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SHORT TECHNICAL NOTE : MATH ADVENTURES — AI-POWERED ADAPTIVE LEARNING PROTOTYPE

OVERVIEW

This project is a Python-based adaptive math learning game designed for children aged 5–10 years, built to feel like a fun arcade-style challenge rather than a traditional quiz.

The system automatically changes the difficulty of math questions based on how the child performs. If they keep answering correctly and quickly, they level up to tougher challenges. If they struggle, the game slows down a bit to make it easier and help them learn comfortably.

The idea is to keep every child in their perfect learning zone (not too easy, not too hard), while making math feel exciting and rewarding.

To match the child's age and ability, the game uses two age groups with different sets of operations and rules.

Age Group: 5 to 7 years

Difficulty	Operations	Notes
Easy	Addition (+)	Simple integer sums
Medium	Multiplication (×)	Integer results only
Hard	Division (÷) or Subtraction (−)	Integer-only results (no decimals)

Age Group: 8 to 10 years

Difficulty	Operations	Notes
Easy	Addition (+) and Subtraction (−)	Integer results
Medium	Addition (+) and Subtraction (−) and Multiplication (×)	Integer results
Hard	Division (÷) and Addition (+) and Subtraction (−) and Multiplication (×)	Decimal answers allowed

ARCHITECTURE / FLOW

Start → Puzzle Generator → User Answer → Performance Tracker (correctness, time) → Adaptive Engine (rule-based) → Adjust Difficulty → Next Question / Summary

ADAPTIVE LOGIC USED

Condition	Action
3 consecutive correct (Easy → Medium)	Level up
5 consecutive correct (Medium → Hard)	Level up
2 consecutive wrong (Any → lower level)	Level down
Otherwise	Stay on same level

Additional logic:

- If the learner answers faster (low average response time), they stay on a good pace for higher levels.
- Once a wrong answer occurs, the consecutive correct streak resets.

By keeping the rules simple and consistent, the system helps children stay confident and engaged, turning mistakes into learning moments instead of frustration.

METRICS TRACKED

Metric	Description	How It Affects Difficulty
Correctness	Whether the child answered right or wrong	Directly determines level-up or level-down transitions
Consecutive Correct/Wrong Count	Number of correct or incorrect answers in a row	Used to trigger difficulty change
Response Time (seconds)	Time taken per question	Helps analyze speed; consistently low time can be a secondary indicator of mastery
Accuracy (%)	Ratio of correct answers	Reported in the end summary for performance evaluation
Average Time per Question	Average time across all attempts	Used in session summary and future improvement insights

WHY YOU CHOSE THIS APPROACH

- The rule-based logic was chosen over a machine learning approach for the following reasons:
- **Simple and Transparent:** It is Easy to understand, explain, and modify - ideal for children's education.
 - **No Data Needed:** It works instantly without training on past data.
 - **Consistent Results:** It has predictable behavior prevents sudden or confusing difficulty jumps.
 - **Lightweight:** It runs offline using only basic Python logic.

CONSOLE

```
(base) harshsrivastava@Harshs-MacBook-Air-2 math-adaptive-prototype % cd ~/Desktop/math-adaptive-prototype
python3 src/main.py

=== Math Adaptive Game ===
Enter name: ejknwe
Enter age (5-10): 6
Choose starting difficulty (easy/medium/hard) [default easy]:
Type 'End' to finish session anytime.

Difficulty: Easy | Question: 9 + 10 = ?
Your answer: 19
✅ Correct!
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Difficulty: Easy | Question: 6 + 9 = ?
Your answer: 15
✅ Correct!
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Difficulty: Easy | Question: 3 + 1 = ?
Your answer: 4
✅ Correct!
Level up! Next question will be harder.
---

Difficulty: Medium | Question: 5 x 4 = ?
Your answer: 6
❌ Wrong. Correct answer: 20
---

Difficulty: Medium | Question: 2 x 1 = ?
Your answer: 4
❌ Wrong. Correct answer: 2
Level down. Next question will be easier.
---

Difficulty: Easy | Question: 10 + 2 = ?
Your answer: end

=== Session Summary ===
Player: ejknwe | Age: 6
Total Questions: 5
Correct: 3
Accuracy: 60.0%
Average Time per Question: 3.3s
Recommended next level: Easy
=====
```