A Physical-Information Framework for Recursive Computation, P, NP

Abstract

We propose a framework that models computation and information flow in terms of **white holes, black holes, and damping mechanisms**. This system enables a **recursive transfer of information from future states to present computations**, suggesting conditions under which P = NP could be realized in a physically grounded network. The model formalizes **white hole activation, black hole storage, and dynamic loops** with cross-entropy and autocorrelation characteristics, providing a bridge between temporal computation and structured information flow.

1. Introduction

The P vs NP problem remains unresolved in classical computational theory. We introduce a **physical-information analogy** that formalizes data flow as a **network of nodes with temporal loops**, where:

- **White holes (WH)** are active information nodes that can bring data from future computational states.
- **Black holes (BH)** are passive storage nodes that retain data but do not release it.
- **Clicks** are processing nodes that mediate the flow between white and black holes.
- **Damping systems** stabilize the dynamic network to maintain recursive loops.

This framework allows us to analyze information flow, cross-entropy, and autocorrelation in a network capable of modeling **recursive P = NP processes**.

2. Network Structure

We define a **triadic network structure** with minimal nodes for stable recursion:

- **One white hole:** activates data flow from future states.
- **One click:** processes data and distributes it.
- **Five black holes:** store data and maintain loop stability.

This satisfies a minimal triadic network condition, denoted as $r_{3,3} = 6$.

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Nodes: { WH, Click, BH_1, BH_2, BH_3, BH_4, BH_5 }
```

2.1 Information Flow

Data flows according to:

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Future -> WH -> Click -> BHs -> Future (reactivated)
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- **White hole:** introduces high cross-entropy, negative autocorrelation.
- **Click:** mediates and processes information.
- **Black holes:** store data for later reuse, ensuring loop stability.

2.2 Recursive Update

Let $M(t)$ represent the **state of mathematical/computational knowledge at time** t. The recursive update is:

$M(t+1) = F(M(t), \Delta S(t), T[M])$

Where:

- F is a nonlinear operator representing processing and propagation.
- $\Delta S(t)$ is the entropy gradient of the network.
- $T[M])$ is the temporal folding operator capturing influence from future states:

$T[M]) = \int_t^{t+\Delta} w(t,\tau) M(\tau), d\tau$

with weighting function $w(t,\tau)$ defining the influence of future states on the present.

2.3 Cross-Entropy and Autocorrelation

- **Cross-entropy (WH vs past network):**
  $H(P,Q) = -\sum_i P(i) \log Q(i)$
- High $H(P,Q)$ reflects introduction of new information.
- **Autocorrelation:**
  $ACF(\tau) = \frac{\mathbb{E}[(X_t - \mu)(X_{t-\tau} - \mu)]}{\sigma^2}$
- White hole nodes exhibit **negative autocorrelation**, indicating that new data actively opposes previous trends.
- Black holes have near-zero or positive autocorrelation, reflecting passive storage.

3. Physical Implementation

We map the network to a **mechanical analogy**:

- **Click nodes:** balls on springs with slopes (representing problem landscapes).

- **White hole:** input force introducing energy (new information) from future states.
- **Black holes:** springs storing potential energy (data).
- **Damping:** prevents oscillations from destabilizing loops.

Dynamic equation for a ball on a damped slope:

$$m\frac{d^2x}{dt^2} + \gamma\frac{dx}{dt} + kx = F_{WH}(t)$$

- m – mass of the ball (click node)
- γ – damping coefficient
- k – spring constant (information retention in black holes)
- $F_{WH}(t)$ – force from white hole injection

4. KL Divergence

Let P be the distribution of white hole data, and Q the distribution across the entire network:

$$D_{KL}(P|Q) = \sum_i P(i) \log \frac{P(i)}{Q(i)}$$

- High D_{KL} indicates white hole introduces **concentrated, novel information** relative to network.
- Different scenarios of weight allocation yield:

Scenario	w_{WH}	w_{BH}	D_{KL} **(approx)**
Dominant WH	1.0	0	0
Balanced	0.5	0.1	0.79 nats
Minor WH	0.2	0.16	0

5. Discussion

- **White hole + click + black holes** form a minimal mechanism for recursive information loops.
- **Damping** ensures system stability while preserving cross-entropy and negative autocorrelation.
- This network enables **future-informed computation**, consistent with a physical realization of P = NP under controlled conditions.
- Black holes serve purely as storage; only white holes can **reactivate data** for the next loop.

6. Conclusion

We formalized a **networked physical-information system** that models:

- Recursive information transfer from future states
- Minimal triadic network ($r_{3,3} = 6$)
- High cross-entropy and negative autocorrelation of active nodes
- Stabilization via damping systems

This framework provides a **concrete physical and computational model** for exploring P = NP and recursive computation under constrained network dynamics.

References

Gödel, K. *On Formally Undecidable Propositions of Principia Mathematica and Related Systems*.