



How Not to Be Wrong: The Power of Mathematical Thinking

Jordan Ellenberg

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The *Freakonomics* of math—a math-world superstar unveils the hidden beauty and logic of the world and puts its power in our hands

The math we learn in school can seem like a dull set of rules, laid down by the ancients and not to be questioned. In *How Not to Be Wrong*, Jordan Ellenberg shows us how terribly limiting this view is: Math isn't confined to abstract incidents that never occur in real life, but rather touches everything we do—the whole world is shot through with it.

Math allows us to see the hidden structures underneath the messy and chaotic surface of our world. It's a science of not being wrong, hammered out by centuries of hard work and argument. Armed with the tools of mathematics, we can see through to the true meaning of information we take for granted: How early should you get to the airport? What does "public opinion" really represent? Why do tall parents have shorter children? Who really won Florida in 2000? And how likely are you, really, to develop cancer?

How Not to Be Wrong presents the surprising revelations behind all of these questions and many more, using the mathematician's method of analyzing life and exposing the hard-won insights of the academic community to the layman—minus the jargon. Ellenberg chases mathematical threads through a vast range of time and space, from the everyday to the cosmic, encountering, among other things, baseball, Reaganomics, daring lottery schemes, Voltaire, the replicability crisis in psychology, Italian Renaissance painting, artificial languages, the development of non-Euclidean geometry, the coming obesity apocalypse, Antonin Scalia's views on crime and punishment, the psychology of slime molds, what Facebook can and can't figure out about you, and the existence of God.

Ellenberg pulls from history as well as from the latest theoretical developments to provide those not trained in math with the knowledge they need. Math, as Ellenberg says, is "an atomic-powered prosthesis that you attach to your common sense, vastly multiplying its reach and strength." With the tools of mathematics in hand, you can understand the world in a deeper, more meaningful way. *How Not to Be Wrong* will show you how.

How Not to Be Wrong: The Power of Mathematical Thinking Details

Date : Published May 29th 2014 by Penguin Press

ISBN : 9781594205224

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Format : Hardcover 480 pages

Genre : Nonfiction, Science, Mathematics, Psychology

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From Reader Review How Not to Be Wrong: The Power of Mathematical Thinking for online ebook

Will Once says

I so wanted to like this book.

It's a topic I enjoy. I flicked through the book and the author was saying things that I agree with. Jordan clearly knows what he is talking about. All the signs were good.

So why the 3 stars? Because the book is unfortunately quite dull. There are long sections where Jordan spends ages proving some mathematical point or other, but then he doesn't draw any conclusions from it.

He starts with a story about school kids not liking mathematics because they can't see the relevance to their lives ... and then he gives us a book which largely proves that the kids were right. Some of his explanations are linked to something useful and real world, but most are not.

And when he does make a point, sometimes he wants to hammer that point in with explanation after explanation. It's as if he is trying to batter us into submission with repeated hammer blows. Yeah, yeah, I got it.

The writing varies from quite readable to fairly turgid. At times it feels like we are wading through a text book.

The title is a complete misnomer. If you are looking for a practical guide on the use of mathematics, then look elsewhere. This does not tell you how not to be wrong. Please, please, either write a book to fit the blurb or change the blurb. This does not do what it says on the tin.

Disappointing. There is a good book in here, but it needs a much stronger edit to make it readable. And it needs to be linked more to real life.

So it's a three star for me. The content ought to make it a five star book. The writing and limited conclusions drag it back to three.

David says

This is a wonderful book about mathematics and its application to everyday life. Jordan Ellenberg shows that the certainty that people associate with math is often misplaced; some areas of math are devoted to uncertainty, and that's where things get very interesting.

Ellenberg starts the book with a beautiful example of application of mathematics, logic, and thinking out of the box. During World War II, a group of mathematicians working for the Statistical Research Group were given a problem by some Air Force officers. Fighter planes returning from missions were analyzed for bullet holes. The number of bullet holes per square foot were counted. For example, there were 1.11 bullet holes per square foot in the vicinity of the engine, 1.73 in the fuselage, 1.55 in the fuel system, and 1.8 in the rest of the plane. The officers wanted to add some armor to the planes; the question was where? The planes could

only support so much weight, and where would additional armor be most advantageous? The officers thought that since the fuselage had the greatest density of bullets, that would be the logical location for more armor. A mathematician named Abraham Wald said exactly the opposite; more armor is needed where the bullet holes *aren't*, namely, around the engines. Planes with lots of bullet holes in the engine did not return at all!

The book discusses the issue of statistical significance. Scientific experiment often use a 95% confidence threshold as an indicator of statistical significance. This means that if a truly random outcome were expected, a positive correlation would be seen only 5% of the time. Ellenberg includes an xkcd cartoon that shows how easy it would be to perform a set of experiments that could come up with statistically significant results like "*Green jelly beans linked to acne!*" at the 95% confidence level.

Some of the section and chapter titles are hilarious. For example, in the chapter titled "*Are you there, God? It's me, Bayesian Inference*", Ellenberg brings up a scary example of the use of "big data". Based on a teenage girl's purchases of unscented lotion, mineral supplements, and cotton balls, the retail store "Target" began sending her coupons for baby gear, because of the (correct) inference that she was pregnant. Another great section title is "*One more thing about God, then I promise we're done.*"

Another interesting title is "*The Cat in the Hat, the Cleanest man in school, and the creation of the universe*", in which Ellenberg reviews some of the probabilistic arguments for and against the existence of god. And I love the famous quote by Richard Feynman:

You know, the most amazing thing happened to me tonight. I was coming here, on the way to the lecture, and I came in through the parking lot. And you won't believe what happened. I saw a car with the license plate ARW375. Can you imagine? Of all the millions of license plates in the state, what was the chance that I would see that particular one tonight? Amazing!

I also love the chapter title, "*If Gambling is exciting, you're doing it wrong*". Ellenberg describes how several groups capitalized on several state lotteries. Due to some strange lottery rules, it is (was?) possible to reliably make a profit, given enough investment of resources. No illegal shenanigans--the states make money no matter what you do. You could make a profit by taking advantage of the rules, and of the people who buy lottery tickets without a coherent strategy. And, I did not realize that Voltaire made his fortune by taking advantage of state lotteries!

Ellenberg brings up the phenomenon of Nate Silver predicting the outcome of the Obama-vs.-Romney election. Silver predicted the probability of both candidates winning state by state, along with the margin of error. By adding up the probable errors, he estimated that he would be wrong by 2.83 states. Critics seemed to have ignored the fact that he was *not* wrong by this many states--in fact he correctly predicted the outcome in all 50 states!

I highly recommend this book to all people who are even vaguely interested in math, probability, logic, and the application to everyday life. This is an excellent book!

kartik narayanan says

I am one of those fortunate individuals who cherishes and loves Mathematics, in all its forms. But, I know, a

lot of people for whom the Maths is a dreaded specter.

Why is that so? Inevitably, this is a problem that arises from the way the subject has been taught. And this is what the book tries to dispel. This book takes us behind the numbers, equations, theories and abstruse concepts to show the practical applications of whatever we have been taught. Along the way, the history of these various ideas are explained as are various anecdotes, which are informative and amusing.

This book is written along similar lines to Metamagical Themas and GEB, while not at the same level. Think of this book as a stepping stone to the fore mentioned books.

The book deals with concepts that we have been taught in our 11th/12th & Graduation. The author doesn't really dumb down the concepts – this means that while they have been explained well, the reader really has to concentrate while reading the book.

Another facet of this book which made me love it were the lovely quotes from history. A couple of examples are below.

When talking about the romantic notion of how mathematicians are portrayed as genius, loner types, the author quotes Mark Twain – “It takes a thousand men to invent a telegraph, or a steam engine, or a phonograph, or a telephone or any other important thing—and the last man gets the credit and we forget the others.”

When talking about the need to focus on practical applications, the author quotes Theodore Roosevelt –

“It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the arena, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails while daring greatly, so that his place shall never be with those cold and timid souls who neither know victory nor defeat.”

The author, Jordan Ellenberg, is a mathematical prodigy. He has deftly weaved the concepts with good writing to bring out the inherent joy in maths.

People interested in Big Data have to definitely read this book. For those who hated mathematics when growing up and now want to figure out what the fuss is all about and those who just want to enjoy a good read, this book is brilliant.

Ian says

This book was an excellent guide to the many ways in which our intuitions and poorly understood statistical training can lead us astray. One of the areas that it covers is regression to the mean, a concept which pretty much everyone needs to be aware of, since a better awareness of its ubiquity would prevent a lot of errors. Among other things, this concept explains why a successful pilot study is likely to give worse results when rolled out, why a good performance is often followed by a worse performance (and vice versa), why sequels are less successful and so on. The book also explains why a lot of medical research is effectively

inconclusive despite statistically significant results and how p-values are generally misinterpreted, so we should take medical research with a large grain of salt. Some of the other areas the author discusses are counter-intuitive. One topical example is that if there are three or more options then unless one option has an absolute majority in its favour then ALL of the options will have a majority opposing them, which explains why politicians can never please everyone. For example, if the government offers three options for reducing the deficit: (a) increase taxes (b) cut health funding (c) cut welfare funding and equal numbers of people favor each option then 66% of people will be opposed to each option, so nothing the government does will please a majority.

This book is full of gold for anyone who hasn't encountered some of these concepts before, such as the story of Abraham Wald's insight regarding how the missing bullet holes determined where bombers should be armoured during WWII or how the Laffer curve governs a lot of phenomena rather than linearity or how a zero correlation doesn't necessarily mean that there is no relationship between two variables (correlation coefficient does not detect non-linear relationships) or the story of why scientists took so long to be certain of a link between smoking and lung cancer (not because of obstruction by the tobacco companies).

Although I am trained both as a mathematician and statistician, you don't need a strong mathematical background to understand and benefit from this book. Most examples require basic arithmetic and the author has a talent for producing crude but enlightening graphics that help to guide the reader's intuitions.

In addition to this book, I would recommend pretty much any recent book by Gerd Gigerenzer, whose work shows how scarily ignorant doctors are of how to properly interpret results of medical tests and why mass screening programs do significant harm while not significantly reducing mortality.

Ben Babcock says

I math for a living. I mathed, both amateurly and professionally, at school. I math quite a bit. And as a math teacher, I like reading "pop math" books that try to do for math what many science writers have done for science. So picking up *How Not to Be Wrong* was a no-brainer when I saw it on that bookstore shelf. I've read and enjoyed some of Jordan Ellenberg's columns on Slate and elsewhere (some of them appear or are adapted as chapters of this book). And he doesn't disappoint.

I should make one thing clear: **I mainlined this book like it was the finest heroin.** Partly that's because I just love reading about math, but in this case I was also days away from moving back to Canada from the UK when I started this, and luggage space was at a premium, so I was on a deadline to finish this book. I injected chapters at a time into my veins, revelling in that rush as Ellenberg charismatically and entertainingly explores the math behind a lot of everyday concepts and ideas. Unlike similar attempts, however, Ellenberg doesn't pull the punches. He's more than willing to go into the higher-concept ideas behind the math, and when it starts getting too esoteric or academic even for this venue, he's always ready with a book recommendation for those interested in some further reading.

Early in my reading, I tweeted I had already decided to give this book five stars because Ellenberg alludes to *Mean Girls* in a footnote. (Specifically, he says, "As Lindsay Lohan would put it, 'the limit does not exist!'") That's really all you need to know about Ellenberg's writing style and sense of humour. Actually, I'm not all that enamoured with the footnotes in general; they interrupted the flow of my reading and the symbols used to mark them were slightly too small, so I kept missing them in the text—but that's a design issue. The content of the footnotes themselves is often informative or, as in the case above, humorous. Ellenberg might

be a university math professor, but he also has a sense of humour and an awareness of pop culture that helps to make his writing accessible.

I'm impressed by the way Ellenberg effortlessly straddles pure and applied mathematics. The child of two statisticians, he clearly has a good grasp and appreciation of the way applied math drives so many areas of society. From economics to gambling, he makes passionate appeals for informed perspectives over simplistic analogies or fallacies. His first chapter criticizes analogies that promote linear thinking about taxation when the very same economists writing these analogies know that taxation probably isn't linear. He doesn't argue for or against an increase in taxes, but rather he points out that it's wrong to oversimplify the concept when trying to sell it to the public. Is a curve really all that much harder to understand than a line?

There's also some great chapters on odds and the lottery, in which Ellenberg recounts how a group of MIT students set up a legitimate operation to bulk buy lottery tickets from a certain game that actually gave them good odds of winning. They made a profit, because they used math to turn a game of chance into a predictable investment strategy (which is more than we can say for the stock market). So, you know, stay in school kids.

But actually, the parts about the lottery that impressed me were more towards the purer end of the math spectrum. Ellenberg started discussing, for example, how best to pick the numbers on one's tickets so that one could maximize the chance of winning at each tier of prizes. It turns out that it's possible to represent the way of picking these numbers geometrically (yes, as in pictures) and that it's related to the way we create error-correcting codes (which allow us to send instructions to spacecraft, and compress data in JPEGs, MP3s, and on discs). He goes into quite a bit of detail about the more advanced concepts behind these ideas. Later, he points out how correlation on scatter plots corresponds to an ellipse—and we know how to deal with ellipses algebraically, which gives us a good toolset for talking about correlation algebraically too.

So, *How Not to Be Wrong* makes an effort time and again to belie the impression that we often get in school that math consists of a series of discrete topics: arithmetic, geometry, statistics, and the dreaded algebra. We teach it that way because it's easier to lay out as a curriculum and focus on the essential skills of each discipline. And also because we are boring. If you're lucky, like me, then as a student you'll start to see the connections yourself. Circles and pi start showing up everywhere, to the point where suddenly you feel like you're being stalked, and no amount of infinite series or integration is going to save you. But really, good teachers start showing these connections as soon as possible. We fail students and leave them behind because, in our rush to equip them with the skills we've been told they need, we rob them of the idea that **math is a creative process**, instead fostering this false impression that math is a sterile, difficult, procedural slog. If it is, then you might be a computer.

Ellenberg never demands a knowledge of integral calculus, of set theory, or of transfinite numbers. What he does demand is an open mind, a willingness to be convinced that not only does math have a useful place in life (it's pretty obvious to most people that *someone* needs to know how to math; they just don't see why it should be them) but that a deeper understanding of the roles and uses of math can enrich anyone's life. One can be a believer in the power of mathematics without necessarily worshipping at its altar, and it's this quest for adherents rather than acolytes that makes this popular math book successful. It helps that Ellenberg's style is witty. It helps that he is passionate without sounding too evangelical. He weaves in enough history, anecdotes, and allusions to demonstrate that mathematicians' journeys and the development of mathematics as a discipline has been just like everything else in life: alternately dramatic and dull, intense, occasionally acrimonious. We don't like to admit it, but we mathematicians are people too. And occasionally we're wrong, very wrong (like those nineteenth-century French eugenicists...). The title here is tongue-in-cheek, and *How Not to Be Wrong* can't guarantee your future correctness with great certitude. All it can do is help

you think more critically, more logically, but more creatively about the problems and questions that you'll face in the future. Because mathematics is a tool for helping us to do amazing things. You can be a novice, or you can be a proficient user of this tool, but either way you'll need to pick it up at some point to do a little handiwork. Don't fear it: embrace it.

Oh, and read this book.

Jimmy Ele says

I loved this book. Brilliant and funny as well as interesting, all mixed in with a touch of that feeling that you are actually learning something and furthering your pursuit of knowledge. 5 stars, great book recommendations throughout as well as a good aid for mathematical concept guidance. This is going in my foundation shelf and I highly recommend it for anyone who is interested in finding out many of the amazing actual world applications that math can be put to use for.

I might expound further on the merits of this book later, but this summary should suffice for now.

Peter McLoughlin says

Makes a good case for the real world of advantages of having a mathematical understanding and how to work with math concepts. The author argues that math is a very strong version of common sense reasoning which can keep a person sharp and savvy in a complex world.

Maryanne says

Where language and math meet is where my head explodes.

That's this book.

Fortunately, the author has a funny, down-to-earth style that keeps me going even when my eyes glaze over and start to roll back into my head. That has nothing to do with him; it's all me. He and I have a fundamental difference in wiring: he loves numbers and the things they can do. For him they sing. For me, they are instruments of torment and deceit.

Let me give you an example. Here's one from page 44 et seq., where he demonstrates that the sum of an infinite string of ones (1+1-1+1-1...) equals zero, except that it might also equal 1. Or maybe it's actually 1/2. You heard me, the sum of an infinite string of whole numbers is a fraction. And they say that numbers are immutable and true and solid, unlike MY stock in trade, words, with their shades of meaning and the ease with which they can be manipulated. HA!

But you cannot frighten me away so easily, sir!

This is a more challenging book than, say, Nate Silver's, because it gives you the method -- the math -- behind the theories. That should not scare you. It should dare you. Along the way, you'll be confused and befuddled, but you'll also laugh and be intrigued and remind yourself that the ways in which you think you know -- really KNOW -- the world are hopelessly flawed, and this guy can prove it. If nothing else, this book is endlessly valuable for that.

WarpDrive says

Enjoyable, entry-level book, particularly recommended to any lover of applied maths who did not get prior significant exposure to the main concepts of statistics and probability calculus.

The author writes in a very engaging and conversational manner, and his enthusiasm for maths is quite contagious; I like how he manages to compellingly convey the message that math is a creative process, not a sterile, procedural slog.

While the book is designed to be understood by a wide audience, so it is necessarily kept at a pretty popular level (which disappointed me a little bit, to be honest, as I was expecting something more meaty from a purely mathematical perspective), I must nevertheless admit that there are some subjects of the book that are brilliantly explained with lucid clarity: the author's treatment of the application of statistical techniques to number theory is nothing short of fascinating, for example; and his explanations of the basic concept of Bayesian inference, of projective geometry, and of the Buffon needle problem, are masterful. Chapters 18 (when he deals with the concept of axiomatic postulating, deduction and self-contradiction) is a real gem (where, by the way, his neo-Platonist view of mathematics comes to fore, view to which I full subscribe). The final chapter is also great, and it represents a passionate defence of mathematics and rationality as fundamental tools for a sceptical, commonsensical, balanced, realistic view of reality, as opposed to the false ideologically motivated "certainties" that permeate some circles (and at which the author pokes some great fun).

????? ?????????????? says

(?? Connections ??? James Burke ??????????????????)

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Maria Espadinha says

Uma Deusa por Defeito e Feitio

Embora invisível, a Matemática encontra-se em quase tudo. É a melhor aproximação (por defeito) de Deus que conheço!;)

Ana Rînceanu says

Having come back to math in my late twenties, this book was comforting and gave me hope that learning the equations and complicated language would not be for nothing. It's also a lot of fun to read.

Stuart says

Here's the deal. If you're a social scientist or a physical scientist (me) who works outside the world of controlled laboratory data, you have to make sense of the world with imperfect experiments. You often have limited data, you can't repeat your experiments, and the differences between your subject and control are sometimes very fuzzy. Yet you have to try to make some inferences even though imperfect data are all you have. How do you do that in an honest and careful way? That's what How Not To Be Wrong is about.

How Not To Be Wrong is, in terms of quality of prose, the best written book on applied math and statistics I've ever read. The author has an MFA as well as a math Ph.D., so maybe that's not surprising. The title isn't quite right, though. The book is really about "how to try to be right even though you know you're going to make mistakes now and then." That's not as catchy a title, I know. There's a lot of useful and thoughtful material here mixed in with the elegant writing. It's not really a layman's book although it's being sold that way. That's OK. Those kinds of books, like Freakonomics, are usually awful and filled with junk analyses. This one, on the other hand, is filled with good stuff. It isn't a perfect book. There are occasional glitches. That's OK, too. Math geeks, especially math geeks who love a good sentence, will love it. I hope that social scientists and scientists who use (and often abuse) math and statistics read it as well.

The Serendipity Aegis ~ ?Misericordia? ?????? ✨*♥♥ says

Is math really twice removed from our lives? Nope.

The very incredibly incredible math story from a math child prodigy (in his day), now a professor (a sensible

one! a rara avis!). Fun and readable and readily comprehensible tale making math closer and WAY cooler!

Paul says

Almost everything that we do these days has some sort of mathematical element to it, from analysis by companies that are looking for patterns, voting, the stock market and ways of winning the lottery.

Ellenberg does make some reasonable arguments; I particularly liked the explanations on the three way voting where the favoured guy can end up being eliminated purely because of the first past the post method, and the way that groups were able to exploit a badly designed lottery.

And most of the time he does a reasonable job of getting his points across using mathematical explanations and details revealing the hidden maths of every day life. But the book suffers from a lack of direction at times it and it regularly jumps into very complex explanations, which some will find difficult. In this sort of book, you also need to stick to one subject at a time, and it sadly flits back and forth as you go through the book.

There are other books out there that are much better at explaining the way that maths affects us.
