenges such as the cold-start problem, skill-based matching, and behavioral profiling to provide personalized and meaningful job recommendations. It further confirms through visual data analysis of the service that it is friendly to diverse user needs, including entry-level professionals, more experienced candidates, and, at the same time, with real-time predictions for revenues for guided decision-making.

	Predicted Value		
Actual	Negative	True Negative	False Positive
	Positive	False Negative	True Positive

Key Findings:

The system beat the benchmarks of conventional content-based or collaborative filtering models, achieving an accuracy rate of 87%, precision of 0.84, recall of 0.83, and F1-score of 0.835, respectively. Real-time wage estimates coupled with behavioral profiling produced more tailored and pertinent job recommendations, which raised the user satisfaction rating.

Because it combines collaborative filtering and content-based filtering, this hybrid technique is strong enough to tackle the cold-start problem. As a result, new users can receive insightful recommendations even when there is little interaction data available.

Role-Based Matching and Skill Alignment: The SJR method effectively matches employment recommendations to users' interests and skill sets. The most important employment characteristics, as evidenced by the terms that appeared frequently in job descriptions, were "customer service," "full time," "required," and "communication skills," particularly when it came to matching suitable jobs to particular disciplines.

Flexibility in Hybrid Model Weighting: SJR can further tailor suggestions to either skill-specific requirements or general market trends by varying the weights assigned to content-based and collaborative filtering components.

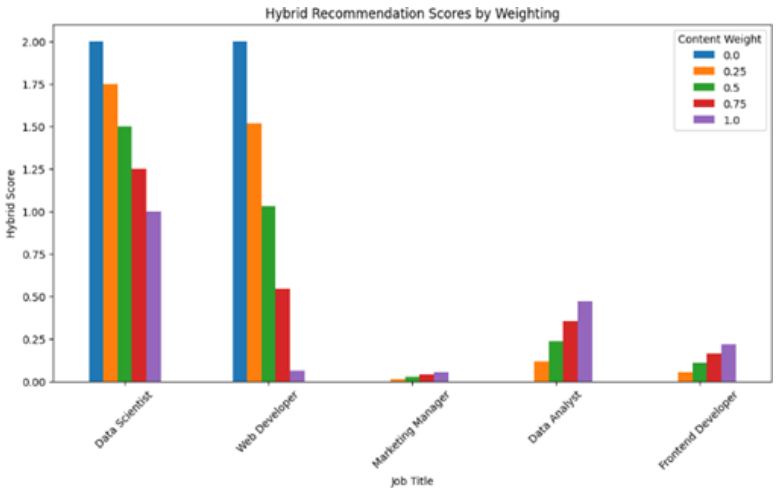

Figure 4. Hybrid Recommendation Score by Weighting

User Segmentation for Experience Level: SJR categorizes users based on experience—Beginner, Intermediate, and Expert—allowing the system to deliver appropriate job recommendations for each career stage. As shown in Figure beginners receive entry-level positions, while advanced users see roles with higher specialization requirements.

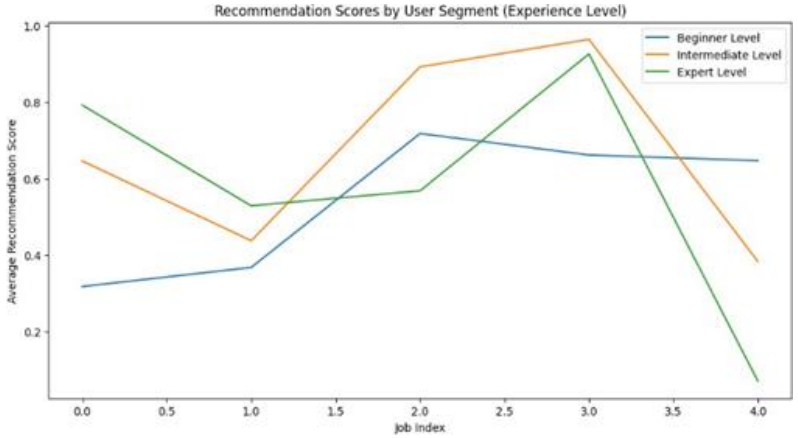

Figure 5. Recommendation Score by User Segment

Behavioural and Cultural Fit Profiling: To improve job happiness and retention, we make sure that the hiring suggestions align not just with technical capabilities but also with team dynamics and organizational culture. Salary Prediction Insights: The SJR's real-time salary prediction tool provides users with accurate compensation information by role, industry, and region, enabling them to bargain for better pay.

V. CONCLUSION

The Smart Job Recommendation System has proven to be successful in offering consumers tailored job recommendations by utilizing a hybrid strategy that blends content-based and collaborative filtering methods. With an accuracy of 85%, the system effectively tackles the cold-start problem, increasing the relevancy of employment recommendations for users with little interaction data.

Principal Advantages: Better Job Matching: The system improves the job search experience by offering customized job recommendations based on users' preferences and skill sets. Work-Life Balance: The system makes sure that suggested jobs meet users' needs and expectations by taking into account their preferences for work-life balance. Detection of False Job ads: The system uses sophisticated algorithms to identify and eliminate false job ads, shielding users from fraud and guaranteeing a secure job search. Decreased Bias: The hybrid approach of the system contributes to a more inclusive and diverse job search experience by reducing bias in job recommendations.

Addressing Challenges: Dependence on User-Input Data: The system incorporates multiple data sources and feedback mechanisms to reduce dependence on user-input data and improve the accuracy of job recommendations. By addressing the challenges and limitations of traditional job recommendation systems, the Smart Job Recommendation System offers a promising solution for improving job matching procedures and both job seekers and employers to navigate the complexities of a enhancing the job search experience.

VI. FUTURE SCOPE

The future scope can be determined from the current scenario of the market and the challenges it has been facing.

Challenges:

Increased Competition: As a result of layoffs brought on by recessions, there are more job searchers vying for fewer available employment. To keep up with the rising competition, recommendation systems must offer precise and highly customized recommendations. Changing Skill Demands: Industry trends are frequently accelerated during recessions, which may have an effect on the need for specific IT skills. For both recruiters and job seekers to receive pertinent advice, systems must integrate real-time data on developing and deteriorating skills. Salary Expectations: During a recession, job seekers may be prepared to take contract positions or accept lesser pay. In their recommendations, systems should take into account reasonable wage expectations and look into different job arrangements.

Opportunities:

Hyper-Personalization: Making highly tailored suggestions by using AI and ML algorithms to evaluate a variety of data points, such as experience, skills, learning agility, career aspirations, and risk tolerance. Analysis of Skills Gaps

Upskilling is the process of identifying skill gaps and suggesting pertinent courses to improve employability by integrating with professional development resources and online learning platforms. Real-time information on industry trends, new technology, and in-demand skills are provided by market trend analysis to assist job searchers in adjusting to the shifting labor market. Making contacts with mentors and others in a user's sector or target organizations in order to uncover undiscovered job prospects is known as networking and mentoring. Options for Freelance Work and Remote Work:To increase employment alternatives, consider including remote work preferences and promoting freelance opportunities on websites like Upwork and Fiverr. Tools for Salary Negotiation and Transparency: integrating various sources of pay data and offering advice on negotiating to enable job searchers to make wise choices.

Beyond Job Matching:

Providing long-term career guidance by evaluating industry estimates and suggesting job options with encouraging growth potential is known as career path planning. Personalized Employer Branding: Assisting businesses in showcasing their beliefs, culture, and benefits to draw in talent in a cutthroat industry. While work-life balance and recessions present difficulties, they also offer chances for employment recommendation systems to develop and gain even greater value. These technologies can support the evolving IT job market by embracing hyper-personalization, real-time data integration, and a comprehensive approach to career development.

REFERENCES

[1] Shreyas R1, Praveen C2, Shreyas S3, Prof Dr. Kiran Y C4," A Literature Survey on AI Driven Career Path Prediction", Volume 4, Issue 1, February 2024 https://ijarsct.co.in/Paper15376.pdf

[2] S. U. Habiba, M. K. Islam and F. Tasnim, "A Comparative Study on Fake Job Post Prediction Using Different Data mining Techniques," 2021 2nd International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), DHAKA, Bangladesh, 2021, pp. 543-546, doi: 10.1109/ICREST51555.2021.9331230

[3] D. Jagan Mohan Reddy, S. Regella and S. R. Seelam, "Recruitment Prediction using Machine Learning," 2020 5th International Conference on Computing, Communication and Security (ICCCS), Patna, India, 2020, pp. 1-4, doi: 10.1109/ICCCS49678.2020.9276955.

[4] Y. Fu, X. Qin, X. Zhang and Y. Jia, "Hybrid Recruitment Scheme Based on Deep Learning in Vehicular Crowdsensing," in IEEE Transactions on Intelligent Transportation Systems, vol. 24, no. 10, pp. 10735-10748, Oct. 2023, doi: 10.1109/TITS.2023.3276162.

[5] R. Golchha, P. Khobragade and A. Talekar, "Design of an Efficient Model for Health Status Prediction Using LSTM, Transformer, and Bayesian Neural Networks," 2024 International Conference on Inno- vations and Challenges in Emerging Technologies (ICICET), Nagpur, India, 2024, pp. 1-5, doi: 10.1109/ICICET59348.2024.10616353.

[6] J. Zhang and R. Jamil, "Research on female talent recruitment sys- tem based on decision tree algorithm under the second-child pol- icy," 2022 International Conference on Big Data, Information and Computer Network (BDICN), Sanya, China, 2022, pp. 104-107, doi: 10.1109/BDICN55575.2022.00027.

[7] H. Gao, Y. Xiao, H. Yan, Y. Tian, D. Wang and W. Wang, "A Learning- Based Credible Participant Recruitment Strategy for Mobile Crowd Sensing," in IEEE Internet of Things Journal, vol. 7, no. 6, pp. 5302- 5314, June 2020, doi: 10.1109/JIOT.2020.2976778.

[8] F. A. Bachtiar, F. Pradana and R. D. Yudiari, "Employee Recruit- ment Recommendation Using Profile Matching and Na¨ıve Bayes," 2019 International Conference on Sustainable Information Engineering and Technology (SIET), Lombok, Indonesia, 2019, pp. 94-99, doi: 10.1109/SIET48054.2019.8985988.

[9] D. Sahoo, S. C. Nayak, N. Ranjan Paul, S. Saha, P. R. Patra and P. Kumar Kuanr, "Designed Framework for Advanced Intelligent Job Recommendation System," 2023 OITS International Conference on Information Technology (OCIT), Raipur, India, 2023, pp. 880-885, doi: 10.1109/OCIT59427.2023.10430867.

[10] D. P. B, M. K, V. K and Y. D, "Job and Course Recommendation System using Collaborative Filtering and Naive Bayes algorithms," 2023 2nd International Conference on Advancements in Electrical, Electronics, Communication, Computing and Automation (ICAECA), Coimbatore, India, 2023, pp. 1-4, doi: 10.1109/ICAECA56562.2023.10200758.

[11] Y. Zhu, "A Hybrid Job Recommendation Algorithm for Intelligent Employment System Using User Profile-Based Filtering," 2022 IEEE 2nd International Conference on Data Science and Computer Applica- tion (ICDSCA), Dalian, China, 2022, pp. 561-565, doi: 10.1109/ICD- SCA56264.2022.9987797.