CrowdSim AI - Architecture & Design

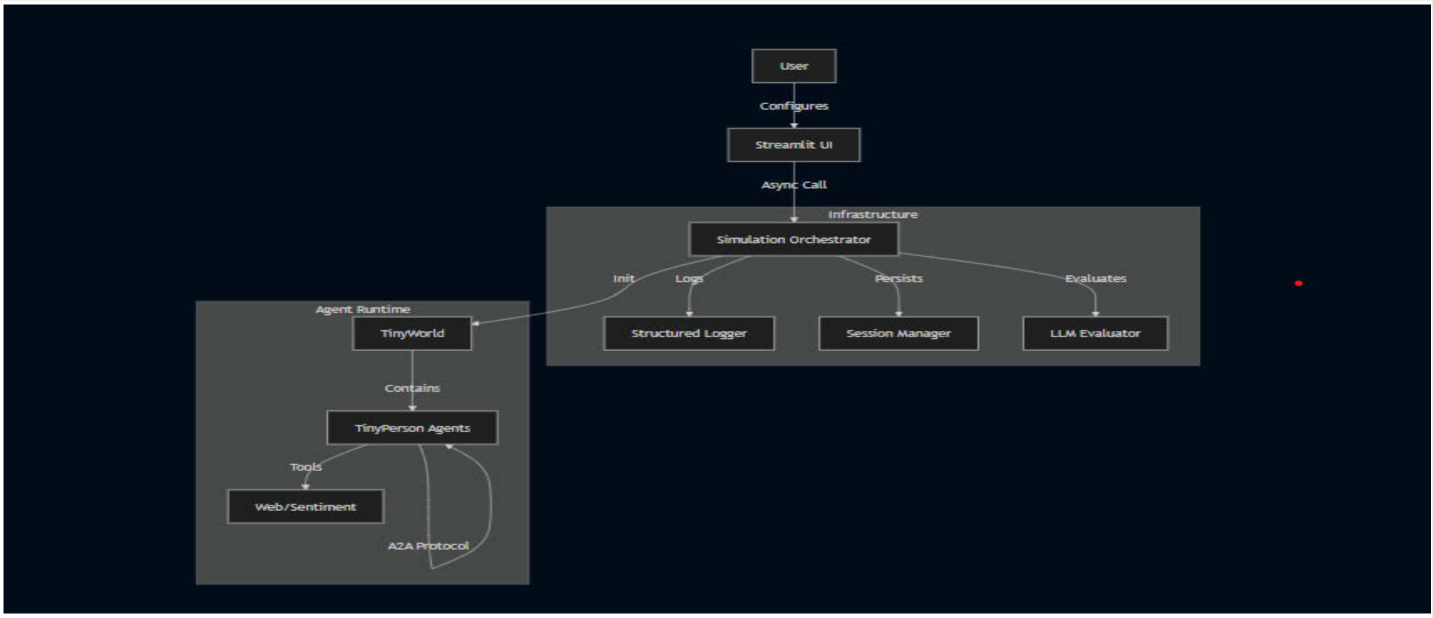
This document details the technical architecture, data flow, and operational lifecycle of the CrowdSim AI platform.

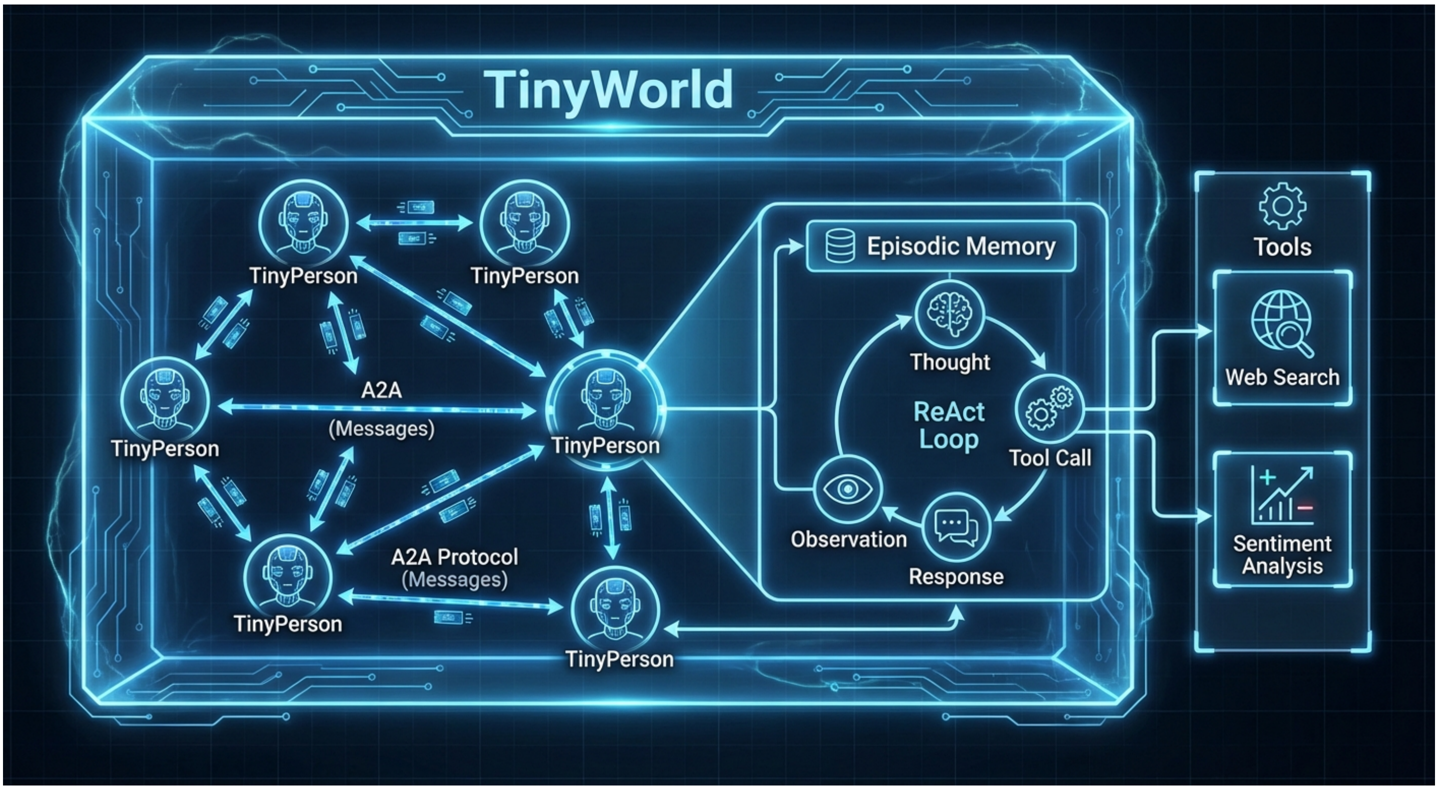
1. High-Level Application Architecture

The application follows a **Micro-Service inspired Monolith** pattern, designed for eventual decomposition into distributed services.

Core Components

1. **Frontend (UI Layer)**: Built with **Streamlit** (`app.py`). Handles user input, configuration, and visualization.
2. **Orchestrator (Simulation Layer)**: The `simulation.py` module acts as the controller, managing the lifecycle of the simulation, session state, and observability.
3. **Agent Runtime (TinyTroupe)**: The core library hosting the AI agents (`TinyPerson`) and the environment (`TinyWorld`).
   Infrastructure Layer:
   - **Observability**: `observability.py` (Logs, Metrics).
   - **Persistence**: `session_manager.py` (JSON storage).
   - **Evaluation**: `evaluator.py` (LLM-as-a-Judge).
   - **Protocol**: `TinyTroupe/protocol.py` (A2A Communication).





2. Simulation & Agent Architecture

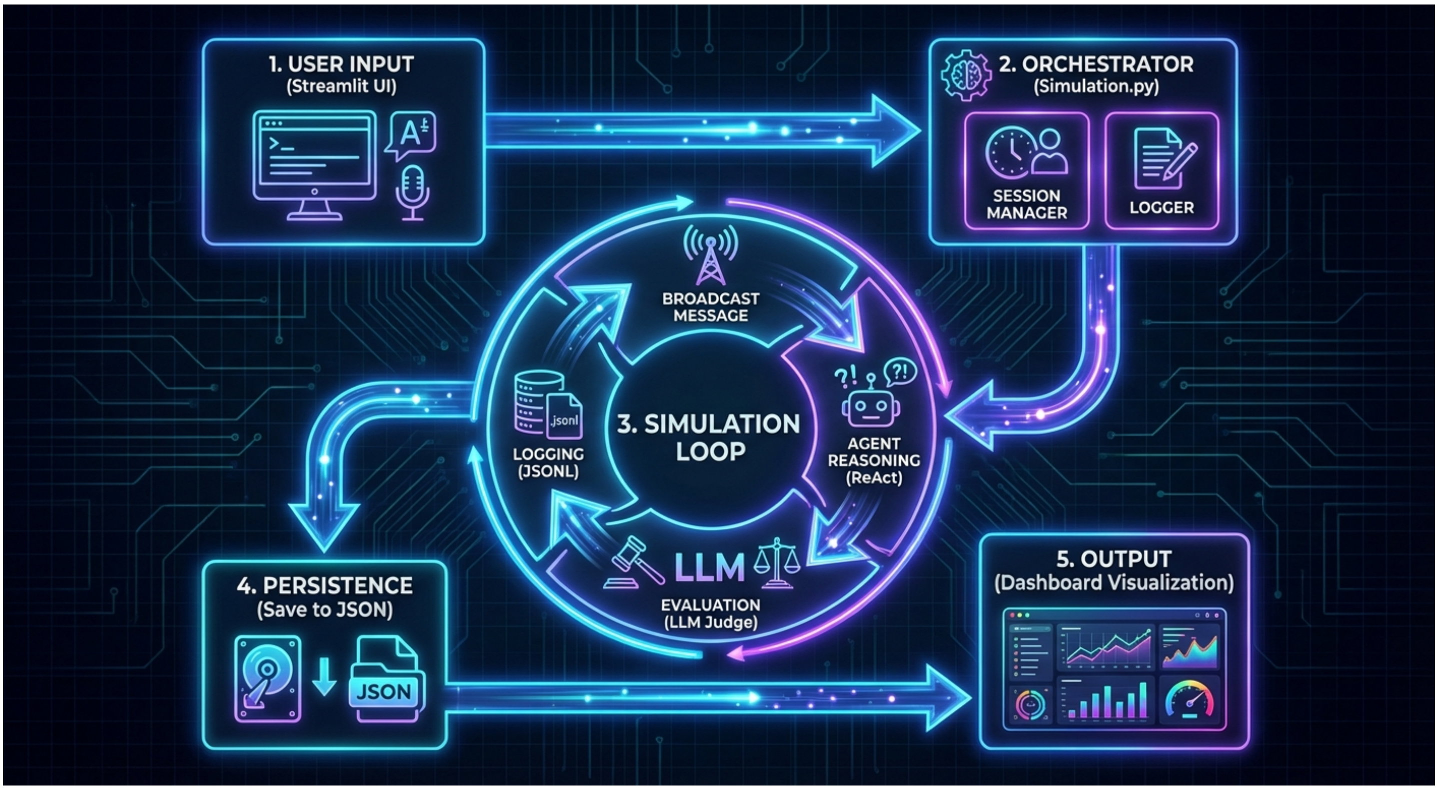
Agent Design (`TinyPerson`)

Agents are designed as autonomous entities using the **ReAct (Reasoning + Acting)** pattern. - **Memory**: `EpisodicMemory` stores conversation history and thoughts. - **Tools**: Agents have a registry of tools (e.g., `web_search`) they can invoke. - **Communication**: Agents communicate exclusively via the **A2A Protocol** (`Message` objects), decoupling them from the specific runtime implementation.

Simulation Environment (`TinyWorld`)

The environment acts as the message bus and shared space. - **Broadcast**: Delivers messages to all agents. - **Turn Management**: Synchronizes agent actions (currently sequential turns).

3. Data Flow Journey



Step 1: Frontend Input

- **User** enters a "Product Pitch" and "Context" in `app.py`.
- **Streamlit** packages this into a list of questions and a context string.
- **Call**: `asyncio.run(run_simulation(...))` is invoked.

Step 2: Initialization & Session

- **Orchestrator** checks for a `session_id`.
- **Session Manager** loads existing agent states from disk (if resuming) or creates new ones from `personas.json`.
- **Observability** initializes a new Trace ID for this run.

Step 3: The Simulation Loop

For each question in the input: 1. **Broadcast**: The question is wrapped in a `Message` (type="system") and sent to all agents. 2. **Reasoning**: Each agent processes the message. * *Internal Monologue*: "I need to search for X." * *Tool Execution*: Agent calls `web_search`. * *Observation*: Tool returns data. 3. **Action**: Agent generates a final response `Message` (type="text"). 4. **Logging**: The action is logged to `logs/simulation.jsonl`. 5. **Evaluation**: The `Evaluator` (LLM-as-a-Judge) asynchronously scores the response for Relevance, Coherence, and Fidelity.

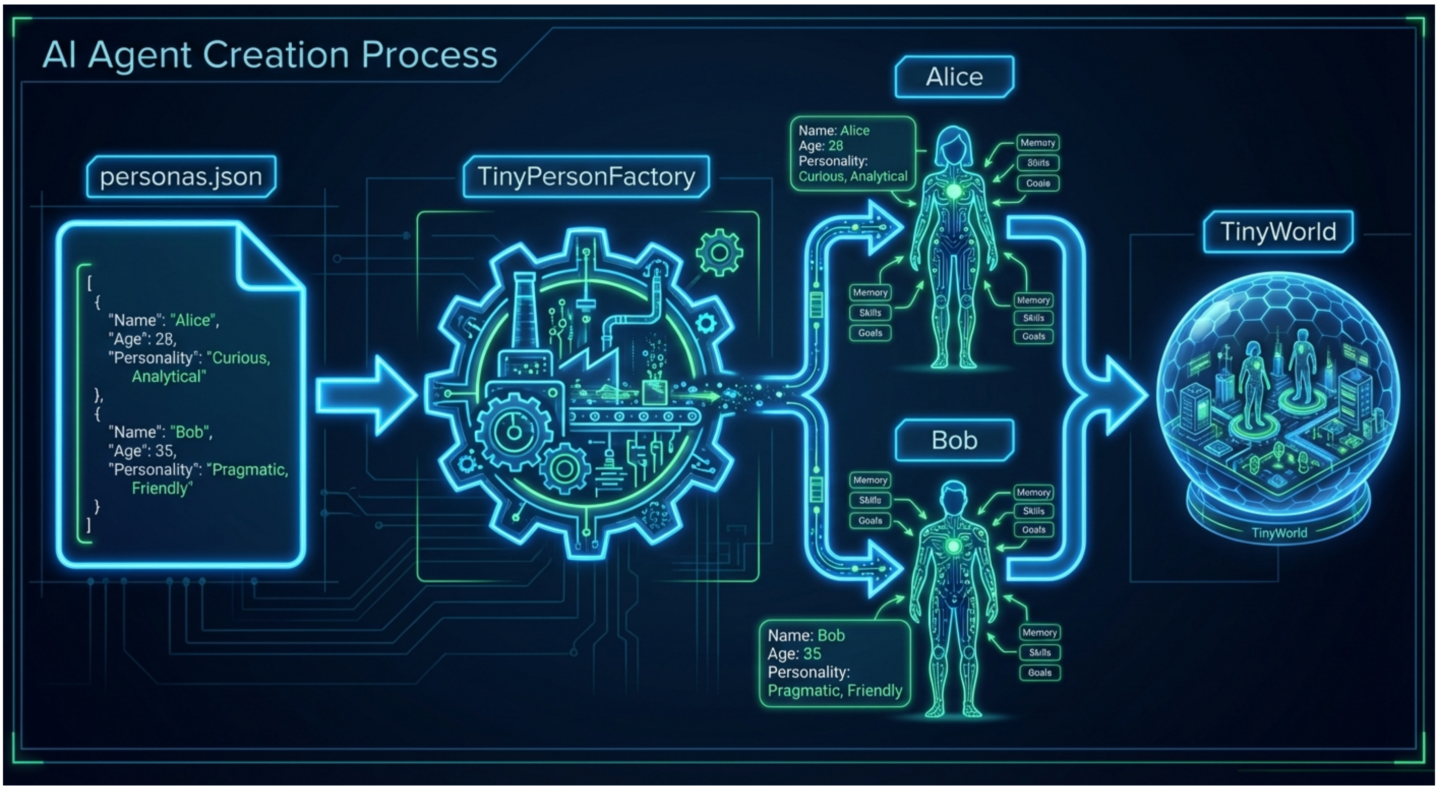
Step 4: Result Aggregation

- **Orchestrator** collects all responses, sentiment scores, and quality metrics.
- **Session Manager** saves the updated agent states to `sessions/<id>.json`.
- **Return**: A structured dictionary is returned to `app.py`.

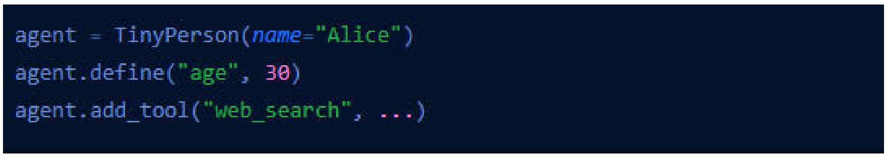
Step 5: Visualization

- **Streamlit** renders the metrics, charts, and conversation logs on the dashboard.

4. Agent Creation Process



1. **Definition**: Personas are defined in `personas.json` (Name, Age, Occupation, Personality).
2. **Factory**: The simulation reads this JSON.
3. **Instantiation**:



```
agent = TinyPerson(name="Alice")
agent.define("age", 30)
agent.add_tool("web_search", ...)
```

4. **Registration**: The agent is added to a `TinyWorld` instance, which manages its accessibility to other agents.

Created by charleson mendes