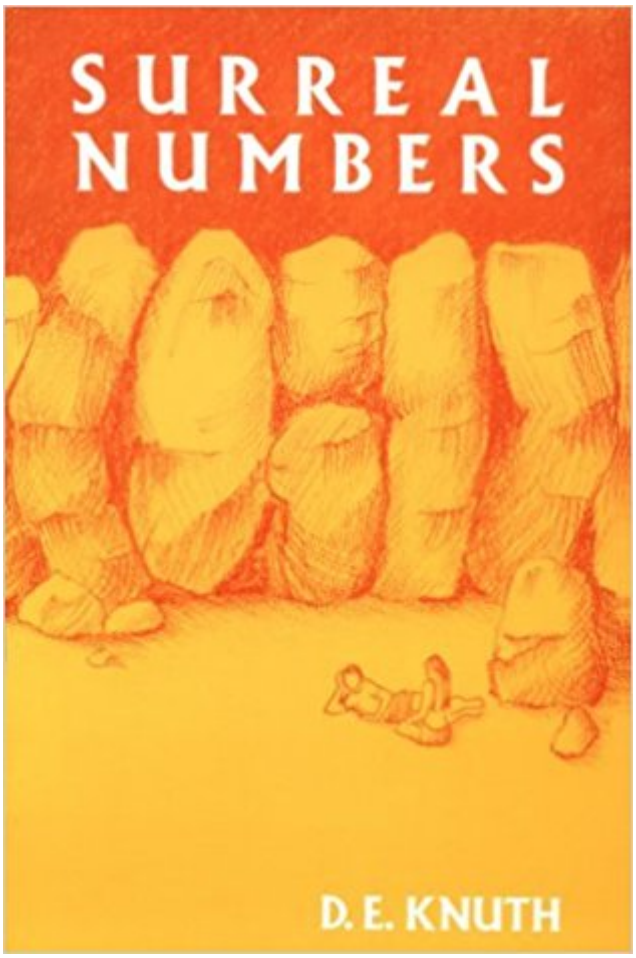
Surreal Numbers



Synopsis

Shows how a young couple turned on to pure mathematics and found total happiness. This title is intended for those who might enjoy an engaging dialogue on abstract mathematical ideas, and those who might wish to experience how new mathematics is created.

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Customer Reviews

Nearly 30 years ago, John Horton Conway introduced a new way to construct numbers. Donald E. Knuth, in appreciation of this revolutionary system, took a week off from work on The Art of Computer Programming to write an introduction to Conway's method. Never content with the ordinary, Knuth wrote this introduction as a work of fiction--a novelette. If not a steamy romance, the book nonetheless shows how a young couple turned on to pure mathematics and found total happiness. The book's primary aim, Knuth explains in a postscript, is not so much to teach Conway's theory as "to teach how one might go about developing such a theory." He continues: "Therefore, as the two characters in this book gradually explore and build up Conway's number system, I have recorded their false starts and frustrations as well as their good ideas. I wanted to give a reasonably faithful portrayal of the important principles, techniques, joys, passions, and philosophy of mathematics, so I wrote the story as I was actually doing the research myself."... It is an astonishing feat of legerdemain. An empty hat rests on a table made of a few axioms of standard set theory. Conway waves two simple rules in the air, then reaches into almost nothing and pulls out an infinitely rich tapestry of numbers that form a real and closed field. Every real number is

surrounded by a host of new numbers that lie closer to it than any other "real" value does. The system is truly "surreal." quoted from Martin Gardner, Mathematical Magic Show, pp. 16--19 Surreal Numbers, now in its 13th printing, will appeal to anyone who might enjoy an engaging dialogue on abstract mathematical ideas, and who might wish to experience how new mathematics is created. 0201038129B04062001

Donald E. Knuth is known throughout the world for his pioneering work on algorithms and programming techniques, for his invention of the Tex and Metafont systems for computer typesetting, and for his prolific and influential writing. Professor Emeritus of The Art of Computer Programming at Stanford University, he currently devotes full time to the completion of these fascicles and the seven volumes to which they belong.

In the early 1970s, mathematician John Conway and computer scientist Donald Knuth had lunch together, during which Conway told Knuth of a way to generate all numbers from a couple of rules.What is a number?Everyone understands what one apple means. We also all understand that if Bill starts with three apples and gives one of those apples to Alice, he will have two apples left. But what are those things we all understand to be "one" or "two" or "three"? They are abstract objects and in modern mathematics we build numbers using set theory. We start with the empty set, then we create a set that contains the empty set, and a set that contains that set, and so on. The empty set is "zero", the set containing the empty set is "one", the set containing one is "two". Each set created this way has a successor set and together they form the Natural numbers. We now have 0,1,2,3,...We create the Integers by giving each Natural number except zero a negative version. We now have 0,1,-1,2,-2,...From the the set of Integers, we create the set of all ordered pairs (a,b) where a is any integer and b is any integer except zero. This gives us all fractions: 1/2, 3/5. We can reduce ordered pairs to simpler ones if they have common factors: 3/3 is the same as 1 while 96/15 is the same as 6 and 2/5. Because they are a ratio of two integers, we call them the Rational numbers.It was a big disappointment for the Greeks to find that these numbers did NOT correspond to every point on the line. All the rational numbers are indeed ON the line but there are points on the line that are NOT fractions--for example the square root of two. This unsatisfactory situation endured until the 19th century when the Real numbers were created from a specific kind of subset of the Rationals called "cuts".So from the empty set, we get the natural numbers, then from those we get the integers, then from those we build the rationals and finally we get the reals. That’s four levels of construction.Amazingly John Conway invented a way to get ALL the numbers in one go, in

a single level of construction. Conway came up with two rules that yield all the numbers on the real line by starting from the empty set and proceeding by iteration. As a bonus, these two rules also generate infinitesimals and transfinite cardinals. Infinitesimals are numbers greater than zero but smaller than all the non-zero positive real numbers, while transfinite cardinals are numbers that characterize different orders of infinity.Donald Knuth jumped at the chance to use the topic to illustrate how much fun doing mathematics can be. He thought Conway's numbers would make an excellent basis for a story about two students working out how to generate the numbers from Conway's two rules and proving many useful theorems along the way. Knuth came up with the name Surreal Numbers (Conway referred to them just as "numbers") because they are in fact more than the Real numbers and yet they are generated using a simpler set of rules. Surreal!Knuth set his story on an exotic island where the two students, Alice and Bill, discover a stone inscribed with the two rules and a short explanation of how to generate zero, one and minus one. From that starting point, Alice and Bill figure out how to work out all the numbers, and also how to add, subtract and multiply them. (SPOILER ALERT) The experience of working together convinces them that they should get married.As far as dramatic literature goes, this isn't anything impressive. Calling the dialogue silly or corny would be generous. But following the math part of the novelette does effectively convey how it feels to work out mathematical theories for oneself and it will show the interested reader just how much fun he or she can have working out theorems for themselves.Vincent Poirier, Montreal

I found this book to be super interesting. I really enjoy math, although I have come to that late in life and am not very good at it. I just finished reading this fairly quickly and am about to start again at the beginning and take it more slowly this time. I like the emphasis on logical development and proofs and the way Knuth returns to the same topics later to identify the weak points that can be further refined. Knuth is trying to help us develop an intuitive understanding of Conway's amazing discovery/invention but more importantly show us how math is developed rather than just presenting it as a finished product. He makes the material easy to read without even requiring full comprehension which is quite a trick. That is not easy to do!I don't understand the other reviewers negative comments about the "story" or the references to food and sex. Just to be clear, there are no explicit references to sex in this book. There are explicit references to eating but hopefully that won't bother most people. The non-math dialog is very brief, serving as a gentle way to open and exit each small chapter and providing a simple context for a conversation about the mathematical concepts.The purpose of this truncated character and story development is to make the text more

accessible to sophomore math students and it works perfectly. I suppose the people who are bothered by this prefer their math straight-up. I can see how a competent mathematician would be annoyed by these brief digressions but this book is not for them. Knuth discusses this in the book's postscript where he points out that the book is targeted to the college sophomore level and he decries the teaching of math concepts in the form of finished products as a major shortcoming of our current education system.I would give this book 6 stars if I could.

A wonderful, accessible and lightweight introduction to abstract math. If you want to understand what numbers really are, read this.

A fun read if you enjoy maths. The book even encouraged me to tinker with the problem within.

Awesome book, just wish there was an extended version though.

It's great even as a book by itself

First of all, a word of advice for the future readers of this book. Do not read it for its story. From the literary point of view, it's bad. Perhaps the only type of reader that will benefit or enjoy this book is the mathematical one.In this book, you will find an exposition of a construction of a special number system (formally, a proper class of number systems). However, this exposition does not follow the formal or even traditional method employed in most mathematics books. It is told in form of a story. Two characters find a stone inscribed with the axioms of the construction of some "surreal numbers" and spend the whole book thinking what these axioms mean in some intuitive way.In a mathematician's perspective (rather, my own), it is very entertaining. The characters' point of view is just as that of two mathematicians talking about some problem. And the construction is very interesting from a mathematician's point of view. So, yet again, for a mathematician, it will be like listening to two colleagues talking about some problem. It also has another element cooked for mathematicians: it has a small discussion about the fact that mathematical thinking is not taught until graduate school.In conclusion, this book is a book about advanced mathematics written in a funny style. Do not expect the story to be good in a literary sense.

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