Vector Image Processing

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University of Auckland Campus Map
Problems and Solutions

The problem:

- The map is pretty, but annoying.
- Easy to find “Statistics”, but hard to find building 303.

The solution:

- Use R to convert the original static PDF into an interactive SVG document.

Mouse over 303 and all instances of 303 on the map are highlighted.
SVG Campus Map Demo
The \texttt{grImport} package

- Convert original image to PostScript (e.g., \texttt{pdftops}).
- Convert PostScript to RGML.
  \begin{verbatim}
  PostScriptTrace("city.ps", "city.xml")
  \end{verbatim}
- Read RGML into R object.
  \begin{verbatim}
  city <- readPicture("city.xml")
  \end{verbatim}
- Draw R object.
  \begin{verbatim}
  grid.picture(city)
  \end{verbatim}
gImport version 0.5
• There are several PostScript commands for drawing text: /show, /ashow, /widthshow, and /awidthshow.

• `grImport` only used to support /show, but now supports the others as well.

• Also improved import of line width and style.
Music, School of  250, 804, 820
Muslim Prayer Room  301
Newman Hall  805
New Start  810
New Zealand Art Research & Discovery, Centre for  421
New Zealand Asia Institute  260
New Zealand Leadership Institute  260
Nga Pae o te Maramatanga (National Institute of Research Excellence for Maori Development and Advancement)  253
'Number 14' Student Flats  436
Old Choral Hall  104
Old Government House  102
O'Rorke Hall  614
Owen G Glenn Building  260
Pacific Studies, Centre for  273
Pharmacy  315
Philosophy, Dept of  207
Photographers  438
Physics, Dept of  303
Planning & Quality Office  103
Political Studies, Dept of  212, 215-216, 220, 408
Polymers & Coatings Science Programme  301
Portables Plus  315
Post Office Agency  315
Property, Dept of  260
Property Services  620
Psychology, Dept of  201
Recreation Centre  314
Research Office  438
Retail Facilities  311, 315
Scholarships & Financial Support  105
School of Graduate Studies  119
Schools Partnership Office  119
Science Centre  301, 303
Security  201
Shared Services  105
Short Courses  260
Sociology, Dept of  201
Spanish, Dept of  206
Staff Common Room  102
Statistics, Dept of  303
Strata, Postgraduate Commons  315

Security
Information Desk
Access Parking
Bus Stop, city service
City-Takamaki Bus Stop
Staff Parking, area no
Underpass
Visitor Parking
Paths versus Polygons

- The new `grid.path()` and `polypath()` functions can draw complex paths.
- `grImport` now makes use of `grid.path()` and `polypath()`.
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grImport version 0.7
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Property Services 620
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Research Office 438
Retail Facilities 311, 315
Scholarships & Financial Support 105
School of Graduate Studies 119
Schools Partnership Office 119
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Short Courses 260
Sociology, Dept of 201
Spanish, Dept of 206
Staff Common Room 102
Statistics, Dept of 303
Strata, Postgraduate Commons 315
• We can now go from PDF to R and on to any format that R can produce.
• Our goal is PDF to R to SVG.
• We could use `svg()` (on Linux or MacOS X), or the Cairo package (on Windows), but that will only produce static SVG.
• Using `gridSVG` instead offers the option of adding interactivity as well.
The gridSVG package

- Draw something with grid (or lattice or ggplot2 or ...)
- Make picture dynamic and/or interactive.
  - grid.animate()
  - grid.garnish()
  - grid.hyperlink()
  - grid.script()
- Export to SVG.
  - gridToSVG()
Producing text and lines with **gridSVG**

- **gridSVG** now has support for paths.
- Also improved export of text (size and orientation) and lines (width and style).
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Adding interaction

The plan:

• Process the components of the map, find all instances of **text** that represents a building number and **add** a semitransparent rectangle over each one.

• Add javascript code to the SVG file so that the rectangles are shown when the mouse hovers over them.
• The imported map consists of many different objects.
Adding interaction

- The imported objects contain all of the information that we need.

```r
> city@paths[[800]]
$text
An object of class "PictureText"

Slot "string":
string
  "303"

Slot "bbox":
[1] 2700.14 4338.37 2777.31 4373.56

- Finding building names is just a regular expression.

bldgName <- "^[0-9]{3}$"
Adding interaction

grid.picture(city, FUN=embellishLabels)

embellishLabels <- function(object, ...) {
  if (class(object) == "PictureText" &&
      grepl(bldgName, object@string)) {
    rg <- rectGrob(x=object@bbox[1], ...,
                    name=paste(object@string,
                               suffix))
    tg <- garnishGrob(grobify(object, ...),
                       onmouseover="rect_on(...)",
                       onmouseout="rect_off(...)"
                      )
    gTree(children=gList(tg, rg))
  } else {
    grobify(object, ...)
  }
}
grid.script(filename="highlight.js")

- The javascript code searches for all instances of the building number and makes them visible.

```javascript
function rect_on(name) {
    for (i = 0; i <= 10; i++) {
        path = document.getElementById(name + i);
        path.setAttribute("visibility", "visible");
    }
}
```
SVG Campus Map Demo

building ranges

other map icons
Conclusions

- R is better at drawing complex paths.
- `grImport` is better at importing text and lines and paths.
- `gridSVG` is better at exporting text and lines and paths.

- These tools can be used to import an image, process it to add interactivity and export the result as SVG.

- The processing of the original map has been programmed, so it can be reused (e.g., there is a Tamaki campus map for Auckland) and generalised (e.g., there is a Warwick University campus map).

- The idea also generalises to many other possible images and transformations.
Warwick Campus Map Demo
Acknowledgements

- Many of the improvements to R packages were motivated by a student project carried out by William Yi Zhu.

- The City Campus map was created by the Geographics Unit, School of Environment, The University of Auckland.