Envisioning Primes: Topology and Geometry

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Abstract

Prime numbers appear across many areas of mathematics but still lack a simple formula to describe or predict them reliably. This brief draft offers two speculative proposals viewing primes not just as numbers, but as entities arising naturally from geometric or topological structures. Additional ideas will be gradually added to further explore these intriguing connections.

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1 Counting Primes via Topological Compression

This first idea takes place in the realm of topology. The proposal is both abstract and visual: consider a topological object with holes (such as a torus, a hyperbolic surface, or a more exotic construction), and imagine deforming or compressing it gradually.

At each stage of this deformation, progressing level by level or centimeter by centimeter, the topology of the object changes. Some holes disappear, others merge, and some persist. The central claim is that, with a carefully constructed initial object, the sequence of topological changes (measured for example by Betti numbers or homology groups) could match the sequence of prime numbers.

From a more technical perspective, this is similar to filtered homology or persistent homology, although the application here would not be to data science, but to detect arithmetic patterns. The goal would be to construct a topological system that counts prime numbers by undergoing specific structural transitions during deformation.

Perhaps prime numbers correspond to those moments when the object structure experiences a critical and indivisible change. The analogy suggests that primes may appear as signatures of topological invariance that cannot be reduced any further.

2 Primes Encoded in Curvature and Tangents

Let us begin with a rigid geometric object, such as a smooth surface with nontrivial curvature. The main interest is not merely the shape of the object, but how it behaves under motion: what happens when one moves along it, what information its tangents contain, and how the curvature changes from point to point.

This idea proposes that there might exist a geometric variety (not necessarily situated within classical Euclidean space) in which, by computing tangents, derivatives, or preferred local directions, one could detect the appearance of prime numbers as part of a hidden differential structure.

This concept is not entirely unreasonable. In arithmetic geometry, for example, certain elliptic curves contain rational points that encode profound number-theoretic information. Therefore, it is worth considering whether the local growth behavior or infinitesimal structure of a surface could be aligned in such a way that the primes emerge naturally.

Perhaps the key lies in moving beyond the explicit equations that define the surface, and instead paying attention to how the surface reacts to infinitesimal motion, as if its differential response contains a numerical sequence that is not immediately visible.

3 Conclusions

These proposals lack formal definitions and should be regarded as conceptual intuitions aimed at opening new perspectives on an age-old problem by shifting the focus from pure arithmetic to geometry, motion, and deformation.

So far, I have outlined some ideas pointing toward the core of primality. If indivisibility defines a prime, then the key might lie in irreducible mathematical structures such as motions that cannot be fragmented, topological features that undergo critical changes but cannot be fully removed, and differential behaviors that resist decomposition.

The aim is not to find immediate answers, but to spark questions that lead to deeper exploration over time.

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