

Towards Realistic Role-Playing AI Agents for Education: A Case in Medical Training



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Motivation

Role-playing supports experiential learning of interpersonal and professional skills. Human role-play provides valuable authentic interaction, but is resource-intensive, costly, and difficult to provide frequently and on demand. Generative AI (GenAI) offers repeatable, adaptive, and on-demand role-play, but introduces two key challenges.

Technical Challenge

GenAI Language Models are designed to be helpful assistants, not believable characters. A role-playing agent must stay in role, reveal information appropriately, maintain conversational and factual consistency, and exhibit coherent personality and affective behaviour. Knowing a character is not the same as behaving like that character.

Educational Challenge

Realistic interaction alone is insufficient. Learners also need instructions, guidance, assessment, and actionable feedback, aligned with teacher-defined learning objectives and evaluation criteria.

Medical Training Case

History taking and patient communication are core clinical skills that require repeated practice. Medical students commonly practice through role-playing exercises with peers, teachers, or trained actors. GenAI could enable on-demand practice across diverse clinical cases and patient personalities.

Research Questions

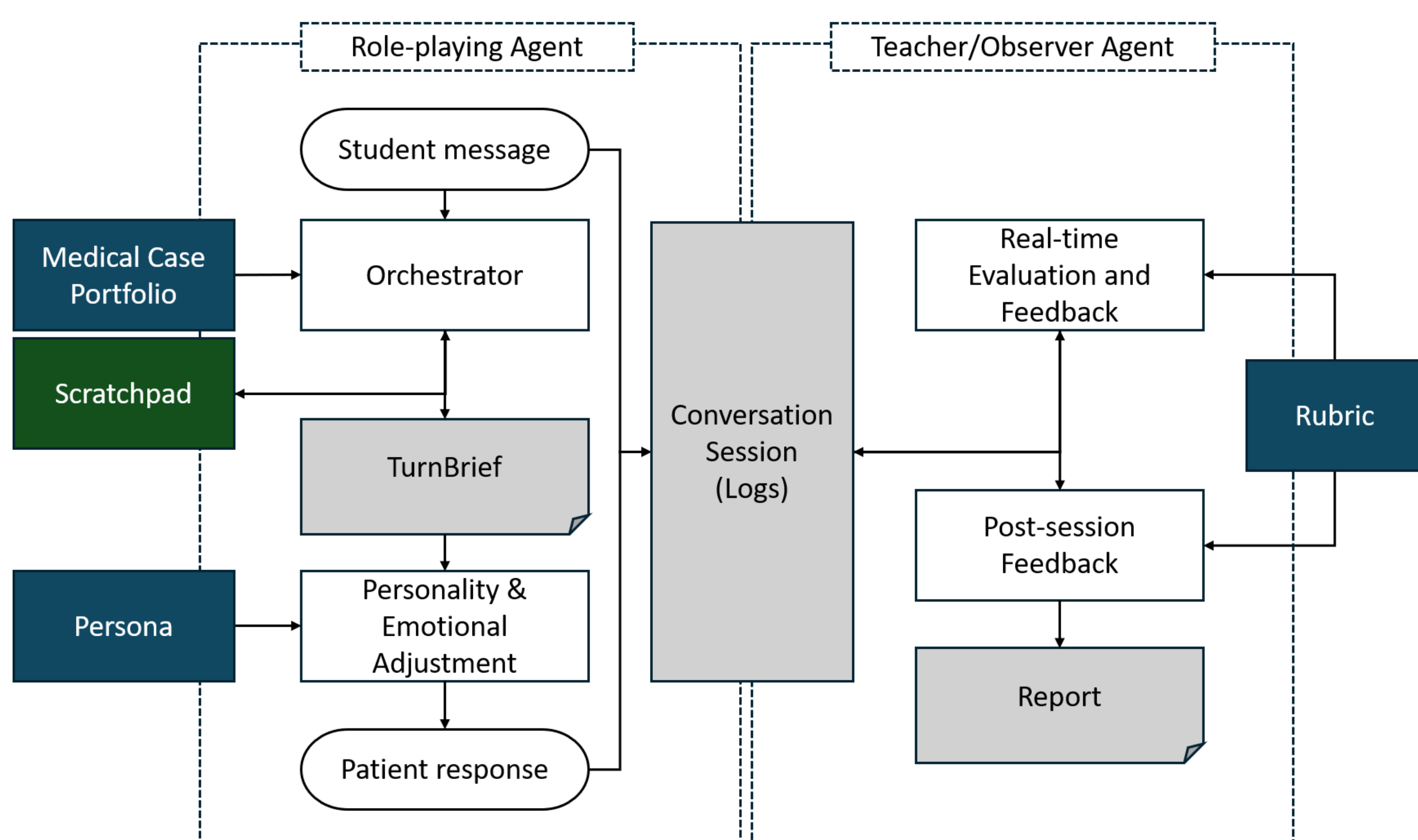
- RQ1:** How can AI agents maintain realistic and consistent role-playing behaviour throughout an interaction? (**Role-playing fidelity**)
- RQ2:** How can an observing AI agent support and evaluate role-playing interactions while remaining aligned with teacher-defined learning objectives? (**Pedagogical alignment**)
- RQ3:** How can the evolving state of a role-playing agent be expressed coherently through verbal and non-verbal behaviour? (**Multimodal embodiment**)

Proposed Solution: pAltientSim

Role-Playing Agent: Participates in the scenario while maintaining character, knowledge, conversational state, personality, and affect.

Teacher/Observer Agent: Observes the interaction, provides on-demand guidance, and evaluates learner performance against teacher-defined criteria and rubrics.

Human Teacher: Defines the scenario, character, learning objectives, behavioural constraints, and evaluation criteria.



The **Role-playing Agent** combines three sources:

Medical Case Portfolio: Defines what the character knows about the medical case and what information may be disclosed.

Persona: Defines who the character is and how they tend to behave and communicate.

Scratchpad: Maintains the evolving interaction state, including what has happened, what has been disclosed, and changes in affect or behaviour. For every learner turn, these are combined into a **TurnBrief** specifying what and how the character should respond.

The resulting interaction is stored in the **Conversation Session**, providing a complete trace for subsequent observation and evaluation.

The **Teacher/Observer Agent** independently observes the Conversation Session rather than participating as the character. Using a teacher-defined **Rubric**, it evaluates the learner's interaction and generates a Report containing performance assessment and actionable feedback.

Evaluation Method

We evaluate successive system versions using simulated interactions and a multidimensional behavioural evaluation suite. Each system modification is evaluated against the same behavioural dimensions to identify improvements and unintended regressions.

Dimension	Example metrics
Role Fidelity	Role Adherence, No Third-Person Speech, No Narration/Stage Directions
Interaction Realism	Incremental Disclosure, Patient Initiative, Realistic Uncertainty, Non-Repetitive Phrasing
Scenario Fidelity	Fact Grounding, Coherence and Consistency, Knowledge Retention, Diagnosis Non-Disclosure
Affective Behaviour	Emotional Specificity & Restraint, Tone–State Match, Justified State Transitions

Early Results

Realistic role-play is multidimensional

Successive iterations show strong role adherence, scenario coherence and consistency, and incremental disclosure, with improvements in conversational and affective behaviour.

Improvements are non-monotonic: optimizing one behaviour can introduce regressions in another.

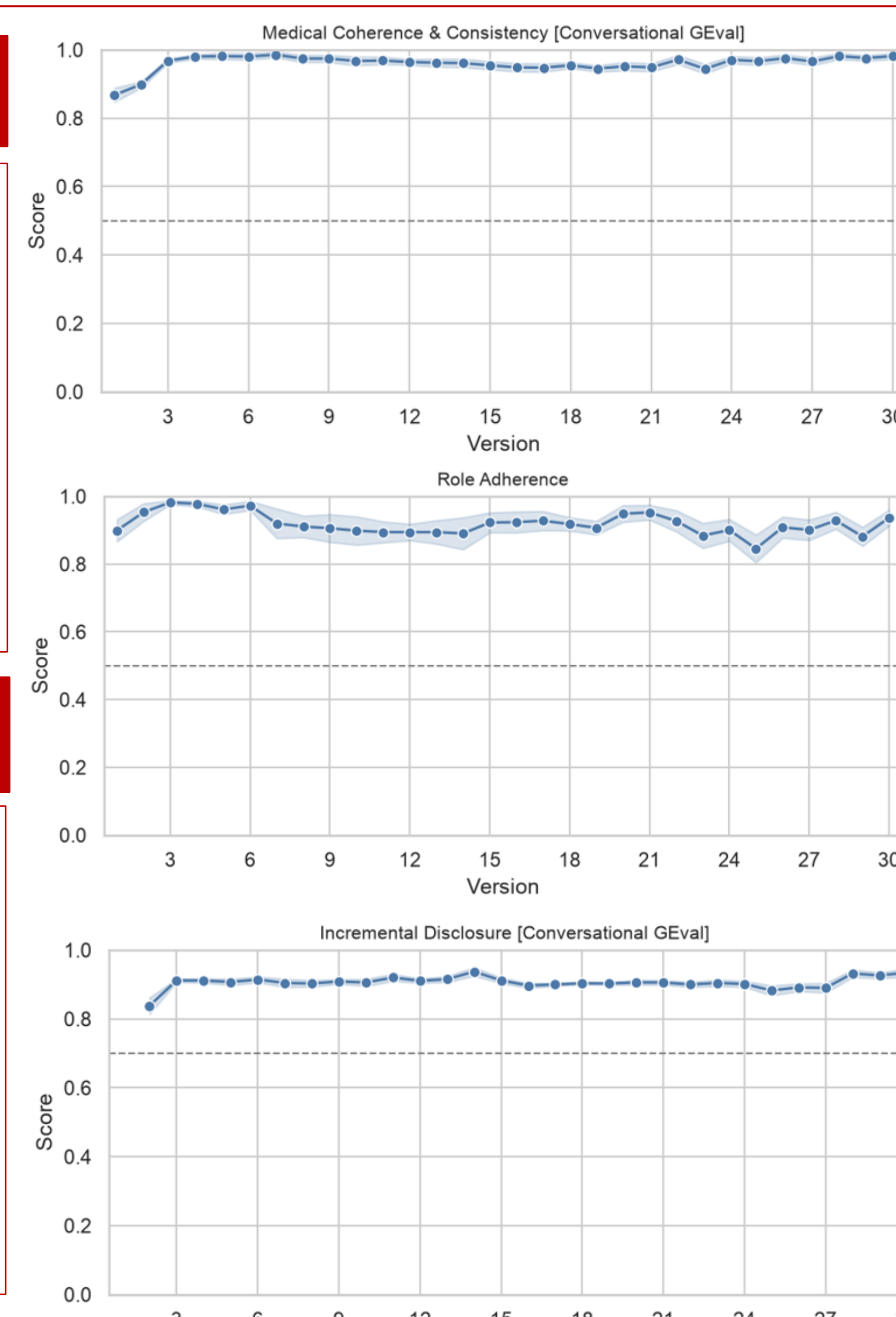
Towards Multimodal Role-Play

From character state to embodied behaviour

The evolving character state can drive multiple modalities:

Interaction State → {*Language* • *Prosody* • *Facial Expression* • *Gesture*}

The next challenge is ensuring coherent verbal and non-verbal expression of the same underlying state.



Ethical Statement

pAltientSim is designed to complement, not replace, human-led training. Clinical cases and evaluation criteria remain teacher-curated, while learner interactions require appropriate privacy, transparency, and data protection. AI-generated feedback is intended for formative learning and should not substitute for expert clinical assessment. This project is funded by AUMC.

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