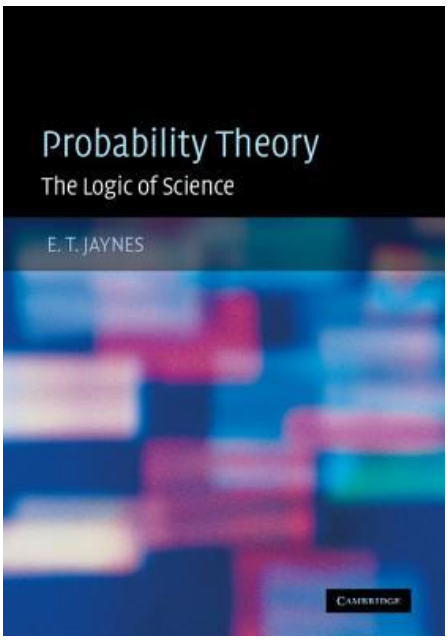

Probability Theory: The Logic of Science

E.T. Jaynes , G. Larry Bretthorst (Editor)

Probability Theory: The Logic of Science

E.T. Jaynes , G. Larry Bretthorst (Editor)

Probability Theory: The Logic of Science E.T. Jaynes , G. Larry Bretthorst (Editor)
Going beyond the conventional mathematics of probability theory, this study views the subject in a wider context. It discusses new results, along with applications of probability theory to a variety of problems. The book contains many exercises and is suitable for use as a textbook on graduate-level courses involving data analysis. Aimed at readers already familiar with applied mathematics at an advanced undergraduate level or higher, it is of interest to scientists concerned with inference from incomplete information.

Probability Theory: The Logic of Science Details

Date	:	Published June 9th 2003 by Cambridge University Press (first published April 9th 1999)
ISBN	:	9780521592710
Author	:	E.T. Jaynes , G. Larry Bretthorst (Editor)
Format	:	Hardcover 753 pages
Genre	:	Science, Mathematics, Philosophy, Nonfiction

From Reader Review Probability Theory: The Logic of Science for online ebook

Paul says

Folks who follow me on Twitter know this is essentially my 2nd bible. (Yes, the first one is The Bible.)

There's really no way to delve into that other than to recapitulate the book, but let me just hammer one point, which I take to be central, home: good old-fashioned Aristotelian two-valued logic is a *special case* of probability theory properly understood. Conversely, probability theory properly understood is a *generalization* of good old-fashioned Aristotelian two-valued logic.

Jaynes makes no claims to originality here—he fully credits the insight to Richard Cox, although Jaynes sees a consistent thread all the way back to Bayes and especially Laplace—but Jaynes struggled for decades to overcome the loss of this insight in the domination of the frequentist approach to statistics that occurred essentially immediately after Laplace's death, but especially in the rise of the Neyman-Pearson era. In fact, when the smoke clears, Jaynes dispenses with the actual theory of probability in the first two chapters. Literally the remainder of the book is elaboration; extensive exploration of the construction of prior probabilities by means of marginalization, transformation groups, or the principle of maximum entropy, which Jaynes humbly declines to point out constitutes his original contribution; and admittedly extremely sharp criticisms of said Neyman-Pearson orthodox statistics.

As a software developer with a life-long interest in artificial intelligence and amateur mathematician who always found his minimal exposure to statistics entirely baffling, the book "is like lightning from a clear sky," to appropriate C.S. Lewis' wonderful review of "The Fellowship of the Ring." It's not only possible, but crucial, to base probability theory on logic and information theory, and when you do so, whole new worlds of application reveal themselves. In a very real sense, it isn't that this is the best book on the subject. It's that it's the *only* book on the subject.

James says

A delightful thrashing of frequentist statistics through extreme precision and philosophy. A worthy read for anyone.

Benson Lee says

It's a good book - it approaches probability from the right direction and develops interesting, useful results. However, the author is often wordy and spends a bunch of time trying to convince the reader why the Bayesian interpretation of statistics is superior to frequentist interpretations.. why would I be reading a book about Bayesian statistics if I thought it was a waste of time, and why do I need to read about application of these ideas to determining whether ESP is real or not? Anyway, still good book, just dinged for (1) sometimes wild tangents and (2) sometimes lengthy derivations whose final formulation does not reveal much interesting insight into the nature of the problem.

0spinboson says

Review can be found here.

Eric says

Jaynes' tome on Bayesian Statistics and its underpinnings. A really important text for me while I was working on my PhD. I found a lot of really useful guidance here on assigning prior probabilities and using maximum entropy principles. It's also just fun to read. Jaynes has a strong voice and is a bold shit-talker when it comes to the short-comings of traditional frequentist statistics.

Steve Davidson says

Best book on statistics ever.

Jake says

“Our theme is simply: probability theory as extended logic. The ‘new’ perception amounts to the recognition that the mathematical rules of probability theory are not merely rules for calculating frequencies of ‘random variables’; they are also the unique consistent rules for conducting inference (i.e. plausible reasoning) of any kind, and we shall apply them in full generality to that end.” - E.T. Jaynes’

As an undergraduate in computer science, I left my statistics course with disdain. The curriculum required the course to be taught with a rigid tradition and formalism that obscured the mathematics. After reading Jaynes’ book I’m given the opinion by a professional statistician, at least in the realm of statistical physics, that there was much more going in the background that I should be pissed off about.

I was speaking with an acquaintance once, who happens to be a math major, and statistics came up. She ended up spurting out, “well statistics isn’t real math” and we both nodded in unison. I wouldn’t understand how wrong I was until I read this book. The usual role a professional is to demand for complexity, arguing that their discipline cannot be reduced to easily repeated formulae. What Jaynes’ shows, by looking back to Aristotle, Boole, LaPlace, etc is that some things are simple and ought to not be obfuscated.

While simple, this subject is not easy and I took full advantage of reading by Audrey Clayborn alongside this text. Aimed at graduate students and practitioners of applied mathematics in the other sciences like physics and biology, this book was written to take the wind out of the psychosomatic trap statisticians have created for themselves and it does that to my understanding. I lucked out by knowing enough combinatorics to make the algebra manageable and enough differential equations/calculus to understand the proofs. But to anyone like myself that may be an undergraduate I would recommend following along with Audrey if anything just to get a second perspective on what you’re reading because it is not an easy subject.

"Often times applied statistics, when pseudorandomness is involved, the question that is difficult is not 'Can you find a needle in a haystack?' It is: 'Can you find hay in a haystack?' You keep going to the haystack and finding needles and you realize it's not a trivial problem." ~ Avi Wigderson

I skipped chapter ten, eighteen and nineteen just due to my lack of time for now. In my personal opinion, teaching the thought patterns to working and dealing with data is as important as the mathematics behind them. It was never explained to me the dichotomy, for instance, that probability, inherently a quantity that deals in future events is used constantly to describe statistics which is a study of the past. This contradiction is what Jaynes' first tackles in chapter one. Our use of language can obscure the thought patterns required to be a serious scientist.

Basing probability theory off of logic and information theory is Jaynes' crucial insight. If I'm Nate Silver and I'm trying to predict the next election with Donald Trump having a 5% chance to win. If I'm a freqentist that means I believe in random variables. That is to say: If we were to have a thousand years of elections that fifty of those years Donald would win. Taking aside how perverted it is to think that we might simulate each year over and over again, somehow producing different results, the assertion doesn't make logical sense.

Jaynes' would argue, that this probability is a measure of our current reality, of all the data at hand. When you look at it through this lens our probability assertion does make logical sense. The unanswered paradoxes of the frequentists can be seen by anyone taking statistics at an undergraduate level.

I'll leave off with a beautiful passage by Jaynes' about his personal hero H. Jefrey's.

"In both science and art, every creative person must, at the beginning of his career, do battle with an establishment that, not comprehending the new ideas, is more intent on putting him down than understanding his message." - E.T. Jaynes'

EDIT: I will not edit the above contents but I will say, that in the time since I read this book. About a month ago. I've become much more sympathetic to R.A. Fisher and the frequentist school by reading the perspective of biologists and other statistical professionals who employ both Bayesian methods and Frequentest. Jaynes' view does not seem discredited but it is a much more complicated and nuanced issue than I first gave it credit for.

Dani Mexuto says

Entendo mellor os Youtubes

Francisco Tapiador says

This book is going to be huge in the next twenty years. Just keep tuned.

Priyank Chaudhary says

Written in Prof. Jaynes's elegantly engrossing conversational style, full of supporting examples, and

unapologetically biased against frequentists, this is a great introductory book of Bayesian statistics.
Rather than serve as a didactic textbook, it forces you to think; You'll know it well why it uses "Logic" in its title. The discussion on maximum entropy approach to select prior probability distributions, which he is famous for, communication theory, and physics of random experiments is as good as anything you will find to this date.
It is dated for a 2003 book as the late Prof. Jaynes discusses papers from 70s and 80s but fundamental Bayesian ideas presented still stand true even as Bayesian Statistics has advanced so much.
It can be less mathematically rigorous for mathematicians and statisticians but just right for physicists and computer scientists.

Dana Larose says

sigh Why do I love adding math books I'm most likely not smart enough to understand?

Doug says

This is a must read for anyone claiming to be a probabilist.

Joshua says

A "frequentist," according Jaynes, is someone who believes in random variables. That would be just about anyone who uses probability theory, right? "No," Jaynes would say. It's anyone who uses orthodox probability theory. The alternative, espoused here, is to consider probability as a measurement for propositions about reality. I'm afraid that I'm not going to be able to explain it any better than that, but if you read the first two chapters of this book, you will concede that it's a neat idea. In the remainder of the book, Jaynes argues that it's more than a neat idea.

Jaynes does not take credit for this so-called "Bayesian" formulation of probability theory (that belongs to Laplace, Cox, and Jeffreys), but its history and implications are certainly codified in this, his magnum opus, published posthumously in 2002. If you did not find your name in the previous sentence, then Jaynes has nothing but scorn for you. But don't worry. He saves the bulk of his wrath for physicists who believe in the probabilistic nature of quantum states. (Amongst the targets of Jaynes's scorn are "idiots" who perform statistical tests on isolated hypotheses. Consequently, I wonder what alternative Jaynes prefers to the "stupid" Copenhagen interpretation of quantum mechanics. He doesn't say.)

The impetus for Jaynes's screed is revealed in Chapter 15. In 1973 some frequentists mistakenly claimed to have found an inconsistency in Bayesian probability theory. Rather than simply point out their mistake, Jaynes elects the nuclear option and asserts that "frequentist thought" necessarily leads to insoluable paradoxes. To support this allegation, Jaynes frequently and, I suspect, intentionally confuses the opinions of a specific frequentist with frequentism. It gets tiresome.

Alhough there is a lot of overlap between frequentist and Bayesian terminology, there are some confusing differences. For example, at the end of Chapter 4 (p. 113), Jaynes says that the standard deviation shrinks "proportional to 1/Sqrt[N]." A frequentist, on the other hand would say it is the standard *error* that shrinks

"proportional to 1/Sqrt[N]." Jaynes never uses the latter term.

Another, possibly more arcane example has to do with noise. I think Jaynes would have approved of my constant reminder to students that "noise" is any aspect of our data that we elect to model probabilistically. However, he would not approve of my description of that noise as the result of a stochastic process. There are no such things, according to Jaynes. Instead, he would specify a prior for noise values. At present, I don't see that it makes any mathematical difference.

Jaynes does assemble a compelling case for considering prior probability distributions whenever a parameter value must be estimated. In certain cases, not considering the appropriate prior can be tantamount to implicitly accepting an implausibly restrictive one, and this can lead to ridiculousness. Moreover, even if a frequentist does use a prior probability distribution in his parameter estimates, by definition, it would have to integrate to 1. On the other hand, there is nothing in the Bayesian framework that prohibits the use of so-called improper priors. These, like 1/x for 0
I was also very pleased to see Jaynes expose one bit of mathematical trickery that I've seen repeatedly perpetrated by youtube number theorists. They perform algebra on infinite sets. Jaynes convincingly demonstrates that anything can be proven when you do that. Taking the limit (e.g. as n goes to infinity) is necessarily the last step in any sensible derivation. (NB: Leaving the limit for last does not guarantee sensibility!)

Here are some good sentences:
1) We do not deny the existence of other definitions which do include nondifferentiable functions, any more than we deny the existence of fluorescent purple hair dye in England; in both cases, we simply have no use for them.
2) An honest man can maintain an ideology only as long as he confines himself to problems where its shortcomings are not evident.
3) In any field, the most reliable and instantly recognizable sign of a fanatic is a lack of any sense of humor. (Jaynes's humourless ideologue is Ronald "F Test" Fisher.)

I know yet neither if nor how these ideas will affect my work. Certainly, my undergraduate lectures on probability theory will be tweaked. Students need to know that there is more than one way to define probability. However, they also need to be able to calculate (what I will continue to call) standard error, and they will need to understand scientific papers that adopt frequentist terminology. Will I refrain from describing the number of spots on top of one tossed die as random? Probably not.

From the papers I've written, it's clear that "generalised" likelihood ratios form the basis of my favourite statistical tests. A frequentist typically compares these ratios with values from a chi-square distribution, with a certain number of degrees-of-freedom. A Bayesian, on the other hand, would simply report the ratio, multiplied by that same number. I still don't really understand why it's the same number. Jaynes explains the number with priors (natch). Frequentists must have a very different explanation, but it seems to be beyond the scope of my (graduate level) textbook on the theory of statistics.
