

Preface

Statistical texts and classes within biology curricula generally ignore or fail to instill foundational concepts.^{*} This deficiency is not surprising, as these topics are not easy to learn or teach. For example, logic provides a framework for statistical inference, and knowledge of algebra and calculus is required to understand the probability-generating functions used in all popular analyses. Unfortunately, this problem has been exacerbated by advances in statistical software. These tools do not require any knowledge of foundational principles. However, a poor understanding of the theory underlying the algorithms often leads to misapplication of analyses, misunderstanding of results, and invalid inferences.[†]

In this book, I have attempted to bridge the gap between statistical foundations and the myriad statistical applications available to twenty-first century biometrists. I do this by harnessing inherent properties of the **R** computational environment (**R**-core development team 2012) that allow students to actively construct their own sense of what is being learned (*sensu* constructivism, Mayer 1999). Unlike its commercial counterparts, **R** does not lock away its statistical algorithms in black boxes. Instead, one can examine the code of complex procedures step by step to elucidate the process of obtaining the results shown in textbooks. In addition, the outstanding graphical capabilities of **R** allow interactive demonstrations to aid in the instruction of complex statistical concepts. A companion library to this book called *asbio* (Aho 2013) has been crafted specifically for this purpose. A novice-to-command-line interfaces can install and load *asbio*, and can access the central "point and click" book menu by typing just three commands into **R**:

```
install.packages("asbio")
library(asbio)
book.menu()
```

Subsequent access to the menu during new work sessions requires only the last two commands.

All the analyses in this book and all but a handful of its 130 figures were obtained using **R**. The code for the implementation of these procedures is provided either directly in the text or from auxiliary chapter files at the book website (<http://www2.cose.isu.edu/~ahoken/book/>). An accompanying document "Introduction to **R**" can also be found at this site.

How to Read This Book

Under the premise that strong foundations lead to a deeper understanding of complex applications, I have, in most chapters, juxtaposed sections with introductory and advanced materials. For chapters with such a format (Chapters 3, 4, 5, 9, 10, and 11), I indicate the

^{*} Among other citations, see Hurlbert (1984), Altman (1991, 1994), Horgan et al. (1991), Yoccoz (1991), Hand (1994), Coste et al. (1995), Finney (1995), Heffner et al. (1996), Feinstein (1997), Bialek and Botstein (2004), Mehta (2004), and Vaux (2012).

[†] See Mehta et al. (2004), VanDongen (2006), Prosser (2010), and Sainani (2011).

location of advanced sections in an initial "how to read this chapter" section. Advanced topics are also specified with a star symbol (★) throughout the book. I have structured the book so that introductory classes can skip "starred" materials with little loss of continuity.

Because of its structure, both introductory and graduate-level biostatistics courses can be taught using this book. To cover materials adequately and decrease frustration, introductory courses should avoid advanced Bayesian topics in Chapters 3, 4, and 5, avoid multifactor ANOVA designs in Chapter 7, cover only simple linear and multiple regression in Chapter 9, cover only one-way ANOVA topics in Chapter 10, and cover only materials up to two-way tables in Chapter 11. A large number of graduate level topics are addressed throughout the book, beginning in Chapter 3. These can be emphasized to varying degrees depending on the interest and needs of students. I assume in all sections of all chapters that students have a familiarity with algebra and general calculus. Linear algebra applications used in Chapters 9 and 10 are described in the book Appendix along with additional mathematical reference materials.