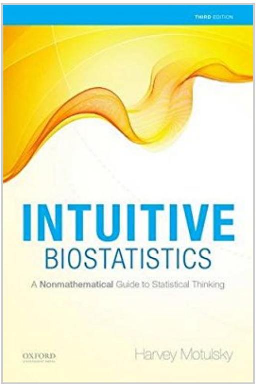

Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition

By Harvey Motulsky

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Thoroughly revised and updated, the third edition of *Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking* retains and refines the core perspectives of the previous editions: a focus on how to interpret statistical results rather than on how to analyze data, minimal use of equations, and a detailed review of assumptions and common mistakes.

With its engaging and conversational tone, this unique book provides a clear introduction to statistics for undergraduate and graduate students in a wide range of fields and also serves as a statistics refresher for working scientists. It is especially useful for those students in health-science related fields who have no background in biostatistics.

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- Binding: Paperback
- 576 pages

Editorial Review

Review

Unlike other statistics texts I have seen, it includes extensive and carefully crafted discussions of the perils of multiple comparisons, warnings about common and avoidable mistakes in data analysis, a review of the assumptions that apply to various tests, an emphasis on confidence intervals rather than P values, explanations as to why the concept of statistical significance is rarely needed in scientific work, and a clear explanation of nonlinear regression (commonly used in labs; rarely explained in statistics books).

--Bruce Beutler, 2011 Nobel Laureate, Physiology or Medicine

This splendid book meets a major need in public health, medicine, and biomedical research training -- a user-friendly biostatistics text for non-mathematicians that clearly explains how to make sense of statistical results, how to avoid common mistakes in data analysis, and how to avoid being confused by statistical nonsense. You may enjoy statistics for the first time!

--Gilbert S. Omenn, Professor of Medicine, Genetics, Public Health,
and Computational Medicine & Bioinformatics, University of Michigan

After struggling with books that weren't right for my class, I was delighted to find Intuitive Biostatistics. It is the best starting point for undergraduate students seeking to learn the fundamental principles of statistics because of its unique presentation of the important concepts behind statistics. It meticulously goes through common mistakes and shows how to correctly choose, perform, and interpret the proper statistical test. It is accessible to new learners without being condescending.

--Beth Dawson, The University of Texas at Austin

I've read several statistics books, but found that some concepts I was interested in were not mentioned and other concepts were hard to understand. You can ignore the "bio" in Intuitive Biostatistics, as it is the best applied statistics books I have come across, period. Its clear, straightforward explanations have allowed me to better understand research papers and select appropriate statistical tests. Highly recommended.

--Ariel H. Collis, Economist, Georgetown Economic Services

"*Intuitive Biostatistics* is a beautiful book that has much to teach experimental biologists of all stripes. Motulsky has written thoughtfully, with compelling logic and wit. He teaches by example what one may expect of statistical methods and, perhaps just as importantly, what one may not expect of them. He is to be congratulated for this work, which will surely be valuable and perhaps even transformative for many of the scientists who read it."--Bruce Beutler, *2011 Nobel Laureate, Physiology or Medicine,* and Director, Center for the Genetics of Host Defense, *UT Southwestern Medical Center*

"Let's face it. Most statistics textbooks intimidate the average student. Motulsky's *Intuitive Biostatistics,* however, is written in a welcoming tone. It takes the static out of statistics. This textbook covers a wide spectrum of statistical concepts in a way that will benefit readers with varying levels of quantitative backgrounds."--Heather Hoffman, *George Washington University*

From the Author

What makes the book unique?

Intuitive Biostatistics is both an introduction and review of statistics. Compared to other books, it has:

- Breadth rather than depth. It is a guidebook, not a cookbook.
- Words rather than math. It has very few equations.
- Explanations rather than recipes. This book presents few details of statistical methods and only a few tables required to complete the calculations.

Intuitive Biostatistics includes many topics often omitted from short introductory texts, including:

- How common sense can mislead. Chapter 1 is a fun chapter that explains how common sense can lead you astray and why we therefore need to understand statistical principles.
- Multiple comparisons. It is simply impossible to understand statistical results without a deep understanding of how to think about multiple comparisons. This isn't just a practical issue, but almost a philosophical issue in analyzing data. Chapters 22, 23, and 40 are devoted to this topic. I explain several approaches used to deal with multiple comparisons, including the false discovery rate (FDR).
- Nonlinear regression. In many fields of science, nonlinear regression is used more often than linear regression, but most introductory statistics books ignore nonlinear regression completely. This book gives them equal weight. Chapters 34 and 35 set the stage by explaining the concept of fitting models to data and comparing alternative models. Chapter 36 then discusses nonlinear regression.
- Bayesian logic. Bayesian thinking is briefly mentioned in Chapter 2 and is then explored in Chapter 18 as a way to interpret a finding that a comparison is statistically significant. This topic returns in Chapter 42, which compares interpreting statistical significance to interpreting the results of clinical laboratory tests. These are only brief introductions to Bayesian thinking. This book is about conventional (Frequentist) statistics, and only briefly introduces Bayesian approaches to data analysis.
- Lognormal distributions. These are commonly found in scientific data, but not in statistics books. They are explained in Chapter 11 and are touched upon again in several examples that appear in later chapters. Logarithms and antilogarithms are reviewed in Appendix E.
- Testing for equivalence. Sometimes the goal is not to prove that two groups differ, but rather to prove that they are the same. This requires a different mindset, as explained in Chapter 21.
- Normality tests. Many statistical tests assume data are sampled from a Gaussian (also called normal) distribution, and normality tests are used to test this assumption. Chapter 24 explains why these tests are less useful than many hope.
- Outliers. Values far from the other values in a set are called outliers. Chapter 25 explains how to think about outliers.
- Comparing the fit of alternative models. Statistical hypothesis testing is usually viewed as a way to test a null hypothesis. Chapter 35 explains an alternative way to view statistical hypothesis testing as a way to compare the fits of alternative models.
- Meta-analysis as a way to reach conclusions by combining data from several studies. This topic is the subject of new chapter (Chapter 43).
- Detailed review of assumptions. All analyses are based on a set of assumptions, and many chapters discuss these assumptions in depth.

- Lengthy discussion of common mistakes in data analysis. Most chapters include lists (with explanations) of common mistakes and misunderstandings.

To make space for these topics, I have left out many topics that are traditionally included in introductory texts:

- Probability. I assume that you have at least a vague familiarity with the ideas of probability, and this book does not explain these principles in much depth. I have added a new chapter (Chapter 2) to this edition that explains why probability can seem confusing. But you can still understand the rest of the book even if you skip this chapter.
- Equations needed to compute statistical tests. I assume that you will be either interpreting data analyzed by others or using statistical software to run statistical tests. In only a few places do I give enough details to compute the tests by hand.
- Statistical tables. If you aren't going to be analyzing data by hand, there is very little need for statistical tables. I include only a few tables in places where it might be useful to do simple calculations by hand.
- Statistical distributions. You can choose statistical tests and interpret the results without knowing much about z, t, and F distributions. This book mentions them but goes into very little depth.

From the Inside Flap
Excerpt from "Q and A about confidence intervals of "proportions (chapter 4, page 40).

Q. Which is wider, a 95% CI or a 99% CI?
A. To be more certain that an interval contains the true population value, you must generate a wider interval. A 99% CI is wider than a 95% CI. See Figure 4.2.

Q. Is it possible to generate a 100% CI?
A. A 100% CI would have to include every possible value, so it would always extend from 0.0 to 100.0% and not be the least bit useful.

Q. How do CIs change if you increase the sample size?
A. The width of the CI is approximately proportional to the reciprocal of the square root of the sample size. So if you increase the sample size by a factor of four, you can expect to cut the length of the CI in half.

Q. Can you compute a confidence interval of a proportion if you know the proportion but not the sample size?
A. No. The width of the confidence interval depends on the sample size.

Q. Why isn't the CI symmetrical around the observed proportion?
A. Because a proportion cannot go below 0.0 or above 1.0, the CI will be lopsided when the sample proportion is far from 0.50 or the sample size is small.

Q. You expect the population proportion to be outside your 95% CI in 5% of samples. Will you know when this happens?
A. No. You don't know the true value of the population proportion (except when doing simulations), so you won't know if it lies within your CI or not.

Excerpt from "Common mistakes: P values" (chapter 15, page 134)

The P value is not the probability that the result was due to sampling error. The P value is computed assuming the null hypothesis is true. In other words, the P value is computed based on the assumption that the difference was due to randomness in selecting subjects--that is, to sampling error. Therefore, the P value cannot tell you the probability that the result is due to sampling error.

The P value is not the probability that the null hypothesis is true. The P value is computed assuming that the null hypothesis is true, so it cannot be the probability that it is true.

The probability that the results will hold up when the experiment is repeated is not (1.0 minus the P value). If the P value is 0.03, it is tempting to think that this means there is a 97% chance of getting similar results in a repeated experiment. Not so. The P value does not itself quantify reproducibility.

A high P value does not prove that the null hypothesis is true. A high P value means that if the null hypothesis were true, it would not be surprising to observe the treatment effect seen in a particular experiment. But that does not prove that the null hypothesis is true. It just says that the data are consistent with the null hypothesis.

Excerpt from "An analogy to understand power" (chapter 20, page 170)

Here is a silly analogy helps illustrate the concept of statistical power (Hartung, 2005). You send your child into the basement to find a tool. He comes back and says, "It isn't there." What do you conclude? Is the tool there or not? There is no way to be sure, so the answer must be a probability. The question you really want to answer is, What is the probability that the tool is in the basement? But that question can't really be answered without knowing the prior probability and using Bayesian thinking (see Chapter 18). Instead, let's ask a different question: If the tool really is in the basement, what is the chance your child would have found it? The answer, of course, is: it depends. To estimate the probability, you'd want to know three things:

- How long did he spend looking? If he looked for a long time, he is more likely to have found the tool than if he looked for a short time. The time spent looking for the tool is analogous to sample size. An experiment with a large sample size has high power to find an effect, while an experiment with a small sample size has less power.
- How big is the tool? It is easier to find a snow shovel than the tiny screwdriver used to fix eyeglasses. The size of the tool is analogous to the size of the effect you are looking for. An experiment has more power to find a big effect than a small one.
- How messy is the basement? If the basement is a real mess, he was less likely to find the tool than if it is carefully organized. The messiness is analogous to experimental scatter. An experiment has more power when the data are very tight (little variation), and less power when the data are very scattered.

Users Review

From reader reviews:

Dorothy Waddell:

What do you consider book? It is just for students since they're still students or the item for all people in the world, exactly what the best subject for that? Just simply you can be answered for that question above. Every person has various personality and hobby for each other. Don't to be pushed someone or something that they don't want do that. You must know how great and important the book Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition. All type of book is it possible to see on many resources. You can look for the internet options or other social media.

Jane Moore:

As people who live in typically the modest era should be upgrade about what going on or details even knowledge to make them keep up with the era and that is always change and move forward. Some of you maybe will certainly update themselves by reading through books. It is a good choice for you but the problems coming to a person is you don't know which you should start with. This Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition is our recommendation so you keep up with the world. Why, as this book serves what you want and want in this era.

Richard Kitterman:

Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition can be one of your basic books that are good idea. We all recommend that straight away because this reserve has good vocabulary that can increase your knowledge in vocab, easy to understand, bit entertaining but still delivering the information. The article author giving his/her effort that will put every word into enjoyment arrangement in writing Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition although doesn't forget the main point, giving the reader the hottest and based confirm resource data that maybe you can be one among it. This great information could drawn you into new stage of crucial thinking.

Gene Baker:

In this era globalization it is important to someone to receive information. The information will make someone to understand the condition of the world. The healthiness of the world makes the information easier to share. You can find a lot of personal references to get information example: internet, newspaper, book, and soon. You will observe that now, a lot of publisher that will print many kinds of book. The particular book that recommended to you personally is Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking, 3rd edition this publication consist a lot of the information of the condition of this world now. This particular book was represented so why is the world has grown up. The terminology styles that writer use to explain it is easy to understand. Typically the writer made some study when he makes this book. Here is why this book appropriate all of you.

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