Memory Evolutive Systems - Mathematical Formulas

1 Colimits in Categories

A colimit captures the idea of binding objects and morphisms into a new higher-level object:

$$\forall X, \exists! \psi : C \to X \text{ such that } \psi \circ \varphi_D = \text{unique} \tag{1}$$

where φ_D represents a universal morphism integrating a pattern.

2 Functorial Evolution of Systems

A functor $F : \mathcal{C}(t) \to \mathcal{C}(t+1)$ models the transformation of system configurations over time:

$$F(A) = A' \quad \text{and} \quad F(f : A \to B) = f' : A' \to B' \tag{2}$$

This ensures structural preservation during evolution.

3 Composition and Associativity

Composition in categories follows an associative rule:

$$(f \circ g) \circ h = f \circ (g \circ h) \tag{3}$$

ensuring a unique way to interpret composition sequences.

4 Universal Property of Limits

Limits generalize constructions like products, ensuring a unique mapping:

$$\forall X, \exists! \psi : X \to L \text{ such that } \varphi_X = \psi \circ \varphi_L \tag{4}$$

where L is the limit object.

5 Complexification Process

Successive complexifications form a hierarchy:

$$C_0 \to C_1 \to C_2 \to \cdots \to C_n \tag{5}$$

Each step integrates patterns into a higher-order structure.

6 Multiplicity Principle

Emergence requires degeneracy in colimits:

$$\exists P, Q \text{ such that } colim(P) = colim(Q) \tag{6}$$

indicating that different substructures can form equivalent emergent objects.

7 Memory Dynamics

The evolution of memory structures can be functorially expressed as:

$$M_{t+1} = F(M_t, P_t) \tag{7}$$

where M_t is the memory at time t, and P_t represents new procedural inputs.