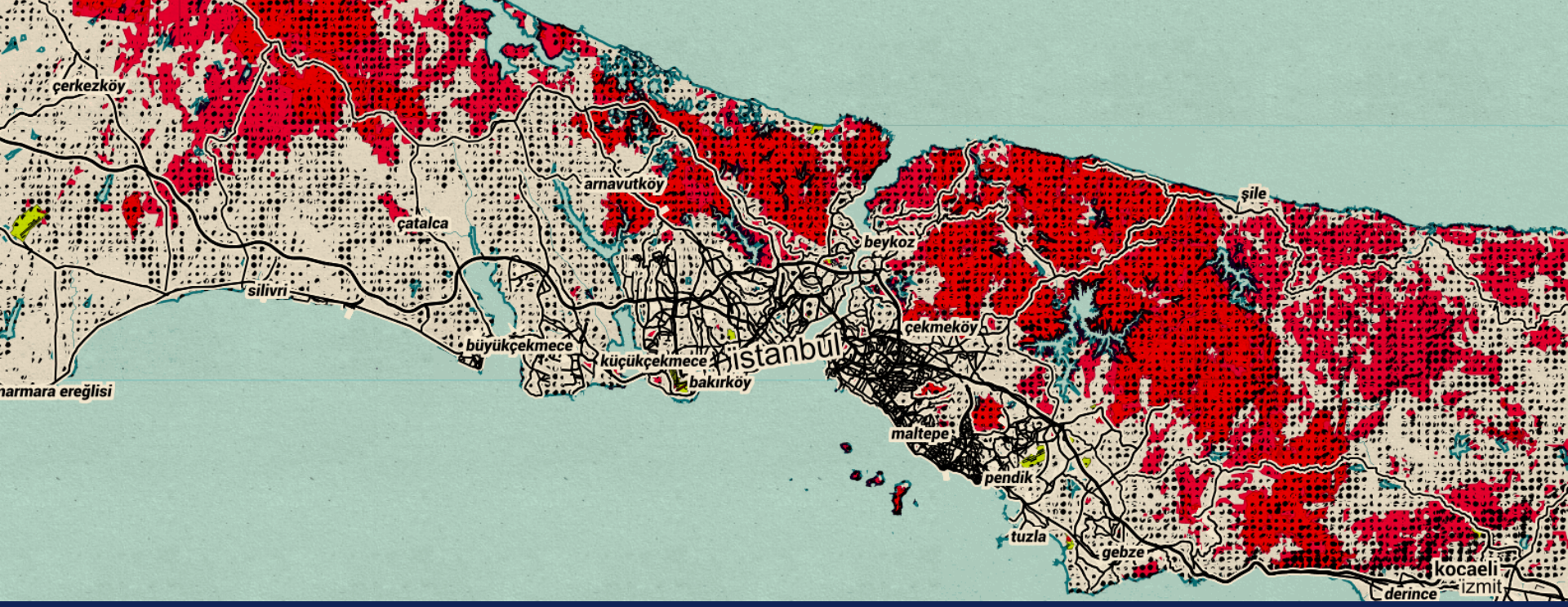


R for Mapping

Dr Alex Singleton

Department of Geography and Planning

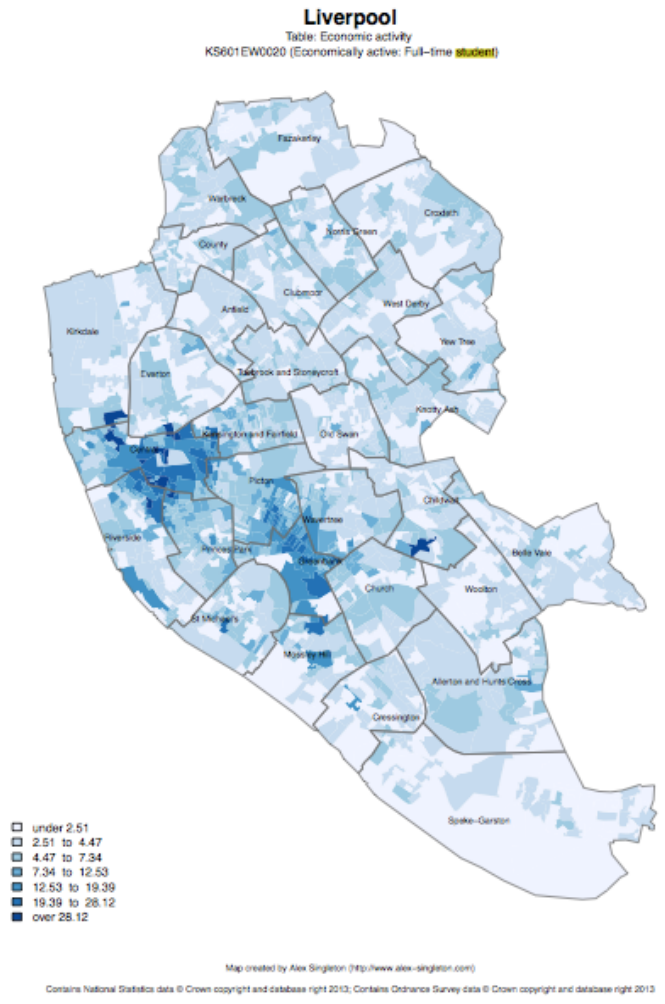
UNIVERSITY OF LIVERPOOL

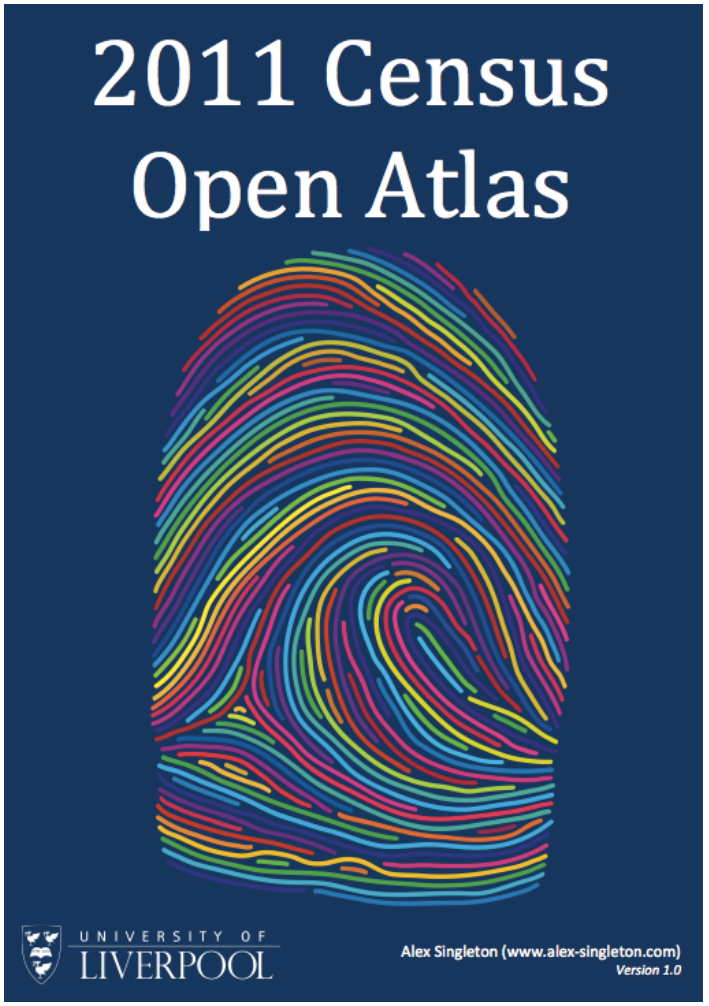
www.alex-singleton.com

Overview and Structure

- R in Action
- R as GIS
- Basics of R for Mapping
- R studio

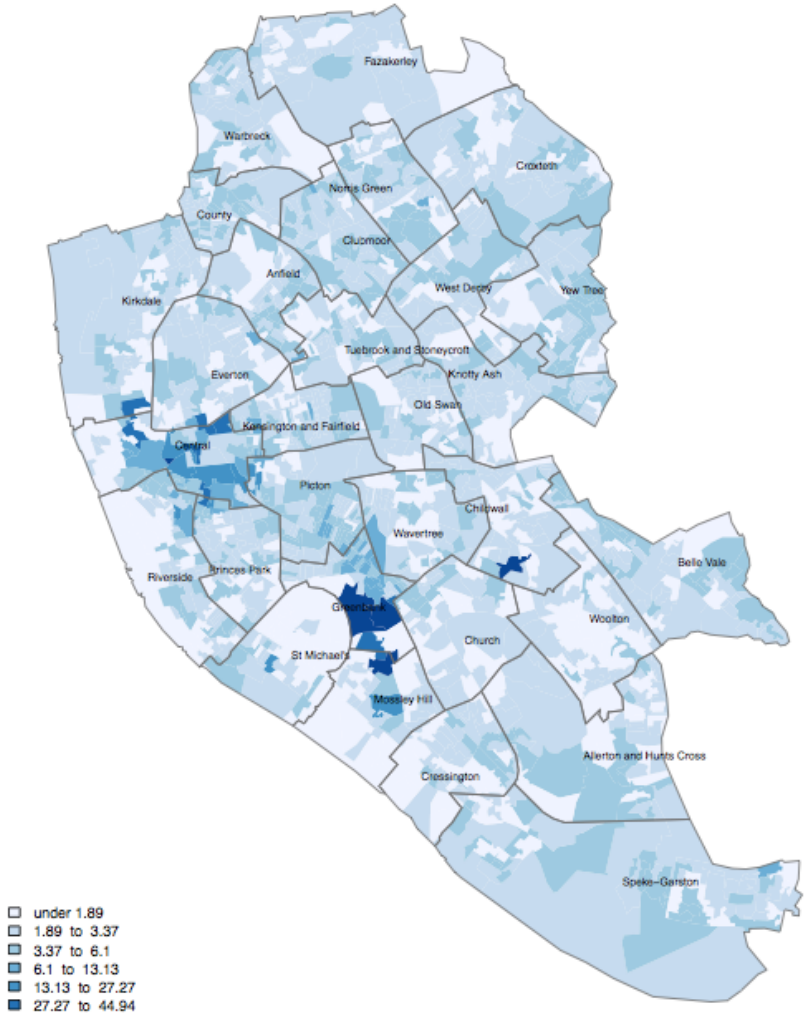
R in Action


Liverpool
Table: Economic activity
KS601EW0020 (Economically active: Full−time student)
under 2.51
2.51 to 4.47
4.47 to 7.34
7.34 to 12.53
12.53 to 19.39
19.39 to 28.12
over 28.12
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


2011 Census
Open Atlas
UNIVERSITY OF
LIVERPOOL
Alex Singleton (www.alex-singleton.com)
Version 1.0

Liverpool

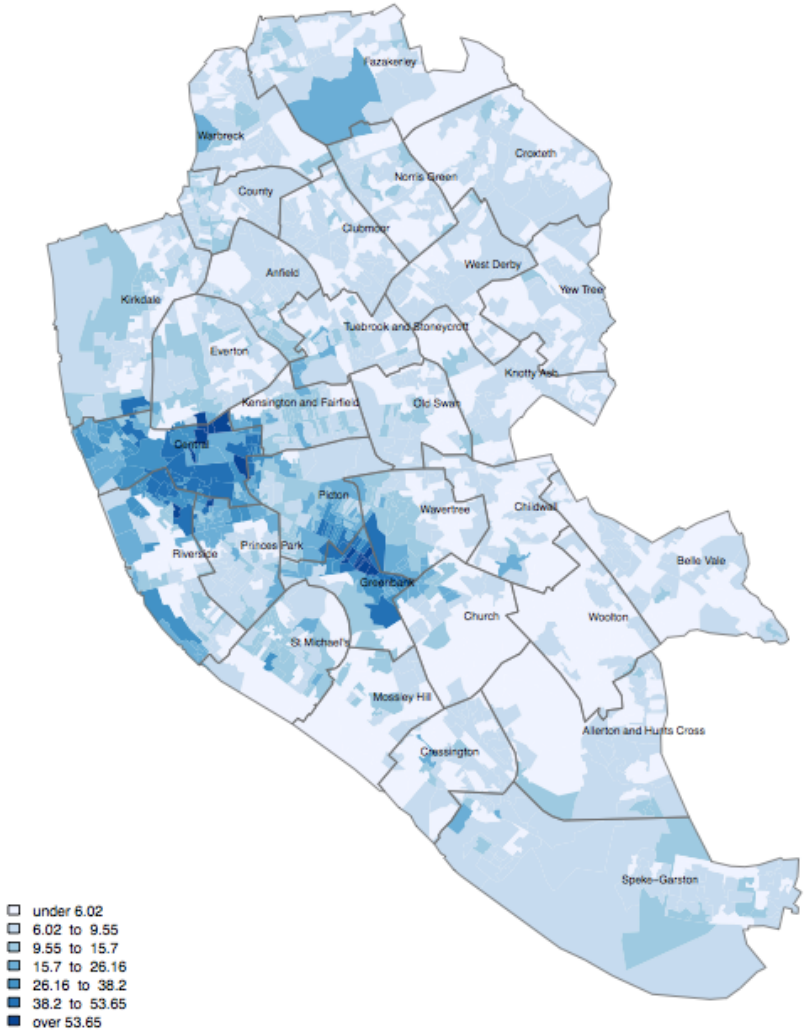
Table: Age structure
KS102EW0026 (Age 18 to 19)



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

Liverpool

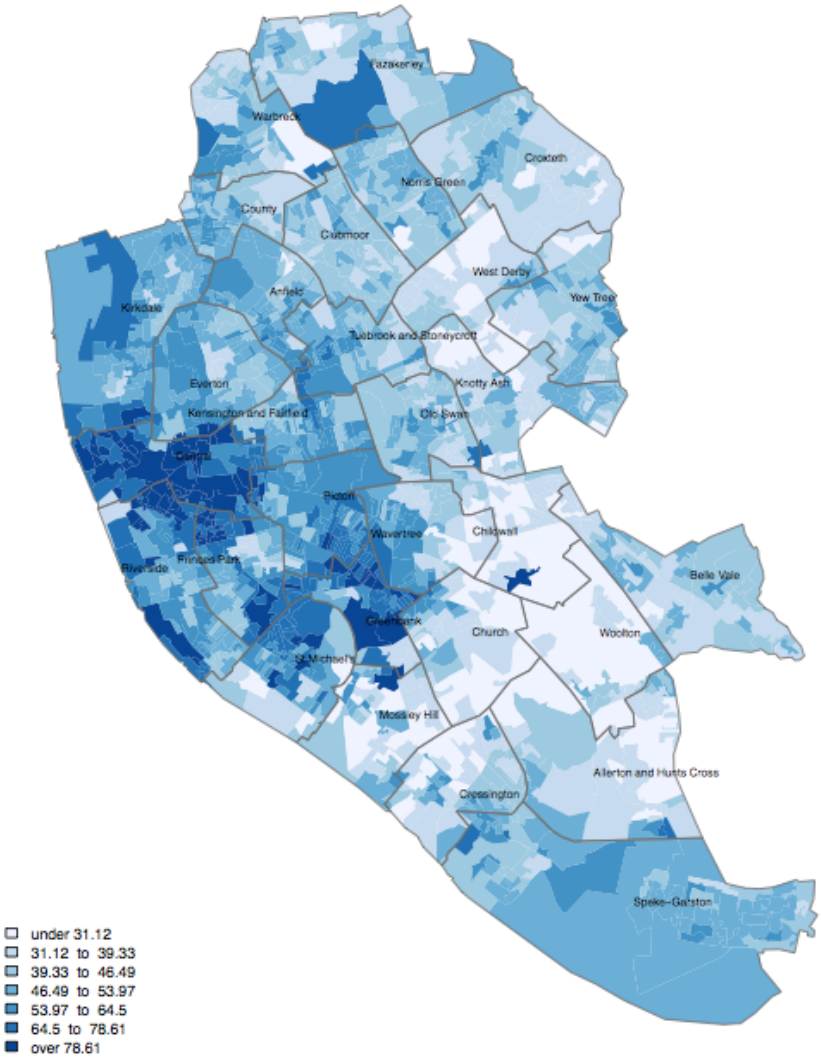
Table: Age structure
KS102EW0027 (Age 20 to 24)



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

Liverpool

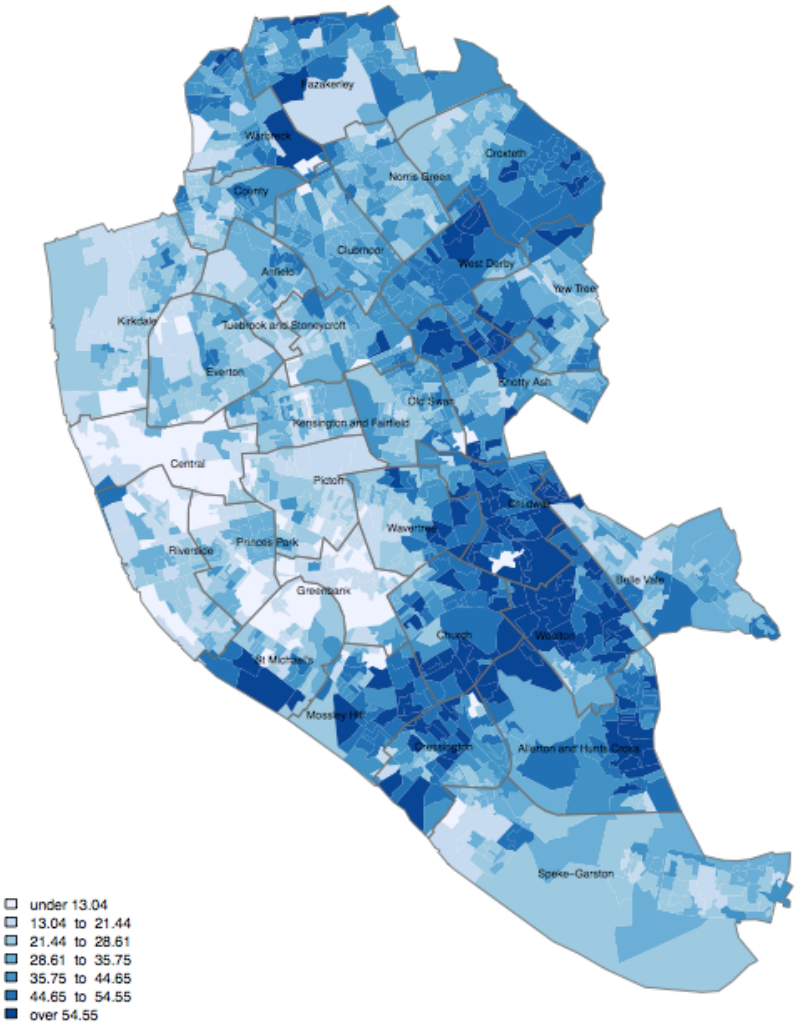
Table: Marital and civil partnership status
KS103EW0008 (Single (never married or never registered a same-sex civil partnership))



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

Liverpool

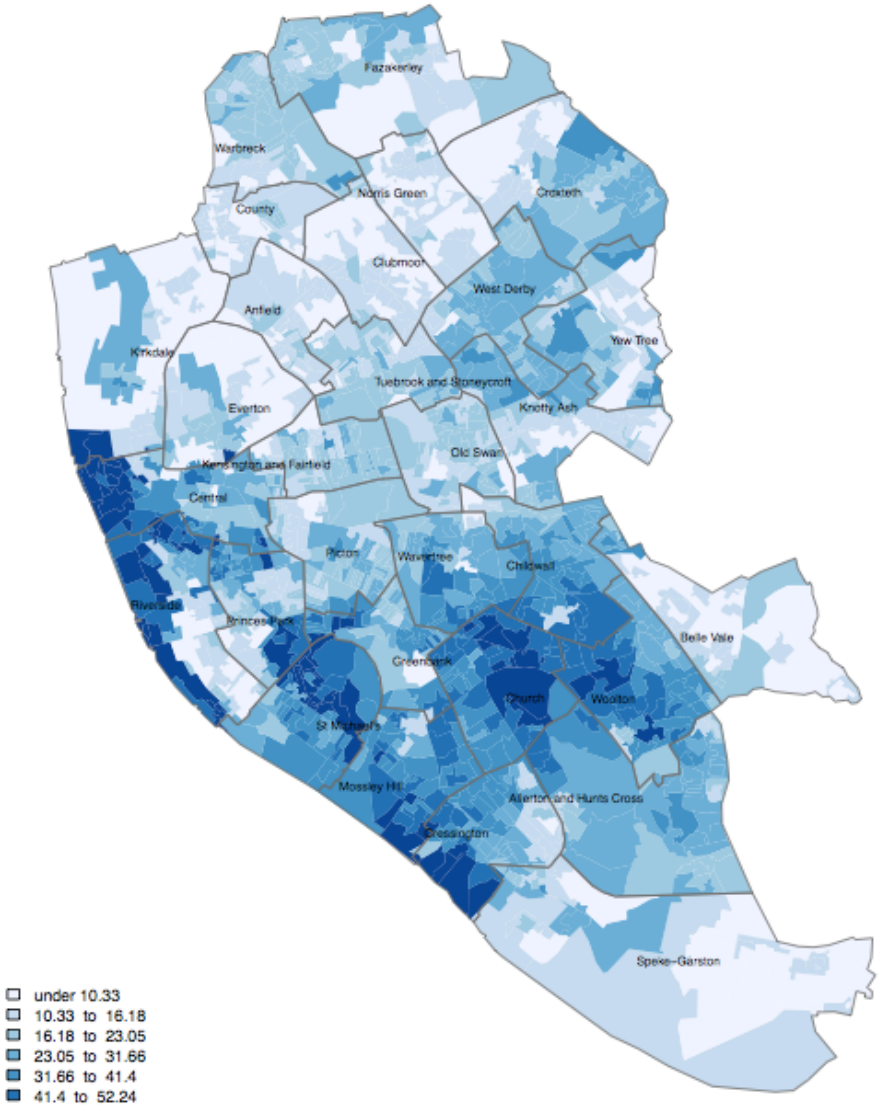
Table: Marital and civil partnership status
KS103EW0009 (Married)



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

Liverpool

Table: Qualifications and students
KS501EW0019 (Highest level of qualification: Level 4 qualifications and above)

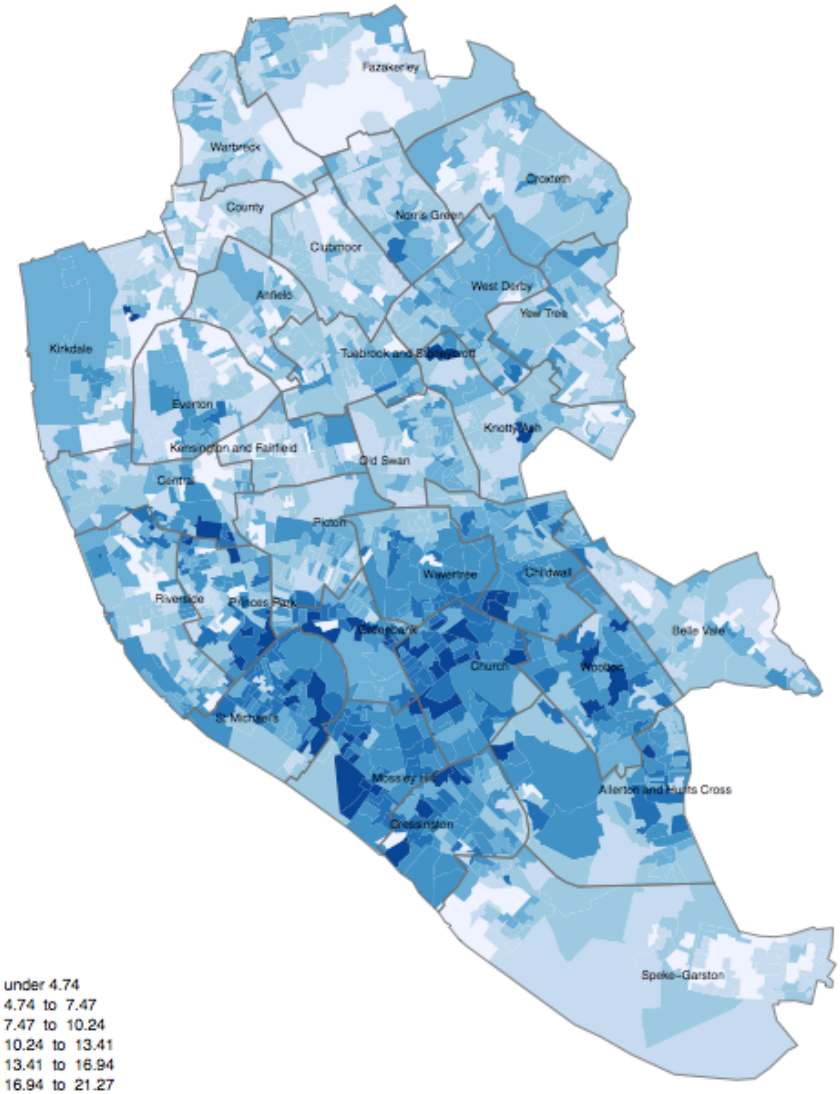


- under 10.33
- 10.33 to 16.18
- 16.18 to 23.05
- 23.05 to 31.66
- 31.66 to 41.4
- 41.4 to 52.24
- over 52.24

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

Liverpool

Table: Industry
KS605EW0035 (P Education)



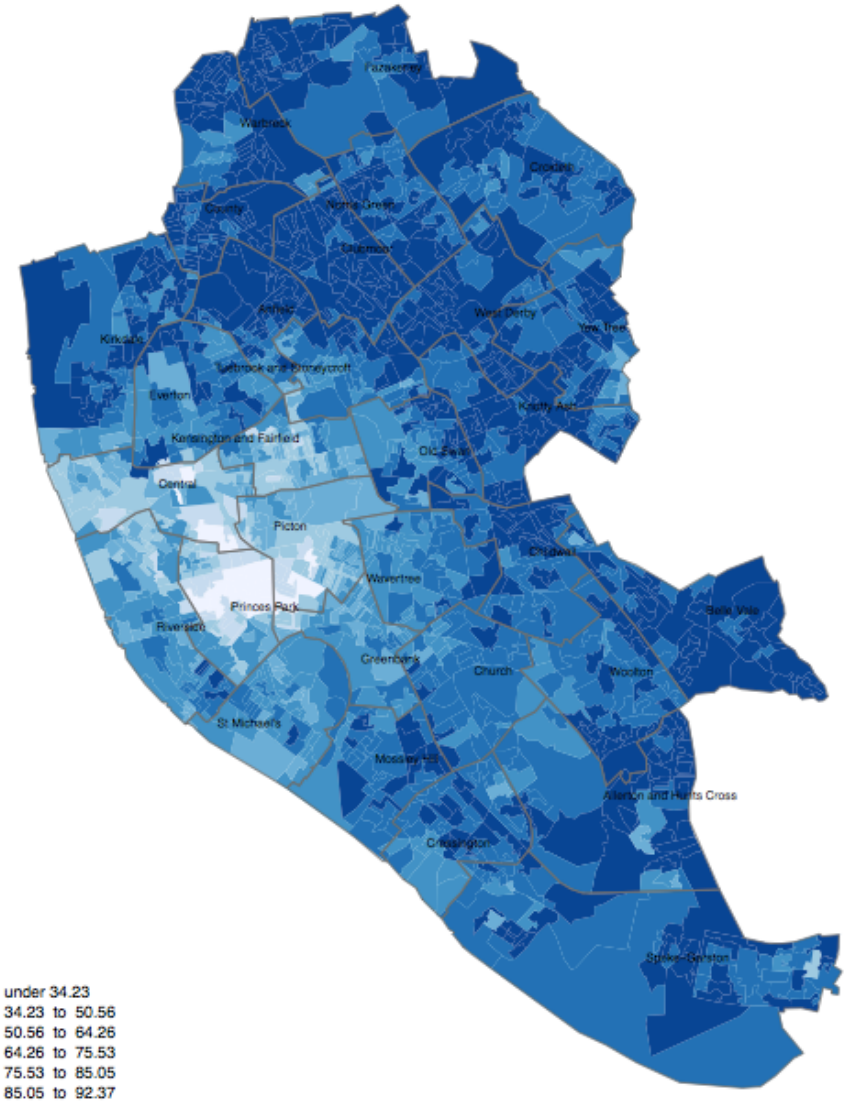
- under 4.74
- 4.74 to 7.47
- 7.47 to 10.24
- 10.24 to 13.41
- 13.41 to 16.94
- 16.94 to 21.27
- over 21.27

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

Liverpool

Table: Ethnic group

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



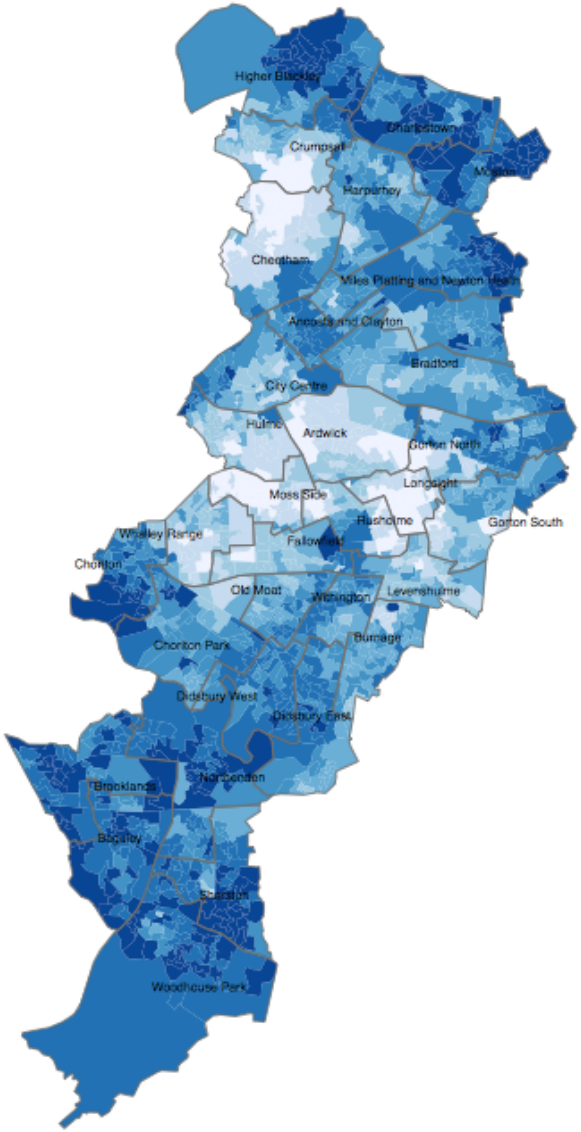
- under 34.23
- 34.23 to 50.56
- 50.56 to 64.26
- 64.26 to 75.53
- 75.53 to 85.05
- 85.05 to 92.37
- over 92.37

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

Manchester

Table: Ethnic group

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



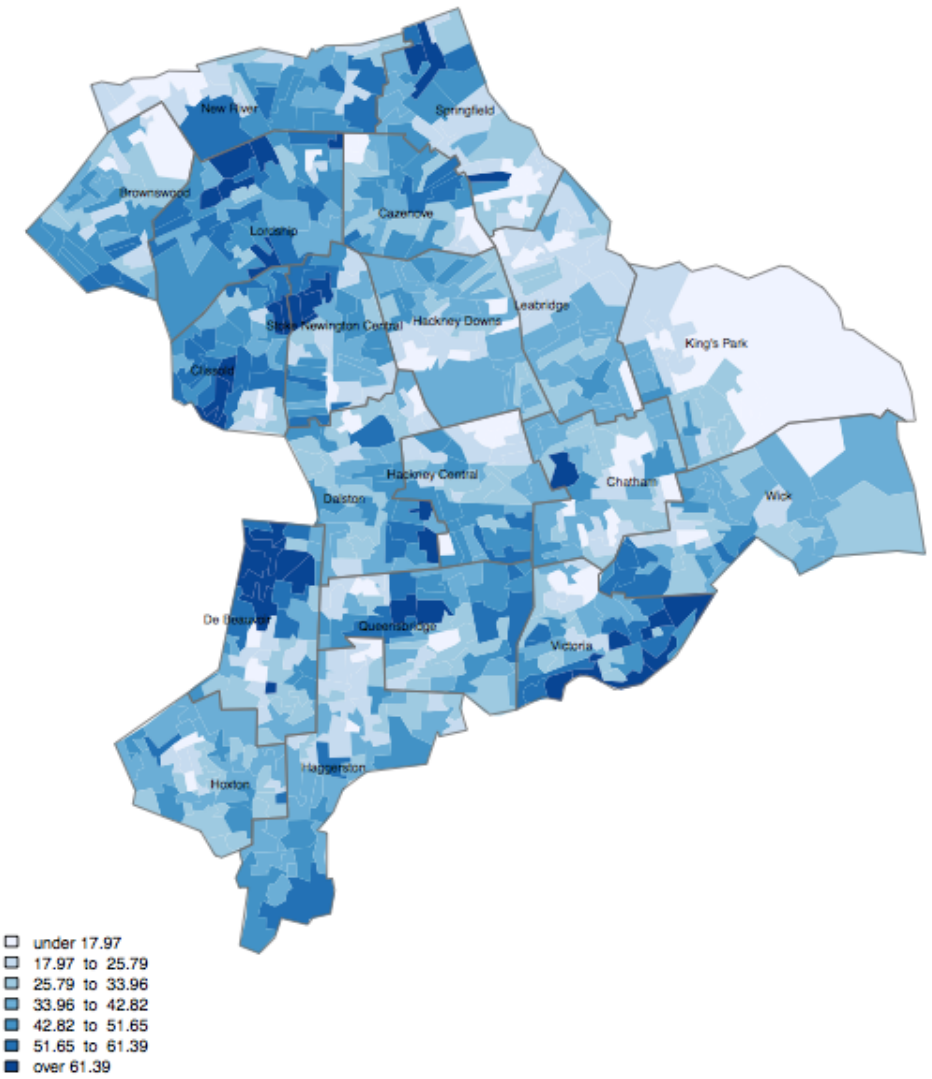
- under 22.23
- 22.23 to 37.27
- 37.27 to 51.56
- 51.56 to 63.9
- 63.9 to 73.94
- 73.94 to 83.21
- over 83.21

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

Hackney

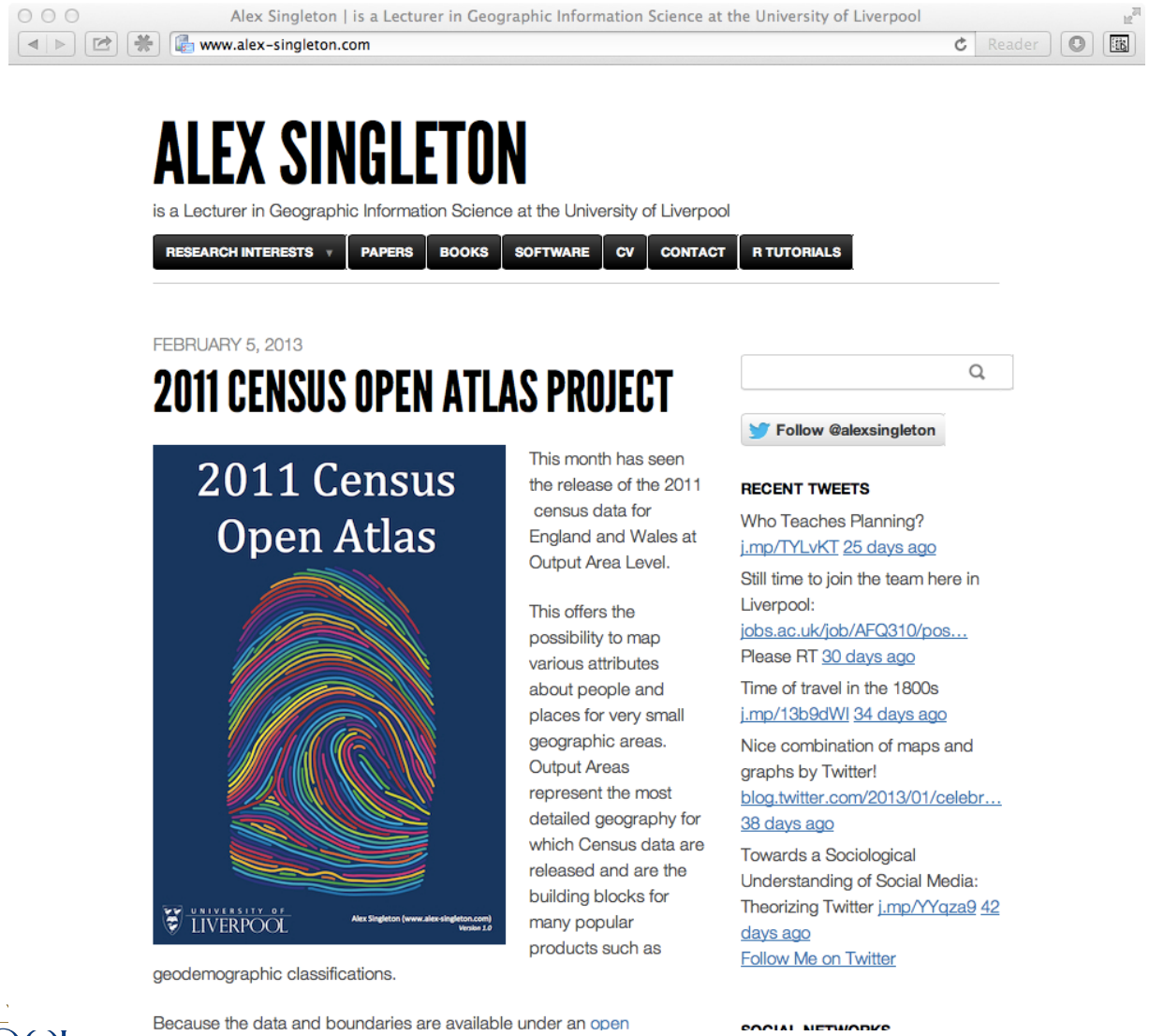
Table: Ethnic group

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



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

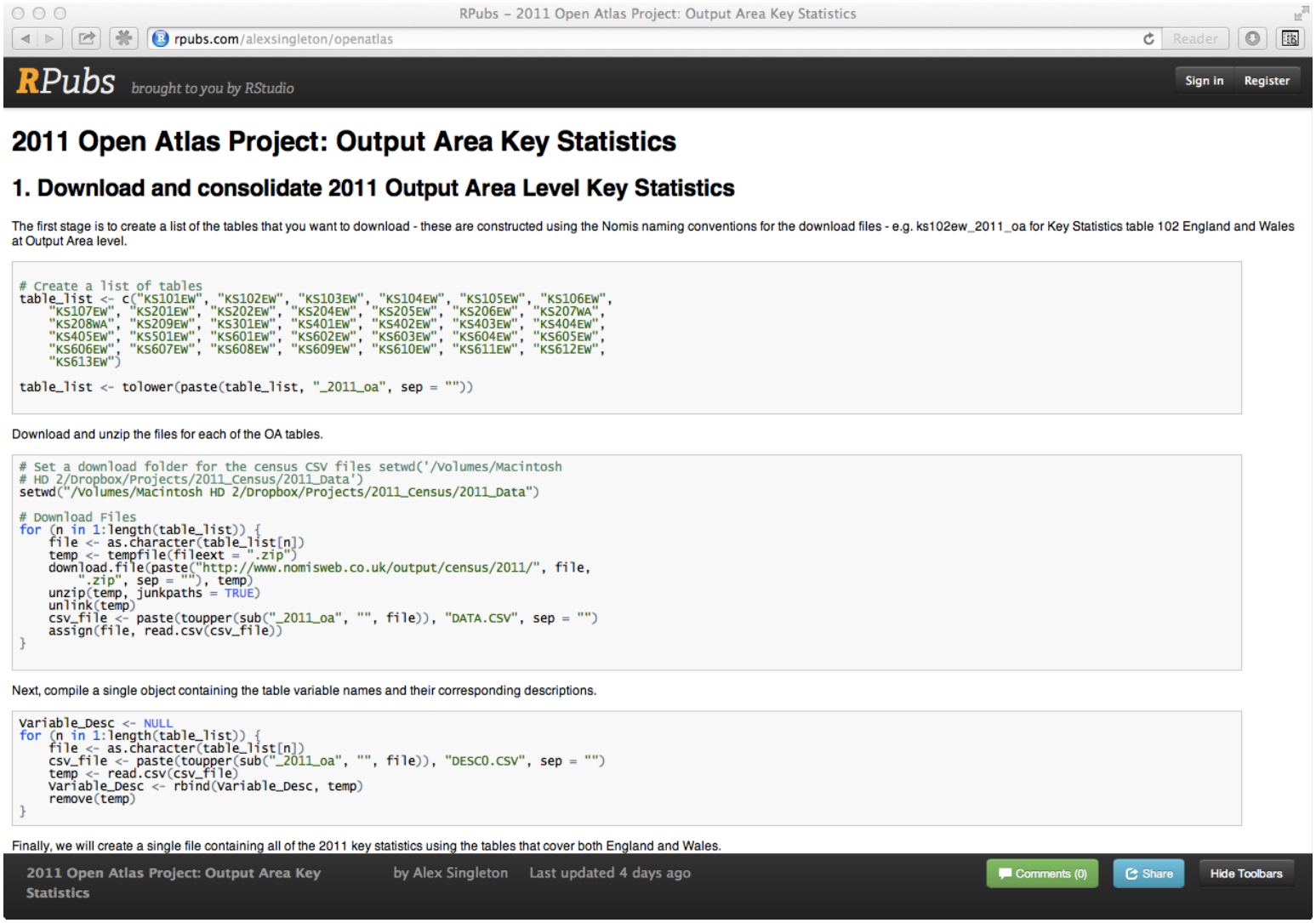
R in Action



UNIVERSITY OF LIVERPOOL

http://www.alex-singleton.com

R in Action



UNIVERSITY OF LIVERPOOL

http://rpubs.com/alexsingleton/

R in Action

- 2 lists –
  - A) All local authorities
  - B) All census variables – prepared for mapping
- Start Loop 1 – for local authority X in A
  - Start Loop 2 – for census variable Y in B
  - *Make a map for variable Y in local authority X*
  - Close Loop 2 when all Y in B are mapped
- Close Loop 1, and move onto next X in A
- End code when all X in A have been mapped

Mapping the census: how one man produced a library for all | News | guardian.co.uk

www.guardian.co.uk/news/datablog/2013/feb/08/census-data-mapped

Reader

theguardian

Your search terms... News Search

News | Sport | Comment | Culture | Business | Money | Life & style | Travel | Environment | Tech | TV | Video | Dating | Offers | Jobs

News › Show and Tell

DATA STORE
SHOW AND TELL

in association with Google™

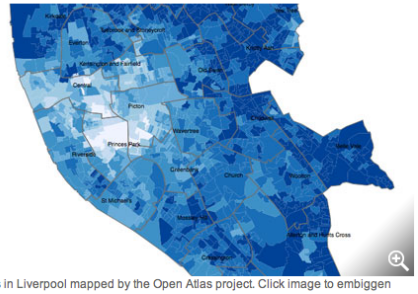
Previous Blog home Next

Mapping the census: how one man produced a library for all

Alex Singleton downloaded every single census dataset for every local authority in England - and then produced a free library of downloadable PDFs. Find out what he did

• More data journalism and data visualisations from the Guardian

Share 3 Tweet 15 +1 0 Share 0 Email



Census in Liverpool mapped by the Open Atlas project. Click image to embiggen

Posted by
Simon Rogers
Friday 8 February 2013
07.30 GMT
guardian.co.uk
Jump to comments (0)

Article history

UK news
Census

World news
Population

Society
Local government

Series
Show and Tell

More from Datablog on

UK news
Census

World news
Population

Society
Local government

Series
Show and Tell

More blogposts

The census is an amazing resource - so full of data it's hard to know where to begin. And increasingly where to begin is by putting together web-based interactives - like this one on language and this on transport patterns that we produced this month.

But one academic is taking everything back to basics - using some pretty sophisticated techniques. Alex Singleton, a lecturer in geographic information science (GIS) at Liverpool University has used R to create the open atlas project.

Singleton has basically produced a detailed mapping report - as a PDF and vectored images - on every one of the local authorities of England & Wales. He automated the process and has provided the code for readers to correct and do something with. In each report there are 391 pages, each with a map. That means, for the 354 local authorities in England & Wales, he has produced 127,466 maps.

Singleton says he's done it because:

1. To demonstrate the value of the 2011 census
2. Provide a free 2011 static Census atlas to anyone who wants one
3. Because I do not believe web maps should necessarily

3 Share 15 Tweet 0 +1 Share

Today's best video

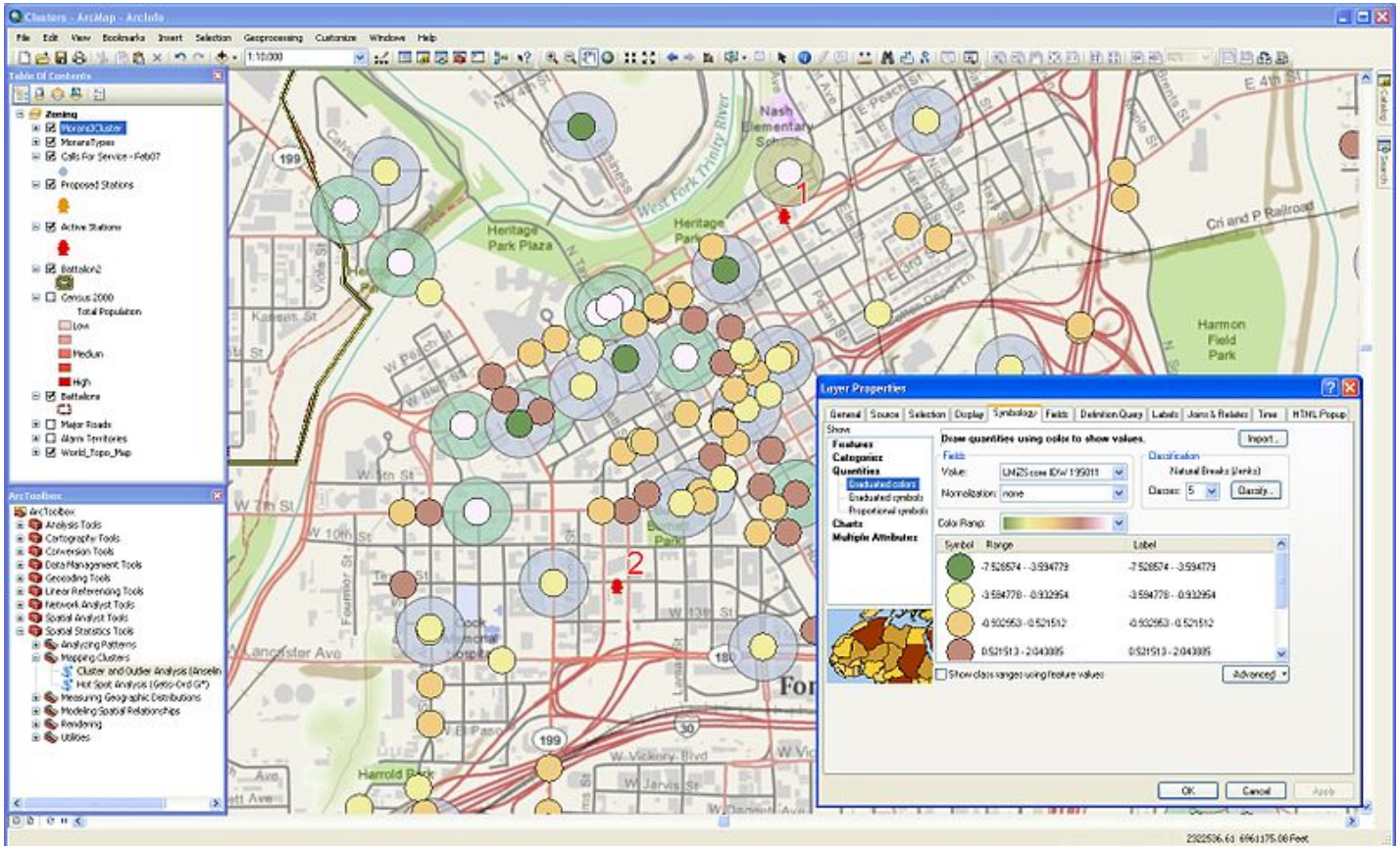
Naples driver's u-turn fiasco causes holdup
A driver attempts a 180-degree turn on a narrow street

Leicester's curry houses: a taste of little India
Marcel Theroux visits Bobby's restaurant for a lesson in Gujarati cooking
75 comments

GIS: Geographic Information Systems

- Almost all human activities and decisions involve an important **geographic component**
- 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**

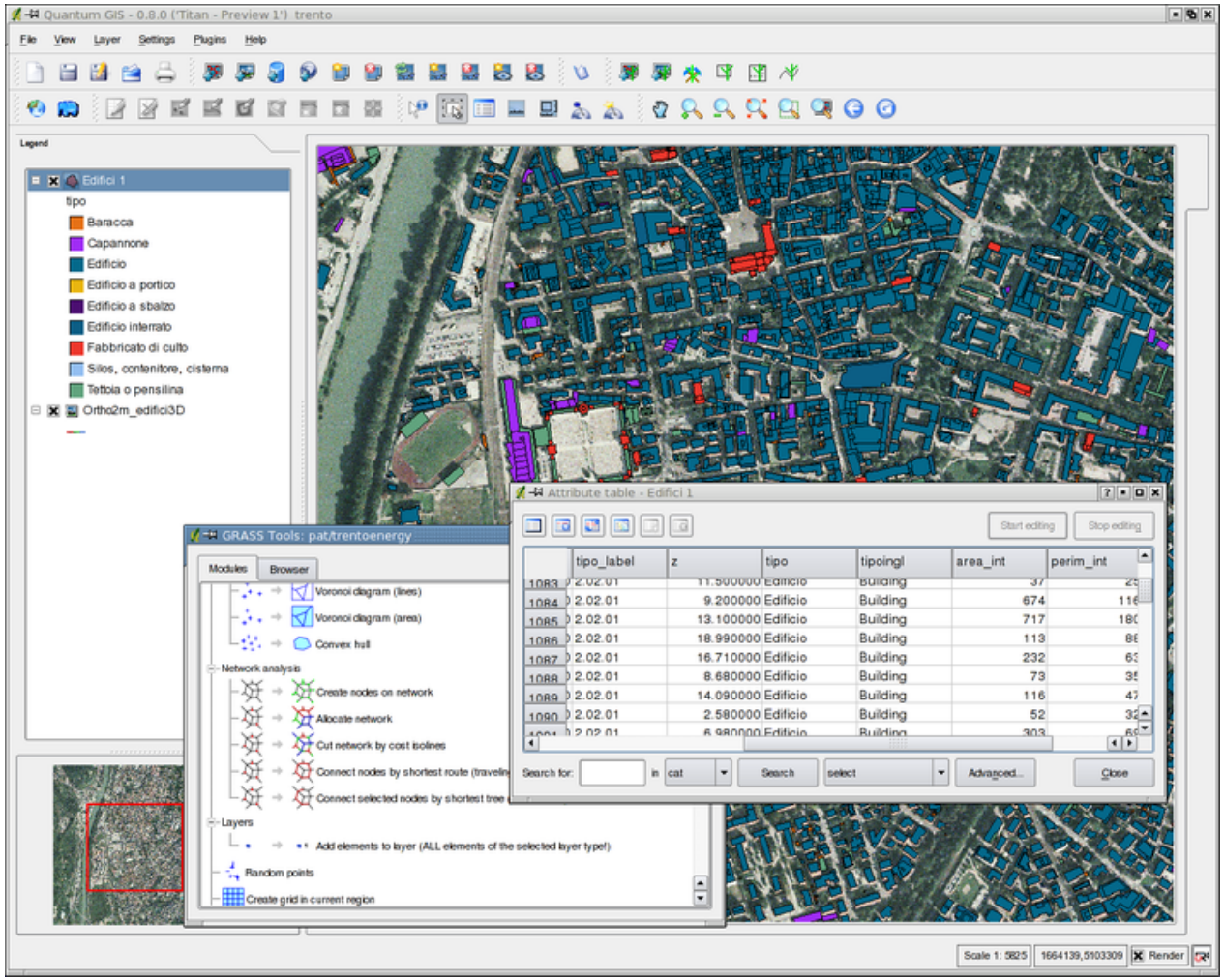
GIS: Geographic Information Systems



http://en.wikipedia.org/wiki/File:Arcgisclusters.jpg

UNIVERSITY OF LIVERPOOL

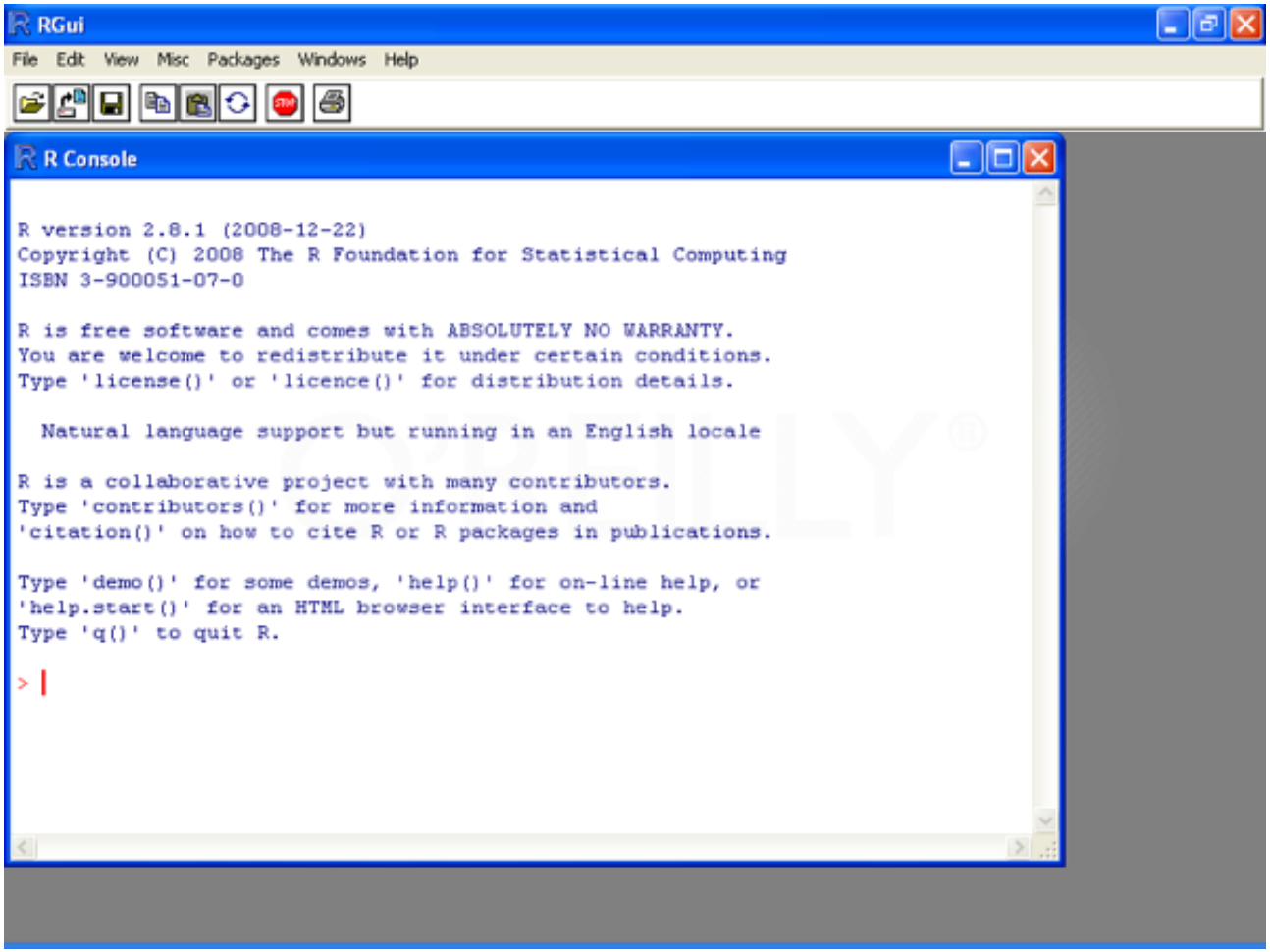
GIS: Geographic Information Systems



UNIVERSITY OF LIVERPOOL

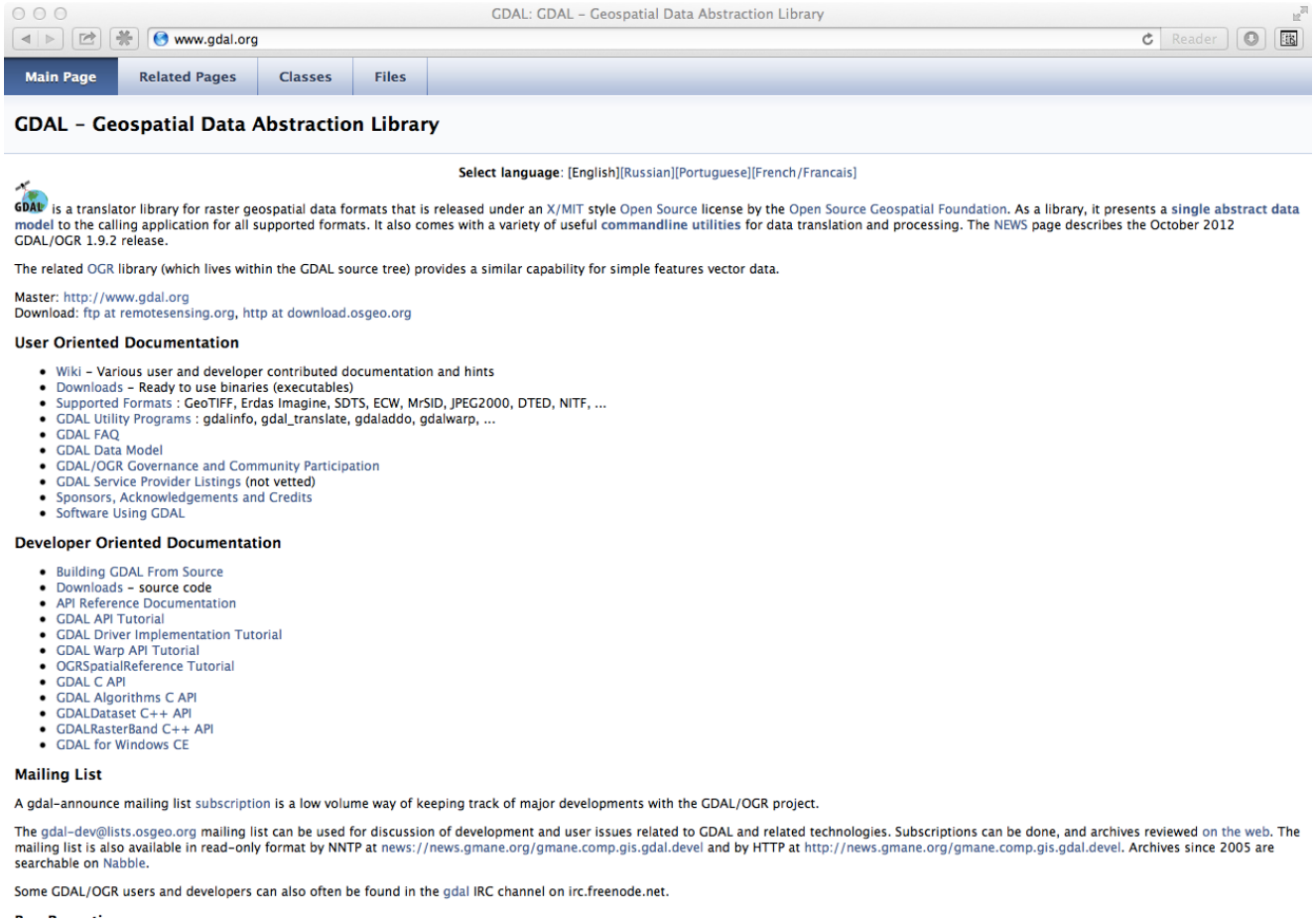
http://en.wikipedia.org/wiki/File:Qgis08_grass6_toolbox.png

GIS: Geographic Information Systems



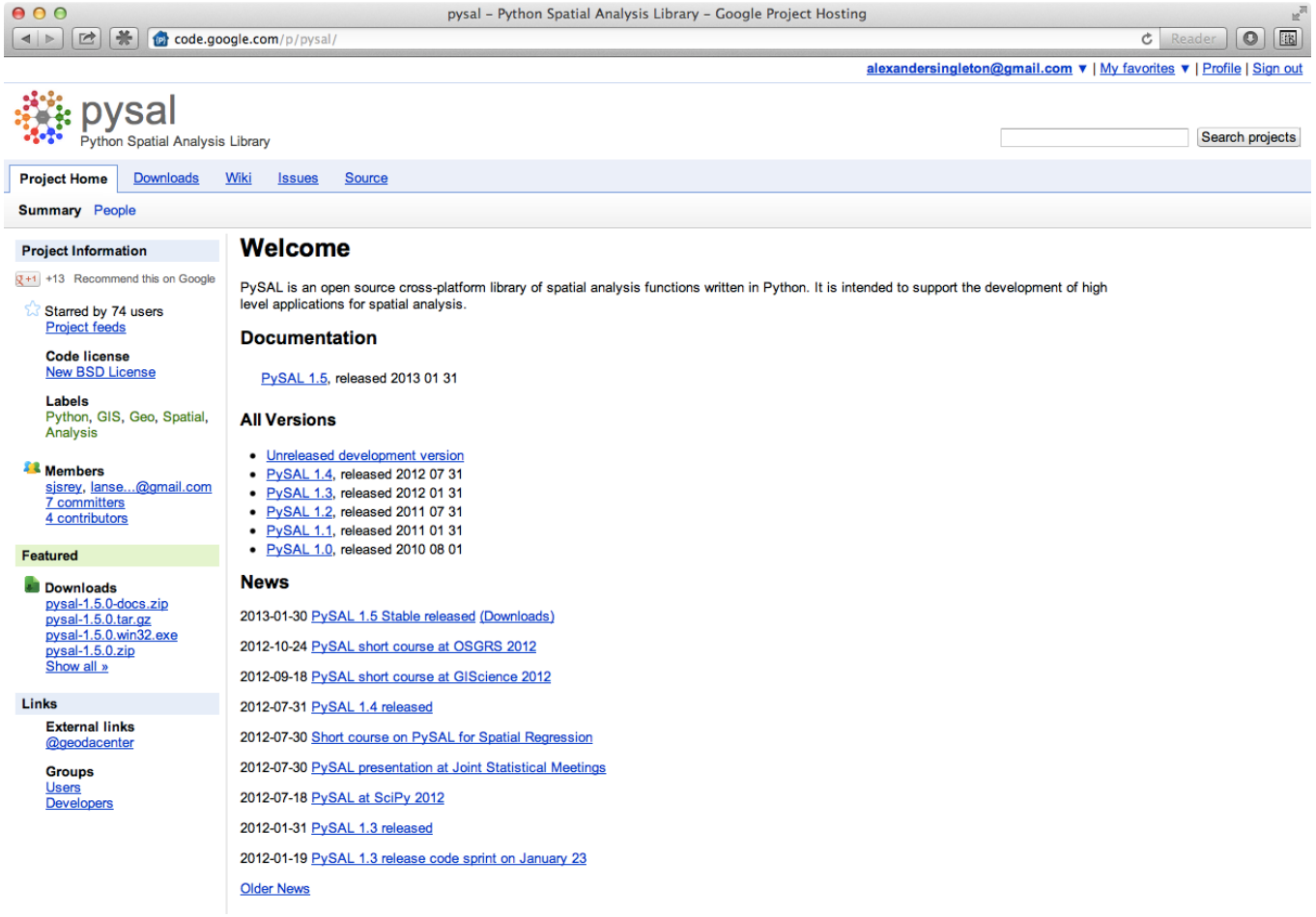
GIS: Geographic Information Systems

GIS: Geographic Information Systems



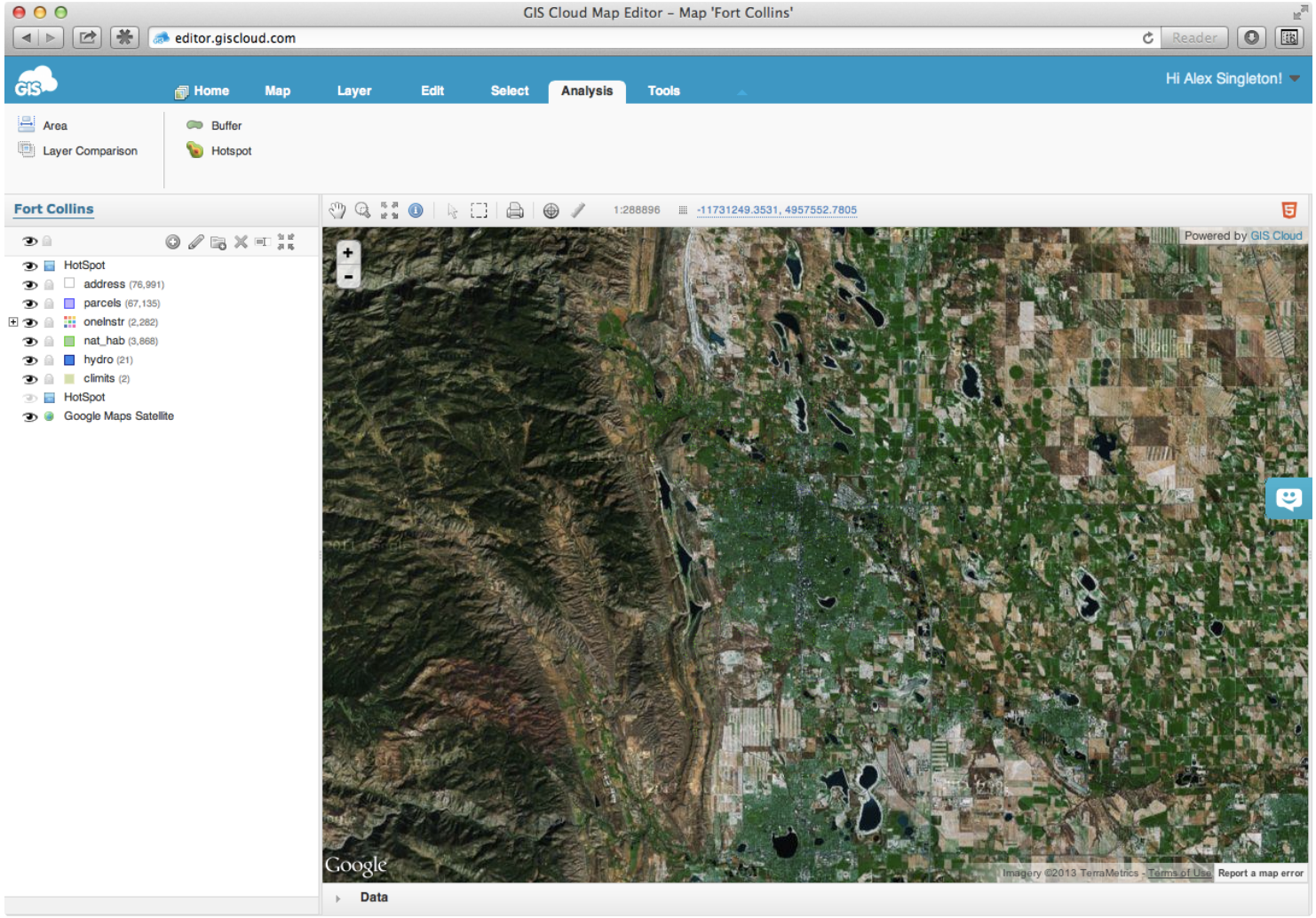
UNIVERSITY OF LIVERPOOL

GIS: Geographic Information Systems



UNIVERSITY OF LIVERPOOL

GIS: Geographic Information Systems



UNIVERSITY OF LIVERPOOL

Databases & Joins

- Organized / structured collection of data
- Tables hold data
- Relationships between tables
- E.g…

Person ID	Surname	Location ID
1	Thomas	1
2	Carl	1
3	Constance	2
4	Frank	2
5	Billy	4

Location ID	Local Authority
1	Liverpool
2	Camden
3	Milton Keynes
4	Manchester
5	Sefton

Person ID	Surname	Location ID	Local Authority
1	Thomas	1	Liverpool
2	Carl	1	Liverpool
3	Constance	2	Camden
4	Frank	2	Camden
5	Billy	4	Manchester

Merging data frames in R

```
New_Object<- merge(object1,object2,
by.x="variable",by.y="variable", in.x=TRUE)
```

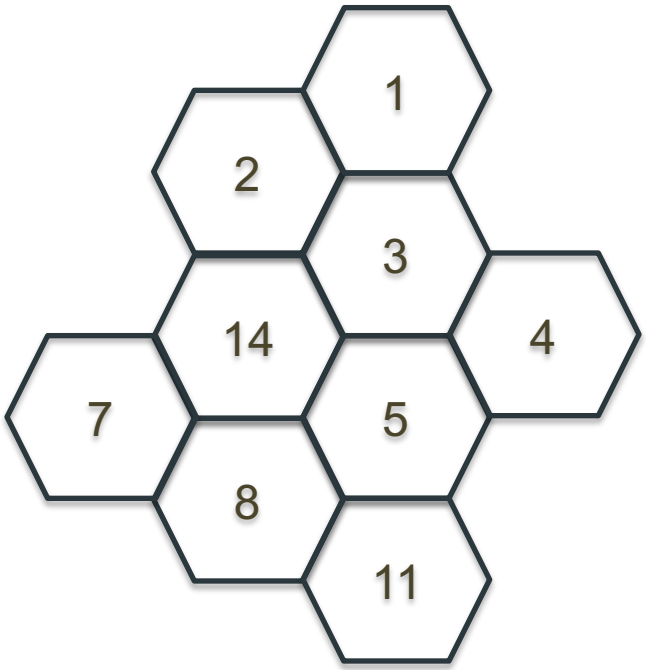
People_Table

Person ID	Surname	Location ID
1	Thomas	1
2	Carl	1
3	Constance	2
4	Frank	2
5	Billy	4

Places_Table

Location ID	Local Authority
1	Liverpool
2	Camden
3	Milton Keynes
4	Manchester
5	Sefton

```
New_Object<- merge(People_Table,Places_Table,
by.x="Location ID",by.y="Location ID", in.x=TRUE)
```



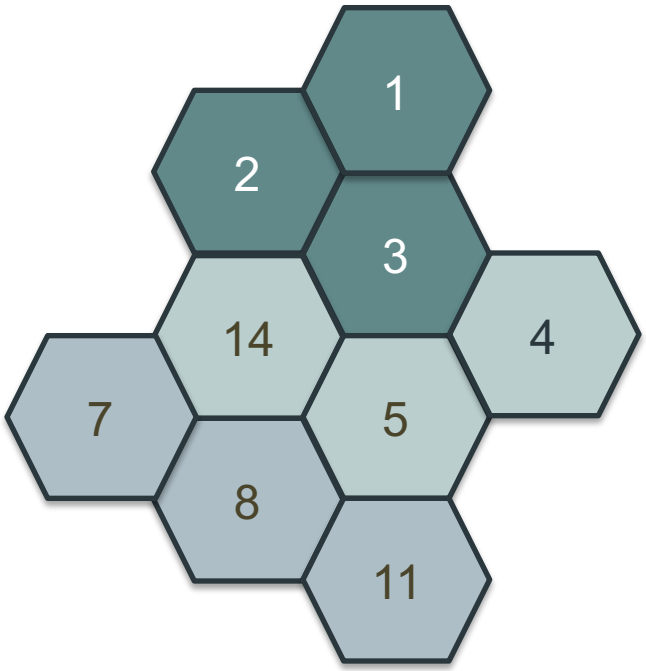
Polygons

Area ID
1
2
3
4
5
14
7
8
11

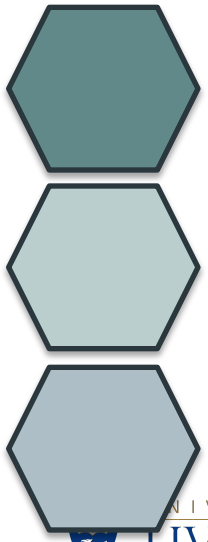
Data

Area ID	Deprivation
1	High
2	High
3	High
4	Average
5	Average
6	Average
7	Low
8	Low
9	Low
10	High
11	Low
12	High
13	High
14	Average
15	Average

Lookup



Area ID	Deprivation
1	High
2	High
3	High
4	Average
5	Average
14	Average
7	Low
8	Low
11	Low



High Deprivation

Average Deprivation

Low Deprivation

Adding data to polygons in R

```
LSOA <- readShapePoly("LSOA/england_low_soa_2001.shp")
Plot(LSOA)
```

Adding data to polygons in R

```
head(LSOA@data)
```

```
   zonecode
0 E01006739
1 E01006687
2 E01006741
3 E01006743
4 E01006528
5 E01006684
```

```
# Order the LSOA spatial polygon data frame
LSOA <- LSOA[order(LSOA$zonecode), ]
# Order the CT_2001_2011_Liverpool data frame
CT_2001_2011_Liverpool <-
CT_2001_2011_Liverpool[order(CT_2001_2011_Liverpool$LSOA_CODE), ]
# Join based on ordering
LSOA@data <- cbind(LSOA@data, CT_2001_2011_Liverpool,
POP_2001_2010_Liverpool)
```

Adding data to polygons in R

These two methods are suitable where the rows in the object are different – e.g. appending a national lookup table

```
# Alternative method 1 (this sometimes causes errors!)
LSOA@data <- merge(LSOA@data, CT_2001_2011_Liverpool
,by.x="zonecode", by.y="LSOA_CODE",in.x=TRUE)
# Alternative method 2
LSOA@data = data.frame(LSOA@data,
CT_2001_2011_Liverpool[match(LSOA@data[,"zonecode"],
CT_2001_2011_Liverpool[,"LSOA_CODE"]),])
```

```
match(LSOA@data[,"zonecode"],CT_2001_2011_Liverpool[,"LSOA_CODE"]
)
```

Making Maps in R

- Create breaks
- Define a colour scheme
- Apply breaks to create colour categories for each area

Making Maps in R

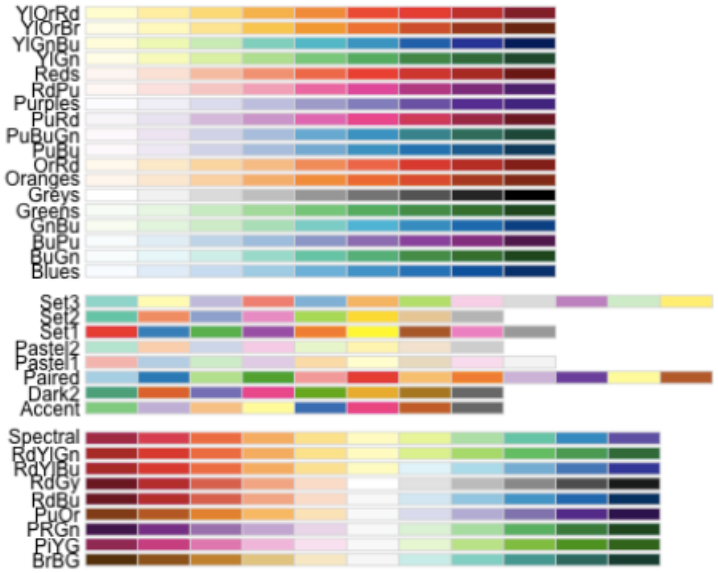
- For a continuous variable, find a sensible set of breaks that can be used to divide up the values into categories

```
#set breaks for 6 categories and then add the values to a single list – style = fisher is jenks
breaks <- classIntervals(LSOA@data$TotPop_PC, n = 6, style = "fisher")
breaks
```

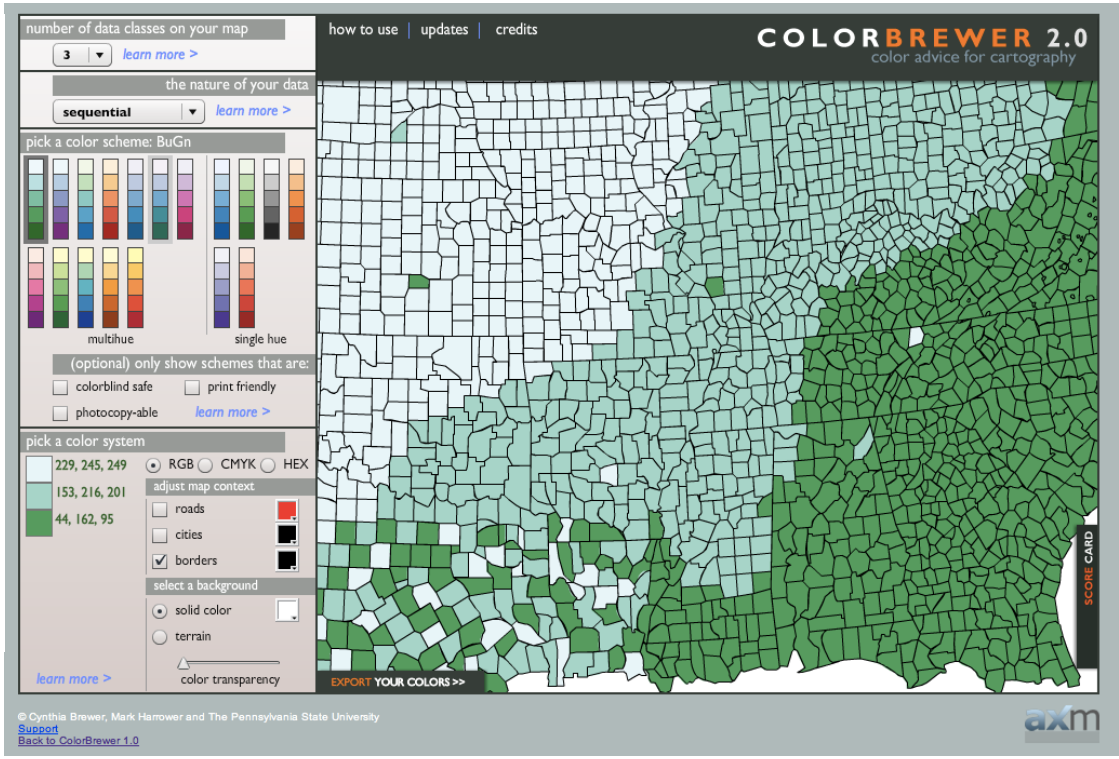
```
[1] -79.007 -44.874 -12.964   4.688  30.600  73.195 127.698
```

Making Maps in R

- Choose a colour pallet using color brewer, or, make up your own list.



display.brewer.all()



http://colorbrewer2.com

UNIVERSITY OF LIVERPOOL

Making Maps in R

```
# Select six colours from the pallet YlOrRd
my_colours <- brewer.pal(6, "YlOrRd")
# Print the colour codes to the terminal
my_colours
```

```
> "#FFFFB2" "#FED976" "#FEB24C" "#FD8D3C" "#F03B20" "#BD0026"
```

http://en.wikipedia.org/wiki/Web_colors
http://www.colorhexa.com
http://research.stowers-institute.org/efg/R/Color/Chart/ColorChart.pdf

Making Maps in R

- Find the appropriate intervals for the continuous data: LSOA@data$TotPop_PC

```
#print the intervals
findInterval(LSOA@data$TotPop_PC, breaks, all.inside =
TRUE)
```

```
  [1] 6 5 4 3 3 3 5 4 3 3 3 3 3 4 3 3 3 4 3 3 3 3 3 3 3 3 5 3 3 3 3 2 3 3 3
 [36] 3 3 3 4 4 4 4 4 3 3 4 3 2 1 3 1 3 3 3 3 3 3 4 3 3 3 3 3 3 3 3 4 4 3 3
 [71] 3 3 4 3 3 4 4 3 3 3 3 3 3 3 3 3 3 2 2 3 2 1 3 3 3 3 4 3 3 3 3 3 3 3 3
[106] 3 3 3 3 3 3 2 3 3 3 3 3 4 3 3 3 3 3 5 3 3 4 2 3 4 5 2 3 4 3 4 3 4 6 6
[141] 4 3 3 4 4 3 3 3 4 3 3 4 2 4 4 3 3 4 4 3 3 4 4 4 3 4 2 4 4 3 3 3 3 5 3
[176] 3 4 3 3 3 3 3 3 4 4 4 3 3 3 3 3 3 3 3 2 3 3 3 4 3 3 3 3 3 3 3 4 3 3 3 5
[211] 4 3 3 2 3 4 2 3 4 3 3 3 4 3 3 3 3 3 3 2 3 3 5 3 4 3 6 3 1 2 6 2 3 3 3
[246] 4 3 3 2 4 3 4 3 3 3 3 4 3 3 2 3 3 3 3 3 4 2 3 3 3 4 3 3 3 4 4 3 4 3 3
[281] 3 3 4 3 3 3 3 3 4 2 3
```

Making Maps in R

- Remember the list my_colours…
  - "#FFFFB2" "#FED976" "#FEB24C" "#FD8D3C" "#F03B20" "#BD0026"
- Also that you can refer to items of the list with the square brackets []
  - E.g. my_colours[2] – second item in list

```
# Returns a list of colours
my_colours[findInterval(LSOA@data$TotPop_PC, breaks,
all.inside = TRUE)]
```

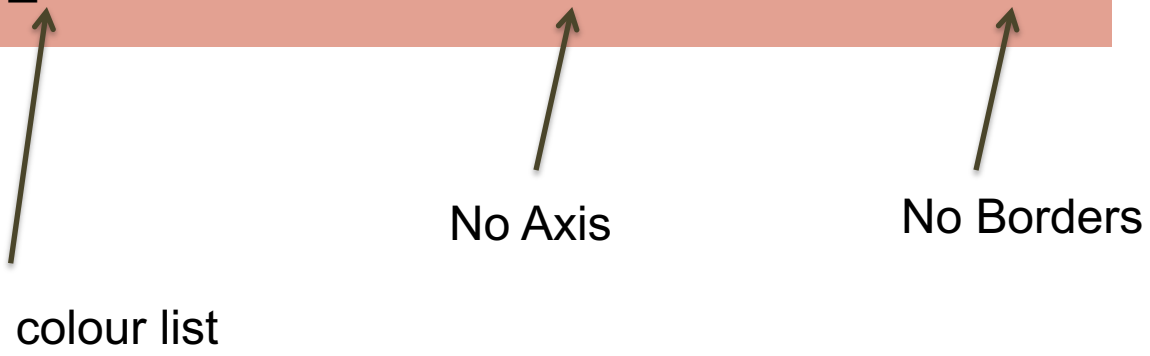
```
  [1] "#BD0026" "#F03B20" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#F03B20"
  [8] "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C"
 [15] "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C"
 [22] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#F03B20" "#FEB24C"
 [29] "#FEB24C" "#FEB24C" "#FEB24C" "#FED976" "#FEB24C" "#FEB24C" "#FEB24C"
 [36] "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FD8D3C" "#FD8D3C" "#FD8D3C"
 [43] "#FD8D3C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FED976" "#FFFFB2"
 [50] "#FEB24C" "#FFFFB2" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
 [57] "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
 [64] "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FEB24C"
 [71] "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FD8D3C"
 [78] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
 [85] "#FEB24C" "#FEB24C" "#FEB24C" "#FED976" "#FED976" "#FEB24C" "#FED976"
 [92] "#FFFFB2" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C"
 [99] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
[106] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FED976"
[113] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C"
[120] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#F03B20" "#FEB24C" "#FEB24C"
[127] "#FD8D3C" "#FED976" "#FEB24C" "#FD8D3C" "#F03B20" "#FED976" "#FEB24C"
[134] "#FD8D3C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FD8D3C" "#BD0026" "#BD0026"
[141] "#FD8D3C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FEB24C"
[148] "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FED976" "#FD8D3C"
[155] "#FD8D3C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FEB24C"
[162] "#FD8D3C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FD8D3C" "#FED976" "#FD8D3C"
[169] "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#F03B20" "#FEB24C"
[176] "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
[183] "#FEB24C" "#FD8D3C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C"
[190] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FED976" "#FEB24C" "#FEB24C"
[197] "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
[204] "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#F03B20"
[211] "#FD8D3C" "#FEB24C" "#FEB24C" "#FED976" "#FEB24C" "#FD8D3C" "#FED976"
[218] "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C"
[225] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FED976" "#FEB24C"
[232] "#FEB24C" "#F03B20" "#FEB24C" "#FD8D3C" "#FEB24C" "#BD0026" "#FEB24C"
[239] "#FFFFB2" "#FED976" "#BD0026" "#FED976" "#FEB24C" "#FEB24C" "#FEB24C"
[246] "#FD8D3C" "#FEB24C" "#FEB24C" "#FED976" "#FD8D3C" "#FEB24C" "#FD8D3C"
[253] "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C"
[260] "#FED976" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C"
[267] "#FED976" "#FEB24C" "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C"
[274] "#FEB24C" "#FD8D3C" "#FD8D3C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C"
[281] "#FEB24C" "#FEB24C" "#FD8D3C" "#FEB24C" "#FEB24C" "#FEB24C" "#FEB24C"
[288] "#FEB24C" "#FD8D3C" "#FED976" "#FEB24C"
```

Making Maps in R

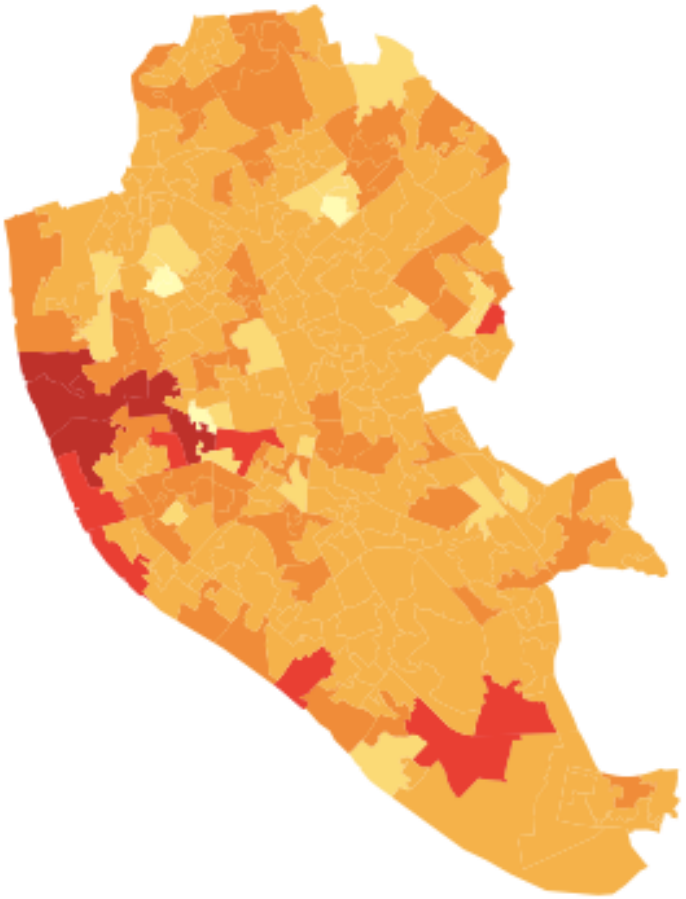
- Create a basic map with plot()

```
#Plot colours
plot_colours <-
my_colours[findInterval(LSOA@data$TotPop_PC, breaks,
all.inside = TRUE)]

# Create a basic choropleth map
plot(LSOA, col = plot_colours, axes = FALSE, border = NA)
```



Making Maps in R

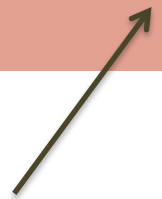


- Missing
  - Labels / context
  - North arrow
  - Scale bar
  - Legend

Making Maps in R

- Add ward borders on top of the previous LSOA plot

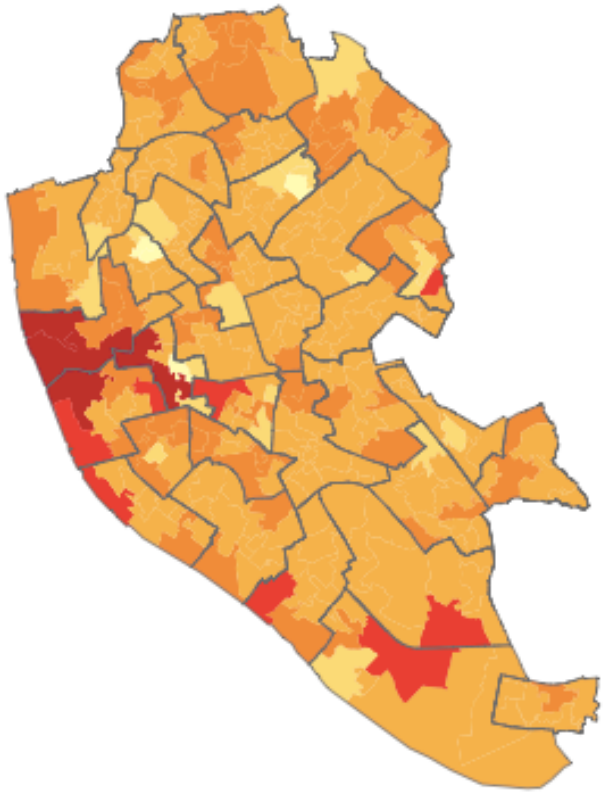
```
# Plot the wards on top of the LSOA choropleth
plot(CASWARD, axes = FALSE, border = "#6B6B6B", add = TRUE)
```



Specify border colour

Add on top of previous plot, rather than starting A new plot

Making Maps in R



Making Maps in R

- Adding labels with text()

Remember – [row,column]!

```
# Add on text labels for the wards
text(coordinates(CASWARD)[, 1], coordinates(CASWARD)[, 2],
labels = CASWARD@data$wards,
    cex = 0.7)
```

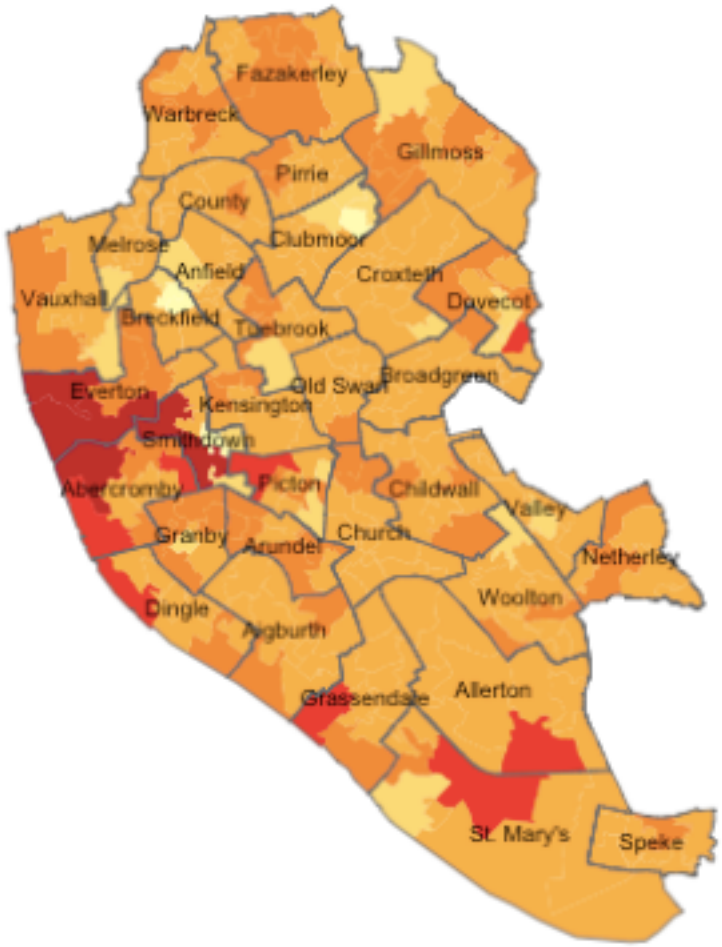
Scales label larger or smaller

Label values

coordinates(CASWARD) extracts a list of centroids for each polygon

Label goes in the centre

Making Maps in R



UNIVERSITY LIVERPC

Making Maps in R

x.y location

```
# Add the legend
legend(x = 333603, y = 386096, legend =
leglabs(round(breaks), between = " to "),
   fill = my_colours, bty = "n")
```

Creates text labels – the round() function reduces decimal places

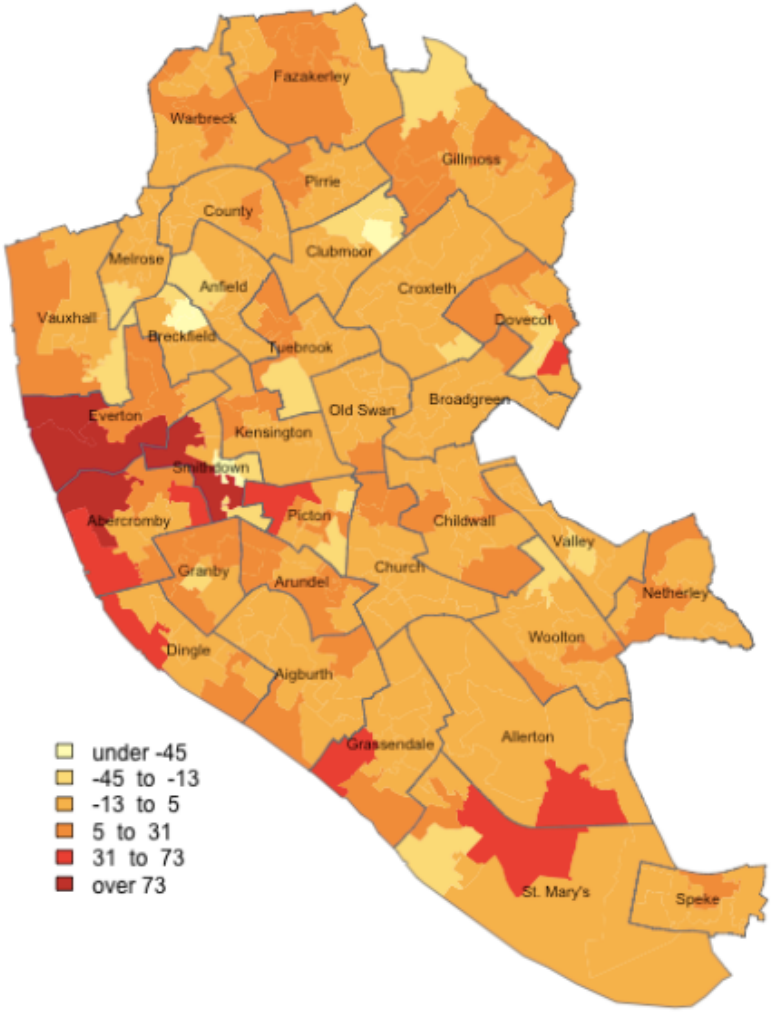
Colour pallet

Backgroun d colour

```
# Finding locations
Locator()
```

UNIVERSITY OF LIVERPOOL

Making Maps in R



UNIVERSITY OF LIVERPOOL

Making Maps in R

Type of arrow

```
# Add North Arrow
SpatialPolygonsRescale(layout.north.arrow(2), offset =
c(333770, 381184), scale = 1000, plot.grid = F)
```

Offset – c(x,y)

Size of the arrow
– in the map units

Making Maps in R

Could also use hex values

Adding scale bar rather than north arrow

```
# Add Scale Bar
SpatialPolygonsRescale(layout.scale.bar(), offset =
c(335379, 381184), scale = 3000,
    fill = c("white", "black"), plot.grid = F)

# Add text to scale bar
text(335379, 381606, "0km", cex = 0.8)
text(335379 + 1500, 381606, "1.5km", cex = 0.8)
text(335379 + 3000, 381606, "3km", cex = 0.8)
```

X

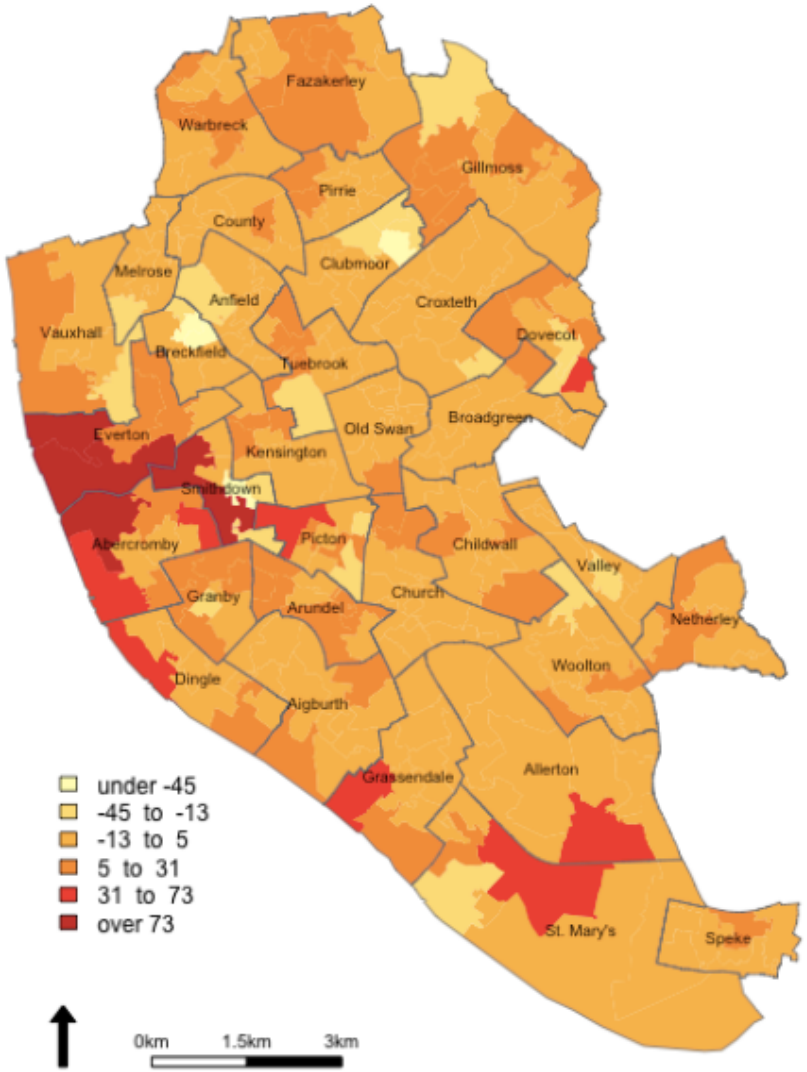
Y

Label

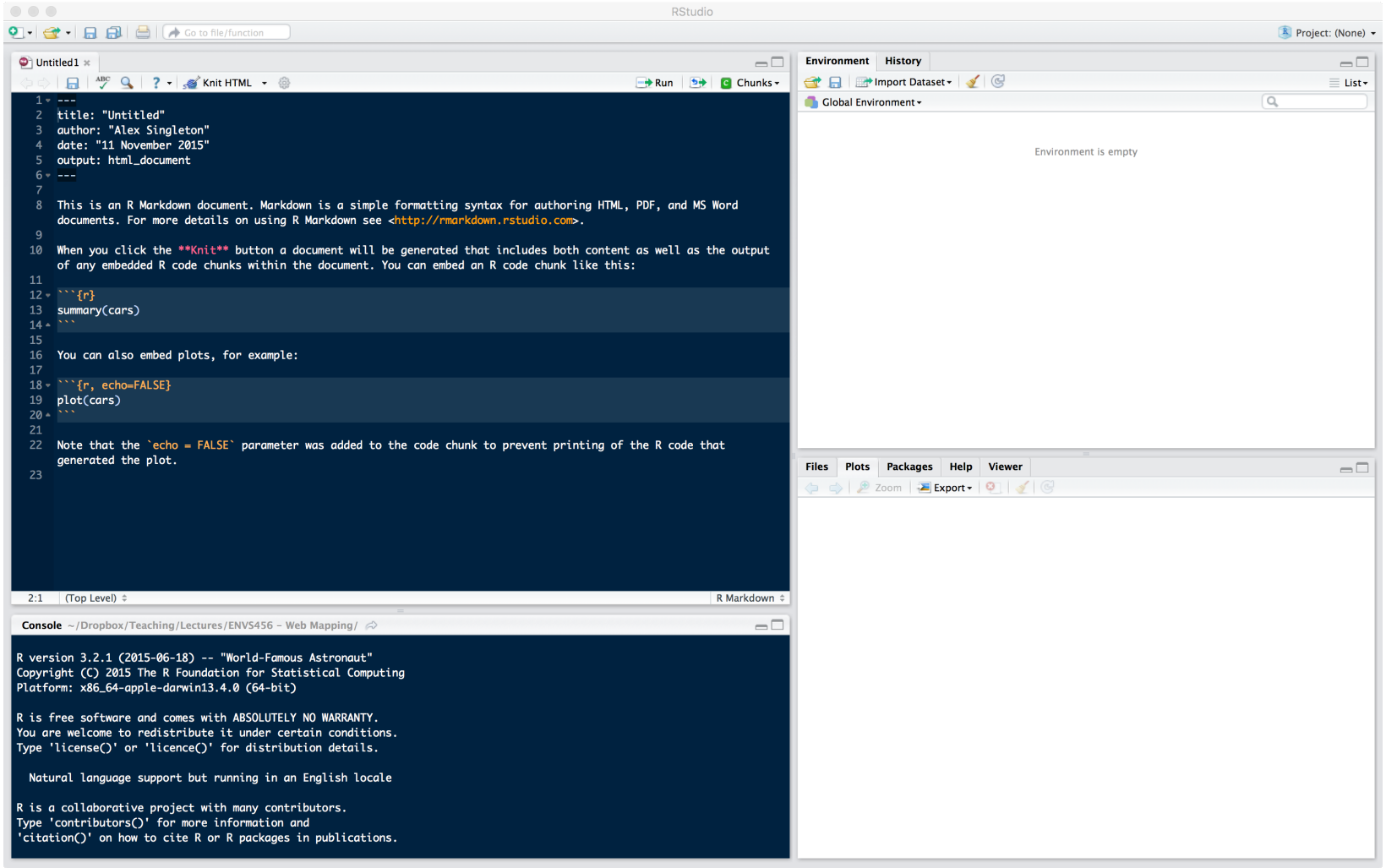
Scaling

UNIVERSITY OF LIVERPOOL

Making Maps in R



R and Markdown



UNIVERSITY OF LIVERPOOL

https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf

Many thanks…

UNIVERSITY OF LIVERPOOL