CALIFORNIA SCIENCE & ENGINEERING FAIR
2018 PROJECT SUMMARY

Name(s)

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Project Number

S1512

Project Title

On the Modular Properties of Hypothetical Collatz Loops

Abstract

Objectives/Goals

The purpose of this project was to observe inherent modular trends within all hypothetical Collatz loops.

Methods/Materials

The Collatz function is defined as follows: start with some positive integer x. If x is odd, multiply it by three and add one, and if x is even, divide it by two. A recursion of this function creates a Collatz series, and the Collatz conjecture predicts that no matter what initial value x is chosen, any Collatz sequence will eventually reach 1. One possible scenario that would disprove this conjecture is if there existed a loop that did not include the number 1. In order to explore these hypothetical loops, I first developed the Collatz modulo web, which is a method that can be used to compute the possible modulo values of the elements in a general Collatz sequence. In order for a loop to be real, it must also exist within the modulo webs, so I developed a depth-first search algorithm that traversed all possible trajectories within the modulo webs to find loops with length n.

Results

By using the traversing program I developed, I was able to test up to n=24, which yielded no non-trivial loops.

Conclusions/Discussion

The Collatz modulo web concept can predict the modulo values of Collatz sequence numbers, and combined with the searching algorithm, it can be used to computationally calculate the existence of loops by loop length, rather than by initial value. This new method to check for loops may bring new insight into the previously unsolved problem.

Summary Statement

I applied modular arithmetic to a generalized formula in order to develop the Collatz Modulo Web, which is a concept that can help identify potential Collatz Loops.

Help Received

I derived all of the mathematical concepts myself. My father assisted me during the develop of the program I used in the second portion of my project.