

Geospatial Data in R



going off-road

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Spatial Packages

What's on CRAN for us?

Spatial Task View

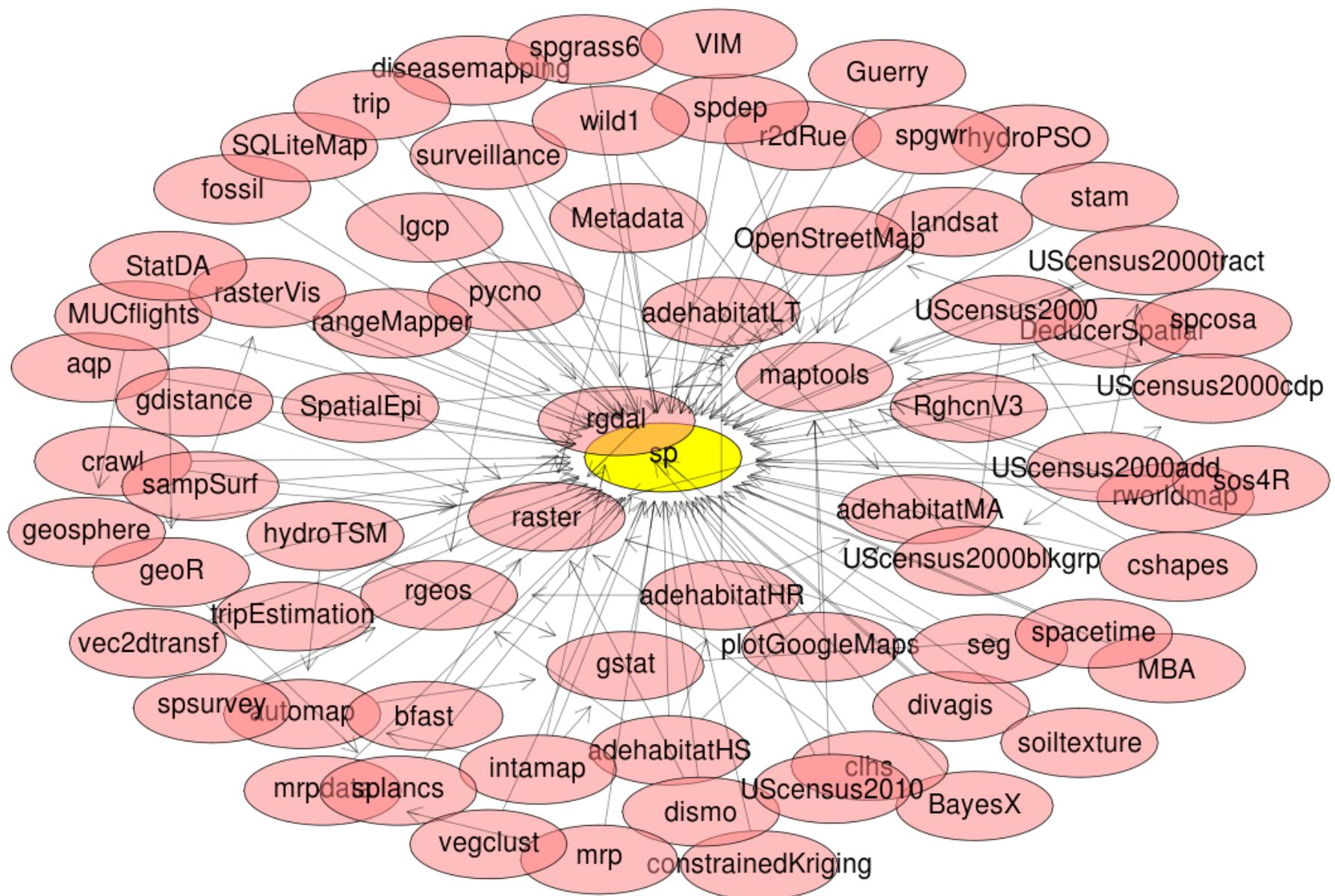
```
ade4, adehabitat, adehabitatHR, adehabitatHS,
adehabitatLT, adehabitatMA, ads, akima, ash, aspace,
automap, classInt, clustTool, ComprandFld,
constrainedKriging, cshapes, DCluster, deldir, DSpat,
ecespa, fields, FieldSim, gdistance, Geneland, GEOMap,
geomapdata, geonames, geoR, geoRglm, geosphere, GeoXp,
glmmBUGS, gmt, gstat, Guerry, hdeco, intamap, landsat,
mapdata, mapproj, maps, maptools, MarkedPointProcess,
MBA, Metadata, ModelMap, ncdf, ncf, nlme, pastecs,
PBSmapping, PBSmodelling, psgp, ramps, RandomFields,
rangeMapper, RArcInfo, raster, RColorBrewer, regress,
rgdal, rgeos, RgoogleMaps, RPyGeo, RSAGA, RSurvey,
rworldmap, sgeostat, shapefiles, sp, sparr, spatcounts,
spatgraphs, spatial, spatialCovariance, SpatialExtremes,
spatialkernel, spatialsegregation, spatstat, spBayes,
spcosa, spdep, spgrass6, spgwr, sphet, splancs,
spsurvey, SQLiteMap, Stem, tgp, trip, tripack,
tripEstimation, UScensus2000, UScensus2000blkgrp,
UScensus2000cdp, UScensus2000tract, vardia, vegan
```

1 Package

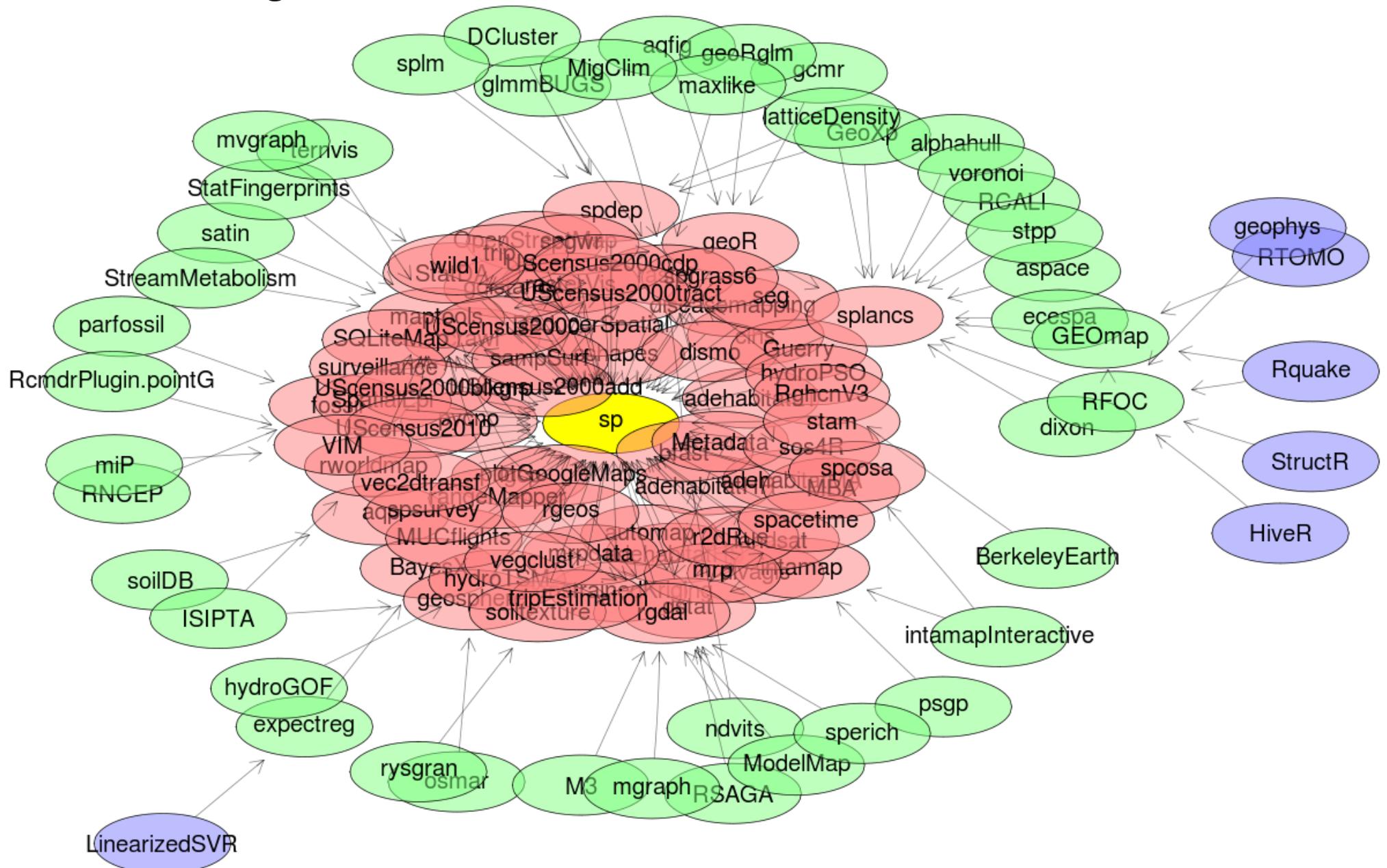


sp

73 Packages



122 Packages



A package does what?

- Geography/Geometry
 - `gdistance`, `geosphere`, `voronoi`, ...
- General Spatial Statistics
 - `geoR`, `spatstat`, `lgcp`, `spgwr`, `gstat`,
`stam`, ...
- Specific Statistics
 - `adeHabitat*`, `Rquake`, `fossil`, ...
- Data
 - `UScensus*`, `MUCflights`, `RghcnV3`, ...

Sounds like a lot of R

- Over 3000 packages on CRAN
- Must be millions of lines of code
- Its not all R

Time travel

Historical Perspective

FORTRAN and C

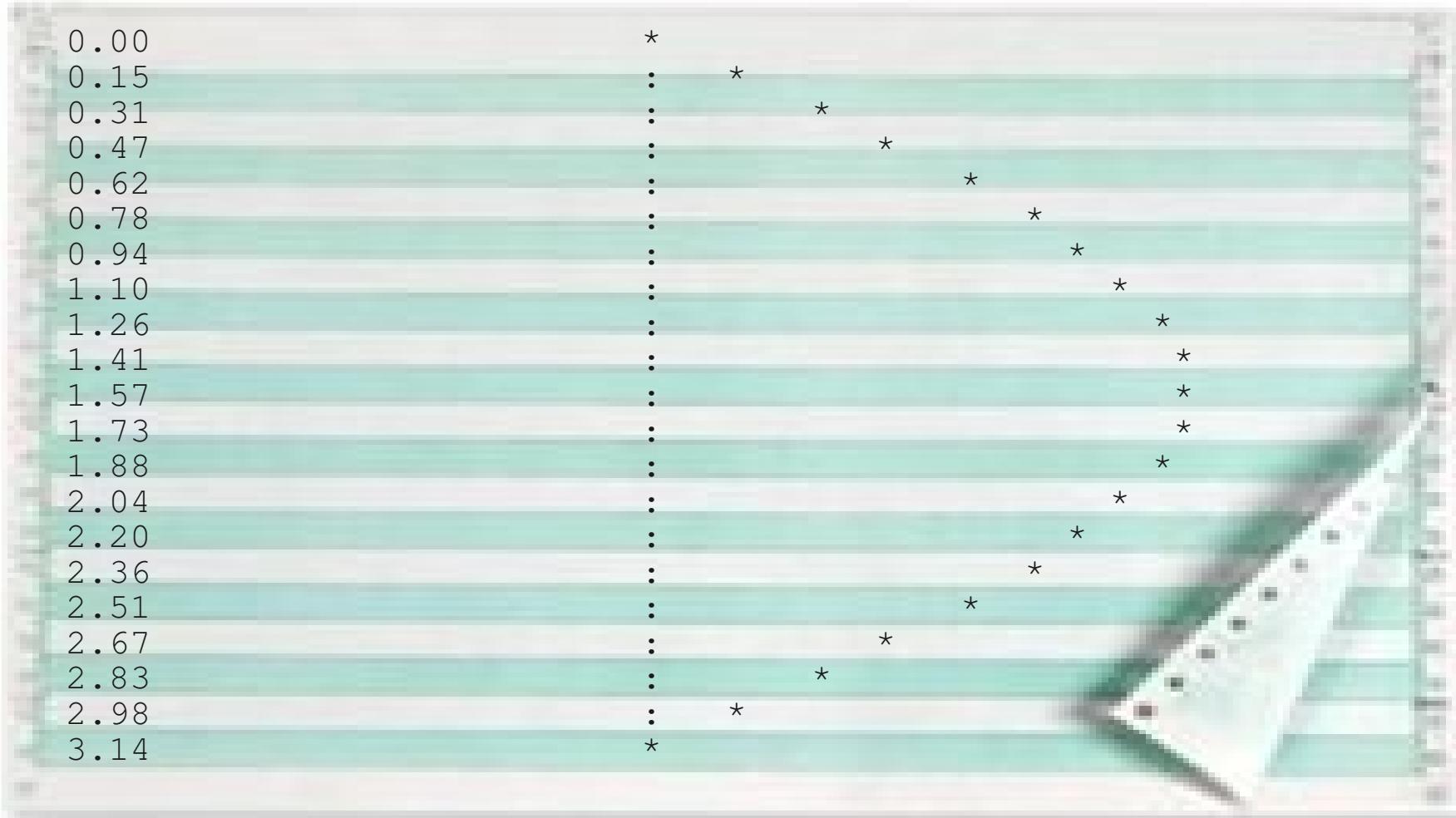
- Scientists and Statisticians wrote FORTRAN and C code
- Everybody started pretty much from scratch
- We realised we didn't all have to reinvent the wheel
- Useful modules of code got arranged into neat, re-usable libraries
- Scientists linked their code with the libraries.

But...

- The process was slow...
 - Write FORTRAN or C code
 - Compile
 - Link with libraries
 - Run
 - Print output



Graphs



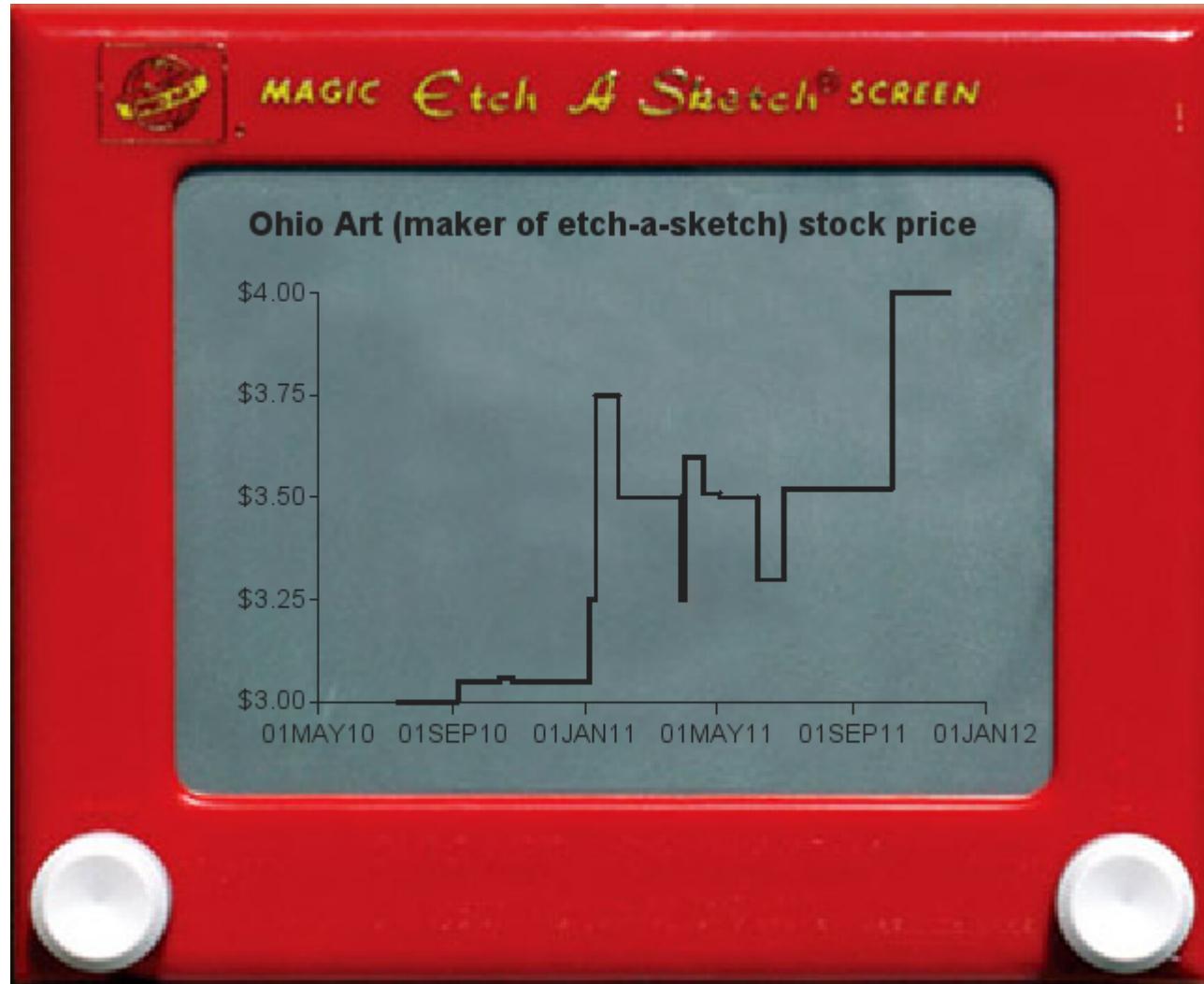
Or plot

- On a graphics terminal





Almost as good...



Anyway...

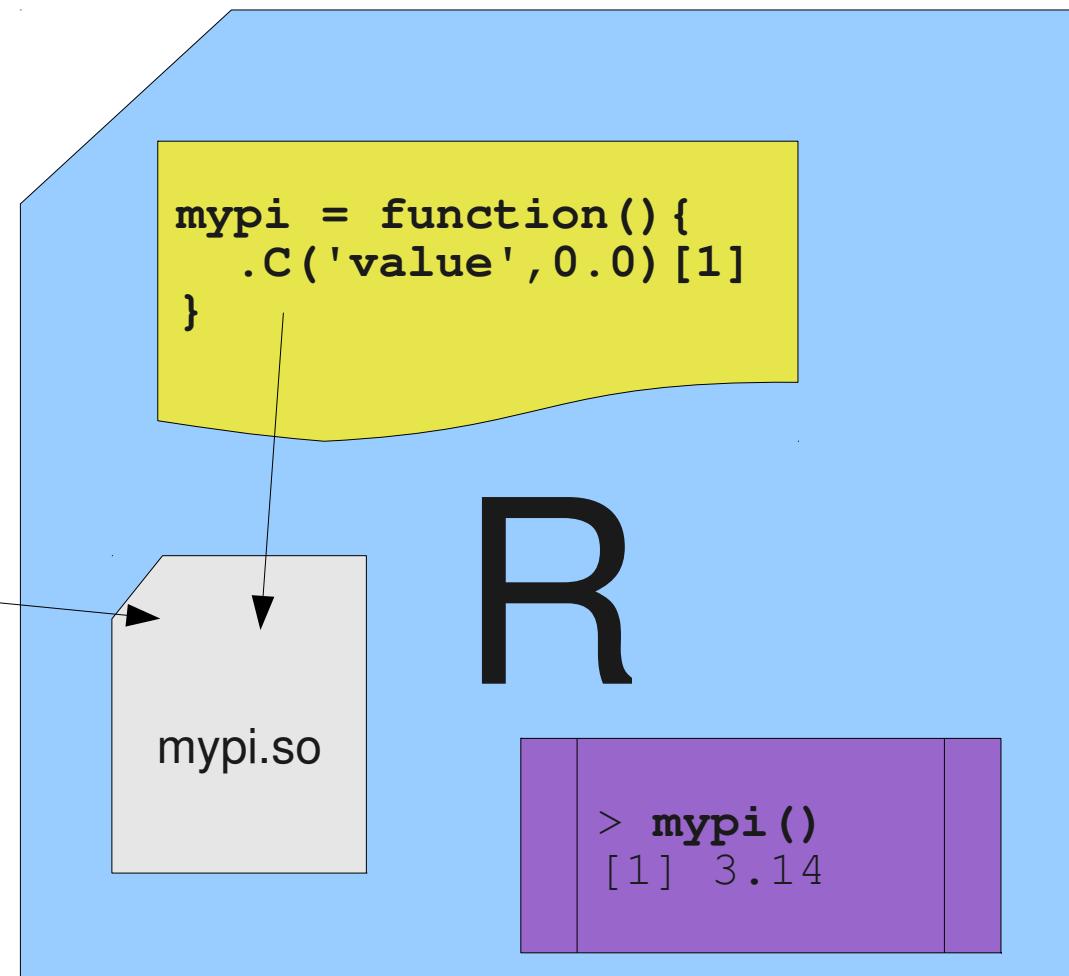
- Graphics Improved
- Communications Improved
- Processors Got Faster
- Statisticians and Scientists Got Impatient
- Started using S
- Interactive, responsive, data handling, graphics
- Perfect Storm for data scientists

Legacy

- What about all my C and FORTRAN code?

mypi.c

```
void value(double &p) {
    &p = 3.14;
    return;
}
```



Entire wrapped C libraries

- GEOS
 - Geometry Engine Open Source
 - Wrapped by `rgeos`
- PROJ4
 - Cartographic Projections
 - Called by `sp:spTransform` and `raster:project`
- GDAL/OGR
 - Read raster and vector datasets
 - Wrapped by `rgdal`, used by `raster`, `sp`



OSGeo Projects

- Open Source Geospatial Foundation
 - Supports development of geospatial software
 - Many of which play nicely with R

Screenshot of the OSGeo website (www.osgeo.org) showing the homepage layout.

The page includes a top navigation bar with links like File, Edit, View, History, Bookmarks, Tools, Help, and various search and filter options. The main content area features the OSGeo logo and tagline "Your Open Source Compass".

OSGeo Foundation

- [Home](#)
- [About the Foundation](#)
- [FAQ](#)
- [Sponsors](#)
- [Sponsor OSGeo](#)
- [Incubator](#)
- [Swag Store](#)
- [Contact](#)

OSGeo Community

- [Welcome](#)
- [Member Area](#)
- [News](#)
- [Events](#)
- [Wiki](#)
- [Mailing Lists](#)
- [Education](#)
- [Blogs](#)
- [Books](#)
- [IRC](#)
- [Service Providers](#)
- [Journal](#)
- [Sol Katz Award](#)
- [Local Chapters](#)
- [Spotlights](#)
- [Gallery](#)
- [Live DVD](#)

Language

- English
- Български
- 简体中文
- Deutsch
- Français
- Greek
- Indonesian

The Open Source Geospatial Foundation...

OSGeo was created to support the collaborative development of open source geospatial software, and promote its widespread use. Join us by signing up to our [mailing lists](#) or check out the [Getting Started](#) page to become more involved.

News

- 2012-04-28 GEOS Graduates OSGeo Incubation
- 2012-04-24 22 Students Accepted for OSGeo Google Summer of Code 2012
- 2012-04-03 PostGIS 2.0 Released
- 2012-03-22 Primera Reunión General OSGeo-es

[RSS](#) | [Submit News](#) more

Upcoming events

- 2012-05-07 GeoAlberta, Calgary, Canada
- 2012-05-20 FOSS4G-CEE & GeoInformatics 2012
- 2012-05-22 GRASS GIS Community Sprint, Prague, CZ
- 2012-06-09 Bolsena Hacking Event 2012 (Date change!!!)

[RSS](#) [Facebook](#) | [Submit Upcoming Events](#) more

Community Blogs

- OSGeo News: GEOS Graduates OSGeo Incubation
- Jackie Ng: About that Ubuntu support ...
- Volker Mische: WhereCampEU 2012 Amsterdam
- Matt Perry: Migrating from Wordpress to Jekyll
- gvSIG Team: Web Seminar about Introduction to gvSIG (May 2nd) / Seminario web de Introducción a gvSIG (2 Mayo 2012)
- Dylan Beaudette: soilDB Demo: Processing SSURGO Attribute Data with SDA_query()
- Jackie Ng: MapGuide Open Source 2.4: A comprehensive preview (part 1: The installer)
- UDIG Team: UDIG in GSoc 2012
- OSGeo News: 22 Students Accepted for OSGeo Google Summer of Code 2012
- gvSIG Team: gvSIG will participate at Google Summer of Code 2012
- Slashgeo (FOSS articles): MapKnitter: Open Source Orthorectification, Stitching and Publishing Tool
- Slashgeo (FOSS articles): OGR2012: Open Source Geospatial Research and Education Symposium - Second Call for computation and statistics

OSGeo Projects

- Web Mapping
- deegree
- geomajas
- GeoMoose
- GeoServer
- Mapbender
- MapBuilder
- MapFish
- MapGuide Open Source
- MapServer
- OpenLayers

Desktop Applications

- GRASS GIS
- Quantum GIS
- gvSIG

Geospatial Libraries

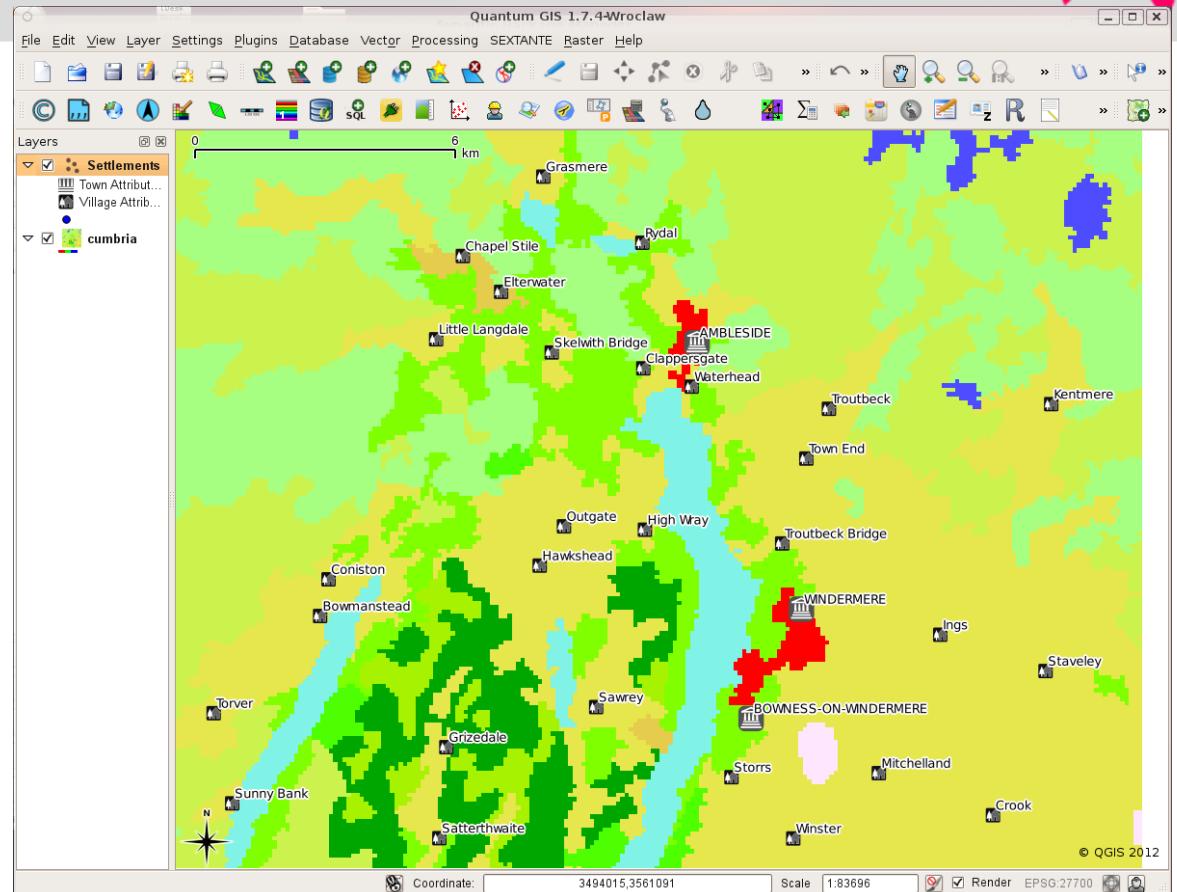
- FDO
- GDAL/OGR
- GEOS
- GeoTools
- MetacRS
- OGCML

Support OSGeo

[Donate](#)

Quantum GIS

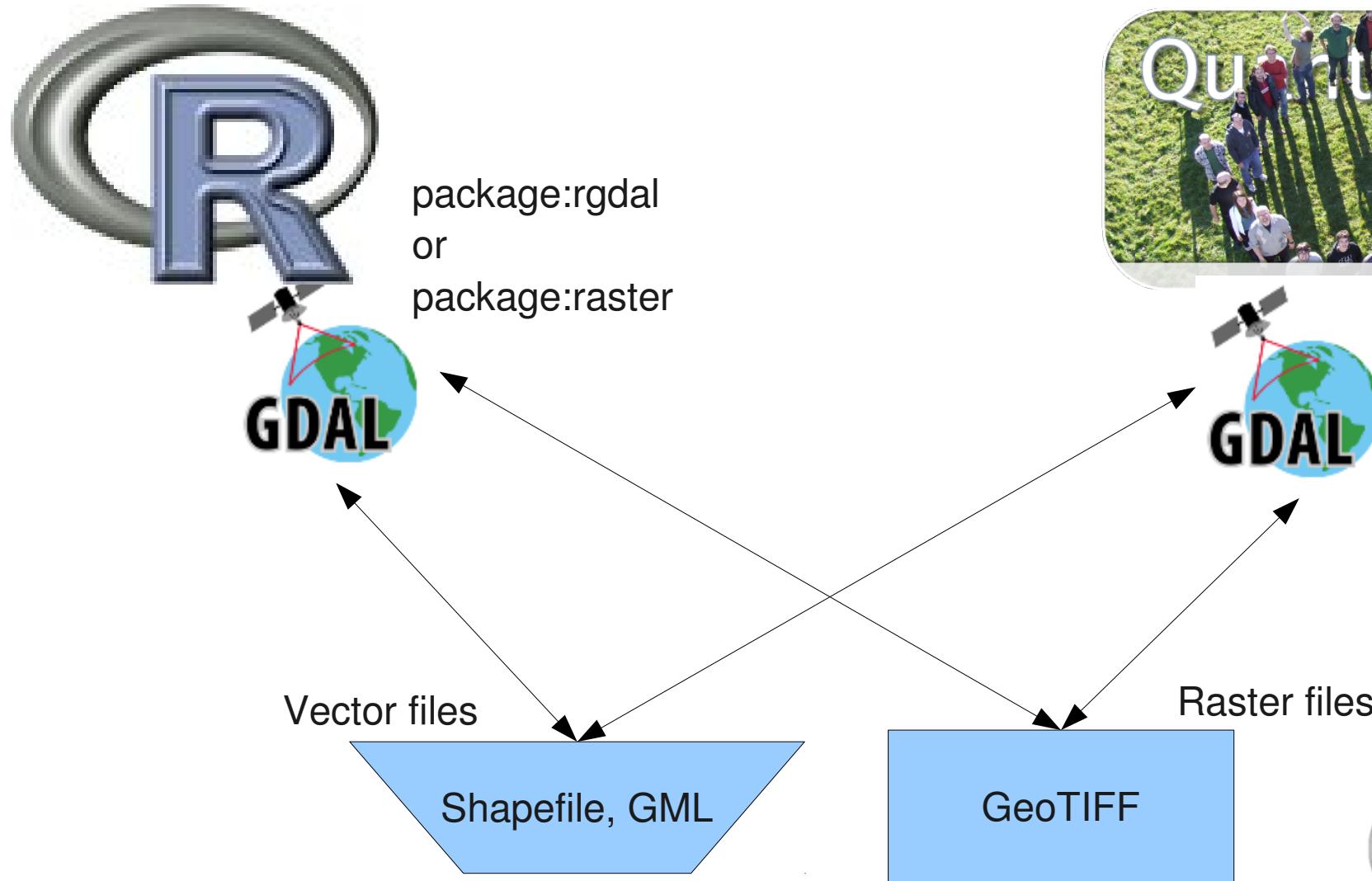
- Desktop GIS
- Windows
- Linux
- Mac
- Written in C++
- Embedded Python
- Extensible in C++
and Python



What do I use it for?

- Interactive Mapping
- Cartography
- Working with Databases

Qgis-R Integration



manageR plugin

File Edit View Layer Settings Plugins Database Vector Processing SEXTANTE Raster Help



Layers

- Settlements
 - Town Attribut...
 - Village Attribut...

- cumbria

editR - untitled1.R*

File Edit Action View Window Help



```
1 z = function(x){sqrt(x)}
```

Find and Replace Toolbar

Whole words Case sensitive

Find: Next

Replace: Replace

Column 25 Line 1 of 1



Coordinate:

3487837,3543574

Scale

1:83696



Render

EPSG:27700

manageR

File Edit Action Workspace Analysis View Window Help



Working Directory Manager

/data/rowlings/Datasets/eea.europa.eu/CorineLandCover

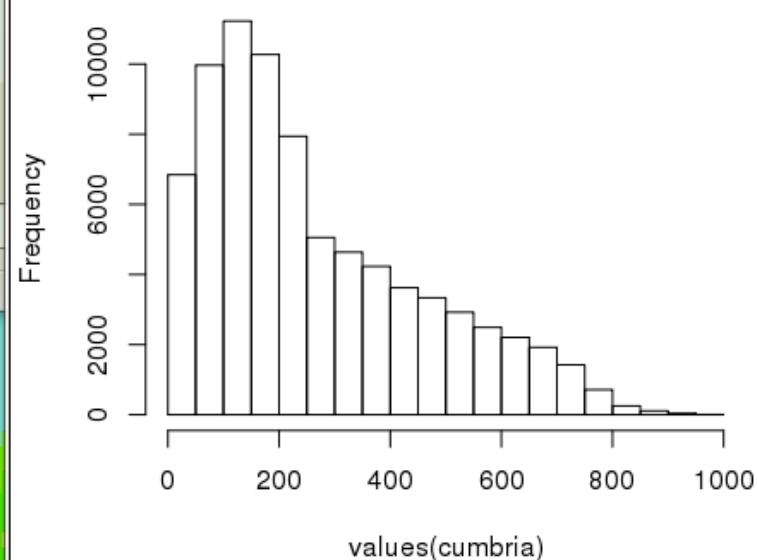
3	4	3	4	1	6	4	3	5	3	5	3
3	4	8	3	5	5	856	857	858	859	860	861
852	853	854	855	856	857	858	859	860	861	862	863
864	865	866	868								
2	3	2	3	2	6	4	6	1	2	2	2
5	1	2	2	5	1	869	870	871	872	873	874
869	870	871	872	873	874	875	876	877	879	880	881
882	883	884	885								
4	4	5	1	3	3	Ske	3ith	B4dge	1	1	1
2	1	3	5	888	889	890	893	894	895	896	897
888	889	890	893	894	895	896	897	898	899	900	901
902	903	904	906								
1	3	1	1	1	1	1	3	1	3	4	2
2	4	2	2	907	908	911	912	915	916	917	918
907	908	911	912	915	916	917	918	919	920	921	924
926	929	932	933								
1	1	3	2								
1	2	1	2	935	938	940	943	947	950	951	953
935	938	940	943	947	950	951	953	955	957	959	961
1	4	1	1	1	1	Otgate	Hawkshead	Sawrey	Thwaite	Torver	Grizedale

>

Find Toolbar

Find:

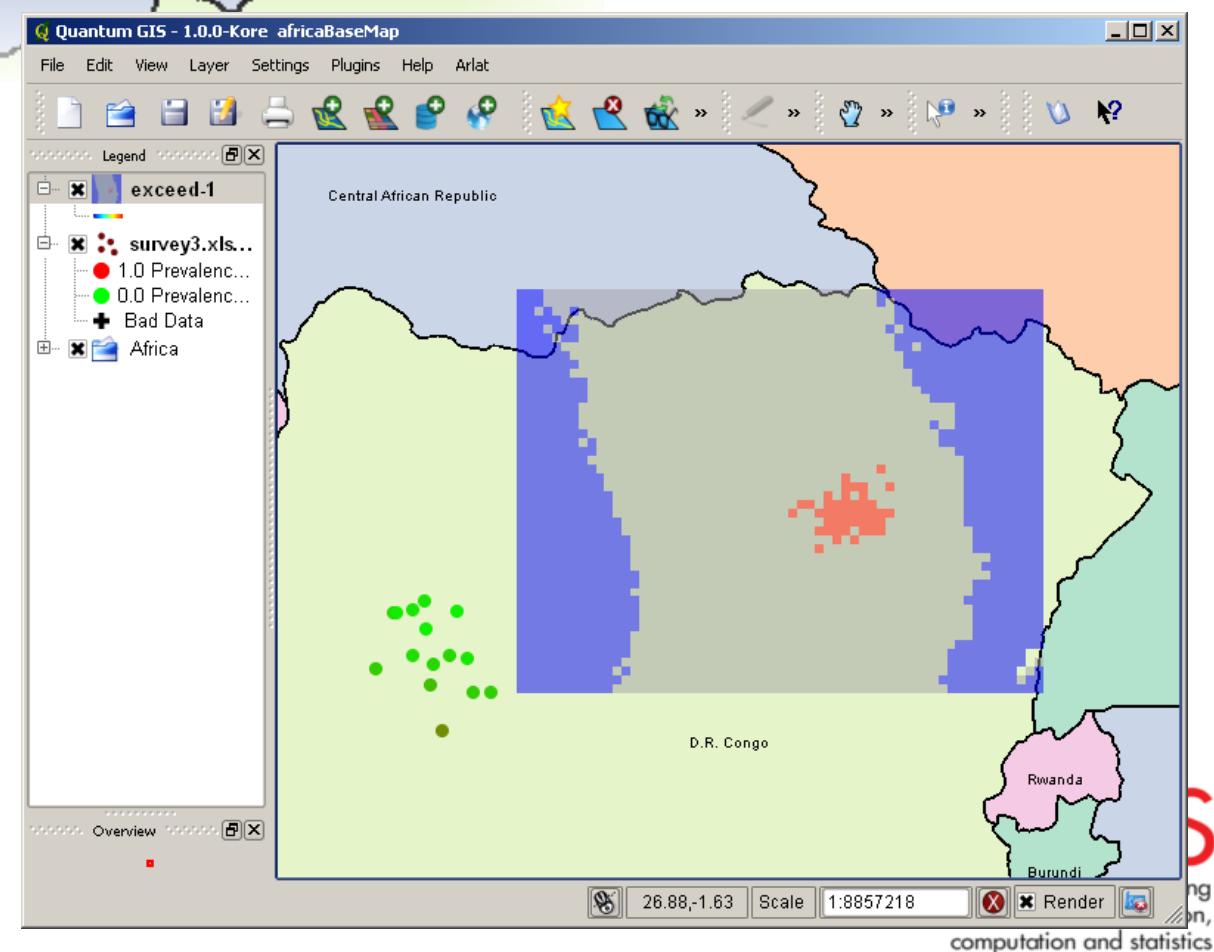
Histogram of values(cumbria)



12

Qgis Plugins with R

- Qgis Python Plugin
 - Adds functionality to Qgis
- Python plugin calls R
 - Python Rpy2 module
- R gets data from Qgis. R writes data to files
- Python plugin adds data to Qgis



PostGIS

The screenshot shows the official PostGIS website. At the top, there's a navigation bar with links for HOME, DOCUMENTATION, DOWNLOADS, SUPPORT, and NEWS. To the right of the navigation is the OSGeo Project logo, which features a green leaf-like icon and the text "OSGeo Project". The main content area has a light gray background with orange wavy patterns at the top. On the left, there's a sidebar titled "News" containing two items: "PostGIS 2.0.0 Released" and "PostGIS 2.0.0 RC1 Released". The "PostGIS 2.0.0 Released" item includes a link to "The Release of PostGIS 2.0!" and a note about it being "26 Months in the Making". The "PostGIS 2.0.0 RC1 Released" item includes a link to "Download, Test!". Below these news items are links for "More News..." and "XML". On the right, there's a section titled "What is PostGIS?" with a detailed description of what PostGIS is and how it adds support for geographic objects to the PostgreSQL database. There's also a small illustration of an elephant holding a globe.

- Spatially Enables the PostgreSQL DB
- Adds Geometry Columns to Databases
- Provides Spatial Queries
- Client: either Rpgsql or rgdal
- Server: PL/R

What do I use it for?

- Managing big data sets
- Spatial queries

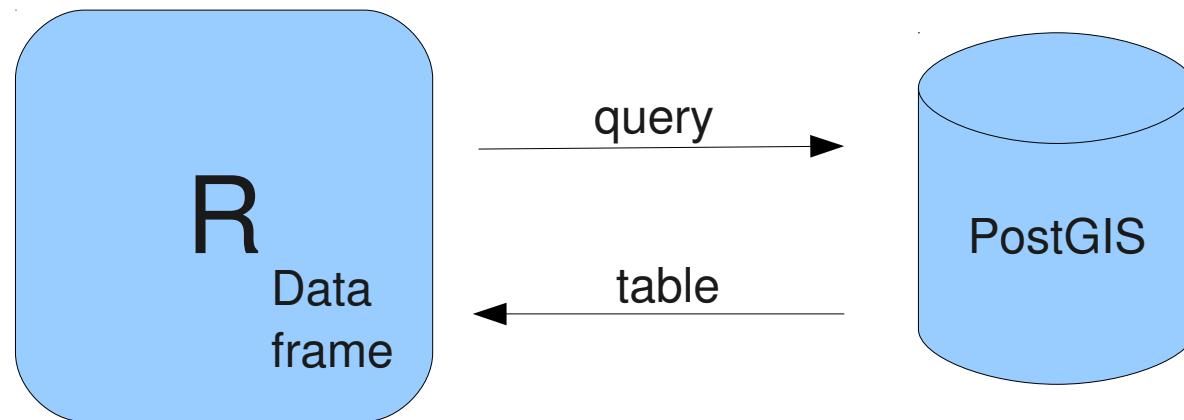
Databases

- SQL Queries
 - `SELECT * from employees where salary > 10000`

- Spatial SQL Queries
 - `SELECT ST_Buffer(the_geom, range) as the_geom from phone_masts;`

R with PostGIS

- Via RpostgreSQL

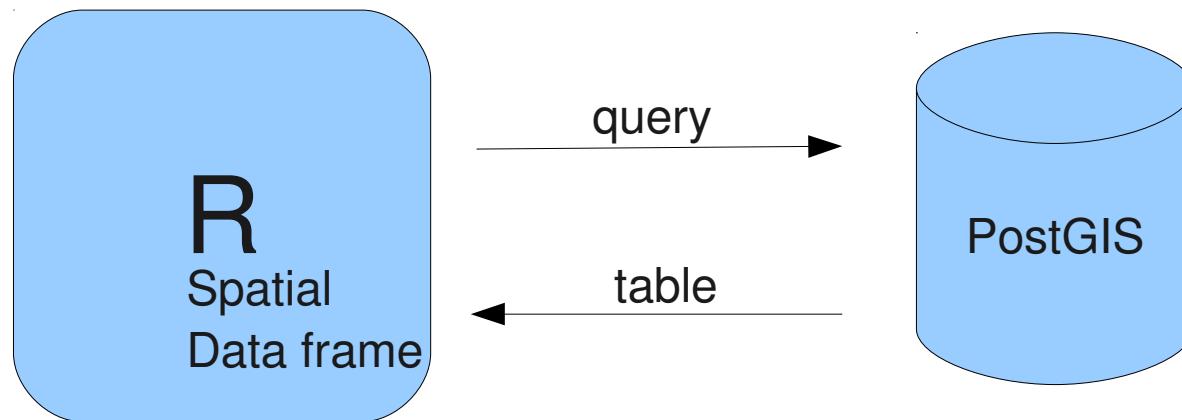


```

> con = dbConnect(dbDriver('PostgreSQL'),
                  user='gis', dbname='maps')
> rs = dbSendQuery(con,
                    'select * from countries where pop > 1000000')
> countries = fetch(rs, -1)
  
```

R with PostGIS

- Via `rgdal`



```
> countries = readOGR('PG: dbname=maps', 'countries')
```

PostGis Integration

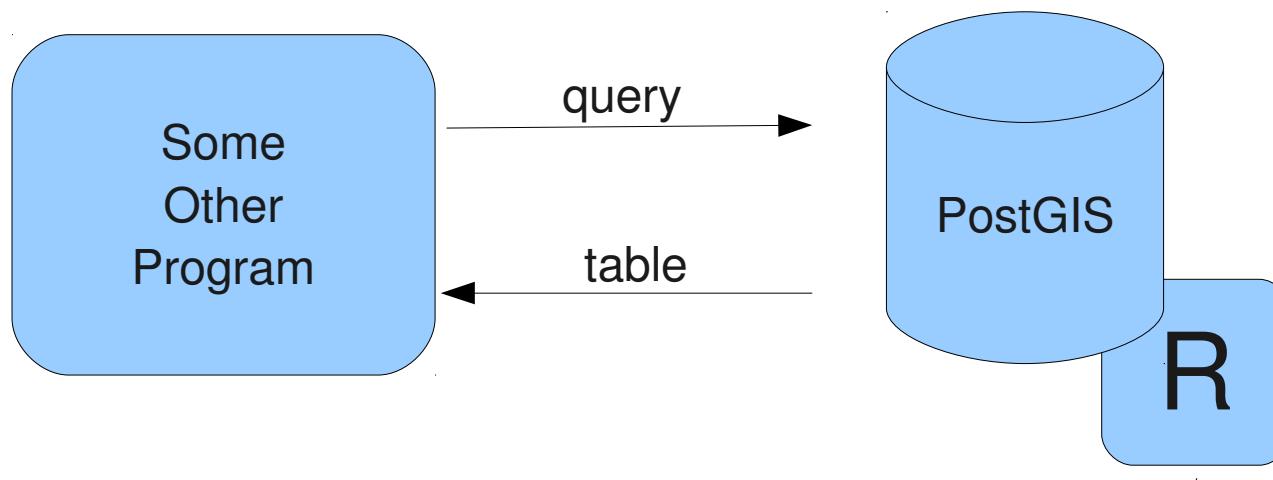


package:rgdal

PostGIS db



PL/R architecture



Can add extra functionality – even spatial functionality – to the database

PL/R in Postgres

Get mean age of people in each town:

```
SELECT town, mean(age) AS m FROM people
    GROUP BY town ORDER BY m;
```

No 'median' function in SQL- so we'll make one...

```
CREATE function r_median(_float8)
    RETURNS FLOAT AS 'median(arg1)' LANGUAGE 'plr';
```

```
CREATE AGGREGATE median (
    sfunc = plr_array_accum,
    basetype = float8,
    stype = _float8,
    finalfunc = r_median
);
```

```
SELECT town, median(age) AS m FROM people
    GROUP BY town ORDER BY m;
```



OpenLayers

St. Lawrence County | Open GeoPortal - Mozilla Firefox
File Edit View History Bookmarks Tools Help
<http://www.opengeohost.com/maps/stlawrence/>

Bryan R. McBride, GISP - Administration St. Lawrence County | Open Geo...

St. Lawrence County, NY

Map Layers

- Administrative Boundaries
 - Town Boundaries
- NYSDOP Imagery Indexes
- Wetlands
- Tax Parcels
 - No Labels
 - ID
 - Owner
 - Address 2010 Tax Parcels
- Transportation
- Hydrography
- Soils

Base Layers

- No Basemap
- NYS Orthoimagery (NYSDOP)
- USGS 1 Meter NAIP Imagery
- USGS 24K Topo
- ESRI Imagery

KML Upload

Parcel Search

Address Search

Print Map Spot Elevation

Map Scales: 1 : 6903 | Coordinates: -75.16989, 44.59096

1024x768

Feature Info

MUNICIPAL BOUNDARIES

Name: Canton

2010 TAX PARCELS

Parcel ID	Owner	Address	Muni	Property Class
88-043-6-13-1	St. Lawrence Co. Court	18 Court St	Canton 651	5

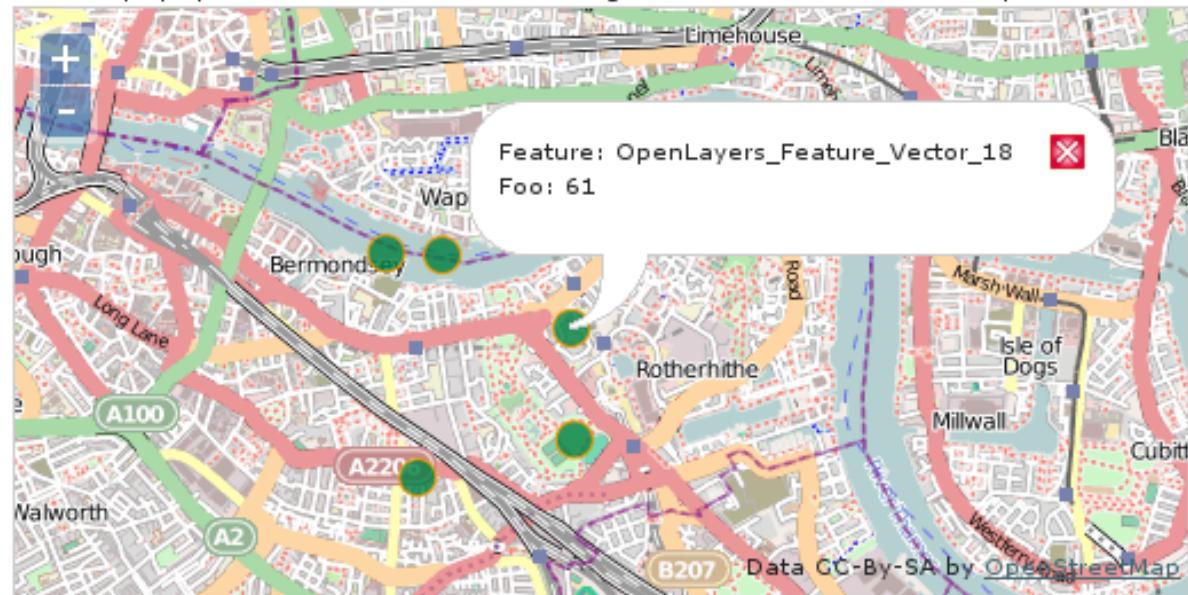
Feature Info

MUNICIPAL BOUNDARIES

Name: Canton

2010 TAX PARCELS

Parcel ID	Owner	Address	Muni	Property Class
88-043-6-13-111	St. Lawrence University, Dr.	111 Lawrence Dr.	Canton 613	5

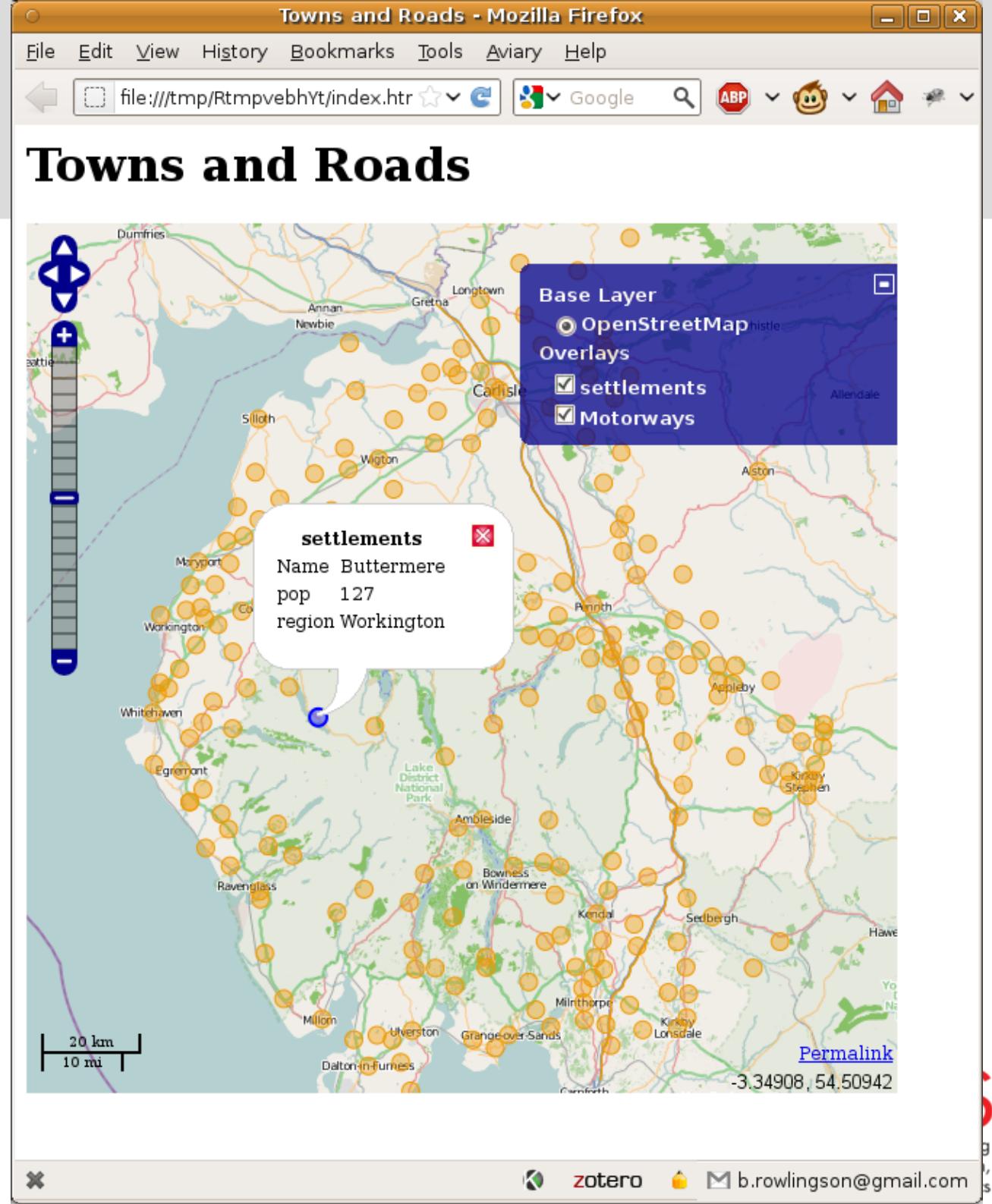


webmaps package (on r-forge)

```
> settlements = readOGR(Datadir,"settlements.shp")  
  
> slayer = layer(spTransform(settlements,  
                           CRS('+init=epsg:4326')),  
                  'settlements')  
  
> mway = readOGR(Datadir,"mways.shp")  
  
> mlayer = layer(spTransform(mway,  
                           CRS("+init=epsg:4326")),  
                  "Motorways")  
  
> osmMap(slayer,mlayer,title="Towns and Roads")  
[1] "/tmp/Rtmbhf7sdd/index.html"
```

Open...

- Fully working interactive web-based map
- Put on a server, share with world
- Customise HTML and JS to suit



OpenLayers map

```
function init(){
    var options = {
        projection: new OpenLayers.Projection("EPSG:900913"),
        displayProjection: new OpenLayers.Projection("EPSG:4326"),
        units: "m",
        maxResolution: 156543.0339,
        maxExtent: new OpenLayers.Bounds(-20037508.34, -20037508.34,
                                         20037508.34, 20037508.34),
        controls: [new OpenLayers.Control.Navigation(),
                   new OpenLayers.Control.PanZoomBar(),
                   new OpenLayers.Control.LayerSwitcher(),
                   new OpenLayers.Control.Permalink(),
                   new OpenLayers.Control.ScaleLine(),
                   new OpenLayers.Control.mousePosition() ]
    };

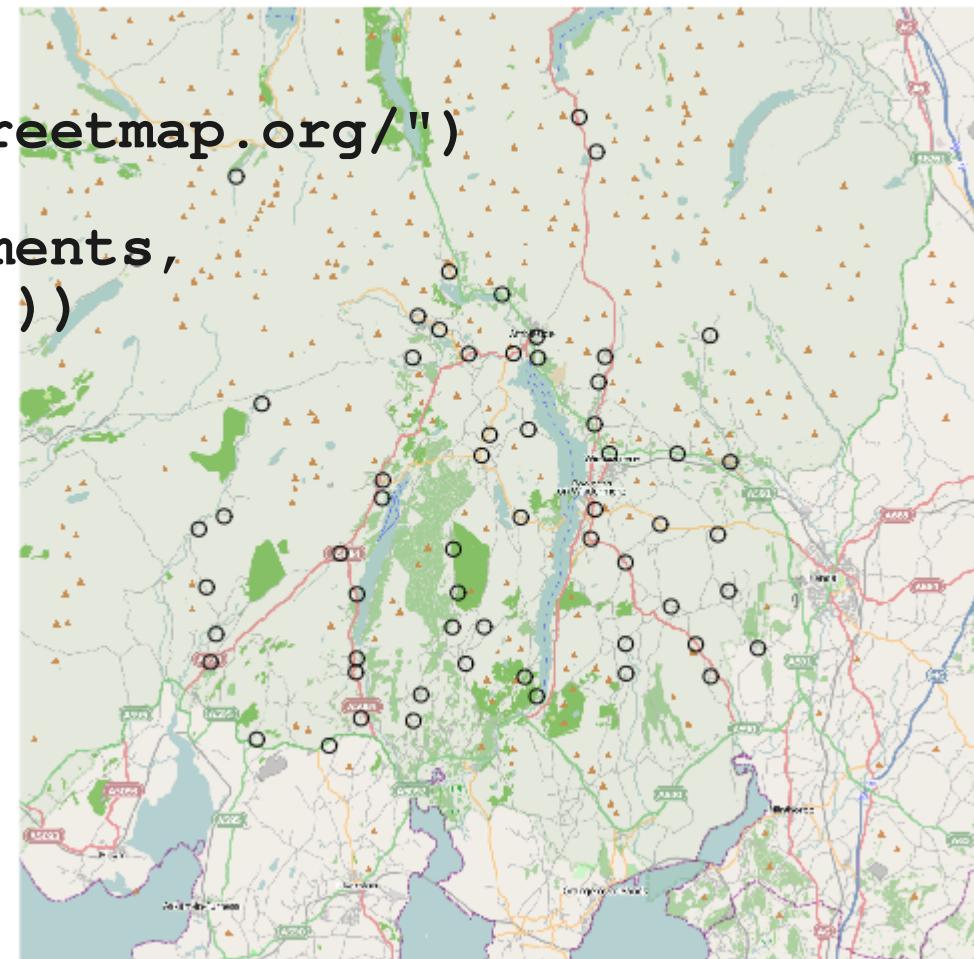
    map = new OpenLayers.Map("map", options);
    var mapnik = new OpenLayers.Layer.OSM.Mapnik("OpenStreetMap");
    map.addLayer(mapnik);

    var settlements = new OpenLayers.Layer.GML(
        "settlements","settlements.gml",{
            projection: new OpenLayers.Projection("EPSG:4326")
        });
    map.addLayer(settlements);
```

webmaps also does tiles

```
> cumbriaT = getTiles(  
+ c(-3.253926, -2.796769),  
+ c( 54.255070, 54.524853),  
+ 11,  
+ path="http://tile.openstreetmap.org/")  
  
> SLL = spTransform(settlements,  
+ CRS ('+init=epsg:4326'))  
  
> image(cumbriaT)  
> points(SLL)  
> title('settlements')
```

Settlements

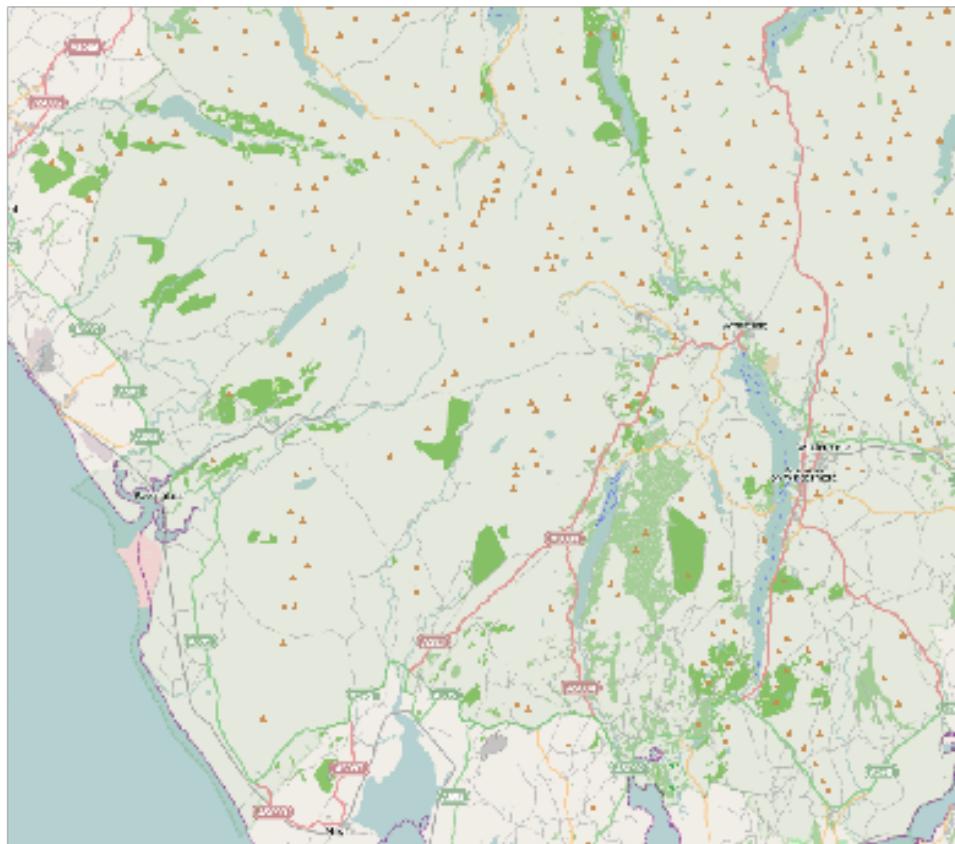


Grabs tiles off servers for plotting in R

OpenStreetMap

Other packages that can do this...

```
> library(OpenStreetMap)  
> map = openmap(c(54.524, -3.523), c(54.255, -2.797), type="osm")  
> plot(map)
```

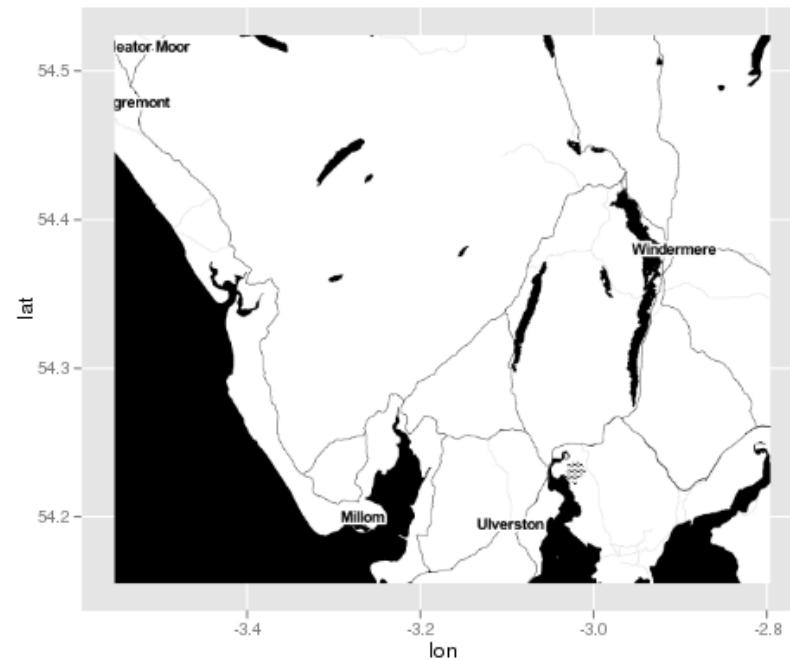
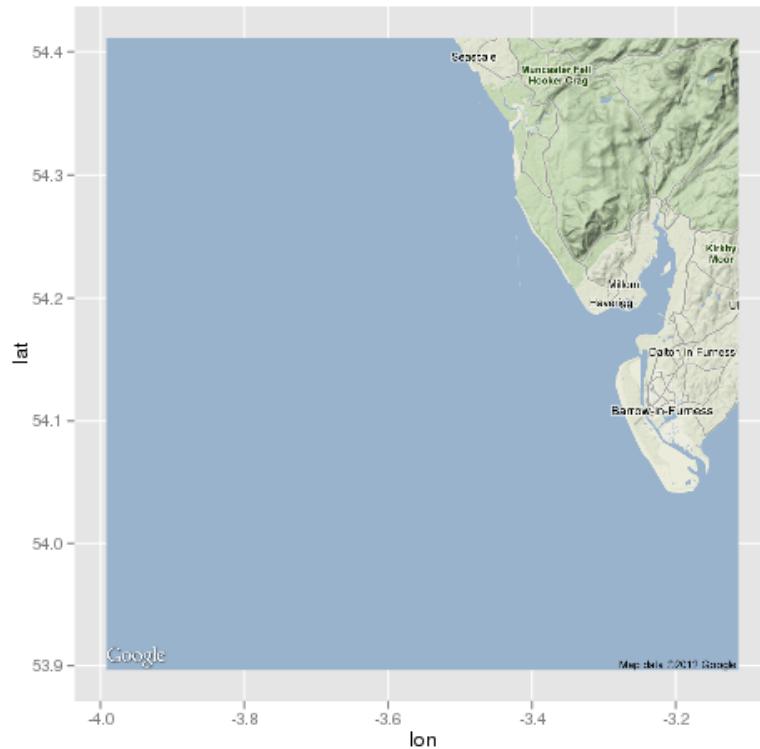


Uses Java, heavyweight



ggmap

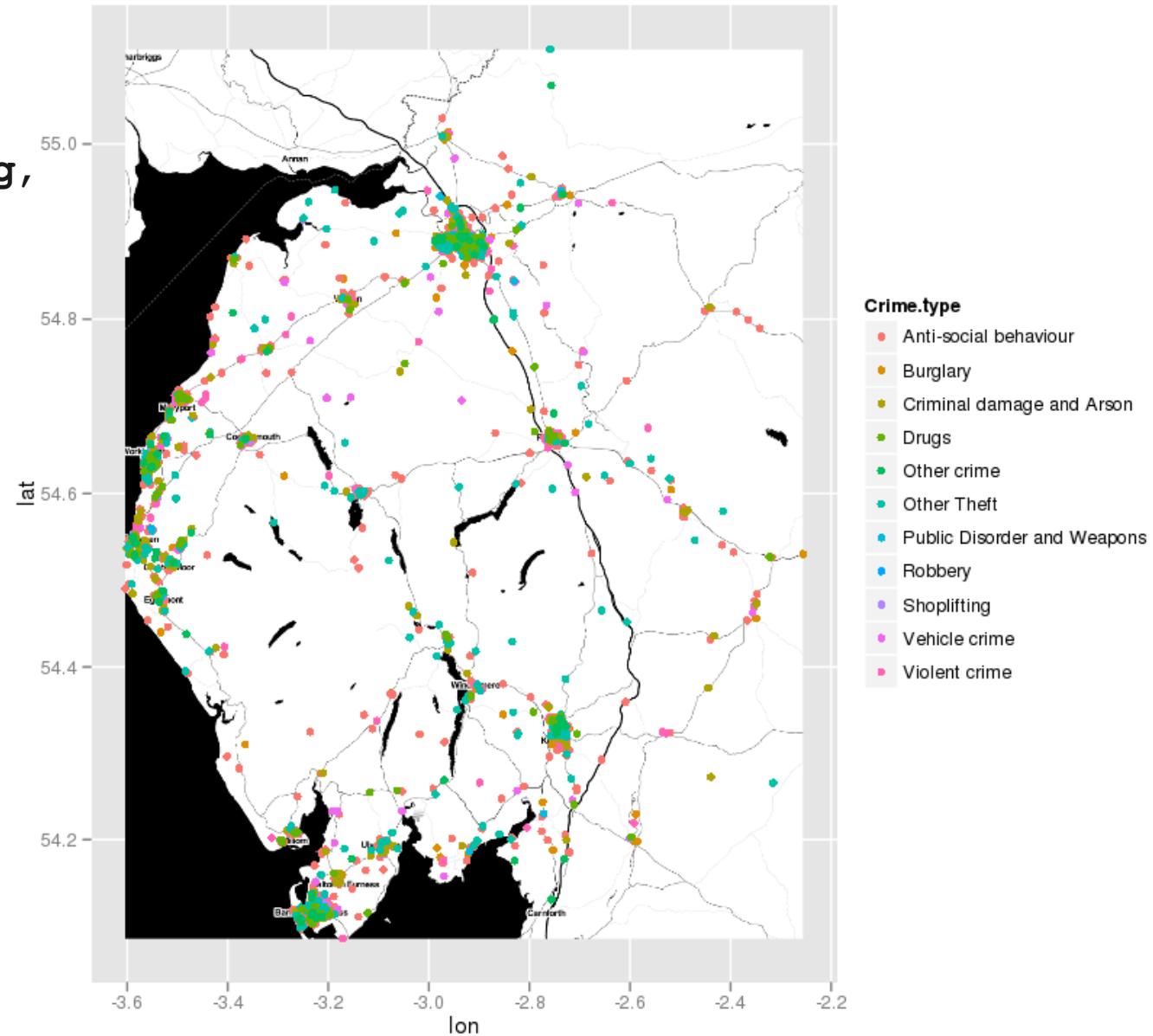
```
> gm = get_map(location=c(-3.553, 54.155, -2.796, 54.524))  
> gm2 = get_map(location=c(-3.553, 54.155, -2.796, 54.524),  
+                 source="stamen", maptype="toner")  
> ggmap(gm)  
> ggmap(gm2)
```



[I have figured out how to get this
into a raster format]

ggmap with data

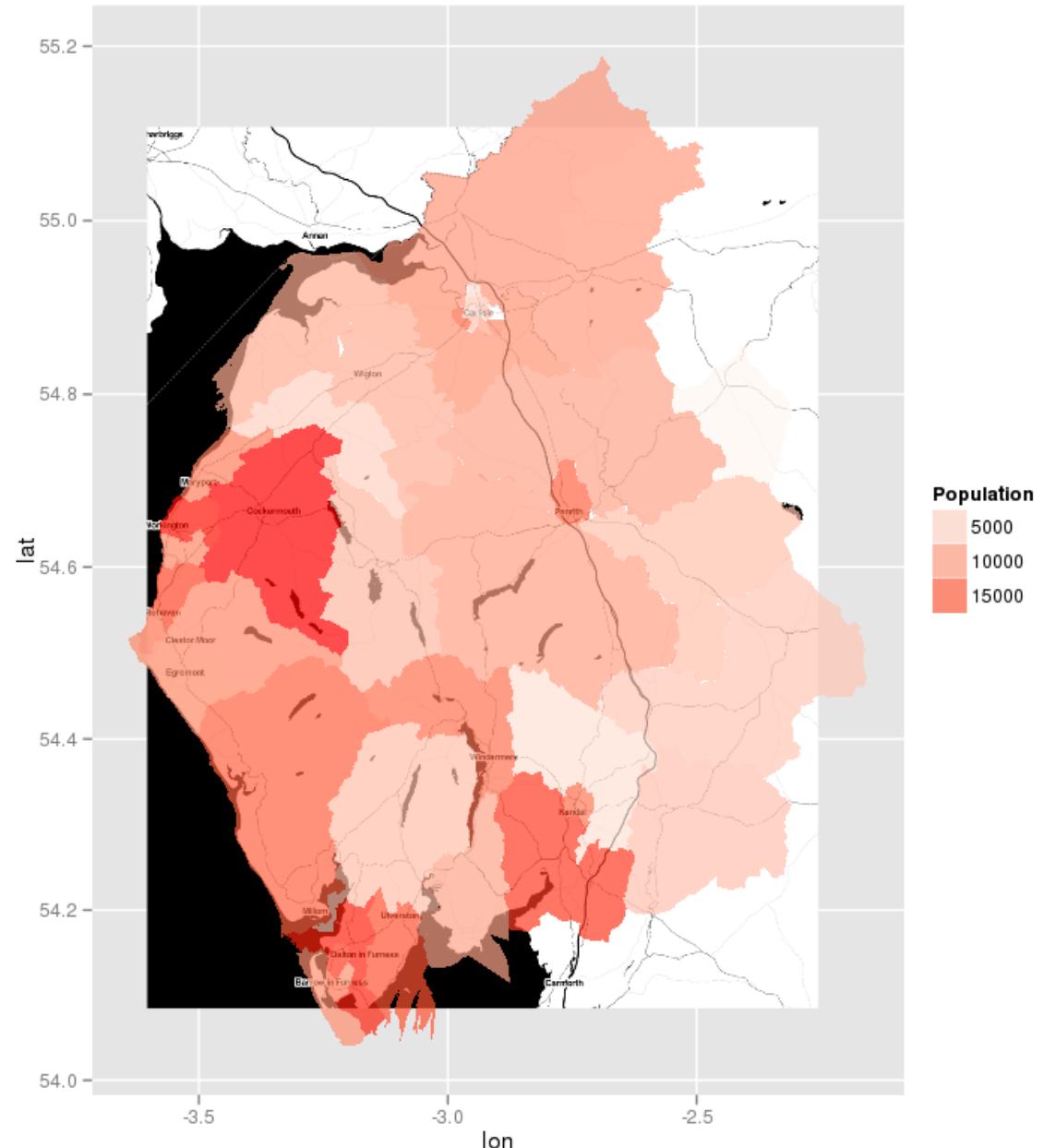
```
ggmap(gm) +
  geom_point(
    aes(
      x=Easting, y=Northing,
      col=Crime.type),
    data=scD)
```





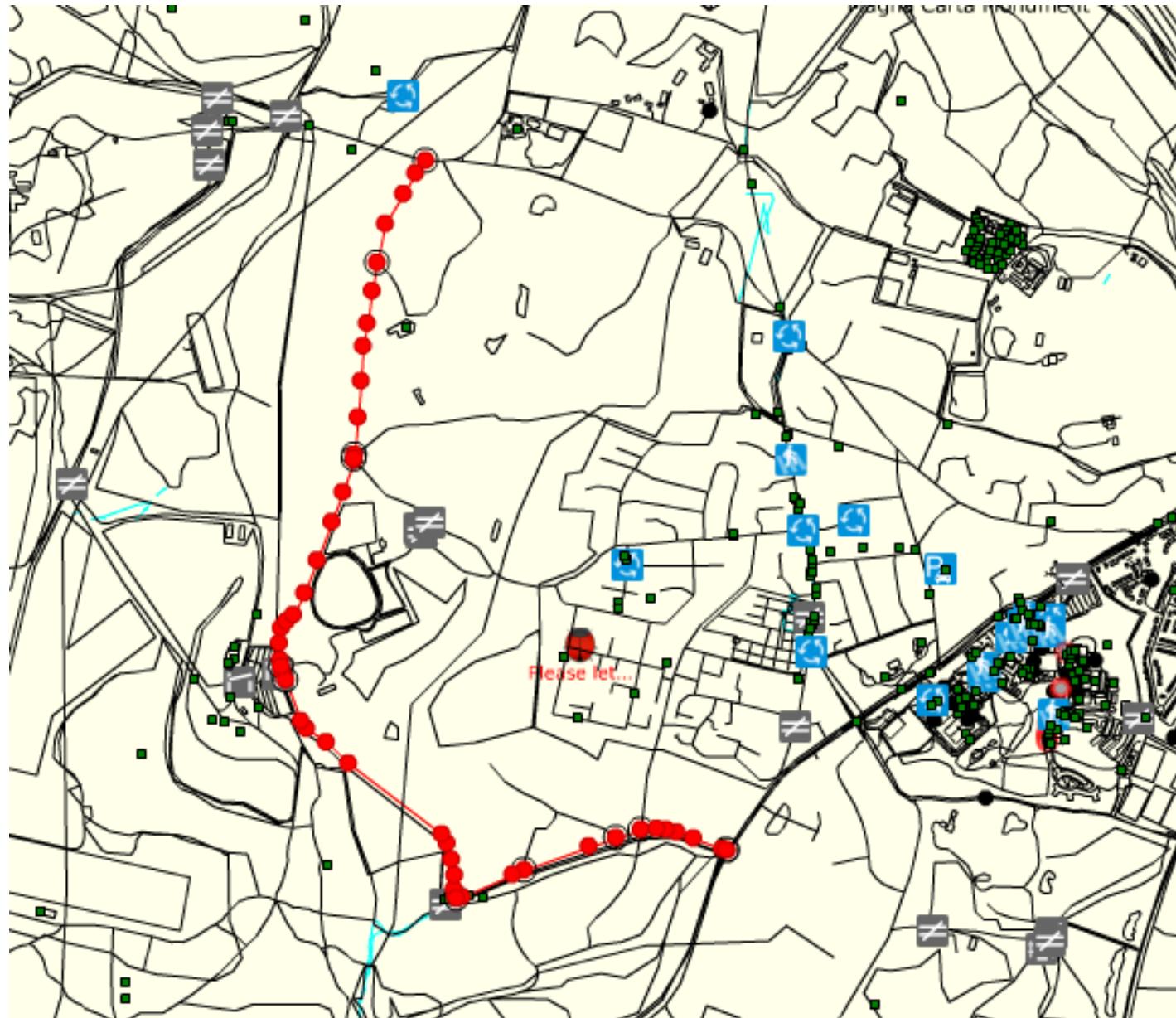
ggmap with polygons

```
ggmap(gm) +geom_polygon(  
  aes(fill=Population,  
      group=id,  
      x=long,y=lat),  
  data=datapoly, alpha=0.7) +  
  scale_fill_continuous(  
    low="white",high="red")
```



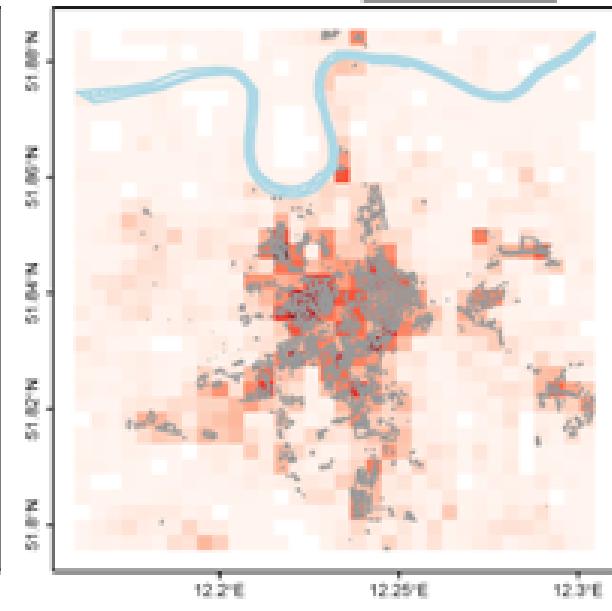
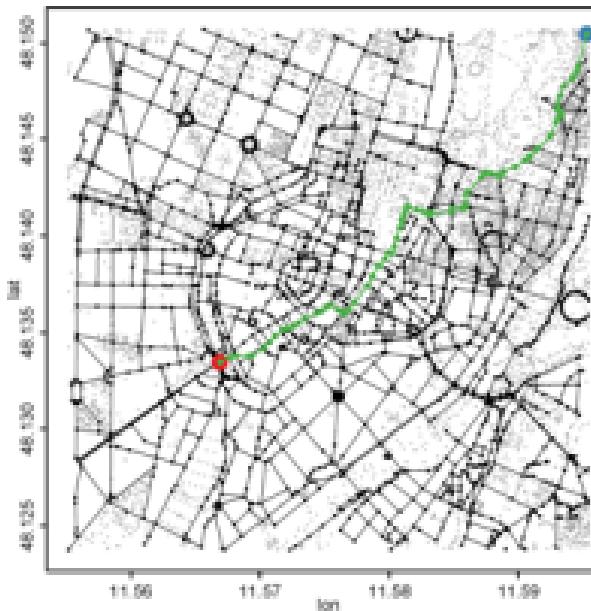
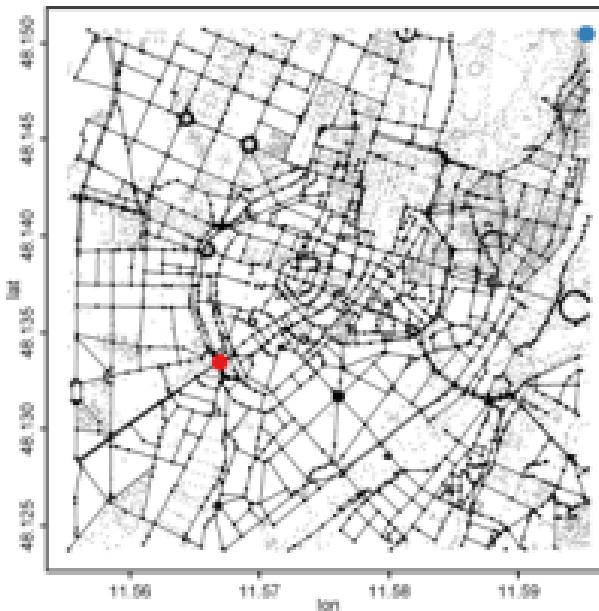
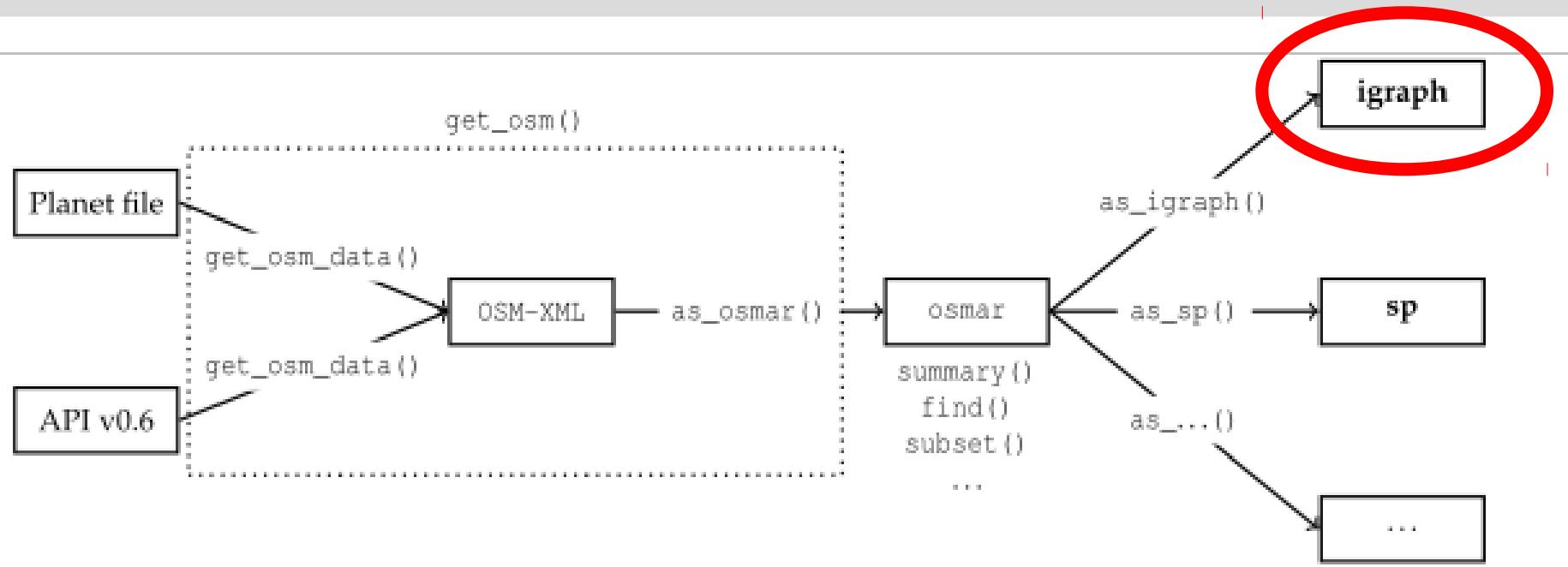
I couldn't get `geom_map` to work with `ggmap`

Raw OSM Data





osmar package



But what about Google Earth?

- Isn't it lovely?
- Look, I can spin and zoom!
- And overlay!
- And animate!
- BUT
- As I keep telling people...

**ITS NOT
OPEN
SOURCE!**

However...

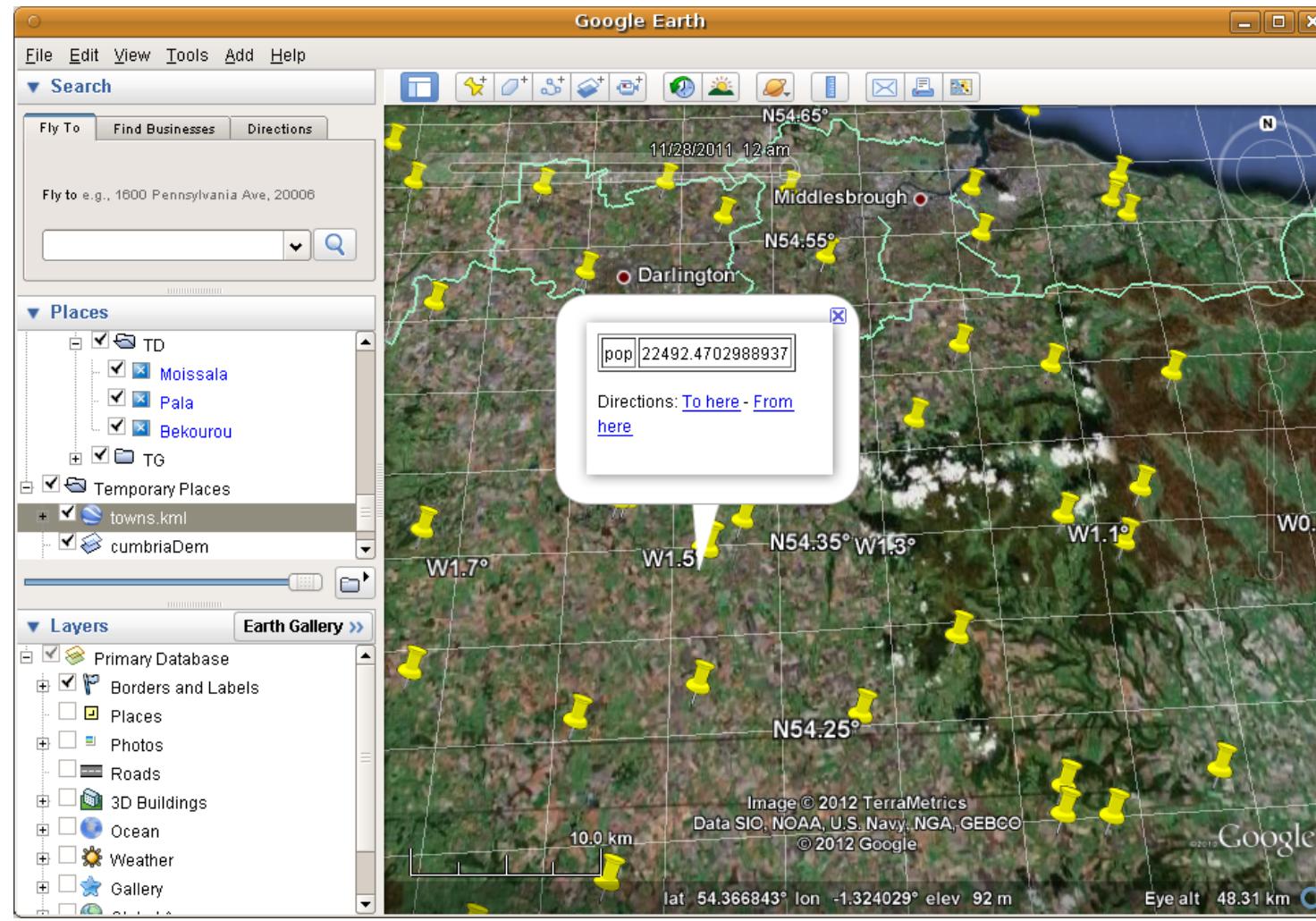
KML is an OGC standard
All 233 pages of it



Making KML

Vectors

```
> writeOGR(Towns, "towns.kml", "towns", "KML")
```

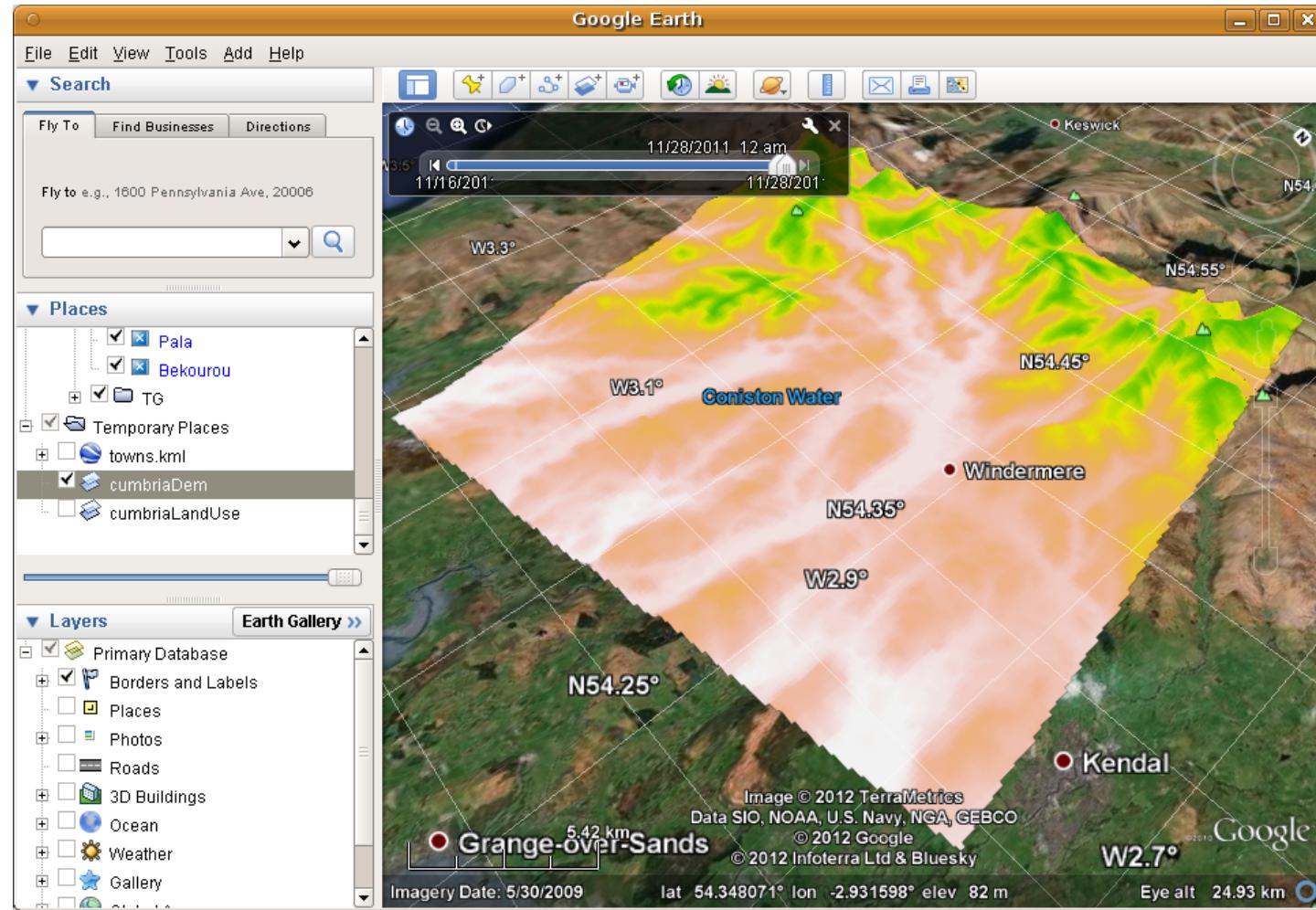




Making KML

Rasters

- > `demLL=projectRaster(dem, crs="+init=epsg:4326")`
- > `KML(demLL, "dem.kmz")`



Custom KML

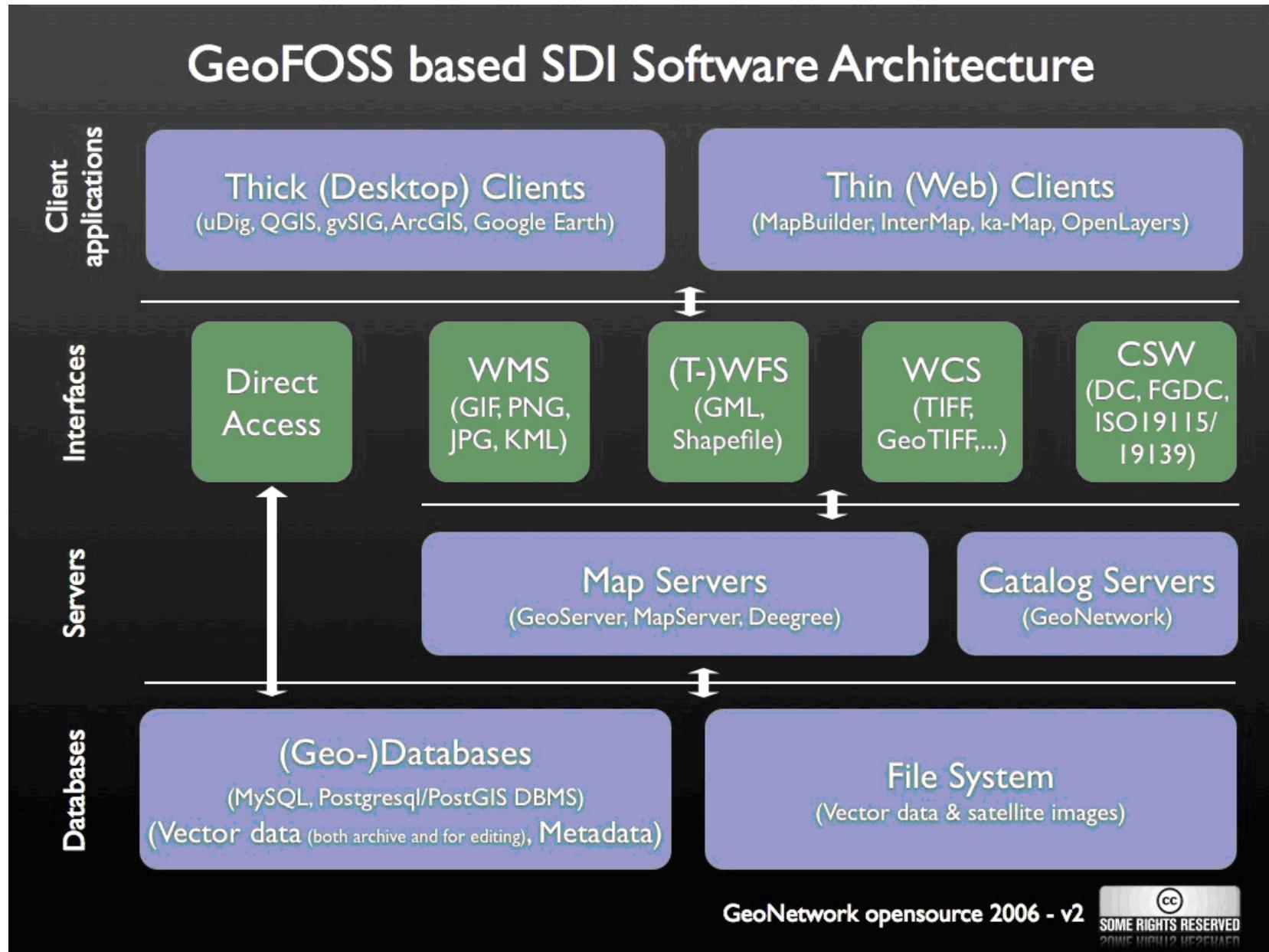
```
<Placemark>
  <ExtendedData><SchemaData schemaUrl="#towns">
    <SimpleData name="pop">18599</SimpleData>
  </SchemaData></ExtendedData>
  <Point>
    <coordinates>
      -1.248,54.09701
    </coordinates></Point>
</Placemark>
```

Using the **brew** package, write a template. Here's an extract:

```
<% for(pt in points) { %>
<Placemark>
  <ExtendedData><SchemaData schemaUrl="#towns">
    <SimpleData name="pop"><%= pt$pop %></SimpleData>
  </SchemaData></ExtendedData>
  <Point>
    <coordinates>
      <%=pt$lon%>, <%=pt$lat%>
    </coordinates></Point>
  </Placemark>
<% } %>
```

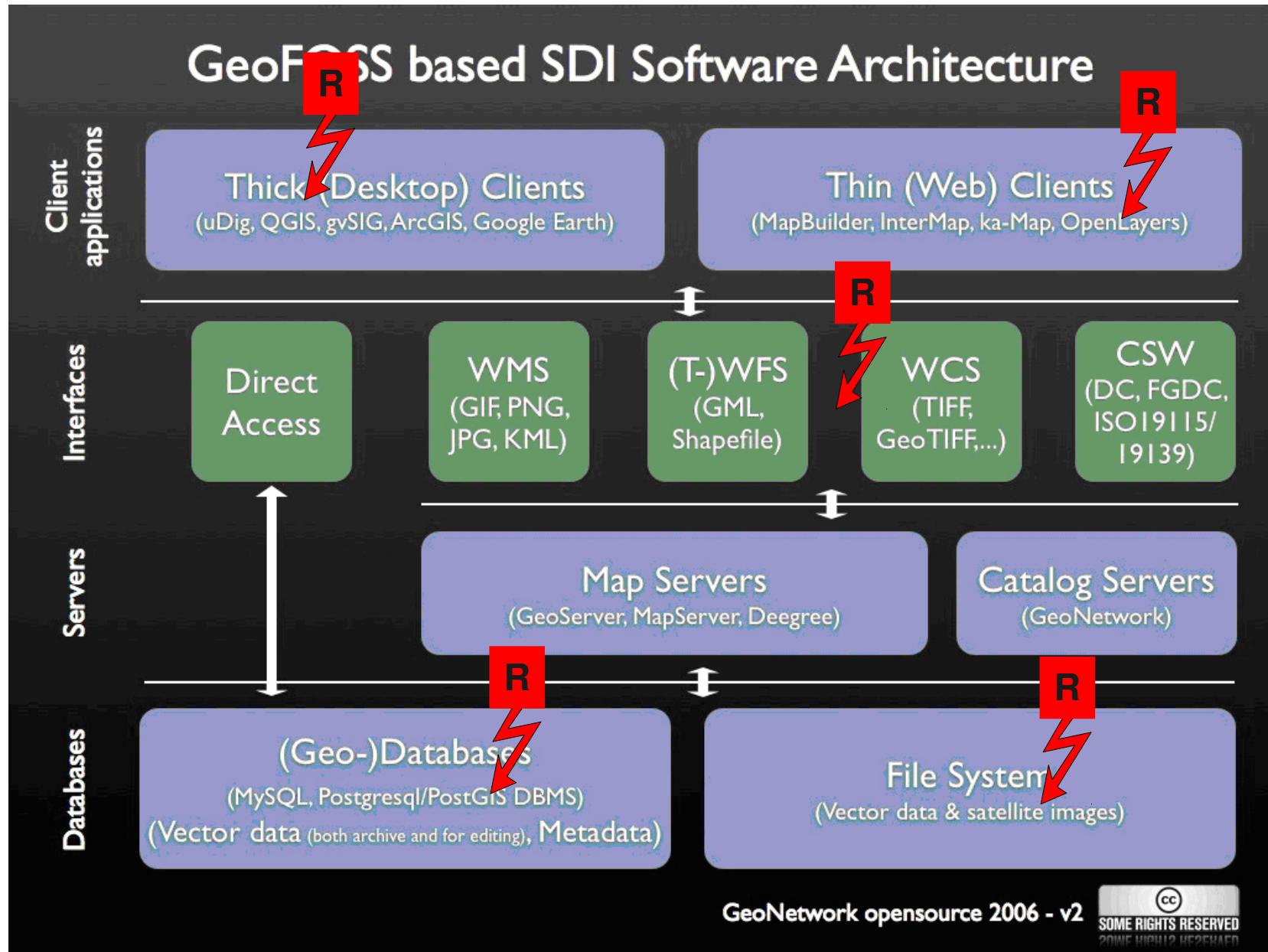


Spatial Data Infrastructure



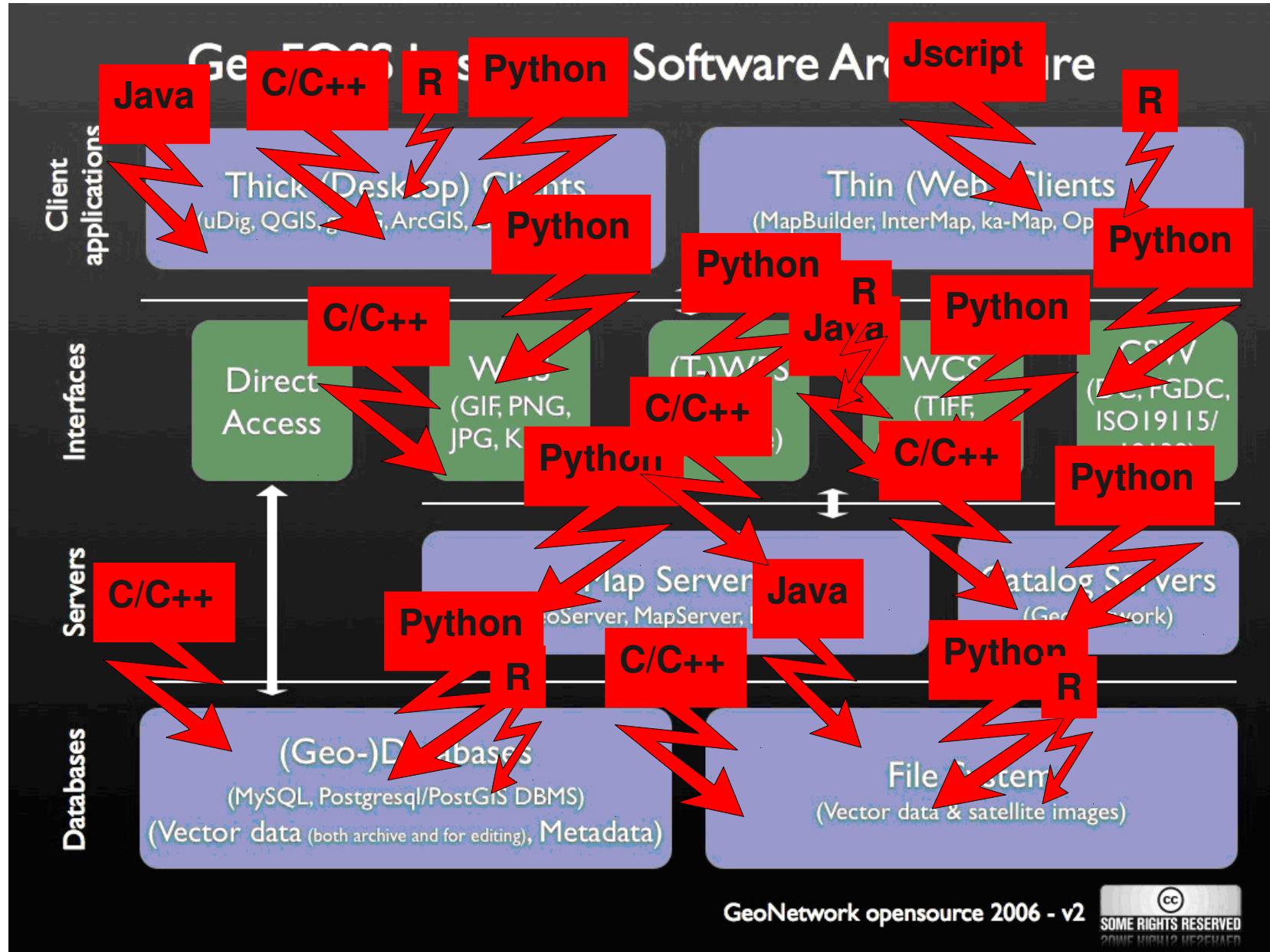


Spatial Data Infrastructure





Spatial Data Infrastructure



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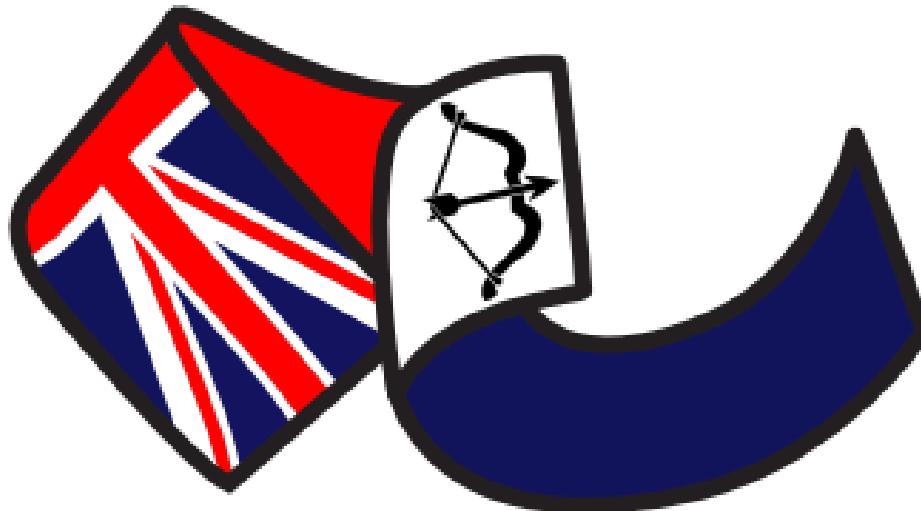


LANCASTER
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Nottingham

free and open source software for geospatial



FOSS4G 2013

Or maybe Finland?



End of Part Two!

- Now you have the tools!

