

A Collatz Conjecture Proof

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Abstract

We represent the generalized Collatz function with the recursive ruler function $r(2n) = r(n) + 1$ and $r(2n + 1) = 1$. We generate even-only and odd-only Collatz subsequences that contain significantly fewer elements term by term, to 2 and 1, respectively, than are present in the original $3n + 1$ and the Terras-modified Collatz sequences. We show that a nonlinear, coupled system of difference equations yields a complete acyclic (except for the trivial cycle) Collatz tree in odds not divisible by 3 with root vertex 1. We construct a complete Collatz tree with the axiom of choice and prove the Collatz conjecture.

1 Introduction: The Collatz sequence and the Collatz conjecture

We address a long-standing and still-open mathematical problem regarding integer sequences attributed to Lothar Collatz in the 1930s (cf. [1]). We represent the non-negative integers with $\mathbb{N}$ and the positive integers with $\mathbb{N}_{>0}$. We define a *sequence* and a *subsequence* of positive integers.

Definition 1.1 (Sequence). For $n \in \mathbb{N}$ and $x_n \in \mathbb{N}_{>0}$ a sequence X in $\mathbb{N}_{>0}$ is an ordered set of positive integers denoted by $X = X(x_0) = (x_n)_{n \geq 0} = (x_0, x_1, \dots)$.

Definition 1.2 (Subsequence). For $n \in \mathbb{N}$ and $x_n \in \mathbb{N}_{>0}$ let $(x_n)_{n \geq 0}$ be a sequence. A subsequence of $(x_n)_{n \geq 0}$ is a sequence $(x_{n_i})_{i \geq 0}$ with $n_i < n_{i+1}$ for all $i \geq 0$.

If a sequence A is a subsequence of B , then we say that B covers A and denote the covering relation by $A \triangleleft B$. For a sequence A the cardinality $|A|$ is the number of elements in A . Definitions 1.1 and 1.2 allow sequences, for example, to have infinite cardinality, to be non-decreasing, or to contain cycles of repeating elements. If we choose to terminate a sequence A at the first occurrence of a particular number, say $f \in \mathbb{N}$, then we denote the finite sequence as A_f with cardinality $|A_f|$. The smallest n such that $a_n = f$ is the stopping time of $A(a_0)$ and is denoted by A_S . Thus, if we have a finite sequence A_f then we have that $|A_f(a_0)| = A_S(a_0) + 1$.

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Robert S. Wolf



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Proof, Logic, and Conjecture Robert S. Wolf, 1997-12-15 This text is designed to teach students how to read and write proofs in mathematics and to acquaint them with how mathematicians investigate problems and formulate conjecture

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