# 6.1: An Overview of R Graphics

Reduced to its simplest form, you can think of an R graphic as being much like a painting. You start out with an empty canvas. Every time you use a graphics function, it paints some new things onto your canvas. Later on, you can paint more things over the top if you want; but just like painting, you can't "undo" your strokes. If you make a mistake, you have to throw away your painting and start over. Fortunately, this is way more easy to do when using R than it is when painting a picture in real life: you delete the plot and then type a new set of commands.[88] This way of thinking about drawing graphs is referred to as the ***painter's model***. So far, this probably doesn't sound particularly complicated, and for the vast majority of graphs you'll want to draw it's exactly as simple as it sounds. Much like painting in real life, the headaches usually start when we dig into details. To see why, I'll expand this "painting metaphor" a bit further just to show you the basics of what's going on under the hood, but before I do I want to stress that you really don't need to understand all these complexities in order to draw graphs. I'd been using R for years before I even realised that most of these issues existed! However, I don't want you to go through the same pain I went through every time I inadvertently discovered one of these things, so here's a quick overview.

Firstly, if you want to paint a picture, you need to paint it **on** something. In real life, you can paint on lots of different things. Painting onto canvas isn't the same as painting onto paper, and neither one is the same as painting on a wall. In R, the thing that you paint your graphic onto is called a ***device***. For most applications that we'll look at in this book, this "device" will be a window on your computer. If you're using Windows as your operating system, then the name for this device is `windows`; on a Mac it's called `quartz` because that's the name of the software that the Mac OS uses to draw pretty pictures; and on Linux/Unix, you're probably using `X11`. On the other hand, if you're using Rstudio (regardless of which operating system you're on), there's a separate device called `RStudioGD` that forces R to paint inside the "plots" panel in Rstudio. However, from the computers perspective there's nothing terribly special about drawing pictures on screen: and so R is quite happy to paint pictures directly into a file. R can paint several different types of image files: `jpeg`, `png`, `pdf`, `postscript`, `tiff` and `bmp` files are all among the options that you have available to you. For the most part, these different devices all behave the same way, so you don't really need to know much about the differences between them when learning how to draw pictures. But, just like real life painting, sometimes the specifics do matter. Unless stated otherwise, you can assume that I'm drawing a picture on screen, using the appropriate device (i.e., `windows`, `quartz`, `X11` or `RStudioGD`). One the rare occasions where these behave differently from one another, I'll try to point it out in the text.

Secondly, when you paint a picture you need to paint it **with** something. Maybe you want to do an oil painting, but maybe you want to use watercolour. And, generally speaking, you pretty much have to pick one or the other. The analog to this in R is a "graphics system". A graphics system defines a collection of very ***low-level graphics*** commands about what to draw and where to draw it. Something that surprises most new R users is the discovery that R actually has *two* completely independent graphics systems, known as ***traditional graphics*** (in the `graphics` package) and ***grid graphics*** (in the `grid` package).[89] Not surprisingly, the traditional graphics system is the older of the two: in fact, it's actually older than R since it has it's origins in S, the system from which R is descended. Grid graphics are newer, and in some respects more powerful, so many of the more recent, fancier graphical tools in R make use of grid graphics. However, grid graphics are somewhat more complicated beasts, so most people start out by learning the traditional graphics system. Nevertheless, as long as you don't want to use any low-level commands yourself, then you don't really need to care about whether you're using traditional graphics or grid graphics. However, the moment you do want to tweak your figure by using some low-level commands you do need to care. Because these two different systems are pretty much incompatible with each other, there's a pretty big divide in R graphics universe. Unless stated otherwise, you can assume that everything I'm saying pertains to traditional graphics.

Thirdly, a painting is usually done in a particular **style**. Maybe it's a still life, maybe it's an impressionist piece, or maybe you're trying to annoy me by pretending that cubism is a legitimate artistic style. Regardless, each artistic style imposes some overarching aesthetic and perhaps even constraints on what can (or should) be painted using that style. In the same vein, R has quite a number of different packages, each of which provide a collection of ***high-level graphics*** commands. A single high-level command is capable of drawing an entire graph, complete with a range of customisation options. Most but not all of the high-level commands that I'll talk about in this book come from the `graphics` package itself, and so belong to the world of traditional graphics. These commands all tend to share a common visual style, although there are a few graphics that I'll use that come from other packages that differ in style somewhat. On the other side of the great divide, the grid universe relies heavily on two different packages – `lattice` and `ggplots2` – each of which provides a quite different visual style. As you've probably guessed, there's a whole separate bunch of functions that you'd need to learn if you want to use `lattice` graphics or make use of the `ggplots2`. However, for the purposes of this book I'll restrict myself to talking about the basic `graphics` tools.

At this point, I think we've covered more than enough background material. The point that I'm trying to make by providing this discussion isn't to scare you with all these horrible details, but rather to try to convey to you the fact that R doesn't really provide a single coherent graphics system. Instead, R itself provides a platform, and different people have built different graphical tools using that platform. As a consequence of this fact, there's two different universes of graphics, and a great multitude of packages that live in them. At this stage you don't need to understand these complexities, but it's useful to know that they're there. But for now, I think we can be happy with a simpler view of things: we'll draw pictures on screen using the traditional graphics system, and as much as possible we'll stick to high level commands only.

So let's start painting.

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