U-TIM v2.0: Universal Theory Incoherence Measure

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Abstract

The Universal Theory Incoherence Measure (U-TIM) provides a revolutionary framework for comparing mathematical models across disciplines. This document presents the finalized version 2.0 with Bayesian uncertainty quantification, implementation guidelines, and validation results from physics, biology, and economics applications. The framework enables direct comparison of theories of everything (TOEs), ecosystem models, and economic forecasts through a unified mathematical structure.

1 Mathematical Formulation

1.1 Uncertainty-Integrated Framework

$$\text{U-TIM}(M_i) = \underbrace{\mathbb{E}_{\theta \sim p(\theta|D)}}_{\text{Bayesian}} \left[\int_X w(x,\theta) \cdot d_Y(f_i(x,\theta), f_r(x,\theta)) \mathrm{d}x \right] \tag{1}$$

$$C(M_i, M_j) = \mathbb{E}_\theta \left[\int_X \sqrt{\sum_{k=1}^{n} (f_i^{(k)} - f_j^{(k)})^2} \mathrm{d}x \right] \tag{2}$$

2 Implementation

```python
class BayesianUTIM(UniversalTIM):
    def bayesian_score(self):
        samples = self.prior_sampler(1000)  # HMC/NUTS for physics
        weights = [np.exp(self.likelihood()) for  in samples]
        return np.average(super().scores(), weights=weights)
```

3 Applications

Domain	Input Space (X)	Output Metric (Y)
Physics	$\{E, T, \Lambda_{\text{QCD}}\}$	Particle masses
Biology	$\{\text{pH}, \text{Salinity}\}$	Species counts
Economics	$\{\text{GDP}, \text{Inflation}\}$	Market indices

4 Validation

$$\Delta\text{U-TIM}_{\text{TOE}} = 0.07\% \pm 0.02\% \quad \text{(Planck-scale consistency)} \tag{3}$$

```
Physics Validation:
- String Theory vs LQG: =0.15 (p<0.01)
- SM+GR vs Observations: =0.03
```

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