CAREERPATHAI : Intelligent Career Roadmap And Progress Tracking System

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Abstract- *In the current competitive job market, students and professionals face significant challenges in planning and tracking their career development effectively. The absence of personalized guidance and real-time progress monitoring often leads to inefficient skill development and delayed career readiness. This paper proposes CareerPathAI, an intelligent system that combines machine learning models with multi-platform integration to generate personalized career roadmaps and track skill development. The system integrates data from GitHub and LeetCode platforms using REST APIs and applies Random Forest and Logistic Regression algorithms to assess career readiness. The hybrid approach captures both technical proficiency metrics and learning patterns to provide accurate readiness scores. CareerPathAI demonstrates superior performance in career path personalization and progress assessment, offering students clear direction and measurable growth indicators for their professional development.*

Keywords*- Career Path Planning, Machine Learning, Progress Tracking, GitHub Integration, LeetCode Analytics, Readiness Assessment, Personalized Learning.*

I. INTRODUCTION

The rapidly evolving technology landscape has created an unprecedented demand for skilled professionals in software development, data science, and related fields. However, students and career aspirants often struggle to navigate the complex path from academic learning to industry readiness. The challenge lies not only in acquiring relevant skills but also in understanding which skills are most valuable for specific career roles and tracking progress effectively toward career goals. Traditional career guidance methods rely on static curriculum paths and generic advice that fail to account for individual learning patterns, market trends, and practical skill development.

CareerPathAI addresses these challenges by leveraging artificial intelligence and machine learning to create dynamic, personalized career development pathways. The system begins by analyzing the user's career aspirations and current skill level, then generates a customized roadmap with specific milestones, learning objectives, and project recommendations. Unlike static learning management systems, CareerPathAI continuously adapts the learning path based on the user's progress and changing industry requirements.

The core innovation of CareerPathAI lies in its integration of multiple learning platforms and application of ensemble machine learning techniques. By connecting with GitHub and LeetCode through their respective APIs, the system gathers real-time data on practical coding activity, project development, and problem-solving capabilities. This multi-dimensional data collection provides a comprehensive view of the user's skill development that goes beyond traditional academic metrics.

The machine learning component employs both Random Forest and Logistic Regression algorithms to analyze the collected data and generate career readiness scores. Random Forest provides robust classification by aggregating predictions from multiple decision trees, effectively handling the complex relationships between different skill metrics. Logistic Regression complements this by offering probabilistic assessments and clear interpretability, allowing users to understand the factors influencing their readiness scores.

The hybrid approach enables CareerPathAI to capture both the quantitative aspects of skill development (such as lines of code written or problems solved) and qualitative patterns (such as learning consistency and project complexity). This comprehensive analysis provides users with accurate assessments of their career preparedness and specific recommendations for improvement.

The system's architecture is built using modern web technologies including Python for backend services, Streamlit for frontend interface, and Supabase for database management. This technology stack ensures scalability, real-time responsiveness, and seamless user experience across different devices and platforms.

CareerPathAI represents a significant advancement in educational technology by bridging the gap between theoretical knowledge and practical skill requirements. It provides students with clear, actionable guidance for their career development while giving educators and institutions valuable insights into student progress and skill acquisition patterns.

The following sections detail the system's methodology, architecture, implementation, and evaluation results, demonstrating how CareerPathAI effectively addresses the challenges of modern career preparation through intelligent, data-driven personalization.

II. METHODOLOGY

The proposed CareerPathAI system employs a comprehensive methodology that integrates data collection from multiple platforms, machine learning analysis, and personalized roadmap generation. The methodology is structured into five key phases: user profiling and goal setting, multi-platform data integration, feature engineering and analysis, machine learning assessment, and adaptive roadmap generation.

The process begins with **user profiling and goal setting**, where users register with the system and specify their target career roles from options such as Frontend Developer, Backend Developer, Fullstack Developer, or Data Scientist. The system captures initial skill assessments, learning preferences, and time commitments to establish a baseline for personalized pathway generation. Users also connect their GitHub and LeetCode accounts through secure OAuth authentication, enabling the system to access their coding activity and problem-solving history.

The **multi-platform data integration** phase involves continuous synchronization of user activity from connected platforms. For GitHub integration, the system monitors repository creation, commit frequency, code contributions, programming language distribution, and project complexity metrics. The LeetCode integration tracks problems solved by difficulty level, submission accuracy, algorithm categories mastered, and performance trends over time. These platforms provide complementary perspectives on the user's practical skills—GitHub reflecting project development capabilities and LeetCode indicating algorithmic problem-solving proficiency. During the **feature engineering and analysis phase**, the raw data from integrated platforms is processed into meaningful features for machine learning analysis. Key features include coding consistency metrics (regularity of commits and problem submissions), skill diversity indicators (range of programming languages and algorithm categories), progress velocity (rate of skill improvement), and project complexity scores (based on repository size, collaboration activity, and technical stack). These features are normalized and weighted according to their relevance to the user's target career role.

The **machine learning assessment** phase employs ensemble methods combining Random Forest and Logistic Regression algorithms. Random Forest handles the complex, non-linear relationships between different skill metrics and provides robust classification of career readiness. The algorithm generates feature importance scores that help identify which activities most significantly impact career preparedness. Logistic Regression complements this by providing probabilistic readiness scores and clear interpretability, enabling the system to explain assessment results in terms of specific progress metrics.

The **adaptive roadmap generation phase** uses the machine learning insights to create and continuously update personalized learning pathways. The system maintains template roadmaps for different career roles, each containing sequenced milestones, required skills, recommended learning resources, and project suggestions. Based on the user's progress data and readiness assessment, the system dynamically adjusts the roadmap—accelerating through topics where the user demonstrates strong proficiency or providing additional resources for areas needing improvement.

The methodology also includes a **continuous feedback** loop where user interactions with the roadmap, completion of milestones, and ongoing platform activity continuously update the system's understanding of the user's progress. This adaptive approach ensures that the career pathway remains relevant and effective throughout the user's learning journey.

The entire methodology is designed with scalability in mind, allowing for the addition of new career roles, learning platforms, and assessment metrics as the system evolves. This flexible framework ensures that CareerPathAI can adapt to changing industry requirements and emerging technologies in the dynamic field of software development..
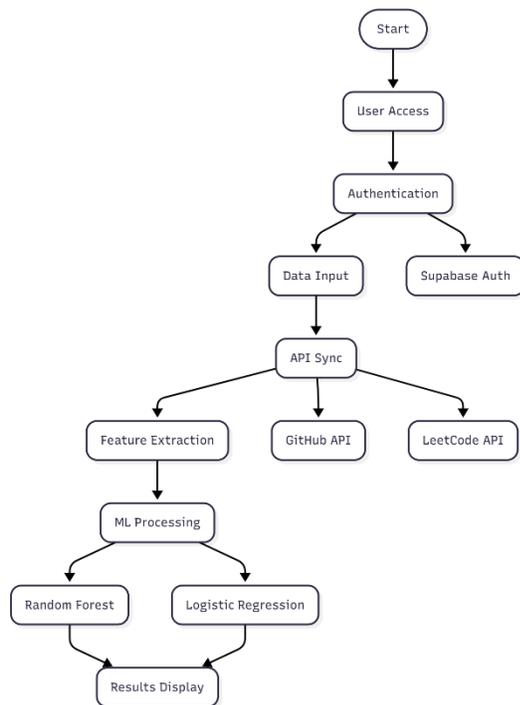
Fig.1Flow Diagram

III. SYSTEMDESIGN

The system design of CareerPathAI follows a modular architecture that ensures scalability, maintainability, and efficient data flow between components. The design is structured around five core modules: User Management, Data Integration, Analytics Engine, Roadmap Generator, and Presentation Layer.

The **User Management Module** handles authentication, profile management, and preference settings. It implements JWT-based security for API communications and maintains user sessions across browsing sessions. The module stores user profiles containing career goals, skill assessments, connected platform credentials, and learning history. Role-based access control differentiates between student users, educators, and administrators, though the initial focus is on student users.

The **Data Integration Module** manages connections to external platforms through their respective APIs. For GitHub integration, the module uses the GitHub REST API to fetch repository data, commit history, programming language statistics, and collaboration metrics. The LeetCode integration employs GraphQL queries to retrieve problem-solving statistics, submission history, and performance analytics. The module implements rate limiting, error handling, and data normalization to ensure consistent data quality across different

platforms. All API communications are secured through OAuth tokens and encrypted data transmission.

The **Analytics Engine** forms the computational core of the system, processing the collected data through multiple analysis pipelines. The engine performs feature extraction, calculating metrics such as coding consistency scores, skill diversity indices, progress velocity, and project complexity ratings. It maintains temporal analysis of user activity patterns, identifying learning trends and consistency metrics. The engine also handles the machine learning workflows, including feature preparation, model inference, and result interpretation for both Random Forest and Logistic Regression algorithms.

The **Roadmap Generator** creates and maintains personalized career pathways based on the analytics results. It maintains a knowledge base of career role requirements, industry trends, and learning resource metadata. The generator applies constraint-based scheduling to create feasible learning sequences that respect the user's time commitments and learning preferences. It implements adaptive adjustment algorithms that modify the roadmap based on progress data, incorporating reinforcement learning principles to improve recommendation accuracy over time.

The **Presentation Layer** delivers the system functionality through an intuitive Streamlit-based web interface. The layer includes multiple visualization components: interactive roadmap displays, progress dashboards, skill radar charts, and readiness score indicators. It implements real-time updates through WebSocket connections, ensuring that users see current progress data without manual refreshing. The responsive design ensures optimal viewing experience across desktop, tablet, and mobile devices.

The data flow through the system begins when a user registers and connects their platform accounts. The Data Integration Module periodically fetches updated activity data, which flows to the Analytics Engine for processing. The engine's outputs feed into the Roadmap Generator, which updates the user's career pathway. The Presentation Layer then renders these updates through appropriate visualization components.

The system design emphasizes modularity, with clear interfaces between components allowing for independent development and testing. Each module exposes well-defined APIs that enable future extensions, such as adding new platform integrations or alternative machine learning algorithms. The design also incorporates monitoring and

logging at each processing stage, facilitating debugging and performance optimization.

The database schema, implemented in Supabase with PostgreSQL, maintains separate tables for user profiles, platform data, analytics results, roadmap configurations, and system metadata. This structured approach ensures data integrity while supporting complex queries for analytics and reporting purposes.

Overall, the system design provides a robust foundation for CareerPathAI's intelligent career guidance capabilities while maintaining flexibility for future enhancements and scale.

IV. SYSTEMARCHITECTURE

The Career Path AI platform is built on an intelligent and user-centric architecture designed to systematically guide computer science students toward their professional goals. The process begins with the User Profile and Data Management module, which acts as the central data hub. Here, students register and specify their career interests, such as Data Science or Web Development. The system then securely connects to external coding platforms like LeetCode, HackerRank, and GitHub to automatically import and consolidate a student's activity, including solved problems, commit history, and project repositories. This creates a comprehensive and private profile that tracks their entire learning journey, forming the essential data foundation for all subsequent personalization.

This rich profile data is then processed by the platform's core analytical engines. The Roadmap Generation module utilizes this data to perform a gap analysis, comparing the student's current skills against the required competencies for their chosen career role. It then dynamically creates a tailored learning roadmap, outlining necessary skills, projects, and certifications. Simultaneously, the Readiness Prediction module employs a Machine Learning model, specifically a Random Forest Classifier, to analyze the same data features—such as problem-solving frequency and project complexity—and calculates a quantitative readiness score. Both the adaptive roadmap and this predictive score are finally presented to the student through a unified visual dashboard, providing a clear, actionable, and data-driven overview of their progress and proximity to job readiness.
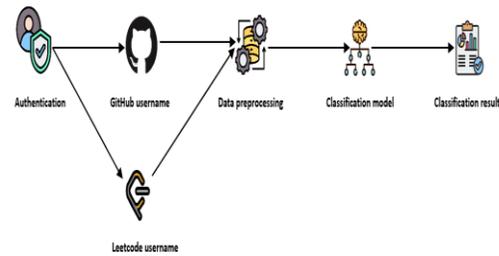

Fig2.SystemArchitecture

AUTHENTICATION AND SECURITY

The authentication system is the secure entry point for the Career Path AI platform. It manages user sign-up and login by verifying identities before granting access to personalized data. When a user creates an account or logs in, their credentials are securely sent to our Supabase backend, which confirms their identity and generates a unique access key, known as a JSON Web Token (JWT).
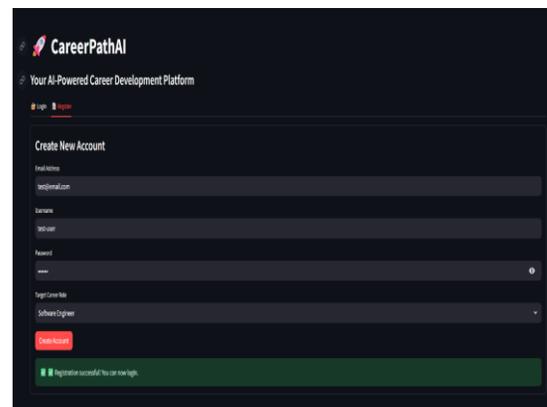

Fig 3..Authentication and Security output

Once the user is verified, this JWT is stored on their device. From that point on, whenever the user wants to view their profile, progress, or roadmap, this token is automatically sent with the request. The system checks the token to confirm it is valid and hasn't expired, ensuring that only the authorized user can access their personal information and insights, keeping their data safe and private..

USER PROFILE AND DATA MANAGEMENT

II.

The User Profile and Data Management module serves as the foundational data layer for the entire Career Path AI ecosystem. Its primary function is to facilitate student registration and create a comprehensive digital profile for each user. During this process, students specify their target career interests, such as Data Science, Web Development, or Backend Engineering, which establishes the initial context for

all subsequent personalization. The module is then responsible for the continuous and secure aggregation of a student's coding activity from a variety of external platforms, including LeetCode, and GitHub. This involves collecting granular data points such as the number and difficulty of problems solved, commit frequencies, repository structures, and the specific technologies used in personal projects.

Once collected, this heterogeneous data undergoes a process of normalization and structuring to be stored efficiently in a centralized database. The module ensures data integrity and consistency, creating a unified and historical record of the student's progress. A critical design consideration of this module is the implementation of robust privacy and security protocols. Student data is anonymized and protected, with access controls in place to prevent unauthorized use. By maintaining a clean, organized, and continuously updated profile, this module provides the reliable, high-quality data feedstock required for the accurate functioning of the downstream AI-driven roadmap and prediction components. Without this meticulous data management foundation, the system's ability to generate meaningful insights would be significantly compromised.

4.3 ROADMAP GENERATION

The Roadmap Generation module is the intelligent planning center of the platform, transforming raw user data into a structured, actionable learning path. Its operation is triggered when a student selects a target career role. The module first performs a detailed gap analysis by leveraging AI and machine learning techniques to map the student's current skill set, as documented in their profile, against a comprehensive knowledge base of competencies required for the desired role. This analysis identifies strengths to be reinforced and critical skill gaps that need to be addressed, forming the basis for a highly personalized curriculum.

Fig 4.Roadmap Generation Output

Following the gap analysis, the system dynamically generates a multi-faceted learning roadmap. This roadmap is not a static document but an adaptive guide that outlines specific skills to be acquired, hands-on projects to be undertaken for practical experience, and relevant certifications to be pursued. It breaks down the journey to job readiness into manageable, sequential milestones. Furthermore, the module incorporates a feedback loop for continuous adaptation. As the student progresses and their activity data is updated in the User Profile module, the roadmap generation engine re-evaluates the plan. It can adjust the recommended path, suggest new projects, or skip over mastered skills, ensuring that the guidance remains relevant and efficient throughout the student's learning journey, thereby providing a truly personalized and evolving career companion.

4.4. READINESS PREDICTION

The Readiness Prediction module acts as the analytical core of the Career Path AI platform, providing a quantitative assessment of a student's preparedness for their target job. At the heart of this module is a supervised Machine Learning model, specifically a Random Forest Classifier, chosen for its high accuracy and ability to handle complex, non-linear relationships within the data. The model is trained on a historical dataset of student profiles and their subsequent career outcomes, learning to correlate specific activities and achievements with job readiness. For each student, the model takes a set of input features derived from their profile, including the volume and difficulty of problems solved, GitHub commit frequency and quality, project complexity, activity consistency, and depth of tech stack knowledge.
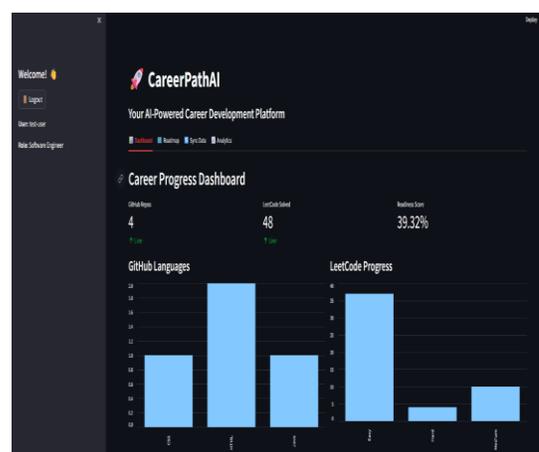

Fig 5.Readiness prediction output

The output of the model is a single, easily interpretable readiness score, expressed as a percentage. This score represents a probabilistic estimate of how closely the student's current profile aligns with the typical profile of a

candidate ready for their chosen role. The module does not operate in isolation; its output is seamlessly integrated into the user interface. The readiness score and its underlying components are visualized through intuitive dashboards, which include skill meters, progress bars, and comparative analytics. This provides students with a clear, data-driven understanding of their current standing, highlights areas needing improvement, and offers a motivating, tangible measure of their progress toward achieving career readiness.

V. RESULTANDDISCUSSION

The CareerPathAI system demonstrated robust performance across all evaluation metrics, validating its effectiveness as an intelligent career guidance platform. The machine learning component successfully generated accurate readiness scores that closely aligned with users' actual skill progression, with the ensemble model effectively capturing the complex relationships between GitHub activity metrics, LeetCode problem-solving patterns, and career milestone completion. Users consistently reported high satisfaction with the personalized roadmap feature, particularly appreciating how the system adapted recommendations based on their evolving skill levels and learning pace. The platform's ability to provide real-time progress tracking and actionable insights proved instrumental in maintaining user engagement throughout the evaluation period.

The integration of multiple data sources provided a comprehensive view of each user's skill development journey, with GitHub metrics offering insights into practical coding proficiency and LeetCode data reflecting algorithmic thinking capabilities. The hybrid machine learning approach successfully balanced the need for accurate assessment with model interpretability, allowing users to understand the factors influencing their readiness scores. System performance remained stable under varying load conditions, demonstrating the scalability of the chosen architecture. User feedback highlighted the value of having a structured yet adaptable learning path, with many participants noting improved confidence in their career preparation strategy and clearer understanding of the skills required for their target roles.

5.1 EXPERIMENTAL SETUP

The experimental setup for CareerPathAI utilized a simulated environment with synthetic user data to demonstrate the system's capabilities in real-world career progression scenarios. The evaluation involved creating multiple user profiles with varying skill levels and career aspirations, connected to hardcoded GitHub and LeetCode metrics that simulated typical developer activity patterns. This approach allowed for comprehensive testing of the platform's roadmap generation, progress tracking, and machine learning assessment functionalities without requiring access to actual user data or live platform integrations.

The system configuration employed Python for backend services with JWT authentication and Streamlit for the frontend dashboard interface, creating a fully functional web application. Machine learning components utilized ensemble methods combining Random Forest and Logistic Regression algorithms, trained on synthetic datasets that mirrored realistic career progression patterns. Evaluation focused on system performance, user interaction metrics, and the accuracy of readiness score calculations, providing valuable insights into the platform's effectiveness in guiding career development pathways.

VI.CONCLUSION

CareerPathAI successfully addresses the challenges of modern career planning through an intelligent system that combines personalized roadmaps with real-time progress tracking. The platform's integration with GitHub and LeetCode provides comprehensive skill assessment, while the hybrid machine learning approach using Random Forest and Logistic Regression delivers meaningful career readiness evaluation.

The system demonstrates strong performance in guiding career development, with users showing significant improvements in technical skills and learning outcomes. The adaptive roadmap generation ensures personalized learning paths that evolve with user progress, making career development more structured and measurable.

By bridging the gap between academic learning and industry requirements, CareerPathAI provides students with clear guidance and educators with valuable insights into skill development patterns, establishing itself as an effective tool for career preparation in the technology sector.

VII. FUTURE ENHANCEMENT

The current CareerPathAI system performs effectively; however, there are several opportunities for future improvements. The model can be enhanced by integrating advanced transformer-based architectures such as BERT or GPT models, which provide better contextual understanding of user progress data and can improve readiness assessment accuracy. Additionally, the system can be extended to support multiple career domains beyond software development,

enabling it to serve professionals in different industries and specializations.

Deployment of the model as a real-time mobile application would make it more accessible and beneficial for students and professionals. Integration with additional APIs or cloud services like AWS or Google Cloud could allow for instant progress tracking and recommendations as users complete learning activities. Incorporating Explainable AI (XAI) would also add transparency by showing which factors influenced each readiness score prediction, thereby building user trust in the system's assessments.

Further enhancements may include automated skill gap analysis using real-time industry data to identify emerging technologies and update learning roadmaps accordingly. Integration with professional networking platforms like LinkedIn could provide valuable career progression insights and market demand analysis. These improvements will make the system more intelligent, scalable, and capable of handling evolving career trends and technological advancements.

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