Vector Image Processing
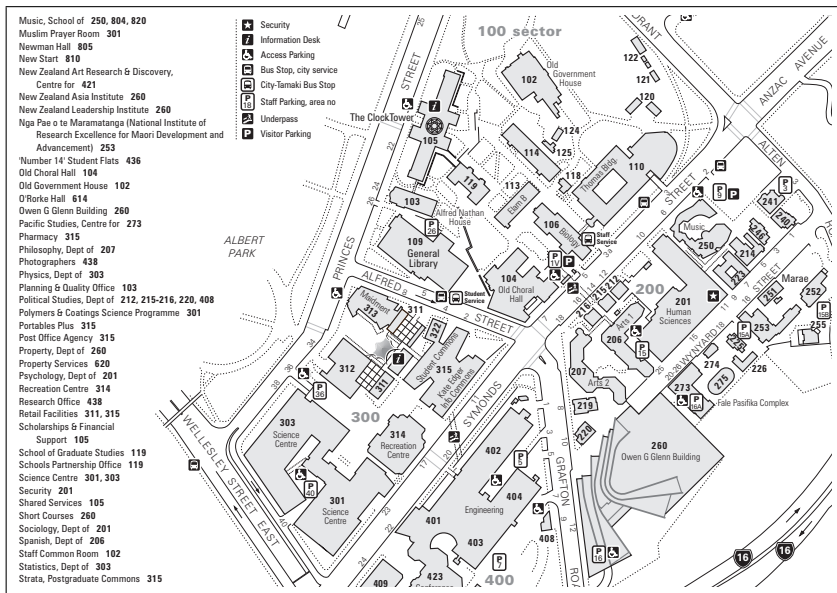
Paul Murrell

The University of Auckland

August 2011

University of Auckland Campus Map

University of Auckland Campus Map

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
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'Number 14' Student Flats **436**
Old Choral Hall **104**
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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**
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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**

Legend

★ Security
i Information Desk
♿ Access Parking
🚌 Bus Stop, city service
🚌 City-Tamaki Bus Stop
P Staff Parking, area no
⤵ Underpass
P Visitor Parking

100 sector

The ClockTower

Old Government House **102**

Alfred Nathan House

109 General Library

ALBERT PARK

103

PRINCES STREET

ALFRED STREET

104 Old Choral Hall

Student Service

311   **312**   **315**

303 Science Centre

300

314 Recreation Centre

301 Science Centre

WELLESLEY STREET EAST

SYMONDS STREET

402

401

403

404

408

Engineering

400

409

423

200

201 Human Sciences

206

207

Arts 2

219

Marae

252

253

255

226

274

273

Fale Pasifika Complex

260 Owen G Glenn Building

GRAFTON ROAD

ANZAC AVENUE

122

127

120

124

125

110

114

118

113

106

250

214

16   **16**

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.

PDF (static)   —grImport→   R   —gridSVG→   SVG (interactive)

- Mouse over **303** and all instances of **303** on the map are highlighted.

SVG Campus Map Demo
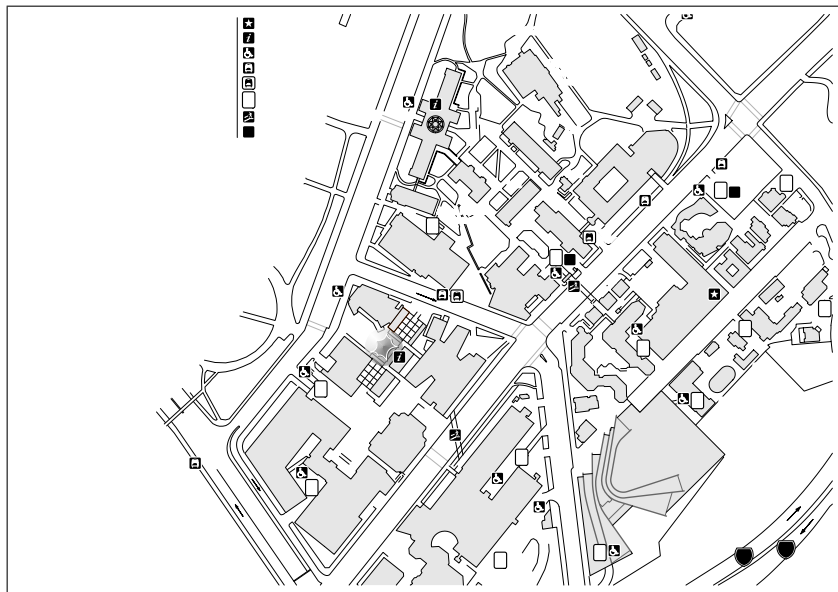
SVG Campus Map Demo

The **grImport** package

PDF $\xrightarrow{\text{grImport}}$ R
(static)

- Convert original image to PostScript (e.g., `pdftops`).

- Convert PostScript to RGML.
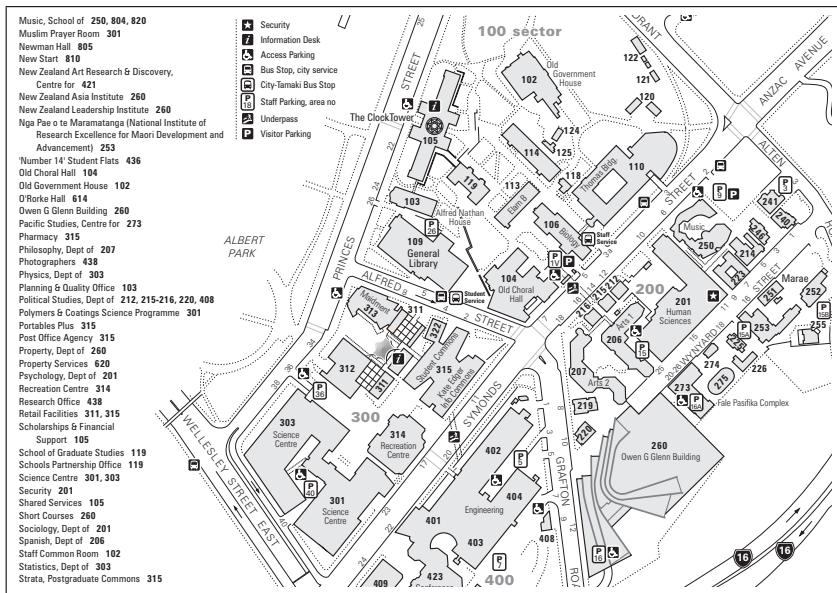
  ```
  PostScriptTrace("city.ps", "city.xml")
  ```

- Read RGML into R object.

  ```
  city <- readPicture("city.xml")
  ```

- Draw R object.

  ```
  grid.picture(city)
  ```

grImport version 0.5

University of Auckland Campus Map

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Security
Information Desk
Access Parking
Bus Stop, city service
City-Tamaki Bus Stop
Staff Parking, area no
Underpass
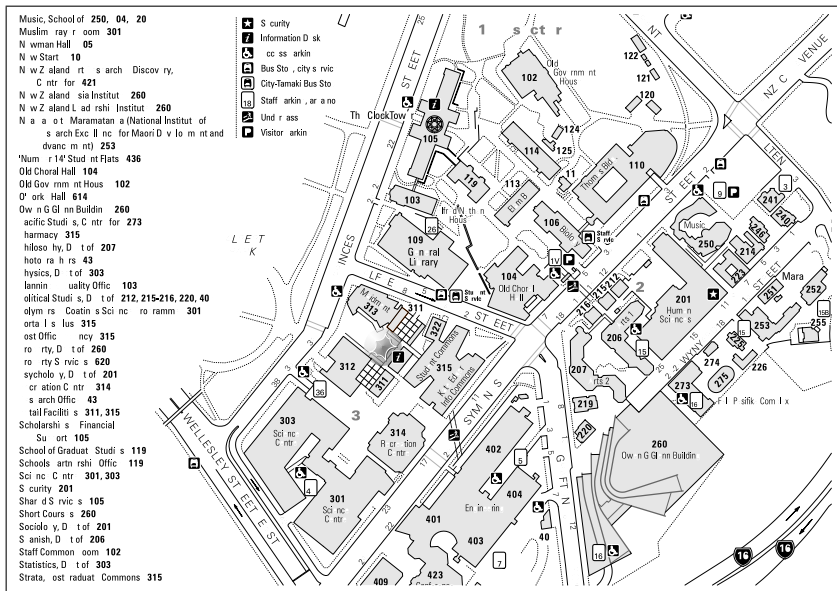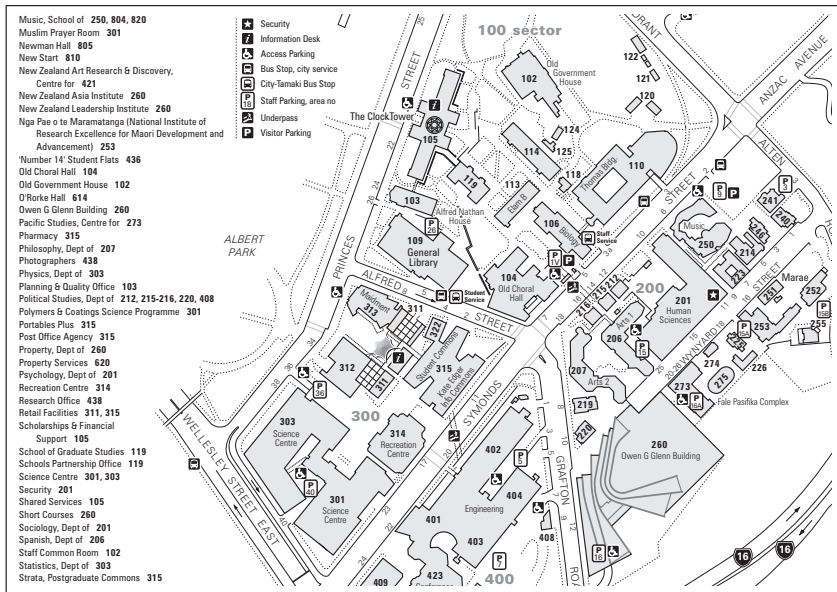Visitor Parking

Importing and Drawing Text with **grImport**

- 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.

grImport version 0.6

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Statistics, Dept of **303**
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Security
Information Desk
Access Parking
Bus Stop, city service
City-Tamaki Bus Stop
Staff Parking, area no
Underpass
Visitor Parking

The Clock Tower

100 sector

Old Government House

ALBERT PARK

Alfred Nathan House

109 General Library

104 Old Choral Hall

Staff Service

Student Service

Marae

201 Human Sciences

200

303 Science Centre

314 Recreation Centre

300

301 Science Centre

Fale Pasifika Complex

260 Owen G Glenn Building

Engineering

400

WELLESLEY STREET EAST

PRINCES STREET

ALFRED STREET

SYMONDS STREET
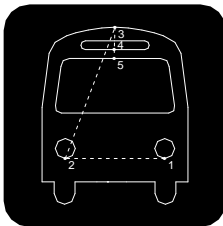
GRAFTON ROAD

ANZAC AVENUE

ALTEN

Paths versus Polygons

A bus as a path   The bus outlines   The bus as a polygon
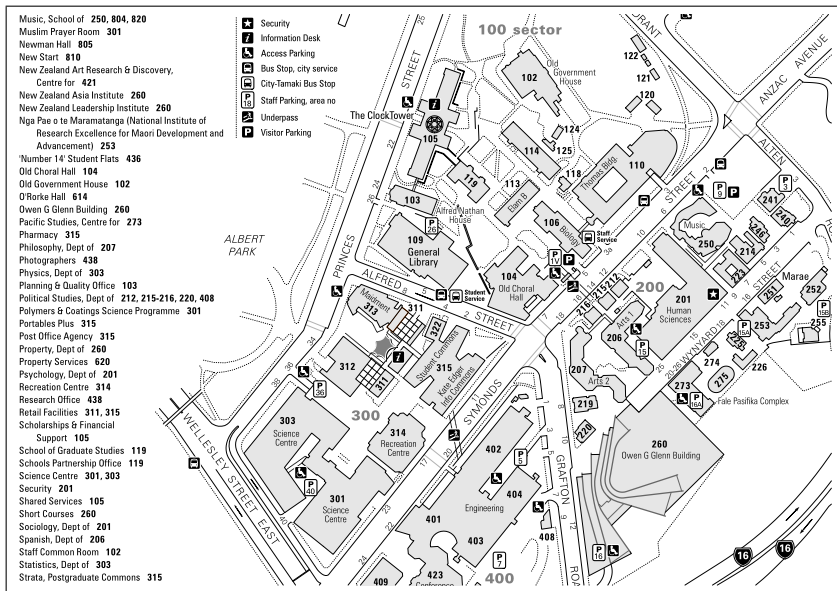
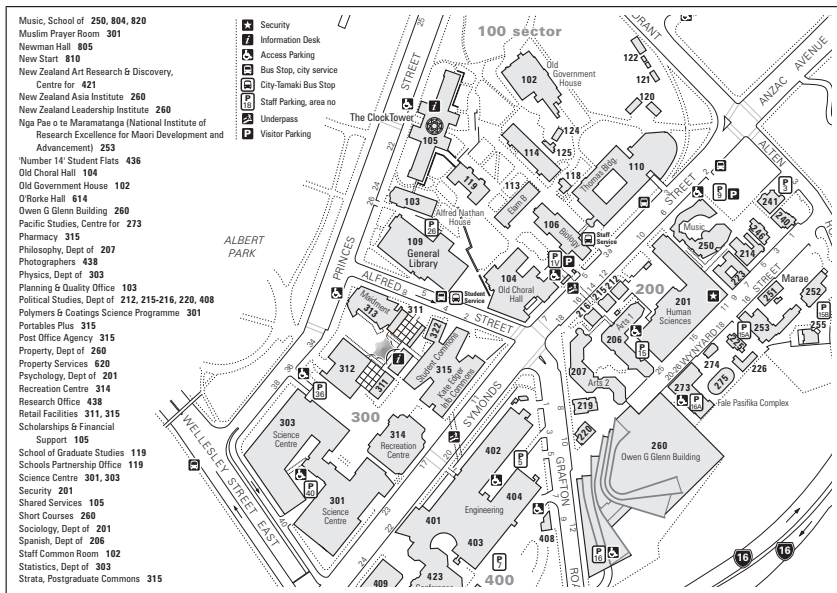- The new grid.path() and polypath() functions can draw complex paths.
- **grImport** now makes use of grid.path() and polypath().

grImport version **0.7**

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Strata, Postgraduate Commons **315**

Security
Information Desk
Access Parking
Bus Stop, city service
City-Tamaki Bus Stop
Staff Parking, area no
Underpass
Visitor Parking

100 sector

The ClockTower

ALBERT PARK

Alfred Nathan House

General Library

Old Choral Hall

Student Services

Old Government House

Music

Marae

Human Sciences

Arts 2

Fale Pasifika Complex

Owen G Glenn Building

Science Centre

Recreation Centre

Science Centre

Engineering

Conference

University of Auckland Campus Map

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Pharmacy **315**
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Photographers **438**
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Planning & Quality Office **103**
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Sociology, Dept of **201**
Spanish, Dept of **206**
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Statistics, Dept of **303**
Strata, Postgraduate Commons **315**

Security
Information Desk
Access Parking
Bus Stop, city service
City-Tamaki Bus Stop
Staff Parking, area no
Underpass
Visitor Parking

Taking Stock

$$\text{PDF} \xrightarrow{\text{grImport}} \text{R} \xrightarrow{\text{gridSVG}} \text{SVG}$$

PDF (static) → R → SVG (interactive)

- 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
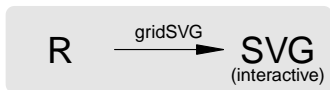
- Draw something with **grid** (or **lattice** or **ggplot2** or ...)
- Make picture dynamic and/or interactive.

```
grid.animate()
grid.garnish()
grid.hyperlink()
grid.script()
```

- Export to SVG.

```
gridToSVG()
```

gridSVG version 0.5

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).

gridSVG version 0.6

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Security
Information Desk
Access Parking
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City-Tamaki Bus Stop
Staff Parking, area no
Underpass
Visitor Parking

100 sector

Old Government House
The ClockTower
Alfred Nathan House
General Library
Old Choral Hall
Student Service
Staff Service

ALBERT PARK
ALBERT STREET
PRINCES STREET
SYMONDS STREET
WELLESLEY STREET EAST
GRAFTON ROAD
ANZAC AVENUE
ALTEN

Marae
Fale Pasifika Complex

200
201 Human Sciences

300
303 Science Centre
314 Recreation Centre
301 Science Centre
312
315

Arts 2

400
402
401
403
404
408
409
423 Conference

260
Owen G Glenn Building
Engineering

University of Auckland Campus Map

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Legend:
- Security
- Information Desk
- Access Parking
- Bus Stop, city service
- City–Tamaki Bus Stop
- Staff Parking, area no
- Underpass
- **P** Visitor Parking

100 sector

The ClockTower

Old Government House **102**
122
127
120

105

119

124
125
114
103
110
113
118

Alfred Nathan House

109 General Library

106
Staff Service

250
214

ALBERT PARK

PRINCES STREET

ALFRED STREET

Student Service

104 Old Choral Hall

200
201 Human Sciences

Marae
252
253
255

206
207
274
226
273
Fale Pasifika Complex

312
315
311

303 Science Centre

300

314 Recreation Centre

301 Science Centre

402
404
Engineering
401
403
408

260 Owen G Glenn Building

423
409
400

SYMONDS STREET

WELLESLEY STREET EAST

GRAFTON ROAD

ANZAC AVENUE

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.

Adding interaction

- The imported map consists of many different objects.
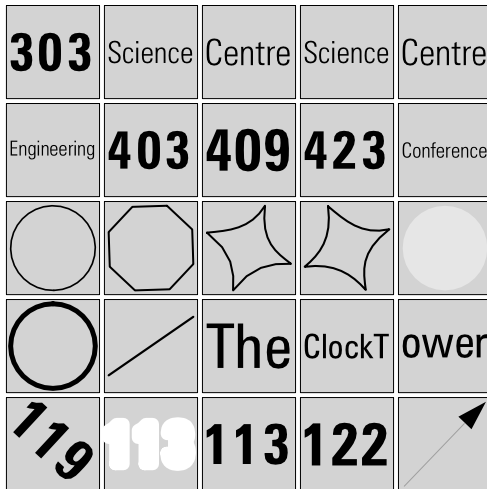
Adding interaction

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

```
> 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, ...)
    }
}
```

Adding interaction

```
grid.script(filename="highlight.js")
```

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

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

Interactive SVG Campus Map

SVG Campus Map Demo

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

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.