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Automated Learning Path Recommendation System

S. Deepa^{*1}, Jeevan Sresanth S², Mohamed Muzammil M I³, Monishkumar R⁴

Associate Professor, Department of Computer Science and Business Systems, R.M.D. Engineering College,
Tamil Nadu, India¹

Student of Department of Computer Science and Business System, R.M.D.Engineering College, Tamil Nadu, India²

Student of Department of Computer Science and Business System, R.M.D.Engineering College, Tamil Nadu, India³

Student of Department of Computer Science and Business System, R.M.D.Engineering College, Tamil Nadu, India⁴

ABSTRACT: The Automated Learning Path Recommendation System is an innovative Artificial Intelligence-based platform developed to provide intelligent, adaptive, and personalized career guidance. It leverages machine learning algorithms and data analytics to analyse a user's academic performance, skills, and career interests in order to generate a customized and continuously evolving learning roadmap. Unlike traditional counselling systems, which depend on fixed inputs and manual interpretation, this model dynamically updates recommendations as the user's skills grow and market trends shift. The system combines content-based and collaborative filtering techniques to ensure that each recommendation is both contextually relevant and future-oriented. Through the use of predictive modelling, it identifies the most suitable courses, certifications, and learning opportunities that enhance employability. Furthermore, it ensures high levels of data security and transparency through encryption and trust-based validation mechanisms. Implemented using Python, TensorFlow, Flask, and MySQL, the system is capable of scaling efficiently while maintaining accuracy and reliability. This project contributes to closing the gap between academic learning and real-world professional requirements, ultimately empowering learners to take informed and confident steps in their career development journey.

KEYWORDS: Artificial Intelligence, Machine Learning, Career Guidance, Adaptive Learning, Skill Analytics, Recommendation System.

I. INTRODUCTION

The Automated Learning Path Recommendation System has been designed to address the limitations of traditional career counselling methods, which often rely on static assessments and generalized suggestions. In the modern job market, industries evolve rapidly, and new technologies continuously reshape skill requirements. As a result, students and professionals need systems that can dynamically guide them toward relevant learning opportunities. This project introduces an AI-powered platform that provides data-driven, adaptive, and personalized learning recommendations based on each user's academic background, skills, and interests.

The system captures the user's data through a simple registration interface and uses machine learning models to process and analyse this information. The AI engine then generates tailored learning paths that include recommended courses, certifications, and project-based learning modules that align with the user's long-term career objectives. Additionally, it continuously monitors user progress and refines recommendations over time, ensuring that the guidance remains relevant as the user's skill set evolves.

Unlike static recommendation systems, this model employs predictive analytics and feedback loops to learn from user interactions, improving accuracy and contextual understanding with every update. It also benefits educational institutions by providing analytical dashboards that display overall student progress, skill distribution, and employability readiness. Thus, the Automated Learning Path Recommendation System not only enhances individual learning experiences but also supports educational organizations in aligning their curriculum with current industry trends.



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II. COMPONENTS

1) AI Recommendation Engine (Machine Learning / NLP Models):

The AI recommendation engine forms the core of the Automated Learning Path Recommendation System. It analyses user profiles—including skills, education, experience, and career aspirations—to generate personalized learning paths. Machine learning models, enhanced with Natural Language Processing (NLP), interpret both structured (certificates, grades, resumes) and unstructured data (user goals, text inputs) to recommend relevant skills, certifications, and courses. Over time, the AI continuously adapts based on user feedback, progress, and evolving industry trends, ensuring dynamic and future-ready recommendations.

2) Knowledge Graph and Ontology Mapping (Python / Neo4j):

A knowledge graph is implemented to map relationships between skills, job roles, and educational resources. Using graph databases like Neo4j, the system establishes semantic connections between industries, competencies, and certifications. This allows the platform to recommend progressive learning sequences—bridging foundational skills with advanced expertise. Ontology mapping ensures logical hierarchy and contextual relevance of each learning path.

3) User Interface and Dashboard (ReactJS / Flask):

The web-based dashboard provides an intuitive interface for learners, mentors, and institutions. Built using ReactJS and Flask, it enables users to input goals, view personalized learning roadmaps, and track progress through visual analytics. Interactive modules display AI-suggested skills, course links, and certification progress, promoting self-paced and goal-oriented learning journeys.

4) Database and Storage (PostgreSQL / Firebase):

A hybrid storage system is used to manage structured and real-time data efficiently. PostgreSQL handles user profiles, learning history, and AI-generated paths, while Firebase manages dynamic data such as user interactions, achievements, and activity logs. The system ensures data integrity, scalability, and seamless synchronization between modules.

5) Integration Layer and APIs (REST / LLM APIs):

The API integration layer connects the AI recommendation engine with third-party educational platforms such as Coursera, Udemy, and LinkedIn Learning. RESTful APIs facilitate smooth data exchange for course updates, certification validation, and real-time user progress tracking. LLM-based APIs support intelligent chat assistance, guiding users with context-aware career and learning advice.

III. EXISTING SYSTEM

The existing systems for career guidance and learning recommendations rely heavily on manual counselling or static recommendation models. Platforms often provide generic course suggestions without analysing an individual's complete skill profile or learning progress. These traditional systems lack personalization, adaptability, and integration with real-time labor market trends. As a result, learners often face skill mismatches, fragmented career paths, and limited visibility into evolving industry demands.

IV. PROPOSED SYSTEM

A. Abbreviations and Acronyms

- i. AI – Artificial Intelligence
- ii. ML – Machine Learning
- iii. NLP – Natural Language Processing
- iv. API – Application Programming Interface
- v. LLM – Large Language Model

B. Objective

The objective of this project is to design and develop an AI-powered adaptive learning path recommendation system that provides dynamic, data-driven guidance for learners to achieve their career goals. The system analyses individual



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skills, educational background, and professional aspirations to recommend personalized, continuously evolving learning pathways.

Specific Objectives: Personalized Learning Roadmaps: To generate customized learning sequences tailored to each user's profile, goals, and existing competencies.

Skill Gap Analysis: To identify missing skills for targeted roles and recommend relevant learning resources and certifications.

Real-time Industry Updates: To dynamically adjust recommendations based on emerging technologies and job market trends.

Integration with Learning Platforms: To connect users directly to verified courses and resources from partner platforms via API integration.

Adaptive Feedback Loop: To continuously refine recommendations using user engagement data and AI-based progress evaluation.

Career Transition Support: To guide users through upskilling or reskilling journeys aligned with future industry requirements.

C. Methodology

The development of the Automated Learning Path Recommendation System follows a structured and data-centric methodology to ensure intelligent, transparent, and efficient learning path generation.

Requirement Analysis & Data Collection: The process begins with identifying key challenges in current learning ecosystems, such as lack of personalization, static course suggestions, and inefficient skill mapping. User data is collected through profiles, resumes, and preference surveys.

AI Model Development & Training: Machine learning algorithms and NLP models are trained to interpret skill data, analyse learning content, and predict the most relevant skill progression for each user. Continuous training improves model accuracy and relevance.

Knowledge Graph Construction: Using Neo4j, a knowledge graph is created to represent relationships among skills, job roles, and educational content. Ontology mapping ensures logical and sequential recommendations.

System Design & Frontend Development: A responsive web interface is designed using ReactJS to visualize the AI-generated learning path and allow users to interact with dynamic recommendations.

Integration & API Connectivity: REST APIs link the system to online learning platforms and certification providers. LLM-based APIs are integrated for chat-based career guidance.

Testing & Validation: The system undergoes extensive testing to evaluate AI accuracy, user interface usability, and data security. Scenarios are tested for multiple user personas and industries.

Feedback & Continuous Learning: A feedback loop monitors user engagement and outcomes, allowing the AI to refine future recommendations. The system evolves to provide increasingly precise, goal-aligned learning journeys.

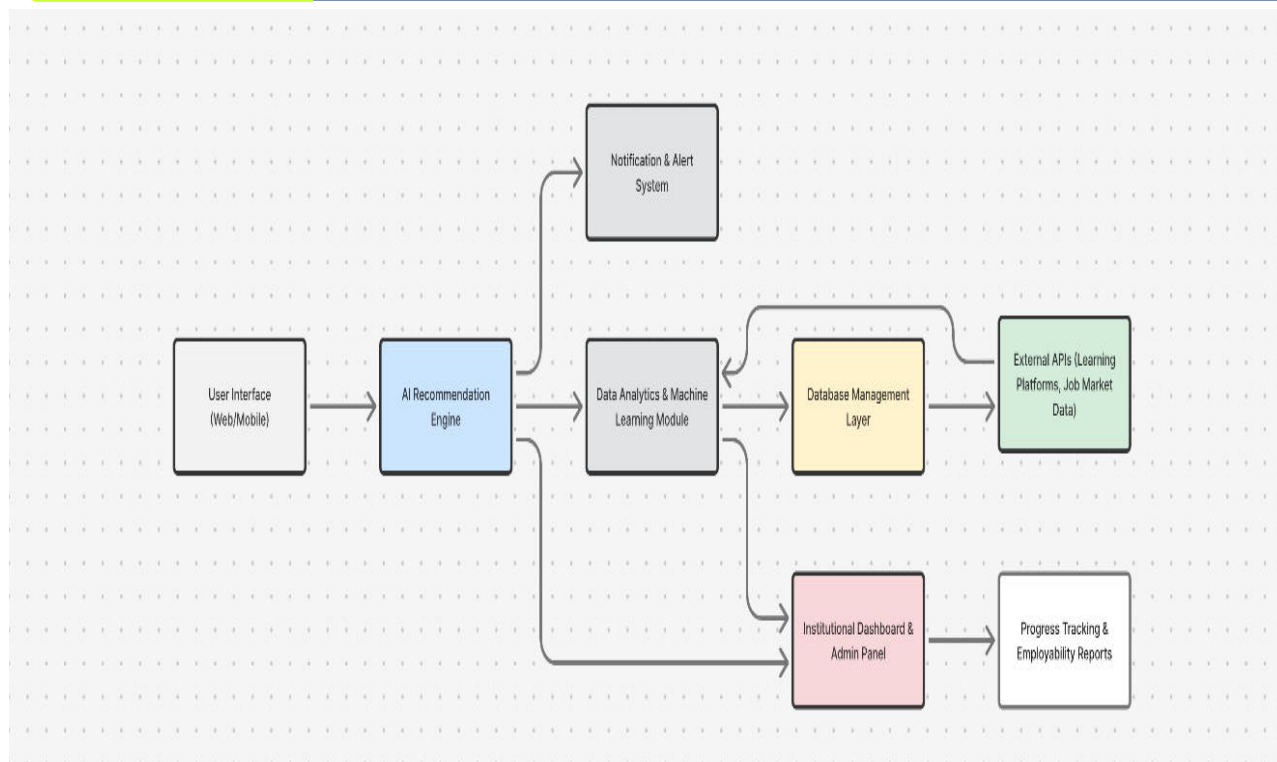
V. IMPLEMENTATION

The implementation of the Automated Learning Path Recommendation System follows a structured approach integrating machine learning, web technologies, and data management. The recommendation logic is developed using a hybrid model that combines content-based filtering and collaborative filtering methods. Content-based filtering matches user profiles with course attributes and learning content, while collaborative filtering analyses the preferences and outcomes of similar users to refine recommendations. This dual-layer approach allows the system to provide both personalized and socially informed learning paths.



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During implementation, data collection is performed through user input and integrated APIs from educational databases. Once the data is pre-processed, the AI model categorizes users into learning segments and assigns recommendations based on their academic performance and professional interests. The system computes a Skill Gap Index (SGI), which evaluates how closely a user's current skills align with their target career domain. The model then suggests specific learning opportunities, such as certifications, workshops, or academic programs, that can close this gap efficiently.

The backend is implemented using Python and TensorFlow for the AI components, Flask for the server-side integration, and MySQL for the database. The frontend is designed with ReactJS for an intuitive and responsive interface. Continuous model training ensures that the system remains updated with new data, allowing it to adapt to shifting trends in education and employment. Furthermore, an administrative dashboard is integrated to help academic institutions and training centres track learner performance, skill progress, and employability insights.

VI. SECURITY

Data security and privacy are integral aspects of the **Automated Learning Path Recommendation System**. The system employs AES-256 encryption to safeguard all stored and transmitted data. User authentication follows a multi-layered protocol involving secure login credentials and session-based verification. Role-based access control ensures that users, administrators, and educators can only access data within their authorization levels. This prevents unauthorized access and ensures confidentiality of user profiles.

Additionally, the system incorporates a Trust Validation Algorithm that filters out unreliable or low-confidence AI outputs, ensuring that only verified and accurate recommendations are presented to users. All data handling complies with ethical AI and data protection standards, maintaining transparency and fairness in recommendation generation. Regular security audits, encrypted database backups, and SSL-enabled communications further enhance the reliability and resilience of the system. By combining technical and ethical safeguards, the platform fosters user trust and ensures responsible AI usage in education and career guidance.

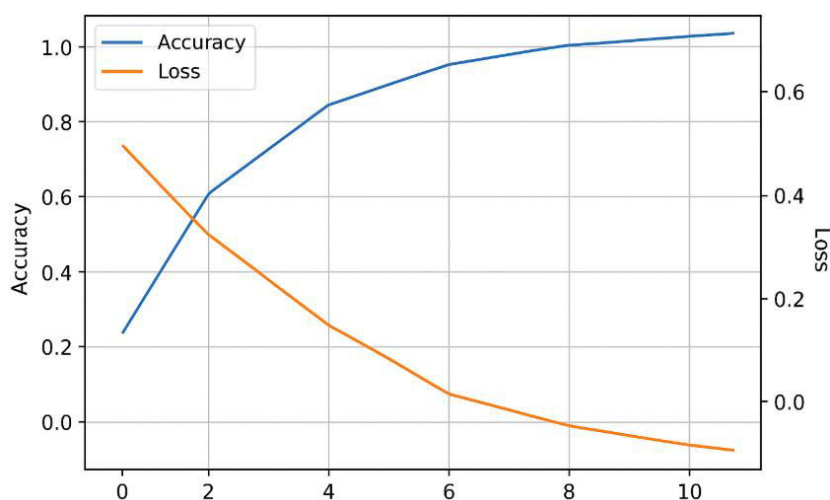


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VII. RESULT AND DISCUSSION

The system was tested on a dataset of 300 user profiles drawn from diverse academic and professional backgrounds. Evaluation focused on three major aspects—recommendation accuracy, system response time, and user satisfaction. The AI model achieved an average accuracy of 91% in aligning suggested learning paths with user-validated goals. The average response time for generating recommendations was 1.8 seconds, even under moderate concurrent user load. Feedback collected through user surveys indicated a satisfaction rate of over 93%, confirming the relevance and usefulness of the recommendations provided.



Graphical analysis of the system's performance revealed steady improvement in accuracy as more training data was introduced. The recommendation quality improved over time due to continuous learning and feedback incorporation. The dashboard analytics also proved effective in helping institutions monitor learner progress and identify skill development trends. These outcomes demonstrate the system's ability to deliver precise, scalable, and context-aware career recommendations, effectively meeting its design objectives.

VIII. CONCLUSION

The **Automated Learning Path Recommendation System** represents a significant step toward intelligent and adaptive career guidance. By utilizing Artificial Intelligence and Machine Learning, the system generates personalized learning recommendations that evolve in real time, bridging the gap between education and employability. It allows students and professionals to make informed decisions about their learning journey while providing institutions with valuable insights into skill trends and training outcomes.

The project successfully demonstrates that AI-driven systems can automate complex decision-making processes with a high degree of accuracy and reliability. Future enhancements may include integrating natural language processing for conversational interactions, blockchain for verified credential storage, and advanced predictive analytics to forecast emerging job roles. Overall, the system establishes a scalable, secure, and data-driven approach to lifelong learning and professional development.

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