grid Graphics and Programming

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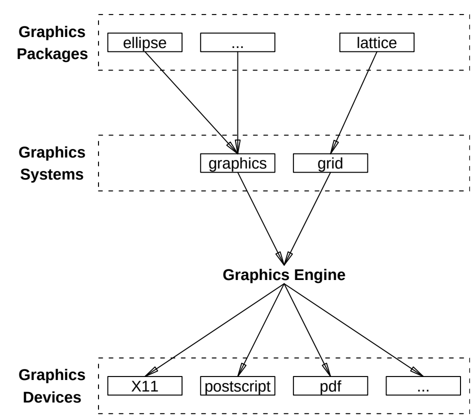
useR! 2004, Vienna

Talk Overview

- Introduction to grid
- Important grid concepts
- Sketching with grid
- Annotating with grid
- Editing with grid
- Combining grid with traditional graphics
- Developing new graphics with grid

Introduction to grid

The Structure of R Graphics



What is grid?

- grid is an alternative to the traditional graphics system provided by the graphics package.
- grid provides low-level graphics functions for producing statistical graphics (at least).

- lattice provides high-level graphics functions using grid

Why grid?

- grid began life purely as support for lattice
- The traditional system has some annoying constraints (e.g., text rotation in margins)
- The traditional system has some annoying inconsistencies (e.g., the meaning of `col`)
- As grid has developed, it has opened up opportunities to do some things that were not conceivable with the traditional system (e.g., interactive editing)

Uses for grid

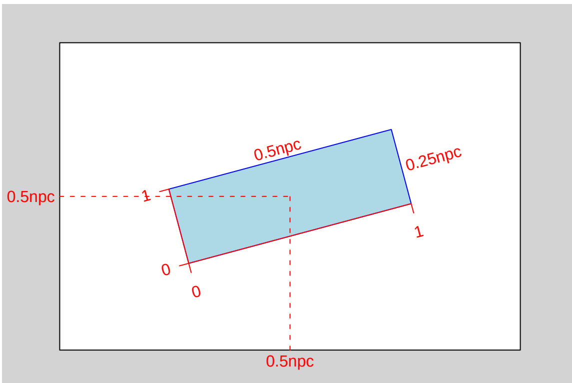
- As a drawing program
- Annotating lattice plots
- Editing lattice plots
- Tricky annotations of traditional plots (gridBase)
- Tricky arrangements of traditional plots (gridBase)
- Develop new graphics functions/components

Important grid Concepts

Viewports

A viewport is a rectangular region.

```
> viewport(x = 0.5, y = 0.5, width = 0.5, height = 0.25, angle = 15)
viewport[GRID.VP.1]
```



Pushing, Popping, Downing, and Upping

The `viewport()` function only creates a description of a viewport. The viewport description must be pushed in order to create a region on the device.

```
> pushViewport(viewport(x = 0.5, y = 0.5, width = 0.5, height = 0.25,
+     angle = 15))
viewport[GRID.VP.8]
```

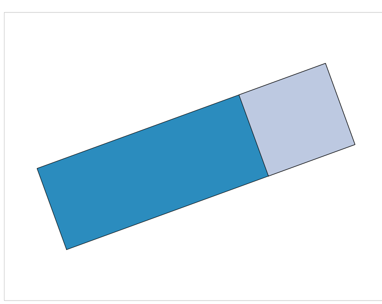
A viewport can be removed from a device by popping it.

```
> popViewport()
viewport[ROOT]
```


Pushing, Popping, Downing, and Upping

Viewports can be nested within each other.

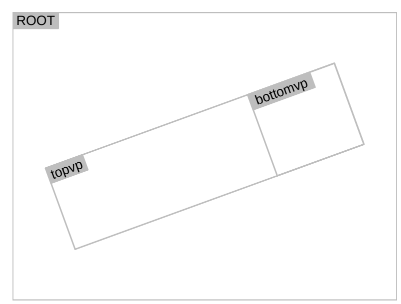
```
> pushViewport(viewport(width = 0.8, height = 0.3, angle = 20,
+     name = "topvp"))
viewport[topvp]
> grid.rect(gp = gpar(fill = rgb(43/255, 140/255, 190/255)))
> pushViewport(viewport(x = 1, width = 0.3, just = "right", name = "bottomvp"))
viewport[bottomvp]
> grid.rect(gp = gpar(fill = rgb(189/255, 201/255, 225/255)))
```



Pushing, Popping, Downing, and Upping

Instead of popping a viewport, it can be left in place, and we can navigate between viewports.

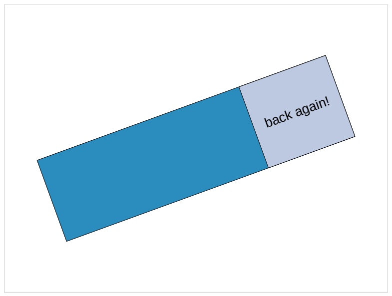
```
> upViewport(0)
viewport[ROOT]
> current.vpTree()
viewport[ROOT]->(viewport[topvp]->(viewport[bottomvp]))
```



Pushing, Popping, Downing, and Upping

Navigation amongst viewports makes use of viewport paths.

```
> downViewport(vpPath("topvp", "bottomvp"))
viewport[bottomvp]
> grid.text("back again!", gp = gpar(fontsize = 20))
```



Units and Coordinate Systems

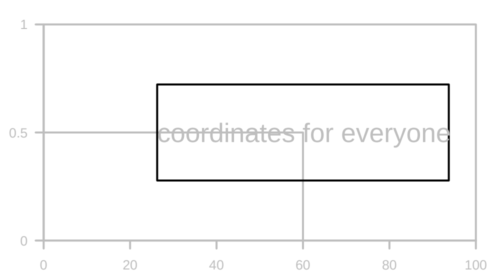
The `unit()` function associates values with coordinate systems.

```
> unit(1, "npc")
[1] 1npc

> unit(1:3/4, "npc")
[1] 0.25npc 0.5npc  0.75npc

> unit(1:3/4, "npc")[2]
[1] 0.5npc
> unit(1:3/4, "npc") + unit(1, "inches")
[1] 0.25npc+1inches 0.5npc+1inches  0.75npc+1inches
> min(unit(0.5, "npc"), unit(1, "inches"))
[1] min(0.5npc, 1inches)
```


Units and Coordinate Systems

Every viewport contains several coordinate systems.

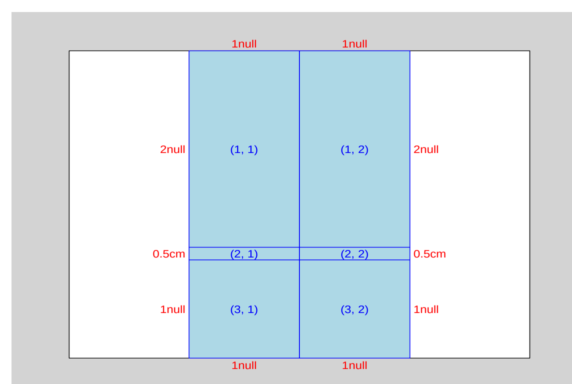
```
> pushViewport(viewport(xscale = c(0, 100)))
viewport[GRID.VP.9]
> pushViewport(viewport(x = unit(60, "native"), y = unit(0.5, "npc"),
+     width = stringWidth("coordinates for everyone"), height = unit(3,
+         "lines")))
viewport[GRID.VP.10]
```



Layouts

A layout divides a viewport into several rows and columns. You can specify different widths and heights of rows and columns.

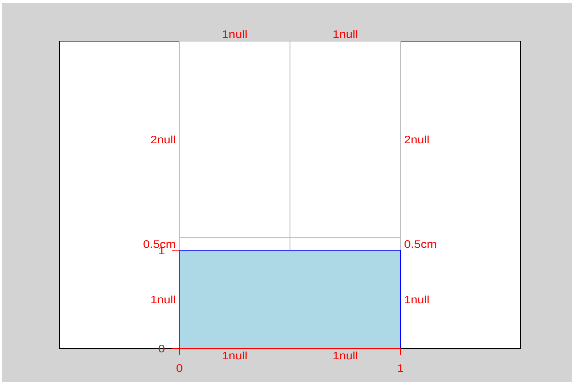
```
> grid.layout(3, 2, heights = unit(c(2, 0.5, 1), c("null", "cm",
+     "null")), respect = TRUE)
```



Layouts

Other viewports can occupy one or more cells of the layout.

```
> pushViewport(viewport(layout = grid.layout(3, 2, heights = unit(c(2,
+     0.5, 1), c("null", "cm", "null")), respect = TRUE)))
> pushViewport(viewport(layout.pos.row = 3))
```



grobs

A grob is a description of a something to draw.

```
> linesGrob(c(0.25, 0.25, 0.75), c(0.75, 0.25, 0.25))
[1] "lines[GRID.GROB.244]"
> rectGrob()
[1] "rect[GRID.GROB.245]"
> textGrob("A label")
[1] "text[GRID.GROB.246]"
```

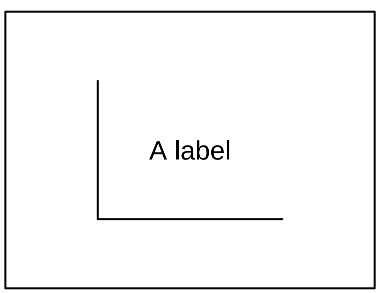
The `grid.draw()` function takes a grob and produces output on a device.

A gTree groups several grobs and allows them to be dealt with as a single object.

Drawing grobs

For every `*Grob()` function there is a `grid.*()` function which creates a grob and draws it.

```
> grid.lines(c(0.25, 0.25, 0.75), c(0.75, 0.25, 0.25))
> grid.rect()
> grid.text("A label")
```



grobs

The following grobs and gTrees are currently available.

moveToGrob()	grid.move.to()
lineToGrob()	grid.line.to()
linesGrob()	grid.lines()
segmentsGrob()	grid.segments()
arrowsGrob()	grid.arrows()
polygonGrob()	grid.polygon()
circleGrob()	grid.circle()
rectGrob()	grid.rect()
textGrob()	grid.text()
pointsGrob()	grid.points()
xaxisGrob()	grid.xaxis()
yaxisGrob()	grid.yaxis()

gpars

A gpar is a collection of graphical parameter settings.

```
> gpar(col = "red", lwd = 4, lty = "dashed")
$col
[1] "red"

$lwd
[1] 4

$lty
[1] "dashed"

attr(,"class")
[1] "gpar"
```

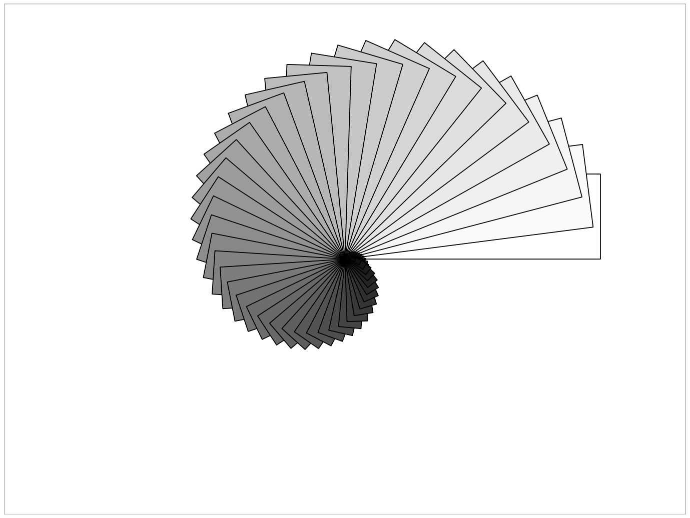
All viewports and grobs can have a gpar associated with them. The gpar settings in a viewport are inherited by grobs drawn in that viewport and by viewports pushed within the viewport.

Recap

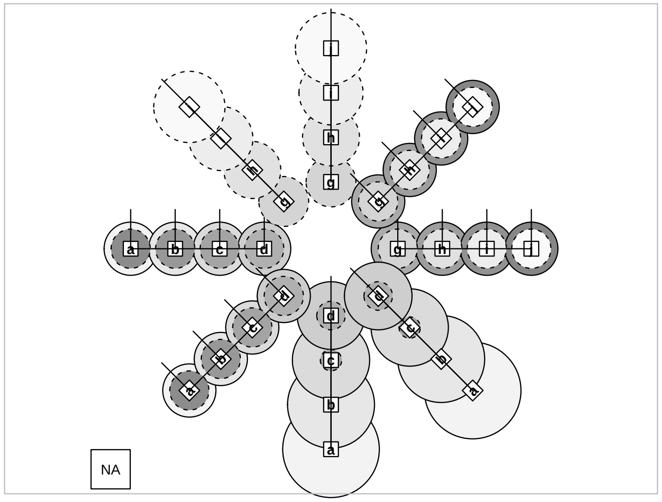
- viewports
- navigating the viewport tree
- units and coordinate systems
- layouts
- grobs
- gpars

Sketching with grid

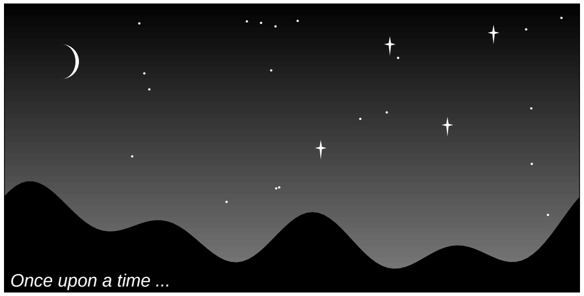
grid examples



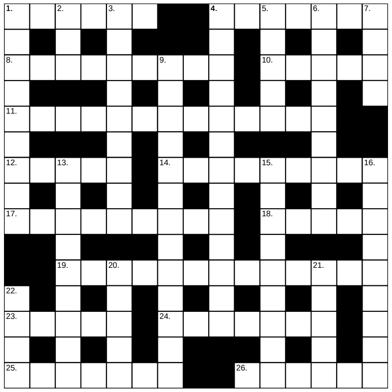
grid examples



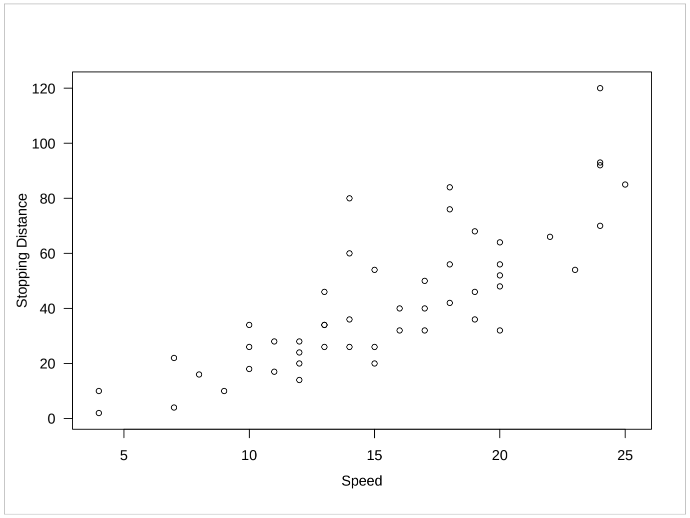
grid examples



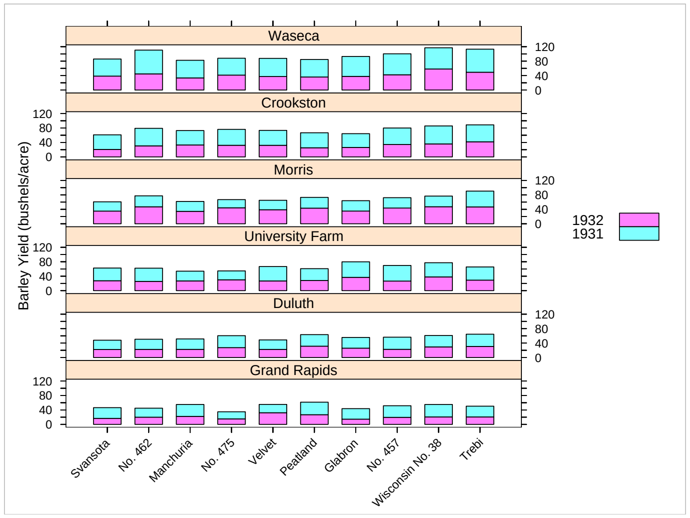
grid examples



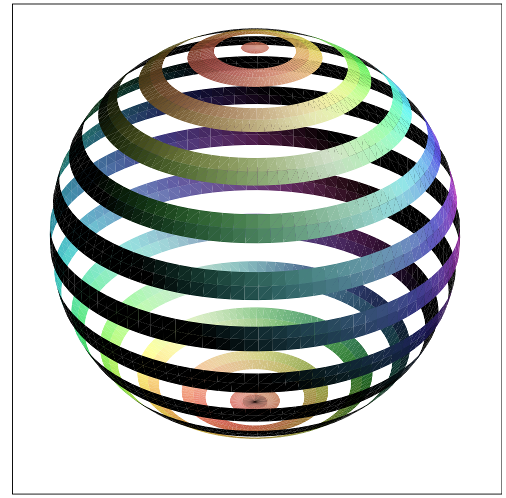
grid examples



lattice examples

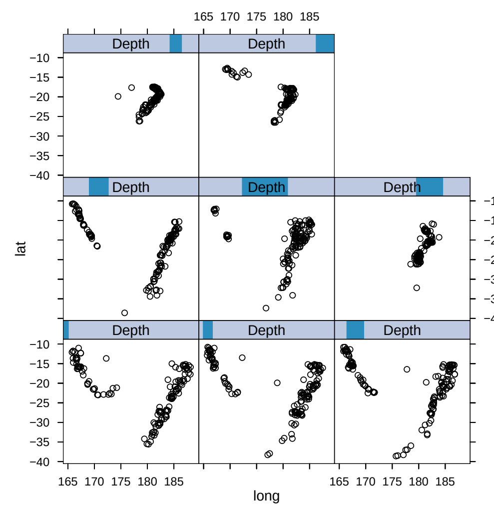


lattice examples



Annotating and Editing with grid

A lattice plot



Viewing the viewports

```
> current.vpTree()
```

```
viewport[ROOT]->(
  viewport[GRID.VP.502]->(
    viewport[GRID.VP.505]
    viewport[GRID.VP.507],
    viewport[GRID.VP.509],
    viewport[GRID.VP.510],
    viewport[GRID.VP.511],
    viewport[GRID.VP.512],
    viewport[GRID.VP.513],
    viewport[GRID.VP.515],
    ...
    viewport[panel.1],
    viewport[panel.2],
    viewport[panel.3],
    viewport[panel.4],
    viewport[panel.5],
    viewport[panel.6],
    viewport[panel.7],
    viewport[panel.8]))
```

← →

Annotating the plot

Navigate to “panel 5”:

```
> downViewport("panel.5")
```

Add a text label in the bottom-left corner:

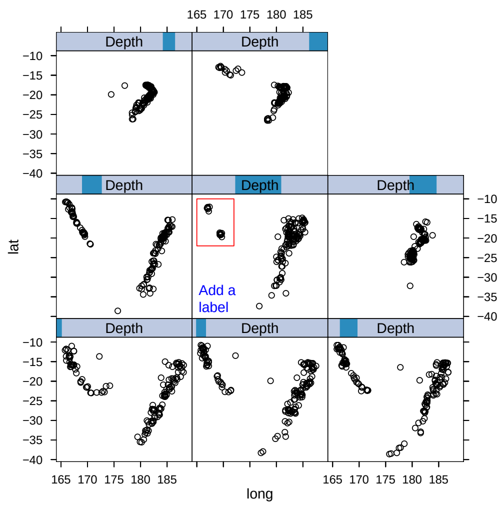
```
> grid.text("Add a\nlabel", x = unit(2, "mm"), y = unit(2, "mm"),
+     just = c("left", "bottom"), gp = gpar(col = "blue", lineheight = 1),
+     name = "ann.panel.5")
```

Draw a rectangle enclosing a data range:

```
> grid.rect(165, -22, 7, 12, default = "native", gp = gpar(col = "red"),
+     just = c("left", "bottom"))
```

← →

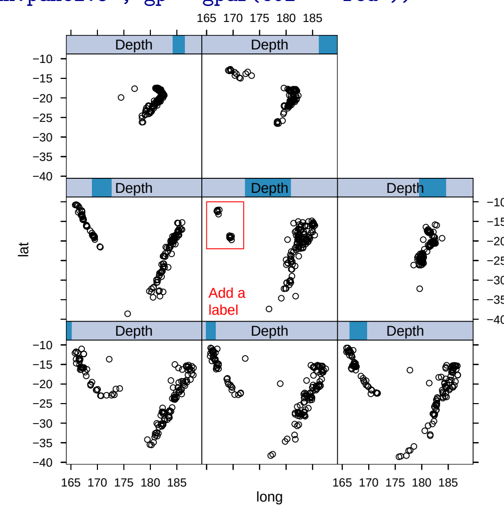
Annotating the plot



← →

Editing the annotations

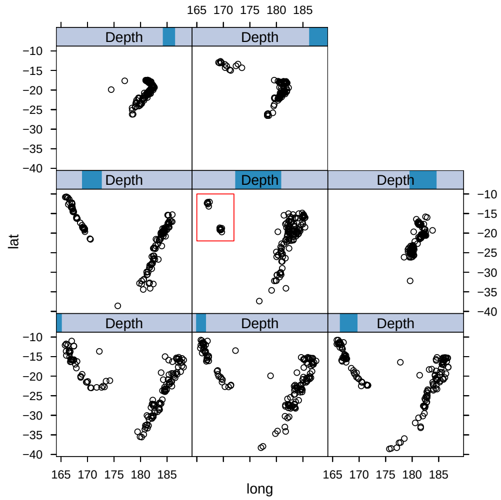
```
> grid.edit("ann.panel.5", gp = gpar(col = "red"))
```



← →

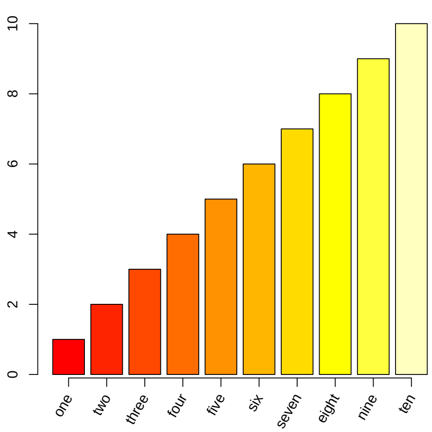
Editing the annotations

```
> grid.remove("ann.panel.5")
```

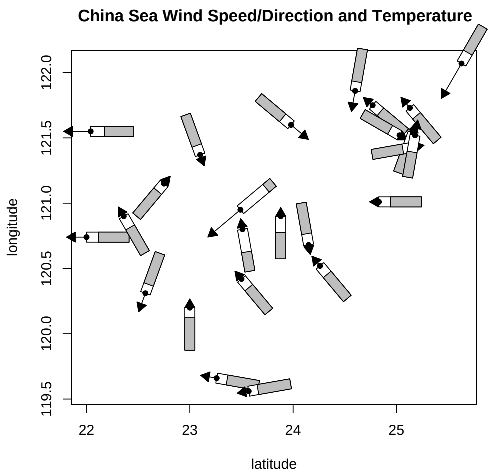


Combining grid and Traditional Graphics

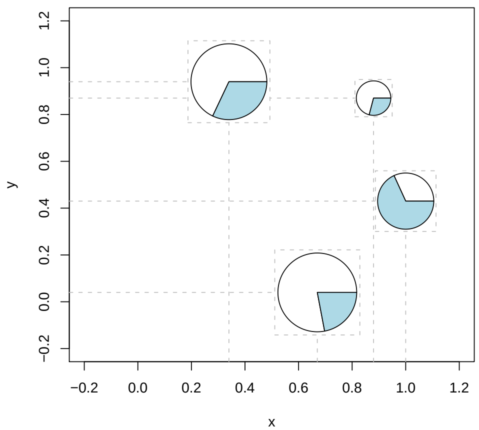
Annotating traditional plots with grid



Annotating traditional plots with grid



Arranging traditional plots with grid



Developing New Graphics with grid

Reasons for using grid

- Greater flexibility in specifying placement of graphical output and arrangements of plots (units and layouts)
- More consistency and generality (viewports and gpars)
- Better access to coordinate systems and output (navigating the viewport tree and interacting with grobs)
- Modular graphics; locations and sizes are declarative and the actual output depends on the viewport context. Graphical functions and grobs can be reused and embedded within other output.
- grobs provide a programatically editable persistent representation of graphical output; there is an API for working with graphical descriptions (`editGrob()`, `removeGrob()`, `addGrob()`, `getGrob()`, and `save()`).

Embedding lattice output