TITLE OF THE INVENTION

Systems and Methods for Quantum-Inspired Rogue Variable Modelling (QRVM), Human-in-the-Loop Decoherence, and Collective Cognitive Inference in Human–AI Symbiotic Systems

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. Provisional Application No. 63/910,500, titled:
"H3LIX: AI–Human Symbiotic Integration Process,"
filed September 2024, the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

The invention relates to artificial intelligence, cognitive modelling, physiological sensing, and human–AI symbiotic systems. It introduces a formal mechanism for representing ambiguous human cognitive states using quantum-inspired structures, detecting divergence, engaging humans to resolve ambiguity, and learning both individually and collectively.

BACKGROUND OF THE INVENTION

Previous H3LIX disclosures (Somatic → Symbolic → Noetic layers) provide a robust ingestion and adaptive architecture. However, they lack mechanisms to:

1. Represent ambiguous or contradictory cognitive states before behavioral collapse.
2. Detect divergence between physiological, behavioral, contextual, and model-internal signals.
3. Request human clarification for pre-determinate cognitive states.
4. Store such events in a structured library.
5. Identify cross-user cognitive patterns for collective inference.

This invention introduces:

- QRVM (quantum-inspired cognitive state encoding)
- Rogue Variable Detection
- Human-in-the-Loop Decoherence (HILD)
- Rogue Variable Library (RVL)
- Rosetta Stone Layer (RSL) for multi-user inference

SUMMARY OF THE INVENTION

The invention provides a **process architecture** comprising:

1. Quantum-Inspired Cognitive Encoding (QRVM)

2. Rogue Variable Detection System

3. Human-in-the-Loop Decoherence (HILD)

4. Rogue Variable Library (RVL)

5. Rosetta Stone Layer (RSL)

The Process is presented in two diagrams:

1. Quantum Cognitive System: Rogue Variable Detection Flowchart
2. Group-Level Rogue Variable Detection Process

The mathematical representation of the elements of the process is presented in one attachment:

1. Quantum Space Representation

DETAILED DESCRIPTION OF THE INVENTION

1. Integration with the H3LIX Feedback Loop

The present invention extends the existing H3LIX human–AI symbiotic framework by introducing a pre-determinate interpretive layer that operates within the quantum-inspired Hilbert-space representation of the Mirrored Personal Graph (MPG). This layer captures ambiguous or unstable cognitive configurations **before** they consolidate into stable, behaviorally visible states.

In the standard H3LIX architecture, multimodal input signals—physiological, behavioral, contextual, and model-derived—continuously update **node metrics** within the MPG. Natural cognitive processes often pass through transitional phases characterized by:

- mismatch between expected and actual cognitive activation,
- temporary instability in cognitive structures,
- conflicting interpretive cues,
- emerging pre-event configurations that have not yet manifested behaviorally.

To formally represent such states, the invention inserts a **Quantum Rogue Variable Modelling (QRVM) layer**, enabling the system to encode transitional cognitive configurations directly in the Quantum MPG State (QMS) and detect when they diverge from patterns implied by the **baseline Hamiltonian spectrum** that governs typical cognitive dynamics.

This integration allows the system to:

- represent cognitive ambiguity without forcing premature interpretation,
- detect cognitive instability using **spectral methods** rather than heuristic thresholds,
- invoke human-in-the-loop clarification when internal inference becomes insufficient,
- refine cognitive interpretation after clarification,
- store ambiguous-state transitions for longitudinal learning.

As a result, the feedback loop becomes a **proactive early-detection mechanism** that maintains interpretive precision even under unstable or contradictory input conditions.

2. Quantum-Inspired Cognitive State Representation

The invention uses a **Quantum MPG State (QMS)** to represent the user's cognitive configuration at any moment. Instead of operating directly on raw physiological or behavioral data, the system updates **MPG node metrics** using multimodal signals. These metrics include importance, recency, valence, stability, topological characteristics, and internal model indicators.

The QMS is constructed by applying a **mapping Ψ_map** to these node metrics:

- *QMS is therefore constructed from node metrics $m_t(v_i)$, which themselves are updated using multimodal signals.*
- *Ψ_map($m_t(v_i)$, C_t) produces the amplitudes $\psi_t(v_i)$.*

The resulting QMS is expressed as a normalized state vector $|\Psi_t\rangle$ in a Hilbert space spanned by the nodes of the Mirrored Personal Graph, which encodes:

- the current activation strength of each cognitive entity,
- contextual relevance,
- stability or instability of these entities,
- and their interrelations as inferred from the MPG structure.

The QMS can represent:

- **multiple potential interpretations simultaneously**,
- **relative likelihoods** of these interpretations,
- **interference patterns** that correspond to cognitive conflict or instability.

The evolution of the QMS over time is governed by a **Hamiltonian operator** constructed from node and edge metrics. Any **discrepancy between Hamiltonian-predicted evolution and the updated QMS** is treated as a dynamical mismatch, indicating potential cognitive instability.

The canonical representation of cognitive states in the system is the state vector $|\Psi_t\rangle$. In some embodiments, the system additionally forms density-matrix–like operators (for example, mixtures or error-weighted combinations of state vectors) and may compute coherence from their off-diagonal elements, while still treating the state vector $|\Psi_t\rangle$ as the primary internal representation.

3. Rogue Variable Detection

Rogue variable detection is the core mechanism by which the invention identifies ambiguous cognitive states that **cannot be confidently resolved** through internal inference alone.

A "rogue variable" is not a specific data point, but rather a **configuration of divergence** across signals and interpretive layers that indicates:

- the system does not have sufficient clarity to produce a stable interpretation,
- the cognitive state is transitioning toward a significant event,
- the current input combination is unprecedented relative to the user's baseline manifold,
- or the system is at risk of generating incorrect or unsafe inferences without human input.

A Rogue Variable is identified when:

- the observed Quantum MPG State $|\Psi_t\rangle$ repeatedly aligns with **rogue factor directions** that dominate during periods of high interpretive error,
- these directions correspond to cognitive configurations inconsistent with the user's **baseline Hamiltonian dynamics**,
- and the instability cannot be resolved internally.

The detection process involves three key stages:

1. Error aggregation

The system measures the degree of mismatch between its Hamiltonian-predicted cognitive evolution and the sensor-updated QMS.

This mismatch produces an **error-weighted operator $\hat{O}_e$** that aggregates cognitive states associated with high interpretive error.

2. Extraction of rogue factor directions

By analyzing $\hat{O}_e$, the system identifies **rogue factor directions**—eigenvector-like patterns representing combinations of cognitive entities that repeatedly dominate during periods of instability.

These patterns reveal how cognitive instability is distributed across the MPG.

3. Identification of high-loading node segments

For each rogue direction, the system identifies **high-loading node sets S_j**—structured subsets of the MPG whose activation contributes disproportionately to interpretive error.

To determine whether a candidate S_j is a true Rogue Variable, the system conducts **ablation-based evaluation Δ(S_j)**:

- removing the influence of S_j from $|\Psi_t\rangle$ and recomputing interpretations,
- then measuring whether this removal systematically improves interpretive coherence.

A Rogue Variable is confirmed only when the **ablation consistently reduces error**, not when a numeric threshold is exceeded.

This spectral method ensures precise and mathematically grounded detection.

4. Human-in-the-Loop Decoherence (HILD)

Human-in-the-Loop Decoherence (HILD) is a structured, safety-focused interaction cycle that resolves ambiguous cognitive states by soliciting **minimal and precisely targeted user input**.

4.1 Trigger Conditions

HILD activates only when:

- the system detects a rogue variable state that internal inference cannot resolve,
- ambiguity persists after defined smoothing intervals,
- the state threatens interpretive or operational accuracy.

4.2 Behavior Constraints During HILD

While in the Clarification Cycle:

- All predictive modeling is suspended.
- No autonomous decisions are made.
- No intention inference, anticipation, or behavioral forecasting occurs.
- System behavior becomes strictly *reactive* to user clarification.
- Sensor ingestion continues but cannot trigger autonomous action.

These constraints ensure user safety, interpretive ethicality, and protection against unintended system influence.

4.3 Clarification Prompt Mechanism

The system issues a clarification request that adheres to the **Clarification Prompt Schema (CPS)**:

- **Context Anchor** – Grounds the query neutrally in observable reality.
- **Observed Ambiguity** – States the mechanical divergence without interpretation.
- **Minimal Direct Request** – Solicits exactly one missing variable needed for collapse.

Examples (not included in filing):

- “Your physiological state suggests heightened activation, but your interaction pattern is stable. Which activity best describes your current situation?”
- “The system detected fast shifts in interpretive stability. Are you preparing for a decision or reflecting?”

4.4 Decoherence Event

When the user provides clarification:

1. node metrics update,
2. a new QMS $|\Psi_t'\rangle$ is formed,
3. the rogue factor direction loses influence,
4. system autonomy is restored.

4.5 Non-response Handling

If the user does not respond:

- The system retries once.
- If still unresolved, it enters Passive Safe Mode.
- The ambiguous event is logged as “unresolved,” and no autonomous action is taken.

This ensures interpretive integrity even under partial communication.

5. Rogue Variable Library (RVL)

The Rogue Variable Library is a persistent storage system that captures and organizes all rogue variable events.

Each RV event generates a structured entry containing:

- the ambiguous pre-event state $|\Psi_t\rangle$,
- active rogue factor directions $|\chi_j\rangle$,
- associated high-loading segments S_j,
- ablation-based improvement $\Delta(S_j)$,
- clarification prompts and user responses,
- the clarified post-collapse state $|\Psi_t'\rangle$,
- and updates made to node metrics and Hamiltonian parameters.

Over time, the library forms a **longitudinal map of user-specific cognitive transitions**, enabling:

- progressive refinement of the baseline Hamiltonian structure,
- reduction in false-positive ambiguity alerts,
- faster collapse in future ambiguity scenarios,
- the formation of early-detection markers for critical cognitive shifts.

RVL also serves as the ingestion foundation for the Rosetta Stone Layer (RSL).

6. Rosetta Stone Layer (Cross-User Cognitive Mapping)

The Rosetta Stone Layer (RSL) generalizes QRVM patterns across multiple users to identify universal cognitive signatures and shared pre-event patterns. In one implementation, the RSL is realized as a shared Hilbert-space representation (a Rosetta Cognitive Reference Space) into which each user's quantum cognitive states are mapped by user-specific alignment operators, enabling direct comparison of states across individuals.

Whereas RVL stores individual histories, the RSL creates:

- cross-user alignment maps,
- similarity graphs,
- cluster structures linking users with similar ambiguous-state topologies,
- population-level invariants indicating common emotional or cognitive precursors.

The RSL enables:

1. Universal Cognitive Signatures

Detection of patterns such as:

- consistent pre-stress physiological–behavioral divergences,
- shared markers of cognitive overload,
- universal precursors to decision instability.

2. Collapse-Path Archetypes

The system learns typical trajectories describing how ambiguous states resolve in groups of users.

3. Group-Level Rogue Variables

When multiple users exhibit similar rogue states, the system can infer:

- organizational tension,
- social contagion of emotional states,
- shared contextual pressures,
- early indicators of collective cognitive drift.

4. Manifold Mapping Between Individuals

The system constructs relational operators mapping one user's baseline manifold into another's coordinate system, allowing cross-normalization.

5. Differential Privacy and Federated Computation

All RSL computations preserve privacy by design.
Aggregated signatures emerge without exposing any individual data.

The RSL forms the foundation for **collective intelligence modelling**, enabling prediction and early detection of patterns that no single-user model could identify.

CLAIMS

1. A method for detecting and resolving ambiguous cognitive states in a human–AI symbiotic system, the method comprising:

(a) receiving multimodal physiological, behavioral, contextual, and model-internal signals;
(b) updating node metrics $m_t(v_i)$ of a Mirrored Personal Graph based on said signals;
(c) generating a Quantum MPG State vector $|\Psi_t\rangle$ by applying a mapping Ψ_map to said node metrics;
(d) predicting cognitive state evolution using a Hamiltonian operator derived from said node metrics;
(e) computing a discrepancy between the Hamiltonian-predicted evolution and the sensor-updated $|\Psi_t\rangle$;
(f) constructing an error operator $\hat{O}_e$ from the discrepancy;
(g) extracting one or more rogue factor directions $|\chi_j\rangle$ from spectral analysis of $\hat{O}_e$;
(h) identifying a high-loading node segment S_j associated with a rogue factor direction;
(i) performing an ablation-based evaluation $\Delta(S_j)$ to determine whether removal of S_j improves interpretive coherence;
(j) detecting a rogue variable condition when $\Delta(S_j)$ indicates unresolved cognitive ambiguity;
(k) initiating a human-in-the-loop clarification cycle comprising generating a clarification request, receiving user input, and collapsing $|\Psi_t\rangle$ into a clarified cognitive state $|\Psi_t'\rangle$;
(l) updating baseline models, Hamiltonian parameters, and longitudinal memory using the clarified cognitive state; and
(m) storing a rogue variable event comprising pre-collapse state, rogue factor direction, high-loading segment, ablation results, user clarification, and post-collapse state in a Rogue Variable Library.

2. A system for detecting and resolving ambiguous cognitive states in a human–AI symbiotic architecture, comprising:

- a processor;
- a memory storing instructions executable by the processor;
- one or more sensors configured to collect multimodal physiological, behavioral, contextual, and model-internal signals;
- a user-interaction interface,

wherein the instructions cause the processor to execute the method of Claim 1.

3. A non-transitory computer-readable medium storing instructions that, when executed by one or more processors, cause performance of the method of Claim 1.

Dependent Claims

4. The method of Claim 1, wherein detecting the rogue variable condition comprises determining that $\Delta(S_j)$ is negative across a plurality of temporal windows.

5. The method of Claim 1, wherein wearable physiological signals contribute to updating node metrics and to constructing the error operator $\hat{O}_e$.

6. The method of Claim 1, wherein the clarification cycle suspends predictive modeling, intention inference, and autonomous decision-making until receipt of user clarification.

7. The method of Claim 1, wherein the Rogue Variable Library is used to adaptively refine the Hamiltonian operator governing the user's baseline cognitive dynamics.

8. The system of Claim 2, wherein the Rogue Variable Library supports federated or distributed storage architectures.

9. The method of Claim 1, further comprising mapping clarified cognitive states from multiple users into a Rosetta Stone Layer to identify cross-user patterns or shared rogue variable configurations.

10. The method of Claim 1, wherein the Rosetta Stone Layer employs differential privacy or secure multiparty computation to generate population-level cognitive invariants without exposing individual user data.

11. The method of Claim 1, wherein the user clarification received during the human-in-the-loop cycle triggers reconstruction of the Quantum MPG State $|\Psi_t'\rangle$ and reduces activation of rogue factor directions in subsequent state updates.

ABSTRACT

A system and process for modelling ambiguous human cognitive states using quantum-inspired representations. Rogue variables are detected based on divergence between physiological, behavioral, contextual, and model-internal signals. A structured human-in-the-loop decoherence cycle collapses ambiguous states using minimal user input. A Rogue Variable Library records state transitions. A Rosetta Stone Layer aggregates these states across users to derive universal cognitive patterns and detect group-level cognitive events.