Can R Draw Graphs?

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R **graph**ics

My first peer review experience ...

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Reviewer's comments

"An obvious reject, trivial, with no research component."

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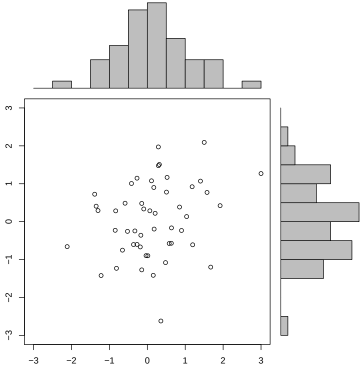
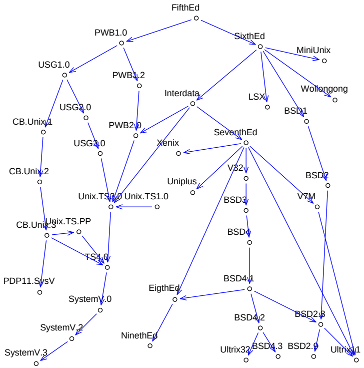
The article was accepted!

R graphics

The article was called *"Layouts: a mechanism for arranging plots on a page"*... **plots** not **graphs**.





Overview

Some new graphics features in R

(... with some applications to arranging **graphs**)

1. New drawing primitives:
   - X-splines.
   - Connectors.
   - Clipping.
2. New ways to query graphical objects:
   - `grobX()`
   - `grobY()`
3. Importing graphics into R:
   - The **grImport** package.

X-splines

Splines are **smooth curves** drawn relative to a set of **control points**. Examples are Catmull-Rom splines, where the curve interpolates the control points, and B-splines, where the curve approximates the control points.

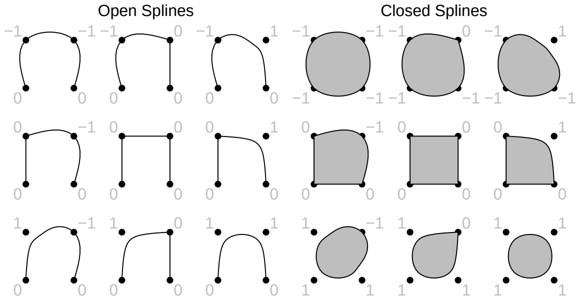
An **X-spline** is a smooth curve drawn relative to a set of control points, where each control point has a parameter indicating whether the curve should interpolate or approximate that particular control point (Carole Blanc and Christophe Schlick, 1995, "X-Splines: A Spline Model Designed for the End-User", *Computer Graphics*, **29**, 377–386).

X-splines have been implemented in the **grid** package for R 2.3.0, via the `grid.xspline()` function.

grid.xspline()

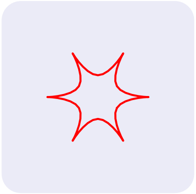
```
grid.xspline(x, y, id, id.lengths, default.units,
             shape, open, arrow, repEnds, name, gp, vp)
```

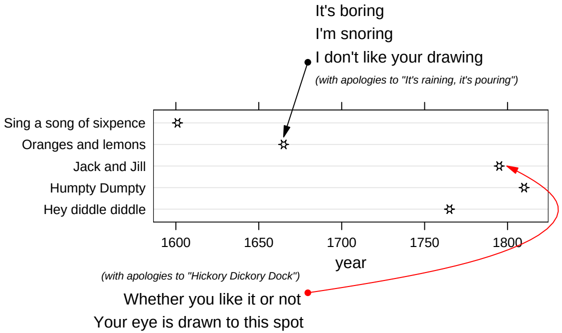
Control points are specified as `x` and `y` locations, a `shape` parameter specifies interpolation or approximation at each control point, and the x-spline can be open or closed. It is also possible to add an `arrow` to either end of an open spline.



Applications of X-Splines

- A more interesting "pointer" from a label to a feature of interest.
- Unusual shapes.



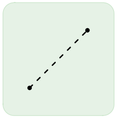

It's boring
I'm snoring
I don't like your drawing
(with apologies to "It's raining, it's pouring")
Sing a song of sixpence
Oranges and lemons
Jack and Jill
Humpty Dumpty
Hey diddle diddle
1600
1650
1700
1750
1800
year
(with apologies to "Hickory Dickory Dock")
Whether you like it or not
Your eye is drawn to this spot

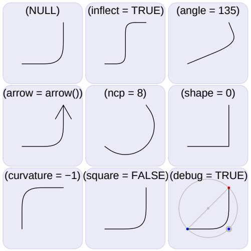
Connectors

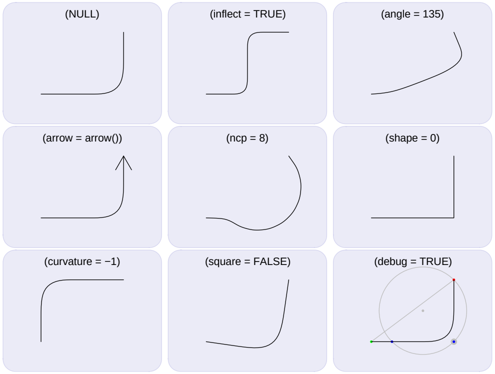
A connector is a curve drawn between two points. The function `grid.curve()` draws a range of connectors.

```
grid.curve(x1, y1, x2, y2, default.units,
           curvature, angle, ncp, shape,
           square, squareShape, inflect,
           arrow, debug, name, gp, vp)
```

Connectors

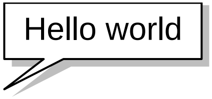



(NULL)
(inflect = TRUE)
(angle = 135)
(arrow = arrow())
(ncp = 8)
(shape = 0)
(curvature = −1)
(square = FALSE)
(debug = TRUE)


(NULL)
(inflect = TRUE)
(angle = 135)
(arrow = arrow())
(ncp = 8)
(shape = 0)
(curvature = −1)
(square = FALSE)
(debug = TRUE)

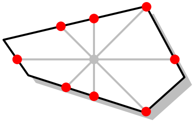
Querying Graphical Objects

It has always been possible to determine the width and height of graphical output via `grobWidth()` and `grobHeight()`. This is useful for doing things like placing decorations around text.



It is now also possible to determine locations on the boundary of graphical output via `grobX()` and `grobY()`.

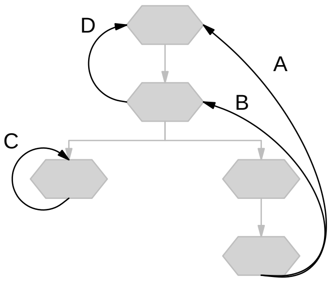
```
grobX(x, theta)
grobY(x, theta)
```



Flow Diagrams

The combination of connectors and being able to determine the boundary points of objects makes it possible to create simple flow diagrams in R.

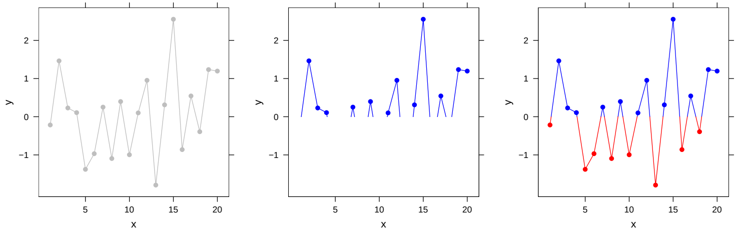
```
hex(.5, .8, name="h1")
hex(.5, .6, name="h2")
...
grid.curve(grobX("h2", 180),
           grobY("h2", 180),
           grobX("h1", 180),
           grobY("h1", 180),
           shape=1, ncp=10,
           square=FALSE,
           curvature=-1,
           arrow=arr)
...
```



Clipping

It has always been possible to clip graphical output to a grid viewport. This is typically done, for example, to ensure that plotted data do not “spill” outside the plotting region.

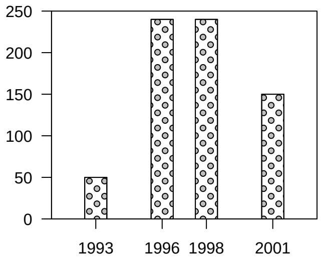
It is now also possible to change the clipping region within a viewport, via the `grid.clip()` function.



Clipping

```
grid.clip(x, y, width, height,
          just, hjust, vjust,
          default.units, name, vp)
```

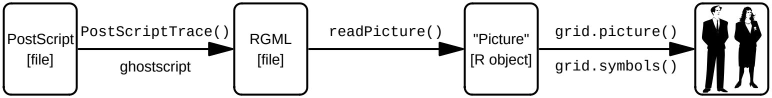
```
...
for (i in 1:length(year)) {
  grid.clip(x=year[i], y=0,
            width=1,
            height=maxpop[i],
            "native",
            just="bottom")
  # pattern fill
  gridPattern()
}
...
```



Importing Graphics

R graphics can be exported in many different formats, including PDF, PostScript, PNG, and (on Windows) WMF. This is useful, for example, for including plots within larger reports.

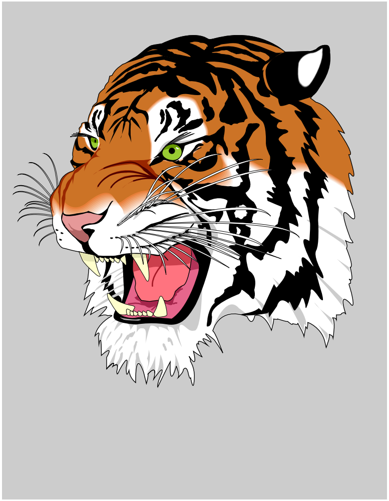
The **grImport** package makes it possible to go the other direction and import external graphics images for use within an R plot.



The PostScript Bezier Tiger

```
%!PS-Adobe-2.0 EPSF-1.2
%%Creator: Adobe Illustrator(TM)
%%For: OpenWindows Version 2
%%Title: tiger.eps
...
.8 setgray
clippath fill
-110 -300 translate
1.1 dup scale

0 g
0 G
0 i
0 J
0 j
0.172 w
10 M
[]0 d
0 0 0 0 k
...
```



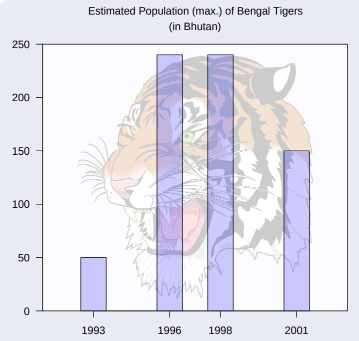
Importing the Tiger

```
PostScriptTrace("tiger.ps")

tiger <-
  readPicture("tiger.ps.xml")
```

Using the Tiger as a Plot Backdrop

```
pushViewport(plotViewport())
...
grid.rect()
grid.xaxis(at=year)
grid.yaxis()
...
grid.picture(tiger)
...
popViewport()
```



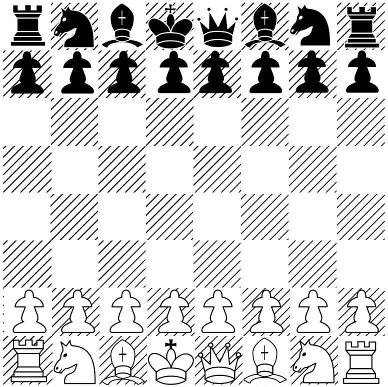
A Chess Board

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE svg PUBLIC "-//W3C//DTD SVG"
"http://www.w3.org/TR/2001/REC-SVG...">
<!-- Created with Sodipodi -->
<svg version="1.0">
...
  <g
     style="font-size:12;"
     id="g874">
    <path
      d="M 0 437 L 437 0 "
      style="fill:none;fill-opacity:1"
      id="path616" />
...
```

```
# Convert SVG to PostScript
# using InkScape

PostScriptTrace("chess.ps")

chess <-
  readPicture("chess.ps.xml")
```

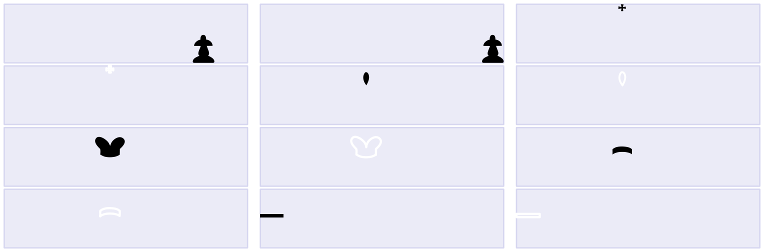


The Paths in the Chess Board

The `picturePaths()` function draws individual paths from a picture, which makes it possible to identify elements of a picture.

`"Picture"` objects can be subsetted, which makes it possible to extract elements of a picture.

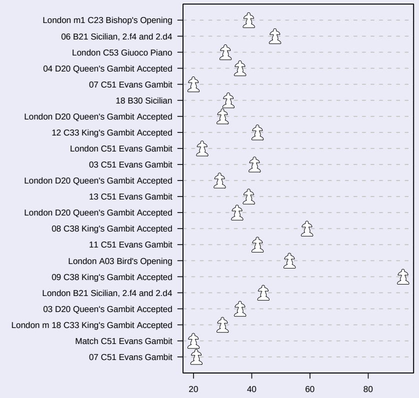
```
picturePaths(chess[125:136])
```



A Chess Piece as a Plotting Symbols

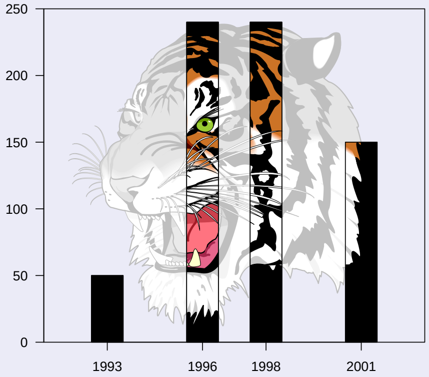
The number of moves required to complete chess games for different opening gambits. From the career of Louis Charles Mahe De La Bourdonnais (circa 1830).

```
grid.symbols(
  chess[205:206],
  x=games$num.moves,
  y=1:ngames,
  "native",
  size=unit(0.5, "cm"))
```



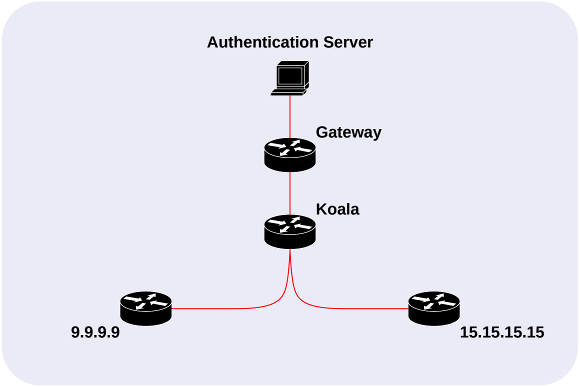
Combining Clipping and **grImport**

```
grid.picture(tiger, x=0.45,
             FUN=greyify)
...
for (i in 1:length(year)) {
  grid.clip(x=year[i], y=0,
            width=1,
            height=maxpop[i],
            "native",
            just="bottom")
  # tiger slice
  grid.picture(tiger)
}
grid.clip()
...
```



Combining Connectors, grobX(), grobY(), and **grImport**

```
router <- readPicture("router.ps.xml")
grid.picture(router, 0.5, 0.4, 0.1, 0.1, name="router2")
grid.picture(router, 0.25, 0.2, 0.1, 0.1, name="router3")
grid.curve(grobX("router2", 270), grobY("router2", 270),
           grobX("router3", 0), grobY("router3", 0))
```



Summary

`grid.xspline()`	Draw a smooth curve relative to control points.
`grid.curve()`	Draw a connector between two end points.
`grid.clip()`	Reset the clipping region within the current viewport.
`grobX()`, `grobY()`	Determine a location on the boundary of a graphical object.
grImport	Import PostScript images for drawing in R.

Can R draw graphs?

Depending on what you meant by "graph", the answer used to be either "yes, of course!" or "yeeessss, sort of". With the new features in R 2.3.0, the answer in either case is a more emphatic "yes".

Acknowledgements

- **Richard Walton** made significant improvements to the **grImport** code last (Southern) Summer.
- The **ggm** package by **Giovanni Marchetti** and **Mathias Drton** was used to produce the example node-and-edge graph in the introduction.
- The dates of first pulication of Nursery Rhymes came from `http://www.rhymes.org.uk/` and `http://www.bbc.co.uk/dna/h2g2/alabaster/A696125`.
- The cartoon bubble text example was motivated by a recent R-help message by **Ivo Welch**.
- The clipping example was motivated by a recent R-help message by **ArrayChip**.
- The tiger image is part of the **ghostscript** distribution; the tiger data are from `http://www.globaltiger.org/population.htm`.
- The greyscale version of the tiger used the **colorspace** package by **Ross Ihaka**.
- The chess board image (by **Jose Hevia**) is from the **Open Clip Art Library** `http://openclipart.org/clipart//recreation/games/chess/chess_game_01.svg`
- The chess data are from **chessgames.com** `http://www.chessgames.com/perl/chess.pl?page=1&pid=31596`
- The network diagram used the **Cisco Network Topology Icons** `http://www.cisco.com/web/about/ac50/ac47/2.html`