Reviewer: Jose M. Pavía
Universitat de València

R Graphics (3rd Edition)

Paul Murrell
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https://www.stat.auckland.ac.nz/~paul/RG3e/

It has been fourteen years since the first edition of *R Graphics* was published (Murrell 2006) and eight since the second one was released (Murrell 2012). For readers, like me, who read the first edition of *R Graphics* but skipped the second one, this third edition of *R Graphics* represents a new, fresh updated version of the book. In transit from the first to the third edition, in addition to including new material, Dr. Murrell has introduced key changes and some rearrangements that have made the whole book more understandable, especially the concepts related to viewports and coordinate systems.

Although major changes were made in the second edition of the book (Cook and Hofmann 2011), this third edition also introduces some changes. This is evident comparing the indexes of the second and the third editions. In particular, paraphrasing the preface of this third edition, Chapter 8 (devoted to developing new grid graphical functions and objects) has been completely rewritten and the fourth part of the book extensively restructured (and, I would add, reduced).

With an emphasis on producing graphics from code[1] (which promotes automation, sharing and reuse), *R Graphics* focuses on (i) offering tools and tricks for drawing detailed and customized graphics in a variety of formats and (ii) explaining how to integrate graphics from multiple systems. This distinguishes this book from other books centered on producing plots in R. *R Graphics* complements other valuable books – such as *R Graphics Cookbook* (Chang 2018), ***lattice**: Multivariate Data Visualization with R* (Sarkar 2008), or ***ggplot2**: Elegant Graphics for Data Analysis* (Wickham 2016) – as an essential and comprehensive guide to graphics in R.

After reading the book, the R practitioner will understand how to integrate the two distinct graphics systems of R (the base graphics system and the **grid** graphics system) and how to customize plots, including **lattice** and **ggplot2** graphics. This book also explains how to import images from external files into R and how to integrate them as part of R graphics output. And, furthermore, it shows how to enrich plots created by R with graphical effects and features not supported by the core R graphics system.

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[1]The book's website contains an electronic version of the R code used in the book.

All this opens up possibilities for creativity by the R analyst for communicating and presenting visual analyses, transforming the question 'Can it be done?' into the question 'How is it done?'. Indeed, as Dr. Murrell (2019, p. xv) states : "[I]t is possible to work with R for years and remain unaware of important and useful features. This book will be useful in making users aware of the full scope of R graphics".

This is, therefore, an essential library reference book. R users will want to refer to it whenever they need a (non-standard) customization of a plot to produce the exact image they want and, in doing so, will improve their comprehension of the R graphics systems. They will be aware of new features as they grow up as R users/developers. The book contains both an overview of the main packages and functions for creating complete plots as well as basic information and tools for customizing graphical representations and for building graphical functions.

For R beginners, this book presents an outline of the base graphics facilities and shows how to modify or add to the output they produce. For slightly more skilled R users, the book provides a comprehensive introduction to the **grid** high-level plotting functions available in the **lattice** package and in the (probably now more popular) **ggplot2** package. For intermediate-level R users, the book teaches how to perform sophisticated customizations of R graphical ouputs. And, for advanced users and R developers, *R Graphics* shows how to develop coherent, reusable, and extensible graphics functions.

The book is structured into 13 chapters: an introductory chapter (22 pages) and 12 more chapters grouped into four parts. Part I has two chapters (2–3; 95 pages) and is devoted to the base graphics system. Part II, with five chapters (4–8; 178 pages), describes the **grid** graphics system, which is unique to R. In my opinion, this contains the most important part of the book, particularly Chapters 6 to 8. Part III, two chapters (9–10; 43 pages), is devoted to the graphics engine, while Part IV with three chapters (11–13; 89 pages) focuses on integrating graphics systems.

Chapter 1 is an introduction to R graphics and includes several examples of the range of different types of graphics that can be produced using R. This motivating introduction certainly encourages the reader to delve further into the book. Chapters 2 and 3 are devoted to the base graphics system, which is based on the 'painters model', where the graphics outputs are added in steps in the drawing device with later output obscuring any previous output that it overlaps. Chapter 2 introduces the main high-level base graphics plotting functions available in the **graphics** package, which is automatically loaded in a standard installation of R. Chapter 3 deals with low-level base graphics functions useful for either controlling details of a base plot or for adding further output to a plot.

Part II could be subdivided into two parts. Chapters 4 and 5, and Chapters 6 to 8. There are two packages based on **grid** to produce complete plots: **lattice** and **ggplot2** packages. Chapter 4 concisely describes how to produce complete plots using the **lattice** package, which is based on Bill Cleveland's Trellis graphics paradigm (Cleveland 1993), while Chapter 5 introduces how to make plots using the **ggplot2** package, inspired by *The Grammar of Graphics* (Wilkinson 2005). As comprehensive, well-written introductions, these chapters put forward justifiable arguments for the great possibilities that these packages offer. The interested reader, nevertheless, should read Sarkar (2008) and Wickham (2016) to, respectively, learn more details about these packages.

Chapter 6 describes the **grid** package functions for producing basic graphical output (such as lines, circles or polygons) and how to build and manage viewports, which are the entities that

offer the context regions where the **grid** functions draw. In addition to producing graphical output, **grid** graphics functions also create objects representing output. Chapter 7 describes how to work with graphical objects (grobs) and also how to directly create grobs without drawing. The main advantage of using grobs is that it is possible to modify a scene that was created using **grid** without having to modify the source code that produced the scene. This helps to overcome the constraints of the 'painters model'. Chapter 8 is the end of Part II and summarises the knowledge acquired in Chapters 6 and 7 proposing guidelines for writing functions whose main purpose is to produce graphical output. This is a chapter that graphics function developers should study in depth.

Chapters 9 and 10 are concerned with the R core graphics engine provided by the **grDevices** package, which is part of the standard installation of R. The functions of this package underlie both the **graphics** and the **grid** outputs. Chapter 9 explains how to produce output in different graphics formats, while instructions about how to customize graphical parameters, such as colours, line styles or text fonts, including mathematical formulae, are described in Chapter 10.

Finally, Chapters 11 to 13 offer some extensions for integrating R graphics with other systems, including combining **grid** and **graphics** outputs. Chapter 11 presents the **grImport** and the **grImport2** packages, which provide functions for importing external images into R and for drawing them as part of R plots. Chapter 12 explains how to combine **graphics** and **grid** outputs using the **gridBase** and the **gridGraphics** packages. And Chapter 13 focuses on the **gridSVG** package, which provides access to SVG features that are not available in standard R graphics.

The issues of deciding what plot is most appropriate given a particular dataset or what presentation is most adequate for a given purpose are not treated in *R Graphics*. The book just focuses on offering lots of useful tools and on describing how to use them to properly draw and customize a plot once the analyst has decided the format of the plot to be drawn. Likewise, in contrast to the second version of the book, this third edition of *R Graphics* only deals with static plots and, although the objectives of the book are masterfully met, yet again, as in the previous versions of *R Graphics*, the book is just printed in black and white, even though the book devotes some attention to colour choice and use. This is a pity, because colour is an important issue for a graphics book.

In short, this is a valuable book that the full range of R users will find of interest. Personally, while reading the book, I used the lessons I was learning to produce, for a research paper, the exact images we have envisioned on the blackboard. For instance, in some plots, after placing several **ggplot2** facets in a layout with viewports of different sizes, we customized text marks and axes with the help of the **grid** package, using different coordinate systems.

Acknowledgments

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Reviewer:

Jose M. Pavía
Universitat de València
Department of Applied Economics
Area of Quantitative Methods
Valencia, Spain 46022
E-mail: pavia@uv.es
URL: http://links.uv.es/4HT5395