

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 $A \ll B$. 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_g . Thus, if we have a finite sequence A_f then we have that $|A_f(a_0)| = A_g(a_0) + 1$.

Conjecture And Proof Conjecture And Proof

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

Proofs and Refutations Imre Lakatos, 1976 Proofs and Refutations is for those interested in the methodology philosophy and history of mathematics **A Transition to Mathematics with Proofs** Michael J. Cullinane, 2013 Developed for the transition course for mathematics majors moving beyond the primarily procedural methods of their calculus courses toward a more abstract and conceptual environment found in more advanced courses A Transition to Mathematics with Proofs emphasizes mathematical rigor and helps students learn how to develop and write mathematical proofs The author takes great care to develop a text that is accessible and readable for students at all levels It addresses standard topics such as set theory number system logic relations functions and induction in at a pace appropriate for a wide range of readers Throughout early chapters students gradually become aware of the need for rigor proof and precision and mathematical ideas are motivated through examples Proof techniques and strategies are thoroughly discussed and the underlying logic behind them is made transparent Each chapter section begins with a set of guided reading questions intended to help students to identify the most significant points made within the section Practice problems are embedded within chapters so that students can actively work with a key idea that has just been introduced Each chapter also includes a collection of problems ranging in level of difficulty which are perfect for in class discussion or homework assignments 2013 354 pages

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mathematics students Observing Projects Workbook for Universe Roger Freedman,2010-01-29 As the title suggests Discovering Number Theory encourages students to figure out many of the important concepts and theorems of number theory for themselves While the content is similar to other one semester undergraduate texts on the subject the organization and presentation of the material revolves around computer activities With the help of interactive computer software students work on research questions before being exposed to the final polished theorems and proofs By actively participating in the development of course topics they develop a solid understanding of the material and gain valuable insights into the realities of mathematical research **Proof Technology in Mathematics Research and Teaching** Gila Hanna,David A.

Reid,Michael de Villiers,2019-10-02 This book presents chapters exploring the most recent developments in the role of technology in proving The full range of topics related to this theme are explored including computer proving digital collaboration among mathematicians mathematics teaching in schools and universities and the use of the internet as a site of proof learning Proving is sometimes thought to be the aspect of mathematical activity most resistant to the influence of technological change While computational methods are well known to have a huge importance in applied mathematics there is a perception that mathematicians seeking to derive new mathematical results are unaffected by the digital era The reality is quite different Digital technologies have transformed how mathematicians work together how proof is taught in schools and universities and even the nature of proof itself Checking billions of cases in extremely large but finite sets impossible a few decades ago has now become a standard method of proof Distributed proving by teams of mathematicians working independently on sections of a problem has become very much easier as digital communication facilitates the sharing and comparison of results Proof assistants and dynamic proof environments have influenced the verification or refutation of conjectures and ultimately how and why proof is taught in schools And techniques from computer science for checking the validity of programs are being used to verify mathematical proofs Chapters in this book include not only research reports and case studies but also theoretical essays reviews of the state of the art in selected areas and historical studies The authors are experts in the field **Rewriting Techniques and Applications** Nachum Dershowitz,1989 Rewriting has always played an important role in symbolic manipulation and automated deduction systems The theory of rewriting is an outgrowth of

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