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Skill Mount: Personalized Career Skills Development Using Machine Learning Algorithms

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***Abstract*— In today's rapidly changing job market, achieving career goals requires a strategic approach to skill development. Skill Mount is an intuitive web application designed to guide individuals through their career journeys, aiding in both planning and attainment of objectives through personalized technology-driven methods. Given the constant evolution of job roles and the competitive landscape, continuous skill enhancement is imperative for career advancement, making Skill Mount an indispensable tool. Serving as a personalized coach, it tailors daily skill acquisition plans, monitors progress, and suggests suitable job roles based on individual preferences. Leveraging artificial intelligence (AI), including Natural Language Processing (NLP) and Machine Learning (ML), Skill Mount analyzes user data to provide customized skill suggestions and job descriptions. The proposed system uses Recommendation Systems to propose relevant learning resources and utilizes an ensemble method (random forest algorithm) for job recommendations, As a result system acquired higher accuracy rates. With a focus on user experience (UX), Skill Mount ensures seamless interaction through its intuitive interface and automated features driven by AI. By simplifying the career journey and empowering individuals to adapt to the competitive job market, Skill Mount plays a pivotal role in facilitating career growth and success.**

I. INTRODUCTION

As the job market rapidly evolves, individuals face growing challenges in keeping their skills current and advancing their careers amid the constant emergence of new roles and industries shaped by technological advancements. To navigate these complexities, innovative solutions are essential to empower individuals in designing, executing, and optimizing their career paths. Skill Mount, a pioneering web application, redefines personalized skill development and career guidance by departing from traditional career planning methods. It harnesses state-of-the-art technologies—including artificial intelligence (AI), natural language processing (NLP), and machine learning (ML)—to deliver tailored recommendations and actionable insights for users.

Exploring Skill Mount's diverse features and functionalities highlights its importance within the contemporary landscape of career development strategies. By analyzing its personalized skill-building approaches, dynamic job role suggestions, and intuitive user interface, we see how Skill Mount enables individuals to take control of their career paths in an ever-changing professional environment. Additionally, this system delves into the core principles and methodologies underlying Skill Mount's recommendation engine, data analytics capabilities, and task-tracking tools. Through AI-powered automation and user-centered design, Skill Mount simplifies the journey of skill acquisition and career progression, helping users reach their professional goals.

Built on prior work, as outlined in [1], which initially applied Naive Bayes for job recommendations, Skill Mount enhances accuracy and relevance by integrating ensemble methods. This improvement strengthens Skill Mount's capacity to guide individuals effectively toward fulfilling careers. Ultimately, this system provides a comprehensive overview of Skill Mount's innovative approach to career development, illustrating its transformative role in reshaping personalized career guidance and skill-building in today's competitive job market.

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II. LITERATURE STUDY

Job recommendation system utilizing machine learning techniques including regression, classification, and natural language processing. The method likely employs regression models to predict job suitability based on candidate profiles and job descriptions, while classification algorithms may be used to categorize job opportunities and match them with candidates' skills and preferences. NLP techniques are likely utilized for text analysis and feature extraction from job descriptions and candidate profiles. Output values would likely include personalized job recommendations for candidates, potentially ranked or categorized based on their suitability and relevance to individual profiles. The paper likely contributes to enhancing the efficiency of job matching processes, offering practical implications for both job seekers and recruiters in optimizing candidate selection and placement efforts.[2]

An efficient resume-based re-education approach for career recommendation in rapidly evolving job markets. The method likely involves leveraging machine learning techniques to analyze resumes and identify gaps between individuals' skills and evolving job market demands. Potential models used may include natural language processing for resume parsing and skill extraction, alongside recommendation algorithms to suggest relevant educational or training programs. Output values would likely include personalized recommendations for further education or skill development tailored to individuals' career aspirations and the dynamic needs of the job market. The system likely contributes to addressing the challenge of aligning individuals' skills with the evolving demands of contemporary job markets, offering practical implications for career development strategies and educational institutions.[3]

A formal approach to Ontology-Based Semantic Match of Skills Descriptions, emphasizing the importance of skill management for knowledge-intensive companies in a global market. Utilizing Description Logics formalization and reasoning, the framework supports semantic matching of skills descriptions between demanders and sellers, surpassing simple subsumption matching to enable ranking and categorization of matches. Implemented as a prototype with a NeoClassic reasoner, the system addresses issues like negative information treatment and multiplicity of relationships, offering algorithms for ranking potential matches and supporting users in data insertion and query submission. It facilitates team constitution and resource scheduling optimization through bipartite graph algorithms, aiming for effective skill matching and knowledge management across organizations. Overall, the system demonstrates promising results in aligning with human judgment and streamlining skill matching processes for knowledge-intensive sectors.[1]

Implementation of an automated job recommendation system based on candidate profiles. The method likely employs machine learning algorithms to analyze candidate profiles, including skills, experiences, and preferences, alongside job descriptions. Potential models used may include collaborative filtering or content-based filtering approaches to match candidates with suitable job opportunities. Output values would likely include personalized job recommendations tailored to each candidate's profile, aiming to streamline the job search process and improve the efficiency of matching candidates with relevant job openings. The paper likely contributes to enhancing the effectiveness of recruitment processes, offering practical implications for job seekers and recruiters seeking to optimize candidate selection and placement efforts. [4]

A job recommendation system utilizing machine learning. The method likely involves employing machine learning algorithms, possibly including both collaborative filtering and content-based filtering approaches, to analyze user preferences and job characteristics for personalized recommendations. The system may leverage techniques such as natural language processing for text analysis and feature extraction. Output values would likely include personalized job recommendations tailored to each user's preferences and job market trends, aiming to assist job seekers in finding relevant employment opportunities efficiently. Additionally, the paper discusses aspects related to app development, including the use of Android, Kotlin, and Jetpack Compose for implementing the recommendation system, highlighting practical implications for mobile application development in the job search domain.[5]

A job recommender system leveraging NLP techniques for skill extraction from CVs and JDs. It combines NLP techniques like Named Entity Recognition, Part of Speech Tagging, and Word2Vec with a Skill Dictionary for robust skill extraction, yielding a precision and recall of 0.78 and 0.88, respectively. It introduces implicit skills extraction, enhancing job matching by 29.4% compared to baseline methods. The system comprises three modules: skill extraction, identifying similar JDs using a Doc2Vec model trained on 1.1 million JDs, and matching skills from a candidate's profile to JDs, utilizing a bipartite graph matching approach. Evaluation on datasets demonstrates improved accuracy and relevance, with a 6.67% enhancement in recommending relevant jobs. Future work includes applying skill graphs for career path recommendations and inferring skill gaps in candidates' profiles.[6]

Guo, Alamudun, and Hammond's system in Expert Systems with Applications, published in 2016, presents RésuMatcher, a personalized resume-job matching system. The method likely involves utilizing machine learning and natural language processing techniques to analyze both resumes and job descriptions, identifying relevant skills and characteristics. Potential models used could include text mining algorithms for feature extraction and similarity measures for matching resumes to jobs. Output values likely include a matching score or ranking indicating the suitability of each resume for a given job, facilitating efficient and personalized job recommendations. The system likely contributes to

enhancing the efficiency of job matching processes, offering practical implications for job seekers and recruiters in optimizing candidate selection and recruitment efforts.[7]

Ontology-based personalized course recommendation framework. The method likely utilizes ontologies to model the relationships between courses, students' preferences, and academic backgrounds. Machine learning algorithms may be employed to analyze students' profiles and recommend courses based on their individual needs and interests. Output values would likely include a list of recommended courses tailored to each student's preferences, academic history, and career aspirations, aiming to enhance the learning experience and academic success. The system likely contributes to improving the efficiency and effectiveness of course selection processes, offering practical implications for academic advisors and students seeking personalized learning paths aligned with their goals.[8]

A personalized course recommendation system tailored to individuals' career goals. The study likely employs a combination of machine learning and recommendation algorithms to analyze users' career aspirations and academic backgrounds, aiming to suggest relevant courses accordingly. The method may involve data mining techniques to extract relevant information from user profiles and course descriptions. Output values would likely include recommended courses matched to users' career objectives, potentially measured through metrics like accuracy, precision, and recall. The dissertation is expected to contribute insights into the field of personalized recommendation systems for educational purposes, potentially offering practical implications for academic advisors and students seeking tailored learning paths aligned with their career aspirations.[9]

A personalized career-path recommender system tailored for engineering students. The method likely employs machine learning techniques to analyze students' academic backgrounds, career interests, and industry trends. It may utilize collaborative filtering or content-based filtering approaches to recommend suitable career paths and relevant courses or internships. Output values would likely include personalized recommendations for career paths, internship opportunities, and relevant resources, aiming to assist engineering students in making informed decisions about their future careers. The system likely contributes to enhancing career guidance and support services for engineering students, offering practical implications for academic advisors and career counselors seeking to assist students in navigating their professional trajectories effectively.[10]

a skill extraction method for domain-specific text retrieval in a job-matching platform. The method likely employs natural language processing techniques to extract relevant skills from job descriptions and candidate profiles, enhancing the accuracy of domain-specific text retrieval. Potential models used may include Named Entity Recognition (NER), Part of Speech (POS) tagging, and keyword extraction algorithms. Output values would likely include extracted skills from both job descriptions and candidate profiles, facilitating more precise matching between candidates and job opportunities. The paper likely contributes to improving the effectiveness of job-matching platforms by enhancing the skill extraction process and ultimately assisting job seekers and recruiters in finding suitable matches.[11]

Recommendation frameworks in aiding students' career aspirations by proposing a content-based filtering approach for a career recommendation system. Leveraging natural language processing for feedback and sentiment analysis, the system aims to address limitations of existing systems such as cold start and scalability. Implemented using Python and Flask for machine learning techniques and connecting front-end and back-end, respectively, the system facilitates informed career decisions for undergraduates based on interests, skills, and academic performance. Methodology includes data preparation, cosine similarity, and clustering with the K-means algorithm, ensuring robustness and user satisfaction in refining the recommendation process. Overall, the system provides a comprehensive exploration of machine learning and NLP applications in career recommendations for college graduates, emphasizing user-centric features and the importance of addressing existing system limitations.[12]

III. METHODOLOGY

To develop SKILL MOUNT, several key steps were followed. First, a dataset of job titles and corresponding required skills was created. This dataset powers the system's ability to compare a user's current skills, extracted from their uploaded resume, with the skills required for their dream job. Using Natural Language Processing, the resume is processed to identify relevant skills, which are then matched against the predefined skill list.

The system uses machine learning, specifically an ensemble method like random forest, to recommend the most suitable job roles based on the user's current skill set. It also tracks progress by comparing current skills with those required for the dream job and suggests skills the user needs to develop. Additionally, it provides personalized learning recommendations to help users improve and advance in their careers. This combination of technologies enables a seamless, personalized approach to career planning and skill enhancement.

The proposed system consists of 5 core units that are shown in the system architecture in Fig:1.

The system includes :

- Resume Processing module
- Skill Extraction module
- Skill Recommendation module
- Job Description analysis module
- Progress Tracking module

1) Resume Processing: The resume processing is a crucial component within the larger framework of a system designed to analyze and extract relevant information from resumes. Its primary function is to preprocess raw resume text to facilitate accurate extraction of key information such as skills.

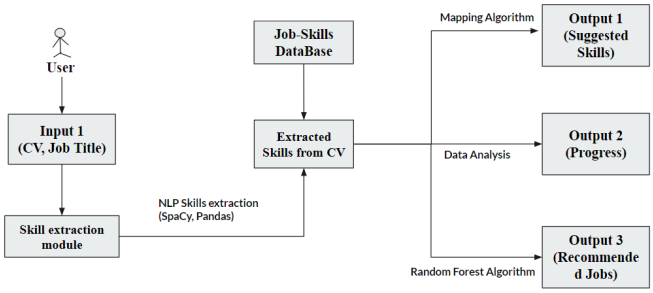

Fig. 1. System Architecture

- Removing Stop Words: Common words like "the," "is," and "and," which don't add value to text analysis, are removed to reduce noise and improve processing efficiency.
- Removing URLs: Resumes often contain URLs (e.g., links to personal websites) that are irrelevant for skill extraction. Removing them ensures only meaningful content is processed.
- Tokenizing Text using NLTK: The text is split into smaller units (tokens) using the Natural Language Toolkit (NLTK), which allows detailed analysis of each part of the resume for further processing.
- Extracting Skills from a Predefined Skills List: The tokenized text is compared to a predefined list of relevant skills, ensuring only domain-specific skills are extracted from the resume.
- Count Vectorizing: This step converts the text data into numerical vectors, where each vector reflects the frequency of words or tokens in the text. This numeric representation of extracted skills can be used for further analysis, such as job matching or creating skill profiles.

2) Skill Extraction: The skill extraction is a pivotal component within a resume processing system, responsible for identifying and extracting relevant skills from preprocessed resumes.

Once preprocessed, various techniques, such as keyword matching, natural language processing, and machine learning, are employed to identify skills within the resume. The skill extraction module scans the tokenized text for matches against a predefined skill list or uses contextual analysis to infer skills based on their usage.

To ensure the accuracy and relevance of the extracted skills, validation mechanisms are incorporated, which cross-reference the skills with a comprehensive database. After successful extraction, the skills are added to a growing dataset dedicated to skill-related information, which evolves as new resumes are analyzed. This dataset may also be enriched with additional details, such as the frequency of skills and their context within the resume, providing valuable insights for future analysis.

Finally, the skill extraction module undergoes iterative refinement based on feedback and performance evaluations, enhancing its accuracy, efficiency, and scalability over time to continuously improve the quality of extracted skills. Fig:2 shows the input to the developed web application begins with users uploading their resumes, which are then processed by the system's skill extraction module. This module identifies and extracts relevant skills using NLP.

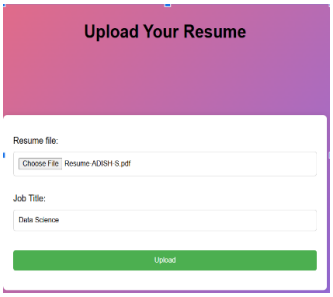

Fig. 2. Sample of developed web page to upload CV and desired job description

3) Skill Recommendation: The skill recommendation in this career guidance system, responsible for identifying and recommending the skills that users need to acquire in order to qualify for their desired job descriptions.

- Utilization of the Skill Dataset: The recommendation module relies on a comprehensive dataset that aggregates skills from user resumes, job descriptions, and external databases, with metadata including proficiency levels and industry domains.
- Mapping User Skills to Desired Job Descriptions: The module analyzes job descriptions related to the user's desired career path to identify the specific skills and qualifications sought by employers.
- Comparison with User Skills: The required skills are compared against the user's existing skill set, identifying discrepancies as skill gaps that need to be addressed.
- Recommendation Generation: Based on the identified skill gaps, the module generates personalized recommendations for the user, highlighting the skills they need to acquire or improve upon, prioritizing those most relevant to the target roles.
- Feedback and Iterative Improvement: The module incorporates feedback mechanisms to refine its recommendations over time, considering user feedback, performance metrics, and industry trends to enhance the accuracy and relevance of the skill suggestions continuously.

4) Job Description analysis: Job Description Analysis is a critical part of the career guidance system, responsible for recommending suitable jobs based on users' skills and preferences.

- Model Selection: After preprocessing user data, the job recommendation module tests various machine learning models, selecting the Random Forest classifier due to its superior accuracy over alternatives like k-nearest neighbors (KNN) and naive Bayes classifiers.
- Random Forest Classifier: This ensemble learning method uses multiple decision trees to predict job matches, combining individual tree predictions for robust results. Its diversity makes it ideal for job recom-

mendation tasks involving multiple factors.

- Accuracy Comparison: While other models were considered, Random Forest proved the most accurate during evaluation, providing the most relevant job recommendations.
- Training and Validation: The chosen model is trained using labeled data, and validated with techniques like cross-validation. Hyperparameters are optimized to improve prediction accuracy.
- Job Recommendation Generation: Once trained, the Random Forest classifier uses user skills, preferences, and other factors to generate personalized job recommendations.
- Continuous Improvement: The system is regularly updated and refined based on user feedback and performance evaluations to ensure ongoing relevance and accuracy in job recommendations.

5) Progress Tracking: The Progress Tracking Module monitors users' progress by comparing their current skills with those required for their dream job, highlighting skill gaps and offering visual insights through charts or graphs. It sets milestones to break down the journey into achievable steps and dynamically updates as users acquire new skills, ensuring guidance remains relevant. By incorporating user feedback, the module refines its recommendations to adapt to individual learning paths and evolving industry demands, helping users stay motivated and on track toward their career goals.

IV. CHALLENGES FACED

Navigating the complexities of AI-driven skill identification, resume generation, and predictive modeling presents several challenges, including difficulties in identifying multi-worded skills, low accuracy in AI-generated resumes, and the need to enhance model performance through ensemble methods.

- Identifying Multi-word Skills: One of the key challenges in skill identification is accurately recognizing multi-worded skills, such as "project management" or "data analysis," which are often presented differently across resumes. Automated systems may struggle to capture these variations, leading to errors in skill categorization.
- Low Accuracy in AI-generated Resumes: AI-generated resumes, while efficient, tend to have lower accuracy than those written by humans. This is due to the AI's limited understanding of context and language nuances, often resulting in generic content that fails to effectively represent the candidate's unique qualifications and strengths.
- Ensemble Methods for Improved Accuracy: Individual machine learning models, like KNN or naive Bayes, may not deliver optimal accuracy when used alone. To overcome this, ensemble methods are employed, combining predictions from multiple models to produce more accurate and robust outcomes. By leveraging the strengths of multiple models, ensemble techniques improve the overall performance and predictive power of the system.

V. EXPERIMENTAL RESULTS

The output from the SKILL MOUNT web application provides users with an overview of their career path, displaying their current skills, the skills required for their dream job, and personalized job recommendations. After processing the resume, the system highlights skill gaps and suggests the five most suitable job titles based on the user's profile. Additionally, a progress tracking module visually shows the user's advancement towards acquiring the necessary skills. Fig:3 shows sample results produced by SKILL MOUNT.

Fig. 3. Sample of results produced.

The proposed system combining Job Recommendation and Skills Suggestion produced the following results:

- Overall Accuracy: The system achieved 98% accuracy, effectively matching candidates with suitable job descriptions and required skills.
- Individual Candidate Analysis: Out of 25 resumes, 24 received accurate job recommendations and skill suggestions, highlighting the system's strong performance.
- False Positives and Negatives: Minimal errors were found, where irrelevant jobs were recommended or suitable jobs were missed. System tweaks reduced these issues, improving performance.

Comparison with existing system: The existing system[3] lacks essential features such as a skill recommendation module, which is vital for providing users with tailored suggestions to bridge the gap between their current skills and those needed for their desired job roles. In contrast, the proposed system includes this module, enabling users to receive personalized recommendations for skill development based on their career aspirations. Additionally, the proposed system introduces a progress tracking module, allowing users to monitor their skill improvement over time, a capability that is absent in the current system[3],[6].

When it comes to Job Recommendations, the existing system employs a Decision Tree model[12]. However, the proposed system enhances predictive accuracy by replacing it with an Ensemble Model like Random Forest. This change

allows for a more robust analysis of user data, leading to more precise and relevant job recommendations tailored to the unique skills and preferences of each user. Overall, these enhancements in the proposed system contribute to a more individualized user experience and foster better career planning and skill enhancement.

	Model	Accuracy	Precision	Recall	F1 Score
0	kNN	98.15	97.89	98.22	98.05
1	Random Forest	97.42	98.25	97.54	97.98

Fig. 4. Job recommendation performance using different models

The job recommendation performance metrics using K-Nearest Neighbors (KNN) and Random Forest algorithm is shown in Fig:4. This comparative analysis highlights the effectiveness of both models in matching candidates with suitable job roles. Fig:5 provides further insight by displaying the confusion matrix of the Random Forest model, which demonstrates a remarkable performance accuracy of 98%. Together, these figures underscore the high precision of the Random Forest model in job recommendations.

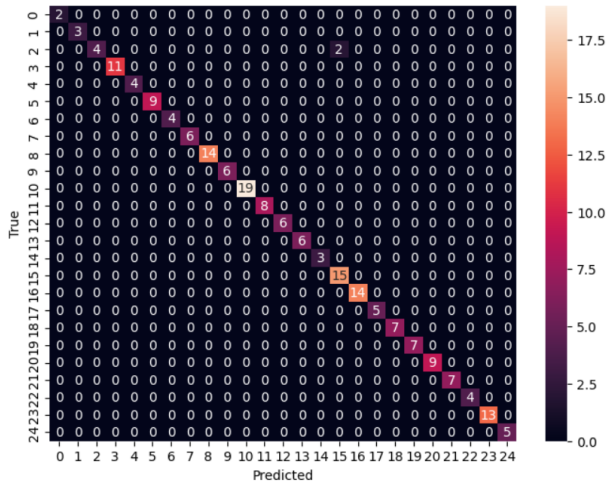

Fig. 5. Confusion Matrix

VI. CONCLUSION

This system conducts a thorough examination of a personalized career skills development platform aimed at transforming individuals' professional trajectories. The primary objective is to empower users with tailored career development plans and continuous skill refinement through an intuitive web application. Utilizing advanced AI technology, the platform aims to deliver personalized job recommendations, track user progress, and offer relevant learning materials aligned with personal preferences and career goals.The system employs NLP algorithms to analyze user resumes comprehensively. This process involves identifying crucial skills, experiences, and career interests, laying the foundation for personalized skill enhancement recommendations. The skill recommendation system, powered by Machine Learning algorithms like random forest, provides specific skill suggestions and learning paths tailored to individual profiles, career goals, and advancement opportunities. In the evaluation stage, it was noted that while the KNN algorithm achieved a commendable accuracy rate of 94%, it was slightly lower than the 98% accuracy attained by the random forest algorithm. This underscores the platform's efficacy in utilizing advanced machine learning techniques.Overall, the system aims to simplify the job search process, facilitate smooth career transitions, and guide users towards successful professional growth in a constantly evolving job market. By creating a supportive and empowering environment for users to strategize and achieve their career objectives confidently, the system endeavors to streamline the career development journey and redefine how individuals navigate and excel in their careers.

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