P vs NP as a Compactification Problem: A Dimensional Reframing

Reinterpreting computational intractability as a manifestation of geometric constraint.

3 Pilgrim LLC
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Abstract

This paper reframes the P vs NP question not as a challenge of computational efficiency, but as a reflection of dimensional constraint. It proposes that nondeterminism arises from under-specification in compactified solution spaces -- regions of mathematics where the interior pathways between known boundaries remain structurally undefined.

1. Dimensional Underdetermination

The P vs NP question is typically presented algorithmically: can every problem whose solution can be verified in polynomial time also be solved in polynomial time? This framing emphasizes efficiency but overlooks a deeper structural issue. In any three-dimensional space, locating a position requires three known coordinates. Without them, the system remains underdetermined.

NP problems resemble such underdetermined spaces: they provide boundary conditions — a start and an end — yet lack the internal constraint needed to resolve a unique trajectory. The solution space is not empty, merely indeterminate.

2. Compactification and Constraint

Compactification closes a space by defining its boundary while concealing its interior structure. NP problems can be viewed as compactified domains — bounded by verification criteria but lacking constructive visibility. Their interiors exist, but traversal is undefined without additional semantic constraint, analogous to requiring a third coordinate to specify depth in an otherwise flat geometry.

3. Multiplicity and Dimensional Reality

If P were equal to NP, every equation would yield a single, efficiently derivable solution. Yet mathematics tells us this is rarely true. Higher-dimensional or nonlinear systems admit multiple valid solutions — a consequence not of computational weakness, but of dimensional behavior itself. Numbers and structures in extended spaces interact and entangle, giving rise to non-unique trajectories.

Nondeterminism, therefore, reflects the nature of dimensional multiplicity, not an algorithmic shortcoming.

4. Implications

The irreducibility of P vs NP may express a fundamental geometric truth: that solution determinism collapses when spatial dimensionality exceeds constraint dimensionality. Computation, in this view, is not bound by machine limits but by the topology of its representational space.
The boundary between P and NP is thus not a line between "easy" and "hard," but between spaces that are topologically complete and those that remain compactified.

References

(Contextual sources: foundational literature on computational complexity, topology, and dimensional compactification. Specific attributions omitted due to AI-assisted synthesis.)