

## OVERVIEW

- AI-powered web assistant with real human voice and text interaction.
- Fast API backend using RAG for context-aware educational responses.
- Database integration for storing and retrieving lecture materials.

## VALUE PROPOSITION

Value Proposition: A web-based AI teaching assistant that delivers personalized, context-aware computer science instruction through voice and text interactions, available whenever students need help.

## KEY REQUIREMENTS

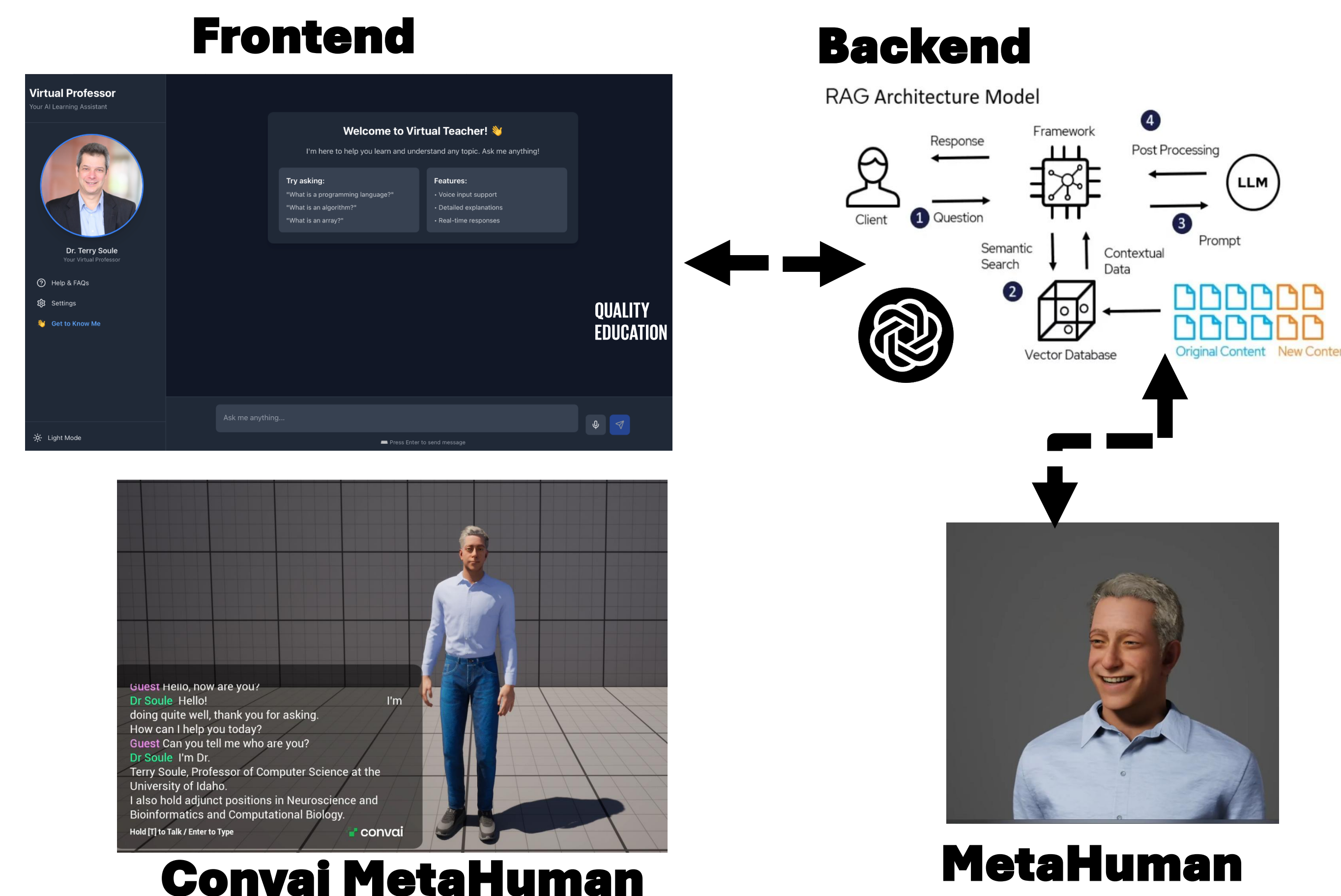
- Interactive web interface with text and voice capabilities
- AI-powered responses to computer science questions
- RAG system for curriculum-aligned content retrieval
- Audio processing for speech-to-text and text-to-speech
- Database for CS lecture content management



## CONCEPT DEVELOPMENT

A fully functional virtual professor, designed to resemble a real instructor and embedded in a website, capable of engaging in real-time interactions and equipped with comprehensive knowledge in Computer Science.

## THE FINAL DESIGN



| Frontend                                                                                                                                                              | Backend                                                                                                                                                                                                    | MetaHuman                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• React-based chat interface</li> <li>• Web Audio voice recording</li> <li>• Eleven Labs realistic speech synthesis</li> </ul> | <ul style="list-style-type: none"> <li>• FastAPI Python REST server</li> <li>• ChromaDB vector-based RAG system</li> <li>• SQL database for CS content</li> <li>• OpenAI embeddings integration</li> </ul> | <ul style="list-style-type: none"> <li>• 3D MetaHuman professor with realistic facial animations</li> <li>• WebSocket integration for backend-Unreal communication</li> <li>• API-driven virtual human interactions</li> </ul> |

## VALIDATION

- Lectures-based knowledge accuracy with RAG system verification
- Voice/text response evaluation for technical correctness
- MetaHuman facial animation fluidity evaluation
- Real-time interaction responsiveness measurement

## CHALLENGES

- Unreal Engine version compatibility issues
- MetaHuman web deployment limitations
- WebSocket communication between RAG system and Unreal
- ElevenLabs API and Audio2Face animation synchronization at real time
- Real-time performance across different platforms

## FUTURE WORK

- Local LLM fine-tuning for CS specialization
- Web-optimized character development
- Comprehensive CS curriculum database
- Web deployment for university students
- Real-time code execution environment