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AI Personalized Learning Path Generator

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Abstract

The AI Personalized Learning Path Generator is developed to address the growing challenge of unstructured and inefficient learning in today's digital era. With the rapid expansion of domains such as Artificial Intelligence, Data Science, and Software Development, learners often face confusion in identifying the right skills and structured path required to achieve their career goals. To overcome this problem, the system leverages Artificial Intelligence and Natural Language Processing to analyze user-specific inputs such as resumes and career objectives. The system extracts relevant skills from the uploaded resume and understands the target role using advanced AI models.A key feature of the system is skill gap analysis, where the user's existing skills are compared with the required skills for the desired role. Based on this analysis, the system generates a structured and personalized learning roadmap using Large Language Models (LLMs), specifically integrated through AI APIs.

The generated roadmap includes clearly defined phases, recommended skills to learn, tasks, and timelines, enabling users to follow a goal-oriented and efficient learning process. Unlike traditional career guidance systems that provide generic suggestions, this system delivers customised recommendations tailored to individual needs. The application is implemented using Python and the Streamlit framework, providing an interactive and user-friendly interface. It also incorporates visualization tools for better understanding of the learning path and allows users to export their roadmap as a PDF report. By integrating AI-driven analysis with structured guidance, the AI Personalized Learning Path Generator improves learning efficiency, reduces confusion, and helps users make informed decisions about their career development. The system contributes to bridging the gap between academic learning and industry requirements by offering a scalable and intelligent solution for personalized education.

1. Introduction

The AI Personalized Learning Path Generator addresses the growing challenge of unstructured learning in today's digital world. Every day, students and professionals are exposed to a vast number of online courses, resources, and career opportunities. While this abundance of information is beneficial, it often leads to confusion, lack of direction, and inefficient learning. Many individuals struggle to identify the right skills required for their desired career roles and find it difficult to organize their learning journey effectively.

Traditional approaches to career guidance rely on generic recommendations, static resources, or manual counseling. These methods often fail to consider individual factors such as a user's current skill set, educational background, and career aspirations. As a result, users may spend time learning irrelevant topics or miss important skills required in the industry. The proposed system overcomes these limitations by leveraging Artificial Intelligence and Natural Language Processing techniques. The system analyzes user resumes to extract relevant skills and understands career goals using advanced AI models. Through intelligent processing, it identifies the gap between the user's existing skills and the skills required for their target role.

Based on this analysis, the system generates a structured and personalized learning roadmap. The roadmap includes step-by-step guidance, recommended skills, tasks, and timelines, enabling users to follow a clear and goal-oriented learning path. This approach is more effective than traditional systems, as it adapts to individual needs rather than providing one-size-fits-all suggestions. Users can upload their resumes, specify their career goals, and instantly receive a customized learning plan.

2. Literature review

Research on personalized learning and career guidance systems has led to the development of various methods for improving skill recommendation and learning efficiency. Initially, traditional systems relied on simple approaches such as predefined rules and generic recommendations, which worked for basic guidance but failed to address individual needs. Researchers such as S. Patel and others in 2023 explored techniques like TF-IDF and similarity-based matching for recommending learning resources, which improved text-based matching but lacked the ability to understand user intent and context. In 2024, R. Kumar and his team introduced advanced machine learning methods such as ensemble models, including Random Forest and XGBoost, which enhanced prediction accuracy but focused mainly on performance forecasting rather than providing structured learning guidance.

Further advancements introduced deep learning approaches, where models such as RNN and GRU were used by researchers like Baniata et al. (2024) to capture sequential learning patterns. Similarly, transformer-based models and advanced AI systems proposed by researchers like A. Gupta (2024) and J. Lee (2025) improved contextual understanding and recommendation quality. However, these systems often required large datasets, had high computational complexity, and lacked interpretability. Other studies, such as those by Kumar and Sharma (2022), focused on resume parsing using Natural Language Processing, which effectively extracted user information but did not provide guidance for skill development.

2.1 Existing System

Existing career guidance and learning recommendation systems primarily rely on basic methods such as generic course suggestions, static learning resources, or simple user-input matching. These systems often provide recommendations based on limited parameters like selected interests or predefined categories, without deeply analyzing the user's current skill set or career objectives.

Some platforms use data-driven approaches and basic machine learning techniques to recommend courses or predict user performance. While these methods improve recommendation accuracy to some extent, they still lack the ability to provide a

complete and structured learning path. Most systems focus only on suggesting resources rather than guiding users through a step-by-step learning process.

Another major drawback is the absence of effective skill gap analysis. Current systems do not clearly compare the user's existing skills with the skills required for a target role. Without this comparison, users are unable to identify what they need to learn and how to prioritize their learning journey.

2.2Proposed System

The proposed system, AI Personalized Learning Path Generator, is designed to overcome the limitations of existing career guidance systems by providing a comprehensive, intelligent, and user-centric solution. Unlike traditional systems that offer generic recommendations, this system integrates multiple functionalities such as resume analysis, goal understanding, skill gap identification, and structured roadmap generation into a single platform. By leveraging techniques from Artificial Intelligence and Natural Language Processing, the system analyzes user inputs like resumes and career goals to extract relevant skills, understand user intentions, and identify the gap between the user's current skills and the requirements of the desired role. This gap analysis forms the foundation for generating a personalized learning path tailored to individual needs.

The system follows a modular and systematic workflow to ensure efficiency and scalability. It begins with resume parsing and skill extraction, followed by goal analysis using AI models to determine the required competencies. The smart gap analysis module then identifies missing or weak skills, and based on this, the roadmap generation module creates a structured learning path consisting of phases, tasks, and recommended resources. The results are presented through an interactive and user-friendly interface, enabling users to easily understand and follow their learning journey. Overall, the system enhances learning efficiency, reduces confusion, and provides clear, actionable guidance, making it a more effective solution compared to traditional approaches.

The working of the system follows a clear workflow, starting from user login and resume upload to skill extraction, goal analysis, gap identification, and roadmap generation. The final output is displayed through an intuitive interface, ensuring accessibility for all users. This system provides several advantages, including personalized learning experiences, structured guidance, and AI-driven insights. It reduces confusion, improves learning efficiency, and helps users achieve their career goals in a systematic manner, making it a more effective and intelligent solution compared to existing systems.

3.Methodology

The working of the system follows a well-defined and systematic workflow, beginning with user login and resume upload, followed by skill extraction, goal analysis, skill gap identification, and roadmap generation. The final output is presented through an intuitive and user-friendly interface, ensuring easy accessibility for all users. The system offers several advantages, including personalized learning experiences, structured guidance, and AI-driven insights. It minimizes confusion, enhances learning efficiency, and supports users in achieving their career goals in a clear and organized manner, making it a more effective and intelligent solution compared to existing systems.

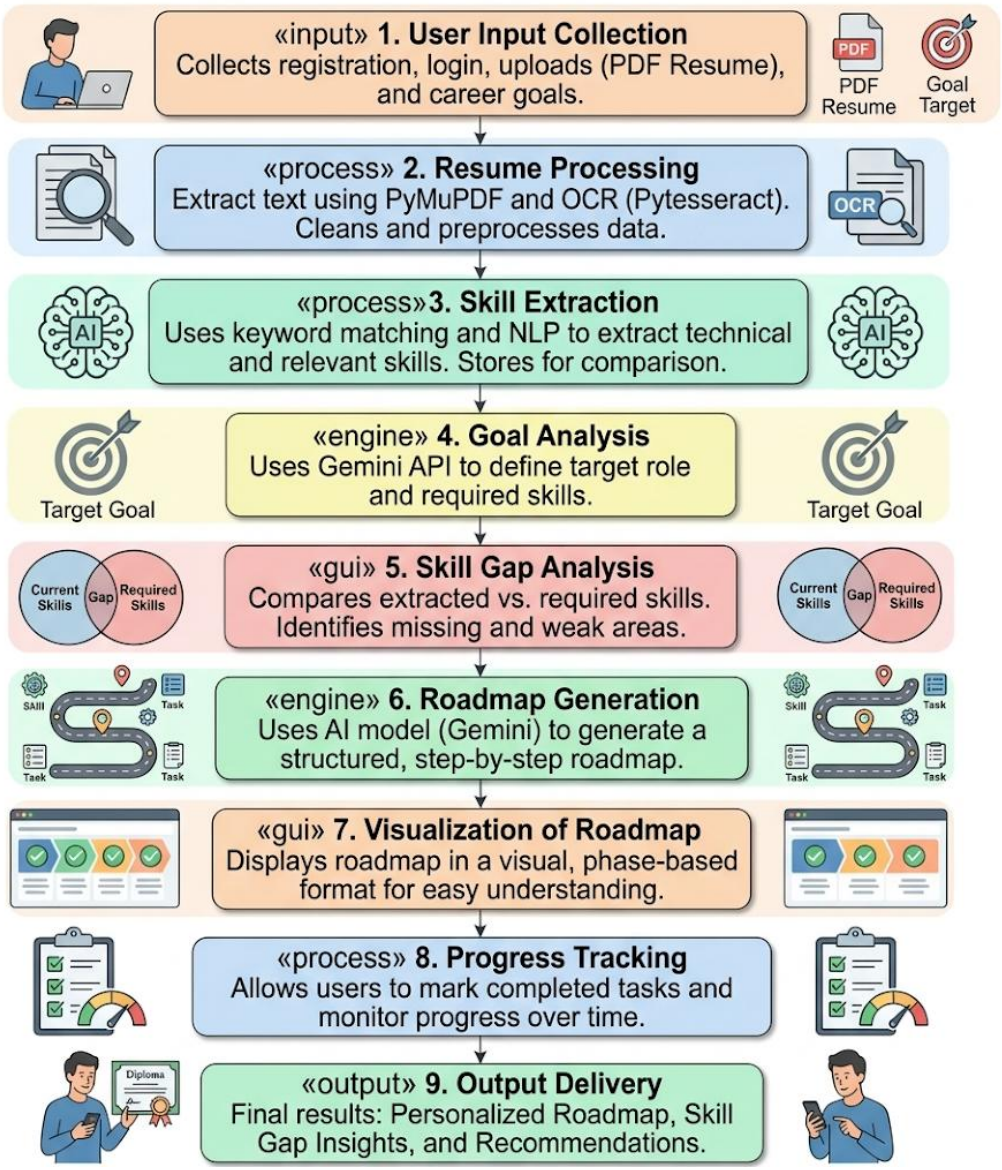
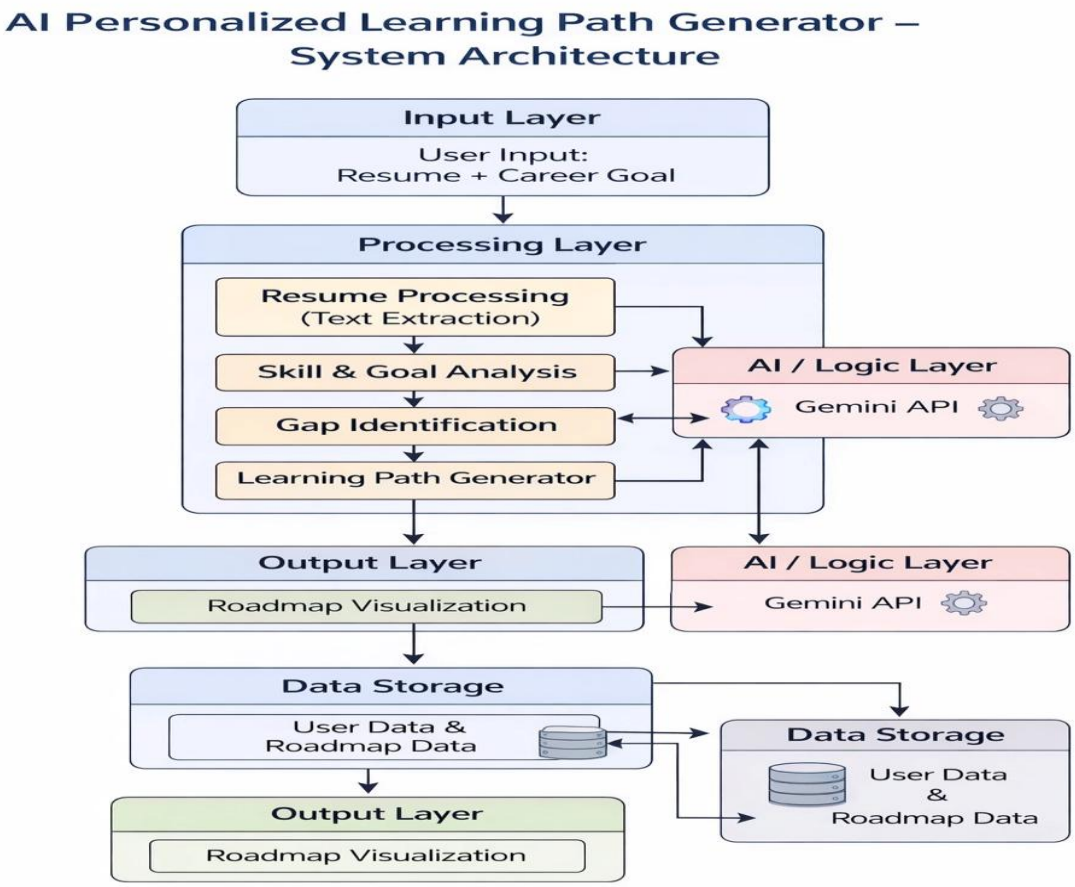


Figure 1 Methodology

4.System Architecture

System architecture refers to the overall structure of a system, including its components, their behavior, and the way they interact with each other. It provides a high level view of how different elements—such as software modules, data processing units, storage systems, and user interfaces work together to perform specific functions. In the context of a software system, architecture defines how various modules are organized, how they communicate through APIs or services, and how data flows across different parts of the system. In the AI Personalized Learning Path Generator, the system architecture follows a modular and layered design. The user interacts with the system through a web-based interface built using Streamlit. The input data, including resumes and career goals, is processed in the application layer where modules such as resume parsing, skill extraction, goal analysis, and gap analysis operate. These modules communicate with the AI integration layer, which utilizes

Artificial Intelligence models to generate personalized learning roadmaps. The processed results are then sent back to the interface for visualization and user interaction.



5.1 Input Acquisition and User Interaction Layer

The Input Acquisition and User Interaction Layer acts as the primary interface through which users interact with the system. In the AI Personalized Learning Path Generator, this layer is implemented using a web-based interface built with Streamlit, allowing users to upload resumes (PDF/JSON) and enter their career goals easily. It also serves as a communication bridge between the user and backend modules by sending input data for processing and displaying outputs like skill gap analysis and personalized learning roadmaps through an interactive dashboard.

5.2 Data Collection and Parsing Layer

The Data Collection and Parsing Layer is responsible for collecting user inputs and converting them into a format suitable for analysis. In the AI Personalized Learning Path Generator, this layer processes uploaded resumes and extracts relevant information such as skills, education, and experience by converting unstructured data into structured content. It utilizes techniques from Natural Language Processing, including tokenization, stop-word removal, and text normalization, to ensure

consistency and accuracy in the extracted data. This layer forms the foundation for further processing by transforming raw input into meaningful and analyzable information.

5.3 AI Powered Summarization Layer

- Identifies key skills, required competencies, and user intent from resumes and career goals.
- Performs intelligent skill gap analysis by comparing existing skills with industry requirements.
- Enhances accuracy by understanding context and providing semantic-level insights.
- Improves efficiency by enabling personalized and data-driven learning recommendations.

5.4 API integration and Communication Layer

This layer provides seamless communication between different components of the system and external services. It enables the flow of information between the user interface, backend processing modules, and storage systems, ensuring smooth execution of tasks such as resume processing, skill analysis, and roadmap generation in real time. By establishing standardized communication protocols, this layer enhances interoperability and scalability across the system.

The key points for this layer include:

1. Uses APIs to facilitate data transfer between different modules of the system.
2. Enables real-time communication between components for faster processing.
3. Supports scalability and integration with external services for enhanced functionality.

5.5 Security and Access Control Layer

- Implements user authentication through login credentials.
- Provides role-based access to restrict sensitive actions.
- Encrypts data during upload and storage for safety.
- Ensures compliance with data privacy and security standards.

5.6 Output Visualization and Download Layer

This layer presents the system's results in a clear, structured, and user-friendly format, enabling users to easily understand and act on the generated insights. In the AI Personalized Learning Path Generator, it displays outputs such as personalized learning roadmaps, skill gap analysis, and progress tracking through an interactive dashboard.

Core elements of this layer include:

1. Displays personalized learning roadmaps and skill gap insights in a structured format.
2. Provides graphical or chart-based visualization for better understanding of progress and data.
3. Enables users to download reports of their learning roadmap for future use.

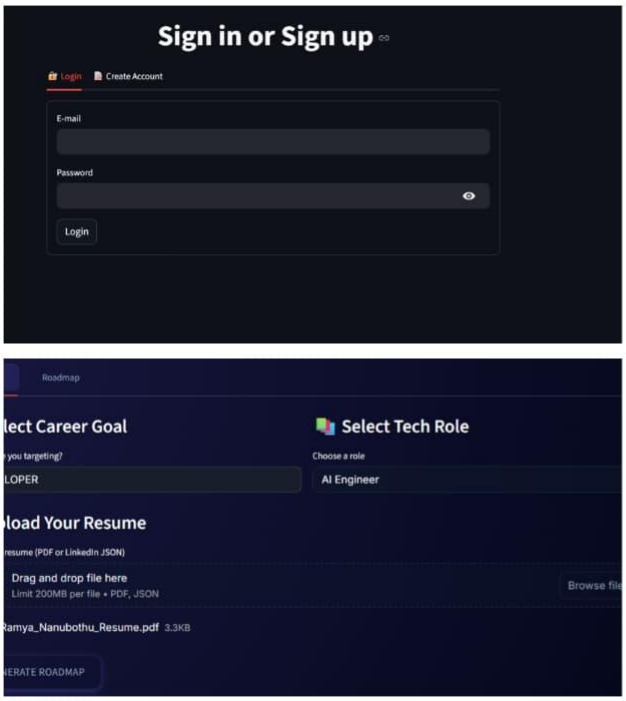
5.7 Testing and Evaluation

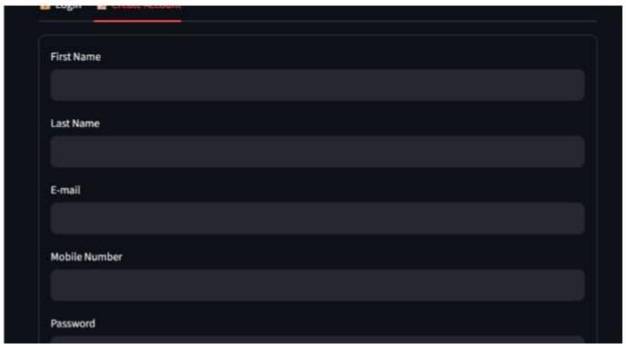
This layer focuses on validating the overall performance, accuracy, and reliability of the system. It ensures that each component of the AI Personalized Learning Path Generator, including resume processing, skill extraction, gap analysis, and roadmap generation, functions correctly across different scenarios. Various test cases and input conditions are used to evaluate the system's behavior and ensure that it meets the required functional and non-functional requirements.

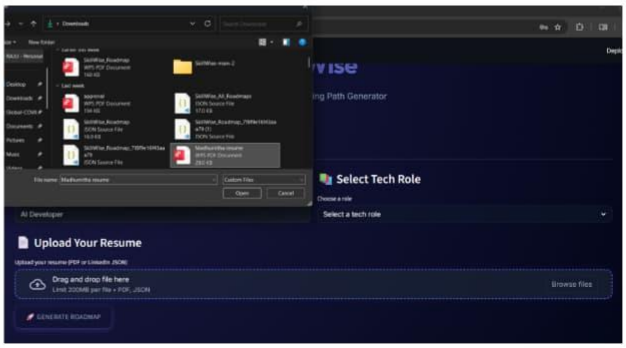
1. Evaluates system performance using metrics such as accuracy, efficiency, and response time.

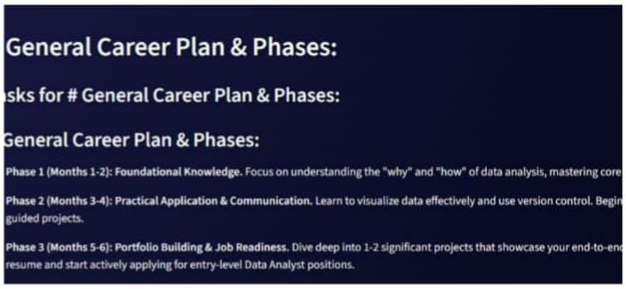
2. Tests how well the system handles different types of user inputs and data variations.
3. Ensures reliability, scalability, and consistent performance in real-world usage environments.

6.Results and Discussion









7.Conclusion

The **AI Personalized Learning Path Generator** provides an intelligent and efficient solution to the challenges of unstructured learning and traditional career guidance systems. By leveraging techniques from Artificial Intelligence and Natural Language Processing, the system analyzes user resumes and career goals to identify skill gaps and generate personalized, structured learning roadmaps. It reduces confusion, saves time, and enables users to focus on relevant skills required for their desired roles. With its user-friendly interface and AI-driven insights, the system improves learning efficiency and supports effective career planning, making it a practical and scalable solution for modern education and skill development.

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