Ian Hacking. **An Introduction to Probability and Inductive Logic**. Cambridge University Press 2000, xvii + 302 pp.

Judging from its title, this book is pitched as an introductory text on probability and inductive logic. The title is somewhat misleading, though, as inductive logic (in the traditional sense of that term) is discussed hardly at all. But, as an introduction to probability, the book is rather good, and as an introduction to statistical inference and decision theory, it is even better.

Hacking writes very clearly and engagingly throughout. A good supply of well-chosen exercises appear at the end of each chapter, and Hacking's solutions to the various problems in the book (both in the main text, and in a "solutions" section at the end of the book) are quite thought provoking and illuminating. The book begins with a set of seven "odd problems", each of which involves a somewhat surprising and/or counterintuitive aspect of probability. This is a very nice way to begin the book, as it grabs students' attention with puzzles, right from the start, and it places a strong emphasis on (probabilistic) *problem solving* — an emphasis which is sustained throughout the book. Hacking returns to and rethinks his "odd problems" (in interesting ways) as the book unfolds.

Chapter one briefly discusses basic deductive logic. This is helpful for students who have little or no deductive logic background, and it is intended to set the stage for Hacking's subsequent discussion of inductive logic in chapter two.

Chapter two is entitled "What is Inductive Logic?" I found this chapter somewhat disappointing. Hacking never makes clear precisely what inductive *logic* consists in. His "rough definition" (18) says that "Inductive logic analyzes risky arguments using probability ideas." Hacking also asserts (14) that probability is a "fundamental tool for inductive logic." This is all quite vague, and the examples in chapter two don't help very much. Some of the examples clearly involve probability (and various kinds of probabilities, at that), and some clearly do not. It is suggested that the scope of inductive logic is limited to arguments which in some way involve probability. But, it is unclear why the scope of inductive logic should be limited in this way. After all, the scope of deductive logic is not so limited. Indeed, it would be helpful if Hacking spent more time here clarifying the relationship between deductive logic and inductive logic (as Carnap so masterfully does in §43 of *Logical Foundations of Probability*). At the end of chapter two, readers may find themselves wondering (among other things) what makes Hacking's inductive logic *logical* (in the way deductive logic is). And, later on, readers may wonder what work the locution "inductive *logic*" is really doing in the book at all, as it appears scarcely beyond chapter two (the disparaging remarks Hacking makes about logical probability later in the book (131) will probably only add to the reader's perplexity — see below).

After a somewhat wobbly start in chapter two, Hacking begins to get into stride. In chapter 3, Hacking returns to some of his "odd problems" in a very clear and edifying discussion of the gambler's fallacy. The closing section "Two Ways to Go Wrong with a Model" (33) of chapter three provides crucial advice (and insight) for anyone who uses probability to model anything.

Chapters 4–7 cover the basic formal and technical machinery of probability theory. Hacking does a good job of explaining the mathematics of axiomatic probability calculus. His use of Venn Diagrams and "calculation trees" is explanatory and informative, and his proofs and illustrations are typically very simple and elegant. Moreover, Hacking cleverly uses his "odd problems" at various points to explain (and justify) important distinctions about conditional probability and Bayes' Theorem.

Chapters 8–10 provide a brief but refreshingly nutritious introduction to expected utility theory, which includes sober analyses of several paradoxical or troublesome examples like the St. Petersburg paradox (91–95), Pascal's wager (115–124), and the decision problems of Allais (109–111), each of which aim to undermine central tenets of the classical theory of rational choice. Hacking is able (in relatively few pages) not only to bring out the fundamental principles of classical decision theory, but also to motivate some of the most important and substantial objections to it. Hacking's plethora of examples, mini-dialogues, brief historical interludes, and other entertaining tid-bits make these chapters a joy to read for both student and teacher.

In chapters 11–15, Hacking turns to the various meanings, applications, and interpretations of probabilities and probability talk. His treatments of personalistic and frequency type probabilities are stimulating and interesting. I especially liked his discussions of Dutch Books, Bayesian learning, and conditionalization (on the personalistic side), and his discussion of limit theorems and stability (on the frequency side). But, his decision (131) to avoid the terms "subjective" and "objective" (which are traditionally used in this context) is not very well motivated, and seems to do little substantive work. And, Hacking's talk (131) of the "supposed logical relation" between (inductive) evidence and hypothesis indicates a less than enthusiastic attitude toward inductive logic *qua logic*. Notably absent here is any serious discussion of logical interpretations of probability (a là Keynes, Carnap, *et al*). This is especially puzzling, in light of the book's title, and the (apparently) "logical" set-up of chapters one and two. Despite this omission, Hacking manages in these chapters to effectively demarcate and explicate the kinds of probability (mainly, personalistic and frequency) that he discusses and applies most frequently in the remainder of the book.

Chapters 15–19 cover important issues in the foundations of statistical inference, often overlooked by textbooks in this genre. I think these chapters are some of the most useful and important in the book. Hacking provides a very accessible introduction to several of the main paradigms in modern statistics. Along the way, he offers sage advice to those who apply or interpret classical statistical methods such as hypothesis testing, confidence intervals, and $p$-values. These chapters should be required reading for anyone with a burgeoning interest in contemporary statistical science. My only complaint about these chapters involves Hacking's discussion of the relationship between Neyman-Pearson hypothesis testing and confidence intervals (240–41). Here, Hacking's usual clarity in exposition seems absent, and the connections made are sketchy, at best. Aside from this momentary (and minor) lapse, these chapters represent some of the most philosophically informed and enlightening introductory material on contemporary statistics that I have seen.

Chapters 20–22 focus on the philosophical problem of induction. Chapter 20 provides a brief historical overview of the (Humean) philosophical problem of induction. In chapter 21, Hacking characterizes Bayesian approaches to learning and induction as evasions of the traditional philosophical problem of induction. Chapter 22 reaches a similar conclusion about Neymanian "inductive behavior" approaches to induction. While Hacking's arguments here are provocative and interesting, they ignore some important material in the contemporary literature on the relationship between the philosophical problem of induction, probability, and inductive logic. I think these chapters would benefit by adding (for instance) some remarks on Goodman's new riddle of induction (a.k.a., "Grue") and the effect its introduction had on the traditional program of inductive logic (*e.g.*, Carnap's program). Moreover, it would be helpful if Hacking would comment on the role inductive *logic* has in this traditional philosophical debate. Hacking talks only about "learning" and "behavior" approaches to induction, and their failure to address the philosophical problem of induction head-on. What about *logical* approaches to induction like Carnap's (or Keynes')? Is Hacking suggesting that inductive logic (generally) is an evasion of the philosophical problem of induction?

To sum up: this book is very useful for getting students familiarized with the basics of probability theory, its various interpretations, and its applications to statistical inference and decision theory. Hacking's writing style is clear (although, sometimes a bit *too* concise). And, Hacking's mastery of (and flare for) the subject shines through in many places. The book also contains many well-placed historical interludes and references, which are essential for understanding the intellectual trajectory of these important concepts. My only significant word of caution is to readers with more of a logical bent (perhaps some readers of this *Bulletin*) who may prefer the more traditional introductory renditions of inductive logic and inductive/logical probability to be found in Skyrms' *Choice and Chance* or Kyburg's *Probability and Inductive Logic*. Nonetheless, I highly recommend this book to those who want a clear and thoughtful introduction to probability, with an emphasis on statistical inference and decision theory.

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