

The Ultimate Challenge: The $3x+1$ Problem



Synopsis

The $3x+1$ problem, or Collatz problem, concerns the following seemingly innocent arithmetic procedure applied to integers: If an integer x is odd then "multiply by three and add one", while if it is even then "divide by two". The $3x+1$ problem asks whether, starting from any positive integer, repeating this procedure over and over will eventually reach the number 1. Despite its simple appearance, this problem is unsolved. Generalizations of the problem are known to be undecidable, and the problem itself is believed to be extraordinarily difficult. This book reports on what is known on this problem. It consists of a collection of papers, which can be read independently of each other. The book begins with two introductory papers, one giving an overview and current status, and the second giving history and basic results on the problem. These are followed by three survey papers on the problem, relating it to number theory and dynamical systems, to Markov chains and ergodic theory, and to logic and the theory of computation. The next paper presents results on probabilistic models for behavior of the iteration. This is followed by a paper giving the latest computational results on the problem, which verify its truth for $x < 5.4 \cdot 10^8$. The book also reprints six early papers on the problem and related questions, by L. Collatz, J. H. Conway, H. S. M. Coxeter, C. J. Everett, and R. K. Guy, each with editorial commentary. The book concludes with an annotated bibliography of work on the problem up to the year 2000.

Book Information

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Customer Reviews

Let me cut to the chase: Lagarias has assembled a fantastic book on a fascinating topic, and it is the type of book that the mathematical community could use more of. The book assembles a variety of articles written about the topic over the last forty years, coming to the material from different

directions and using different flavors of mathematics, all in service of trying to solve this problem. --MAA Reviews[This book] contains...two surveys by editor Lagarias...the world's foremost expert. [It also contains] a tremendously useful, richly annotated bibliography...[to] round out the volume.A must for all libraries. Highly recommended. --D.V. Feldman, Choice[T]his book is a thorough account of an open and challenging problem. --Vincente Muqoz, The European Mathematical Society

The book is a great source for several papers that are otherwise difficult to chase down. In particular the translation of Collatz's "On the Motivation and Origin of the $(3n+1)$ -problem", Everett's "Iteration of the number-theoretic function: $f(2n) = n$, $f(2n+1) = 3n+2$ ", and several others. There are also some helpful surveys, some of which are available in the wild. The diagram on the cover has so many errors (beyond 133 vs 113 mentioned by Webysther) that it must be seen as some sort of test for the reader. $21 \rightarrow 64$ not 32 ! $3 \rightarrow 10$ not 5 ! $1 \rightarrow 4$ not 2 ! $13 \rightarrow 40$ not 20 ! $17 \rightarrow 52$ not 26 ! There's a pattern to the errors but they're still errors. Rather strange that AMS and Lagarias didn't catch this. It's also worth noting that Lagarias has an additional Annotated Bibliography covering 2000 - 2009 on arxiv.org

The cover have a problem: 133 not decay to 170, is 200. The correct is $113 \cdot (113 \cdot 3 + 1) / 2 = 170$ $(133 \cdot 3 + 1) / 2 = 200$

Much more analytical than what I was expecting. Covers a lot on the $3x+1$ problem. However, the only reason I bought this book was for the FRACTRAN section at the end. :-)

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