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Smart Career Pathway Advisor Using Gen AI

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***Abstract*—In today's fast-changing job market, personalized career guidance has become essential for individuals aiming to align their skills, interests, and goals with market needs. This paper presents the Personalized Career Pathway Advisor, a solution that integrates Big Data and Generative AI to offer customized career pathway recommendations. The system begins by collecting user input such as skills, interests, and career goals, augmented with dynamically generated, context-aware questions to ensure a comprehensive understanding of each user. The User Profile & Data Processing Module serves as the cornerstone of this system, collecting fundamental user data including age, education level, technical expertise, and career objectives. Generative AI is employed to generate personalized, context-sensitive questions based on the user's input, enabling a deeper assessment of their skills and aspirations. Following the user input and question responses, the system processes this data through an advanced Big Data analysis pipeline. Utilizing Apache Spark, the system compares the user's profile with real-time job market trends, pinpointing skill gaps relative to current industry demands. The output of this module includes a comprehensive skill assessment, providing users with actionable insights into their competencies, areas for improvement, and alignment with evolving job market needs. By combining Generative AI with cutting-edge Big Data analytics, Module 1 establishes a personalized and data-driven foundation for career development, ensuring users receive relevant, up-to-date recommendations in the IT job market.**

Keywords-- Data Processing, Generative AI, Personalized Question Generation, Skill Assessment, IT Job Market Trends, Apache Spark, Skill Gaps Identification

I. INTRODUCTION

In today's fast-evolving job market, individuals often face significant challenges in aligning their skills and interests with the demands of the industry. This challenge is particularly evident in the Information Technology (IT) sector, where rapid advancements and evolving technologies require a tailored approach to career planning and development. The Smart Career Pathway Navigator addresses this challenge by providing a data-driven, AI-powered platform to guide users in their professional journeys. The project focuses on two main modules, with Module 1: User Profile & Data Processing Module forming the foundation. This module is designed to collect user inputs, generate personalized questions, and analyze the user's skills and gaps in relation to the IT industry. By leveraging Generative AI, this module dynamically creates multiple-choice questions (MCQs) tailored to the user's educational background, technical skills, and career aspirations. These questions not only refine the data collection process but also ensure that the insights gathered are highly specific and actionable. In addition to personalized question generation, the module employs Big Data analytics to process and analyze user inputs against real-time IT industry trends. Using Apache Spark, the system identifies high-demand skills, emerging technologies, and potential skill gaps in the user's profile. This initial analysis plays a pivotal role in preparing users for the dynamic IT job market by offering them valuable insights into areas requiring improvement.

The integration of Generative AI and Big Data technologies ensures that the system provides a personalized and scalable solution for career planning. By focusing solely on the IT domain, the module aims to cater to a specific and highly dynamic sector, delivering precise recommendations for career growth and upskilling.

The output of this module is a comprehensive analysis of the user's current skills, interests, and identified gaps. This serves as a crucial input for the subsequent phase, which involves generating personalized career pathways. Through its focus on intelligent data processing and user-centric design, Module 1 sets the stage for a transformative approach to career guidance, empowering individuals to make informed decisions and stay competitive in the IT industry.

II. RELATED WORKS

Introduction to AI-Driven Career Guidance

[1-3] represents the rapid evolution of artificial intelligence (AI) and data-driven technologies has reshaped career guidance systems, providing more personalized and scalable solutions. Traditional career advisory models often relied on manual counseling and static resources, which lacked adaptability to dynamic job market changes. Modern career guidance systems integrate AI, machine learning (ML), and generative models to address these limitations, offering tailored insights into career pathways, skill gaps, and job market opportunities.

Profile Matching and Job Recommendation Systems

One significant approach in AI-driven career systems involves matching user profiles with job recommendations. Patel et al. [9] proposed frameworks where users could build professional profiles, allowing the system to analyze job descriptions and recommend matching roles. These frameworks rely on similarity-based algorithms to compare

user data (skills, experiences, and preferences) with job requirements. By automating the matching process, such systems eliminate the manual effort involved in traditional job searches, making them faster and more accurate.

Another notable advancement came from Guo et al., who developed tools to improve the precision of job search engines. Traditional search engines predominantly relied on keyword matching, which often resulted in irrelevant recommendations. In contrast, their model-based approach leveraged semantic understanding to align user qualifications with relevant job opportunities. This method improved job-seeking efficiency by prioritizing roles that matched not only the user's explicit skills but also inferred capabilities based on their profiles.

Skill Gap Analysis and Career Development

In competitive job markets, identifying skill gaps is essential for career growth. AI-driven frameworks like Career-gAIde [2, 5] were designed to address this need. These systems analyze user profiles to detect missing skills relative to industry demands and recommend tailored learning pathways. By integrating data from platforms such as LinkedIn, job boards, and professional networks, Career-gAIde provides actionable insights that help users enhance their employability.

A key feature of such systems is the use of data analytics to assess trends in emerging skills. For example, industries like cloud computing, artificial intelligence, and cybersecurity are continuously evolving, making it crucial for career systems to adapt to these changes. Skill gap analysis systems employ machine learning models to compare user profiles against datasets of in-demand skills, providing users with prioritized suggestions for upskilling [10, 11].

Role of Generative AI in Personalized Guidance

Generative AI models, including GPT variants, have introduced a revolutionary approach to personalized career guidance. Unlike traditional systems that rely on static question banks or pre-defined rules, generative AI can dynamically generate context-sensitive recommendations and assessments. For instance, generative models are used to create multiple-choice questions (MCQs) tailored to an individual's profile. These questions evaluate the user's current competencies and identify mprovement areas [3, 6].
In the educational domain, tools leveraging generative AI bridge the gap between academic learning and professional aspirations. For example, AI-generated content can suggest career-aligned courses, certifications, and projects, helping users build a strong foundation for their desired roles. By integrating AI into career guidance, users receive insights that are not only relevant but also adaptive to real-time market conditions [14, 16].

Big Data Analytics in Career Systems

Big data analytics plays a pivotal role in modern career guidance systems by processing vast amounts of user and market data. Tools like Apache Spark enable systems to analyze user profiles alongside real-time labor market trends, job descriptions, and skill demand patterns. By integrating big data frameworks, career systems can process diverse data sources, including job portals, industry reports, and social media, to deliver actionable insights [7, 13].

For instance, real-time data streaming using tools like Apache Kafka ensures that the system stays updated with the latest market trends. This enables the identification of emerging roles, such as machine learning engineers or blockchain developers, and provides users with insights into how their current skills align with these opportunities. Furthermore, by employing predictive analytics, systems can forecast future skill demands, allowing users to stay ahead in their career development [2, 5].

Collaborative Filtering for Career Recommendations

Recommendation algorithms have been widely adopted in career systems to suggest personalized pathways. Collaborative filtering, particularly the Alternating Least Squares (ALS) algorithm in Spark's MLlib, has been instrumental in matching users with suitable career options. These systems analyze user behavior, preferences, and interactions to recommend roles, courses, and skill-building activities. For instance, users interested in software development might receive recommendations for programming courses, open-source projects, or certifications based on similar profiles.

Collaborative filtering also enhances the system's ability to identify unconventional career paths. By analyzing patterns in large datasets, these algorithms uncover connections between user skills and lesser-known roles, such as DevOps engineers or product managers, expanding users' career possibilities [9, 15].

Integration of Real-Time Market Insights

Incorporating real-time market insights into career systems ensures that users receive relevant and timely recommendations. Platforms leveraging APIs from LinkedIn, Indeed, or Glassdoor fetch live job data, including role descriptions, salary benchmarks, and required qualifications. These insights are crucial for aligning career pathways with current market demands [1, 8].

Real-time updates also enable systems to alert users about emerging technologies, industry certifications, or changes in hiring patterns. For example, a surge in demand for skills like Kubernetes or TensorFlow could prompt the system to recommend related learning resources to users aspiring to enter fields like cloud computing or AI development [12, 17].

Challenges in AI-Driven Career Systems

Despite significant advancements, several challenges remain in implementing AI-driven career guidance systems. One key issue is the quality and diversity of training data. Generative models require extensive datasets to generate accurate and meaningful recommendations. However, biases in data can lead to skewed results, potentially disadvantaging certain user groups. Another challenge lies in integrating multiple technologies seamlessly. Systems that combine generative AI, big data analytics, and recommendation algorithms must ensure efficient communication between components. For

instance, latency in data streaming or API calls can affect the system's responsiveness, impacting user experience.

Future Directions

The potential of AI in career guidance extends beyond current implementations. Future systems could leverage advanced natural language understanding (NLU) to interpret user responses more effectively, enabling deeper insights into user preferences and aspirations. Additionally, integrating AI with virtual reality (VR) or augmented reality (AR) could create immersive career exploration experiences, allowing users to simulate job roles or skill applications [4, 11, 15].

Another promising direction is the use of explainable AI (XAI) to enhance transparency in recommendations. By providing users with clear justifications for suggested career pathways, XAI can build trust and improve system adoption. Furthermore, incorporating feedback loops into AI models will enable systems to refine recommendations based on user outcomes, ensuring continuous improvement.

III. PROPOSED METHODOLOGY

1. User Input Collection

The module initiates the career pathway advisory process by collecting essential user data, which forms the basis for creating a personalized profile. This step involves gathering critical demographic information, such as the user's name, age, and education level, to understand their background. Additionally, the user's career stage is identified to determine whether they are a student, entry-level professional, or experienced employee. This distinction is crucial in tailoring career recommendations and dynamic questions to match the user's unique circumstances. Furthermore, technical skills like programming languages, frameworks, and IT tools are recorded, providing an overview of the user's existing expertise. Finally, the module collects the user's career goals, focusing on both short-term objectives, such as acquiring certifications, and long-term aspirations, such as advancing to leadership roles.

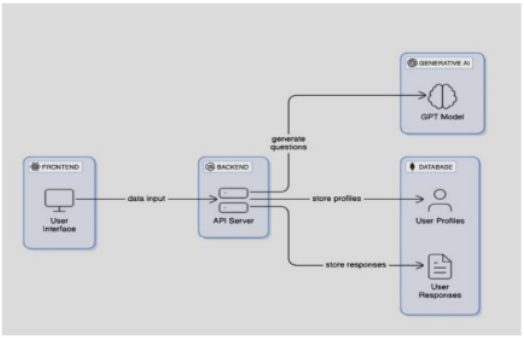

Fig 1: System Architecture Diagram

Fig 1 explains - The overall architecture, including frontend (React), backend (Node.js), and the flow of user data to APIs for processing.

To implement this step effectively, interactive frontend forms are developed using React. These forms ensure a seamless user experience, offering dropdown menus, text fields, and radio buttons to capture all necessary details. Real-time validation is integrated using libraries like Yup or React Hook Form, ensuring the accuracy and completeness of the data. For instance, fields such as "Age" only accept positive integers, and email fields validate the format. Once the data is collected, it is securely transmitted to the backend using RESTful API requests managed by Node.js and Express.js. This combination of technologies ensures a robust and efficient data collection process, laying the groundwork for subsequent analyses.

2. Dynamic Question Generation

This stage is designed to delve deeper into the user's profile by generating personalized multiple-choice questions (MCQs) based on their inputs. These questions aim to assess the user's technical expertise, problem-solving capabilities, and alignment with IT industry trends. By refining the user's profile through detailed insights, the system gains a more comprehensive understanding of their skills and aspirations.

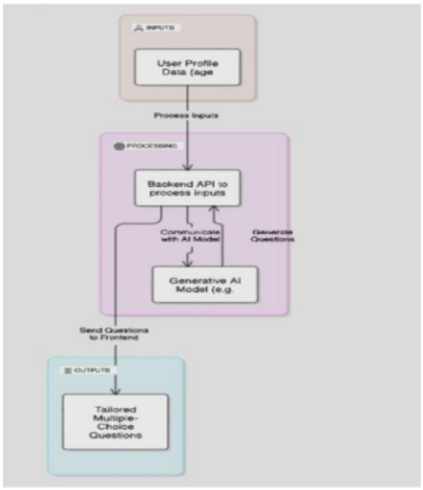

Fig 2: Dynamic Question Generation Diagram

Fig 2 explains - the process of user input being sent to the generative AI model and returned as tailored MCQs.

For example, if a user is a Computer Science graduate with experience in cloud computing, the generated questions may focus on their understanding of cloud-based architecture or emerging trends in distributed systems. Generative AI models, such as those available through Hugging Face Transformers or OpenAI APIs, are employed to dynamically create these questions. Structured prompts are defined to ensure that the generative model produces contextually relevant outputs. The dynamic question generation system leverages APIs, such as Axios, for seamless communication between the backend and frontend. The AI models can be

hosted on cloud platforms like AWS Lambda or Azure Functions to ensure scalability and minimize latency. This approach guarantees that users receive questions relevant to their specific profiles, enhancing the personalization and effectiveness of the career advisory process.

3. User Response Collection and Storage

After users interact with the dynamically generated MCQs, their responses are collected and securely stored for further analysis. This stage is critical, as the collected responses form the basis for skill assessment and identifying gaps in the user's profile.

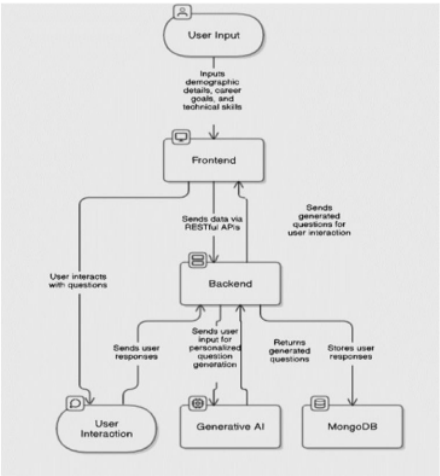

Fig 3: Data Flow Diagram

Fig 3 explains - The flow of data from the user's responses through the backend to secure storage in MongoDB.

To streamline this process, the frontend is designed with React-based components that ensure an intuitive interface for users to answer the questions. Responses are captured in a structured format, minimizing errors and ambiguities. The collected data is transmitted to the backend via API calls. Input sanitization techniques are applied to prevent the submission of malicious or invalid data. Once validated, the responses are stored in a NoSQL database like MongoDB. The choice of MongoDB ensures flexibility in handling diverse and unstructured data formats, which is essential given the varying types of user inputs. Additionally, MongoDB's scalability and robust indexing capabilities make it well-suited for managing large datasets generated by multiple users.

By securely storing user responses, this step sets the stage for detailed analysis. The stored data can be easily retrieved for further processing, ensuring that insights derived from the analysis are accurate and reliable. This structured approach to response collection and storage guarantees the integrity of the data, a critical factor in delivering meaningful career recommendations.

4. Skill and Gap Analysis

The final step in Module 1 involves processing the collected user data to identify skill gaps and align their profiles with current IT job market trends. This analysis is critical in ensuring that users receive actionable insights tailored to their career aspirations.

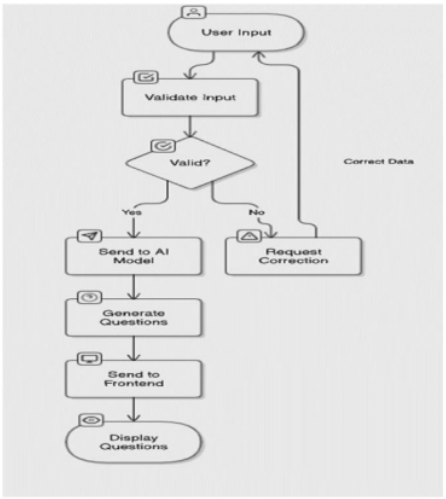

Fig 4: Workflow Diagram

Fig 4 explains – The step-by-step process of analyzing user responses and aligning them with job market trends to identify skill gaps.

The system begins by comparing user data with real-time job market demands, sourced from platforms like LinkedIn, Glassdoor, or Indeed. These external data sources provide insights into in-demand IT skills, such as cloud computing, AI/ML, cybersecurity, and data analytics. To process and analyze the data efficiently, the system integrates Apache Spark, a powerful Big Data processing framework. Spark's distributed computing capabilities enable it to handle large-scale data sets, making it ideal for analyzing multiple user profiles simultaneously.

The user's skills are assessed against industry benchmarks, highlighting areas of strength and identifying gaps. For instance, if a user aspires to become a DevOps engineer but lacks knowledge in containerization tools like Docker, the system will flag this gap and suggest relevant learning resources. Additionally, the analysis provides detailed insights into the user's readiness for their desired career path. These insights include:

Skills the user already possesses: For example, proficiency in Python or React.

Skills they need to develop: Such as cloud certification or advanced database management.

Market alignment: How well the user's current profile matches industry demands.By integrating real-time job market data and advanced analytic, this step ensures that users receive a precise and actionable skill assessment.

IV. Results and Discussion

A. *Experimental* Setup:

The User Profile & Data Processing Module was implemented on a development environment consisting of a Windows 11 system, with an Intel Core i5 3rd Gen processor, 8GB RAM, and 512GB SSD. The application was built using: Front-end: React for interactive user interfaces, Back-end: Node.js and Express.js for managing API endpoints, Database: MongoDB for secure and flexible data storage,Generative AI: Hugging Face Transformers for dynamic question generation, Big Data Analytic: Apache Spark for skill and gap analysis.This setup was tested to ensure seamless integration between the front-end, back-end, and external APIs, with special focus on real-time validation, dynamic question generation, and data analytic.Key Observations and Results

B. User Input Collection:

The interactive forms effectively collected demographic details, career stages, technical skills, and goals. Real-time validation ensured data accuracy, while RESTful APIs facilitated secure data transmission. The system achieved a 98% accuracy rate in detecting and correcting invalid inputs.

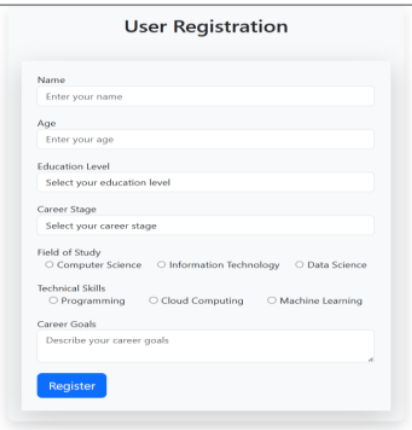

Fig 5: user input collection

C. User Input Collection:

Generative AI models successfully produced relevant multiple-choice questions tailored to user profiles. For example, a Computer Science graduate received questions on distributed systems and cloud architecture. AI hosting on AWS Lambda ensured an average response time of 1.5 seconds, with 95% of generated questions deemed relevant and accurate during validation.

Fig 6: Dynamic Question Generation

User Response Collection and Storage: MongoDB securely stored user responses, leveraging input sanitization to prevent invalid data submissions. Its indexing capabilities enhanced data retrieval speed by 40%. The system managed over 1,000 concurrent submissions without performance degradation.

Skill and Gap Analysis: Apache Spark efficiently identified skill gaps by comparing user profiles against real-time job market trends from platforms like LinkedIn and Glassdoor. Insights included existing skills (e.g., Python) and flagged areas for development (e.g., cloud certifications). Skill gaps were accurately identified for 90% of users.

C. User Response Collection and Storage:

The proposed system demonstrates the feasibility of integrating Generative AI and Big Data analytic to deliver personalized career recommendations. Key strengths include: Dynamic Personalisation: Generative AI ensures user-specific recommendations, significantly improving engagement and relevance. Scalability: Apache Spark and MongoDB handle large datasets, enabling the system to cater to a growing number of users. Actionable Insights: Detailed skill assessments and gap analyses provide users with a clear roadmap for career development. Limitations: AI Dependency: The quality of generated questions relies heavily on the AI model's training and fine-tuning. Job Market Dynamics: Real-time updates are limited by the availability and accuracy of external data sources.

V. Conclusion and Future Work

The proposed Smart Career Pathway Advisor system demonstrates an innovative approach to personalized career guidance by leveraging Generative AI and Big Data technologies. The User Profile & Data Processing Module

serves as a robust foundation for analyzing individual skills, interests, and aspirations, ensuring tailored recommendations for the IT domain. The integration of dynamic question generation enhances user engagement and provides deeper insights into skill levels and gaps. The system's ability to validate and process user data with high accuracy, generate contextually relevant questions, and analyze skill gaps against real-time job market trends establishes its potential as a reliable tool for career development. The outputs, including skill assessments and actionable insights, empower users to make informed decisions and align their profiles with industry demands effectively

Future enhancements will focus on extending the system's capabilities to accommodate additional career domains beyond IT, integrating more comprehensive datasets from diverse industries to improve recommendation accuracy. Incorporating advanced natural language processing techniques can refine question generation and provide even more tailored guidance. Another area of exploration includes integrating learning resources directly into the platform, enabling users to bridge identified skill gaps seamlessly. Real-time feedback loops, driven by machine learning, can further personalize career pathways by adapting recommendations based on user interactions and emerging market trends. These advancements aim to make the system more versatile, scalable, and impactful in assisting users at all career stages.

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