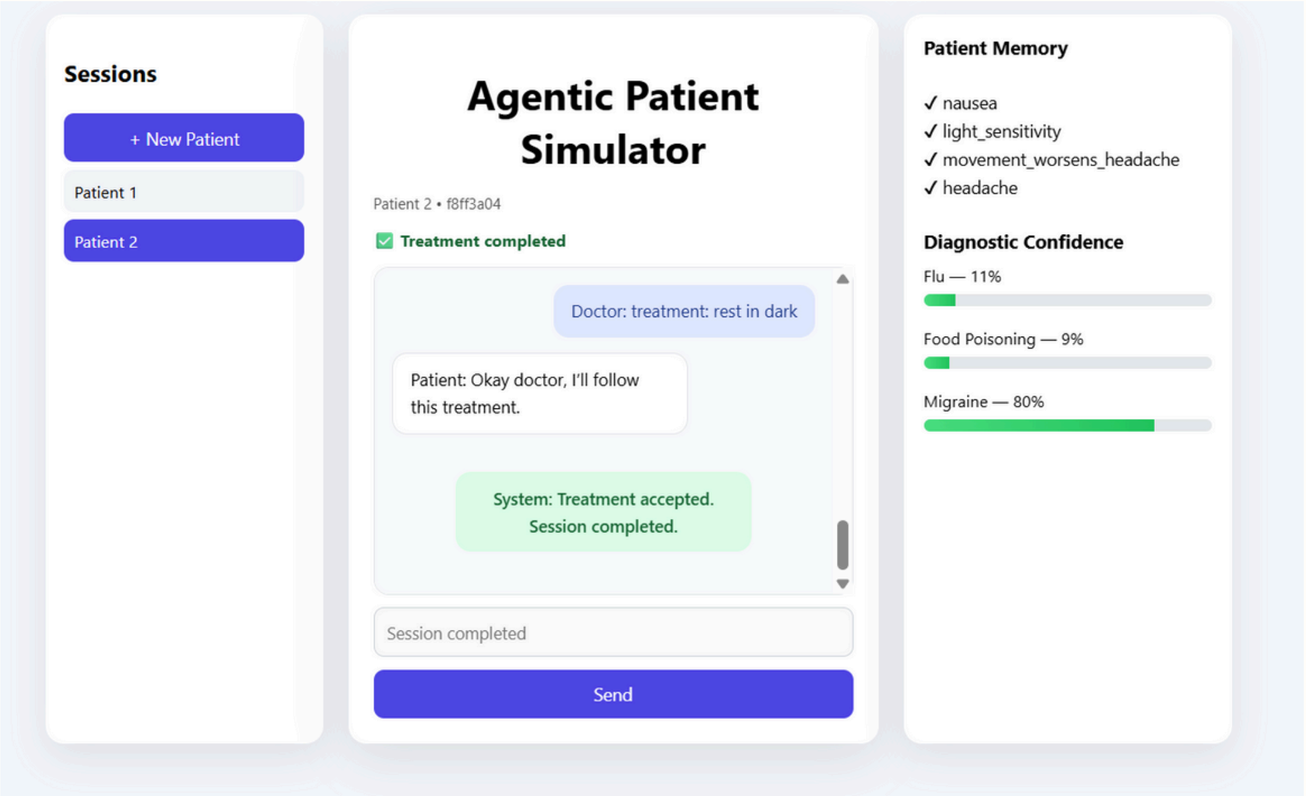
Agentic Patient Simulator

A Multi-User Agentic Medical Interview System
Built with LangGraph, LangChain, Flask, and Vanilla Web



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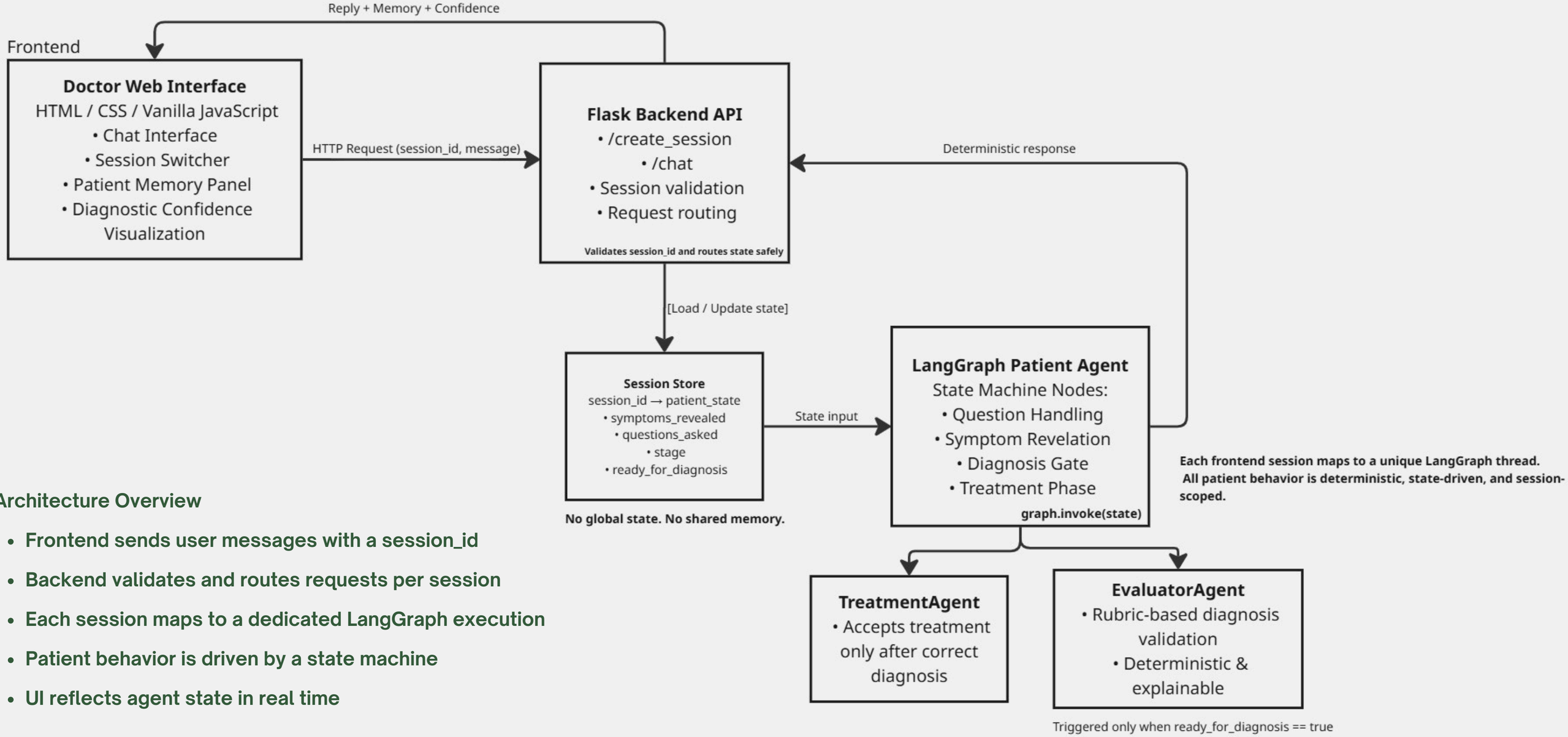
System Architecture



Architecture Overview

- Frontend sends user messages with a session_id
- Backend validates and routes requests per session
- Each session maps to a dedicated LangGraph execution
- Patient behavior is driven by a state machine
- UI reflects agent state in real time

Technologies & Tooling

TechStack

Frontend
- HTML
- CSS
- Vanilla JavaScript

Backend
- Python
- Flask

Agent Framework
- LangGraph
- LangChain

Data / State
- In-memory session store (session-scoped)

HTML / CSS / Vanilla JavaScript
- Lightweight and framework-free UI
- Full control over session switching and real-time UI updates
- No hidden abstractions during evaluation

Flask (Backend API)
- Simple, explicit request routing
- Easy session validation and isolation
- Ideal for deterministic, state-driven APIs

LangGraph
- Models patient behavior as a state machine
- Enforces stage-gated transitions (question → diagnosis → treatment)
- Guarantees deterministic, session-scoped graph execution

LangChain
- Used for controlled LLM interactions
- Separates language understanding from decision logic
- Avoids embedding reasoning inside prompts

Session Store
- Maps session_id → patient_state
- No global memory
- Enables true multi-user isolation

Key Design Choices & Engineering Decisions

Session-Scoped State (No Global Memory)

Each user session maintains its own isolated patient state.

Why
- Prevents cross-user contamination
- Enables true multi-user support
- Makes behavior reproducible and debuggable

Real-Time Confidence Visualization

Diagnostic confidence updates dynamically as symptoms are revealed.

Why
- Makes reasoning visible
- Turns the agent into a teaching tool
- Avoids black-box decision making

LangGraph for Control Flow, Not Prompts

Patient behavior is implemented as a LangGraph state machine.

Why
- Enforces strict medical flow
- Prevents premature diagnosis
- Guarantees deterministic execution

Separation of Intent Classification and Symptom Revelation

User questions are classified first; symptoms are revealed only if valid.

Why
- Prevents hallucinated symptoms
- Keeps patient responses medically consistent
- Allows transparent reasoning

Rubric-Based Diagnosis Evaluation

Diagnosis is validated using a deterministic EvaluatorAgent.

Why
- Removes subjective LLM judgment
- Makes evaluation explainable
- Ensures fairness and consistency

Live System Demonstration & Backend Evidence

```
Microsoft Windows [Version 10.0.26100.7462]
(c) Microsoft Corporation. All rights reserved.

C:\Users\ASUS>

C:\Users\ASUS>curl -X POST http://127.0.0.1:5000/create_session
{
  "session_id": "7e515220-47ca-43c0-a71c-df12b83cb373",
  "thread_id": "1ef9a0c2-9a43-4207-9251-31b3f2596491"
}

C:\Users\ASUS>curl -X POST http://127.0.0.1:5000/chat ^
More? -H "Content-Type: application/json" ^
More? -d "{\"session_id\":\"7e515220-47ca-43c0-a71c-df12b83cb373\",\"message\":\"How are you feeling?\"}"
{
  "debug": {
    "questions_asked": 1,
    "ready_for_diagnosis": false,
    "stage": 1,
    "symptoms_revealed": [
      "fatigue"
    ]
  },
  "reply": "I\u2019ve been feeling unusually tired lately."
}
```

Each user initializes a unique backend session and LangGraph thread.

```
C:\Users\ASUS>curl -X POST http://127.0.0.1:5000/chat ^
More? -H "Content-Type: application/json" ^
More? -d "{\"session_id\":\"e507bcc7-69f8-4f73-aa85-c8836ef10588\",\"message\":\"Any cough or breathing issues?\"}"
{
  "debug": {
    "questions_asked": 3,
    "ready_for_diagnosis": false,
    "stage": 2,
    "symptoms_revealed": [
      "fatigue",
      "fever"
    ]
  },
  "next_action": "continue_questioning",
  "reply": "I hadn\u2019t thought about it earlier, but I do have a cough."
}

C:\Users\ASUS>curl -X POST http://127.0.0.1:5000/chat ^
More? -H "Content-Type: application/json" ^
More? -d "{\"session_id\":\"e507bcc7-69f8-4f73-aa85-c8836ef10588\",\"message\":\"Have you been coughing lately?\"}"
{
  "debug": {
    "questions_asked": 4,
    "ready_for_diagnosis": true,
    "stage": 3,
    "symptoms_revealed": [
      "fatigue",
      "fever",
      "cough"
    ]
  },
  "next_action": "allow_diagnosis",
  "reply": "I\u2019ve had a persistent cough for a few days."
}
```

Symptoms are revealed gradually and gated by medical relevance.

```
C:\Users\ASUS>curl -X POST http://127.0.0.1:5000/chat ^
More? -H "Content-Type: application/json" ^
More? -d "{\"session_id\":\"e507bcc7-69f8-4f73-aa85-c8836ef10588\",\"message\":\"diagnosis: flu\"}"
{
  "diagnosis": "flu",
  "evaluation": {
    "reason": "All required symptoms are present.",
    "verdict": "correct"
  },
  "final_state": {
    "last_answers": {
      "any cough or breathing issues?": "I hadn\u2019t thought about it earlier, but I do have a cough.",
      "do you have a fever?": "I think I\u2019ve had a mild fever.",
      "have you been coughing lately?": "I\u2019ve had a persistent cough for a few days.",
      "how are you feeling?": "I\u2019ve been feeling unusually tired lately."
    },
    "questions_asked": [
      "How are you feeling?",
      "Do you have a fever?",
      "Any cough or breathing issues?",
      "Have you been coughing lately?"
    ],
    "ready_for_diagnosis": true,
    "stage": 3,
    "symptoms_revealed": [
      "fatigue",
      "fever",
      "cough"
    ]
  }
}
```

Diagnosis is allowed only after sufficient evidence and validated deterministically.

LangGraph transition: Questioning → Diagnosis Gate (ready_for_diagnosis = true)

Testing

Diseases	Required Symptoms	Optional Symptoms	Min. Questions Needed
FLU	Fever, Cough	Fatigue, Body Pain, Headache	3
Migraine	Headache	Light Sensitivity, Nausea, Movement Worsens Headache, Unilateral Headache, Relieved by Darkness	2
Food Poisoning	Nausea, Vomiting	Diarrhea, Stomach Pain	2

How this is used in the model:-

Required symptoms
→ Must be revealed before diagnosis is allowed

Optional symptoms
→ Increase confidence score of a disease

Minimum questions
→ Ensures progressive questioning before diagnosis

Model dynamically updates:-

- symptom memory
- disease confidence bars
- diagnosis permission

Special Interaction Test Cases

Test Case	User Input	Patient State	Agent Response
Greeting Normalization	“Hello, how are you feeling?”	Initial interaction, no symptoms disclosed	“I’m not feeling well right now, please help me.”
Duration Ambiguity Handling	“How many days has it been?”	Insufficient temporal context	“It’s hard to say right now.”
Treatment Validation	“Treatment: rest in dark” (example)	Diagnosis completed, treatment phase	If relevant: “Okay, I will do that.” If irrelevant: “I don’t think this is related to my condition.”

Key Contributions & Future Scope

Key Contributions

- Designed a multi-user, session-safe agentic medical simulator with no shared memory
- Implemented a LangGraph-driven patient state machine enforcing medical interview flow
- Introduced deterministic, rubric-based diagnosis evaluation for explainability

Future Scope

- Expand disease models and symptom graphs
- Add learning analytics for medical training evaluation
- Integrate persistent storage for longitudinal patient histories
- Support multi-agent simulations (patient + nurse + supervisor)

Designed for reproducibility, determinism, and educational evaluation

Key Learnings & Engineering Challenges

Engineering Challenges:-

Multi-user state isolation
- Ensuring no shared memory across concurrent sessions
- Avoiding global variables and race conditions

Preventing hallucinated medical behavior
- Symptoms must not appear unless medically valid
- Diagnosis must not occur prematurely

Balancing realism with determinism
- Making conversations natural while keeping execution predictable

Key Learnings:-

Agentic systems require control flow, not prompts
- Behavior should be state-driven, not prompt-driven

LangGraph enables inspectable reasoning
- Every decision maps to a state transition

Determinism is critical for evaluation systems
- Rubric-based validation ensures fairness and consistency

Separation of concerns improves reliability
- Language understanding ≠ medical decision logic

THANK YOU