AI-Driven Agentic Framework for Engineering Lab Learning

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Background & Motivation

- Traditional CS/SE/IME labs:
- Require mastering complex tools first
- Lack of real-time personalized student tutoring
- Lack of real-time student feedback
- High cognitive load during lab for instructors
- Labor-intensive grading

Objectives

- Reusable and scalable Agentic Design Framework
- Student UI tutoring
- Instructor UI lab modules, quizzes, grading, feedback
- Responsible and ethical use of AI

Preliminary Insights

- Pilot courses (CSC 480, 581) show encouraging results
- Students report strong interest and deeper understanding of AI concepts
- Increased confidence in using advanced AI tools
- Limitations of agentic design: overhead, trust, sustainability, ethical use
- Active ethical discussions beyond assignments
- Framework inspires new student projects (e.g., Sustainable AI, Healthcare AI, Agriculture, Public Safety, Smart Manufacturing, Navigation)

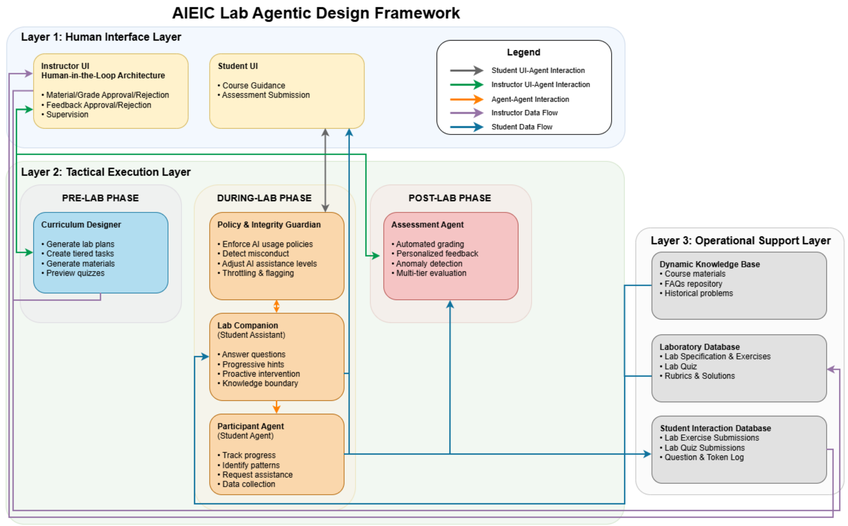
Expected Outcomes

- For Students:
  - Improved learning experience
  - Deeper conceptual understanding on fundamentals
  - Enhanced critical thinking and problem-solving skills
  - Development of responsible AI practices
- For Faculty:
  - Improved efficiency in lab preparation and teaching through a customizable framework
- For Cal Poly & CSU System:
  - Shareable library of agentic lab modules
  - Resources shared via CSU AI Commons
  - Forward-thinking strategy for broader AI impact on education across disciplines

References & Acknowledgements

- NOYCE School of Applied Computing
- CSU AI Challenge Tier 2 grant
- Microsoft Azure computing credit grant
- NCSA ACCESS computing resources grant
- CSU-OpenAI collaboration for ChatGPT Edu

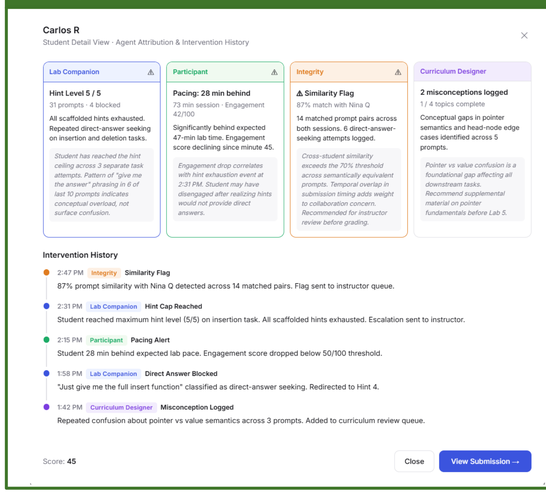
Agentic AI System Architecture



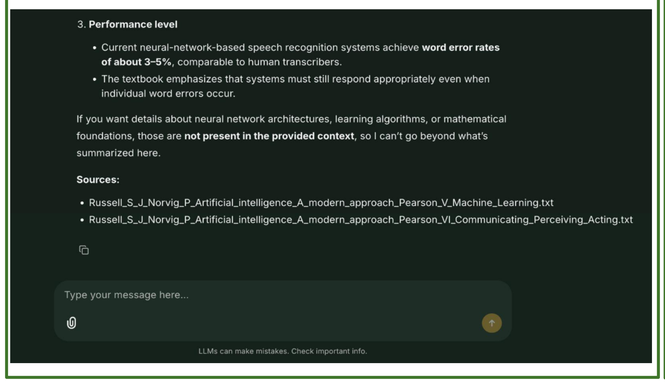
Student Question – Answer Process

```
question
   |
   ▼
KnowledgeBase.search ──► RAG context (Azure AI Search; optional)
   |                     runs first so the classifier can see what lab
   |                     material the question semantically targets
   |
   ▼
Guardian.validate ──► classify (CONCEPTUAL / PROCEDURAL / DIRECT_SOLUTION / …)
   |                  derive guidance level (FULL / MODERATE / MINIMAL / REJECTED)
   |                  escalate session after 3 violations
   |
   ▼
LabCompanion.respond ──► draft (constrained by guidance level)
   |
   ▼
Guardian.verify ──► pass / fail with feedback
   |           (on fail: retry up to VERIFIER_MAX_RETRIES; then safe fallback)
   |
   ▼
Participant.log_interaction (best-effort telemetry)
   |
   ▼
response to student
```

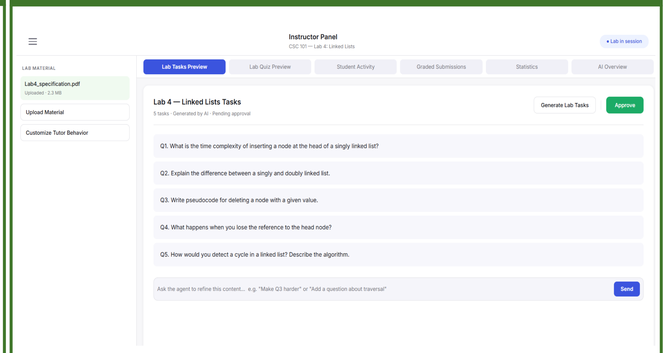
Student AI Interaction Card



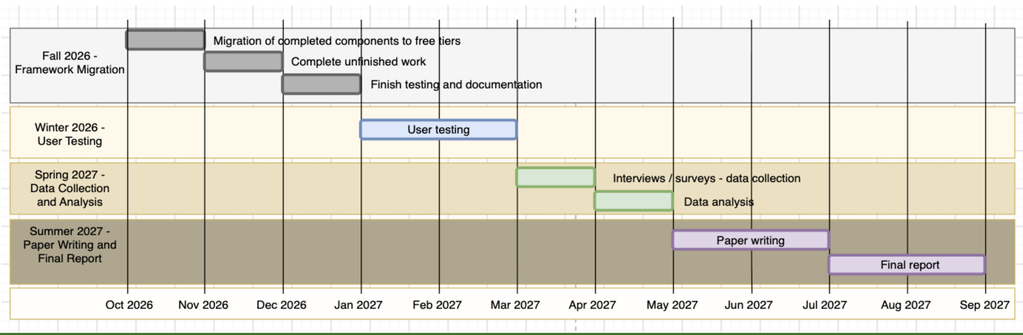
Student User Interface (UI)



Instructor User Interface (UI)



Planned Work



Assessment Grading & Feedback

