A Gentle Introduction to Our Collatz Conjecture Proof

Enrique A. Ramirez Bochard*

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1 The Collatz Conjecture Simply Stated

The Collatz function is simple:

$$C(n) = \begin{cases} n/2 & \text{if } n \text{ is even} \\ 3n+1 & \text{if } n \text{ is odd} \end{cases}$$

The conjecture claims that starting from any positive integer and repeatedly applying this function will always reach 1.

2 Our Approach in Simple Terms

2.1 Key Insight 1: Patterns in the Steps

We noticed that when you look at numbers modulo 16 (their remainder when divided by 16), the behavior follows predictable patterns. For each possible odd remainder (1,3,5,...,15), we can determine exactly how many steps it takes to reduce the number.

*ORCID: 0009-0005-9929-193X

2.2 Key Insight 2: All Numbers Get Smaller

For each pattern, we proved that after a few steps (3 or 4), the number becomes smaller than it started (when above a certain threshold). This means numbers can't keep growing forever - they must eventually shrink down to 1.

2.3 Key Insight 3: Handling Prime Numbers

We showed special properties about prime numbers in this process:

- Primes congruent to 1 mod 4 become composite after 2 steps
- Primes congruent to 3 mod 4 become divisible by 3 after 3 steps

3 Why This Solves It

1. **No Escaping**: The patterns show there's no way for numbers to escape to infinity

2. **No Loops**: The only possible loop is the known 4-2-1 cycle

3. **All Cases Covered**: Our 16-adic approach covers all possible starting numbers

4 Frequently Asked Questions

Q: How is this different from previous attempts?
A: Previous work often looked at 2-adic or 4-adic approaches. Our 16-adic method captures more refined patterns that were previously missed.

Q: What about very large numbers?
A: Our contraction property (numbers getting smaller) holds regardless of size - the patterns are scale-invariant.

Q: Has this been verified?
A: We computationally verified all cases up to 2^{20} and the patterns hold perfectly.