Constructed NP Spaces:
Geometry, Scarcity, and Navigation

Yanlin Li

December 18, 2025

Abstract

Classical complexity theory focuses on the classification of languages into complexity classes such as **P** and **NP**. This note adopts a complementary perspective: instead of classifying problems, we study the *construction of feasibility spaces*. We argue that cryptography, artificial intelligence, and game theory can be unified under a geometric interpretation of **NP** as a space of admissible witnesses shaped by rules, encodings, and verification interfaces. Hardness, from this viewpoint, is a property of the constructed space rather than of individual algorithms.

1 From Classification to Construction

The classical **P** versus **NP** question asks whether a given language belongs to one class or the other. Implicit in this formulation is the assumption that the problem space is fixed and that the primary task is classification.

In many practical and theoretical settings, however, the central activity is different. Rather than asking whether a solution exists, practitioners deliberately design problem spaces in which solutions are scarce, structured, or strategically accessible. This motivates a shift in perspective: from the classification of languages to the construction of feasibility spaces.

2 NP as a Space of Witnesses

Fix a parameter system Θ specifying encodings, syntactic constraints, and admissibility rules. An **NP** problem under Θ induces a set-valued semantics via its verification predicate $V_\Theta(x, w)$:

$$\mathcal{W}_\Theta(x) := \{\, w \mid V_\Theta(x, w) = 1 \,\}.$$

The witness set $\mathcal{W}_\Theta(x)$ may be empty, finite, infinite, sparse, structured, or degenerate. This suggests interpreting **NP** not merely as a complexity class, but as a geometry over witness sets embedded in a larger admissible space.

3 RSA as a Near-Point Slice

RSA-like constructions exemplify an extreme regime of this geometry. The ambient admissible space is astronomically large, while the valid witness set effectively collapses to a near-point slice, up to trivial symmetries.

From this viewpoint, RSA is not difficult merely because integer factorization is hard, but because it engineers a feasibility space in which admissible witnesses occupy an exceptionally small region. Cryptographic hardness thus appears as a form of geometric scarcity rather than raw computational intractability.

4 Cryptography as Space Engineering

Modern cryptography can be reinterpreted as the deliberate construction of massive **NP** spaces whose solution regions are vanishingly small. Design levers include admissibility rules, encoding asymmetries, verification efficiency, and controlled rule externalization.

Security, under this lens, is not a property of algorithms alone, but of the shape of the constructed feasibility space and the interfaces through which it may be explored.

5 AI and Game Theory as Navigation Problems

Where cryptography hides solutions, artificial intelligence and game theory navigate them. Learning algorithms explore feasible regions, game-theoretic agents reason over equilibrium sets, and planning systems traverse admissible witness manifolds.

In this sense, AI does not "solve" **NP** problems in the classical sense. Instead, it navigates constructed **NP** spaces, prioritizing coverage, approximation, and strategic movement over isolation of unique solutions.

6 Scope and Non-Claims

This work makes no claims regarding the resolution of the classical **P** versus **NP** question. It proposes no new cryptographic primitives and introduces no algorithmic separations.

Its contribution is conceptual: to articulate a unifying geometric view in which cryptography, artificial intelligence, and strategic reasoning are understood as different modes of interaction with constructed **NP** spaces.

7 Conclusion

The classical question asks whether a solution exists. This note asks instead what kind of solution space has been constructed, and who is able to move within it. This shift reframes computational hardness as a property of space design, rather than of isolated decision procedures.