Abstract

The demand for more individualized and flexible learning experiences has been highlighted by the explosive growth of e-learning technologies. While effective to some level, traditional e-learning systems frequently produce generic and subpar educational outcomes since they do not take individual learner variations into consideration. By utilizing adaptive machine learning techniques, this research attempts to close this gap by creating a novel framework for individualized learning within e-learning platforms. An adaptive recommendation engine, a dynamic learning pathway generator, an engagement analytics system with a user feedback loop, and a user profile mechanism are all included in the proposed system. This research aims to improve user engagement, retention of knowledge, and overall pleasure by customizing the learning experience to each individual's needs. In doing so, it hopes to provide a useful and approachable answer to the rapidly developing field of personalized e-learning.

This thesis presents one of the components, enhanced user profiling. Personalized e-learning can only be successful if it can correctly identify and accommodate each learner's unique profile. The creation of a sophisticated student learning profiling module that collects, evaluates, and dynamically updates user profiles is the main goal of this research project. Structured forms and questionnaires are used to gather preliminary user data, such as learning preferences, historical performance, and expected results. After that, these data points are processed by algorithms based on Python to produce initial profiles that are quite detailed. The system uses artificial intelligence (AI) tools such as OpenAI and GeminiAI to improve profile accuracy even more. These tools allow for continual modifications based on user behavior and performance in real time. A MySQL database is used to safely maintain and save profiles, guaranteeing convenient access and a smooth interface with the larger adaptive learning framework. By providing a detailed and evolving understanding of each learner, this module plays a critical role in delivering personalized learning experiences that are both effective and engaging.

Acknowledgement

With great gratitude, we would like to thank Mr. Sanjeevi Chandrasiri and Ms. Akshi De Silva of the Sri Lanka Institute of Information Technology for your unwavering assistance and direction in finishing this project. Their knowledge, recommendations, and critiques served as the primary sources of guidance for this research study and contributed to its success. Their dedication to our studies cannot be overstated, and they have played a crucial role in helping us overcome the challenges we faced. Even though it seems cliche, the writers consider themselves fortunate to have had the opportunity to work with them.

Additionally, we would like to express our gratitude to Mr. Harshana Samaranayake for his invaluable support in giving technical feedback that enhanced the caliber of our research and for his role as Associate Technical Lead of Tiqri (Pvt) Ltd. He took the initiative to ascertain which of the information would benefit the project and assist us in resolving technical problems that advanced the progress on the project. We are truly appreciative of his efforts during the current investigation.

Finally, but just as importantly, we would like to express our gratitude to Mr. J. W. P. Nuwan Deshapriya, our Senior Site Reliability Engineer, for his guidance and assistance during the project. For example, he made substantial contributions to the project's technical components, particularly in the dependability concerns as well as system architecture in general. Additionally, I want to appreciate his efforts. He committed himself to carefully reviewing our work and showing concern for the caliber of the research.

Introduction

1. Background & Literature Survey

The swift growth of e-learning platforms has revolutionized the way education is imparted, providing unparalleled worldwide access to educational materials. But this expansion has also brought to light serious difficulties in meeting the varied demands of students. A one-size-fits-all strategy is frequently used by traditional e-learning systems, which ignores individual variations in learning preferences, past knowledge, and engagement levels. Insufficient personalization may result in low motivation, inadequate knowledge retention, and unsatisfactory learning results.

Personalized learning has been developed by educational technology improvements recently to address these issues. Customizing learning routes based on user profiles has shown potential with the use of AI-powered recommendation systems and adaptive learning algorithms. Research has looked into a number of methods to customize content delivery depending on user interactions, including content-based filtering, collaborative filtering, and hybrid recommendation systems. Nevertheless, the precision and comprehensiveness of the user profiles these systems rely on frequently place a cap on their efficacy.

2. Research Gap

There is still a significant gap in the precise and dynamic profile of learners, even with the advancements in individualized e-learning. The majority of current systems mostly rely on preliminary evaluations or static data, which might not accurately represent how a learner's skills, interests, and degree of involvement change over time. Furthermore, there hasn't been much research done on how to include behavioral analytics and attention indicators—two non-traditional data sources—into user profiles to improve personalization. This gap in the literature points to the need for a more advanced method of user profiling that offers a more comprehensive picture of the learner's journey and is constantly adaptive to their progress.

3. Research Problem

The creation of a reliable and dynamic student learning profiling module that can precisely record, examine, and update user profiles in real-time is the main research issue this component attempts to solve. To construct a comprehensive and flexible user profile, the issue is to integrate non-traditional indicators like attention metrics and behavioral patterns with classic data sources like learning preferences and historical performance. The efficacy of individualized learning interventions will be increased if this profile is consistently updated to reflect the learner's changing preferences and skills.

4. Main Objectives

Creating and implementing a dynamic student learning profiling module for an e-learning system is the main goal of this research. The objective of this module is to furnish a precise and dynamic comprehension of every student, facilitating the provision of extremely customized learning encounters that enhance involvement, retention, and overall educational results.

5. Specific Objectives

Data Collection and Initial Profiling: To generate the initial iteration of the learner's profile, establish a system for gathering and analyzing user data via forms, surveys, and preliminary evaluations.
Non-Traditional Data Inclusion: To improve the precision and comprehensiveness of user profiles, incorporate non-traditional data sources—such as attention indicators and behavioral analytics—into the profiling process.
Update user profiles dynamically by putting in place algorithms that do so on a regular basis using data that is available in real time, such as engagement metrics, learning behaviors, and progress.
AI-Driven Improvements: Make advantage of AI technologies, like OpenAI or GeminiAI, to hone and improve user profiles, making sure they stay true to life and accurately represent the learner's present situation.
Secure Profile Management: To store and manage user profiles and enable easy access and integration with other e-learning system components, set up a scalable and secure MySQL database.

Methodology

The process of creating an e-learning system's "Student Learning Profiling Module" is organized to guarantee a methodical approach to collecting, evaluating, and using user data to produce dynamic and customized learning profiles. The system architecture, procedure, technologies and tools utilized, as well as the functional and non-functional requirements, are all described in this part.

1. System Architecture

The "Student Learning Profiling Module"'s system architecture is made to manage preprocessing, user profile creation, and the smooth integration of several data sources. The following essential elements are included in the architecture:

Process of Collecting User Information:
The first step of the module is gathering comprehensive user data using a variety of methods, including surveys, user interviews, and data from interactions on the e-learning platform. The user preferences, learning styles, historical performance, and personal information are all included in this raw data.

Module for Data Acquisition:
The gathered information is arranged and handled in a centralized database. After that, the Data Acquisition Module preprocesses the data, removing any errors and getting it ready for analysis.

Engine for User Profiling:
The User Profiling Engine uses statistical methods to examine the preprocessed data and find

trends and correlations. The engine creates dynamic user profiles that are subject to updating in response to fresh information and interactions.

Testing Usability and Prototypes:
The user profiling component's prototype is created and linked with the online learning platform. Representative users participate in usability testing sessions to assess the prototype's efficacy and usability. The system is improved and refined iteratively using the feedback.

2. Process

The "Student Learning Profiling Module" is being developed in an iterative manner via several stages:

Gathering of Data:
User preferences, objectives, and experiences are the subject of surveys and interviews, which are used to get qualitative information.
Quantitative data about user interactions with the e-learning platform, such as quiz scores, course completion rates, and time spent on modules, is also collected by the system.

Analyzing Data:
Statistical Analysis: To find important patterns and correlations that can guide the development of individualized learning profiles, the gathered data is subjected to statistical analysis techniques.

Development of Prototypes:
User Profiling Component: To create initial user profiles, a prototype of the user profiling component is produced by combining the collected data with analysis algorithms.

Testing for Usability:
Testing and Input: A representative user sample is used to test the prototype. Metrics related to user happiness and engagement are used to assess how effective the user profiling component is. The component is improved by taking into account feedback.

Assessment and Repetition:
Refinement: To increase the precision and utility of the user profiles, the system is iteratively refined based on usability testing.

3. Tools & Technologies

The following resources and technologies are utilized in the creation of the "Student Learning Profiling Module":

Tools for Gathering Data:

Survey tools: Use Typeform or Google Forms to collect qualitative data.
Tools for measuring and logging user interactions are included in the e-learning platform.

Tools for Data Analysis:
NumPy and Pandas are two Python packages used for statistical analysis.
Matplotlib and Tableau are examples of visualization tools that can be used to find patterns and relationships.

Tools for Testing and Development:
Frameworks written in Python or JavaScript are used to create the user profiling engine.
Usability testing tools for conducting sessions and gathering feedback include UserTesting and UsabilityHub.

Database:
You can store and manage user data with PostgreSQL or MySQL.

4. Functional & Non-Functional Requirements

Functional Requirements:

User Information Gathering:

Through surveys, interviews, and interaction tracking within the e-learning platform, the system has to collect user details.
For additional processing, the system has to keep the gathered data in a centralized database.
Analyzing Data:

To determine user preferences and learning patterns, the system has to statistically analyze the data that was gathered.
Based on the findings, the system needs to provide dynamic user profiles.
The profiling of users:

As fresh data is gathered and processed, the system has to dynamically update user profiles.
To offer tailored learning experiences, the system needs to incorporate the user profile component into the e-learning platform.
Testing for Usability:

In order to improve the user profiling component, the system has to provide usability testing sessions and take user feedback into account.

Non-Functional Requirements

Scalability

Without experiencing any performance deterioration, the system must be able to manage a big number of users and data points.
Safety:

To abide by privacy laws and stop unwanted access, user data must be managed and stored securely.
Usability:

Both administrators and end users should find it straightforward to navigate the system's intuitive UI.
Achievement:

To guarantee that individualized learning pathways are constantly up to date, the system has to process and update user profiles in real-time.

4. System Requirements

In order to initiate the "Student Learning Profiling Module," the subsequent system prerequisites must be fulfilled:

Hardware prerequisites:

A server that can manage operations related to data gathering, processing, and analysis should have enough processing power and storage.
Fast internet access to provide smooth data transfer and interaction monitoring.
Software prerequisites:

Operating System: An application hosted on a Linux-based server operating system (such as Ubuntu).
Database: PostgreSQL or MySQL are used to manage user data.
Python is used for data analysis and backend development, while JavaScript, HTML, and CSS are used for frontend interface development.