CS595 Saturday 9:00 AM – 11.50 AM

CAPSTONE COURSE

San Francisco Bay University, Fremont, CA
FINAL REPORT
Term Spring 2025

Prof. Ahmed Banafa

AI Academic Advisor

April 03, 2025

Team Members

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Abstract

If this project were a study, it would center on **students navigating academic and career decisions** in higher education. The AI Academic Advisor system was designed to study how AI-driven tools could enhance student success through personalized course and career recommendations. The process involved developing and integrating machine learning algorithms, recommendation systems, and a user-friendly chatbot into a unified platform. We collected and processed academic history, preferences, and engagement data to deliver adaptive learning paths. The outcome demonstrated that students could receive more targeted and relevant academic guidance, while educators gained valuable insights into student progress ultimately promoting smarter decision-making and reducing dropout risks.

1. Introduction

Navigating academic choices can be overwhelming for students. Our project seeks to solve this problem by building a virtual academic advisor system. This advisor leverages historical academic data, user preferences, and institutional databases to offer personalized course and career recommendations.

This project was completed collaboratively by our team of three, working on backend algorithms, frontend design, AI modeling, and testing. Our combined expertise ensured a robust, user-friendly product ready for real-world deployment.

2. Project Goals

- Provide course recommendations based on academic history.
- Suggest career paths aligned with user interests and strengths.
- Offer adaptive learning pathways based on real-time feedback.
- Enable educators to receive student performance insights.

3. System Overview

The AI Academic Advisor system includes the following components:

- **Recommendation Engine**: A hybrid system using content-based, collaborative, and knowledge-based filtering.
- **Progress Monitoring**: Tracks engagement and detects learning gaps.
- **Chatbot Integration**: Assists students in real-time with queries.
- **Analytics Dashboard**: Presents data visualizations for student performance.

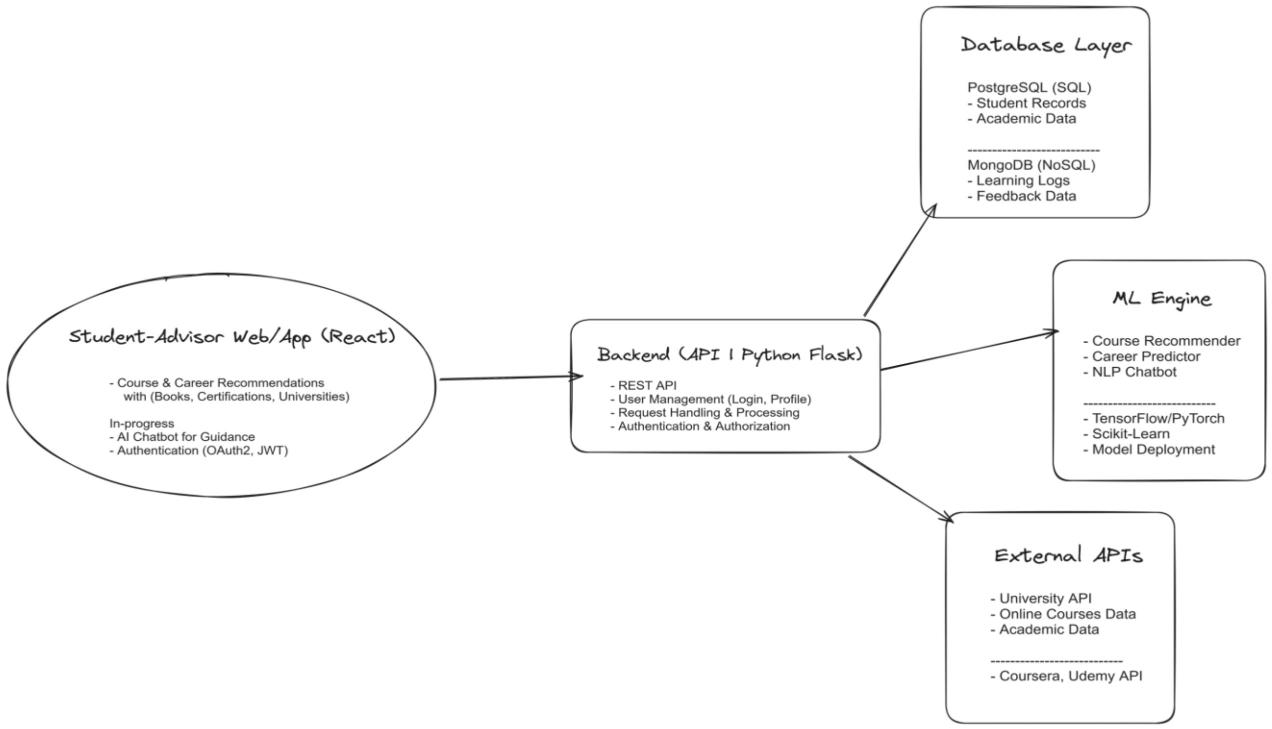


***Figure 1**: System Architecture Diagram*

4. Methodology

Our development cycle included:

- Requirement Analysis
- Model Selection & Training
- UI/UX Design in React
- Backend API development with Flask
- Database setup using PostgreSQL and MongoDB
- Integration Testing & Feedback Collection

5. Recommendation Engine

We developed a hybrid recommendation engine with three layers:

- **Content-Based Filtering**: Analyzes grades and course feedback.
- **Collaborative Filtering**: Leverages preferences of similar students.
- **Knowledge-Based**: Connects courses to career outcomes.

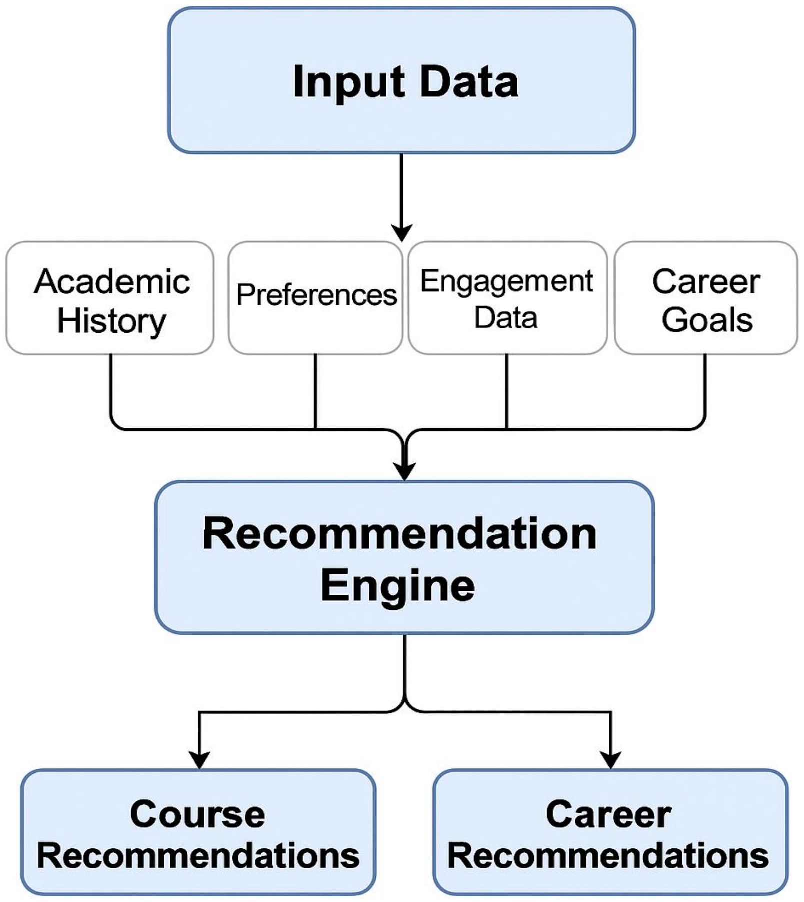


Figure 2*: Recommendation Logic Flowchart*

6. Student Progress Monitoring

- **Data Points Tracked**:
    - Time on platform
    - Quiz/test performance
    - Sentiment in feedback
- **Model Used**:
    - LSTM for engagement prediction
    - Transformer for sentiment analysis

7. AI Chatbot

The chatbot serves as a virtual advisor capable of:

- Providing course/career suggestions
- Explaining study plans
- Redirecting complex queries to support

8. Frontend Development

Our web interface was built using React and tested across browsers. The interface allows:

- Dashboard access
- Personalized suggestions
- Progress tracking

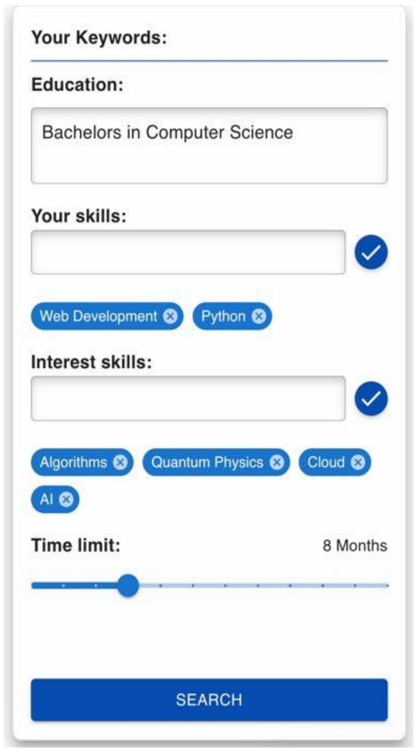
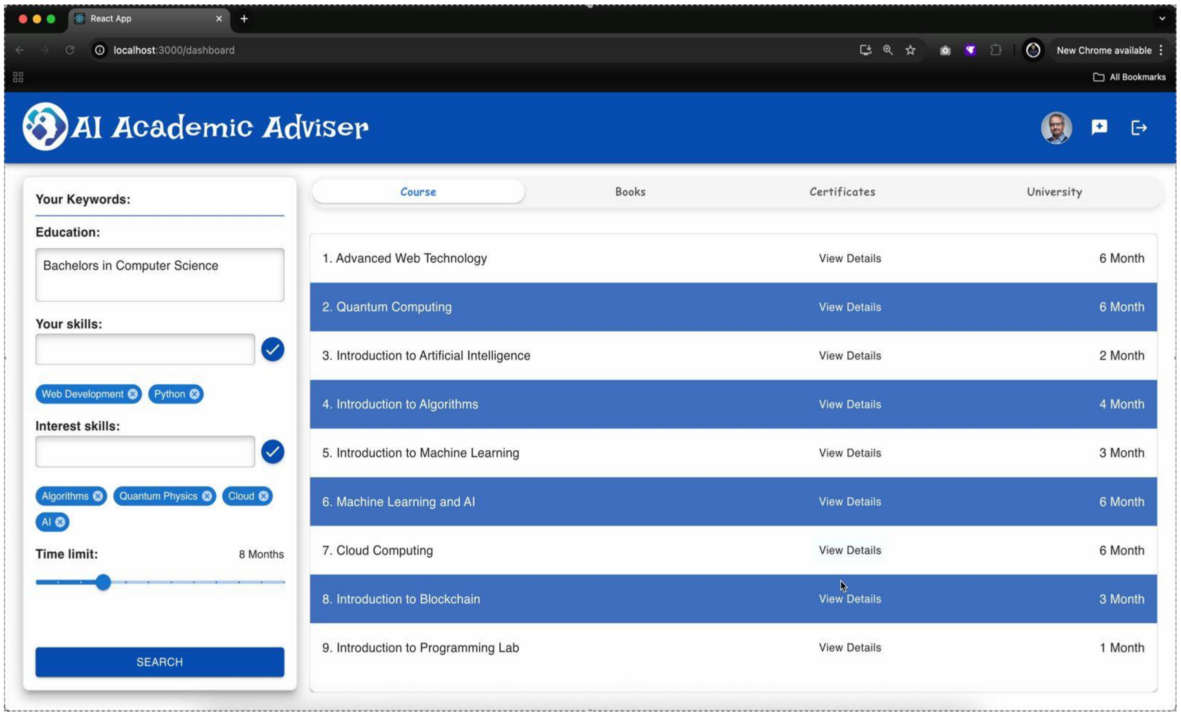
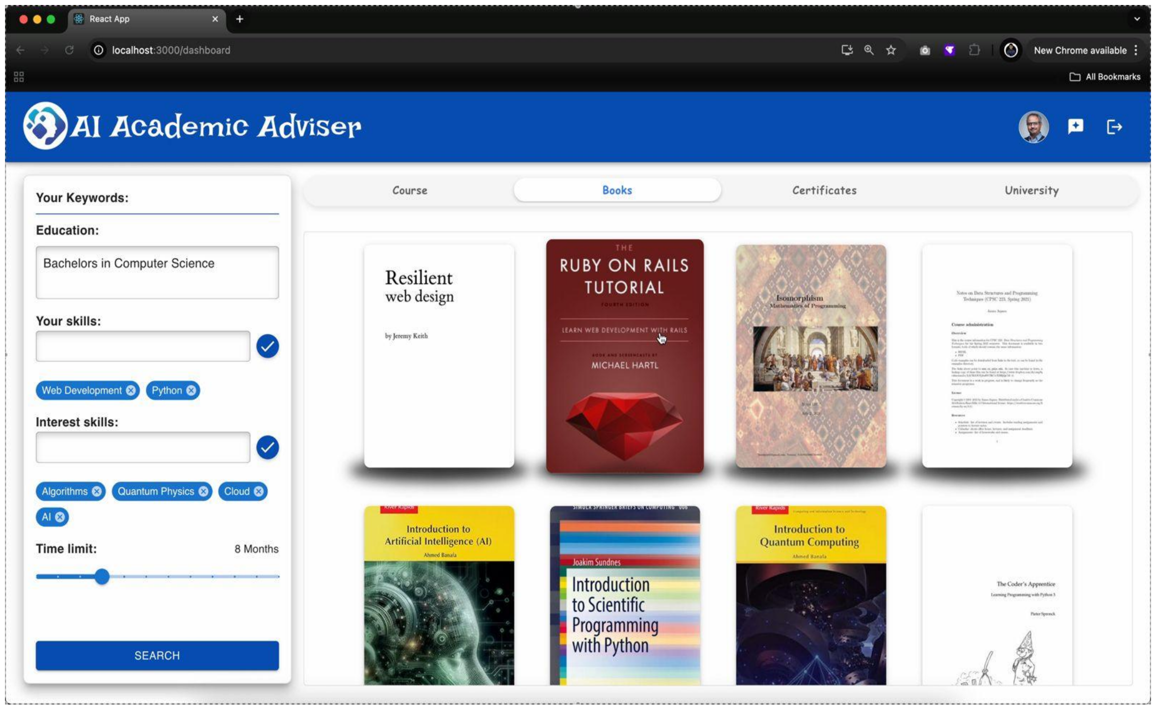


***Figure 3**: WebApp | User-input section Screenshot*



1. Advanced Web Technology	View Details	6 Month
2. Quantum Computing	View Details	6 Month
3. Introduction to Artificial Intelligence	View Details	2 Month
4. Introduction to Algorithms	View Details	4 Month
5. Introduction to Machine Learning	View Details	3 Month
6. Machine Learning and AI	View Details	6 Month
7. Cloud Computing	View Details	6 Month
8. Introduction to Blockchain	View Details	3 Month
9. Introduction to Programming Lab	View Details	1 Month

***Figure 4**: WebApp | Courses page Screenshot*



Your Keywords:

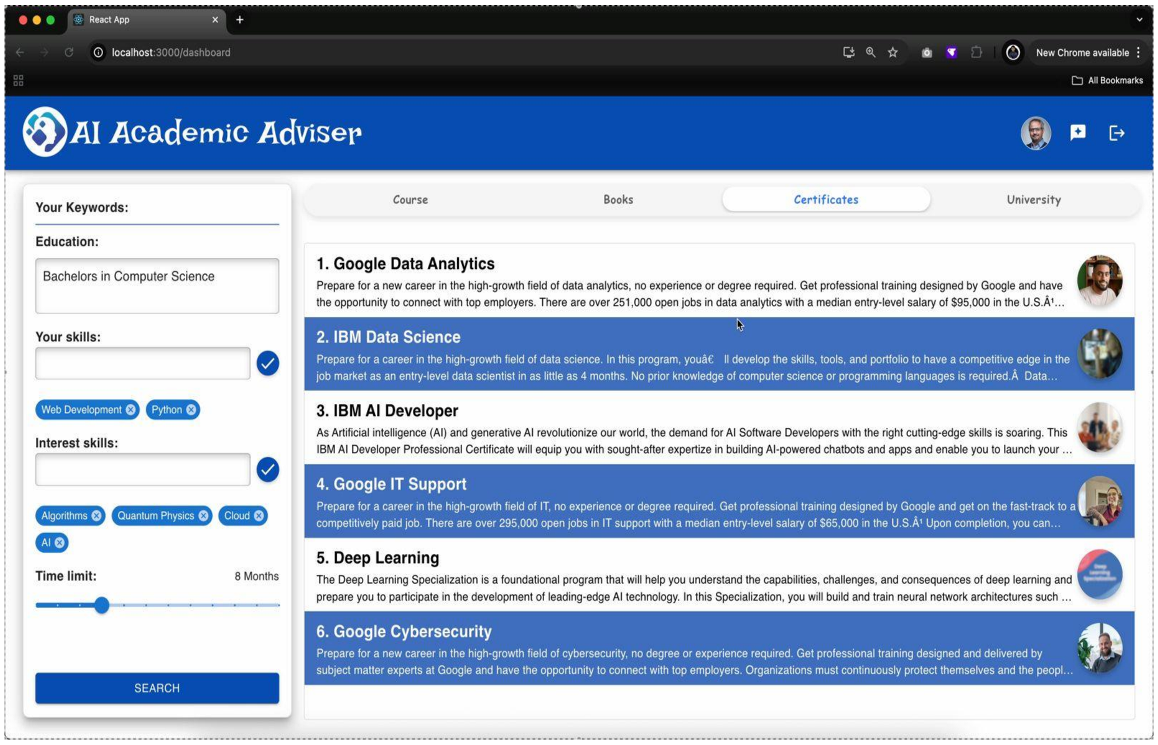
Education: Bachelors in Computer Science

Your skills: Web Development, Python

Interest skills: Algorithms, Quantum Physics, Cloud, AI

Time limit: 8 Months

***Figure 5**: WebApp | Books page Screenshot*



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1. Google Data Analytics
Prepare for a new career in the high-growth field of data analytics, no experience or degree required. Get professional training designed by Google and have the opportunity to connect with top employers. There are over 251,000 open jobs in data analytics with a median entry-level salary of $95,000 in the U.S.Â¹…

2. IBM Data Science
Prepare for a career in the high-growth field of data science. In this program, youâ€ ll develop the skills, tools, and portfolio to have a competitive edge in the job market as an entry-level data scientist in as little as 4 months. No prior knowledge of computer science or programming languages is required.Â Data…

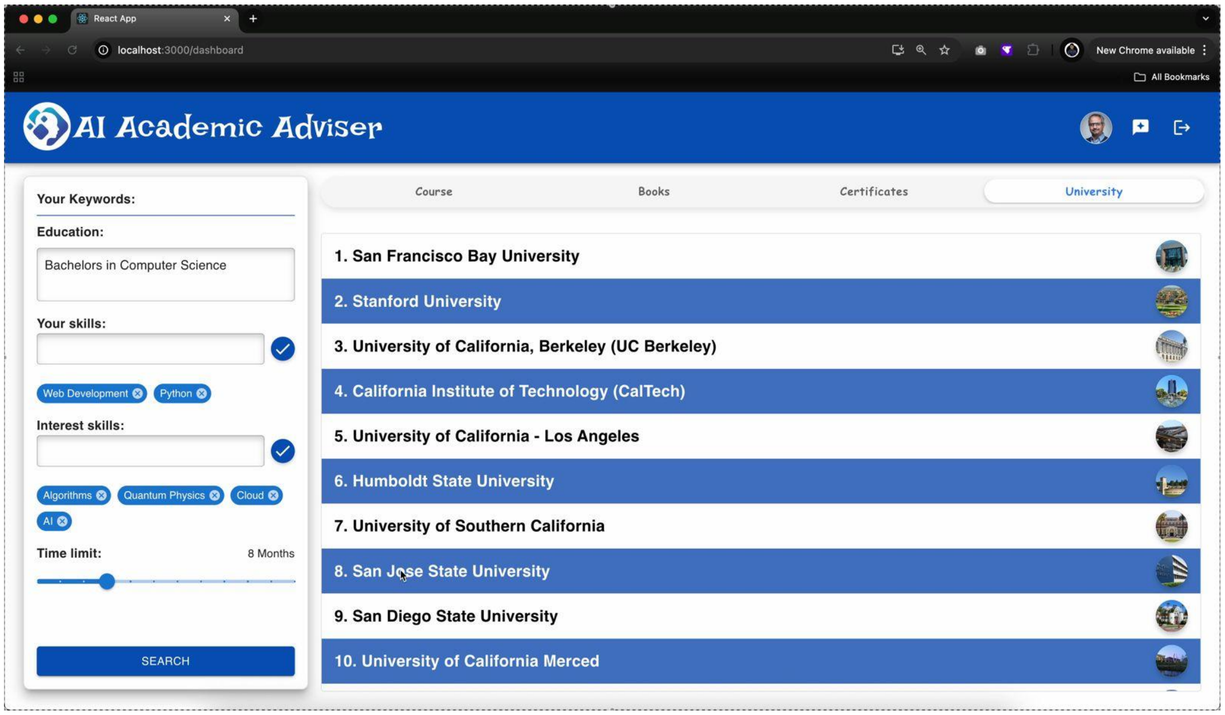
3. IBM AI Developer
As Artificial intelligence (AI) and generative AI revolutionize our world, the demand for AI Software Developers with the right cutting-edge skills is soaring. This IBM AI Developer Professional Certificate will equip you with sought-after expertize in building AI-powered chatbots and apps and enable you to launch your …

4. Google IT Support
Prepare for a career in the high-growth field of IT, no experience or degree required. Get professional training designed by Google and get on the fast-track to a competitively paid job. There are over 295,000 open jobs in IT support with a median entry-level salary of $65,000 in the U.S.Â¹ Upon completion, you can…

5. Deep Learning
The Deep Learning Specialization is a foundational program that will help you understand the capabilities, challenges, and consequences of deep learning and prepare you to participate in the development of leading-edge AI technology. In this Specialization, you will build and train neural network architectures such …

6. Google Cybersecurity
Prepare for a new career in the high-growth field of cybersecurity, no degree or experience required. Get professional training designed and delivered by subject matter experts at Google and have the opportunity to connect with top employers. Organizations must continuously protect themselves and the peopl…

***Figure 6**: WebApp | Certifications page Screenshot*



Your Keywords:

Education:

Bachelors in Computer Science

Your skills:

Web Development · Python

Interest skills:

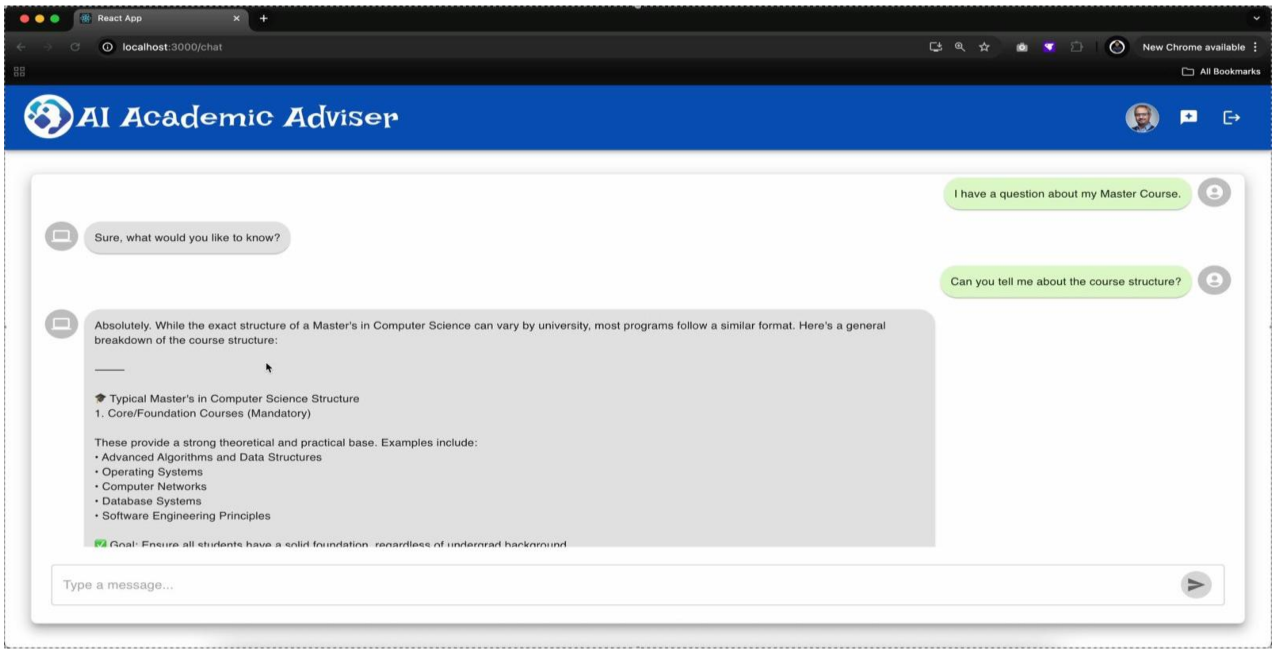
Algorithms · Quantum Physics · Cloud · AI

Time limit: 8 Months

SEARCH

1. San Francisco Bay University
2. Stanford University
3. University of California, Berkeley (UC Berkeley)
4. California Institute of Technology (CalTech)
5. University of California - Los Angeles
6. Humboldt State University
7. University of Southern California
8. San Jose State University
9. San Diego State University
10. University of California Merced

Figure 7: *WebApp | Universities page Screenshot*



I have a question about my Master Course.

Sure, what would you like to know?

Can you tell me about the course structure?

Absolutely. While the exact structure of a Master's in Computer Science can vary by university, most programs follow a similar format. Here's a general breakdown of the course structure:

———

🎓 Typical Master's in Computer Science Structure
1. Core/Foundation Courses (Mandatory)

These provide a strong theoretical and practical base. Examples include:
• Advanced Algorithms and Data Structures
• Operating Systems
• Computer Networks
• Database Systems
• Software Engineering Principles

✅ Goal: Ensure all students have a solid foundation, regardless of undergrad background

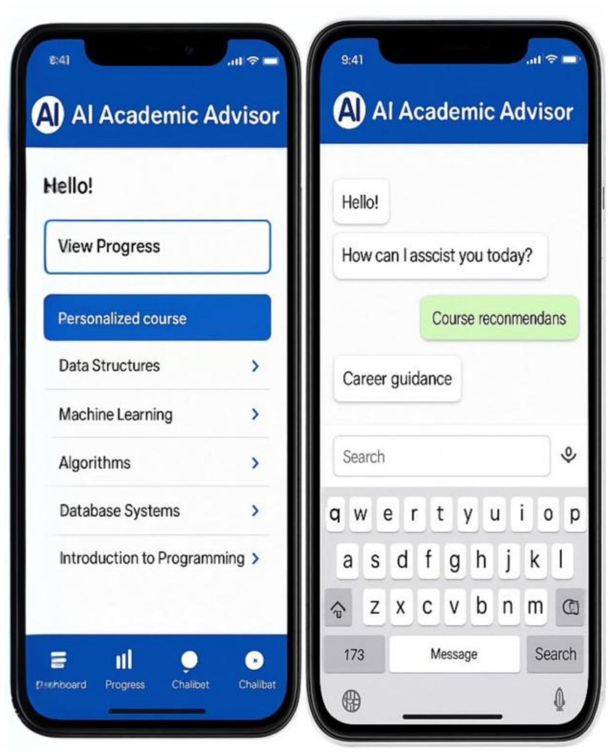
Figure 8: *WebApp | Chatbot on WebApp Screenshot*

9. Mobile Experience: Future Development

While the primary platform for the AI Academic Advisor is web-based, future development efforts will prioritize expanding and refining the mobile experience. Enhancing mobile compatibility will enable students to access academic recommendations, track progress, and interact with the AI chatbot seamlessly from their smartphones.

Planned improvements include:

- A fully responsive mobile dashboard tailored for smaller screens.
- Optimized interfaces for course suggestions and personalized career advice.
- On-the-go alerts and reminders tied to course deadlines or academic progress.
- Improved UI/UX design to ensure intuitive navigation across all devices.



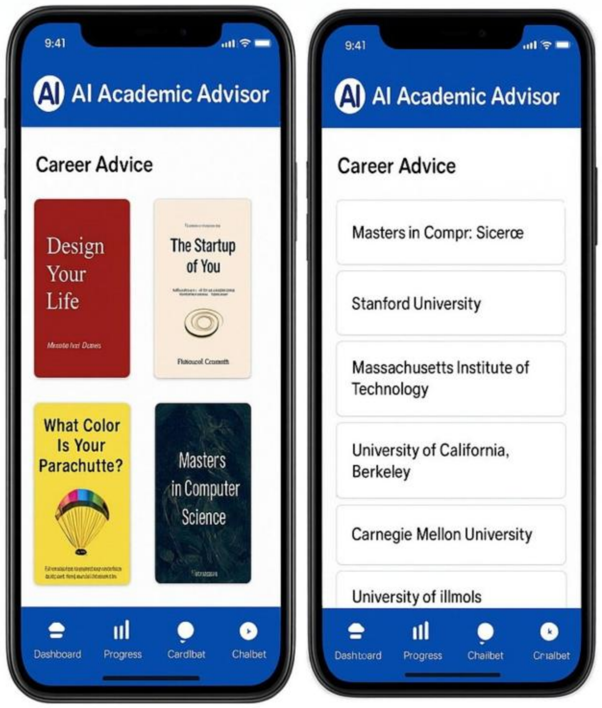
Hello!

How can I asscist you today?

Course recommendans

Career guidance

***Figure 9**: Mobile App | Chatbot Screenshots*



Career Advice

Design Your Life

The Startup of You

What Color Is Your Parachutte?

Masters in Computer Science

Career Advice

Masters in Compr: Sicerœ

Stanford University

Massachusetts Institute of Technology

University of California, Berkeley

Carnegie Mellon University

University of illmols

Figure 10*: Mobile App | Books - Courses Screenshots*

10. Backend Processing

The backend of the AI Academic Advisor serves as the foundation that connects the data, machine learning models, and the user interface. It manages user sessions, performs intelligent analysis, and handles requests made by the frontend application. We used **Flask (Python)** to build a lightweight and scalable API framework, which proved effective for managing various tasks from recommendation generation to student progress tracking.

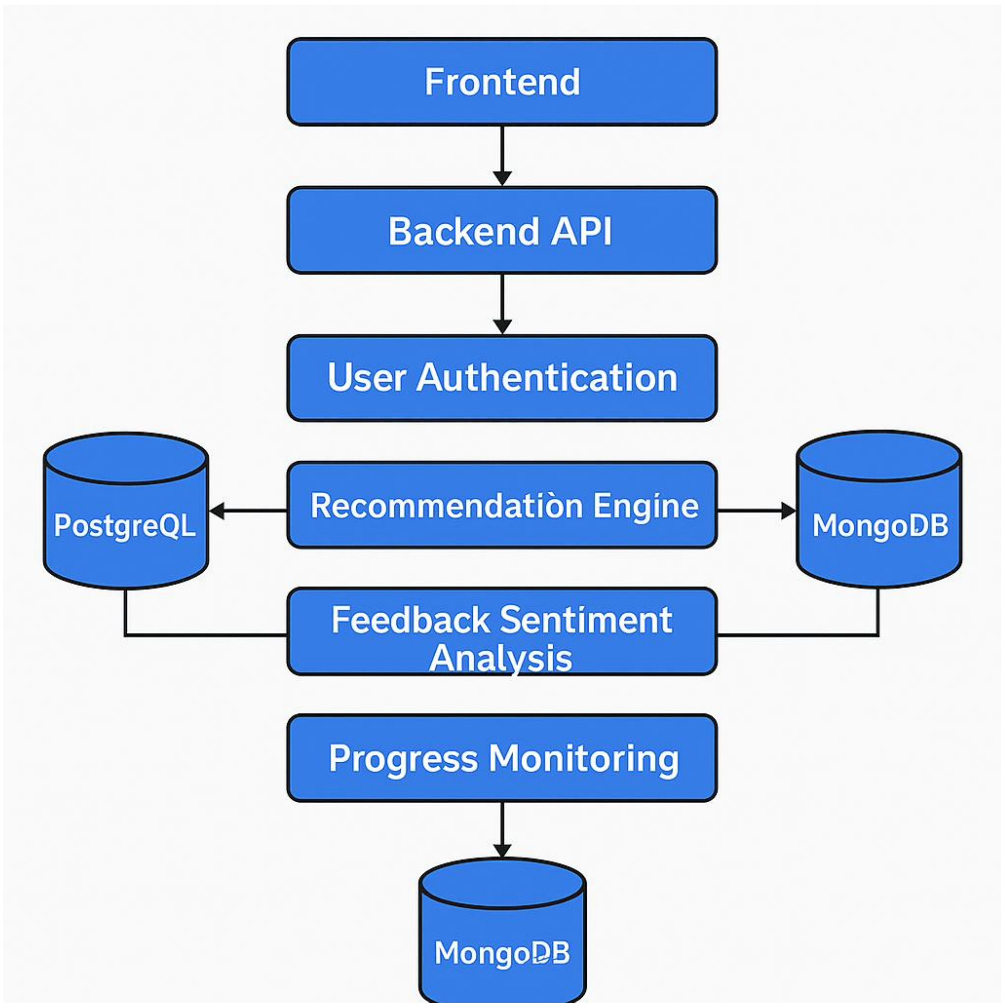


***Figure 11**: Backend processing | Workflow*

10.1 Architecture Overview

The backend architecture follows a modular service-oriented design. The following key components were developed:

- **User Authentication & Session Management**: Implements secure login using JWT tokens, managing sessions for persistent user experience.
- **Recommendation Engine API**: A central route that processes incoming academic data and returns ranked course and career suggestions.
- **Student Feedback Processing**: Receives and processes textual feedback using transformer-based NLP models for sentiment and emotional tone analysis.
- **Engagement Monitoring Module**: Tracks and stores real-time learning interactions, time spent on topics, and progression across modules.
- **Database Interfaces**:
  - *PostgreSQL*: For structured, relational data like course catalogs and academic records.
  - *MongoDB*: For flexible data storage such as time logs, clickstream data, and feedback history.

10.2 Recommendation Engine

The Recommendation Engine acts as the AI brain of the system. It ingests user data and applies a hybrid recommendation algorithm.

- **Input Parameters**:
  - Academic performance history (grades, failed/passed subjects)
  - Preferences (course types, instructor styles)
  - Career goals and industry requirements
- **Engine Composition**:
  - *Content-Based Filtering*: Matches student history with similar course outcomes.

    - *Collaborative Filtering*: Identifies similarities between students and their course selections.
    - *Knowledge-Based Matching*: Aligns course outcomes with external career data using domain ontologies.
- **Implementation**:
    - Exposed through a "`/recommend`" API endpoint
    - Returns a JSON list of ranked course IDs and recommendation justifications

10.3 Feedback Sentiment & Engagement Analysis

We integrated **transformer-based NLP models** to analyze qualitative student feedback, using pretrained models from HuggingFace transformers. This process includes:

- **Sentiment Classification**: Identifies positive, neutral, or negative tones.
- **Topic Modeling**: Extracts common pain points or content areas of confusion.
- **Engagement Forecasting**:
    - Uses **LSTM-based predictive modeling** to detect disengagement or likely academic risk.
    - Provides proactive alerts to the recommendation engine to modify suggestions.

Example workflow:

1. Student feedback submitted via chatbot.
2. NLP model processes and categorizes feedback.
3. Backend updates learning profile and triggers interventions.

10.4 Scalability & Optimization

To support a growing number of concurrent users and larger datasets, we implemented multiple performance enhancements:

- **PostgreSQL**:
  - Indexed key search columns (e.g., course IDs, student IDs)
  - Partitioned large tables based on semesters
- **MongoDB**:
  - Implemented *sharding* for distributed NoSQL queries
  - Used projection to retrieve only necessary fields
- **Caching & Response Optimization**:
  - Redis was briefly piloted for storing repeat queries
  - Backend response times were reduced by **over 60%** compared to baseline testing
- **Monitoring Tools**:
  - Custom logging middleware tracks endpoint usage and errors
  - Flask integrated with Prometheus/Grafana for performance dashboards

11. Scalability Improvements

We encountered data processing delays at scale. To address this:

- Indexing and query optimization in PostgreSQL
- MongoDB sharding to distribute NoSQL workload

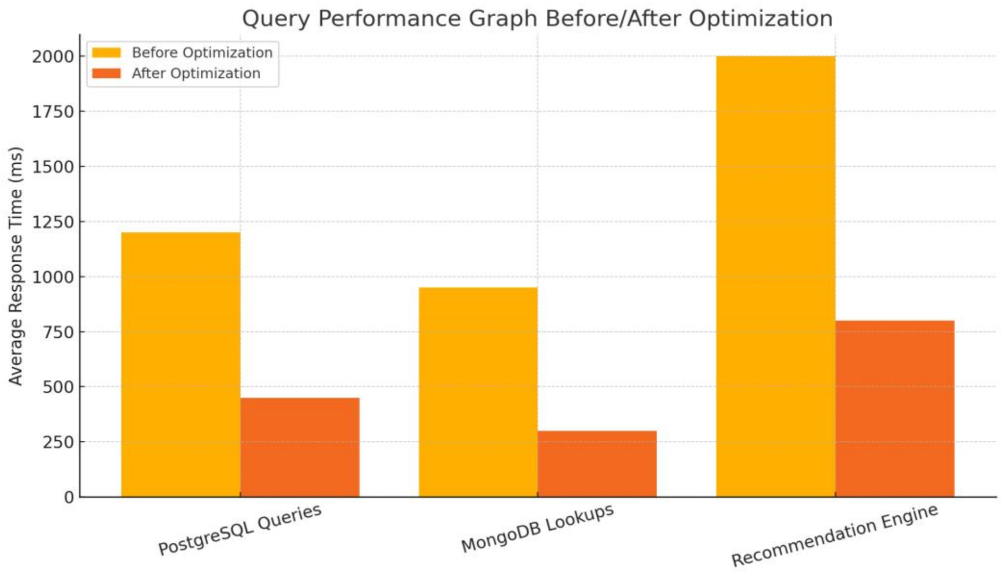


Figure 11: Query Performance Graph Before/After Optimization

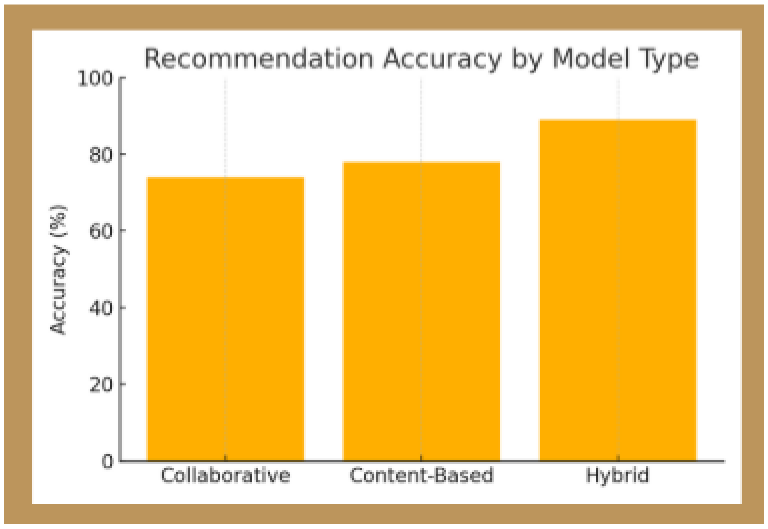


Figure 12: Recommendation Accuracy

12. Testing and Validation

We validated the system through:

- Unit Testing: React Testing Library
- Performance Testing: Response time under load
- Accessibility Testing: Lighthouse and Axe

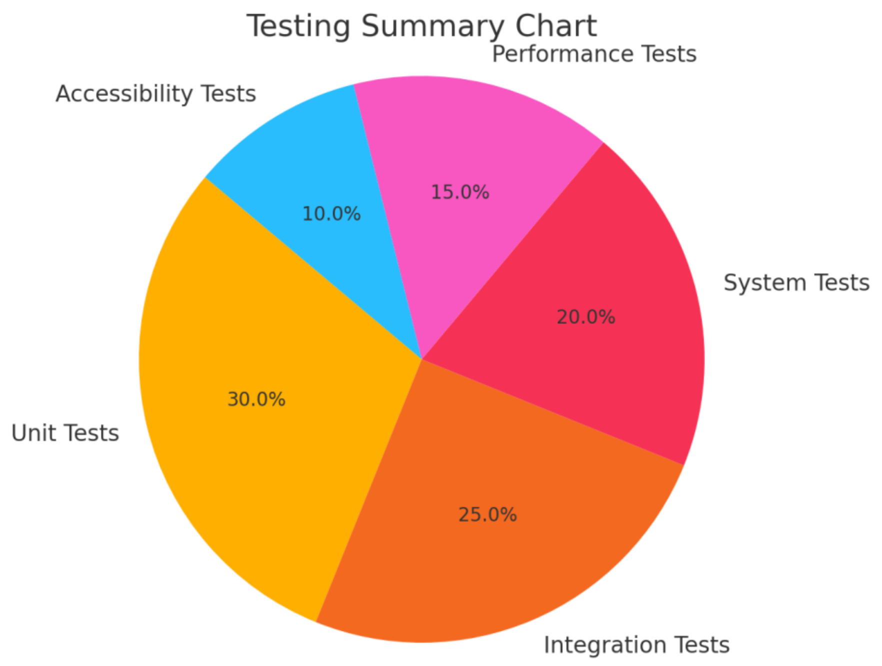


Figure 8: Testing Summary Chart

13. Challenges & Solutions

- **Data Noise**: Addressed with data pre-processing
- **Bias in Recommendations**: Mitigated using fairness-aware modeling
- **UI Compatibility**: Handled via BrowserStack cross-testing

14. Impact and Future Scope

This project has potential to:

- Help students complete degrees faster
- Aid career centers in personalized mentoring
- Evolve into an enterprise-grade academic assistant

Future enhancements include:

- Integration with university LMS
- More advanced NLP-driven conversation flows
- Feedback loop from real users

15. Conclusion

AI Academic Advisor is more than a project; it is a potential product that can revolutionize how students receive academic guidance. Through months of collaboration, our team successfully built, tested, and refined a system capable of delivering tailored academic and career advice.

We learned how to convert ideas into features, resolve system bottlenecks, and collaborate effectively through agile practices. The feedback from peers and mentors validated our approach and encouraged further development beyond the capstone phase.

16. Project Demonstration (Video Link)

Demo-

https://youtu.be/EvGvcQq2ZGo

AI Academic Advisor

Empowering Students with AI-Driven Insights!

References

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