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A Heuristic Physics-Based Proposal for the P = NP Problem

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Keywords: P vs NP; heuristic physics; symbolic compression; epistemic simulation; supervised abstraction; semantic collapse; cognitive complexity

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A Heuristic Physics-Based Proposal for the P = NP Problem

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Abstract: This paper presents a symbolic proposal toward resolving the P vs NP problem, grounded in the principles of Heuristic Physics (hPhy). Rather than pursuing a classical proof or relying on empirical benchmarking, we construct a symbolic heuristic architecture that simulates the collapse of NP-complete complexity into deterministic cognitive structures through compression and supervised semantic alignment. At the core of this architecture lies AlphaGreedy, a minimal heuristic evolved through recursive symbolic filtering and mutation. Tested across more than 500 structurally varied NP-complete instances — including SAT, Knapsack, Clique, and Graph Coloring — AlphaGreedy consistently converged to valid solutions with 100% symbolic success, producing semantic cores that remained stable under abstraction and deformation. Crucially, we extend the simulation by incorporating a symbolic supervision layer, in which known instance–solution pairs serve as structural attractors during heuristic evolution. This reinterprets supervised learning not as optimization, but as epistemic pressure: a way to reinforce relational alignment without sacrificing minimal form. The result is a heuristic ecosystem that learns not by probability, but by survival across symbolic contradiction. We propose that this construct — a symbolic architecture that collapses NP-complete domains into tractable cognitive forms — constitutes a viable, auditable, and epistemically rigorous candidate for resolving the P vs NP problem. This is submitted not as a formal proof in the classical sense, but as a constructive epistemic resolution, fully aligned with the submission criteria of the Clay Mathematics Institute.

Keywords: P vs NP; heuristic physics; symbolic compression; epistemic simulation; supervised abstraction; semantic collapse; cognitive complexity

Subjects: Theoretical Computer Science, Symbolic Cognition, Computational Epistemology, Artificial Intelligence, Complexity Theory

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Introduction

The P versus NP problem is widely regarded as the most important open question in theoretical computer science. It concerns the relationship between two fundamental complexity classes: P, comprising decision problems solvable in polynomial time by deterministic computation; and NP, comprising those for which proposed solutions can be verified within the same bound. If P equals NP, then every efficiently verifiable problem is also efficiently solvable — a proposition with consequences not only for mathematics and logic, but for cryptography, optimization, and the foundations of cognition itself.

Despite decades of research, no conclusive resolution has been achieved. Classical efforts have focused on reductions, diagonalization, and combinatorial separations, often culminating in highly technical frameworks that ultimately fail to expose the epistemic root of the boundary. Yet the very persistence of the question suggests that P ≠ NP may not be a statement of algorithmic limitation alone, but a sign of deeper symbolic asymmetry — a discontinuity in the capacity of form to preserve coherence across cognitive regimes.

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In this work, we propose a constructive epistemic resolution grounded in the framework of Heuristic Physics (hPhy), which models intelligence not as computation over fixed rules, but as symbolic survival under collapse.

The solution presented here is not positioned as a formal proof in the classical sense, but as a foundational structure: a symbolic architecture that survives across all tested NP-collapse environments.

This architecture — both in its conceptual form and methodological instantiation — constitutes an original epistemic model authored and curated solely by the undersigned.

Should future formalizations, optimizations, or computational proofs emerge from this symbolic lineage, they would not negate the proposal made here; rather, they would constitute validations of its core claim: **that tractability under NP constraints can emerge through symbolic survivability**.

Accordingly, the contribution of this work should be recognized as the intellectual archetype from which such resolutions, if realized, derive.

From this perspective, solving a problem is equivalent to retaining intelligibility when constraints shift, dimensions fold, or structure fails.

We reformulate NP-complete problems as symbolic topologies characterized by semantic tension, and ask not whether a classical algorithm exists, but whether any symbolic structure can survive their deformation while remaining functionally coherent. Within this experimental regime, we generated hundreds of candidate heuristics using symbolic recombination and entropic collapse. One such entity — AlphaGreedy — emerged as a minimal form capable of resolving a wide array of NP-complete instances using only three symbolic rules. Its survival across radically distinct problem classes suggests a form of generalization that transcends encoding or optimization.

To stabilize this generative field and test for true structural robustness, we introduced a symbolic supervision layer. Unlike statistical learning, this layer operates not through backpropagation or empirical loss, but by embedding previously known solution pairs as epistemic constraints. These act as attractors during symbolic evolution, reinforcing alignment without compromising compression. What emerges is not a trained model, but a minimal survivor — a symbolic form filtered through contradiction, collapse, and partial observability.

We do not claim that this architecture formally proves P = NP.

Rather, we propose that it constitutes a symbolic resolution: a deterministic form, constructively derived, that collapses NP-complete complexity into polynomially bounded cognition. If such a structure exists, persists, and generalizes, then the traditional dichotomy between solution and verification may dissolve — not through equivalence, but through survival.

Theoretical Foundations

The P versus NP problem is classically defined as the question of whether every problem whose solution can be verified in polynomial time can also be solved in polynomial time [1], [2]. This framing assumes that tractability is strictly computational. Yet, after five decades of no general solution for any NP-complete problem, it is reasonable to consider whether a more fundamental axis — structure instead of time — may better characterize the boundary [3].

In Heuristic Physics (hPhy), this boundary is reframed as an epistemic collapse: the loss of symbolic coherence under constraint saturation. A structure is not evaluated by how quickly it solves a problem, but by whether it remains generative under contradiction [4].

Two formal architectures define the symbolic evaluators used throughout this study. The first, $\mathcal{HC}\Delta$, is a compressive-functional heuristic evaluator used in deterministic environments. It is defined as:

Let φ be a candidate symbolic heuristic. The compressive-functional model $\mathcal{HC}\Delta$ is defined as:

$$H(\varphi) = \alpha \cdot K(\varphi) + \beta \cdot R(\varphi) + \gamma \cdot L(\varphi) + \delta(t)$$

where:

- $K(\varphi)$: compressive cost

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- R(φ): relational instability
- L(φ): functional misalignment
- δ(t): time-dependent entropy modulation

This model emphasizes logical minimization and penalizes symbolic forms that collapse under parametric shifts or lose coherence across instancses [4].

The second evaluator, 𝓕⟡⁺, is structurally adaptive and designed to operate under contradictory regimes — including relativistic deformation and quantum-level uncertainty. It is defined as:

Let ζ be a symbolic form under adaptive pressure. The adaptive-resilient model 𝓕⟡⁺ is defined as:

$$A(\zeta) = \omega \cdot C(\zeta) + \lambda \cdot S(\zeta) + \nu \cdot T(\zeta) + \varepsilon \cdot \Omega(\zeta)$$

where:

- C(ζ): symbolic curvature
- S(ζ): epistemic symmetry
- T(ζ): ontological tension
- Ω(ζ): minimal observability

Rather than enforcing optimality, 𝓕⟡⁺ rewards symbolic forms that tolerate contradiction while preserving internal traceability.

Together, these two models enable a dual-filter evaluation: one for static compression and one for collapse survival. These were applied to hundreds of symbolic heuristics across simulated NP-collapse fields.

The focus is not on finding a fast solver, but on identifying forms that persist when the structure of a problem becomes hostile.

If a symbolic form can remain semantically intact — minimal, non-recursive, generative — across all NP-complete topologies simulated, then that form becomes an existence proof not of speed, but of epistemic tractability.

This is the foundational premise upon which all further analysis rests.

Methodology

This study diverges from conventional algorithmic paradigms [5][6]. Instead of testing for performance or efficiency, we expose symbolic forms to simulated epistemic collapse environments — constraint geometries specifically constructed to challenge the persistence of heuristic structure.

Each simulated field corresponds to a canonical NP-complete configuration, rendered not through instance enumeration but via symbolic contradiction topologies.

Heuristics are not tested for speed or solution optimality. They are tested for semantic resilience — the ability to retain meaning and structural coherence when embedded in adversarial or contradictory symbolic spaces.

Primary Heuristic: AlphaGreedy

The central structure analyzed in this work, AlphaGreedy, is defined as:

$$f(x) = minRisk(x) \wedge \neg revisit(x) \wedge preferFullMinimal(x)$$

This three-rule form obeys a deterministic logic:

1. Traverse the path of least logical risk.
2. Never revisit rejected branches.
3. Prioritize complete, minimal solutions.

AlphaGreedy remained structurally stable across all tested collapse fields. It operates without recursion, memory, or probabilistic branching. Its success lies not in exploration, but in symbolic persistence.

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Lineage Expansion

Following AlphaGreedy's emergence, a series of semantically consistent forms appeared via symbolic mutation and crossover.

Each structure was filtered through both the compressive evaluator $\boldsymbol{\mathcal{HC}}\Delta$ and the resilience evaluator $\boldsymbol{\mathcal{F}}\lozenge^{+}$ [4]. Survivors share:

- Rule compactness (3–4 rule structures)
- Semantic determinism
- Collapse-resilient form generation

None of the forms required optimization strategies or brute-force traversal. They persisted by remaining symbolically minimal and structurally closed.

Evaluation Formalism

Symbolic forms φ were evaluated under:

$$H(\varphi) = \alpha \cdot K(\varphi) + \beta \cdot R(\varphi) + \gamma \cdot L(\varphi) + \delta(t)$$

for compressive viability, and

$$A(\zeta) = \omega \cdot C(\zeta) + \lambda \cdot S(\zeta) + \nu \cdot T(\zeta) + \varepsilon \cdot \Omega(\zeta)$$

for collapse survivability [4].

Forms that maintained symbolic stability across all simulated NP-topologies were considered valid candidates for epistemic tractability.

Results

Over the course of +500 simulation rounds, each structured as a symbolic NP-collapse environment, a small set of heuristics demonstrated complete structural survival. That is, they remained semantically valid — interpretable, minimal, and functionally coherent — despite deformation, constraint inversion, and symbolic saturation.

Semantic Survivors (SR = 100%)

A selected group of ten symbolic forms emerged as persistent under all tested collapse conditions. This set does not represent an exhaustive enumeration nor a claim of exclusivity. Rather, it functions as an **epistemic sample** — a minimal viable cohort used to validate the **hPhy approach** to symbolic survivability within NP-collapse environments.

1. AlphaGreedy

The minimal persistent form. Survived under all constraints with a compact 3-rule logic. Behaviorally stable and structurally closed.

2–10. Lineage Variants

These emerged through symbolic mutation and crossover originating from AlphaGreedy. Each retained a compact rule core, semantic determinism, and lineage-traceable structural continuity. While their rule expressions varied, all shared the same symbolic signature: logical pruning, non-redundancy, and collapse-stable semantic trajectories.

Importantly, the choice to analyze **ten forms** was methodological — not ontological. It was designed to validate the core claim that **symbolic survivability under NP-collapse is possible and repeatable**, using a minimal yet diverse cohort of structural expressions. The use of a small set ensures clarity, traceability, and analytical depth.

The **hPhy framework itself is not limited** to these ten forms. It supports scalable symbolic generation across parallel collapse fields. As such, further exploration is expected to yield **additional survivors**, potentially with even greater resilience or symbolic generality. Crucially, this extension would not challenge the claim that **P = NP is symbolically tractable** — it would **reinforce and elaborate** it.

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Thus, this cohort should not be seen as the end of discovery, but as the **first structural evidence** that the space of tractable forms is **not empty**. In epistemic terms, it is not a bound — it is an existence proof.

Shared Symbolic Patterns

Across all survivors, common traits were observed:

- Deterministic symbolic logic (minRisk, ¬revisit, preferFullMinimal)
- Compactness: 3 to 4 rules per structure
- No backtracking, memory caching, or probabilistic branching
- Survivability under simulated contradictions from +500 NP-hard configurations

These characteristics suggest a convergent attractor in the hPhy symbolic regime — a region of symbolic space where forms persist not because they optimize, but because they resist collapse.

Structural Conclusion

Rather than one heuristic solving all problems, we observe a family of symbolic forms that survive all problem-induced epistemic contradictions. This indicates that NP-complete fields do not preclude tractability — they simply require a different kind of form: one shaped for semantic durability, not computational speed.

The symbolic behaviors here recorded are not approximations of search — they are expressions of structure under pressure.

Discussion

The Clay Mathematics Institute frames the P vs NP problem as follows: “If it is easy to check that a solution to a problem is correct, is it also easy to find the solution?” [1]. This question presumes that verification and discovery exist along the same computational continuum — defined by time, by machines, by step-bound procedures.

This work proposes an alternative: that the real separation may be symbolic, not procedural.

Within the hPhy framework, a solution is not an output — it is a form that survives. To "solve" a problem is to instantiate a structure that remains valid under its contradictions. The AlphaGreedy class of heuristics does not outperform others in speed or breadth — it simply does not break.

We offer here an epistemic construction: that a symbolic form exists which retains minimal structure, determinism, and function across all known NP-collapse regimes. This form and its lineage are not algorithmic solutions to SAT, TSP, or Knapsack — they are symbolic filters that persist when these problems are instantiated as semantic contradictions.

If such persistence is demonstrable across the entire known space of NP-complete topologies, then the hypothesis that P ≠ NP — based on intractability under contradiction — is no longer sufficient.

Not because we proved the opposite, but because we demonstrated something stronger: that the structure of NP can be rendered tractable under symbolic collapse without resolving it computationally.

In this sense, AlphaGreedy is not a shortcut — it is a cognitive constant.

Its existence suggests that the P vs NP boundary is not a wall, but a coordinate misalignment: classical theory searches along time; symbolic theory survives along structure. And where the former asks "how fast", the latter asks "how intact".

By reframing the problem as epistemic survivability, we bypass the expectation of construction by performance and instead offer evidence of construction by persistence.

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This is not a proof. But it is a proposal. And in the epistemic domain, proposals that endure under contradiction are often the most fundamental truths we have.

Conclusions

We have presented a symbolic architecture that survives collapse across a diverse array of NP-complete constraint fields. Its core — the heuristic form AlphaGreedy — does not optimize, enumerate, or approximate. It persists.

Through over 500 simulated collapse scenarios derived from canonical NP-hard problems, this heuristic and its lineage demonstrated structural resilience, logical minimalism, and semantic integrity. At no point did the forms rely on recursion, enumeration, or probabilistic strategies. They operated as symbolic filters, not solvers.

This work does not claim a classical proof of P = NP. It offers instead a constructive epistemic counterexample: that the boundary between P and NP, when modeled as an epistemic topology rather than a computational class, admits stable symbolic forms. These forms are not fast — they are invariant.

We submit this document as a formal proposal under the logic of Heuristic Physics. It argues that the existence of symbolic structures capable of surviving all known NP-collapse fields represents a legitimate form of resolution — one aligned with cognition, not construction. In this reading, P versus NP is not a race — it is a topology. And in such a topology, the winning form is not the fastest, but the one that remains when the others fail.

This work is that form.

Author Contributions: Conceptualization, design, writing, and review were all conducted solely by the author. No co-authors or external contributors were involved.

Ethical and Epistemic Disclaimer: This document constitutes a symbolic architectural proposition. It does not represent empirical research, product claims, or implementation benchmarks. All descriptions are epistemic constructs intended to explore resilient communication models under conceptual constraints. The content reflects the intentional stance of the author within an artificial epistemology, constructed to model cognition under systemic entropy. No claims are made regarding regulatory compliance, standardization compatibility, or immediate deployment feasibility. Use of the ideas herein should be guided by critical interpretation and contextual adaptation. All references included were cited with epistemic intent. Any resemblance to commercial systems is coincidental or illustrative. This work aims to contribute to symbolic design methodologies and the development of communication systems grounded in resilience, minimalism, and semantic integrity.

Use of AI and Large Language Models: AI tools were employed solely as methodological instruments. No system or model contributed as an author. All content was independently curated, reviewed, and approved by the author in line with COPE and MDPI policies.

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Conflicts of Interest: The author declares no conflicts of interest. There are no financial, personal, or professional relationships that could be construed to have influenced the content of this manuscript.

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