

GENERATIVE AI BASED PERSONALIZED CAREER PATH RECOMMENDER USING SKILL PROFILING

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Abstract: Choosing an appropriate career path is a significant challenge for students and job seekers due to the increasing number of career options and lack of personalized guidance systems. Traditional approaches such as rule-based systems, fuzzy logic, and probabilistic models provide limited adaptability and often generate generic recommendations. These systems fail to incorporate real-time user preferences and evolving industry requirements.

Recent advancements in Artificial Intelligence (AI), particularly in Natural Language Processing (NLP) and deep learning, have improved the capability of systems to analyze user inputs and generate meaningful recommendations. Furthermore, the emergence of Large Language Models (LLMs) has enabled the development of intelligent systems capable of generating context-aware and personalized outputs.

This paper proposes a Personalized Career Path Recommendation System using Skill Profiling and Generative AI. The system leverages an LLM-based approach to generate career paths, perform skill gap analysis, and provide structured learning roadmaps. Additionally, a chatbot-based interaction module enables continuous user engagement and real-time guidance. The proposed system provides a comprehensive, scalable, and dynamic solution for career recommendation, overcoming limitations of existing system.

Keywords: Career Recommendation System, Generative AI, Large Language Models (LLMs), LLaMA 3.1, Skill Profiling, Prompt Engineering, Artificial Intelligence, Machine Learning, Natural Language Processing (NLP), Skill Gap Analysis, Personalized Learning, Chatbot Interaction, Flask Framework, Real-Time Recommendation, Career Guidance System

1.INTRODUCTION

The rapid expansion of career opportunities in the modern digital era has created both advantages and challenges for students and job seekers. While diverse career options are available, individuals often struggle to identify suitable career paths that align with their skills, interests, and goals [9], [13]. This lack of structured guidance leads to confusion and poor decision-making.

Traditional career guidance systems rely on manual counseling, rule-based systems, and statistical models, which are not scalable and lack personalization [2], [10]. Techniques such as fuzzy logic and Naïve Bayes provide limited accuracy and depend heavily on predefined rules and datasets [2], [6]. These approaches fail to adapt to real-time user inputs and dynamic industry trends.

Machine learning-based systems improved recommendation accuracy but are still limited by their dependency on static datasets and lack of contextual understanding [10], [11]. Similarly, skill-based recommendation approaches using distance metrics and embeddings enhance matching but do not provide complete career guidance [3], [5].

Resume-based systems using deep learning and NLP techniques focus mainly on job matching rather than comprehensive career planning [4]. These systems fail to provide structured learning pathways and continuous guidance.

The emergence of Generative AI and Large Language Models (LLMs) has significantly transformed recommendation systems [12], [17], [19]. These models can generate dynamic, context-aware, and personalized outputs based on user inputs without relying on predefined datasets.

Motivated by these advancements, this research proposes a Personalized Career Path Recommendation System using Skill Profiling. The system collects user inputs and uses an LLM to generate personalized career paths, skill gap analysis, and learning roadmaps. Additionally, an interactive chatbot module provides continuous guidance and enhances user experience [12], [13].

Another important challenge in career recommendation systems is the lack of adaptability to continuously evolving industry requirements. With rapid advancements in technology, new job roles and skill demands are emerging frequently, making it difficult for traditional systems to stay updated. Existing approaches that rely on static datasets and predefined mappings fail to incorporate real-time labor market trends and user-specific learning progress. This limitation reduces the effectiveness of recommendations and highlights the need for intelligent systems that can dynamically adapt to changing environments [10], [11], [18].

Recent studies have emphasized the importance of integrating Artificial Intelligence with user-centric design to improve the effectiveness of career guidance systems. AI-based frameworks enable better analysis of user behavior, preferences, and skill patterns, leading to more accurate and personalized recommendations. However, many of these systems still lack interactive capabilities and fail to provide continuous support to users. The absence of real-time feedback mechanisms and conversational interfaces limits user engagement and reduces the overall usability of such platforms [13], [14], [20].

To address these challenges, modern approaches are increasingly focusing on combining Generative AI with interactive systems to create intelligent career advisors. By leveraging Large Language Models, it is possible to generate not only career recommendations but also detailed explanations, skill development strategies, and step-by-step learning plans tailored to individual users. This integration enhances both personalization and scalability, enabling the development of systems that provide holistic career guidance. The proposed system builds upon these advancements to deliver a comprehensive, adaptive, and user-friendly career recommendation solution [12], [17], [19].

2.LITERATURE REVIEW

Jiang et al. [1] proposed a personalized learning path recommendation system using a time-aware attention mechanism combined with reinforcement learning. The system adapts learning paths dynamically by analyzing user behavior and temporal patterns, thereby improving personalization in educational recommendations. However, the approach is primarily focused on learning path optimization and does not extend to complete career guidance, such as skill gap analysis or career roadmap generation. This highlights the need for an integrated system that combines learning path recommendation with broader career guidance using skill profiling techniques.

Balasubramani et al. [2] developed a career path recommender system integrated with a resume builder, utilizing Natural Language Processing and rule-based techniques. The system aims to assist users in both career selection and resume enhancement by providing suggestions based on user input. While this integration improves employability support, the system mainly focuses on resume building and lacks deep personalization and real-time adaptability. Therefore, there is a need for a more advanced AI-driven system capable of generating dynamic career paths along with skill gap analysis.

Siswipratini et al. [3] proposed a personalized career path recommendation model for IT students using Naïve Bayes combined with Educational Data Mining and grounded theory. The model classifies users into suitable career domains based on academic performance and other features. Although the system provides a structured approach to career prediction, it is limited to a specific domain and lacks real-time adaptability. This limitation indicates the necessity for a scalable and flexible AI-based system that can generate real-time career recommendations across multiple domains.

Angskun et al. [4] introduced a career recommendation approach based on employability skills using the Modified Euclidean Distance (MED) technique. The system measures similarity between user skills and job requirements to suggest appropriate career options. While this method improves recommendation accuracy through skill matching, it relies on a rule-based mechanism and lacks deeper contextual understanding. Additionally, it does not provide comprehensive career planning features such as learning roadmaps, emphasizing the need for intelligent AI-driven personalized recommendation systems.

Ashrafi et al. [5] presented a resume-based career recommendation system that utilizes Convolutional Neural Networks and Natural Language Processing techniques. The system analyzes resumes to extract relevant features and recommend suitable job roles. Although this approach enhances the processing of unstructured textual data, it is primarily focused on job matching and does not provide holistic career guidance. This limitation highlights the need for systems that go beyond resume analysis to include skill gap identification and structured career development plans.

Ong and Lim [6] proposed SkillRec, a data-driven job skill recommendation system that uses embeddings and feedforward neural networks to identify relevant skills for career growth. The model captures relationships between job roles and required skills, thereby improving recommendation accuracy. However, the system focuses only on skill recommendation and does not provide complete career paths or structured learning roadmaps. This gap indicates the need for an integrated system that combines skill recommendation with career path generation and development planning.

Westman et al. [7] conducted an analytical study on Artificial Intelligence in career guidance, focusing on current requirements, challenges, and future prospects. The study emphasizes the importance of AI in improving personalization, scalability, and efficiency in career recommendation systems. However, it does not provide a practical implementation or system architecture.

This limitation highlights the need for real-world AI-based systems that offer interactive and personalized career guidance solutions.

Qamhie et al. [8] proposed the Personalized Career Path Recommendation System (PCRS) using fuzzy logic for engineering students. The system maps user inputs such as academic performance and interests to career options using predefined rules. While fuzzy logic improves decision-making under uncertainty, the system suffers from limited accuracy and domain-specific constraints. It also lacks scalability and adaptability, indicating the need for advanced AI-based systems that can provide generalized and dynamic career recommendations.

3. RESEARCH GAP

Despite significant advancements, existing career recommendation systems still face several limitations. Traditional approaches lack personalization and adaptability, as they depend on predefined rules and datasets [2], [6]. Machine learning-based systems improve accuracy but fail to provide real-time and dynamic recommendations [10], [11].

Skill-based and resume-based systems focus only on specific functionalities such as skill matching or job recommendations, without offering complete career guidance [3], [4], [5]. Additionally, many AI-based systems lack user-friendly interfaces and real-time interaction capabilities [13], [14].

Although LLM-based systems provide dynamic and context-aware outputs, they are often not integrated into scalable and user-centric platforms [12], [17], [19]. Therefore, there is a need for a comprehensive system that combines personalization, real-time interaction, and structured career guidance.

Furthermore, many existing systems do not effectively incorporate continuous user feedback and learning progression, which limits their ability to update recommendations dynamically over time. This results in static outputs that do not evolve with the user's skill development or changing career interests. In addition, most systems lack the capability to generate structured and actionable outputs such as detailed learning roadmaps and step-by-step career planning strategies, which are essential for practical implementation [5], [18].

Another limitation is the absence of integration with real-world industry trends and emerging job roles, making recommendations less relevant in rapidly evolving technological environments. Existing approaches also struggle to provide explainable recommendations, reducing user trust and understanding of the suggested career paths. Therefore, there is a growing need for intelligent systems that not only provide accurate recommendations but also offer transparency, adaptability, and continuous guidance.

4. METHODOLOGY

4.1 System Architecture

The proposed system architecture is designed to provide an efficient and scalable framework for generating personalized career recommendations using Generative AI and the Meta LLaMA 3.1 Large Language Model [12], [17]. The architecture follows a modular design consisting of frontend interaction, backend processing, input handling, AI-based recommendation generation, and output visualization. This structured approach ensures seamless data flow, real-time processing, and improved system scalability compared to traditional career recommendation systems [9], [10].

The system begins with the user layer, where users interact with the application through a web-based interface developed using HTML, CSS, and JavaScript. Users provide inputs such as skills, education, interests, and career goals. This interface ensures accessibility and ease of use, addressing the limitations of traditional career guidance platforms that lack user-friendly interaction mechanisms [8].

The input data is transmitted to the Flask-based backend server, which acts as the central processing unit of the system. The backend manages API endpoints such as /recommend and /chat, handling communication between the frontend and the AI module. It is responsible for request handling, data validation, and coordination of different system components. This centralized architecture improves system reliability and enables efficient request processing [7], [10].

Once the input is received, it is passed to the input processing module, where validation and formatting are performed. This module ensures that the user data is clean, structured, and suitable for further processing. Proper preprocessing enhances the quality of input and addresses the shortcomings of earlier systems that lack structured data handling and contextual understanding [6], [11].

The processed data is then forwarded to the Generative AI module, which utilizes the Meta LLaMA 3.1 Large Language Model. In this stage, prompt engineering techniques are applied to convert user inputs into a structured prompt that guides the model in generating meaningful outputs. The LLM analyzes the user profile and generates personalized career recommendations, including career paths, skill gap analysis, and a 30-60-90 day learning roadmap. This approach enables dynamic, context-aware output generation without relying on static datasets, overcoming limitations of traditional machine learning and rule-based systems [4], [12].

In addition to recommendation generation, the architecture includes a chatbot interaction module, which allows users to engage in real-time conversations with the system. The chatbot uses the same LLM to respond to user queries, providing continuous

guidance and improving user engagement. This interactive feature enhances system usability and addresses the lack of real-time interaction in existing career recommendation systems [13], [14].

Finally, the generated results are delivered through the output display module, where the recommendations are presented in a structured and user-friendly format. The output includes personalized career paths, skill gap analysis, and learning roadmaps. The integration of chatbot responses within the output layer ensures continuous interaction and improved user experience. This architecture ensures efficient data flow, real-time adaptability, and scalability, making the system suitable for real-world applications [18].

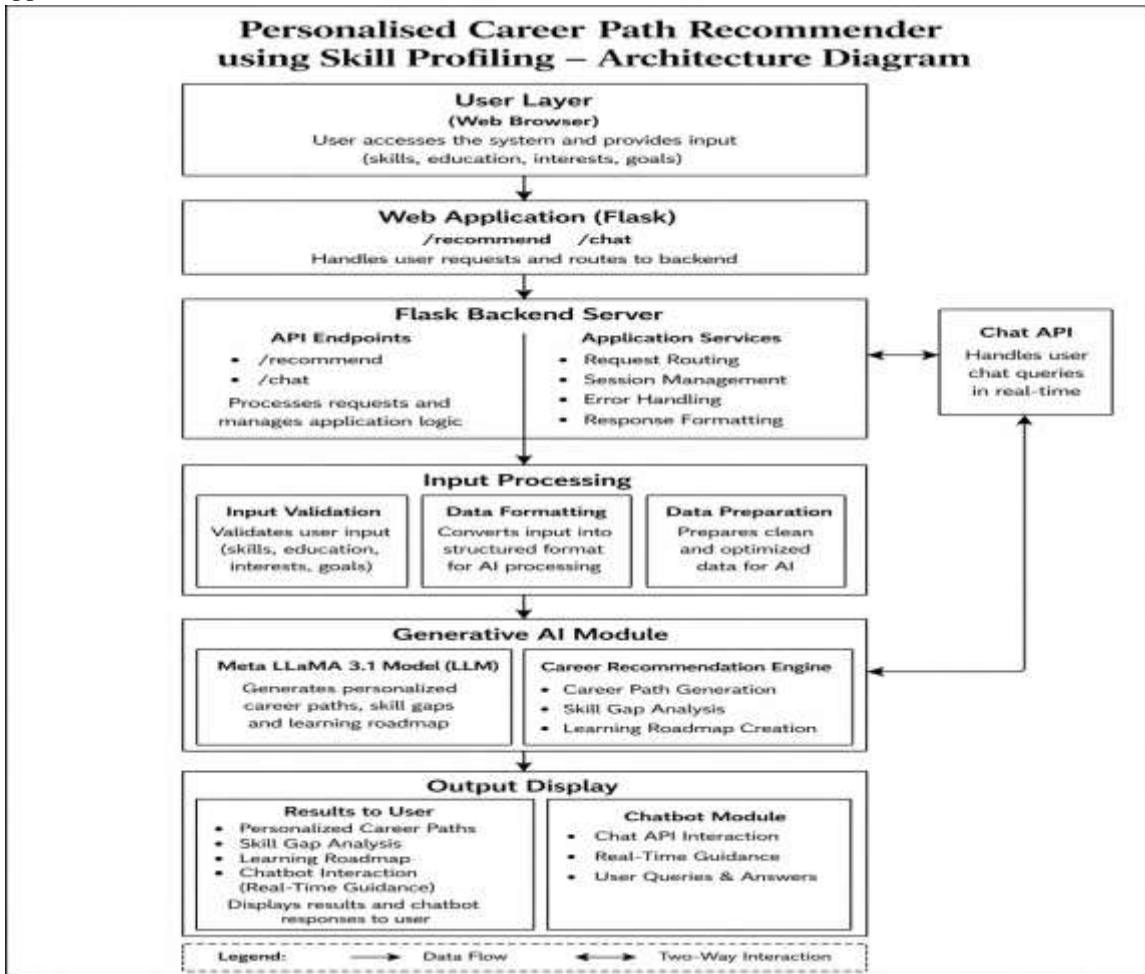


Fig.1 System Architecture

4.2 Data Collection:-

The system collects input data directly from users through a web-based interface, where users provide information such as skills, educational background, interests, and career goals. This real-time data collection approach ensures high personalization and eliminates dependency on pre-existing datasets [9], [10]. Unlike conventional systems that rely on historical or domain-specific datasets, the proposed system uses user-driven inputs to dynamically generate recommendations, improving flexibility and scalability [2].

4.3 Input Processing:-

Input processing is performed to ensure that the collected user data is clean, structured, and suitable for further analysis. The system validates user inputs, removes inconsistencies, and organizes the data into a standardized format. This step enhances the clarity and quality of the input provided to the language model, thereby improving the accuracy of generated outputs. It also addresses limitations observed in traditional systems that lack proper preprocessing and contextual understanding [6], [11].

4.4 Model Loading and Optimization:-

The system utilizes the Meta LLaMA 3.1 Large Language Model, which is loaded using the Hugging Face Transformers library. To optimize performance and reduce computational requirements, techniques such as 4-bit quantization are applied during model loading. This significantly reduces memory usage while maintaining efficiency, enabling deployment on limited hardware resources. Such optimization strategies are essential for building scalable AI systems that can operate in real-world environments [17], [20].

4.5 Response Generation (LLM):-

The structured prompt is passed to the LLaMA model, which processes the input and generates personalized career recommendations. The model produces outputs including suitable career paths, identification of skill gaps, and structured learning roadmaps tailored to the user profile. Parameters such as token length and temperature are used to control output quality and

diversity. This step represents the core intelligence of the system, where Generative AI enables dynamic, real-time, and context-aware recommendations, overcoming the limitations of traditional machine learning and embedding-based approaches [4], [5].

4.6 Chatbot Interaction Module:-

To enhance user engagement, the system integrates a chatbot module that allows interactive communication between the user and the system. Users can ask follow-up questions related to career choices, required skills, and learning strategies. The chatbot utilizes the same LLM to generate responses in real time, enabling continuous guidance and personalized interaction. This feature improves usability and addresses the lack of interactivity observed in earlier career recommendation systems [7], [13].

4.7 Output Generation:-

The final output generated by the system is delivered through a user-friendly interface. The results include personalized career paths, skill gap analysis, and a structured 30-60-90 day learning roadmap. The output is presented in a clear and organized format, enabling users to easily understand and act upon the recommendations. This step ensures effective communication of insights and enhances overall user experience, making the system practical and accessible for students and job seekers [10], [18].

5. RESULTS AND DISCUSSION

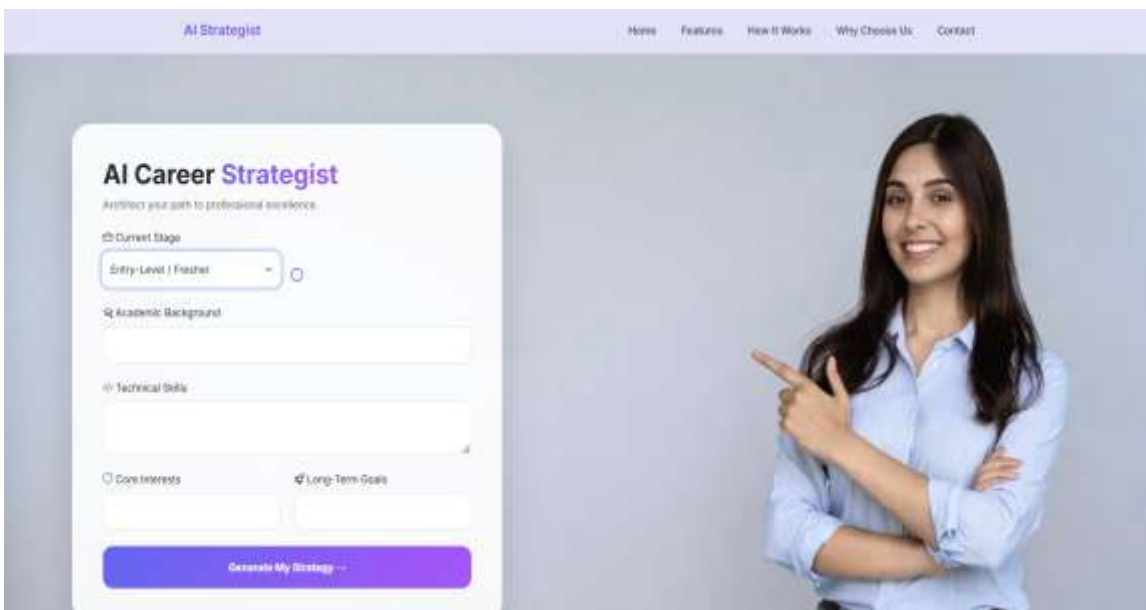


Fig. 1. User interface to collect user inputs

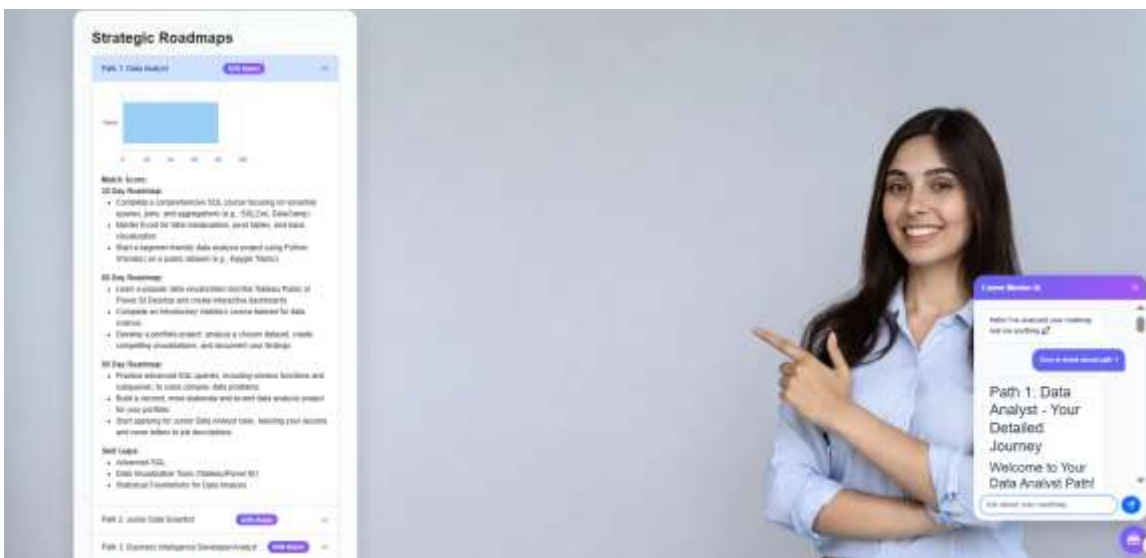


Fig. 2. Displays the generated career recommendations

6.CONCLUSION

This research presents a Personalized Career Path Recommendation System using Skill Profiling and Generative AI, leveraging the Meta LLaMA 3.1 Large Language Model to address the challenges associated with career decision-making. The proposed system effectively overcomes the limitations of traditional career recommendation approaches by generating dynamic, context-aware, and personalized outputs in real time. By integrating prompt engineering with LLM-based response generation, the system provides comprehensive career guidance, including career paths, skill gap analysis, and structured learning roadmaps.

The inclusion of a chatbot-based interaction module further enhances the system's usability by enabling continuous user engagement and real-time query resolution. Additionally, the use of model optimization techniques such as 4-bit quantization ensures efficient performance and scalability. The results demonstrate that Generative AI can be effectively utilized to build intelligent, adaptive, and user-centric career recommendation systems. Overall, the proposed system offers a scalable, efficient, and practical solution for real-world career guidance applications, particularly benefiting students and job seekers in making informed career decisions.

7. FUTURE ENHANCEMENTS

- **Mobile Application Development:** The system can be extended into a mobile-based application to enhance accessibility and usability, enabling users to receive personalized career guidance anytime and anywhere through a more interactive and user-friendly interface [10], [13].
- **Integration with Real-Time Job Market Data:** Incorporating real-time job market trends, industry demands, and salary insights can significantly improve the relevance and accuracy of recommendations, ensuring alignment with current employment opportunities and evolving skill requirements [9], [11].
- **Advanced Model Fine-Tuning:** The performance of the system can be further enhanced by fine-tuning the LLaMA model using domain-specific datasets related to career guidance, skills, and job roles, thereby improving contextual accuracy and reducing irrelevant outputs [1], [17].
- **Resume Analysis and Job Matching:** Future enhancements can include resume parsing and analysis modules that automatically map user profiles to suitable job roles, providing more precise and personalized career recommendations based on structured and unstructured user data [4], [7].
- **User Progress Tracking and Adaptive Recommendations:** The system can be improved by incorporating a progress tracking mechanism that continuously monitors user learning and dynamically updates career recommendations based on skill development and performance over time [5], [18].
- **Multi-Language Support and Global Expansion:** Adding multilingual support will make the system accessible to a broader global audience, enabling its adoption across diverse regions while addressing language and cultural differences in career guidance [8], [16].

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