Project Proposal: Human-in-the-Loop – Feedback Based Learning Math Agent

**1. Introduction**

This project aims to build a smart **Math Question Answering Agent** that not only solves math queries using symbolic computation (like a math teacher) but also integrates a **human-in-the-loop feedback system** to continuously improve itself.

The agent follows an **Agentic-RAG architecture**, starting with a local **knowledge base (VectorDB)** and falling back on **web search** when required. A human reviewer can correct or validate answers, enabling feedback-driven learning.

**2. Objective**

To design and deploy an AI-powered agent that:

* Solves math problems with **step-by-step solutions**.
* Uses **knowledge retrieval** from a vector store.
* Falls back to **web search** if the answer is unknown.
* Supports **human correction/feedback**, enabling learning.
* Is deployed using a modern, shareable frontend (Streamlit).

## ****3. Architecture Overview****

### ****Components:****

1. **Math Query Interface (Streamlit):**  
   User submits a question.
2. **VectorDB (Qdrant):**  
   System checks if the question has already been asked and answered. Semantic similarity is used for match retrieval.
3. **Math Solver (SymPy):**  
   If no answer found in VectorDB, the system computes it using symbolic math libraries.
4. **Web Search Fallback (Tavily/Serper API):**  
   If symbolic methods fail, the system performs a real-time web search to extract potential answers.
5. **Answer Comparison Engine:**  
   Cross-verifies AI-generated and web-derived answers.
6. **Human-in-the-Loop Feedback (DSPy or Manual Input):**  
   Human reviewer can correct the answer or validate it.
7. **Answer Logging and Learning:**  
   If new/correct answer provided by human, it’s stored in the knowledge base for future use.

**4. Tools and Technologies Used**

| **Component** | **Technology** |
| --- | --- |
| Interface | Streamlit |
| VectorDB | Qdrant |
| Math Solver | SymPy |
| LLM Agent Framework | DSPy |
| Web Search | Tavily or Serper |
| Feedback Loop | Manual Input / DSPy Chain |
| Deployment | Streamlit + ngrok |
| Language | Python |
| Version Control | GitHub |

**5. Workflow Diagram (Architecture)**

[User Input]

↓

[Vector DB Search] ←–––––––––––––––––← [Answer Logging + Feedback Update]

↓ (not found)

[Math Solver (SymPy)]

↓ (unsure)

[Web Search Engine]

↓

[Answer Comparison + Validation]

↓

[Human Feedback (Optional)]

↓

[Final Answer → Displayed on UI]

**6. Features**

* Step-by-step symbolic math solving
* Intelligent fallback using web search
* Learns from feedback (continuous improvement)
* Stores corrected answers for future use
* Uses advanced NLP with vector similarity for matching
* Fully deployed using Streamlit + ngrok

**7. Deployment**

* The project is deployed on **Streamlit** and made public using **ngrok** for testing/demo purposes.
* App Live Link: https://0d9f-35-245-175-37.ngrok-free.app  
   GitHub

## ****8. Limitations & Future Scope****

### Current Limitations:

* Relies on internet-based web search, which may be slow.
* Human feedback is currently manual, not via UI.
* Uses free-tier ngrok deployment (limited duration).

### Future Improvements:

* Integrate with few **JEE Bench** for benchmarking for time being.
* Use **LangGraph or CrewAI** for more modular agent flows.
* Add a built-in feedback UI for seamless correction.
* Migrate to a **permanent hosting platform**.

**9. Conclusion**

This Math Agent demonstrates how AI, combined with structured feedback, can create intelligent educational tools. The use of **Agentic-RAG architecture**, **vector similarity**, **web search fallback**, and **human-in-the-loop learning** makes the system powerful and scalable for real-world math education and assistance.