Appendix—Brief Introduction to R

R is an environment for statistical computing and graphics. It is similar to the S language that was developed at Bell Laboratories (formerly AT&T now Lucent Technologies). R is a different implementation of the S language that is public domain (a so called "GNU") Project. The advantages of R is that it is freeware and there is a lot of help available. It is widely used throughout the world as a research tool in academia and industry. R will run on a Windows computer, Macintosh, or Linux. There is also a GUI interface for R, called RStudio, that will give R the same interface on all of these operating systems.

R can be obtained from `http://www.r-project.org/`. To install R, assuming you are on a Windows computer and have an Internet connection, go to the Web site then:

1. click on download CRAN

2. choose a download site

3. choose Windows as the target operating system

4. click base

5. choose Download the latest version of R for Windows and choose the default answers to all questions.

For Macintosh or Linux operating systems follow the instructions on the Web site.

To install the RStudio interface on a Windows computer go to the Web site `http://www.rstudio.org/`, then:

1. click download RStudio

2. click download RStudio Desktop

3. click Recommended for Your System

4. download the .exe file and run it (choose default answers for all questions)

The RStudio interface contains a console window in the lower left. In this window R commands can be typed after the ">" prompt, and the results will be shown. If output results more than fill the screen, you can scroll back and forth to view all of it. The upper left part of the interface contains an editor window that is also called a script window. In this window, you can type and edit commands and save them to .R script files that can be opened in future sessions. You can run a command or group of commands from the script window, by highlighting the commands you want to run, then clicking the Run icon at the top right corner of the window. The Web site for the book

contains all the R commands or code in the book organized by chapters. You can download these from `https://lawsonjsl7.netlify.app/webbook/` and open them in the script window using the `File->Open File` menu.

In addition to base R commands, several user written *packages* are illustrated in this book. A *package* or a *library* is a group of user written functions and data frames that can be loaded and used during an R session. The package `daewr`, for example, includes data sets for the examples shown in this book and several useful functions. Some packages come with the standard R installation, and others must be installed. In RStudio, on the Packages Tab in the lower right window, you can see a list of what packages are installed, or type the command `library()` in the console window to get a list of packages installed there. To install additional packages click the "Install Packages" icon on the Packages Window, and when the template appears give the package name you want to install. You can do this through the network if you have a connection, or from a package archive where you can place previously downloaded .zip files. Once a package is installed, it must then be loaded before it can be actually used in an R session. To load a package, either click the check box in front of the package name on the Package Window, or give the command `library ("packagename")` in the console, where `"packagename"` is the name of the package you would like to use. Once a package is loaded, it will remain loaded until the current R session ends.

User written packages that are illustrated in this book are `Vdgraph  mixep car,  multcomp`, `BsMD`, `FrF2`, `DoE.base`, `AlgDesign`, `lme4`, `gmodels`, `MASS`, `agricolae`, `gdata`, `leaps`, `effects`, `GAD`, `crossdes`, `rsm`, and `nlme`. The Web site:
`http://cran.r-project.org/web/views/ExperimentalDesign.html` has information on many other R packages that are useful in the design and analysis of experiments.

In the future, it is possible that some of the R packages illustrated in this book may be removed from CRAN, if the developer drops support, or they may be changed by the developer so that the examples in the book no longer work. If problems such as this arise, revisions will be made to the code online so that a working copy of the examples will be available.

There is extensive help for R available on the Internet. A .pdf document called *A (very) short introduction to R*, gives a basic overview of R and RStudio. It can be downloaded from:
`cran-r-project/doc/contrib/Torfst+Bauer-Short-R-Intro`. More lengthy manuals such as *An Introduction to R*, and *R Data Import/Export* are available from `cran-r-project.org/manuals/`. For those wishing more details there are published guides such as: Zuur *et al.*'s (1985) *A Beginner's Guide to R*, and Dalgaard's (2004) *Introductory Statistics with R*. Also the pdf book *R for Beginners* by Emmanuel Paradis is available online at:
`https://cran-r-project.org/doc/contrib/Paradis-rdebuts_en.pdf`