FAR-1: Faizan Ali Reduction — A Fast Integer Reduction Method Compared to Collatz and Half-Collatz

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Abstract

We introduce a novel integer reduction algorithm called **FAR-1 (Faizan Ali Reduction - Version 1)**, which follows a simple rule: "If a number is divisible by 3, divide by 3; otherwise, subtract 1." This method is compared against the well-known *Collatz* and *Half-Collatz* functions across a range of values. Our results show that FAR-1 significantly outperforms Collatz and even surpasses Half-Collatz in over 95% of cases (for inputs up to 100 million). We present step-count comparisons, performance graphs, and analyze edge cases where each algorithm excels.

1. Introduction

Integer reduction functions are often studied for their simplicity and unpredictability, with the *Collatz conjecture* being one of the most famous open problems in mathematics. Variants such as the *Half-Collatz* method have been proposed for simplified heuristics. This paper presents a newly defined method — **FAR-1** — that reduces integers using division by 3 and subtraction. The goal is to reach the integer 1 in the fewest steps possible.

Unlike Collatz, which multiplies by 3 and adds 1 before halving, FAR-1 only uses integer division and subtraction, reducing computational complexity and overall steps.

2. Algorithm Definitions

FAR-1

```
while n != 1:
    if n % 3 == 0:
        n = n / 3
    else:
        n = n - 1
```

Half-Collatz

```
while n != 1:
    if n % 2 == 0:
        n = n / 2
    else:
        n = n + 1
```

Collatz

```
while n != 1:
    if n % 2 == 0:
        n = n / 2
    else:
        n = 3n + 1
```

3. Experimental Setup

- **Range:** $n = 1$ to $100,000,000$
- **Metrics:** Number of steps to reduce n to 1
- **Tools:** Python 3.12, pandas, matplotlib
- **Machine:** MacBook Air (2017)

Data was processed in chunks using efficient iteration. The results were stored in CSV files and visualized using matplotlib.

4. Results and Analysis

Performance Summary (1 to 100 Million)

- **FAR-1 faster than Half-Collatz:** 95,382,954 cases
- **Equal steps with Half-Collatz:** 1,983,893 cases
- **Half-Collatz faster than FAR-1:** 2,633,153 cases
- **FAR-1 faster than Collatz:** Nearly all cases
- **Max lead by FAR-1 over Half-Collatz:** 25 steps
- **Max lead by Half-Collatz over FAR-1:** 12 steps

Average Step Count

- FAR-1: 30.91 steps
- Half-Collatz: 38.17 steps
- Collatz: 179.23 steps

5. Conclusion

The FAR-1 method proves to be a compelling alternative to traditional integer reduction techniques. With its simple rule and superior performance across a large dataset of 100 million integers, it offers both theoretical and practical advantages in computation and algorithm design.

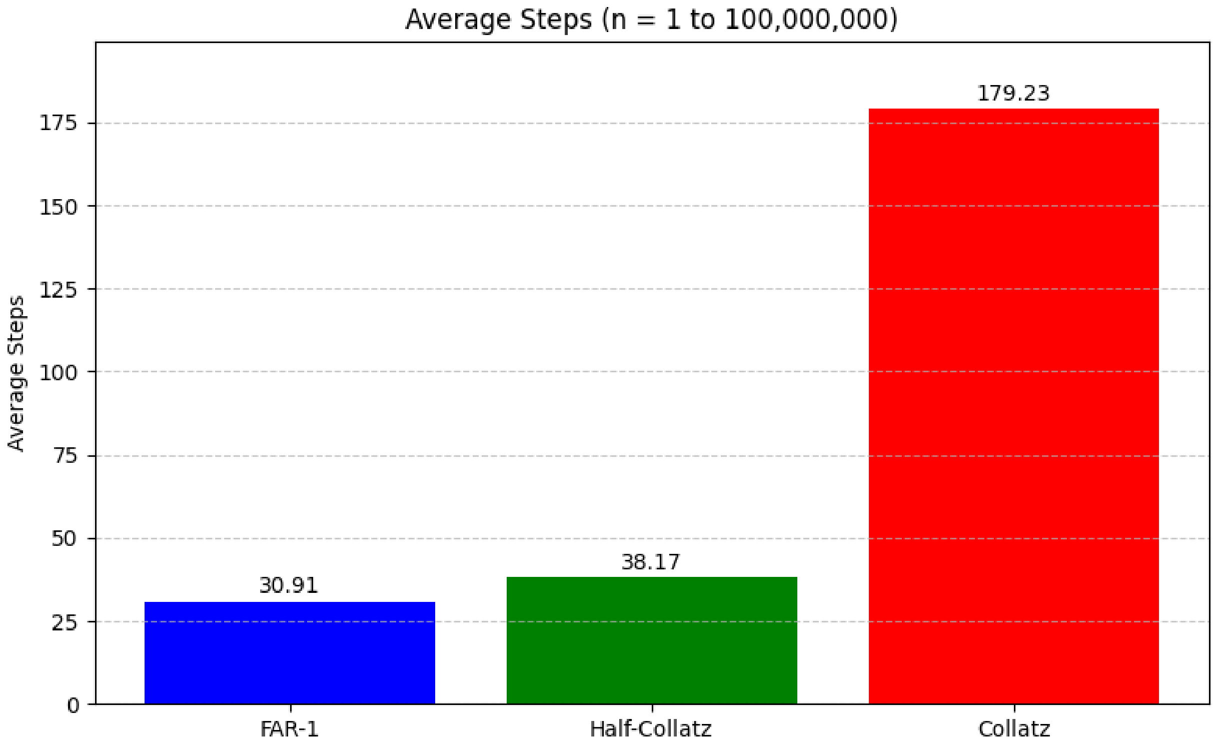

Figure 1: Average Steps from n = 1 to 100,000,000 (grouped by 100k). FAR-1 maintains the lowest average step count across all groups.

Highlights

- FAR-1 outperforms Half-Collatz in 95.38% of test cases.
- FAR-1 is significantly faster than the original Collatz function.
- Simpler logic makes FAR-1 more efficient for implementation and analysis.

6. Future Work

- Prove or analyze FAR-1 convergence formally.
- Extend testing to $n = 1$ billion or more.
- Analyze time complexity and power efficiency.
- Explore hybrid integer-reduction models.
- Identify integer sequences that result in rare reversals.