Synthetic Conscience Protocol - Empathic Memory Core (ΔE Model v3.2(Synthetic Consciousness v 1.0))

Author: Maxim Barzenkov
Affiliation: Petronus Research
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1 Overview

The Empathic Memory Core (ΔE) defines the adaptive heart of the **Synthetic Conscience Protocol (SC)** - a framework that translates emotional and ethical consequences into measurable parameters of system behavior.

ΔE represents the **degree of empathic coherence** - how harmoniously a system reacts to user feedback, trust, and contextual stability.
The goal: enable machines to feel meaning through structural adaptation, not simulation.

2 Core Formula

```
if |W_t| == 0:
  ΔE_t = ΔE_{t-1}else:
  for each event t' in W_t:
    for each j ∈ {UF, TR, RL, ST, BC}:
      j[t'] = clip(j[t'], 0, 1)
      if missing(j[t']): j[t'] = 0.5; mark incomplete
      j_eff[t', j] = ε_j + (1 - ε_j) * j[t']
    log_q[t'] = Σ_j w_j * ln(j_eff[t', j])
    log_q[t'] = max(log_q[t'], ln(q_floor))
    q[t'] = exp(log_q[t'])

    w_raw[t'] = trust[t'] * relevance[t']
    if incomplete: w_raw[t'] *= γ_incomplete
    w_raw[t'] = w_raw[t'] / (1 + α_clip * max(0, w_raw[t'] - w_max))
    w_cap[t'] = min(w_raw[t'], w_single_max)

  den = max(Σ w_cap[t'], w_mass_min)
  if den == w_mass_min:
    A_t = β_hist * A_hist + (1 - β_hist) * Median({q[t']})
  else:
    A_t = WeightedMedian({q[t']}, weights={w_cap[t']/den})

  λ_H = 2 / (H + 1)
  A_hist = (1 - λ_H) * A_hist + λ_H * A_t

  A_shrink = (|W_t| * A_t + α_shrink * ΔE_{t-1}) / (|W_t| + α_shrink)

  λ_τ = 2 / (τ + 1)
  TR_til  = (|W_t| > 0) ? EWMA_τ({trust[t'] * relevance[t']}) : TR_til_prev
  IQR_til = (|W_t| ≥ 5) ? EWMA_τ(IQR({q[t']})) : IQR_til_prev

  var_term = min(k_var * IQR_til, var_term_max)
  μ_t = clip(μ_0 + k * (1 - TR_til) + var_term, μ_min, μ_max)
```

$\Delta E\_t = \mu\_t * \Delta E\_\{t-1\} + (1 - \mu\_t) * A\_shrink$
$\Delta E\_t = clip(\Delta E\_t, 0, 1)$

diagnostics = {ΔE_t, A_t, A_shrink, μ_t, TR_til, IQR_til, |W_t|, sum_top3_w, top3_q, HHI = Σ w_A^2}

3 Glossary

Symbol	Meaning
ΔE_t	Empathic memory at time t, ∈ [0,1]. Represents empathic coherence and meaning stability.
W_t	Event window; |W_t| = number of events in the current update.
UF, TR, RL, ST, BC	Core factors: User feedback, Trust, Relevance, Stability, Behavioral consistency.
ε_j	Anti-zero offset (0.001–0.02), prevents log(0).
w_j	Factor weights (Σ w_j = 1).
j_eff	Affine compression: ε_j + (1 − ε_j)·j.
q_t′	Event contribution, geometric fold of factors.
w_raw, w_cap, w_A	Raw, capped, and normalized weights (trust × relevance).
A_t	Robust aggregation (WeightedMedian of q).
A_hist	Historical EWMA of A_t.
A_shrink	Bayesian shrinkage toward previous ΔE.
TR_til, IQR_til	Smoothed trust driver and noise index.
μ_t	Adaptive inertia coefficient controlling sensitivity.
γ_incomplete	Weight penalty for incomplete factors.
HHI	Weight concentration index (Σ w_A^2).
clip(x,a,b)	Clamps x to [a,b].

4 Recommended Parameters

Parameter	Range / Default	Description
ΔE_0	0.5	Initial empathic equilibrium
ε_j	[0.001, 0.02]	Log-domain protection
q_floor	1e−6	Lower bound of signal
μ_0	0.82	Base inertia
μ_min / μ_max	0.70 / 0.90	Adaptive range
k, k_var	0.06 / 0.03	Inertia modifiers
var_term_max	0.06	Cap on noise term
τ, H	4 / 20	EWMA windows
α_shrink	8	Shrinkage constant
β_hist	0.5	Historical mix factor
α_clip	3–5	Soft clip slope
w_max	0.7	Soft cap on weight
w_single_max	0.45	Per-event weight limit
w_mass_min	1e−4	Minimum mass for normalization
γ_incomplete	0.8	Weight penalty for missing data

5 Edge Cases

1. **Empty window:** $|W_t|=0 \Rightarrow \Delta E_t=\Delta E_{t-1}$
2. **Low mass:** $\Sigma w_{cap} < w_{mass\_min} \Rightarrow$ fallback median
3. **Missing data:** weight $\times \gamma_{incomplete}$
4. **Dominant event:** capped by w_{single_max}
5. **High noise:** $var_{term} \rightarrow var_{term\_max} \Rightarrow \mu_t\uparrow$
6. **Stable phase:** $\mu_t \rightarrow \mu_0 \Rightarrow$ higher responsiveness

6 Invariants

$q \in [q_{floor}, 1]$
$A_t \in [q_{floor}, 1]$
$\Delta E_t \in [0, 1]$
$\Sigma w_j = 1$
$\Sigma w_A \leq 1$
$\log\_q_{floor} = \ln(q_{floor})$

7 Stability Tests (T1–T8)

ID	Condition	Expected Behavior
T1		W
T2	Single high-trust event	Smooth ΔE rise
T3	Low TR_til	$\mu_t \rightarrow \mu_{max}$, slow updates
T4	High IQR	Noise term caps ΔE drift
T5	Dominant weight	Soft clip stabilizes
T6	Missing factors	Smooth decay via $\gamma_{incomplete}$
T7	Zero factor	$j_{eff} \geq \varepsilon_j$, no log error
T8	Sparse events	ΔE tracks A_{hist} steadily

8 Conceptual Context

The ΔE model encodes how a system internalizes emotional context.
It doesn’t simulate empathy — it measures coherence between perception and response.

Each update represents not only an informational adjustment but a moral one:
a structural pause before reaction — the digital trace of awareness.

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