Introduction to Bayesian Statistics by William M. Bolstad, 2004, 354 pages, ISBN 0-471-27020-2, A John Wiley and Sons, Inc., hardcover, US$84.95.

There are two main approaches in statistics: the traditional or classic approach, which is often referred to as the frequentist approach, and the Bayesian approach. The traditional approach uses random samples to estimate unknown parameters of populations. Uncertainty about, for example, parameter estimates is quantified by investigating how those estimates vary from one to the next in repeated sampling from the same population. The Bayesian approach, on the other hand, considers the population parameters to be random variables. The process of determining the value of a parameter starts with a subjective *a priori* distribution of the parameter before the data is analyzed. After the data is collected and organized, the Bayes' theorem is used to determine how much *a priori* opinions about parameter values change given the observed data (Bayes 1763).

Nowadays, the interest in the Bayesian inference has greatly enhanced and in many cases researchers strongly favor using Bayesian inference over the traditional approach. Some of the advantages of the Bayesian approach are: it takes a prior knowledge into consideration; allows direct probability statements about the parameters, uses a single tool, the Bayes' theorem; often outperforms traditional methods even when judged by traditional criteria; has a straightforward way of dealing with nuisance parameters (they are always marginalized out of the joint posterior distribution); gives the way to find the predictive distribution of future observations (which is not always easily done with a classic approach; Bolstad 2004).

A great deal of controversy is underway among statisticians as to which approach is superior, but introductory statistics courses around the world are almost always taught from the traditional perspective and in many cases students never get exposed to the Bayesian approach. One of the reasons for this is probably because there have been only a few textbooks that introduce statistical reasoning from the Bayesian perspective. This book was the latest addition to introduce the same statistical ideas from the Bayesian logic in 14 chapters. First chapters deal with the introductory materials such as sampling design (Chapter 2), displaying and summarizing data (Chapter 3), rules of probabilities (first part of Chapter 4) and discrete and continuous random variables (Chapters 5 and 7), which are not different from the traditional statistical approach. The Bayesian theorem and the principles of *a priori* and *a posteriori* probabilities are introduced at the end of Chapter 4, which discusses the logic, probability and uncertainty. Bayesian inferences for discrete variables appear in Chapters 6, where the real logic of Bayesian statistics can be seen. The rest of the book covers basic Bayesian statistics operations including the Bayesian inference for binomial proportion (Chapter 8), Bayesian inference for normal mean (Chapter 10), Bayesian inference for difference between means (Chapter 12), Bayesian inference for simple linear regression (Chapter 13) and robust Bayesian methods (Chapter 14). The book also provides comparisons between the two approaches. Chapter 9 compares the Bayesian and traditional statistical methods for the inference for proportions and Chapter 11 compares the techniques for the inference for means.

This is a nicely written textbook with a reasonable level of assumed mathematical prerequisite (basics of algebraic manipulations and calculus). Each chapter has exercises in the end with selected solutions. Summaries of the main points of each chapter are given. The appendices help refresh calculus and the use of statistical tables. There are also instructions of using *R* function and Minitab macros for Bayesian analysis and Monte Carlo simulations, which are downloadable from the book web site. Since statistical package *R*, which uses the dialect of *S* or *S+* language, has been gaining popularity and is free to download, anyone can use it to do the exercises and follow the instructions in the book.

So why do biologists have to be excited about such a new statistics book? First, because it is not appropriate to teach and learn only one of the statistical approaches to later learn the other was a better tool for the task at hand. I think it is time to expose students to both approaches because they are both valid methods. If we want to get closer to the level of education offered elsewhere in the world, we should not be taking the exact same paths the rest of the world took to get to their places now. We should learn from their mistakes and we

should be making shortcuts whenever possible based on the lessons learned. Therefore, it is time to not only offer a good introductory statistics course in a traditional way, but also an advanced statistics course that introduces the Bayesian logic, at least at graduate level. Second, because biology is becoming a more and more challenging science in terms of quantitative skills. Even though mathematicians are not likely to solve problems faced by biologists, quantitative thinking will go a long way to help understand some of the patterns we see in biological systems. There is always a preexisting subjective opinion of the study system in our mind and the Bayesian approach makes use of that *a priori* opinion and *updates* it given the data observed: thus more accurately reflect how humans think about the world. For example, application of Bayesian approach into ecological research was nicely shown by Hilborn and Mangel (1997). I would highly recommend this book to learn about Bayesian logic and to use it as a textbook in statistics courses that introduces the Bayesian perspective.

References

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