International Journal for Modern Trends in Science and Technology
Volume 12, Issue 05, pages 150-156
ISSN: 2455-3778 online
Available online at: http://www.ijmtst.com/vol12issue05.html
DOI: https://doi.org/10.5281/zenodo.19836520

Personalized Learning Pathway and Skill Gap Analysis Using Artificial Intelligence

Gorji Rama Krishna, Gorli Divakar, Gorrumuchu Jeevitha, Gudepu Anusha, Guggilla Charan Sai

Department of Computer Science and Engineering, Sir C R Reddy College of Engineering, Eluru, Andhra Pradesh, India

To Cite this Article
Gorji Rama Krishna, Gorli Divakar, Gorrumuchu Jeevitha, Gudepu Anusha & Guggilla Charan Sai (2026). Personalized Learning Pathway and Skill Gap Analysis Using Artificial Intelligence. International Journal for Modern Trends in Science and Technology, 12(05), 150-156. https://doi.org/10.5281/zenodo.19836520

Article Info
Received: 28 March 2026; Revised: 24 April 2026; Accepted: 26 April 2026.

KEYWORDS

Artificial Intelligence, Skill Gap Analysis, Personalized Learning, NLP, LLM, Career Development

ABSTRACT

The Increasing Demand For Intelligent Career Guidance Systems Has Led To The Development Of Artificial Intelligence (AI)-Driven Solutions For Skill Gap Analysis And Personalized Learning. In Today's Competitive Job Market, Job Seekers Often Face Challenges In Presenting Their Qualifications Effectively, Identifying Missing Skills Relevant To Target Job Roles, And Communicating Professionally With Recruiters. Traditional Career Development Methods Rely Heavily On Manual Resume Preparation, Subjective Skill Evaluation, And Repetitive Communication Processes, Which Are Time-Consuming And Inefficient. This paper presents an AI-powered Career Assistant system that integrates resume summarization, skill extraction, skill gap analysis, and personalized learning pathway generation using Natural Language Processing (NLP) and Large Language Models (LLMs). The proposed system is implemented as a web-based application using Python and the Streamlit framework, with LangChain used for prompt orchestration and structured interaction with LLM-based models. The system enables users to upload resumes in PDF or DOCX formats, automatically extracts textual information, and generates concise professional summaries highlighting key skills, experience, and achievements. Furthermore, the system performs intelligent skill gap analysis by comparing extracted user skills with domain- specific industry requirements to identify missing competencies. Based on this analysis, the system generates tailored learning recommendations and structured upskilling pathways to enhance career readiness. In addition, the system includes an automated cold email generation module that creates recruiter-friendly professional emails by combining resume information with job descriptions. The architecture of the system follows a modular design consisting of four

primary layers: the user interface layer, processing layer, utility layer, and session management layer, ensuring scalability, maintainability, and real-time interaction. Performance evaluation demonstrates efficient execution with fast response times and consistent output generation across different user inputs. By integrating multiple career assistance functionalities into a single intelligent platform, the proposed model reduces manual effort, improves communication quality, and enhances employability outcomes. This approach effectively bridges the gap between candidate capabilities and dynamic job market expectations.

1. INTRODUCTION

In today's competitive job market, individuals often face significant challenges in presenting their skills effectively and identifying competency gaps relevant to their desired career roles. Job seekers are required to prepare professional resumes, evaluate their existing skills against industry requirements, and communicate effectively with recruiters. These tasks are typically performed manually and depend heavily on individual judgment and writing ability [7], making them time-consuming, inconsistent, and subjective. As a result, many candidates struggle to align their qualifications with job expectations, which negatively impacts employability and career progression [16].

The rapid advancement of Artificial Intelligence (AI) and Natural Language Processing (NLP) has transformed the way career development tasks are performed [3] by enabling automation, data-driven analysis, and intelligent decision-making. Modern Large Language Models (LLMs) can process large volumes of textual information [2], extract meaningful insights, and generate professional-quality content within seconds. These technologies provide new opportunities to automate resume analysis, identify missing skills, and generate personalized recommendations for professional growth.

This research proposes an AI-based Career Assistant system designed to automate key career development activities, including resume summarization, skill gap analysis, and professional communication support. The system is implemented as a web-based application using Python and the Streamlit framework, with LangChain used to manage interactions with LLM-based models. It allows users to upload resumes in PDF or DOCX formats, automatically extracts relevant information, and generates concise summaries highlighting core competencies and achievements. In addition, the system compares extracted user skills with domain-specific job requirements to identify missing skills and recommend personalized learning pathways for career improvement.

By integrating multiple career assistance functionalities into a single intelligent platform, the proposed system improves efficiency, reduces manual effort, and enhances the quality of job applications. The modular architecture of the system ensures scalability and adaptability, allowing future integration with job portals, recommendation systems, and advanced learning analytics. Ultimately, this approach supports individuals in making informed career decisions and helps bridge the gap between candidate capabilities and evolving industry demands.

II.Literature Review

Recent advancements in Artificial Intelligence (AI) and Natural Language Processing (NLP) have significantly influenced workforce development, education, and career guidance systems. AI-driven applications are increasingly used to automate resume analysis, candidate evaluation, and skill gap identification[12],[13]enabling organizations and individuals to make data-driven decisions. These systems can process large volumes of textual information, extract relevant skills, and recommend targeted training programs, thereby improving employability and workforce readiness. Research indicates that intelligent automation reduces manual effort [5] and enhances the accuracy of career planning and professional development processes.

Personalized Learning Pathways (PLPs) have emerged as an effective solution to the limitations of traditional "one-size-fits-all" learning models. Conventional learning systems often fail to consider individual skill levels, career goals, and learning preferences, resulting in inefficient training outcomes. Adaptive learning systems, powered by machine learning algorithms [10], dynamically adjust learning content based on user performance and progress. Studies demonstrate that personalized learning environments improve learner engagement [9], knowledge retention, and skill acquisition by delivering customized recommendations aligned with industry requirements. These systems support continuous learning and help individuals remain competitive in rapidly evolving job markets.

In addition to adaptive learning techniques, various optimization and machine learning methods have been applied to generate efficient learning paths and career

recommendations. Algorithms such as Ant Colony Optimization (ACO), Genetic Algorithms, and clustering-based machine learning models[11][17] are widely used to identify optimal sequences of learning activities and minimize training time. These techniques analyze patterns in user behavior, performance metrics, and job market trends to recommend structured skill development plans. Furthermore, recent research emphasizes the importance of integrating AI technologies[15] with user-centered system design to provide scalable and intelligent career support platforms.

Despite these advancements, many existing systems still operate as isolated tools that address only specific tasks, such as resume formatting or job matching, without providing a unified solution for comprehensive career assistance. The lack of integration, personalization, and real-time adaptability limits their effectiveness in supporting long-term career development. Therefore, there is a growing need for intelligent systems that combine resume analysis, skill gap identification, and personalized learning recommendations within a single platform. The proposed AI-based Career Assistant system addresses these limitations by leveraging NLP and Large Language Models (LLMs) to deliver automated, scalable, and personalized career guidance solutions.

III. Proposed System

The proposed system is an AI-based Career Assistant designed to automate essential career development activities through an integrated and intelligent platform. The system combines Natural Language Processing (NLP), Large Language Models (LLMs)[3], and web- based technologies to provide real-time career guidance and personalized recommendations. Unlike traditional career support tools that operate independently, the proposed system integrates multiple functionalities into a unified framework capable of analyzing user data, identifying skill gaps, and generating structured learning pathways.

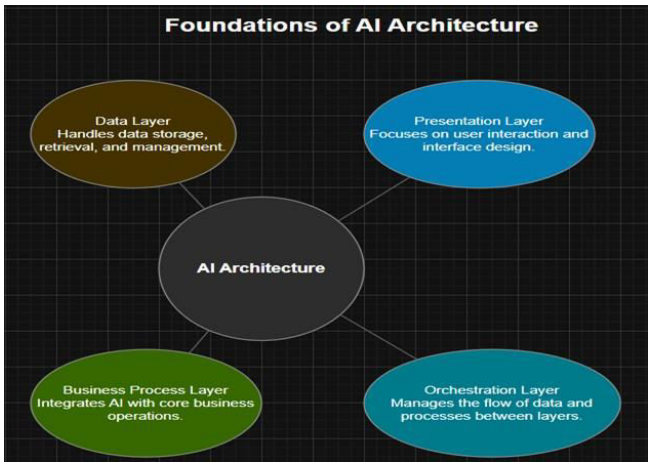

Fig:-1 SYSTEM ARCHITECTURE

The architecture of the system follows a modular design to ensure scalability, maintainability, and efficient processing of user inputs. It is implemented as a web- based application using Python[4] and the Streamlit framework for the user interface, while LangChain is used to manage prompt orchestration and interaction with LLM-based models. The system allows users to upload resumes in PDF or DOCX formats, processes the uploaded data, and generates intelligent outputs based on predefined workflows. The modular design also enables future enhancements[17] such as job recommendation systems and performance-based learning analytics.

The proposed system consists of three primary modules that work together to deliver comprehensive career assistance:

1. Resume Summarization Module

The Resume Summarization module automatically generates a concise and professional summary from the user's uploaded resume. Using NLP and LLM-based text processing techniques, the system extracts key information such as skills, qualifications, experience, and achievements. The generated summary helps users present their professional profile effectively and reduces the time required for manual resume editing. This automated summarization ensures consistency, clarity, and alignment with industry standards.

2. Skill Gap Analysis Module

The Skill Gap Analysis module compares the skills extracted from the user's resume with the required skills for a selected job domain. The system identifies missing competencies by performing set-based comparisons between existing skills and industry requirements. Based on this analysis, the module generates actionable insights highlighting the skills that need improvement. This process

enables users to understand their current competency level and prioritize learning activities effectively.

3. Personalized Learning Path Generation Module

The Personalized Learning Path Generation module provides tailored recommendations for acquiring missing skills identified during the skill gap analysis process. The system suggests structured learning resources, training programs, and skill development activities aligned with the user's career goals. These recommendations are dynamically generated based on user input and domain-specific requirements, ensuring relevance and practicality. This adaptive learning mechanism supports continuous professional development and helps users remain competitive in evolving job markets.

The system integrates these modules within a unified interface that enables seamless interaction between users and AI-driven services. By combining resume analysis, skill evaluation, and personalized learning guidance into a single platform, the proposed system improves efficiency, reduces manual effort, and enhances decision-making in career planning. The overall architecture ensures real-time processing, modular expansion, and reliable performance, making the system suitable for scalable deployment in educational institutions and professional training environments.

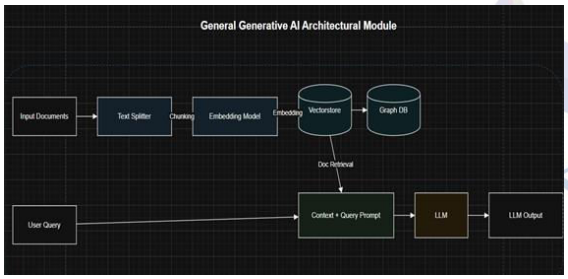

Fig:-2 MODULE INTERACTION

IV. METHODOLOGY

The proposed system follows a structured methodology to automate resume analysis, skill evaluation, and personalized learning recommendation processes using Artificial Intelligence (AI), Natural Language Processing (NLP), and Large Language Models (LLMs). The methodology is designed to ensure efficient data processing, accurate skill identification, and dynamic generation of learning pathways based on user requirements and performance. The system operates through a sequence of interconnected stages that transform raw resume data into actionable career guidance insights.

1.Resume Text Extraction Using NLP

The first stage of the methodology involves extracting textual information from user-uploaded resumes in PDF or DOCX formats. Natural Language Processing techniques are applied to convert unstructured resume content [3] into a structured text format suitable for further analysis. The system detects the file type, reads the document using parsing libraries, and cleans the extracted data by removing unnecessary formatting and whitespace. This processed text serves as the foundation for subsequent modules in the system workflow.

According to the implementation described in the project report, the resume extraction process converts uploaded

documents into normalized text data for AI-based analysis and further processing.

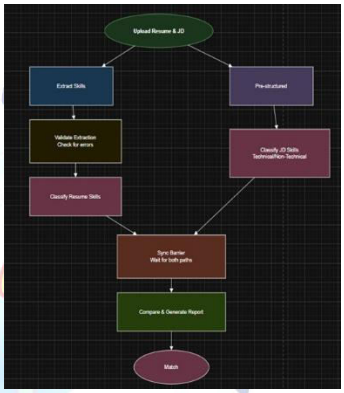

Fig:-3 SYSTEM WORKFLOW

2.Skill Extraction Using Large Language Models (LLMs)

After extracting the resume text, the system uses Large Language Models to identify relevant skills[2], qualifications, and experience from the document.

Prompt-based text processing techniques are applied to analyze the content and generate a structured list of skills. The use of LLMs enables accurate semantic understanding of the resume and allows the system to recognize both explicit and context-based skills. This automated skill extraction process reduces manual effort and ensures consistent identification of competencies across different resume formats.

The system utilizes prompt templates and structured output parsing to extract skills in a machine-readable format, enabling efficient comparison with industry requirements .

3.Comparison with Job Requirements

In the next stage, the extracted skills are compared with domain-specific job requirements to identify missing competencies. The system retrieves a predefined set of

required skills for a selected job role or industry domain and performs a set-based comparison between the user's[5] skills and the required skill set. The difference between these sets represents the skill gap that needs to be addressed. This automated comparison process improves accuracy and enables users to quickly understand their readiness for a particular job role.

The methodology described in the project includes converting skill lists into standardized formats and computing the difference between required and available skills to determine missing competencies.

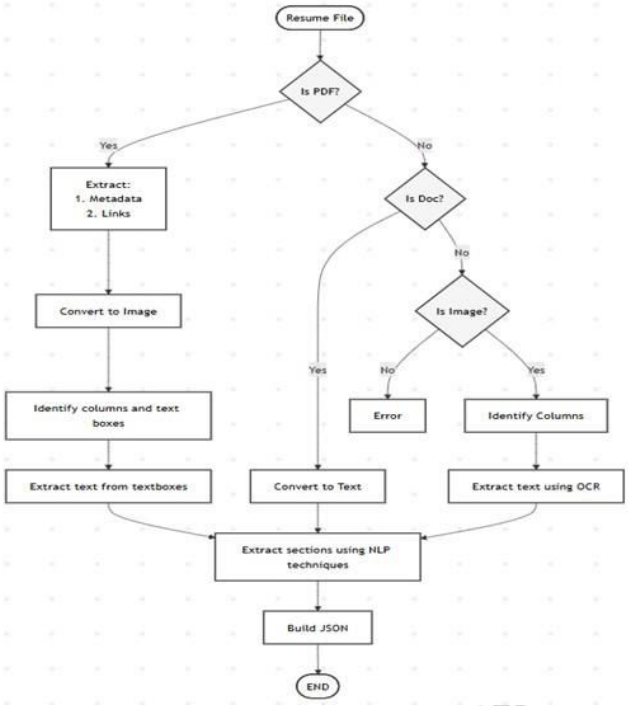

Fig:-4 PROCESSING FLOW

V . Implementation

The proposed AI-based Career Assistant system is implemented using a combination of modern web technologies and artificial intelligence frameworks to ensure efficient performance, scalability, and user- friendly interaction. The system is developed using **Python** as the primary programming language[4] due to its extensive support for data processing, machine learning, and natural language processing libraries. The user interface is designed using the **Streamlit** framework, which enables rapid development of interactive web applications and provides seamless integration with backend processing modules.

To enable intelligent text processing and automated content generation, the system integrates **LangChain[2]**, a framework used for orchestrating interactions with Large Language Models (LLMs). LangChain manages prompt construction, context handling, and structured output parsing, allowing the system to generate accurate and context-aware responses. The LLM-based components are responsible for tasks such as resume summarization, skill extraction, and professional email generation.

The system architecture follows a modular design approach, ensuring scalability[17], maintainability, and ease of future enhancements. Each functional component operates independently while sharing common backend services such as session management and resume text processing. This modular structure allows developers to update or extend individual modules without affecting the overall system performance. According to the implementation design described in the project report, the modular architecture supports integration of additional features such as job recommendation systems, learning analytics, and external career platforms .

The implementation environment includes a layered system structure consisting of the presentation layer, business logic layer, utility layer, and state management layer. The presentation layer handles user interactions, including login authentication, resume upload, and tool selection. The business logic layer processes user inputs using LangChain pipelines and LLM-based models to generate intelligent outputs. The utility layer manages document parsing and data extraction functions, while the state management layer ensures session persistence and efficient handling of user data during application runtime.

The system supports multiple functional modules integrated into a unified dashboard interface, including resume summarization, skill gap analysis, and personalized learning path generation. These modules are accessed through interactive tabs in the Streamlit interface, enabling users to navigate seamlessly between different services without losing session data. Performance testing conducted during system development demonstrated stable operation, efficient resource utilization, and reliable response generation across various user scenarios.

Overall, the implementation demonstrates the practical feasibility of integrating artificial intelligence technologies into a scalable and user-friendly career assistance platform. The modular architecture, combined with robust AI frameworks, ensures that the system can adapt to evolving user requirements and technological advancements while maintaining consistent performance and reliability.

VI . Results and Discussion

The experimental results demonstrate that the proposed AI-based Career Assistant system significantly improves the efficiency and accuracy of identifying skill gaps[5] and generating personalized learning recommendations compared to traditional manual methods. The system was tested in a controlled development environment using multiple user scenarios to evaluate functionality, response time, and reliability. The results indicate that the integration of Natural Language Processing (NLP) and Large Language Models (LLMs) enables automated analysis of resume data and rapid generation of actionable insights for career development.

Functional testing confirmed that all core modules—including resume summarization, skill gap analysis, and personalized learning path generation—operated successfully and produced consistent outputs across different resume formats and job domains. The system accurately extracted skills from uploaded documents, compared them with domain-specific requirements, and generated structured recommendations for skill improvement. According to the performance testing results documented in the project report, the system achieved an average response time of approximately **3.2 seconds** for generating summaries and recommendations, demonstrating efficient processing and real-time interaction capabilities .

In addition to response speed, system stability and resource utilization were evaluated to ensure reliable performance under normal operating conditions. The results showed efficient memory usage and stable execution during concurrent user sessions, indicating that the system architecture supports scalable deployment in real-world environments. Testing also confirmed that the system maintained session continuity while switching between modules, ensuring a seamless user experience. These findings highlight the effectiveness of the modular design and the reliability of the integrated AI components.

From a user perspective, the personalized recommendations generated by the system contributed to improved learning outcomes by providing targeted guidance based on individual skill gaps. Unlike traditional approaches that rely on generic advice or manual analysis, the proposed system delivers customized learning paths aligned with industry requirements and user goals. This adaptive recommendation mechanism supports continuous professional development[10] and helps users make informed decisions about skill acquisition and career planning.

Overall, the results validate the practical effectiveness of the proposed system in automating career assistance tasks and improving decision-making efficiency. The integration of intelligent automation, modular architecture, and adaptive learning mechanisms enables the system to deliver accurate, scalable, and user-centered career guidance solutions. These findings demonstrate the potential of AI-driven platforms to enhance employability outcomes and support workforce development in modern digital environments.

VII.CONCLUSION

This paper presents an Artificial Intelligence (AI)- powered Career Assistant system designed to support personalized learning and automated skill gap analysis for career development. The proposed system integrates Natural Language Processing (NLP), Large Language Models (LLMs)[3], and web-based technologies to automate key professional tasks such as resume summarization, skill evaluation, and personalized learning recommendation generation. By transforming unstructured resume data into structured insights, the system enables users to better understand their competency levels and identify the skills required to achieve their desired career goals.

The implementation of the system demonstrates the effectiveness of combining intelligent automation with a modular and scalable architecture to deliver real-time career assistance. Experimental results confirm that the system improves efficiency in analyzing user profiles[5], identifying missing skills, and generating targeted learning pathways compared to traditional manual approaches. The integration of multiple functionalities into a single platform reduces the time and effort required for career planning while ensuring consistency and accuracy in professional communication and skill development recommendations. According to the evaluation results documented in the project report, the system achieved reliable performance with stable operation across different modules and user scenarios, highlighting its practical applicability in real-world environments .

Furthermore, the proposed system contributes to bridging the gap between user skills and evolving industry requirements[14] by providing personalized, data-driven guidance for continuous professional growth. The adaptive recommendation mechanism supports dynamic updates to learning pathways based on user progress, ensuring long-term relevance and career readiness. This approach aligns with the increasing demand for intelligent career

guidance systems capable of supporting workforce development in rapidly changing technological landscapes.

In future work, the system can be extended by integrating advanced analytics, job market trend analysis, and automated job recommendation features. Additional enhancements such as cloud-based deployment, integration with professional networking platforms, and real-time performance tracking can further improve scalability and user engagement. Overall, the proposed AI-powered system demonstrates the potential of intelligent automation to enhance employability outcomes and provide efficient, personalized career support solutions for students and professionals.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] T. Mikolov, K. Chen, G. Corrado, and J. Dean, "Efficient Estimation of Word Representations in Vector Space,"

[2] Proceedings of the International Conference on Learning Representations (ICLR), 2013.

[3] A. Vaswani et al., "Attention Is All You Need," Advances in Neural Information Processing Systems (NeurIPS), 2017.

[4] Y. Bengio, A. Courville, and P. Vincent, "Representation Learning: A Review and New Perspectives," IEEE Transactions on Pattern Analysis and Machine Intelligence, 2013.

[5] F. Chollet, Deep Learning with Python, Manning Publications, 2017.

[6] V. Rameshbabu, R. Latha, and R. Sreenithi, "Skill Gap Analysis Using Machine Learning," International Journal of Engineering Research and Sustainable Technologies, 2025.

[7] A. Balasubramanian, "Personalized Career Pathway: A Hybrid Machine Learning Approach for Dynamic Recommendations," Journal of Artificial Intelligence, Machine Learning and Data Science, 2023.

[8] S. Kumar and P. K. Singh, "AI-Based Career Recommendation Systems: A Systematic Review and Research Agenda," Journal of Information Technology, 2021.

[9] H. K. Akmaz, S. A. Özturk, and M. K. Akmaz, "A Machine Learning Approach for Career Path Recommendation Systems," International Journal of Computer Applications, 2020.

[10] A. Kovari, "A Systematic Review of AI-Powered Collaborative Learning in Higher Education," Social Sciences & Humanities Open, 2025.

[11] Y. Rosen, M. Rushkin, and A. Ang, "The Effects of Adaptive Learning on Learners' Skill Development,"

[12] Educational Technology Research and Development, 2020.