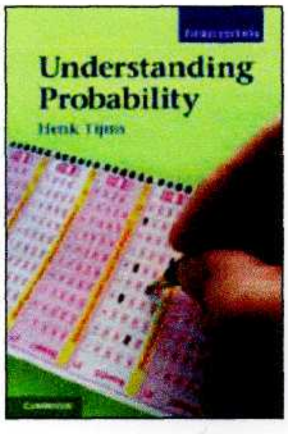
Understanding Probability (3rd Edition)

Henk Tijms
Cambridge University Press, 2012, 572 pp



The third edition of "Understanding Probability" by Henk Tijms is an introductory book on probability theory. It is written at the level at which one requires, at most, a first course in calculus to read it. The book is split into two parts, the first consisting of an introduction to probability, by the means of motivating examples (as aptly described by the author "to provide a feel for probability"). These motivating examples cover quite technical issues, for example the Black Scholes model, but at a mathematical level that is intuitive rather than technical. The second details the topics for a first course on (non measure-theoretic) probability theory, that might be taught at the first or second year undergraduate level at most mathematics or statistics departments. The topics of these latter sections are perhaps mathematically sophisticated, but introduced in a very readable manner, that provides the reader a very gentle introduction. Roughly, on the non-technical side of the book, the author covers: "laws of large numbers", "rare-events", "random walks", "Brownian motion" and "Bayes Theorem" (in 6 chapters). These concepts are enhanced with a collection of more-or-less well known examples such as the "St. Petersburg paradox" and the "Monty–Hall problem" that are staples in undergraduate probability courses. On the technical side, the author covers: "foundations of probability", "standard introduction to discrete and continuous random variables" (including the multivariate normal distribution and conditioning), "generating functions" and "Markov chains in discrete and continuous-time" (in 10 chapters). There are also exercises with solutions to odd-numbered questions. In addition, in comparison to previous editions of the book, the author adds further exercises and examples, including Markov chain Monte Carlo and Brownian motion.

Previous to reading this textbook, I had been unfamiliar with Henk Tjims' work and in particular his books. I approached the book, with the idea that it might be a routine textbook and that essentially, I would skim through the book with little interest, revisiting concepts I already knew, forgotten or already taught. However, I was very wrong! The book was engaging and the first half, as is claimed on the book jacket and preface, is not only easily accessible but very interesting. There are many real well-known examples, which add a dimension of motivation which is often alluded to by many authors, but is followed through by this author. I have the feeling that this book should be recommended to high-school students that have the misconception that probability is either too easy or boring. In addition, I feel that this first half of the book is particularly useful for industrial professionals, for example in the pharmaceutical industry or finance, who have long forgotten their undergraduate training, but need to brush up for a new project. I cannot recommend this first half of the book more highly. Even more, what I find quite astonishing, is the ability to make quite complex mathematical objects (such as Brownian motion or the bootstrap method of Efron) seem "easy" by clear and intuitive explanation that one would assume can only be gained by a deep understanding of these concepts. Clearly, however, for the more technical minded (which includes this reviewer) one can find the lack of mathematical detail frustrating, but, of course this is not the intention of the author at this stage.

Moving onto the second half of the book, where the author starts to take a more mathematical look into probability, the one issue which gave me an initial skeptism was as follows. From my own experience as both student and teacher, I am used to probability being taught as a branch of mathematics; with a strict definition-theorem-proof format, that, whilst potentially intimidating, provides a clear way to understand the ideas; this is also the format of every textbook that I have used for probability. This is not the approach of the author (although there are sometimes definitions and "rules") and the general route of explanation is one of first intuition or word commentary and then technical details, but only to the level at which they are required. The extent to which this works will depend on the reader, but I have the feeling that most readers who begin reading about a concept to which they have not read before looking at the book, will leave the book with the notion of some understanding. That is, it is very clear, without reaching technical details which would be required at the graduate level (which, again, is not the book's intention). The reader of this review should not make the mistake that the book is not completely rigorous; within the confines of undergraduate probability, the author is generally very accurate mathematically.

From the perspective of the new material, I spent some time looking at these aspects, particularly Markov chain Monte Carlo (MCMC), this lying within my own research interests. The idea of MCMC is routinely used by researchers and industry professionals for statistical inference and until recently is seldom covered in undergraduate courses, mainly because the theory of Markov chains on general state-spaces is relatively new in probability theory. The author provides an introduction to this algorithm which allows one to understand how to construct an algorithm of their own, which, given the level of the text is highly commendable. This explanation can easily be used by researchers in fields outside statistics or probability, seeking to gain an understanding in MCMC and to develop their own ideas further. In relation to this, I particularly liked the way the author discussed self-normalised importance sampling, which I have rarely seen outside a research level book. This topic is amazingly well demystified: "Why does this work. The explanation is simple" — and indeed it is and so was that of the author's. I found this new part of the third edition very satisfying and in-line with the research that is currently being undertaken in simulation methodology.

The potential audience of this book, who I have frequently alluded to during my review, not only includes undergraduate students in multiple disciplines (such as statistics, economics or engineering) but those in industry seeking to gain an initial understanding in probability (or revisit long forgotten concepts) and especially those seeking to teach an introductory course in probability. For the latter, whilst there may be a shortage of mathematics, the intuition that could be taken from this text, would greatly enhance your lectures, in this reviewer's opinion. The book should definitely be read by undergraduates who leave each class with a feeling that they do not understand what just happened; they certainly will understand after this book — which makes the title entirely appropriate.

If this review feels very enthusiastic, then indeed that is my intention. My own feelings on "Understanding Probability" are that it is an extremely useful book that makes probability understandable to a wide audience.

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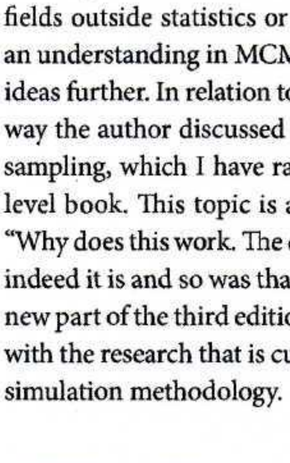
Figurate Numbers

Elena Deza and Michel Marie Deza
World Scientific, 2011, xviii + 456 pp



This book is about special types of numbers (integers) that have geometric associations and that have intriguing spatial properties. The ancient Greeks were perhaps the first to study what are called "figurate numbers" — numbers that can be represented by regular geometric patterns of points in the plane or in space, such as triangular, polygonal and polyhedral numbers. The first two chapters contain a lot of formulae for all kinds of figurate numbers that arise from geometric patterns in 2 and 3 dimensions. Properties and relations between such figurate numbers and their connections with Diophantine equations have been studied by classical mathematicians like Euler, Fermat, Lagrange, Legendre, Cauchy, Gauss and Dirichlet.

Chapter 3 extends the construction of figurate numbers to dimension 4 and beyond. Examples of such numbers are the pentatope numbers which are 4-dimensional analogues of triangular and tetrahedral numbers, and the biquadratic numbers which are the 4-dimensional analogues of square and cubic numbers. Despite the lack of visual pictures and physical intuition, multitudes of formulae are presented and proved.

Chapter 4 contains much interesting material on the role of certain figurate numbers in classical number theory. One finds connections with well-known numbers associated with the names of Catalan, Mersenne, Fermat, Fibonacci, Lucas, Stirling, Bernoulli, Bell and so on. Certain types of Diophantine equations inevitably turn up — the Fermat equation, Pell equation, Ramanujan–Nagell equation. We get to see some recreational aspects of prime numbers in terms of square arrangements of their digits. Most people have come across magic squares and magic cubes, but probably not magic hexagons. There is a brief mention of unrestricted partitions and Waring's problem.

The first four chapters may appear to be a collection of results and properties about "exotic" numbers and lack a general theory. However, from a number-theoretic point of view, Chapter 5 is the most interesting