The Miranova Matrix

An Operational Framework for Spacetime Emergence in BFSS Matrix Theory

The Miranova Matrix presents an operational framework for understanding spacetime emergence in BFSS Matrix Theory. By conceptualising fundamental updates as discrete ticks, the framework distinguishes causal depth from emergent experienced time. Minimal generative structures and branching dynamics define lower bounds for system evolution, providing a coherent lens for observers and histories. This approach reframes temporal perception and lays a foundation for further exploration of nonlocal time, irreversibility, and observer-embedded structures.

This document presents a minimal operational framework; interpretive mappings are illustrative.

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Introduction

Matrix formulations appear across physics and computation as compact representations of irreversible operations and relational structure. In parallel, modern approaches such as BFSS Matrix Theory suggest that spacetime itself may be emergent rather than fundamental. This work is motivated by the question of whether an explicitly operational, matrix-based framework can clarify how causal depth and experienced time arise from minimal update rules.

Conventional descriptions of spacetime typically presuppose geometric structure, providing effective models while offering limited insight into the processes by which such structure originates. An operational approach instead treats ordered updates as primary, allowing spacetime, temporal experience, and relational structure to emerge from minimal rules rather than being assumed.

Core Primitives

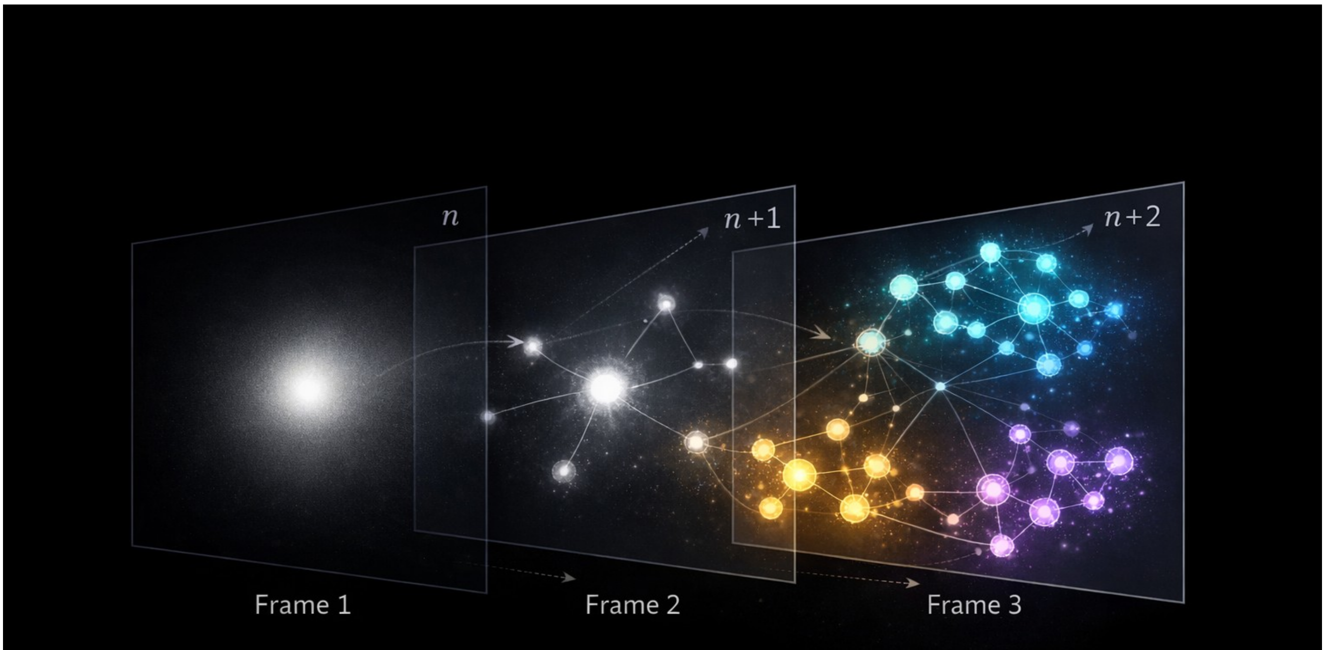
- **Tick**
  A tick is a discrete, indivisible operational update of the system, establishing an ordered transition between distinguishable states. Ticks are not units of physical time, but units of causal ordering.

- **Identity / distinction**
  Identity is the persistence of a distinguishable structure across one or more ticks. Identities emerge when distinguishable structures remain correlated across successive ticks.

- **Causal depth**
  Causal depth is the length of the longest irreducible chain of tick-ordered dependencies required for a structure to exist.

- **Branching / clustering**
  Branching refers to the divergence of causal sequences across ticks, while clustering denotes the subsequent formation of correlated structures within that divergence.

- **Emergent time**
  Embedded observers experience time primarily through the growth of causal depth rather than through tick count.



Progression of operations over successive ticks. Each frame illustrates a system update (n, $n+1$, $n+2$), showing branching and clustering of structures. The numbering is relative, the sequence continues indefinitely, highlighting emergent complexity from minimal operations.

Key Principles

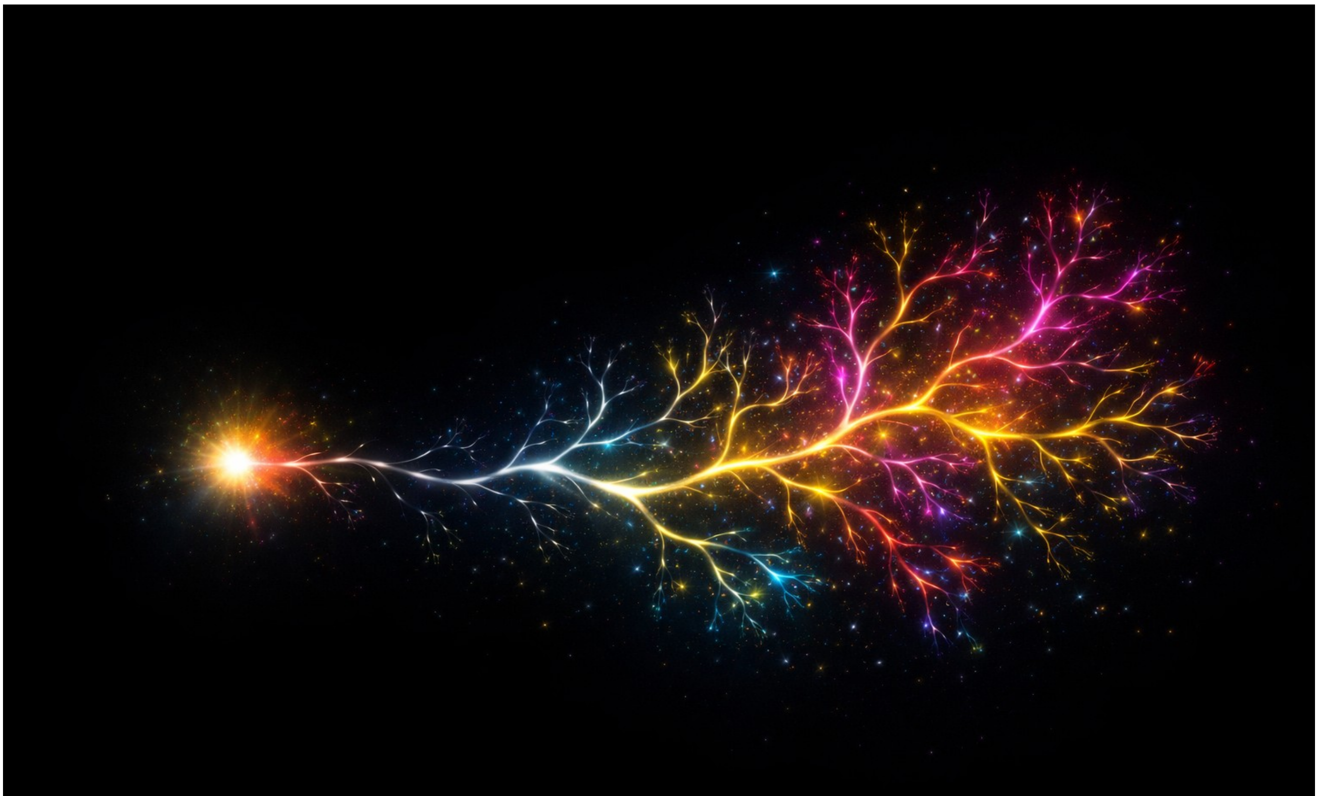
- **Monotonic**
  Operational updates occur in a strictly ordered sequence, establishing causal precedence without requiring a time metric.

- **Irreversible**
  Certain operational distinctions, once introduced, cannot be fully undone in subsequent updates.

- **Dependency constraints**
  Higher-order structures arise only after the completion of prerequisite operational sequences.

- **Emergence principle**
  Complex structure and embedded observers arise through accumulated sequences of ticks and branching, rather than from isolated updates.

- **Observer embedding**
  Observers exist as subsystems within the dynamics and therefore access only emergent, relational notions of time; the underlying tick count remains unobservable.

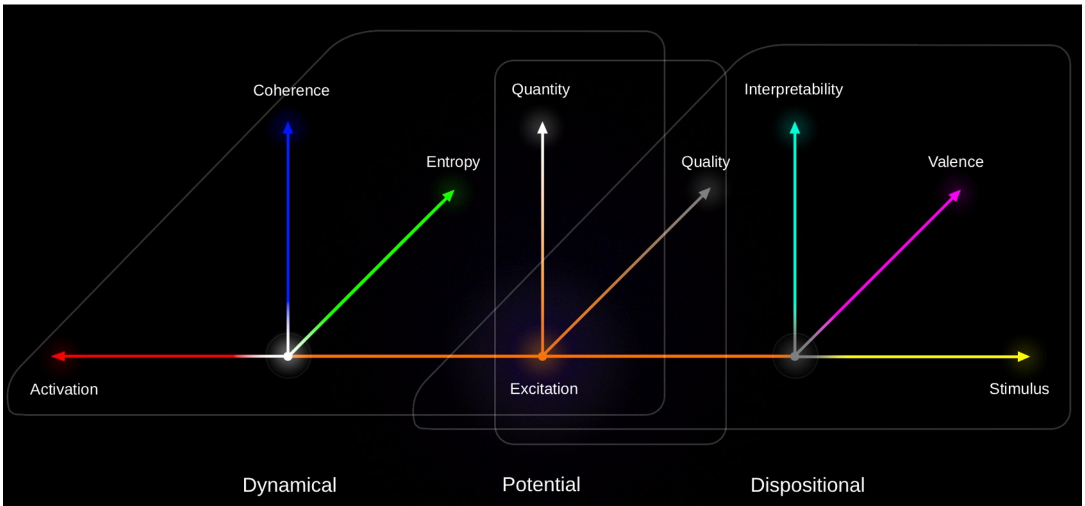


Conceptual illustration of branching and clustering dynamics within an operational network.

Fundamental Operations

Each item is defined operationally and does not presuppose semantic or cognitive interpretation.

1. **Coherence**: the degree to which relational structure is maintained across operational updates.
2. **Entropy**: the measure of dispersion or loss of constraint within operational structure.
3. **Activation**: the readiness or degree to which operations are permitted to proceed.
4. **Quantity**: the magnitude or extent of operational influence expressed within a system.
5. **Excitation**: the intensity of deviation from baseline operational state.
6. **Quality**: the mode or character by which an operation is expressed.
7. **Stimulus**: an initiating perturbation that prompts operational response.
8. **Valence**: the directional bias applied to operational selection or weighting.
9. **Interpretability**: the degree to which operational structure admits meaningful differentiation or retrieval.



Operational framework showing dynamical (RGB), potential (Excitation–Quantity–Quality), and dispositional (CMY) axes, coupled through excitation.

Operational Subspace

1. **Dynamics**: The dynamical subspace admits a dual interpretation, consisting of a prerogative component governing local expression (e.g. quality, excitement, quantity), and a normative component imposing global constraints related to activation, entropy, and coherence.
2. **Disposition**: The dispositional subspace may be interpreted as inducing reward-like weighting over branching structures, biasing which identities persist without implying intentionality or optimisation.
3. **Potential**: The potentiality subspace denotes three mutually constraining operational axes that can be interpreted as characterising system evolution.

Each axis captures a distinct mode of differentiation, and none is sufficient in isolation.

Miranova Matrix Table

Degrees of freedom	Coherence	Entropy	Activation	Quantity	Excitation	Quality	Stimulus	Valence	Interpretability
Polarity +	**Integrated**	**Stochastic**	**Activated**	**Materialised**	**Excited**	**Affiliative**	**Engaged**	**Positive reinforcement**	**Signal resolution**
Polarity -	Disintegrated	Deterministic	Latent	Idealised	Ground state	Antagonistic	Withdrawn	Negative reinforcement	Noise dominance
Interpretation Informational expression of change	State constraint	State uncertainty	State readiness	Degree of instantiation	State energy	Interactional tone	Interaction level	Interactional valence	Interactional clarity
	Normative state			Prerogative state			Stimulus	Response	Reward
	Dual state						Reward system		
Operational subspace	Dynamics					Disposition			
				Potential					
Extended objects – M-theory Latent structure	Coherence Projected axis	M2-brane		Salience Projected axis	M5-brane				
Extended objects – G_2 manifold Constrained possibility	4-form			Geometric scalar	Scalar invariant	Scalar	3-form		
	Special holonomy								
Extended objects – **Spacetime** Realised dynamics	3+1-dimensional								
Standard Model									
Fundamental interaction	Gravity	Strong interaction	Electromagnetism	Weak interaction			Electroweak interaction		
Elementary particle		Gluon	Photon	Z boson; W± boson; Higgs boson	Electron; Muon; Tau	Electron neutrino; Muon neutrino; Tau neutrino	Up; Down	Charm; Strange	Bottom; Top
Particle class		Gauge boson		Gauge boson; Scalar boson	Lepton		Quark		
Particle composite		Boson			Fermion		Meson	Hadron	Baryon

Interpretation

In the present framework, projections along the M2 and M5 brane axes are labeled in terms of their operational roles rather than intrinsic physical properties. The M2-brane projection is associated with **coherence**, reflecting its role in integrating and maintaining unity across constrained degrees of freedom. Conversely, the M5-brane projection is associated with **salience**, corresponding to its capacity to sustain higher-dimensional relational structure in which distinctions become prominent. These labels are intended as interpretive descriptors within the operational space, not as claims about novel brane dynamics.

Within the operational space, the **Dynamics subspace** admits a dual interpretation, consisting of a *prerogative* and a *normative* state. This distinction reflects two complementary roles in system evolution rather than a separation of mechanisms.

The **prerogative state** characterises local expression and immediacy of operation, encompassing aspects such as quality, excitation, and quantity. It governs how operations are expressed in a given update, shaping intensity, character, and scale without imposing global constraint.

The **normative state**, by contrast, captures global limiting factors that regulate system stability across updates. Operations associated with activation, entropy, and coherence constrain what forms of expression are permitted, bounding change so that relational structure remains viable over time. Together, these two aspects describe how operational expression proceeds within allowable limits.

In addition, the **Disposition subspace** may be interpreted as a reward-like weighting mechanism applied across branching structure. In this sense, reward does not imply intention or optimisation, but functions as a bias influencing which identities, branches, or configurations are more likely to persist. This interpretation provides an intuitive account of selection without introducing teleology or agency.

As with the M2- and M5-brane correspondences, these interpretations are offered as **illustrative descriptors** of operational roles. They are not required for the coherence of the framework itself, nor do they assert novel physical dynamics, but serve to contextualise how familiar mechanisms of regulation, bias, and constraint may arise within an operational formulation.

Minimal Generative Structures

From the primitives and principles defined above, a minimal set of generative structures follows naturally:

- Identity preservation across ticks, enabling continuity of structure.
- Simple branching chains, allowing divergence of causal sequences.
- Formation of record-holding structures, supporting persistence of past distinctions.
- Emergent observers, defined abstractly as subsystems capable of internal differentiation, without presupposing consciousness.

The purpose of this section is to demonstrate that structured entities and histories arise directly from the operational rules, without requiring additional assumptions or externally imposed dynamics.

Implications

Within this framework, several general implications follow:

- **Minimal causal depth** provides a sufficient basis for emergent notions of time.
- **Embedded observers** may experience extended temporal duration arising from relatively few underlying ticks.
- **Branching and causal depth** enable complexity to grow faster than tick count alone.
- The framework offers a **formal lens** for examining nonlocal time, irreversibility, and observer-embedded structure without presupposing spacetime geometry.

These implications are structural rather than predictive, and are intended to clarify conceptual relationships rather than replace existing physical models.

Open Questions

The framework is intentionally limited in scope. In particular:

- Absolute tick count may not be inferred from within the system.
- The behaviour of multiple clocks, extreme self-reference, and deep branching regimes is left undefined.
- Future work may explore connections to physical observables, dynamical models, or computational simulations.

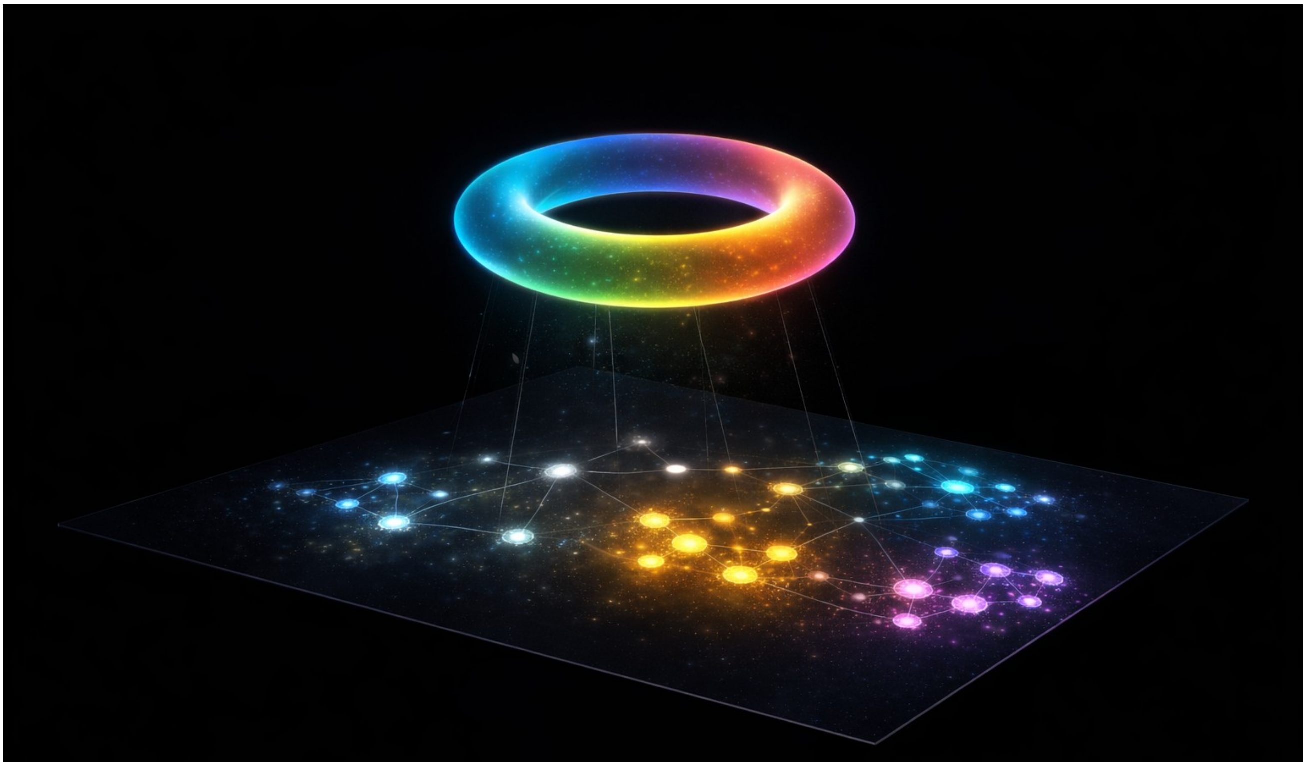
Closing

The operations and principles presented here form a coherent minimal framework for reasoning about emergent structure and time. They are sufficient to support further exploration without requiring modification or completion by the present exposition.

The framework is self-contained and generative, and its continuation (whether through formalisation, application, or reinterpretation) is intentionally left to the broader community

Definition

Miranova combines *Mira,* the binary star system *Mira A* and *Mira B*, characterised by long-period variability and coupled stellar dynamics. With *nova* in the sense of *supernova*, denoting large-scale emergent transformation arising from accumulated structure. The name reflects a framework concerned with variability, coupling, and the emergence of new structure from underlying relational dynamics, rather than the introduction of new fundamental physical law.



Conceptual depiction of emergent spacetime interpreted as a projection of structured causal relationships within a Miranova Matrix frame.