

Computer Graphics Concepts, R, and ImageMagick on Linux

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<http://biostat.mc.vanderbilt.edu/LinuxGraphicsSeminar>

Computer Display Made of Pixels

In digital imaging, a pixel^[1] (or picture element) is the smallest item of information in an image. Pixels are normally arranged in a 2-dimensional grid, and are often represented using dots or squares. Each pixel is a sample of an original image, where more samples typically provide more-accurate representations of the original.

<http://en.wikipedia.org/wiki/Pixel>

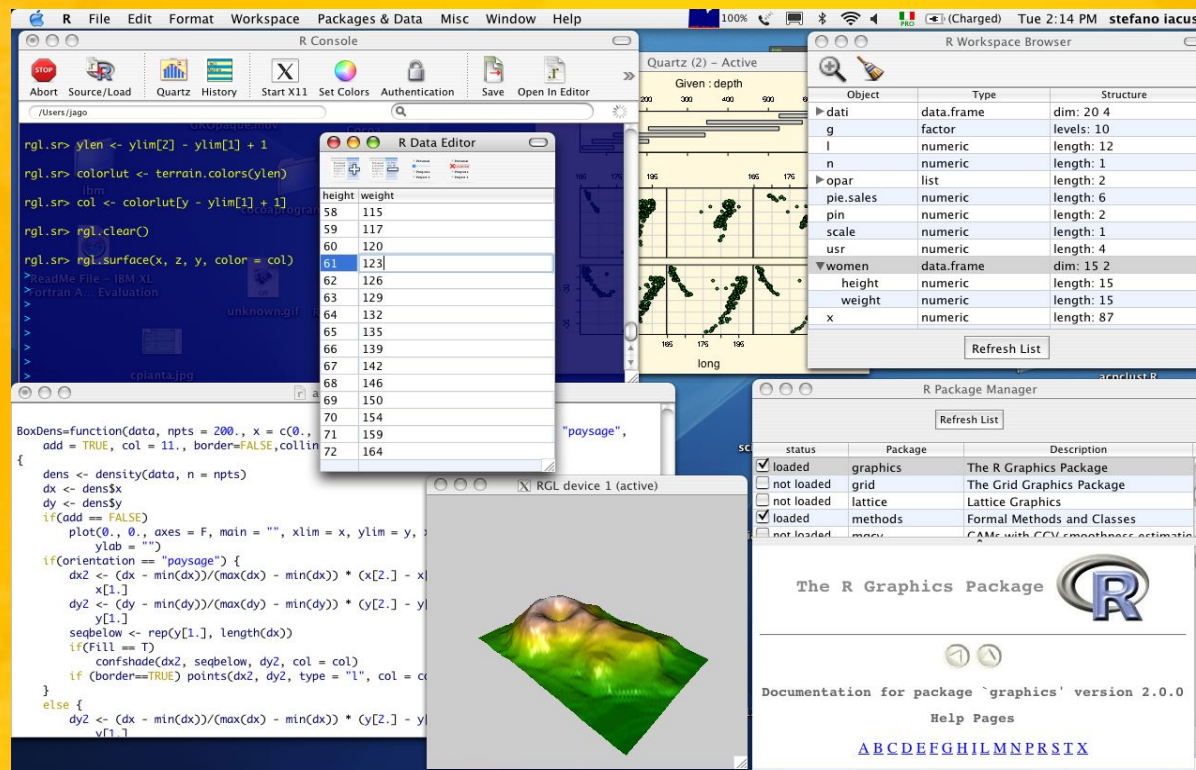
Pixel Density

The PPI of a computer display is related to the size of the display in inches and the total number of pixels in the horizontal and vertical directions. This measurement is often referred to as dots per inch, though that measurement more accurately refers to the resolution of a computer printer

http://en.wikipedia.org/wiki/Pixel_density

A 15 inch display, whose dimensions work out to 12 inches wide by 9 inches high, capable of a maximum 1024 by 768 pixel resolution can display around 85 PPI in both the horizontal and vertical directions.

http://en.wikipedia.org/wiki/Pixel_density



Dots Per Inch (DPI) Measurement in Printing

Up to a point, printers with higher DPI produce clearer and more detailed output. A printer does not necessarily have a single DPI measurement; it is dependent on print mode, which is usually influenced by driver settings. The range of DPI supported by a printer is most dependent on the print head technology it uses. A dot matrix printer, for example, applies ink via tiny rods striking an ink ribbon, and has a relatively low resolution, typically in the range of 60 to 90 DPI. An inkjet printer sprays ink through tiny nozzles, and is typically capable of 300-600 DPI. A laser printer applies toner through a controlled electrostatic charge, and may be in the range of 600 to 1800 DPI.

http://en.wikipedia.org/wiki/Dots_per_inch

Raster Graphics

In computer graphics, a raster graphics image or bitmap is a data structure representing a generally rectangular grid of pixels, or points of color, viewable via a monitor, paper, or other display medium. Raster images are stored in image files with varying formats.

http://en.wikipedia.org/wiki/Raster_graphics

Popular file formats for raster graphics are PNG, JPG, TIFF, BMP.

Vector Graphics

Vector graphics is the use of geometrical primitives such as points, lines, curves, and shapes or polygon(s), which are all based on mathematical equations, to represent images in computer graphics.

http://en.wikipedia.org/wiki/Vector_graphics

Popular vector graphics file formats are SVG, PDF, EPS, SWF, and VML.

R Graphics Devices

Raster devices include **png()**, **jpeg()**, **tiff()**, **bmp()** - great for computer displays and web sites. Sizes are expressed in pixels.

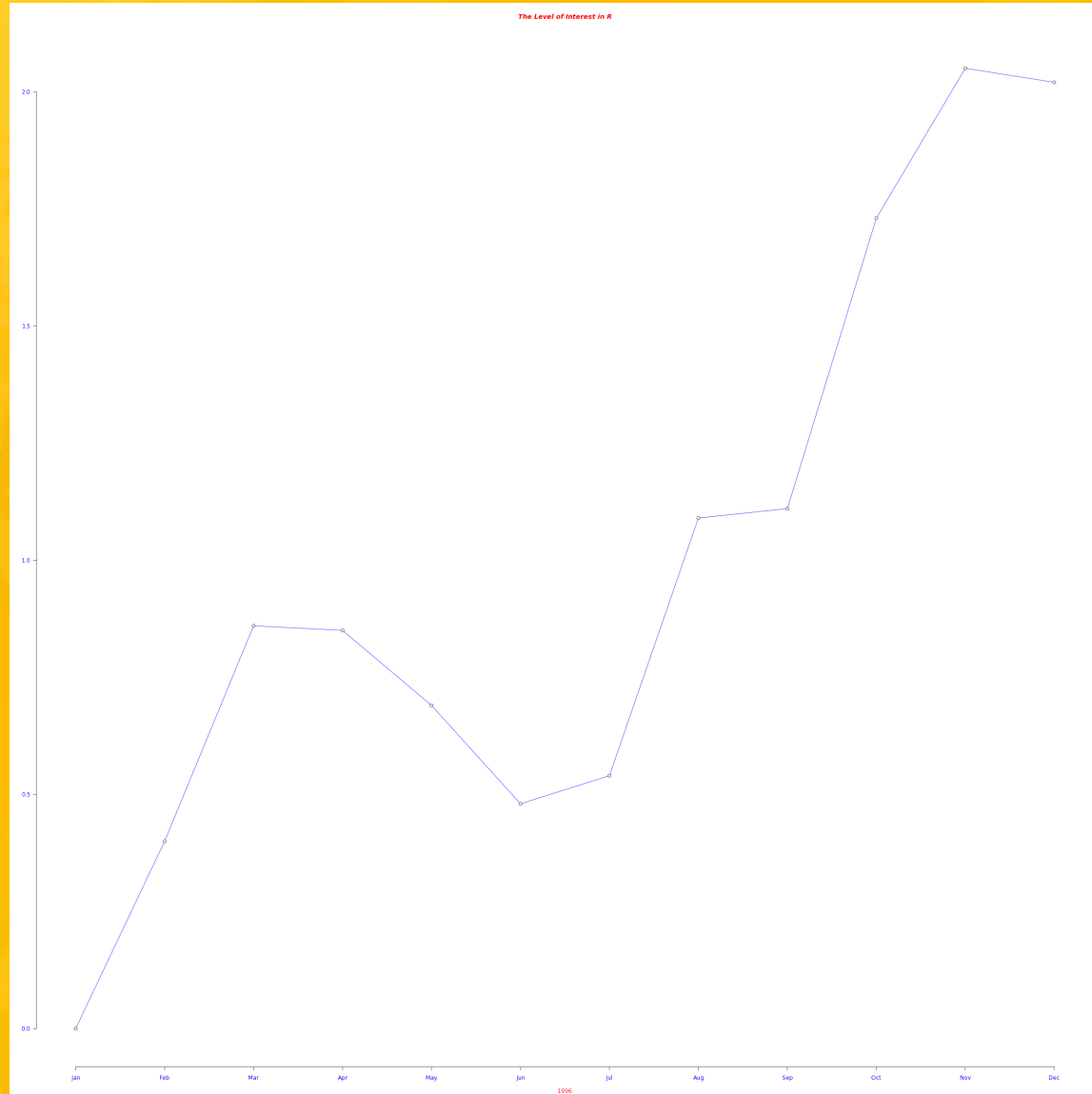
Vector devices include **postscript()**, **pdf()** - great for journal submissions and printer output of any size paper or poster. Sizes are expressed in inches.

Cairo dependent vector devices include **svg()**, **cairo_ps()**, and **cairo_pdf()**. Still experimental.

Poor Output with R Raster Device **tiff()**

```
tiff( width=4*600, height=4*600 )
x <- c(0.00, 0.40, 0.86, 0.85, 0.69,
      0.48, 0.54, 1.09, 1.11, 1.73, 2.05, 2.02)
plot(x, type="n", axes=FALSE, ann=FALSE)
lines(x, col="blue")
points(x, pch=21, bg="lightcyan", cex=1.25)
axis(2, col.axis="blue", las=1)
axis(1, at=1:12, lab=month.abb, col.axis="blue")
title(main= "The Level of Interest in R",
      font.main=4, col.main="red")
title(xlab= "1996", col.lab="red")
dev.off()
```

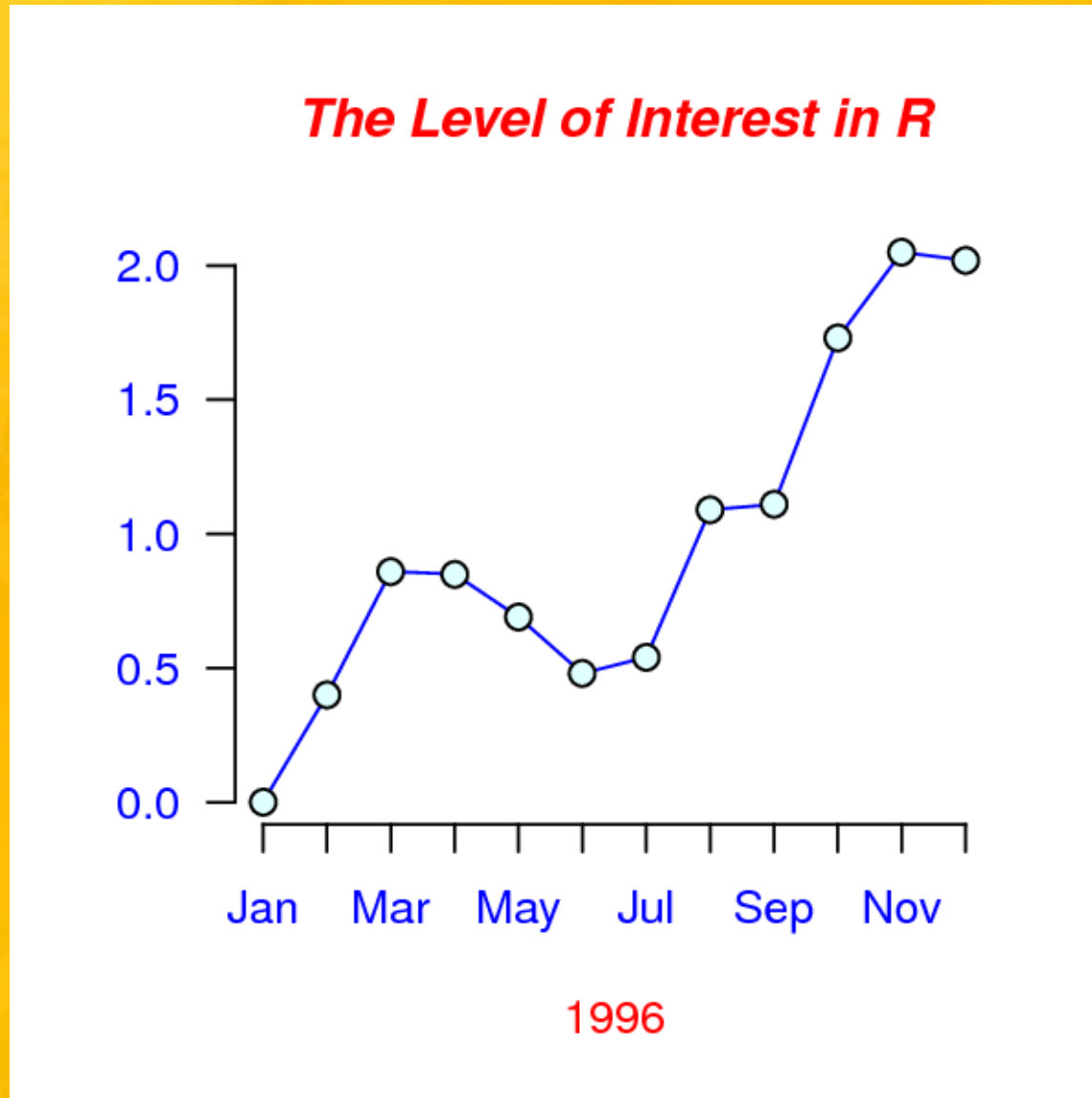
Poor Output with R Raster Device **tiff()**



Better Output with R Vector Device **pdf()**

```
pdf( width=4, height=4 )
x <- c(0.00, 0.40, 0.86, 0.85, 0.69,
      0.48, 0.54, 1.09, 1.11, 1.73, 2.05, 2.02)
plot(x, type="n", axes=FALSE, ann=FALSE)
lines(x, col="blue")
points(x, pch=21, bg="lightcyan", cex=1.25)
axis(2, col.axis="blue", las=1)
axis(1, at=1:12, lab=month.abb, col.axis="blue")
title(main= "The Level of Interest in R",
      font.main=4, col.main="red")
title(xlab= "1996", col.lab="red")
dev.off()
```

Better Output from R Vector Device pdf()



How Did I Do That?

OpenOffice Impress cannot
include pdf files directly.

Grr!

ImageMagick on Linux

```
pdf( file="plot.pdf", width=4, height=4 )
x <- c(0.00, 0.40, 0.86, 0.85, 0.69,
      0.48, 0.54, 1.09, 1.11, 1.73, 2.05, 2.02)
plot(x, type="n", axes=FALSE, ann=FALSE)
lines(x, col="blue")
points(x, pch=21, bg="lightcyan", cex=1.25)
axis(2, col.axis="blue", las=1)
axis(1, at=1:12, lab=month.abb, col.axis="blue")
title(main= "The Level of Interest in R",
      font.main=4, col.main="red")
title(xlab= "1996", col.lab="red")
dev.off()
system("convert -density 150x150
      plot.pdf plot.png")
```

ImageMagick on Linux

ImageMagick® is a software suite to create, edit, and compose bitmap images. It can read, convert and write images in a variety of formats (over 100) including DPX, EXR, GIF, JPEG, JPEG-2000, PDF, PhotoCD, PNG, Postscript, SVG, and TIFF. Use ImageMagick to translate, flip, mirror, rotate, scale, shear and transform images, adjust image colors, apply various special effects, or draw text, lines, polygons, ellipses and Bézier curves.

The functionality of ImageMagick is typically utilized from the **command line** or you can use the features from programs written in your favorite programming language. Choose from these interfaces: G2F (Ada), MagickCore (C), MagickWand (C), ChMagick (Ch), ImageMagickObject (COM+), Magick++ (C++), JMagick (Java), L-Magick (Lisp), NMagick (Neko/haXe), MagickNet (.NET), PascalMagick (Pascal), PerlMagick (Perl), MagickWand for PHP (PHP), IMagick (PHP), PythonMagick (Python), RMagick (Ruby), or TclMagick (Tcl/TK). With a language interface, use ImageMagick to modify or create images dynamically and automatically.

<http://www.imagemagick.org/>

ImageMagick on Linux

Convert a directory of images to a size whose maximum width and/or height is 400 pixels.

```
$ for i in *.png; do  
    convert -geometry 400x400 $i 400_${i}  
done
```

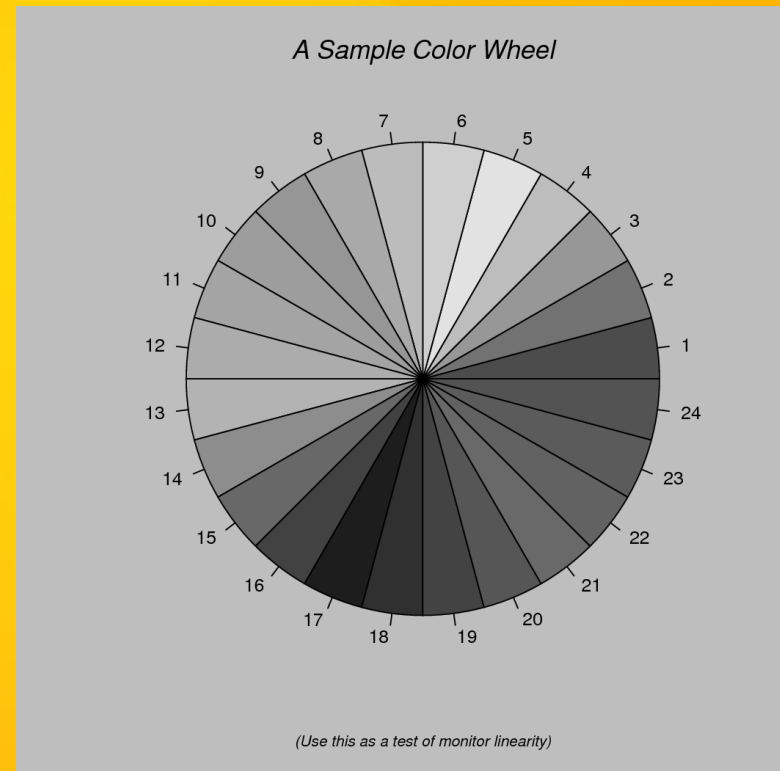
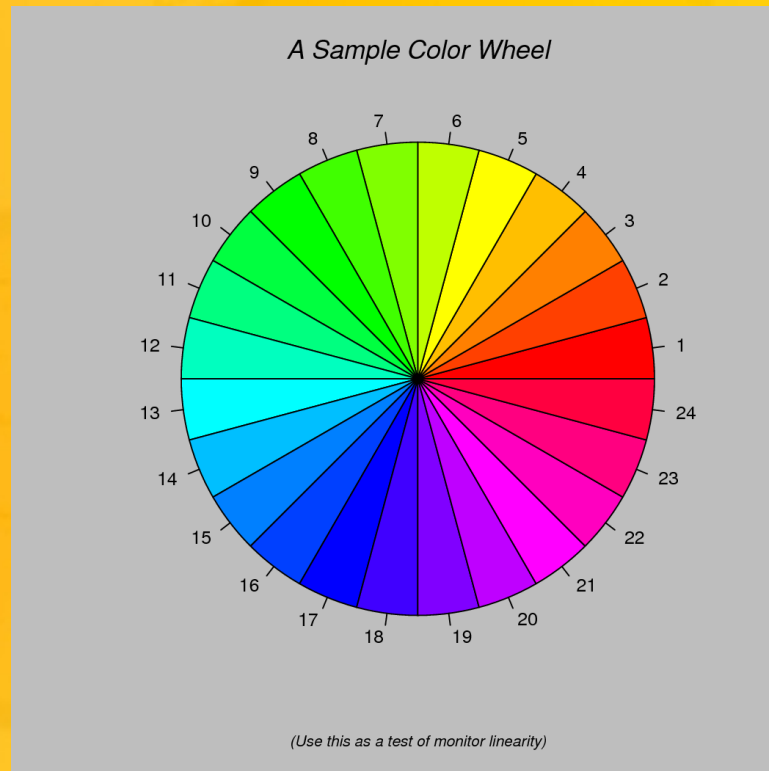

ImageMagick on Linux

Convert a color pdf file to a grayscale png file with 150 PPI.

```
$ convert -density 150x150 -type  
    GrayScale Rplots.pdf Rplots.png
```

ImageMagick on Linux

Convert a color pdf file to a grayscale png file with 150 PPI.



ImageMagick on Linux Features

- Format conversion: convert an image from one format to another (e.g. PNG to JPEG)
- Transform: resize, rotate, crop, flip or trim an image
- Transparency: render portions of an image invisible
- Draw: add shapes or text to an image
- Decorate: add a border or frame to an image
- Special effects: blur, sharpen, threshold, or tint an image
- Animation: create a GIF animation sequence from a group of images
- Text & comments: insert descriptive or artistic text in an image
- Image identification: describe the format and properties of an image
- Composite: overlap one image over another

<http://www.imagemagick.org/>

ImageMagick on Linux Programs

- Compare
 - mathematically and visually annotate the difference between an image and its reconstruction.
- composite
 - overlap one image over another.
- conjure
 - interpret and execute scripts written in the Magick Scripting Language (MSL).
- convert
- convert between image formats as well as resize an image, blur, crop, despeckle, dither, draw on, flip, join, re-sample, and much more.
- display
 - display an image or image sequence on any X server.
- identify
 - describe the format and characteristics of one or more image files.
- mogrify
 - resize an image, blur, crop, despeckle, dither, draw on, flip, join, re-sample, and much more. Mogrify overwrites the original image file, whereas, convert writes to a different image file.
- montage
 - create a composite image by combining several separate images. The images are tiled on the composite image optionally adorned with a border, frame, image name, and more.

Other Linux Graphics Programs

- Gnu Image Manipulation Program (GIMP)
 - Similar to Adobe Photoshop – suitable for photo retouching and image authoring. Very stable.
- Scribus
 - Similar to Adobe Illustrator – a page layout program. Fairly stable. Many in the department have successfully used Scribus to create posters.
- Inkscape
 - Program specifically for creating vector graphics.
- Graphviz
 - Graph visualization software – graphs are written in the DOT language and output to just about any graphics format.
- Okular
 - PDF viewer with the ability to copy page selections to a raster image.

Thanks!

Questions?