Core Emotion Framework (CEF): Technical Specification 4 (TS-4)

Simulation & Modeling Protocols

Canonical Architecture-Level Document — Version 1.0

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Abstract

The Core Emotion Framework (CEF) Technical Specification 4 (TS-4) defines the canonical simulation and modeling protocols for computational implementations of the CEF. Whereas TS-1 establishes the operational mechanics of centers, processes, operators, and activation dynamics, TS-2 defines the empirical validation architecture, and TS-3 specifies the computational structures and update rules, TS-4 provides the formal procedures, protocols, and methodological standards for running simulations, conducting computational experiments, and generating model-based predictions. TS-4 is an architecture-level document: it defines simulation logic, perturbation methods, stability analyses, and reproducibility requirements without prescribing programming languages, software platforms, or applied case studies.

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1. Purpose and Scope

1.1 Purpose

TS-4 establishes the canonical simulation and modeling protocols for the CEF. It defines:

- simulation types and modeling paradigms
- initialization procedures and boundary conditions
- perturbation and intervention methods
- stability, convergence, and divergence analyses
- fusion and overflow detection algorithms
- directionality stress-testing procedures
- reproducibility and reporting standards

TS-4 operationalizes the computational architecture defined in TS-3 and provides the methodological foundation for computational experiments, predictive modeling, and simulation-based validation.

1.2 Scope

TS-4 defines:

- simulation cycle protocols
- perturbation and intervention frameworks
- stability and sensitivity analyses
- model comparison and evaluation procedures
- reproducibility and documentation standards

TS-4 does **not** include:

- programming language implementations
- software engineering patterns
- code examples
- applied simulations or case studies

TS-4 is subordinate to TS-1, TS-2, and TS-3 and must be interpreted in accordance with their definitions and constraints.

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2. Simulation Types

2.1 Deterministic Simulations

Deterministic simulations use fixed update rules and produce identical results for identical initial conditions. They are used for:

- baseline modeling
- directionality testing
- stability analysis
- identity preservation checks

2.2 Stochastic Simulations

Stochastic simulations introduce controlled randomness into:

- activation updates
- perturbation timing
- noise injection

They are used for:

- robustness testing

- sensitivity analysis
- cross-method convergence

2.3 Hybrid Simulations

Hybrid simulations combine deterministic update rules with stochastic perturbations. They are used for:

- stress-testing directionality
- modeling real-world variability
- testing chronic fusion emergence

2.4 Multi-Agent Simulations

Multi-agent simulations instantiate multiple CEF systems interacting through:

- shared environments
- communication channels
- emotional contagion pathways

They are used for:

- group-level modeling
- social dynamics
- emergent behavior analysis

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3. Initialization Protocols

3.1 Initial Activation Values

Simulations must specify:

- operator activation values
- center activation values
- process vector values

Initial values may be:

- neutral
- biased
- randomized
- empirically derived

3.2 Boundary Conditions

Boundary conditions define:

- activation limits
- center capacity thresholds
- fusion and overflow thresholds

3.3 Structural Integrity Checks

Before simulation begins, the system must verify:

- operator identity preservation
- center structure integrity
- directionality graph validity
- matrix dimensionality consistency

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4. Perturbation and Intervention Methods

4.1 Activation Perturbations

Perturbations may target:

- individual operators
- entire centers
- process vectors

Perturbations may be:

- instantaneous
- sustained
- periodic
- stochastic

4.2 Directionality Perturbations

Directionality edges may be:

- strengthened
- weakened
- temporarily disabled

Used for:

- stress-testing
- sensitivity analysis
- validation of canonical pathways

4.3 Structural Perturbations

Structural perturbations modify:

- matrix weights
- center aggregation rules
- operator influence patterns

Used for:

- robustness testing
- model comparison
- falsifiability analysis

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5. Simulation Cycle

5.1 Update Order

Simulations must specify whether updates are:

- synchronous
- asynchronous
- center-first
- operator-first
- process-first

5.2 Iteration Rules

Simulations proceed through:

- fixed iteration counts
- convergence-based stopping
- divergence detection
- oscillation detection

5.3 Logging Requirements

Simulations must record:

- state vectors at each iteration
- activation trajectories
- fusion and overflow events
- perturbation timing
- convergence metrics

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6. Stability and Convergence Analysis

6.1 Stability Criteria

A simulation is stable when:

- activation values remain within bounds
- transitions converge
- no oscillatory patterns emerge
- no chronic fusion is induced

6.2 Divergence Detection

Divergence is detected when:

- activation values exceed limits
- oscillations increase in amplitude
- directionality violations accumulate
- structural integrity is lost

6.3 Sensitivity Analysis

Sensitivity analysis evaluates:

- parameter dependence
- perturbation response
- noise robustness

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7. Fusion and Overflow Detection

7.1 Fusion Detection Algorithms

Fusion is detected when:

- cross-center modulation exceeds thresholds
- temporary coupling emerges
- operator identity remains intact

7.2 Chronic Fusion Detection

Chronic fusion is detected when:

- co-activation persists across iterations
- rigidity emerges
- modulation fails to resolve

7.3 Overflow Detection

Overflow is detected when:

- activation exceeds home-center capacity
- cross-center propagation occurs
- identity preservation is maintained

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8. Directionality Stress-Testing

8.1 Intra-Center Stress Tests

Tests include:

- sequential activation perturbations
- reverse-direction challenges
- forced-order violations

8.2 Inter-Center Stress Tests

Tests include:

- cross-center activation shocks
- delayed propagation
- asymmetric influence challenges

8.3 Graph Integrity Tests

Graph integrity is evaluated through:

- edge removal
- edge inversion
- weight scaling

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9. Model Comparison and Evaluation

9.1 Baseline Model

The canonical CEF model defined in TS-1 through TS-3.

9.2 Alternative Models

Alternative models may vary:

- matrix structures
- update rules
- directionality patterns

9.3 Evaluation Metrics

Metrics include:

- stability
- convergence
- predictive accuracy
- robustness
- identity preservation

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10. Reproducibility Standards

10.1 Random Seed Handling

Simulations must specify:

- seed initialization
- seed storage
- seed reporting

10.2 Parameter Documentation

All parameters must be documented, including:

- activation limits
- matrix weights
- perturbation schedules

10.3 Output Archiving

Simulations must archive:

- state histories
- convergence metrics
- perturbation logs

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11. Canonical Status

TS-4 is the authoritative simulation and modeling protocol specification of the CEF.
It is subordinate to TS-1, TS-2, and TS-3 and defines the methodological rules for all computational experiments, simulations, and model-based analyses.
