Technical Note: AI-Powered Adaptive Math Learning Prototype

1. Introduction

This prototype demonstrates a basic adaptive learning mechanism that adjusts math problem difficulty based on student performance. The objective is to maintain an appropriate learning challenge by increasing difficulty when the learner performs well and decreasing it when they struggle. A rule-based approach is used to keep the system transparent and simple.

2. System Architecture

Puzzle Generator: Creates math problems for Easy, Medium, and Hard difficulty levels using different numerical ranges.
Performance Tracker: Records correctness and response time and compiles these into summary statistics.
Adaptive Engine: Adjusts difficulty using rule-based logic driven by a performance trend value.
Main Application: Runs the full learning session using a command-line interface and coordinates all modules.

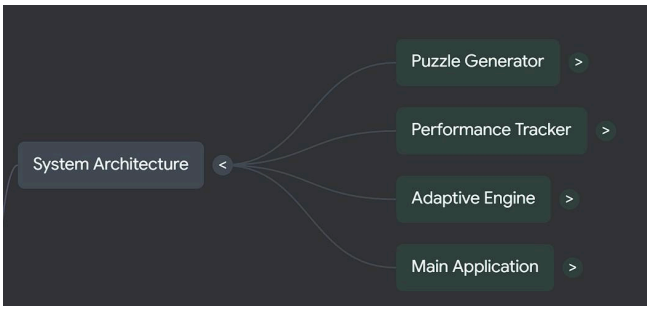


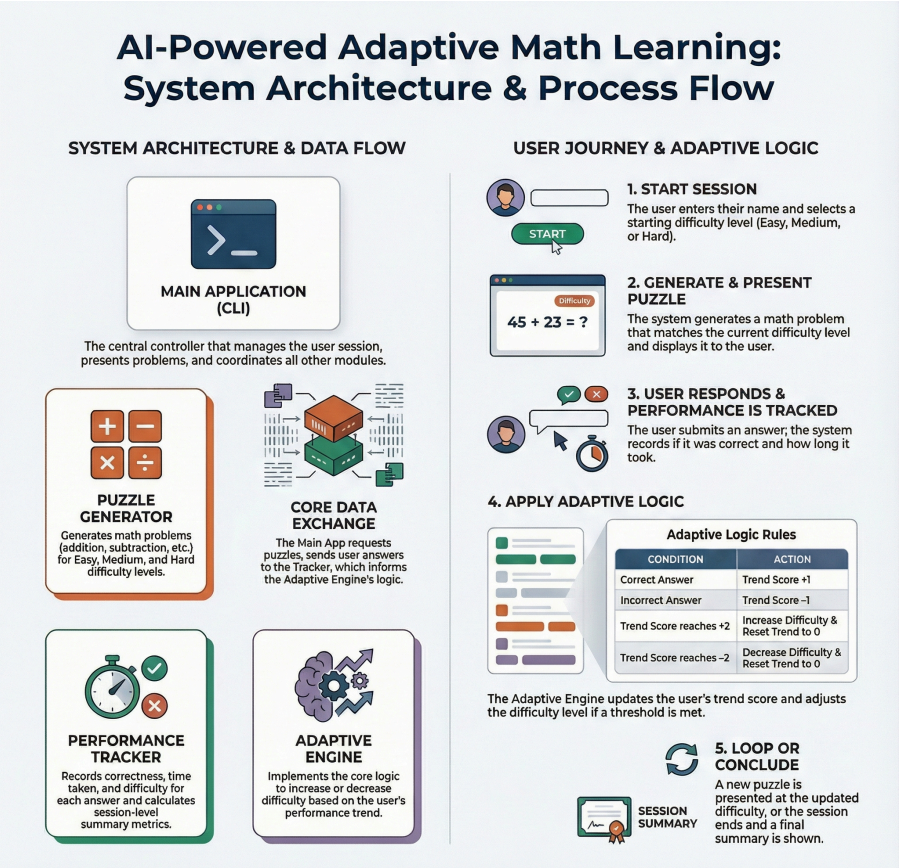
Fig: System Architecture

3. System Flow

Start → User selects difficulty → Puzzle generated → User answers → Performance tracked → Adaptive engine updates difficulty → Next puzzle → Summary displayed.

4. Adaptive Logic

The system uses a short-term trend score reflecting recent performance:
Correct answer: +1
Incorrect answer: –1
Trend reaches +2 → Increase difficulty
Trend reaches –2 → Decrease difficulty
Trend resets after each difficulty change.
This creates stable and predictable difficulty transitions.



5. Metrics Tracked

The system records: correctness, time taken, and difficulty for each question.
The summary reports: overall accuracy, average response time, and number of questions attempted.

6. Rationale for Rule-Based Approach

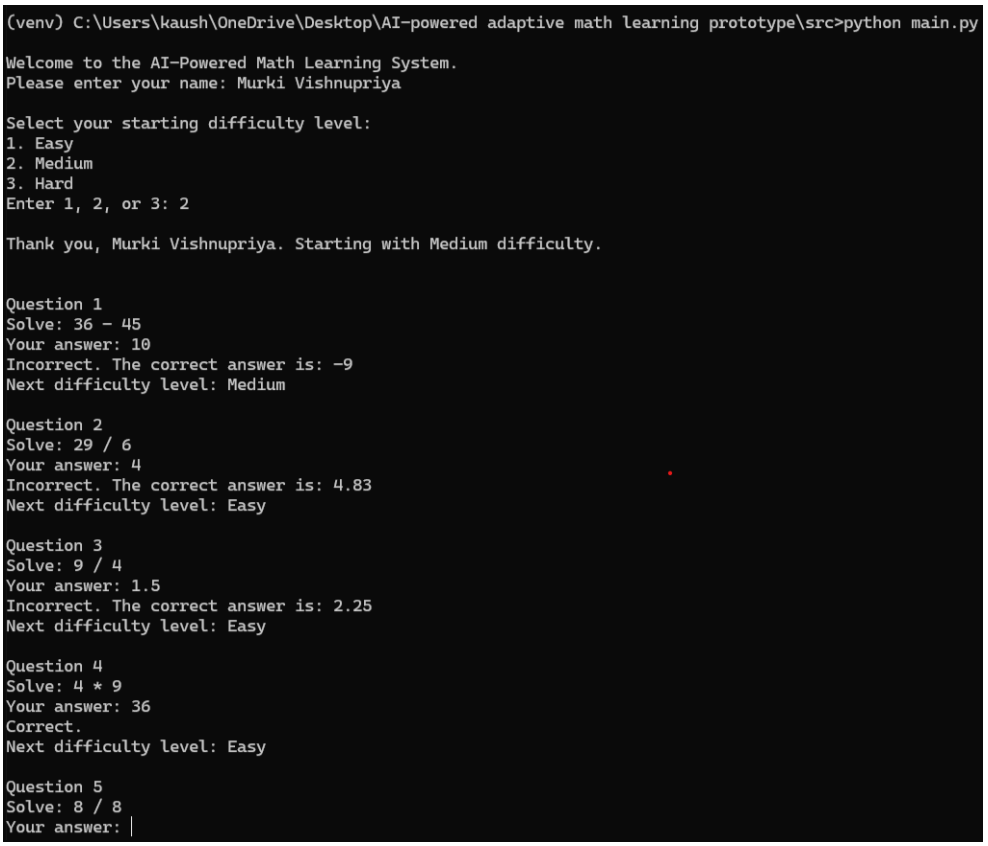
A rule-based system was selected because it requires no dataset, is easy to interpret, and is aligned with the prototype's simplicity goals. Although machine learning could offer more

sophisticated adaptation, it would require a larger volume of historical performance data and additional engineering effort.

7. Potential Extensions

- Introducing ML-based prediction for difficulty adjustment
- Adding more math types (fractions, word problems, mixed operations)
- Developing a web or mobile interface
- Implementing user profiles to track long-term learning progress

8. OUTPUT



9. Conclusion

The system successfully demonstrates how adaptive logic can personalize learning by modifying difficulty based on real-time performance. The modular design provides a strong foundation for advanced versions involving richer content and data-driven personalization.