Capstone: Self-Learning AI Tutor

Role: Software Engineer (Capstone Project)
Tech: Python, Streamlit, MongoDB, OpenAI API, REST APIs

Problem:

The problem presented in this capstone project deals with the capability of learning tools to adapt to a student/users needs to help them learn better. Students and learners everywhere struggle with a one-size-fits-all approach that does not adapt to individual understanding or confidence. The goal of this project was to make one-on-one, personalized academic support accessible for all learning-styles.

My Contributions:

During this project I focused on a multitude of different features. I personally designed and implemented the adaptivity algorithm that dynamically selects questions based on weakest skills. This involved fine-tuning an algorithm that takes into consideration weighted accuracy scoring, confidence-based inputs, and exploring multiple skills early in the quiz before targeting the weakest skill area. This took numerous iterations to get the algorithm to both adapt and focus on the skills the student needed most help with.
I also helped develop and sanitize MongoDB-backed APIs with filtering and pagination capabilities. This was challenging since prior to this project I had never worked with MongoDB databases. However, when our sponsor decided he wanted only open-ended questions instead of MCQs, I was able to tackle the task of cleaning the database with confidence and haste to ensure client satisfaction. Another area I was involved in was testing. I managed end-to-end testing on numerous features to reduce incorrect academic feedback, ensure features were functioning properly, and further refine prompts used for LLM-based feedback.

Technical Highlights:

- OpenAI model evaluation and token-cost analysis
- JSON schema validation for LLM feedback
- One-time database migration scripts
- REST API design for scalable question retrieval

Impact:

This project not only helped me grow my skills as an engineer but it also is a point of pride that I was able to work on such impactful software. Through my contributions related to the adaptivity algorithm and LLM API integration, this software furthers the future of education as a whole. Our software improves learning personalization, reduces misinformation risk, increases accessibility and equity in education for students with all different learning-styles. The Self-Learning AI Tutor has built a foundation for future dynamic content generation which my team plans to continue work on throughout our next semester and make the software even more personalized.

Status: Actively maintained by the team with plans for expanded dynamic content generation and improved adaptivity.

Diagrams: