"Bayesian Probability Theory: Applications in the Physical Sciences", by Wolfgang von der Linden, Volker Dose, Udo von Toussaint, Cambridge Univ. Press, 2014, pp: 541, ISBN: 9781107035904, price 120.95

Probability theory and its cousin, statistics, are unique areas of mathematics in that their interpretation is still under debate. Two schools of thought contend: For many years, the frequentist interpretation, where probability is defined in terms of limiting frequencies (e.g., the number of heads divided by the number of coin flips, or "trials"), has dominated. More recently, the Bayesian interpretation, where probability is defined as the "degree of rational belief" in a proposition, has gained many converts. The frequentist interpretation has been more familiar and, in the eyes of its adherents, is more "objective." The Bayesian view, which can be applied to non-repeatable events, has a wider applicability, allows for a more systematic and more intuitive presentation of basic concepts. Also, its explicit incorporation of prior information can sometimes lead to much stronger inferences.

The book *Bayesian Probability Theory: Applications in the Physical Sciences*, by Wolfgang von der Linden, Volker Dose, and Udo von Toussaint, wears its colours on its cover: It is the most thorough exposition to appear of the Bayesian view of probability and data analysis that is written by and for physicists. The authors, senior theorists from Germany and Austria, have been active in applying Bayesian ideas in a wide range of areas, ranging from condensed-matter physics to astronomy to climate research. The book includes a rich variety of case studies based on their work, including, as a random sampling, estimation of the quantum Hall constant, detection of outlier experiments among the measurements of the gravitational interaction constant, and the problem of inferring absorbance for a complex response function given noisy measurements of its real part over a limited frequency range.

Although the book has many advanced applications, it assumes no prior knowledge of either probability or statistics. Indeed, the early chapters can serve as a text for advanced undergraduate or graduate courses on the topic, depending on the subset used. Later chapters will interest those caring about specific applications and theorists interested in the foundations of the field or in Monte Carlo methods to handle the high-dimensional integrals that are a part of Bayesian analyses. A particular strength of the book is its dual presentation of Bayesian and frequentist methods. Since the latter are so embedded in scientific papers and elementary discussions of data analysis, it is vital to understand both points of view. The authors here take the logical tack of presenting short chapters on frequentist perspectives *after* their Bayesian version has been presented. They keep the clarity of the Bayesian view while adding a broader perspective.

The combination of an elementary level start and state-of-the-art completeness makes for a big book — 637 pages. Some of the heft results from repetition, as the same topic is often revisited as different points of view or techniques are developed. My main complaint, though, is that the presentation, notation, and language are often rather stiff and formal.   A random example: "It has been proved that Bayesian probability theory is the only theory which handles partial truths consistently. It is the content of the next chapter." (p. 31). The statements are accurate, but a native speaker would not put it quite that way. Further, the notation can be pedantic. For example, the authors make the important point that every probability depends on background information. True, but is it necessary to write $P(A \mid I)$ rather than $P(A)$ everywhere in the book? Perhaps stating the point and reminding the reader from time to time would be enough. Finally, the authors have a tendency to state a general result first and give comments and examples afterwards. Some readers will like that style, which can be clear, precise, and rigorous; others will prefer that the intuition come first.

As a first introduction, this book competes with slimmer ones that are lighter in their prose. A personal favourite is D. S. Sivia's *Data Analysis: A Bayesian Tutorial* (2nd ed., Oxford Univ. Press, 2006). But the present work by von der Linden, Dose, and von Toussaint is an impressive book, and all those interested in serious problems in data analysis in physics would do well to read and study it.

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