

Using Google Maps with R

Tue 8th July, 10:45am – 4pm

Dr Nick Bearman @nickbearmanuk
Department of Geography and Planning

Geographic Data Science Lab



UNIVERSITY OF
LIVERPOOL



Welcome

- Using Google Maps with R
- Who has used Google Maps before?
- Who has used R before?
- Who has used another GIS before?
 - (ArcGIS, MapInfo, QGIS,)
- Who has used spatial data before?
 - (and not raised their hand so far!)

Outline of the day

- 11am – 11:30am – Talk
- 11:30am – 12:45pm – Practical
- 12:45pm – 1:30pm – Lunch
- 1:30pm – 2:30pm – Practical
- 2:30pm – 3pm – Talk
- 3pm – 4pm – Optional Mapping Clinic

Outline

- What will you get from the course?
- What is R & what can you do with it?
- R as a GIS
- Projections / Coordinate Systems
- Notes on using R
- Notes on crime data

What will you get from the course?

- What are you expecting from the course?
- Post-it notes

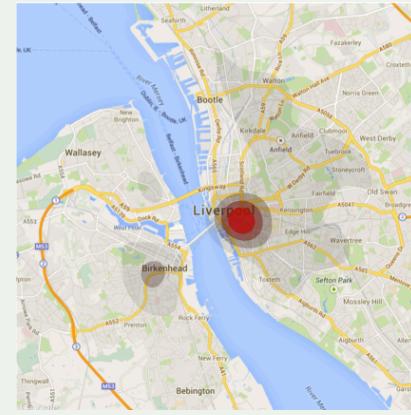
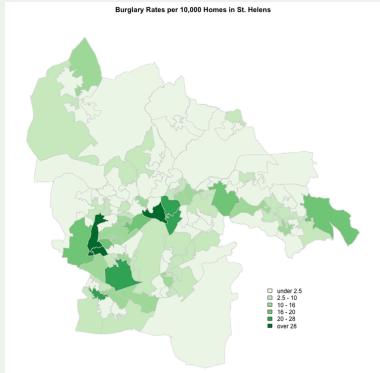
What will you get from the course?

- Background on R and using R as a GIS
- How to do mapping in R
 - With Google and without
- Pros and cons of using R
- Working with sensitive data
 - Presentations etc. will be available online

What is GIS?

- Turning (spatial) data into information

#	camp	mass	Time	rt	index	chg	\$1	\$2	\$3	\$4
0	1	300.130	13.271	218.720	2	35.200	71.000			
1	2	300.156	13.265	218.720	2	35.200	71.000	48.500	69.700	
2	4	300.150	18.879	269.890	1	26.700	22.600			
3	5	300.155	14.974	250.627	2	11.400	26.700	25.700		
4	7	300.150	14.974	250.627	2	11.400	1085.000	495.000	352.000	
5	9	300.170	27.355	459.410	3	27.700	21.400			
6	10	300.174	18.841	303.145	1	191.000	20.300	16.000		
7	11	300.189	19.380	321.203	2	21.600	23.800			
8	12	300.190	20.750	350.840	2	123.000	470.000	690.000	353.000	
9	13	300.190	20.750	350.840	2	123.000	306.000	114.000		
10	14	300.190	20.750	350.840	2	123.000	1085.000	1085.000		
11	15	300.480	18.593	109.823	3	18.300	26.000	26.000		
12	16	300.480	14.727	237.073	3	42.000	23.500			
13	17	300.480	14.727	237.073	3	42.000	21.000	39.000		
14	22	300.640	29.241	490.978	2	82.000	86.800	90.400	100.000	
15	23	300.649	17.935	300.048	1	43.500	45.200	26.500	34.100	
16	24	300.649	17.935	300.048	1	43.500	45.200	26.500	34.100	
17	26	300.690	14.093	231.220	2	446.000	399.400	618.000	607.000	
18	27	300.681	11.919	357.260	1	43.800	15.400			
19	28	300.698	11.919	357.260	1	43.800	15.400	12.800	22.200	
20	29	300.698	22.229	377.470	2	1400.000	1290.000	73.200	95.400	
21	31	300.700	18.390	306.732	2	182.000	156.000	200.000	245.000	
22	33	300.700	18.390	306.732	2	182.000	156.000	110.000	100.000	
23	35	301.155	19.741	319.060	1	23.000			11.500	
24	37	301.158	16.577	619.438	1	16.800	38.600	49.200	32.000	
25	38	301.158	16.577	619.438	1	16.800	38.600	49.200	32.000	
26	40	301.161	14.108	237.775	2	73.300	78.600		110.000	
27	41	301.164	16.110	270.677	1	24.900	19.700		52.100	
28	42	301.164	16.110	270.677	1	24.900	28.200		52.100	
29	44	301.181	20.429	344.366	2	54.300	51.600	55.100	80.500	
30	45	301.181	21.619	365.506	2	104.000	104.000	90.600	87.100	
31	46	301.200	24.271	412.480	2	127.000	117.100	90.000	84.000	
32	49	301.200	24.271	412.480	2	127.000	127.000	86.900	103.000	
33	50	301.200	22.727	385.908	2	204.000	283.000	341.000		



- Using this information to answer questions
 - How have housing conditions changed in the past ten years?

GIS – Geographic Information Systems

- Almost all human activities and decisions involve an important **geographic component**
 - the ‘**where?**’
- Working with geographic information involves **unique, complex** and **difficult choices**
 - Why we need specialized software
 - **organize** and **store**
 - **access** and **retrieve**
 - **manipulate** and **synthesize**
 - apply to the solution of **problems**

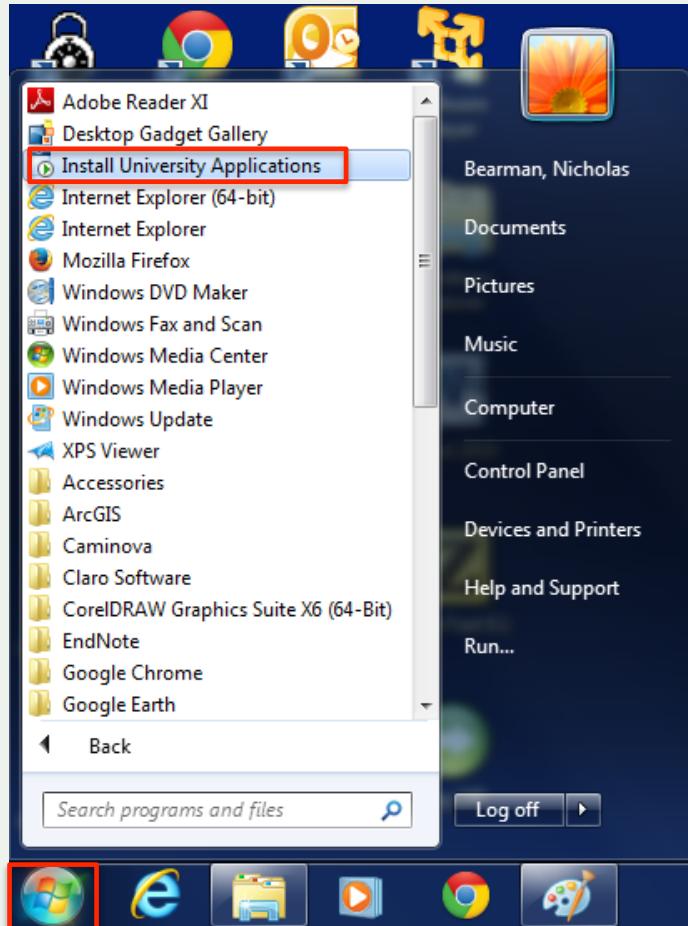
What is R?



- “a **freely available** language and environment for statistical computing and **graphics**”
- **freely available** = ‘free as in beer’ and ‘free as in speech’
- **graphics** = GIS
- user contributed – GIS
- packages / libraries

Installing R 3.0.1...

Logon



Installing R 3.0.1...

Screenshot of the "Install University Applications" window.

The window title is "Install University Applications".

Left sidebar (Category list):

- <All>
- Accessibility
- Architecture
- Audio
- Bibliographic
- Business Systems
- Chemistry
- Earth Sciences
- Engineering
- Fixes
- Graphics
- History
- Internet
- Life Sciences
- Management School
- Mathematics
- Office

Right pane (Application list):

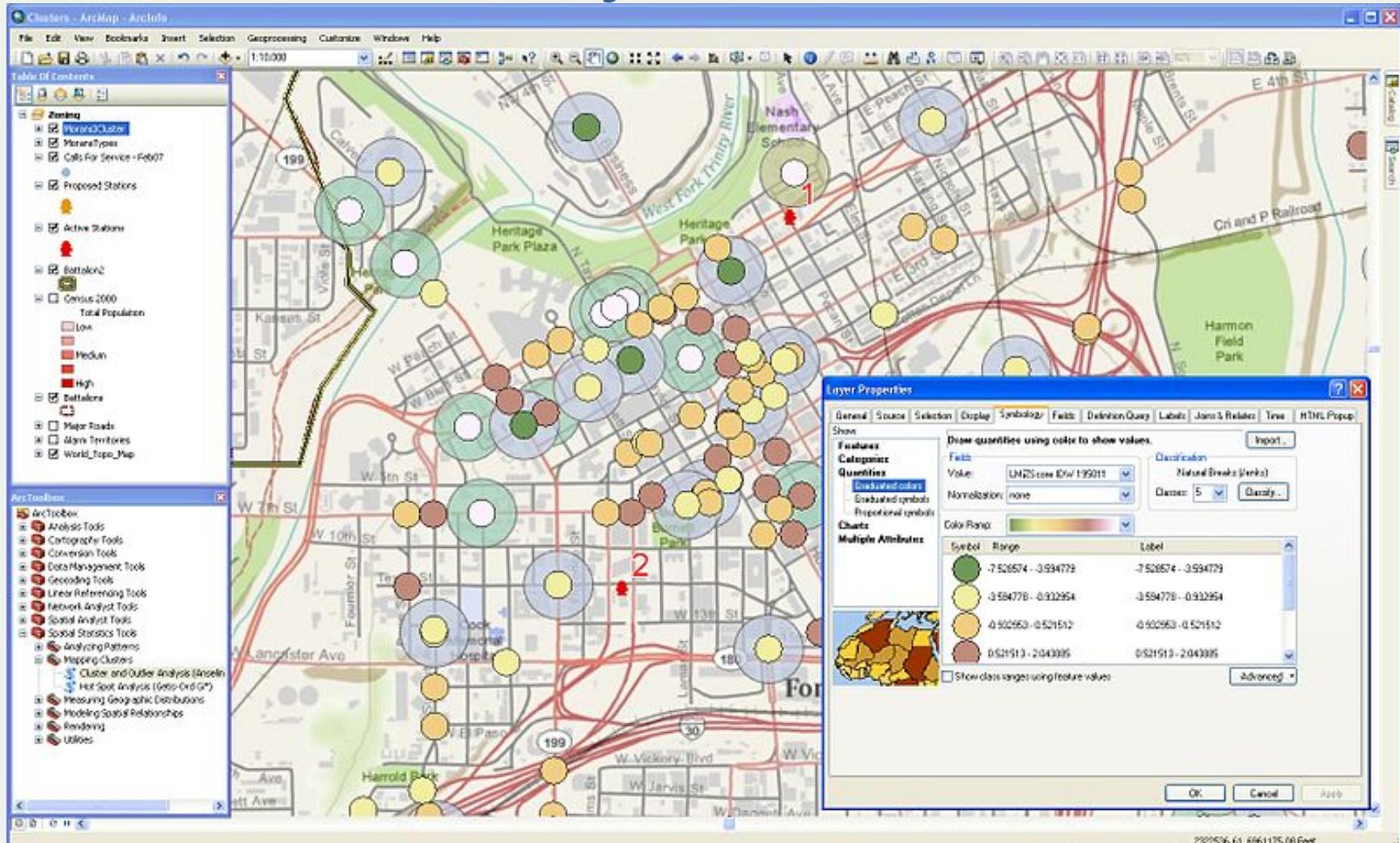
Application	Info
QAS Pro 6.75	Available
QQ International 2.11	Available
QUANTAX 70v1.1.0.370	Available
QUANTAX 70v1.1.0.372	Available
Quantum GIS 2.0.1	Available
QuickTime 7.7.3	Installed
R 3.0.1	Available
R 3.1.0	Available
Raynoise 3.1f	Available
Refresh Group Policy - Computer	Available
Refresh Group Policy - User	Available
Refresh SCCM Policy	Available
Reread Group Memberships - Computer	Available
Reread Group Memberships - User	Available
Response 6.71	Available
Review Manager 5.2.7	Available
Revit 2011 IIR2 64bit	Available

Detailed view for R 3.0.1:

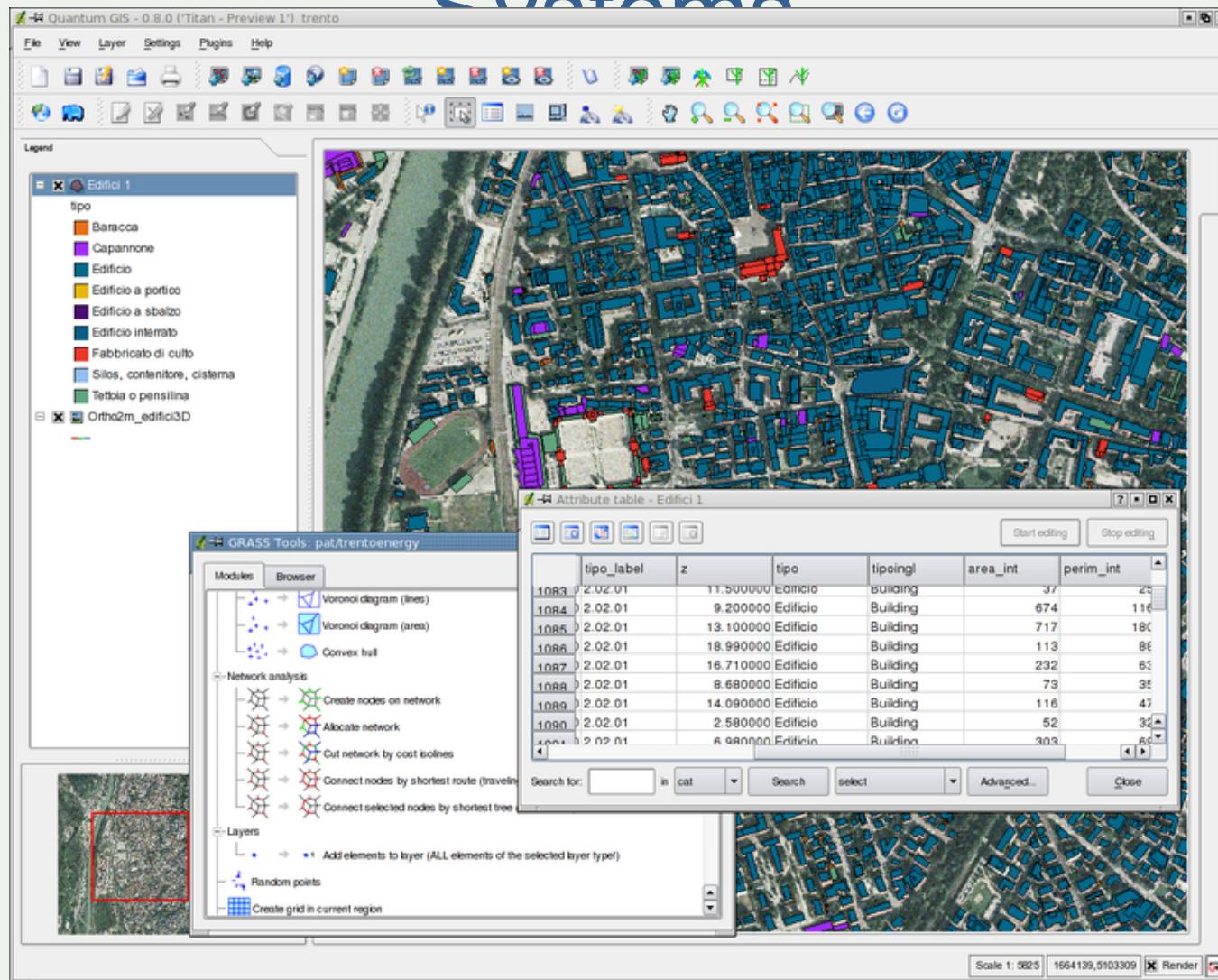
More Info >>>	Run	Remove	Install
Requirements: 700MB Disk	Department: Computing Services Department		
Est. Install Time: 10 minutes	Contact: Helpdesk	Email	
Reboot: Not needed	Test status: Live		

Bottom status bar: Current operation: Idle.

GIS – Geographic Information Systems

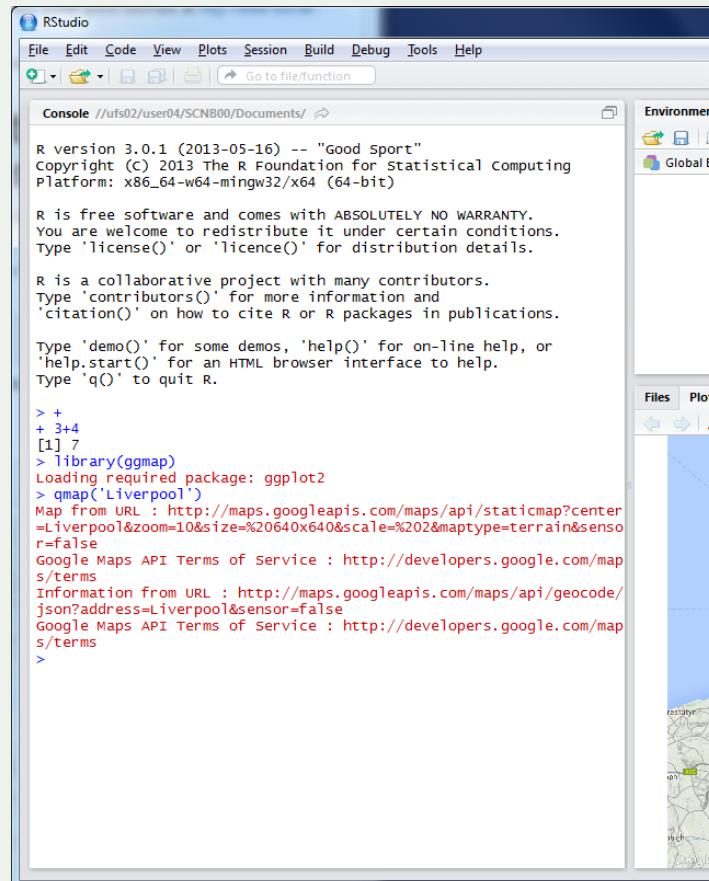


GIS – Geographic Information Systems



R as a GIS

- Command line driven, rather than GUI
- Disadvantages
 - Remembering commands
 - Steeper learning curve

A screenshot of the RStudio interface. The console window shows R version 3.0.1 (2013-05-16) running on a Windows 7 system. The user has run the command 'qmap("liverpool")' which loads the ggmap package and displays a map of Liverpool. The environment tab shows various global variables.

```
R version 3.0.1 (2013-05-16) -- "Good Sport"
copyright (C) 2013 The R Foundation for statistical computing
Platform: x86_64-w64-mingw32/x64 (64-bit)

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

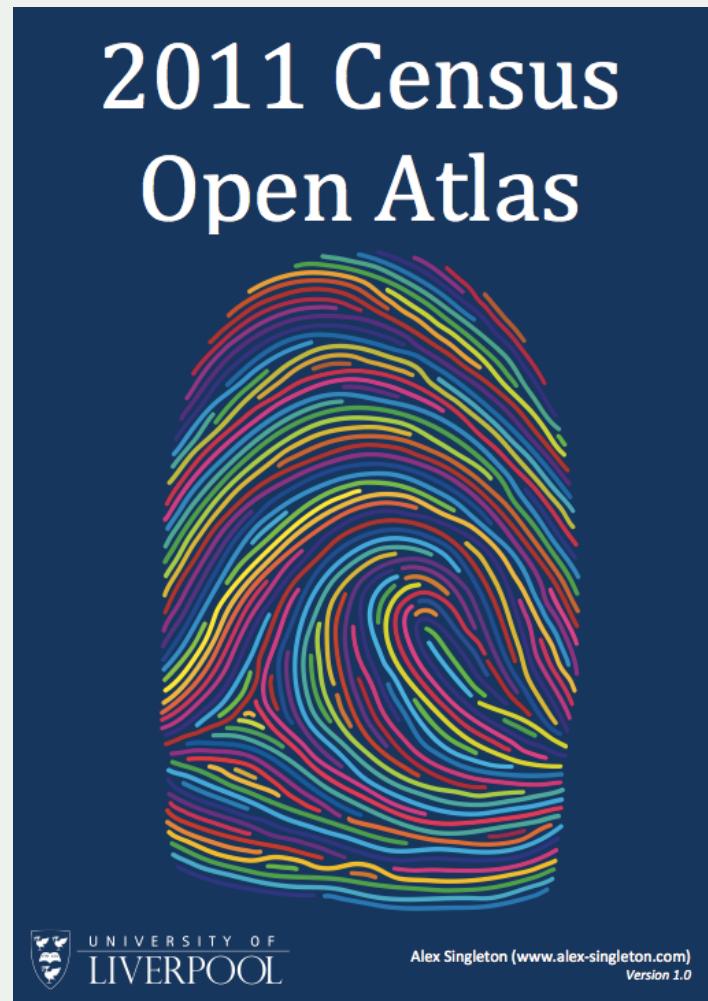
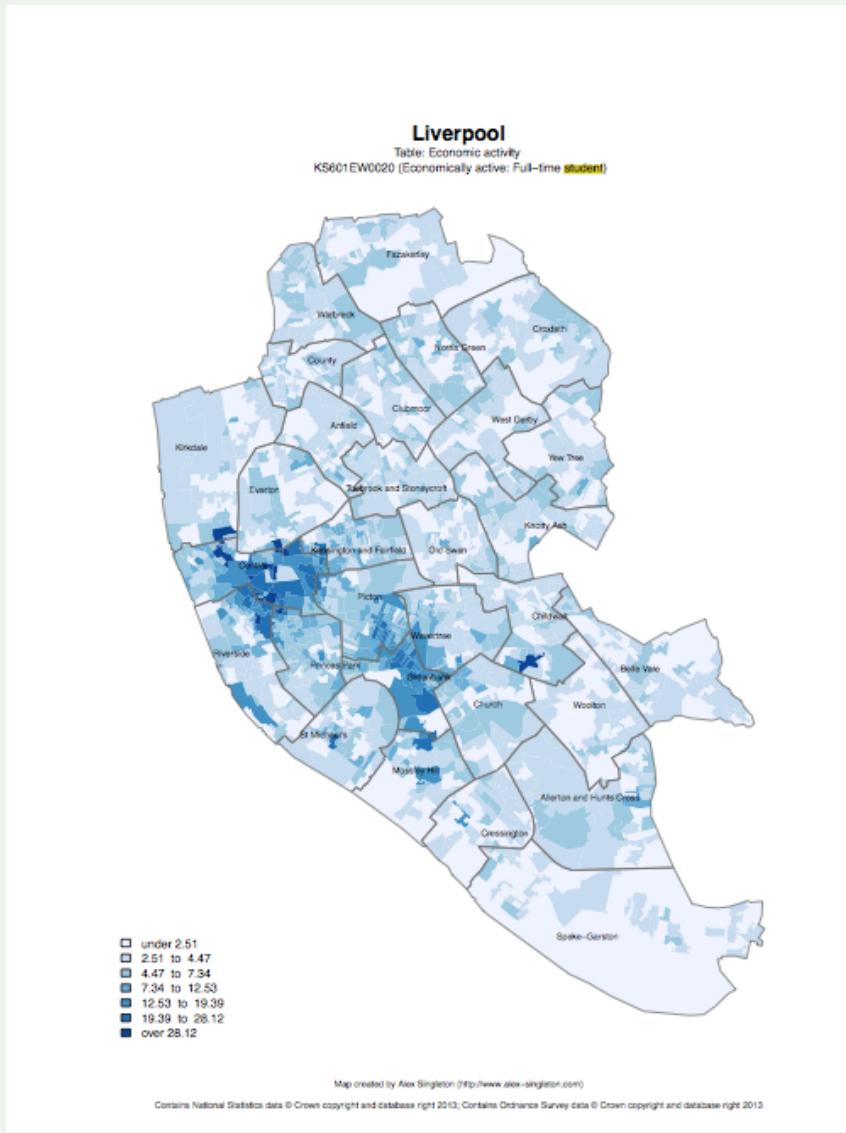
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

> +
+ 3+4
[1] 7
> library(ggmap)
Loading required package: ggplot2
> qmap('liverpool')
Map from URL : http://maps.googleapis.com/maps/api/staticmap?center
=Liverpool&zoom=10&size=%20640x640&scale=%202&maptype=terrain&senso
r=false
Google Maps API Terms of Service : http://developers.google.com/map
s/terms
Information from URL : http://maps.googleapis.com/maps/api/geocode/
json?address=liverpool&sensor=false
Google Maps API Terms of Service : http://developers.google.com/map
s/terms
>
```

R as a GIS

- Advantages
 - Easy to record what you did and repeat specific pieces of work
 - Lots of reproducible examples on the web
 - Easily scriptable. 134,567 maps? easy!
 - 2011 Census Open Atlas
 - <http://www.alex-singleton.com/r/2014/02/05/2011-census-open-atlas-project-version-two/>

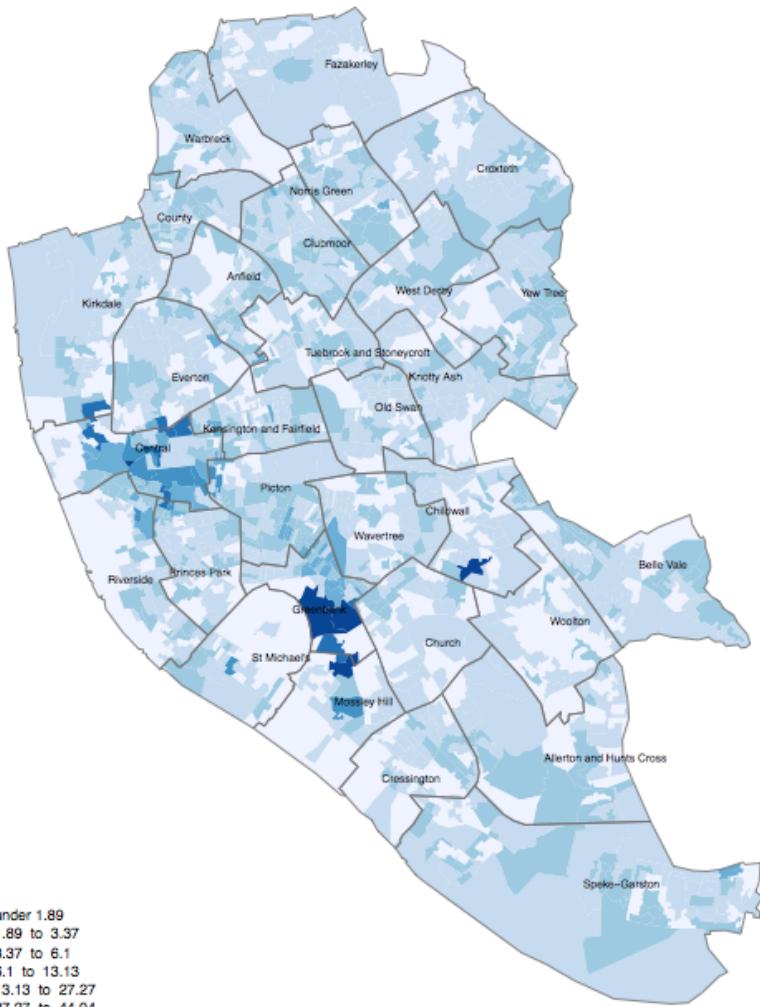
R in Action



Economically active – Full-time students

Liverpool

Table: Age structure
KS102EW0026 (Age 18 to 19)



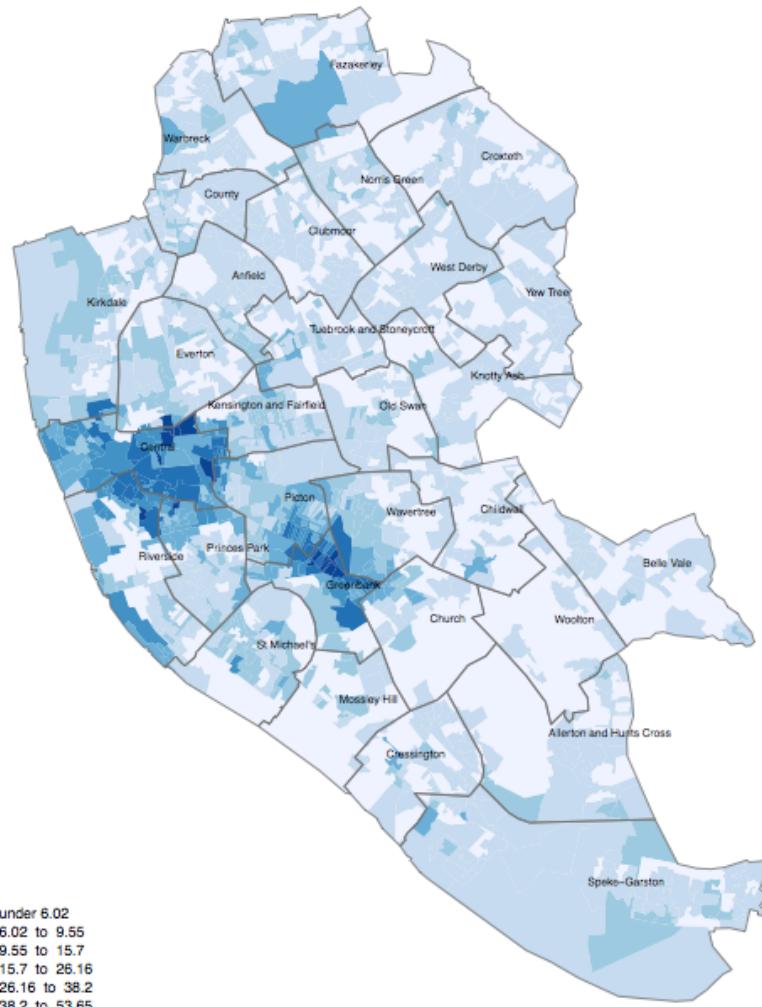
Map created by Alex Singleton (<http://www.alex-singleton.com>)

Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

Age structure – 18 to 19

Liverpool

Table: Age structure
KS102EW0027 (Age 20 to 24)



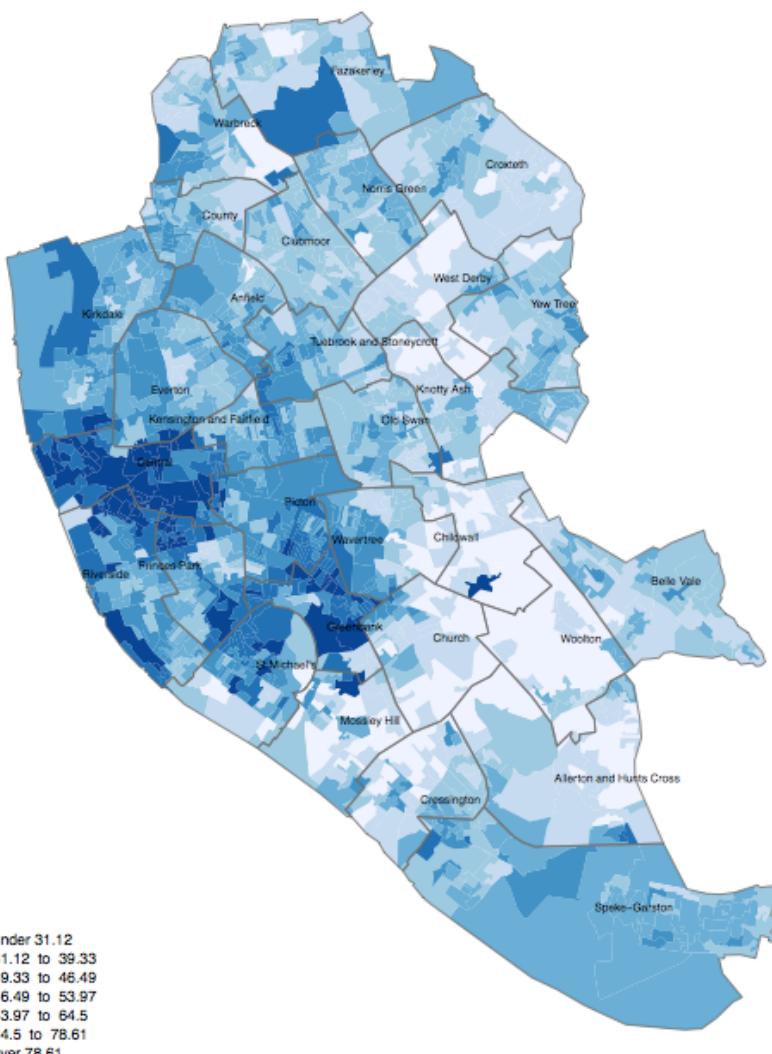
Map created by Alex Singleton (<http://www.alex-singleton.com>)

Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

Age structure – 20 to 24

Liverpool

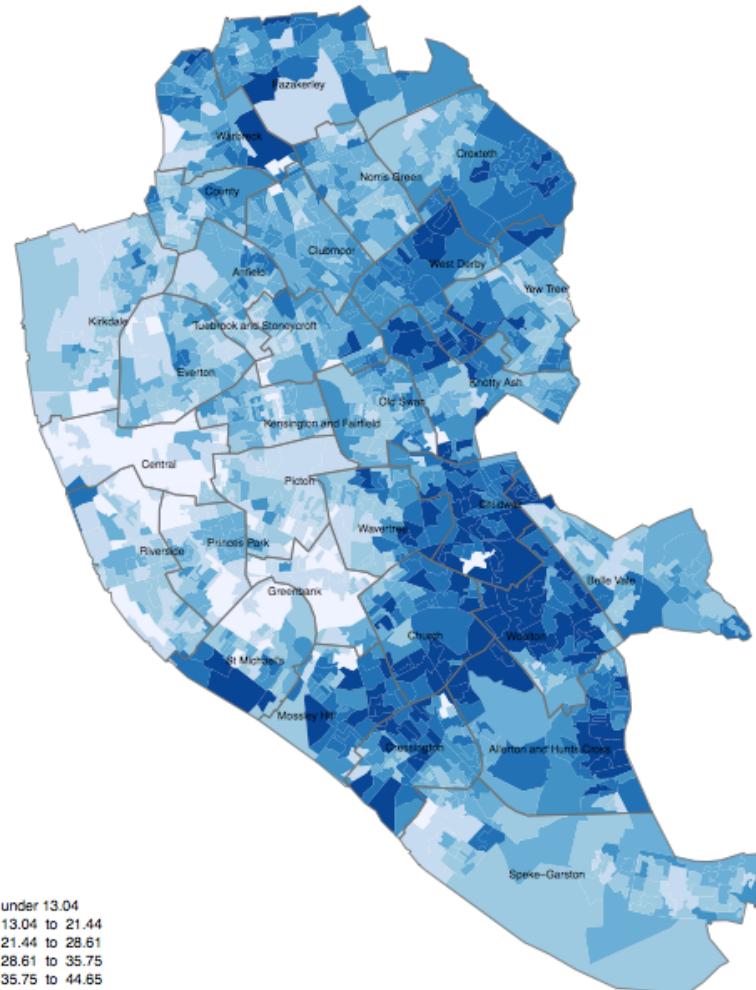
Table: Marital and civil partnership status
KS103EW0008 (Single (never married or never registered a same-sex civil partnership))



Single

Liverpool

Table: Marital and civil partnership status
KS103EW0009 (Married)



Married

Map created by Alex Singleton (<http://www.alex-singleton.com>)

Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

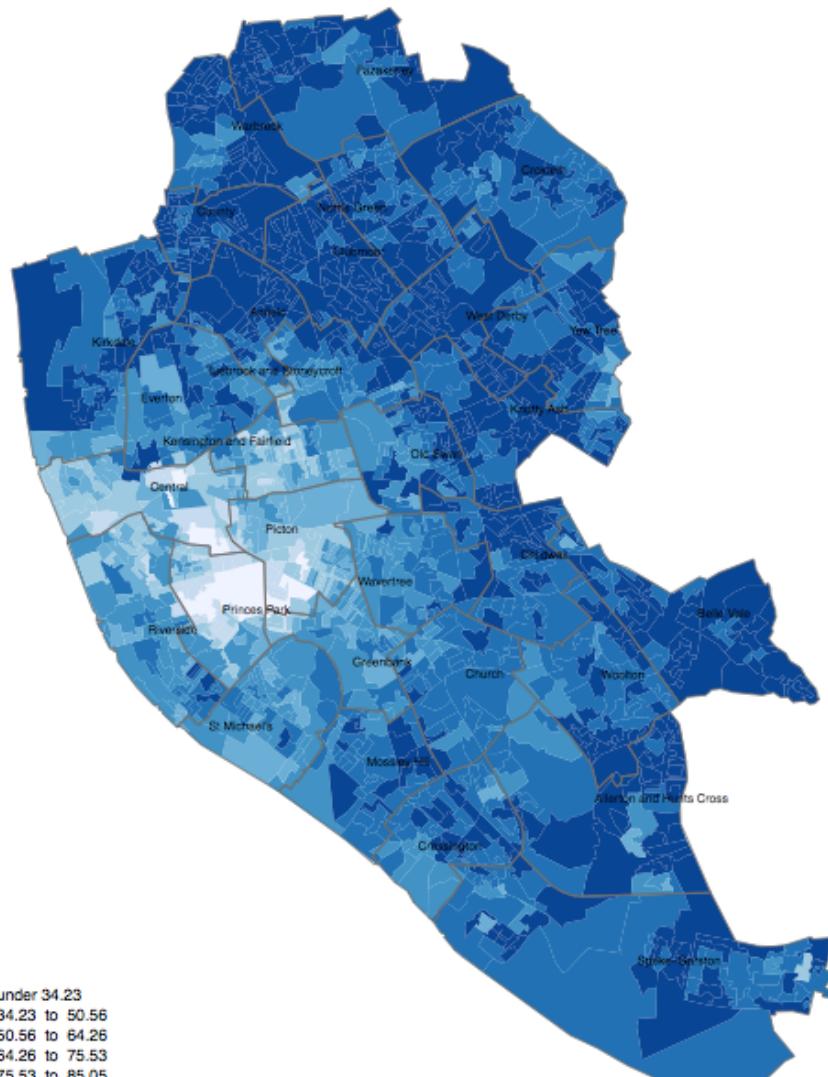
Map created by Alex Singleton (<http://www.alex-singleton.com>)

Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

Liverpool

Table: Ethnic group

KS201EW0020 (White: English/Welsh/Scottish/Northern Irish/British)



Map created by Alex Singleton (<http://www.alex-singleton.com>)

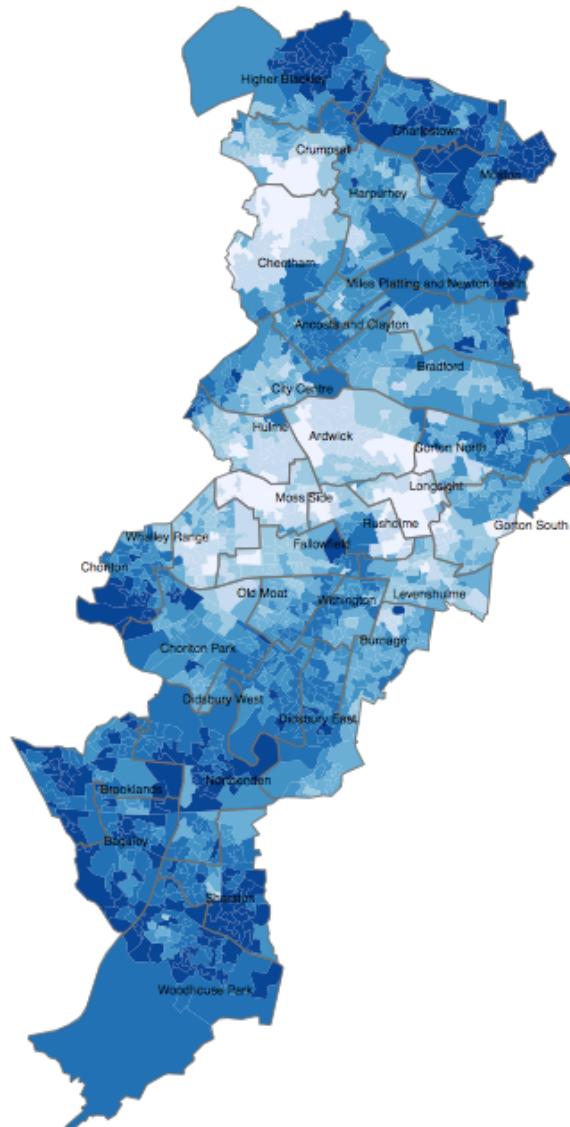
Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

Ethnic group: white

Manchester

Table: Ethnic group

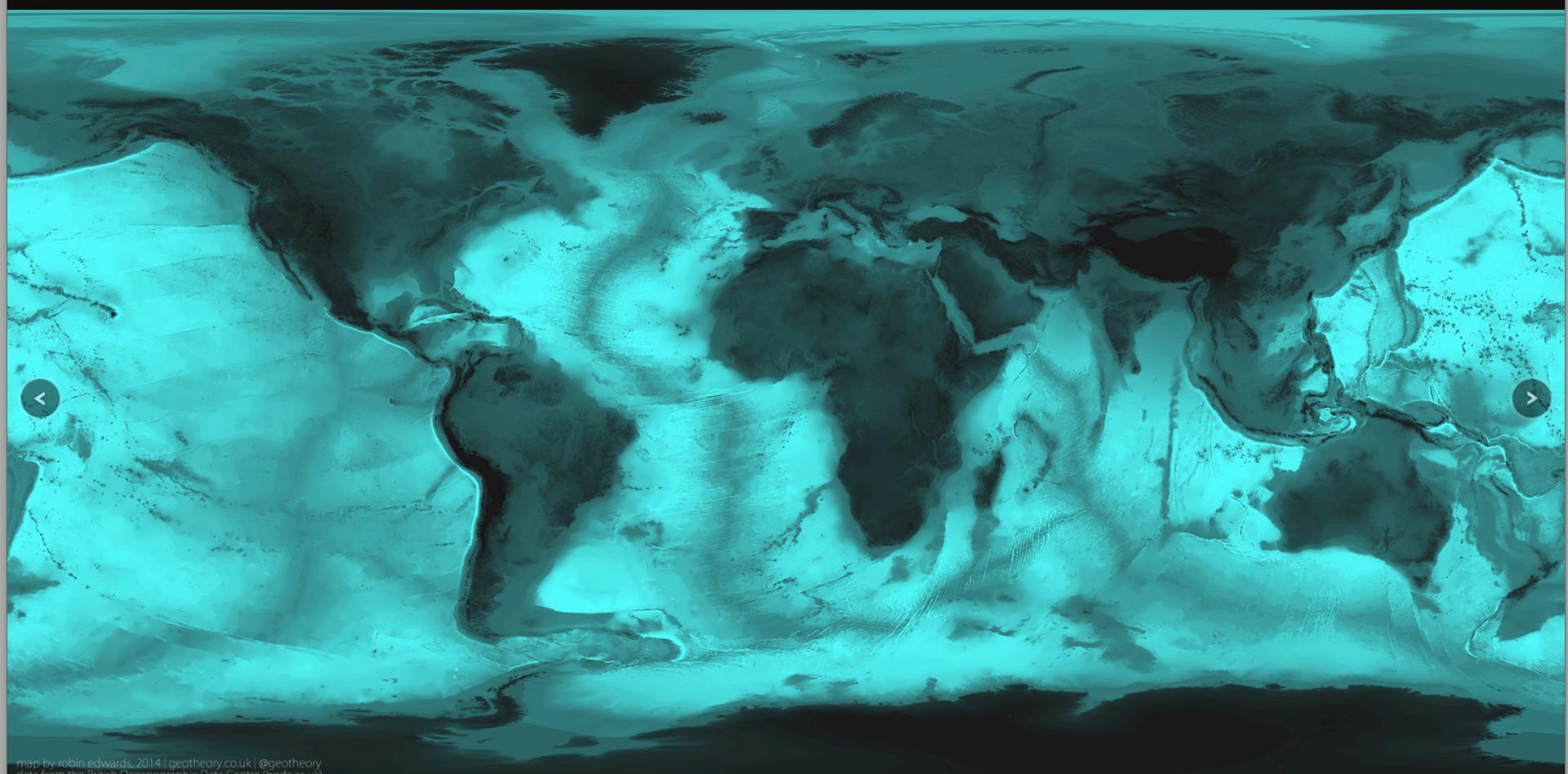
KS201EW0020 (White: English/Welsh/Scottish/Northern Irish/British)



Map created by Alex Singleton (<http://www.alex-singleton.com>)

Contains National Statistics data © Crown copyright and database right 2013; Contains Ordnance Survey data © Crown copyright and database right 2013

Topography



map by robin edwards, 2014 | geotheory.co.uk | @geotheory
data from the British Oceanographic Data Centre (bodc.ac.uk)

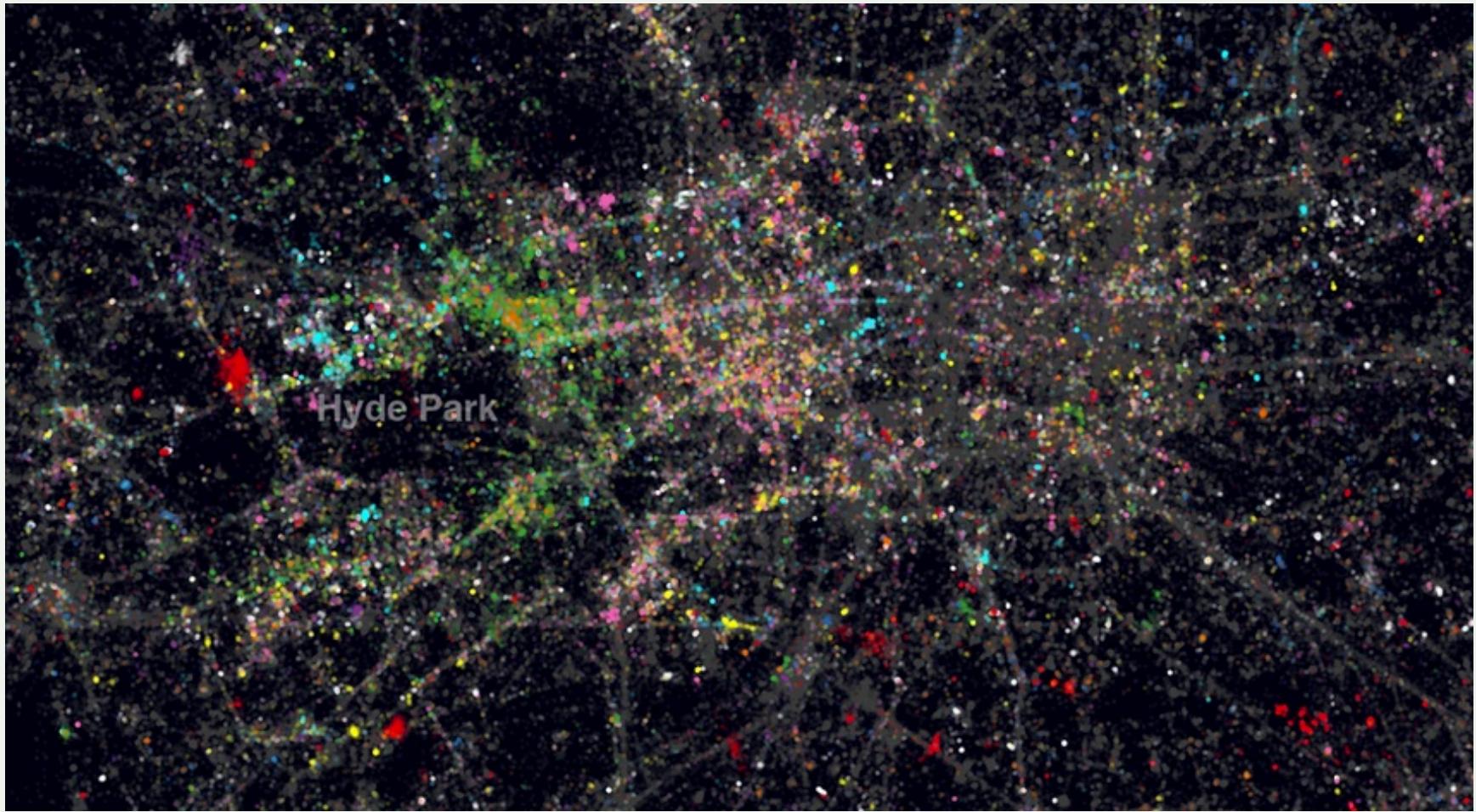
<http://topography.geotheory.co.uk/>

3D Mapping – London's rental costs



<http://spatial.ly/2013/05/3d-mapping-r/>

Twitter Languages in London



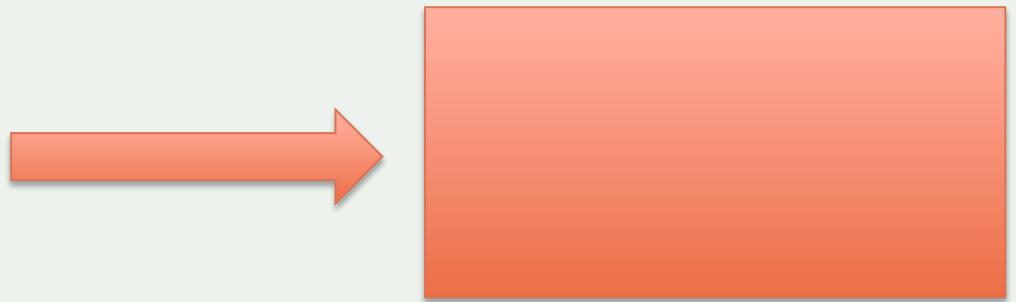
<http://spatial.ly/2012/10/londons-twitter-languages/>

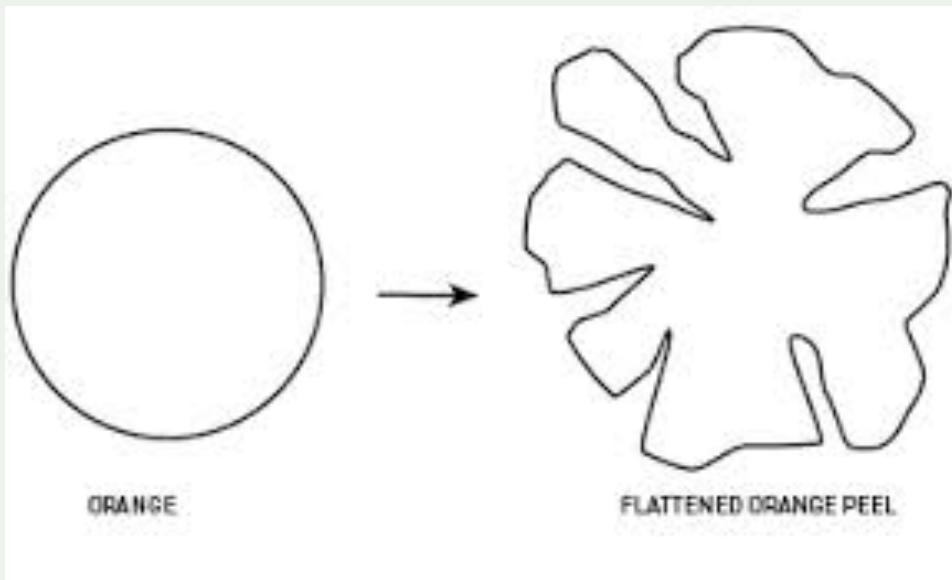
R as a GIS

- R is just another tool in the toolbox
- I use it alongside ArcGIS, QGIS, etc.

Projections

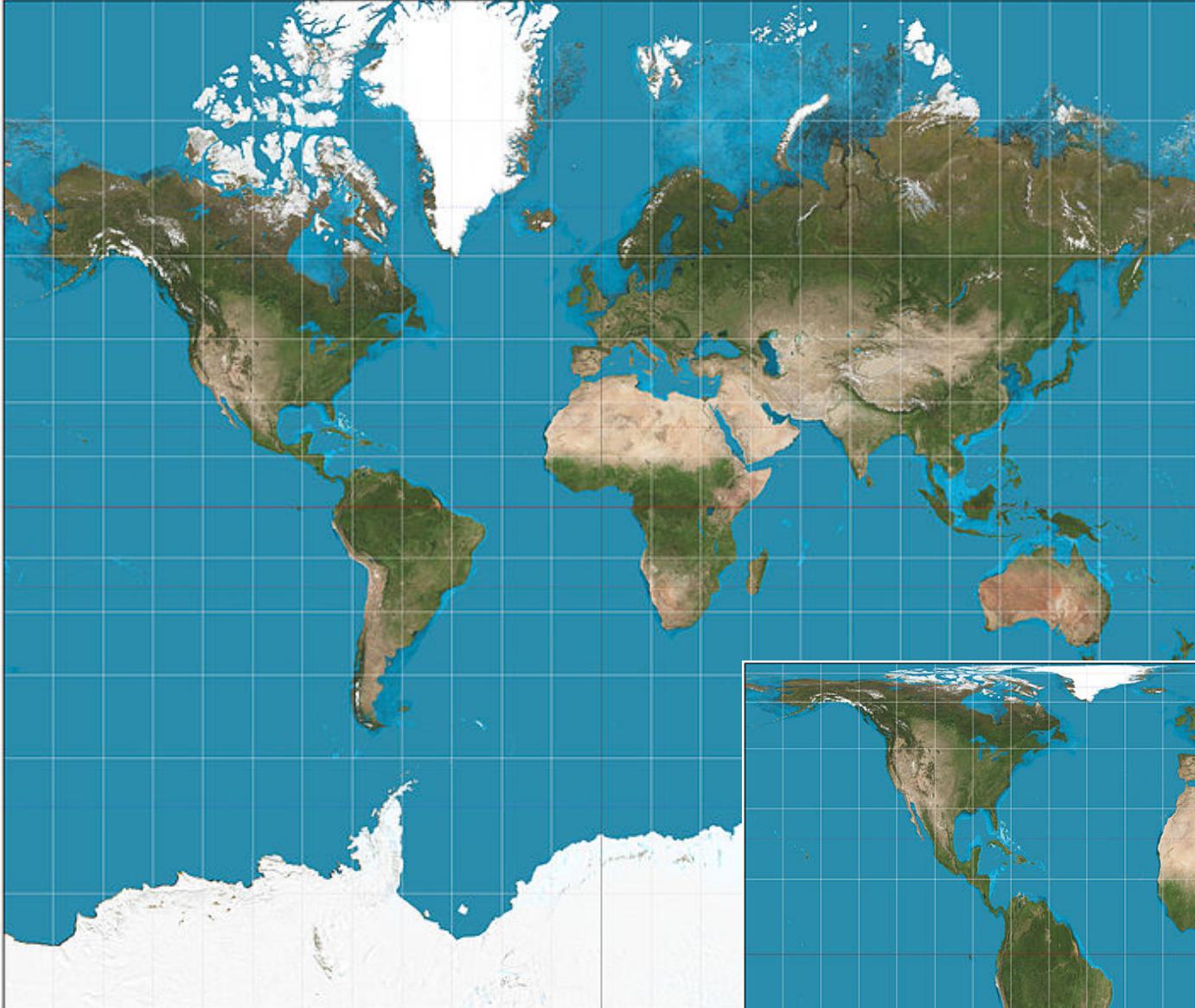
- Projection – going from a sphere to a flat surface



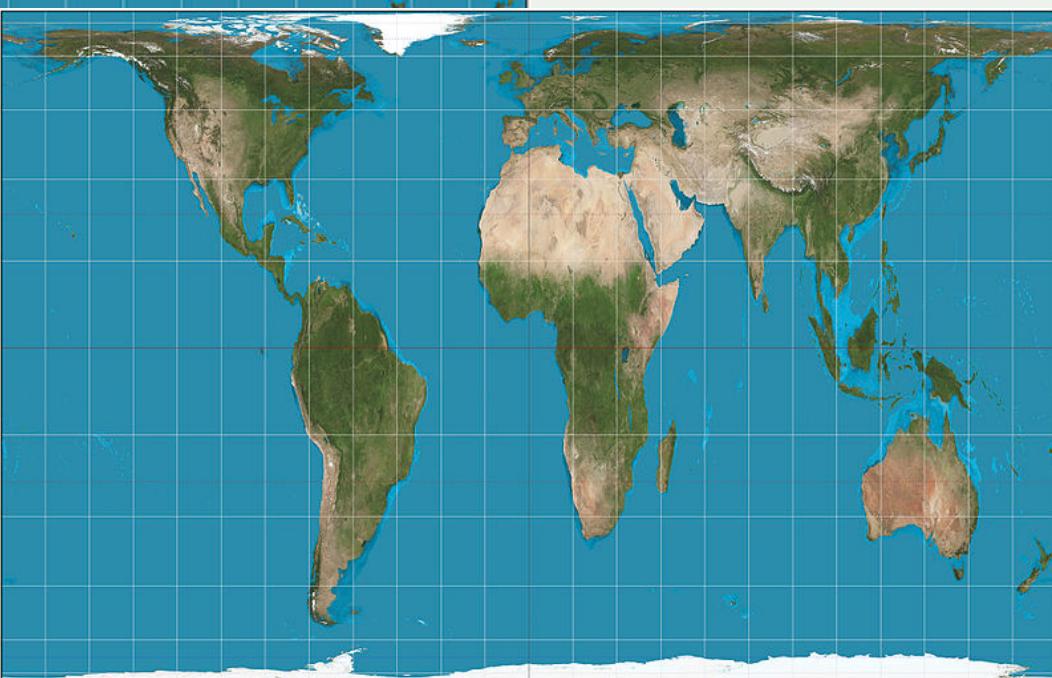


This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license. http://en.wikipedia.org/wiki/File:Mercator_projection_SW.jpg

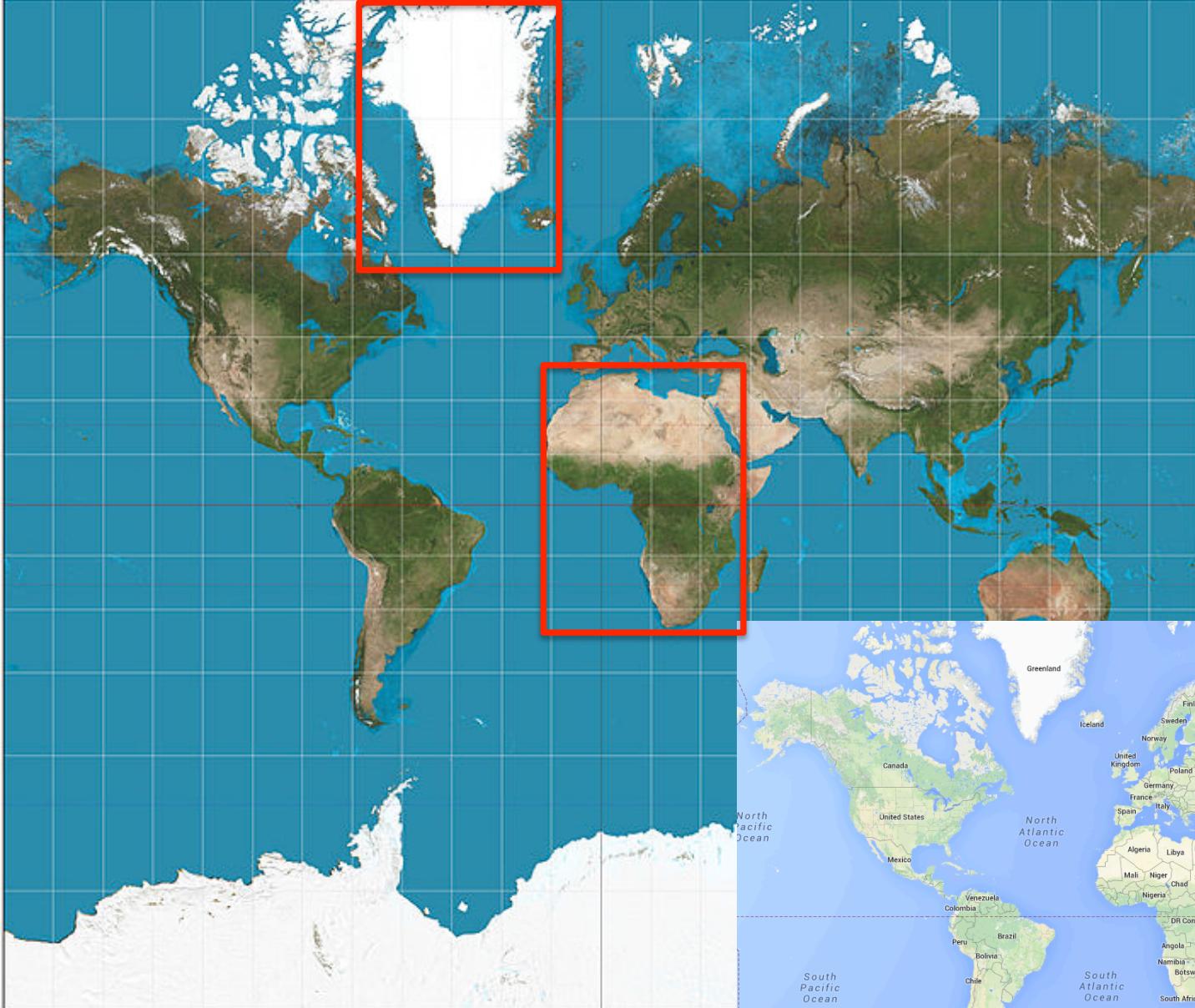
Mercator projection



Peters projection

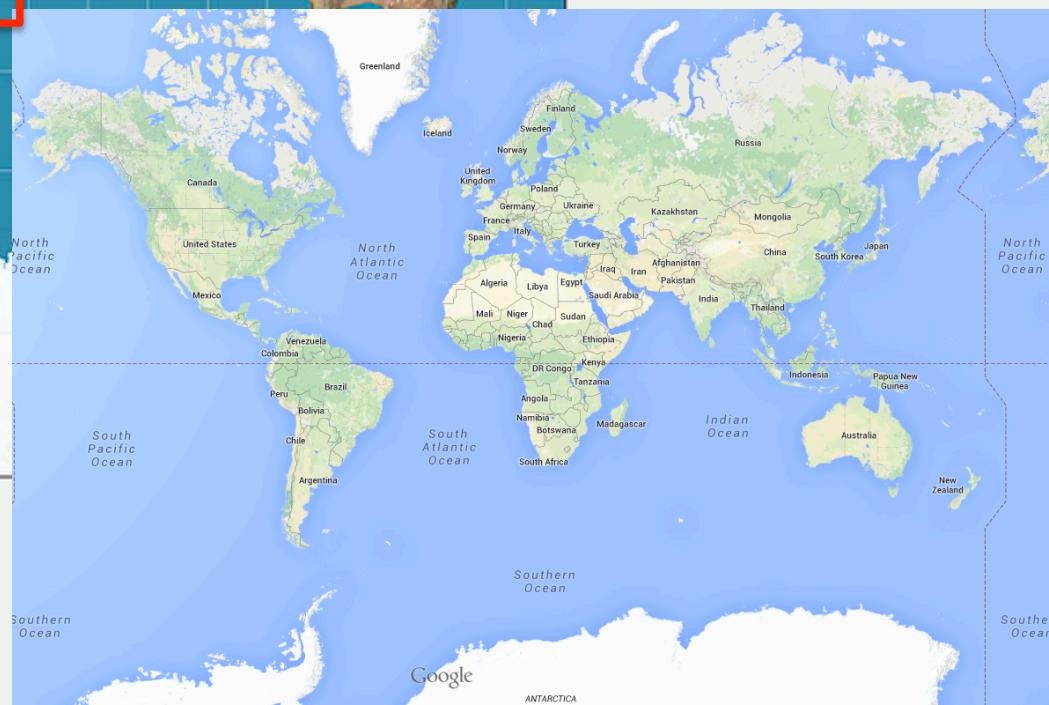


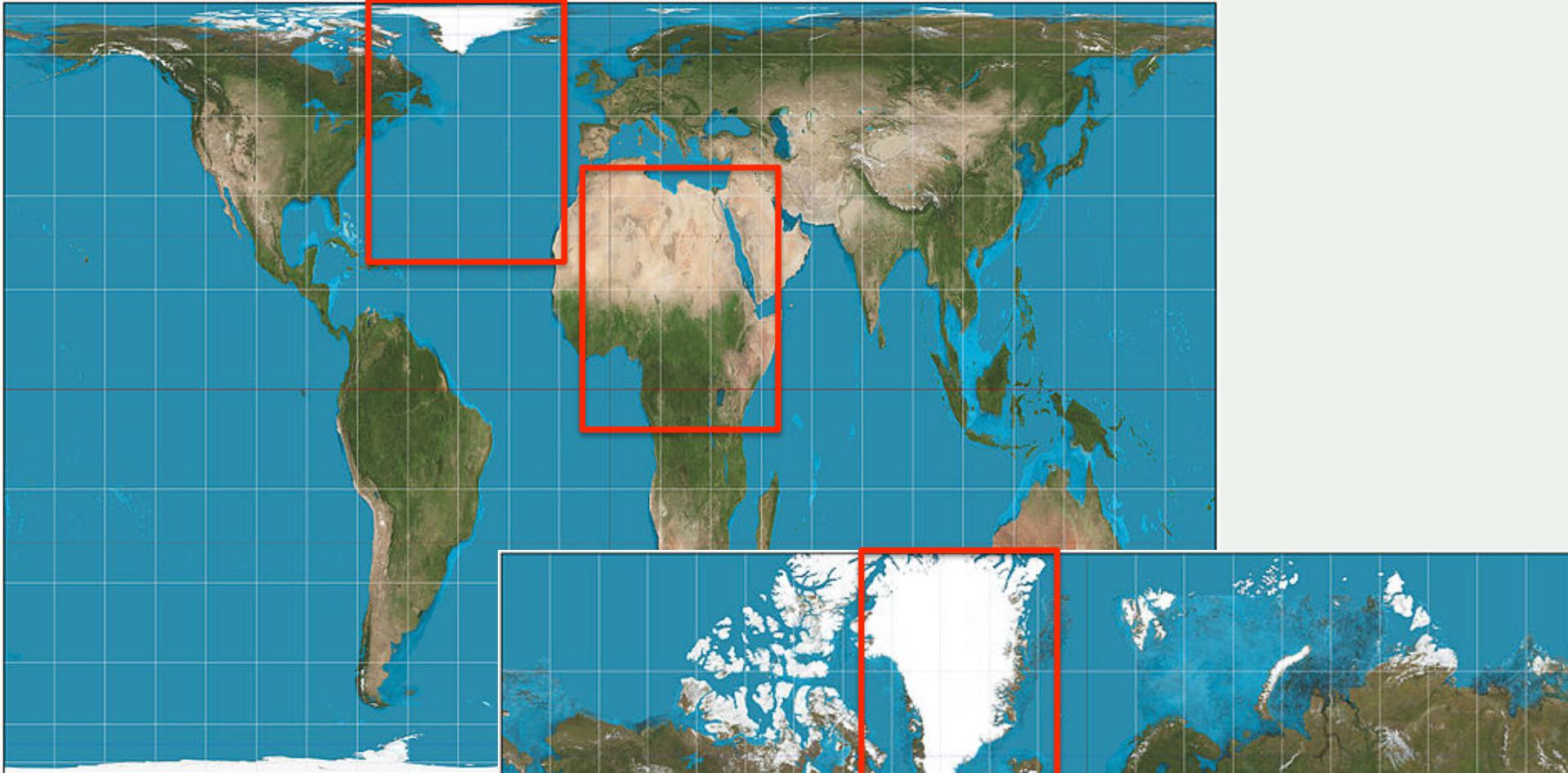
This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license. http://en.wikipedia.org/wiki/File:Gall%20Peters_projection_SW.jpg



Africa: 30 million sq km

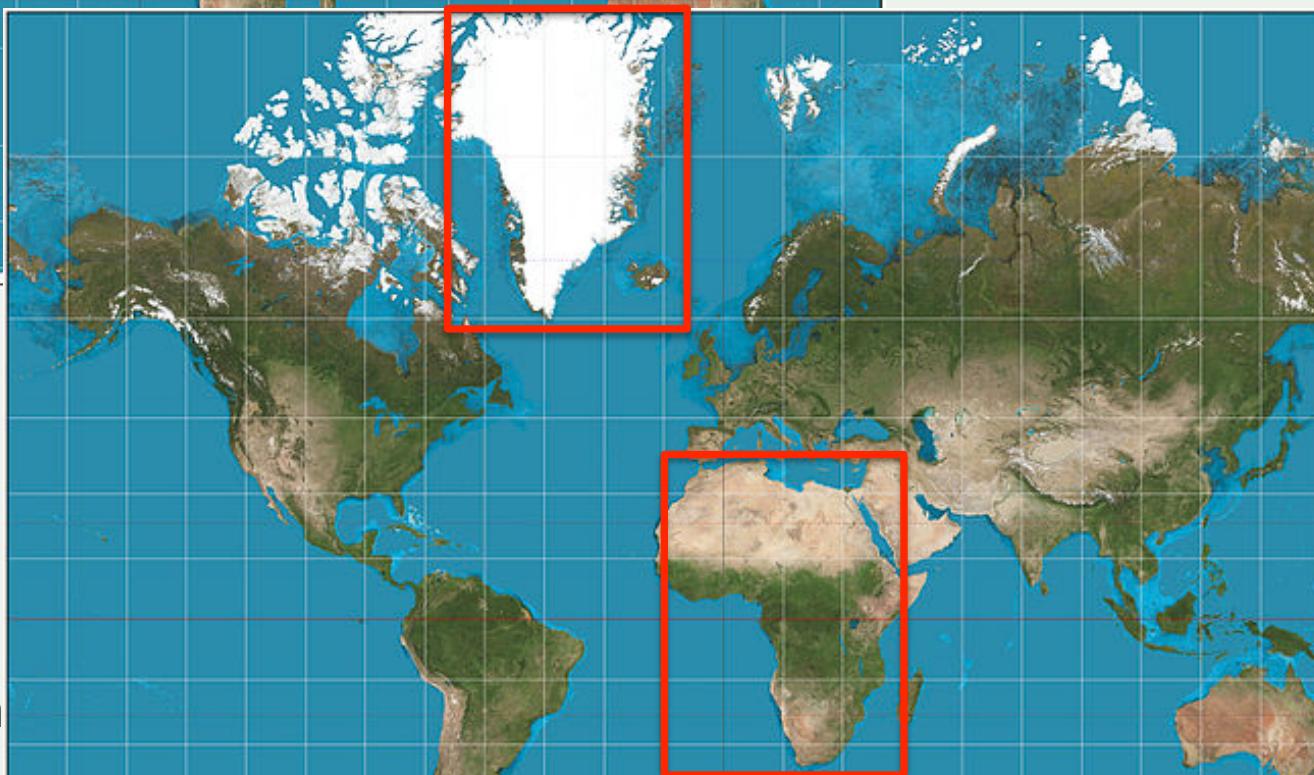
Greenland: 2 million sq km





Africa: 30 million sq km

Greenland: 2 million sq km

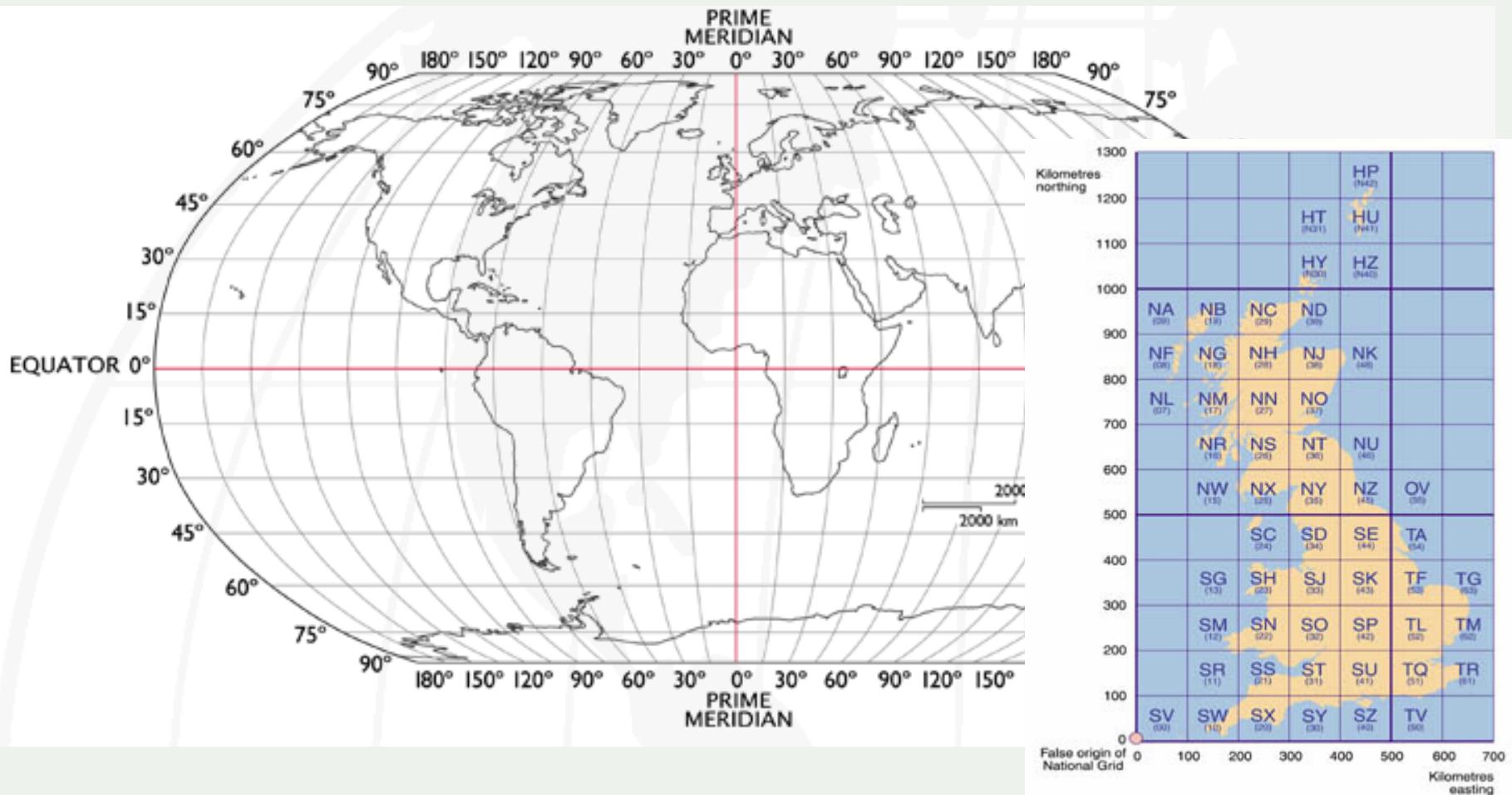


Why are Projections important?

1. The map(s) may not be as they appear
2. Coordinate Systems

Coordinate Systems

- Latitude and Longitude (WGS 1984) EPSG = 4326
 - 52°N 37' 30.32" (52.6250) 1°E 14' 2.05" (1.2339)



Working Directory

- R uses a ‘working directory’ to store your files in
- You might have a different one for each project / piece of work
- e.g. M:\Documents\GIS
- `setwd("M:/Documents/GIS")`

Variables

- R uses variables to store information – listed in your ‘workspace’ (top-right)
- When you close R Studio, save workspace
- ```
motorways <- readShapeSpatial('meridian-2/
motorway_polyline',
proj4string =
CRS("+init=epsg:27700"))
```



## Console //ufs02/user04/SCNB00/Documents/

```
R version 3.0.1 (2013-05-16) -- "Good sport"
Copyright (C) 2013 The R Foundation for statistical computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

```
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
```

```
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
```

```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```

&gt;

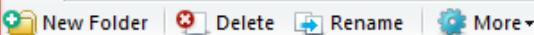
This is the console where you can type in commands

## Environment History



This lists the variables you have

## Files Plots Packages Help Viewer



| Name        | Size | Modified |
|-------------|------|----------|
| My Music    |      |          |
| My Pictures |      |          |
| My Video    |      |          |

Here will show either your files  
(the files tab) or your plots (the  
plots tab)

## Console //ufs02/user04/SCNB00/Documents/ ↻

```
R version 3.0.1 (2013-05-16) -- "Good Sport"
Copyright (C) 2013 The R Foundation for Statistical Computing
Platform: x86_64-w64-mingw32/x64 (64-bit)
```

```
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
```

```
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
```

```
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```

```
> +
+ 3+4
[1] 7
> library(ggmap)
Loading required package: ggplot2
> qmap('Liverpool')
Map from URL : http://maps.googleapis.com/maps/api/staticmap?center
=Liverpool&zoom=10&size=%20640x640&scale=%202&maptype=terrain&senso
r=false
Google Maps API Terms of Service : http://developers.google.com/map
s/terms
Information from URL : http://maps.googleapis.com/maps/api/geocode/
json?address=Liverpool&sensor=false
Google Maps API Terms of Service : http://developers.google.com/map
s/terms
>
```

## Environment History

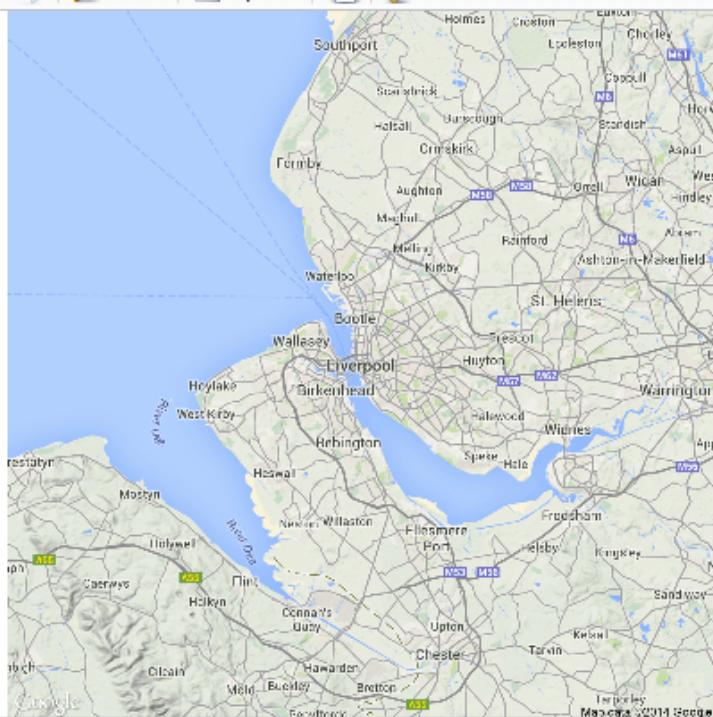
Import Dataset Clear

Global Environment

Environment is empty

## Files Plots Packages Help Viewer

Zoom Export Clear All



File Edit Code View Plots Session Build Debug Tools Help

+ Go to file/function

Project: (None)

Untitled1 \*

Source on Save | Run | Source |

This is where you can write scripts

1 |

1:1 (Top Level) R Script

Console //ufs02/user04/SCNB00/Documents/

```
R version 3.0.1 (2013-05-16) -- "Good Sport"
Copyright © 2013 The R Foundation for Statistical Computing
Plat This is the console where you can type in commands

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
```

> |

Environment History

Import Dataset Clear List

Global Environment

This lists the variables you have

Files Plots Packages Help Viewer

New Folder Delete Rename More

Home

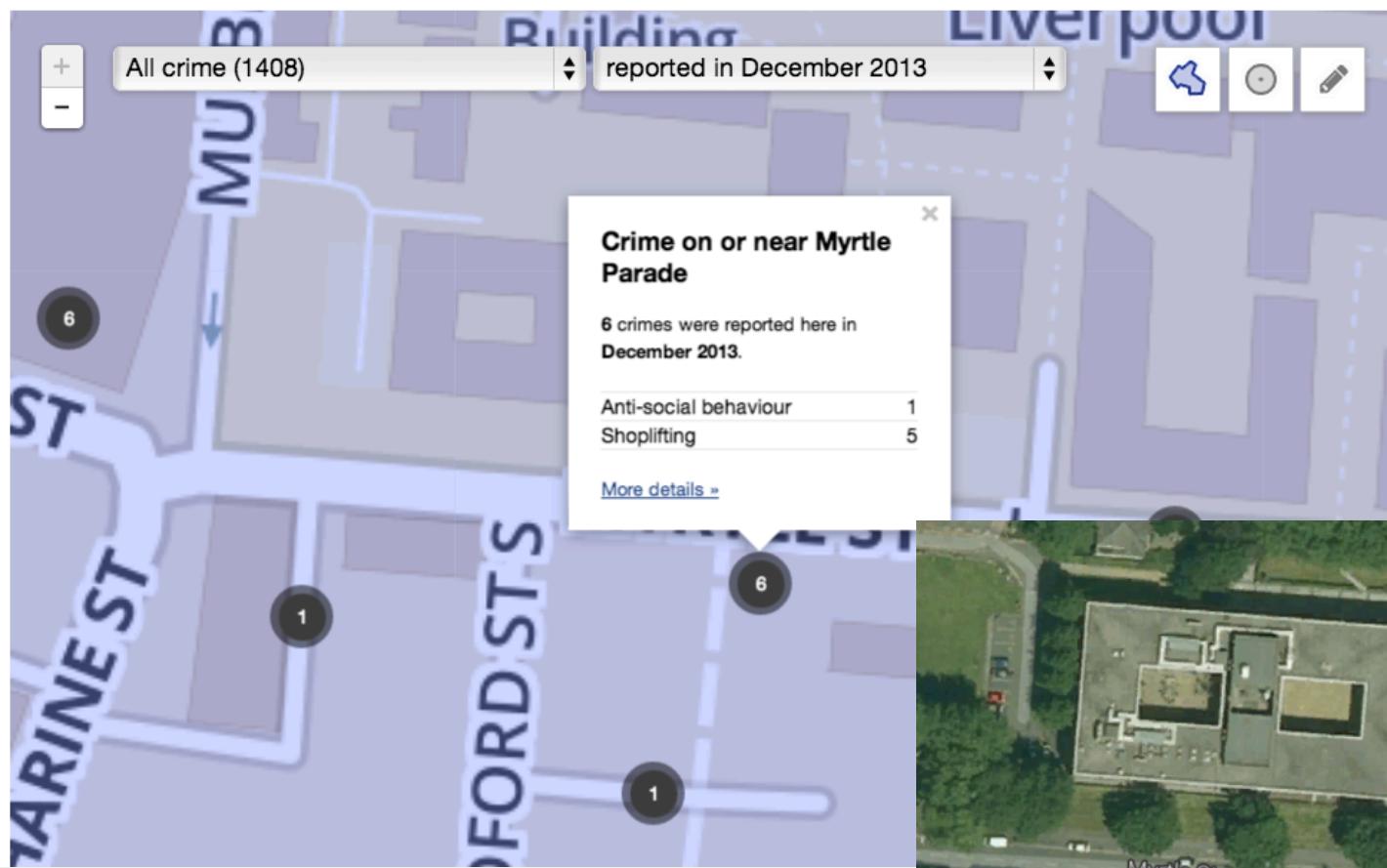
| Name        | Size | Modified |
|-------------|------|----------|
| My Music    |      |          |
| My Pictures |      |          |
| My Video    |      |          |

Here will show either your files  
(the files tab) or your plots (the  
plots tab)

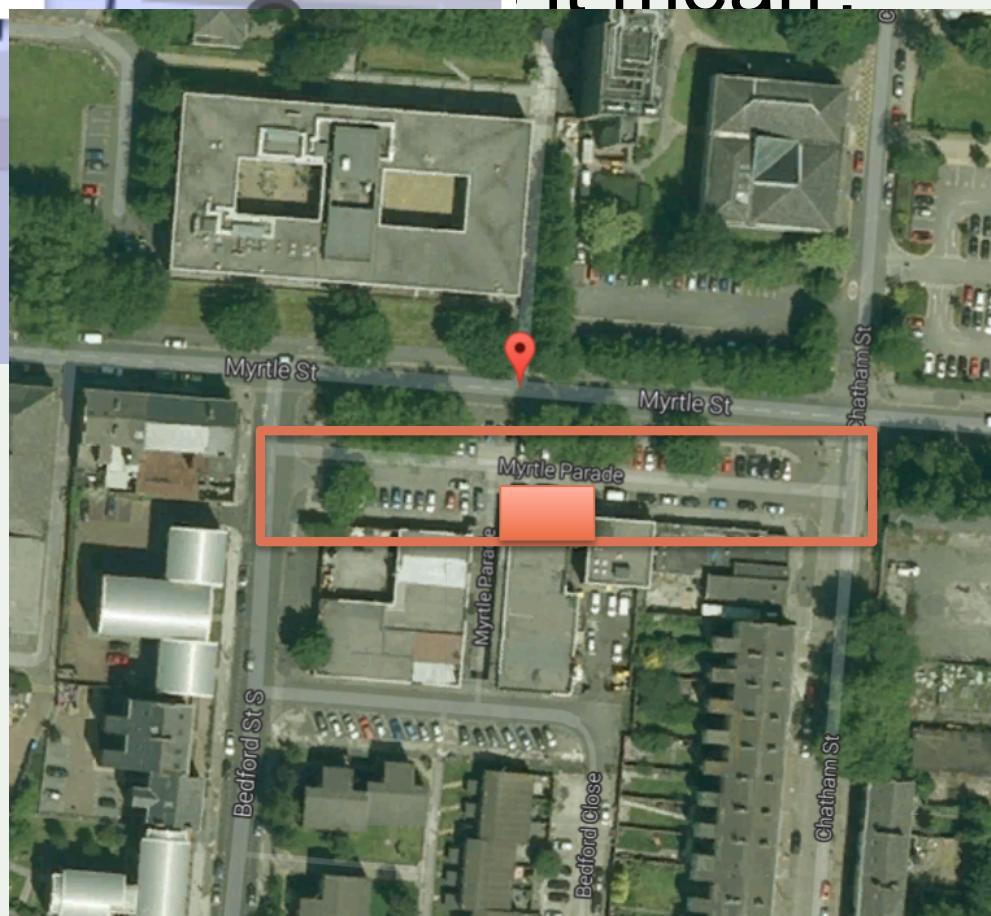
# Crime Data

| A          | B       | C            | D            | E         | F         | G            | H         | I           |
|------------|---------|--------------|--------------|-----------|-----------|--------------|-----------|-------------|
| Crime ID   | Month   | Reported by  | Falls within | Longitude | Latitude  | Location     | LSOA code | LSOA name   |
|            | 2013-11 | Merseyside F | Merseyside F | -2.715214 | 53.394732 | On or near T | E01012393 | Halton 001B |
| 27d062e622 | 2013-11 | Merseyside F | Merseyside F | -2.799099 | 53.354676 | On or near O | E01012391 | Halton 008B |
|            | 2013-11 | Merseyside F | Merseyside F | -2.830329 | 53.334337 | On or near D | E01012401 | Halton 008C |
|            | 2013-11 | Merseyside F | Merseyside F | -2.873557 | 53.485957 | On or near S | E01006448 | Knowsley 00 |
|            | 2013-11 | Merseyside F | Merseyside F | -2.869972 | 53.48824  | On or near R | E01006448 | Knowsley 00 |
|            | 2013-11 | Merseyside F | Merseyside F | -2.873557 | 53.485957 | On or near S | E01006448 | Knowsley 00 |
|            | 2013-11 | Merseyside F | Merseyside F | -2.873557 | 53.485957 | On or near S | E01006448 | Knowsley 00 |
|            | 2013-11 | Merseyside F | Merseyside F | -2.873557 | 53.485957 | On or near S | E01006448 | Knowsley 00 |
| 10         | 2013-11 | Merseyside F | Merseyside F | -2.873557 | 53.485957 | On or near S | E01006448 | Knowsley 00 |

```
> head(mersey.lsoa@data)
 gid geonorth popnorth geoeast name label popeast zonecode asb.count Overall Income Employment
0 458 381722 383625 342348 Liverpool 058B 04BYE01006739 342928 E01006739 12 28.57 0.16 0.12
1 459 383167 384902 323263 Wirral 033B 04CBE01007284 325257 E01007284 0 32.52 0.26 0.18
2 461 420336 418219 332592 Sefton 004B 04CAE01006950 334110 E01006950 1 44.76 0.27 0.21
3 2023 379256 380601 326022 Wirral 040F 04CBE01007191 327837 E01007191 1 47.43 0.30 0.19
4 2024 380279 380955 325469 Wirral 040E 04CBE01007190 326631 E01007190 3 16.85 0.09 0.09
5 2025 381092 381843 324075 Wirral 040B 04CBE01007187 325788 E01007187 1 8.24 0.06 0.05
 Health Education Housing Crime Environment
0 0.89 45.18 27.09 -0.13 17.46
1 0.62 32.94 22.70 -0.25 13.97
2 1.48 41.17 15.69 0.15 53.71
3 1.28 30.56 27.79 1.30 47.11
4 0.20 4.51 30.09 -0.49 33.65
5 -0.35 1.76 26.61 -0.63 12.82
>
```



ly as  
it mean?



# Practical

**R**Pubs brought to you by RStudio

[Sign in](#) [Register](#)

## R and Google Map Making

### R Basics

R began as a statistics program, and is still used as one by many users. At a simple level you can type in "3 + 4", press return, and R will respond "7". Try the example below. Code for you to type into R is shown like this:

```
3 + 4
```

Then R's output is shown like this:

```
[1] 7
```

R has developed into a GIS as a result of user contributed packages, or libraries, as R refers to them. We will be using several libraries in this practical, and will load them as necessary.

*If you are using this worksheet outside of the course, you may need to install the R libraries as well as loading them. To do this, run `install.package("package_name")`!*

We won't spend too much time on the basics of using R - if you want to find out more, there are some good tutorials at <http://www.social-statistics.org/?p=764> or <http://rpubs.com/nickbearman/gettingstartedwithr>.

We are going to use a program called [R Studio](#), which works on top of R and provides a good user interface. I'll talk a little bit about it in the presentation, but the key areas of the window are these:

The screenshot shows the RStudio interface with several panels highlighted by red boxes:

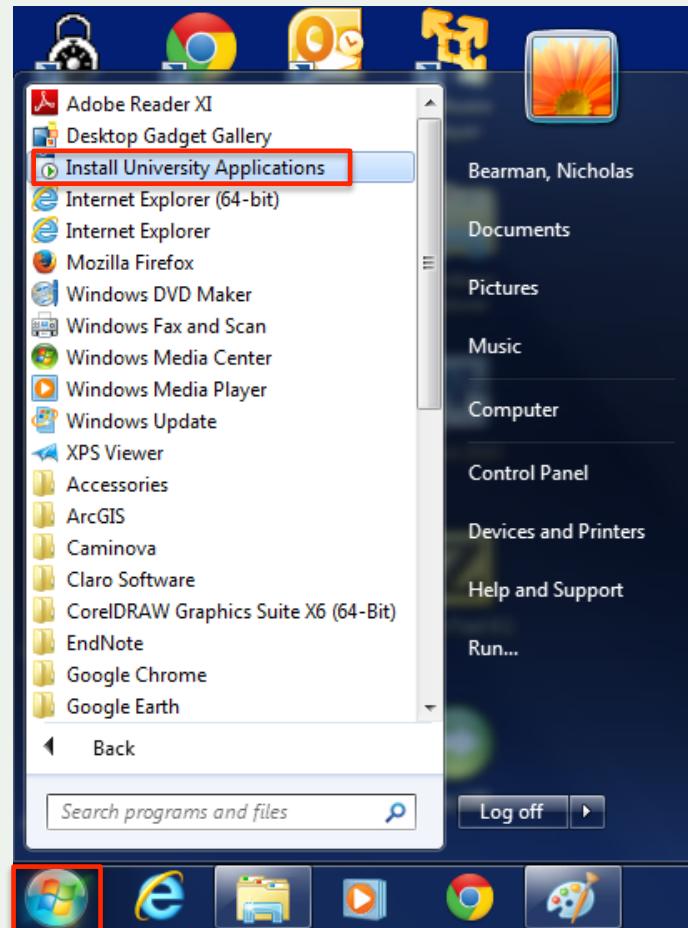
- Console:** The leftmost panel where you can type R commands. It contains the R startup message and a prompt (>). A red box highlights this area with the annotation: "This is the console where you can type in commands".
- Environment:** The top-right panel showing the Global Environment. A red box highlights this area with the annotation: "This lists the variables you have".
- Files:** The bottom-right panel showing a file tree with "Home" expanded, showing "My Music", "My Pictures", and "My Video". A red box highlights this area with the annotation: "Here will show either your files (the files tab) or your plots (the plots tab)".
- Plots:** The middle-right panel, currently empty, which displays plots when available.

At the bottom of the page, there are navigation links: "Using R for Google Map Making" by Nick Bearman, "Last updated 28 minutes ago", "Comments (-)", "Share", and "Hide Toolbars".

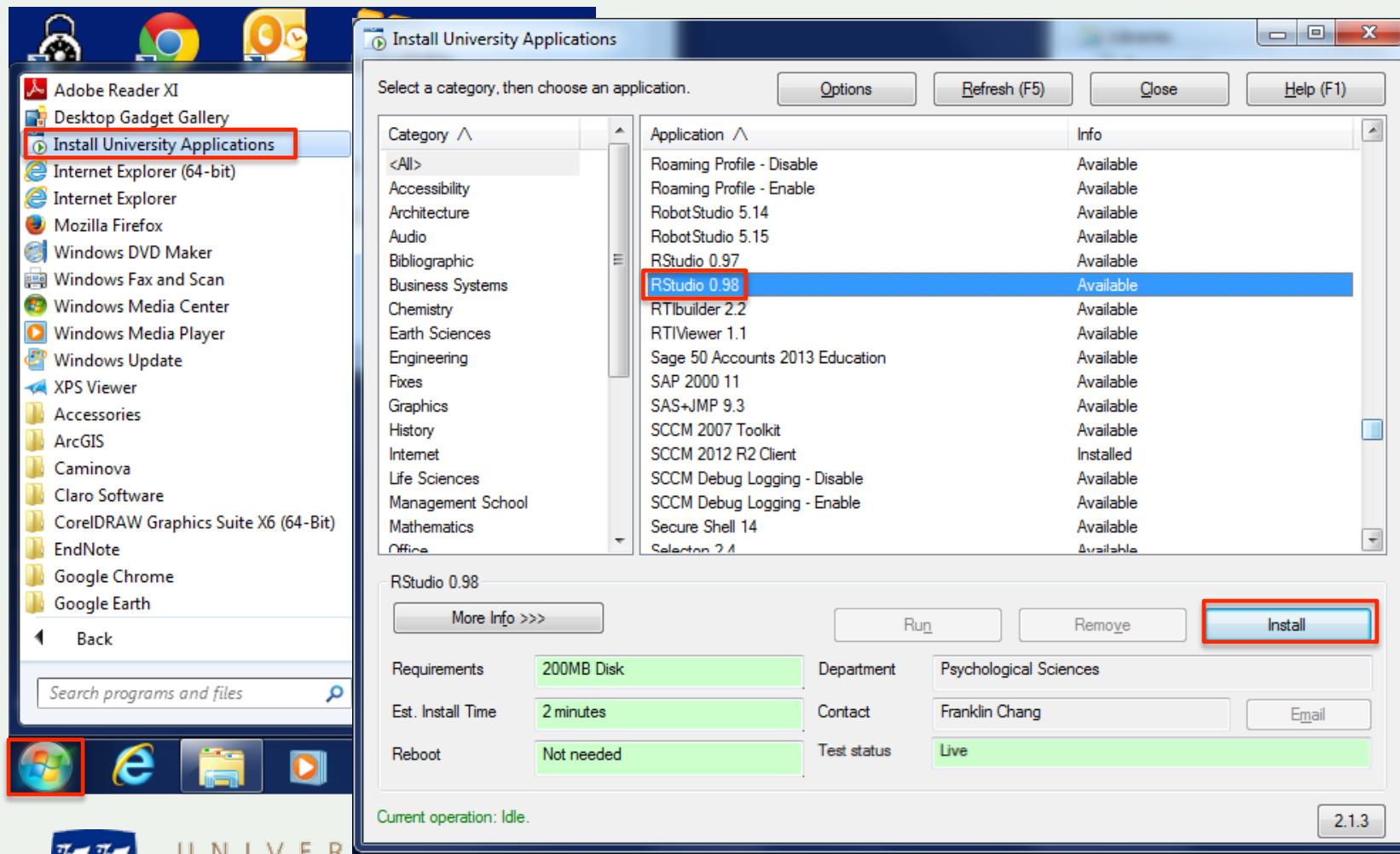
# Survey Questions

- Part of my research is GIS teaching
- Very quick (7 ques) survey of your GIS experience
- Follow up in 6 months / 1 year
- Optional

# Installing R Studio 0.98...



# Installing R Studio 0.98...



Survey:  
[bit.ly/1oBRqmY](http://bit.ly/1oBRqmY)

Practical:  
[bit.ly/1mAH3kY](http://bit.ly/1mAH3kY)

- Go!



UNIVERSITY OF  
LIVERPOOL

E·S·R·C  
ECONOMIC  
& SOCIAL  
RESEARCH  
COUNCIL

# Recap

- Recap of the practical
- What is sensitive data?
- Encryption
- Cloud
- Feedback
- Where now?

# The Practical

- Using R & R Studio
- Creating R scripts (& saving them!)
- Importing data (crime, roads, LSOAs)
- Plotting on top of Google Maps basemap
- Routing & Density plots
- Available online
  - Thursday on Geodemographics

# Why is sensitive data important?

- Data Protection Act
  - “**Appropriate** technical and organisational **measures** shall be taken against **unauthorised** or unlawful processing of **personal data** and against accidental **loss** or destruction of, or damage to, personal data.”
  - [Information security \(Principle 7\)](#)
- Laptops on trains & buses....

# What is sensitive data?

- Personally identifiable data
  - DOB, Race, Location...
- Often data provider will insist on certain measures
- School census data
  - Encryption, only identified authorised users
- Your experience?? (discuss)

# Encryption

- Recommended for desktop, required for laptop computers
- TrueCrypt for sets of files
  - <https://truecrypt.ch/> / [GRC](#)
- Windows BitLocker / OSX File Vault 2
- Research. Also backups!
- Don't forget organisational measures

# Sensitive data in the Cloud

- Data Protection Act
  - Personal data **shall not be transferred** to a country or territory **outside the EEA unless** that country or territory ensures an **adequate level of protection** for the rights and freedoms of data subjects in relation to the processing of personal data.
  - [Sending personal data outside the European Economic Area \(Principle 8\)](#)

# Sensitive data in the Cloud

- Google Cloud Computing
  - Finland, Belgium, Ireland
  - "however at this time selection of data center will make no guarantee that your data at rest is kept only in that region" ([FAQ](#))
- Amazon EC2 – Ireland (not UK)
- Things will change in the future

# Where now?

- R resources on the web
  - [www.rpubs.com/nickbearman](http://www.rpubs.com/nickbearman)
  - [www.youtube.com/user/marininstatlectures/playlists](http://www.youtube.com/user/marininstatlectures/playlists)
  - <http://cran.r-project.org/doc/contrib/intro-spatial-rl.pdf>
- R problems
  - [www.alex-singleton.com/R-Tutorial-Materials/](http://www.alex-singleton.com/R-Tutorial-Materials/)
  - “Why doesn’t my code work? - Common things to check”

# Feedback

- Feedback is really important for me
- Post-its
  - One thing you found fun
  - One thing you found challenging and useful
  - One thing you would improve
- Or email / phone / in person

# Thank you!



UNIVERSITY OF  
LIVERPOOL

E·S·R·C  
ECONOMIC  
& SOCIAL  
RESEARCH  
COUNCIL