# Truncation Error as a Detection Mechanism for Simulated Universes

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### Abstract

This paper proposes a novel, falsifiable method for detecting whether our universe is operating on a computational substrate. The hypothesis centers on the concept of truncation error: the inevitable rounding or loss of precision that occurs in any finite-precision computing system. By attempting to calculate conserved quantities, such as total universal energy or entropy, to arbitrary precision, we may encounter resolution limits that betray the simulated nature of our reality. This framework offers a scientific path forward in the long-standing philosophical debate on simulation theory.

## 1. Introduction

Simulation theory has traditionally relied on philosophical arguments or probabilistic reasoning. This paper presents a concrete, testable hypothesis grounded in numerical methods, entropy behavior, and the limits of computability. The foundational claim is simple: any universe simulated on finite computational hardware must employ approximations, and these approximations necessarily introduce truncation error.

## 2. Background

### 2.1 Truncation Error in Computing

In numerical analysis, truncation error is the difference between the true mathematical value and the representation used in computation. It accumulates in systems that rely on finite-precision floating-point numbers. In physics simulations, these errors are typically negligible — but they become critical when compounded at universal scale.

### 2.2 Conservation Laws and Entropy

The laws of thermodynamics, particularly the conservation of energy and the behavior of entropy, are foundational to modern physics. In a non-simulated reality, these laws operate without loss of precision. However, in a simulated environment, conserving energy to the last decimal digit may be impossible without error buildup or artificial constraints.

# 3. Hypothesis

If the universe is a simulation, it must simulate physical quantities — such as energy, entropy, and particle state — using discrete logic and finite resolution. Therefore, it cannot resolve these quantities with infinite precision.

### Testable Claim:

> If we are able to calculate or measure a conserved quantity (such as the universe's total energy or entropy) to arbitrary precision, and we detect unexpected truncation, jitter, drift, or rounding patterns — especially at extreme scales — this would constitute evidence of a simulation substrate.

# 4. Experimental Framework

- Identify a conserved physical quantity (e.g. total energy, mass-energy equivalence).
- Theoretically predict exact values using unified physical laws.
- Design measurement systems that push beyond current resolution boundaries.
- Look for signs of numerical truncation inconsistent with known physical noise (e.g. quantum uncertainty).
- Monitor entropy behavior in high-isolation environments.

# 5. Philosophical and Physical Implications

If truncation or quantization artifacts are observed, several implications follow:

- The universe is not continuous but rendered.
- Information loss is not purely entropic — it is structural.
- The conservation laws are being approximated, not enforced.
- The substrate has a maximum representational fidelity.

This would reshape cosmology, particle physics, and even epistemology.

# 6. Limitations and Objections

- Current measurement tools may be insufficiently precise.
- Quantum mechanics already introduces uncertainty — distinguishing this from truncation is non-trivial.
- Requires acceptance of a high standard of theoretical prediction.

Nonetheless, the method is falsifiable and based on known computational principles.

# 7. Conclusion

Simulation theory has lacked a scientific detection protocol. This paper introduces truncation error as a possible lens for detection, leveraging the universal weakness of finite computing systems. While we cannot yet resolve total universal quantities to extreme decimal precision, the framework is in place. Future technology may provide the tools to stress-test the resolution limits of our reality.

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