NEUROMORPH QUANTUM ARCHITECTURE

Technical Whitepaper & Mathematical Derivations

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1. The Quantum Neural Hamiltonian

1. The Quantum Neural Hamiltonian

We model the neural system as a graph G(V, E) where each node (neuron/column) is a qubit state |psi>. The total system Hamiltonian is:

$$H_{sys} = H_{local} + H_{int}$$

Fluctuations in local cognitive potential are modeled as Pauli-Z rotations, while edges E represent entangled states using an XY-interaction model:

$$H_{int} = -\sum_{\langle i,j \rangle} J_{ij}(t) \left(\sigma_+^{(i)} \sigma_-^{(j)} + \text{h.c.} \right)$$

Information transfer probability is proportional to the square of the transition amplitude:

2. Hebbian Plasticity Derivation

2. Hebbian Plasticity from First Principles

Ideally, 'Neurons that fire together, wire together'. In Quantum terms: 'Qubits that phase-lock maximize mutual inductance'. We define a Plasticity Operator K that acts on the couplings J:

$$\frac{dJ_{ij}}{dt} = \eta \langle \Psi | \hat{K}_{ij} | \Psi \rangle$$

By minimizing the 'Optimization Hamiltonian' H_opt = -Sum sigma_x sigma_x, we derive the update rule:

$$J_{ij}(t+1) = J_{ij}(t) + \alpha \cos(\phi_i - \phi_j)$$

3. Prime Resonance Field Theory

3. Prime Resonance Regularization

We postulate that critical stability follows the Montgomery-Odlyzko Law (Riemann Zeta zeros). We define a Prime Potential density:

$$V_p(x) = \sum_k \delta(x - x_k)(\ln p_k)^{-1}$$

To prevent runaway excitation (epilepsy), we damp the Hebbian term with this potential:

$$\Delta J_{ij} = \alpha \cos(\Delta \phi_{ij}) \cdot (\ln p_i \ln p_j)^{-1}$$

4. Generative AI as Quantum Control

4. The Generative-Quantum Isomorphism

We leverage the mathematical equivalence between Generative Diffusion Models and Quantum Many-Body Physics. The Reverse Diffusion process is formally identical to 'Cooling' a quantum system to its ground state in Imaginary Time.

$$\frac{d\rho}{dt} = \mathcal{L}(\rho) \Leftrightarrow \frac{dx}{dt} = -\nabla U(x) + \xi(t)$$

By training a Generative Model on 'Healthy Brain States', we can 'denoise' a demented brain state back to health.

5. Variational Free Energy Objective

5. Variational Free Energy (ELBO)

In Generative AI, we maximize the ELBO. In Physics, we minimize Free Energy (F). These are the same objective.

$$\mathcal{L}_{ELBO} = \mathbb{E}_q[\log p(x|z)] - D_{KL}(q(z|x)||p(z))$$

Mapping to the Quantum Domain:
- The 'Likelihood' corresponds to measurement fidelity.
- The 'Prior' corresponds to the Prime-Resonant Hamiltonian.

$$F = \langle \psi | H | \psi \rangle - TS_{vonNeumann}$$

The Gemini 3.0 driver optimizes parameters to minimize this F.