Visualising Geographical Data with Leaflet

Dr. Peter Mooney

Aims of this lecture today

- To introduce you to some basic concepts of Visualising Geographical data on a Web-based Map
- After the lecture you should be able to create simple visualisations of Geographical data on web-based maps using Open Source Components
- You will see that much of the work in Visualisation of Geographical comes from preparing the SPATIAL data for display on the web-based maps

TIMETABLE FOR TODAY

- Session 1 09:30 – 11:30 (no break)
- Session 2 14:00 – 16:00 (no break)
- The class today is a little shorter than normal as I am teaching in other lectures outside of the times mentioned above.

Which browser should you use for the lecture today?

Safari

GitHub Page for Today's Materials

https://github.com/petermooney/SummerSchool2016

Keep this page open in a browser today – as it will have lots of links to web applications which we will be using in the lecture

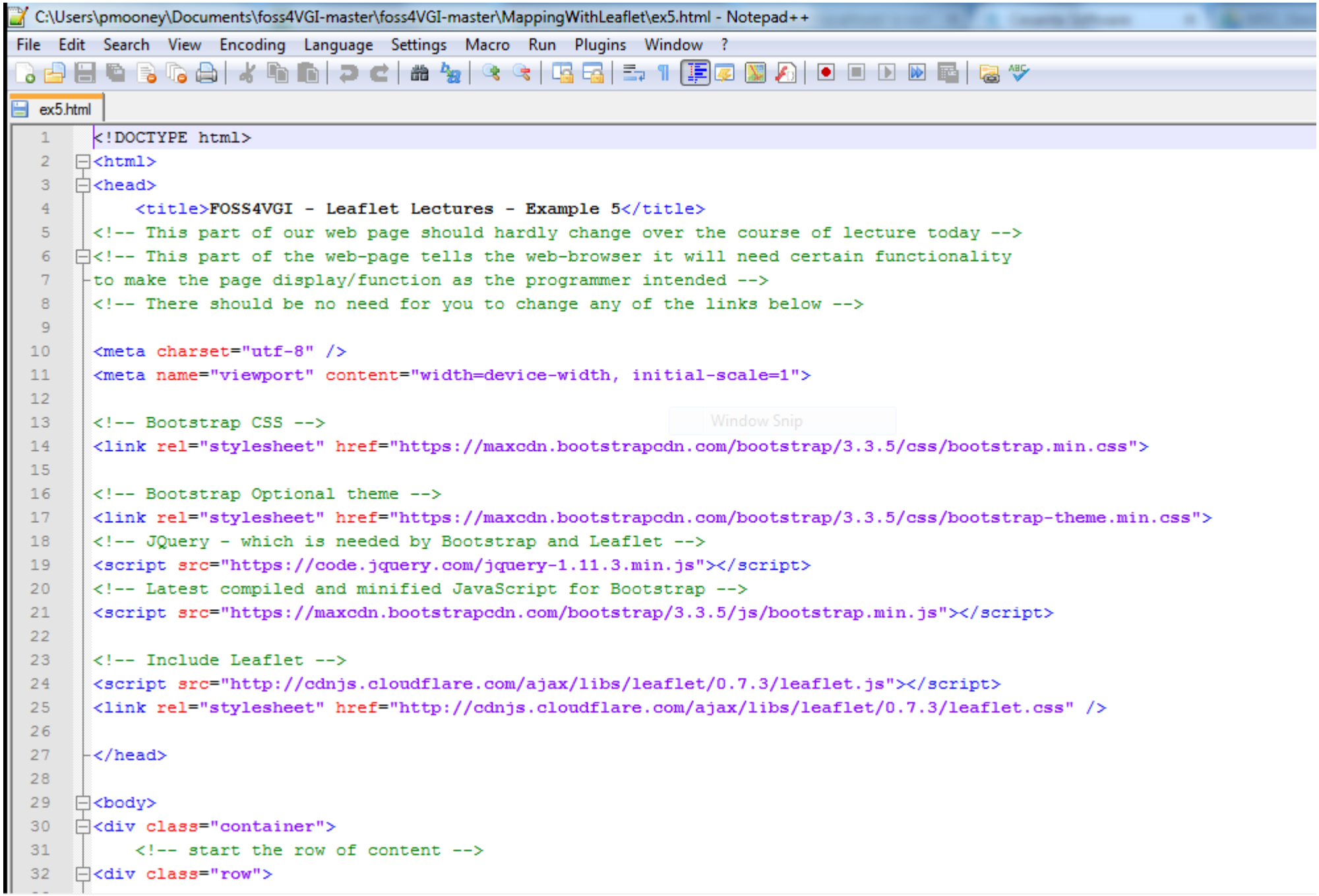
We are also going to need to have a nice text editor installed

- A text editor is one of the most important tools which a web developer uses
- Like web servers there are LOTS of options.
- We need a text editor which will give us some user friendly editing functionality for HTML and Javascript

Suggested Text Editors

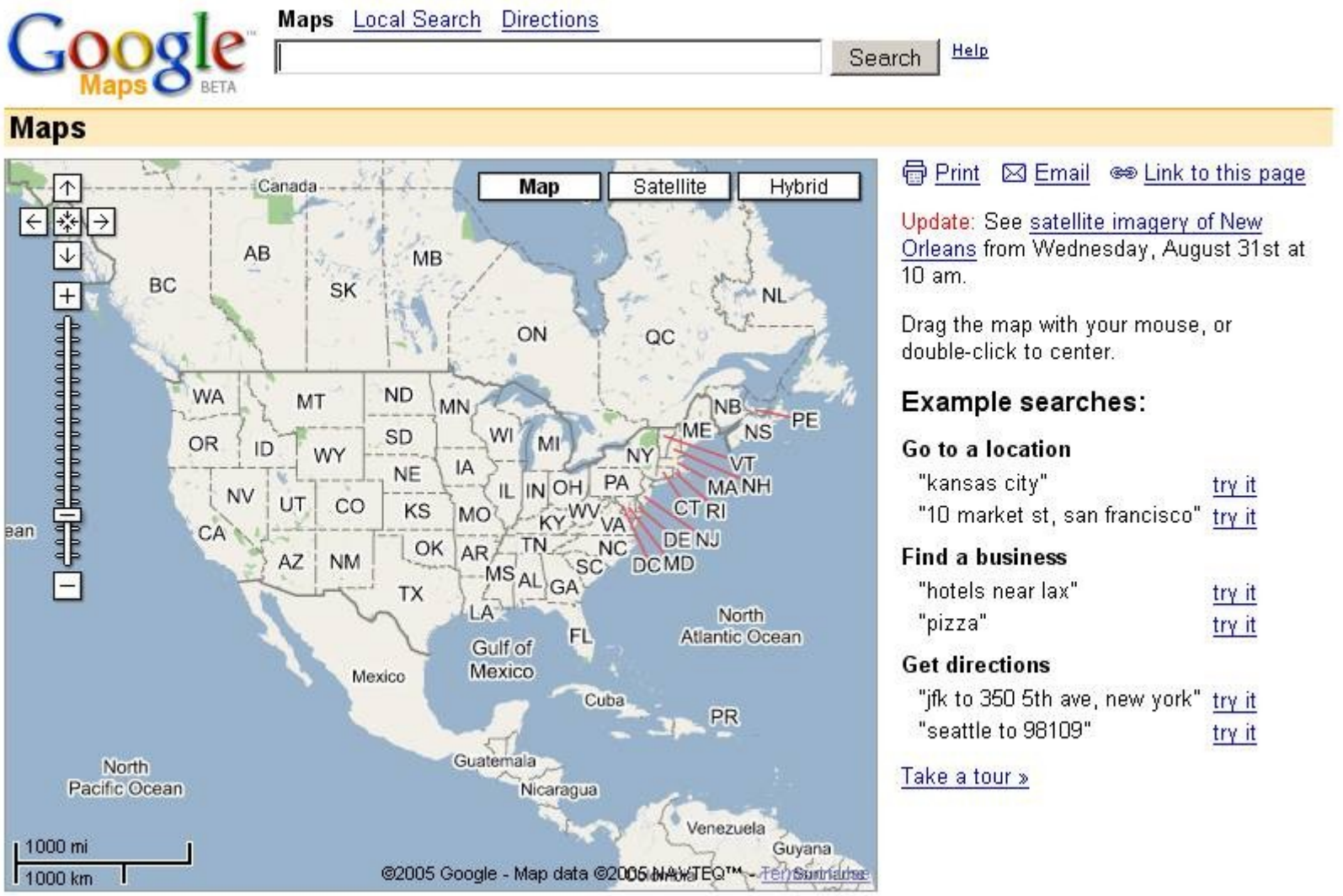
- **ANY ONE OF .....**
- **The Geany**
- **Bluefish**
- **Notepad++**
- **Sublime**
- Perhaps Bracket or TextMate for MAC specifically
- The links are available on the GitHub page

Notepad++ is installed

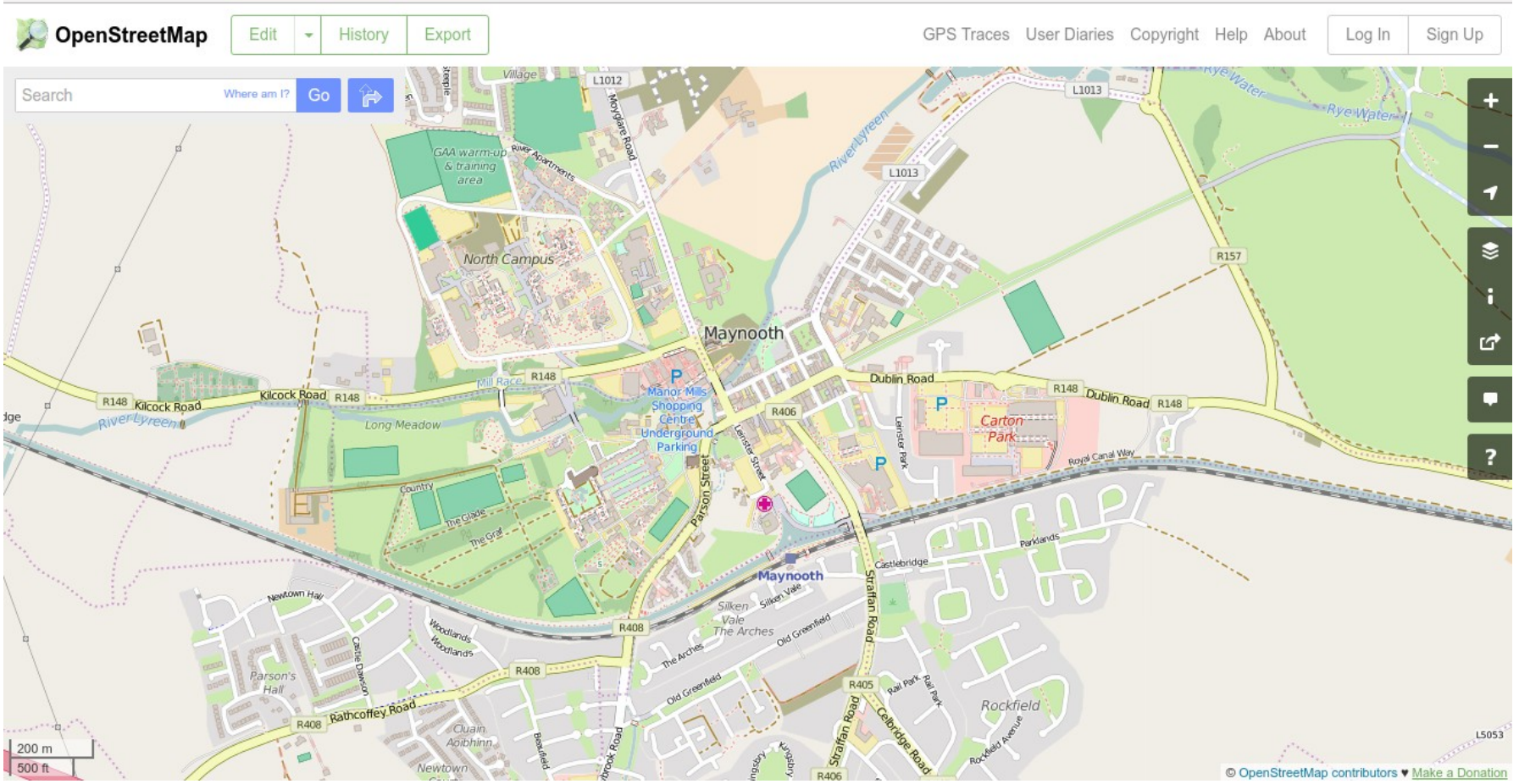


http://copystar.github.io/intro-web-mapping-odd14/#10

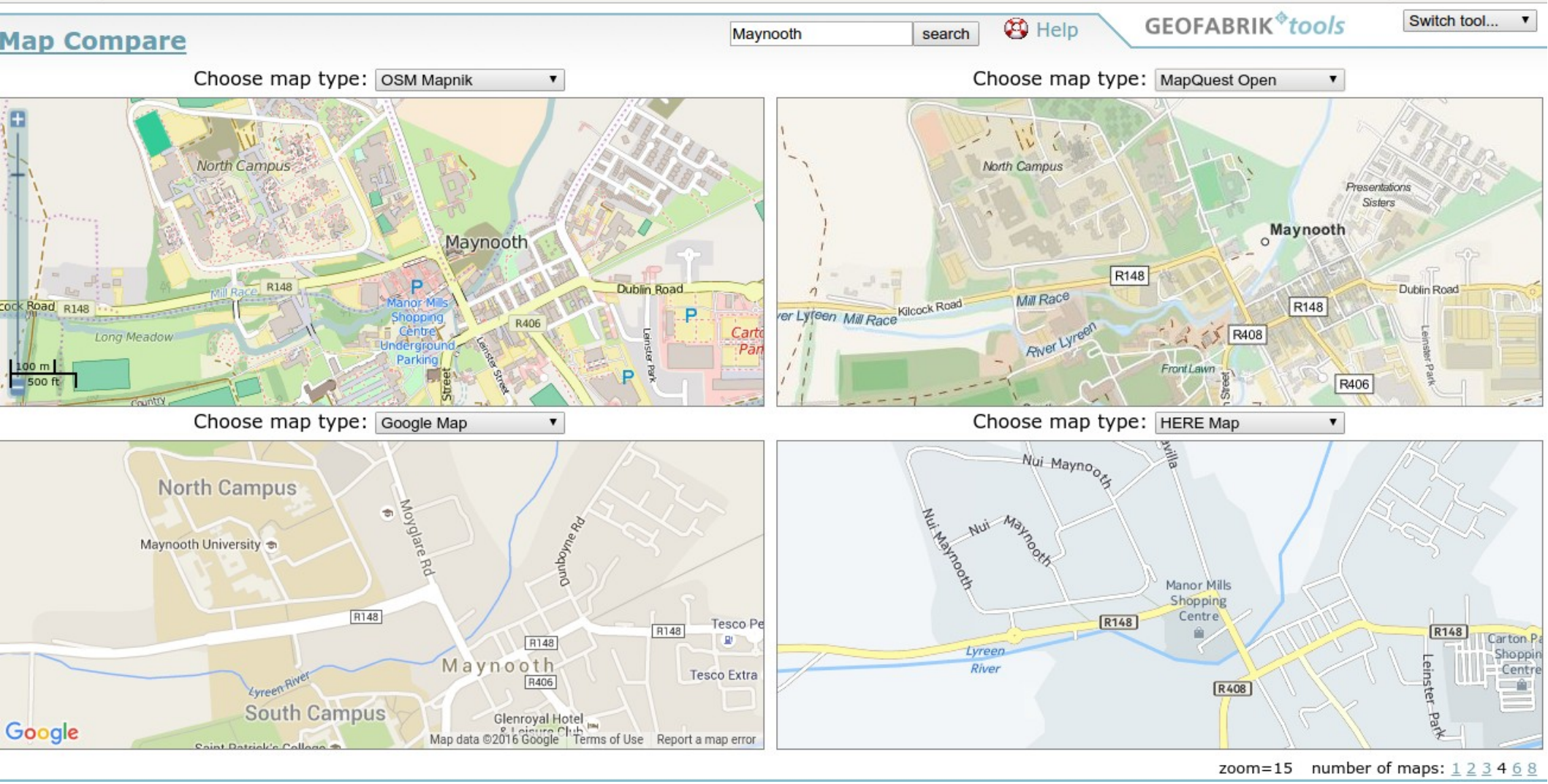
In 2005 Google Maps was launched. It was a game changer



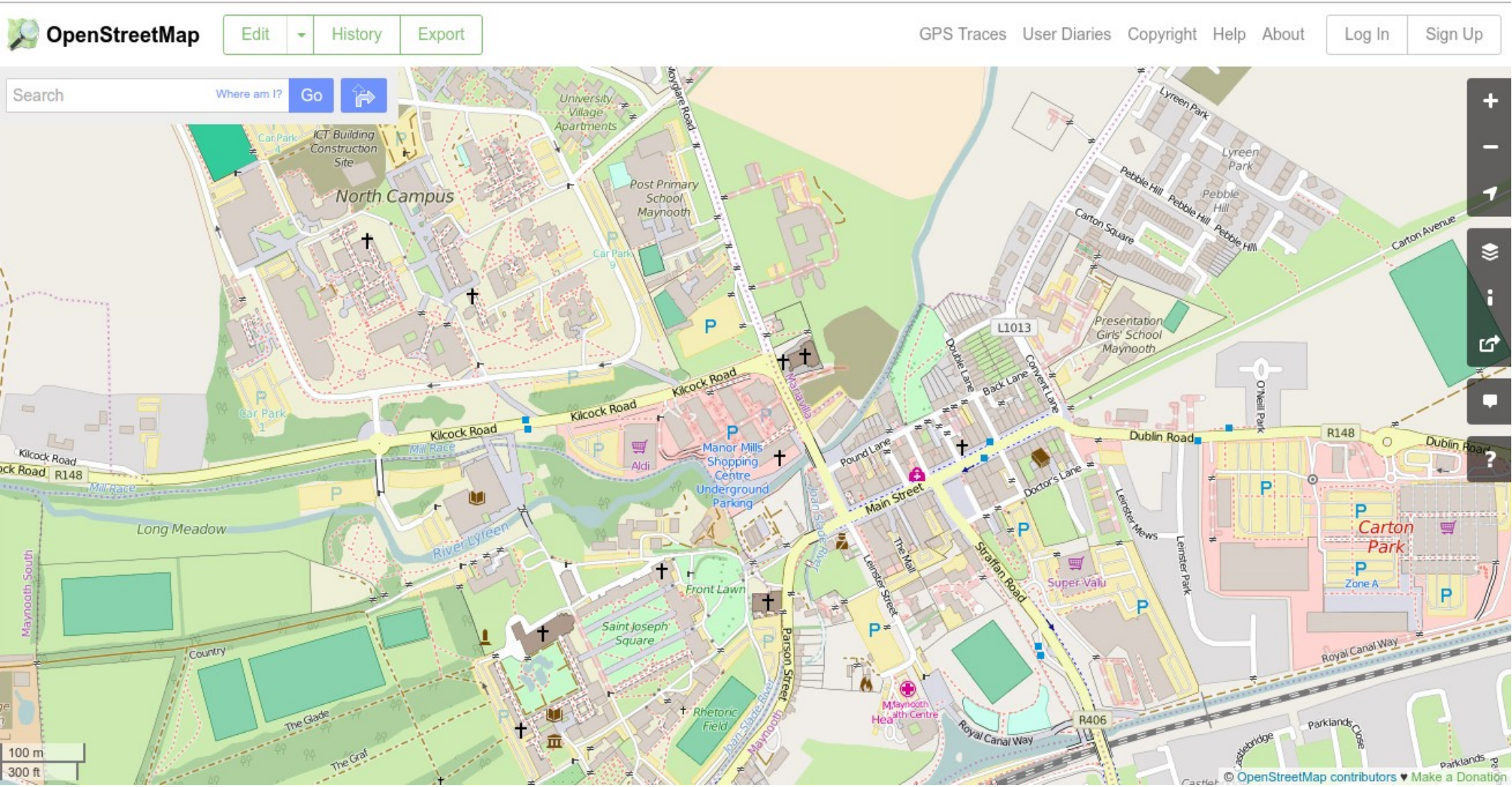
This is a web map



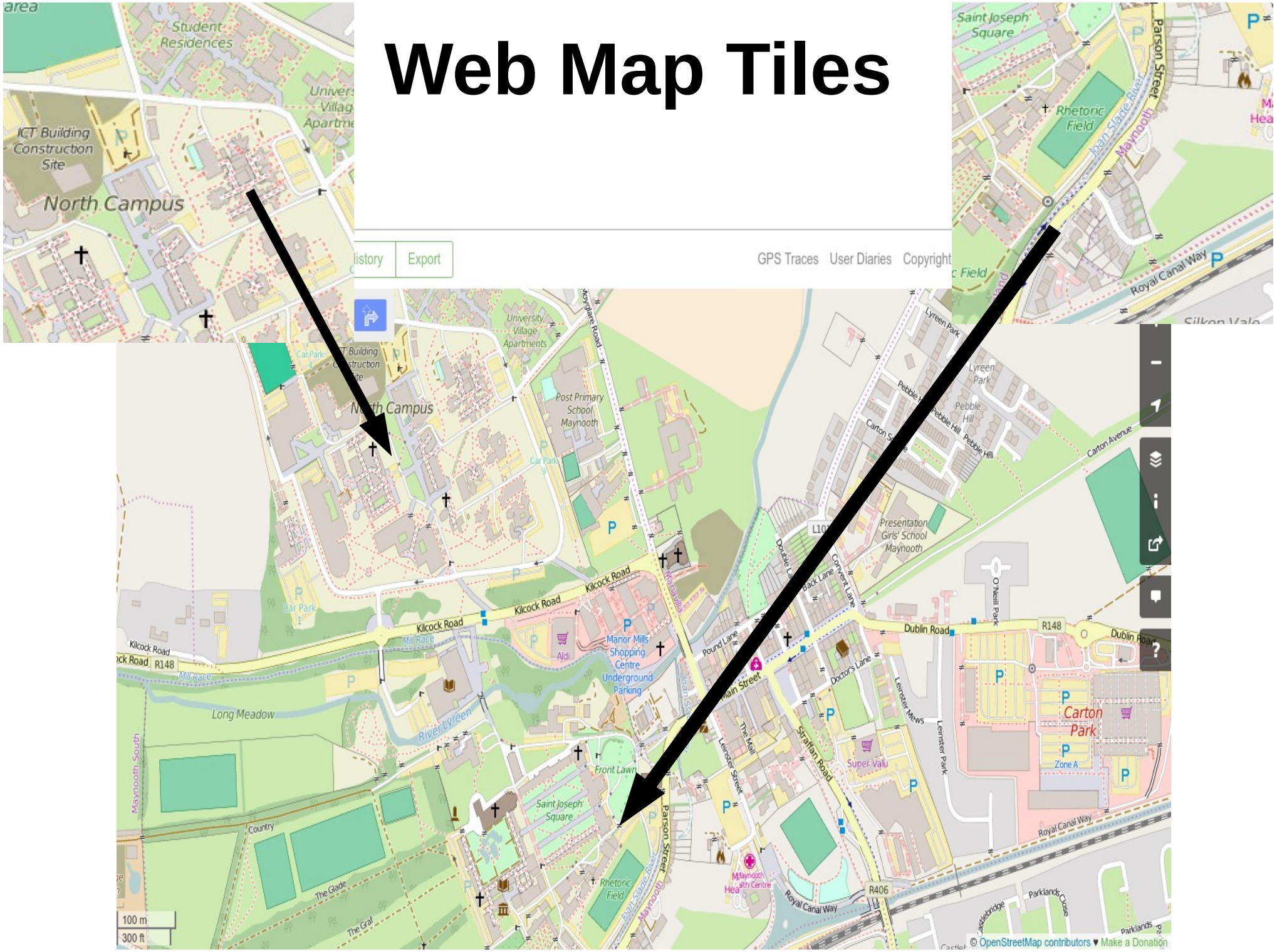
Here is four different web maps on the same page



A web map is actually a collection of small map pictures called **TILES**



Web Map Tiles



Luckily for us – there are lots of FREE and OPEN web map tile SERVICES online which we can use to get web based maps

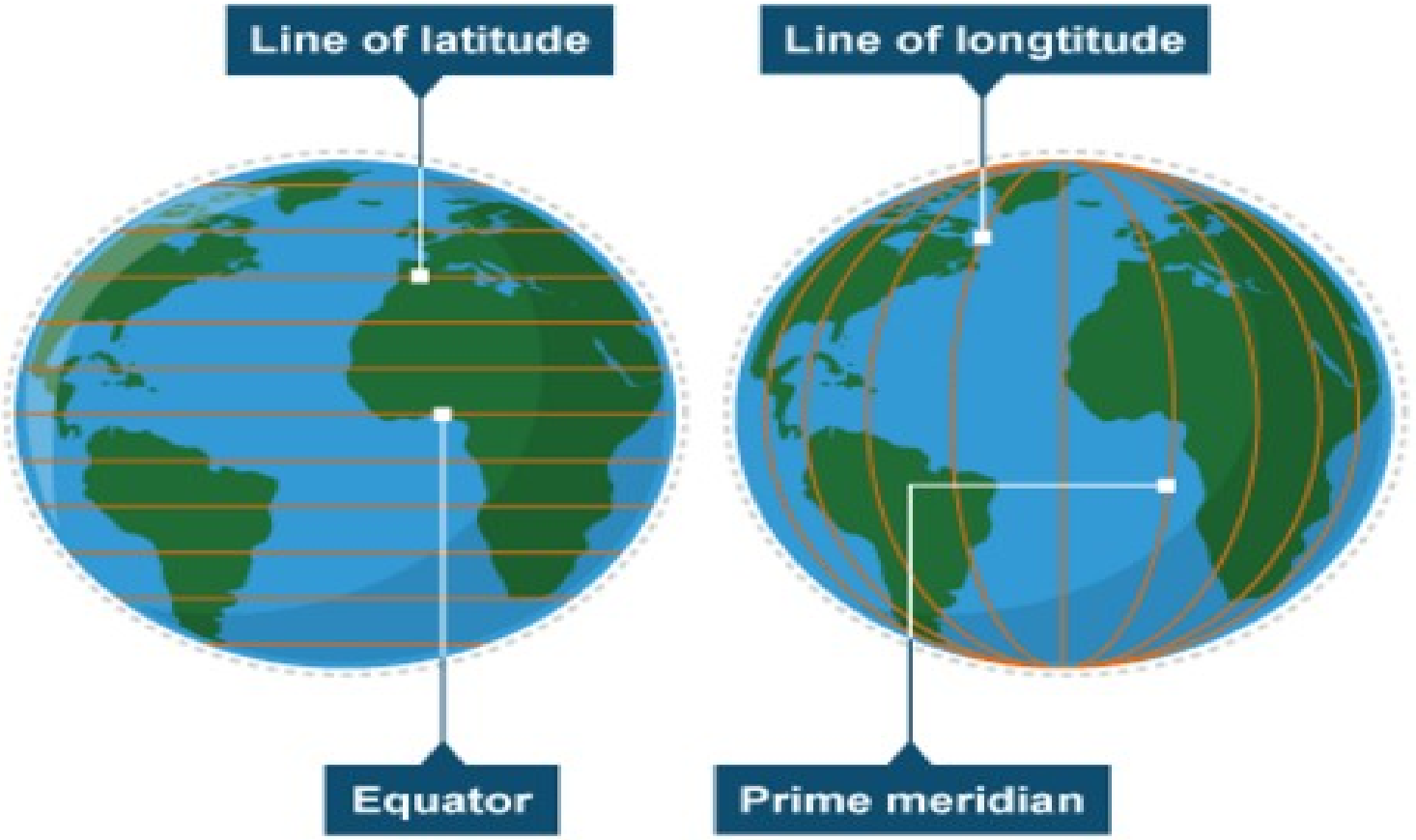
What we need to do is to write some HTML and Javascript code to display the web based maps inside a web page

Before we start we need to do a little bit of geography

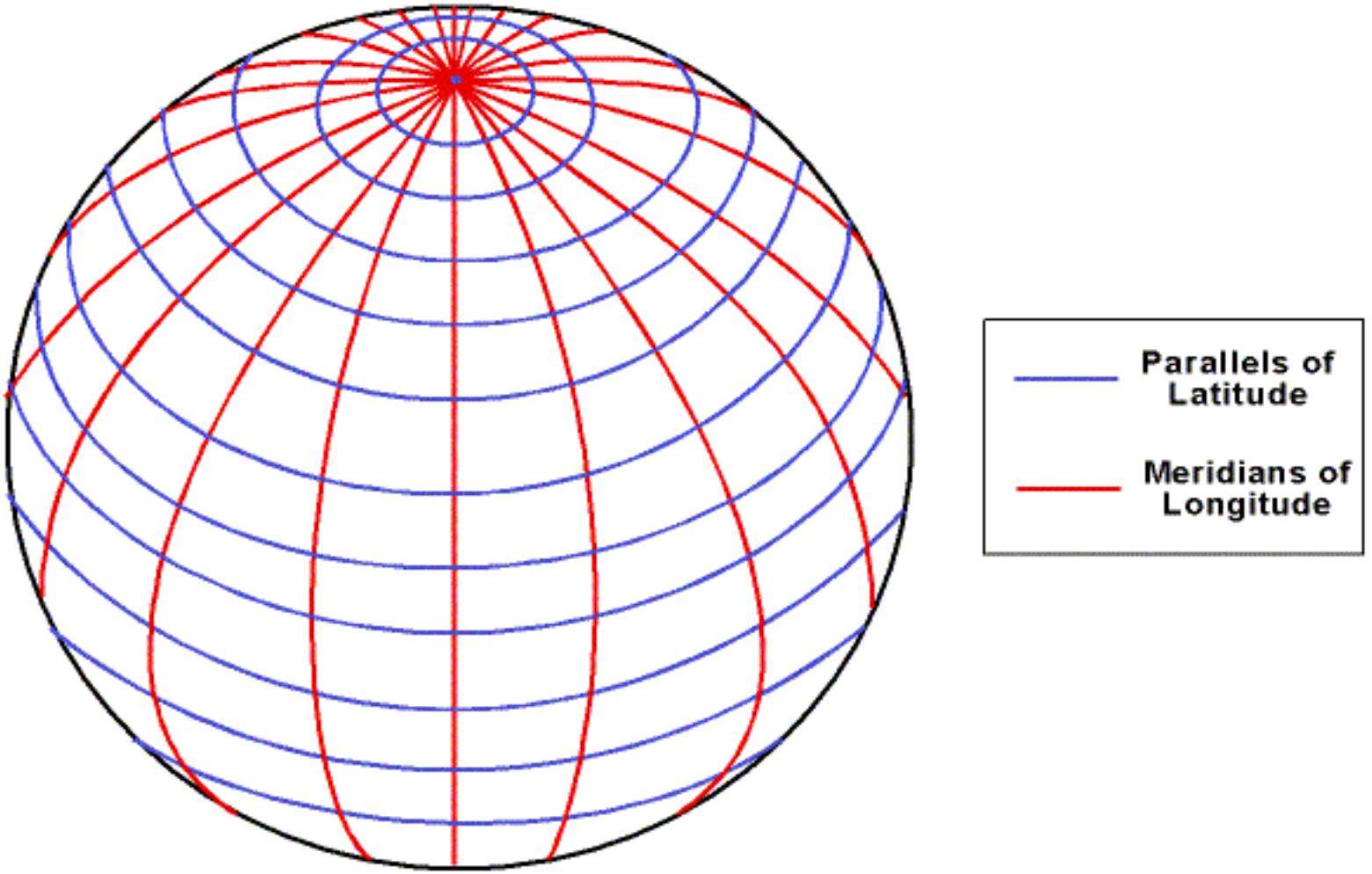
Latitude and Longitude

Latitude and longitude

Lines of *latitude* and *longitude* are used to locate places accurately on the Earth's surface.



Can you imagine our earth like this?



Tony Kirvan 11/8/97


IRELAND
LATITUDE & LONGITUDE MAP
10°W
9°W
8°W
7°W
6°W
12°W
11°W
5°W
54°N
55°N
53°N
52°N
SCOTLAND
NORTHERN IRELAND
WALES
ATLANTIC OCEAN
Irish Sea
North Channel
St. George's Channel
Malin Head
Aran
Rossan Point
Donegal Bay
Achill
Lough Conn
Lough Allen
Inishbofin
Slyne Head
Lough Corrib
Clare
Shannon
Lough Ree
Inishmore
Galway Bay
Loop Head
Lough Derg
Liffey
Dundalk Bay
Wicklow Head
Barrow
Nore
Suir
Carnsore Point
The Lakes of Killarney (Lough Leane)
Cape Clear
Gweedore
Letterkenny
Donegal
Belmullet
Bundoran
Killala
Ballina
Sligo
Monaghan
Westport
Boyle
Cavan
Dundalk
Clifden
Longford
Ardee
Galway
Mullingar
Navan
Drogheda
Athlone
Kinnegad
Balbriggan
DUBLIN
Ennis
Newbridge
Naas
Roscrea
Bray
Wicklow
Listowel
Limerick
Adare
Carlow
Dingle
Tralee
Kilkenny
Cashel
Arklow
Killarney
Cahir
Clonmel
Waterville
Mallow
New Ross
Sneem
Lismore
Waterford
Wexford
Cork
Tramore
Youghal
Rosslare Harbour
Clonakilty
0 25 50 KM
0 25 Miles
Copyright © 2014 www.mapsofworld.com
(Updated on 7th Aug, 2014)
LEGEND
Intl. Boundary
River
Country Capital
City
Waterbody

The GPS on your smartphone uses Latitude and Longitude for positioning and navigation

The Sat Nav in your car uses latitude longitude

Two of the most important features of a web based map are **(1) The Latitude Longitude of the Center of the Map and (2) The Zoom level that you display the map at**

By knowing the Latitude and Longitude COORDINATES we can give the location of ANYWHERE in the world (on the earth's surface)

This is called GEOLOCATION

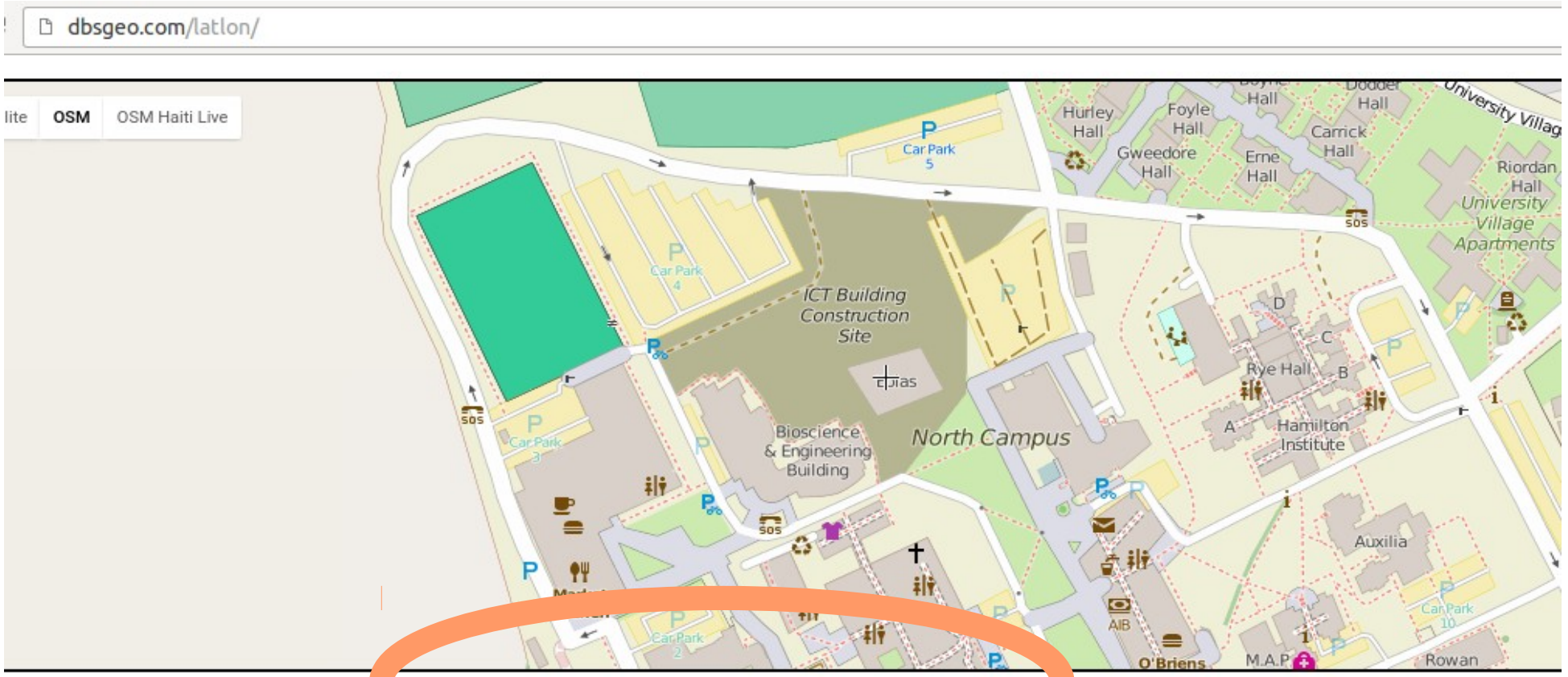
How can we find out the geolocation or the latitude longitude coordinates of our school, our house, our favourite restaurant?

Go to this website

http://dbsgeo.com/latlon/

Use the map to zoom in and find the Latitude Longitude of your school, or your football or sports club or of your favourite shop

Here is the Latitude, Longitude of the Eolas Building (where we are)



Latitude, Longitude: 53.38494, -6.60180

Google Maps zoom level: 17

GeoJSON: { "type": "Point", "coordinates": [-6.60180,53.38494] }

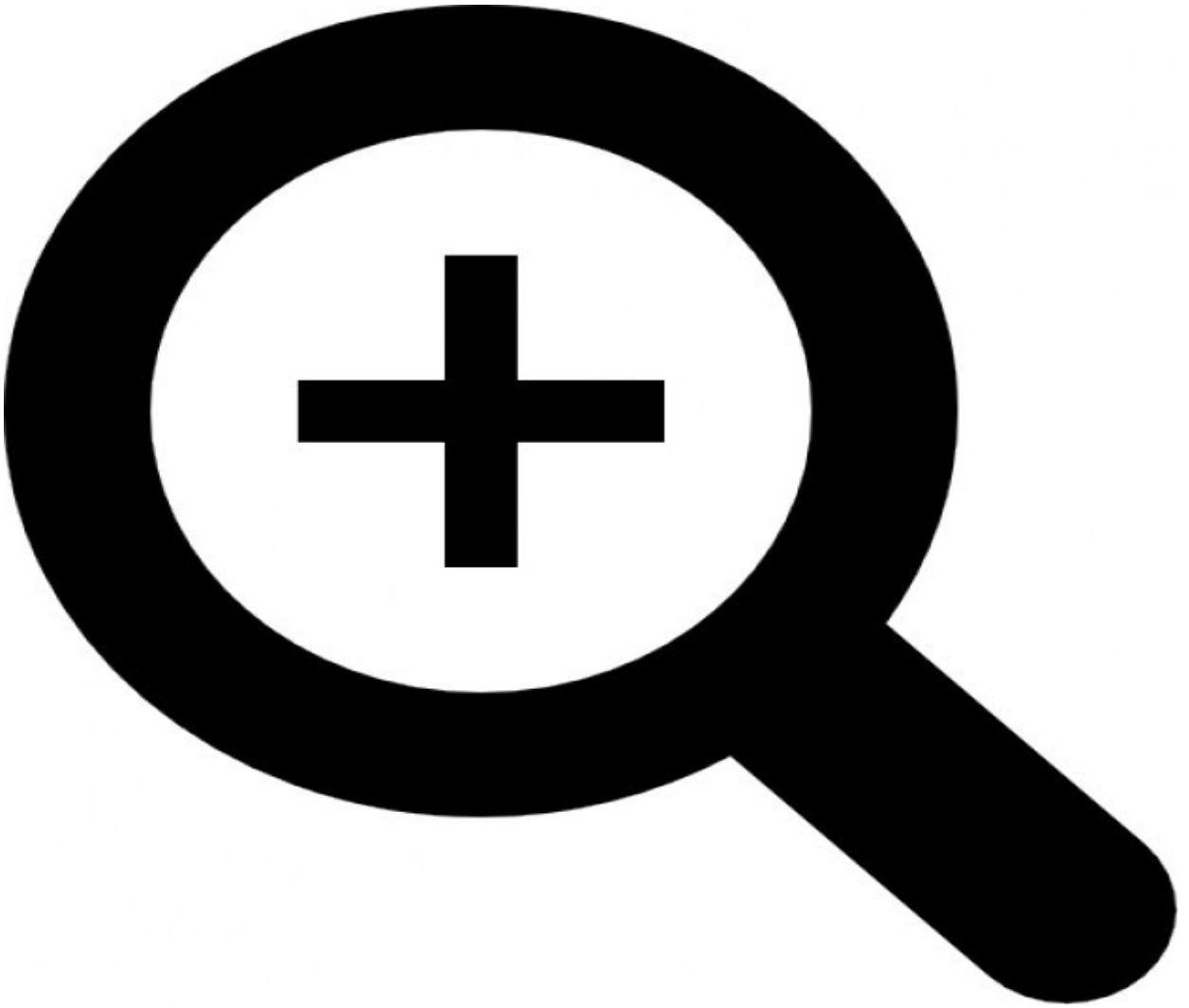
Wikipedia: {{Coord|53.38494|-6.60180|display=title}}

Make note of this website

http://dbsgeo.com/latlon/

We will be using it a few times today

Zoom levels in web based maps

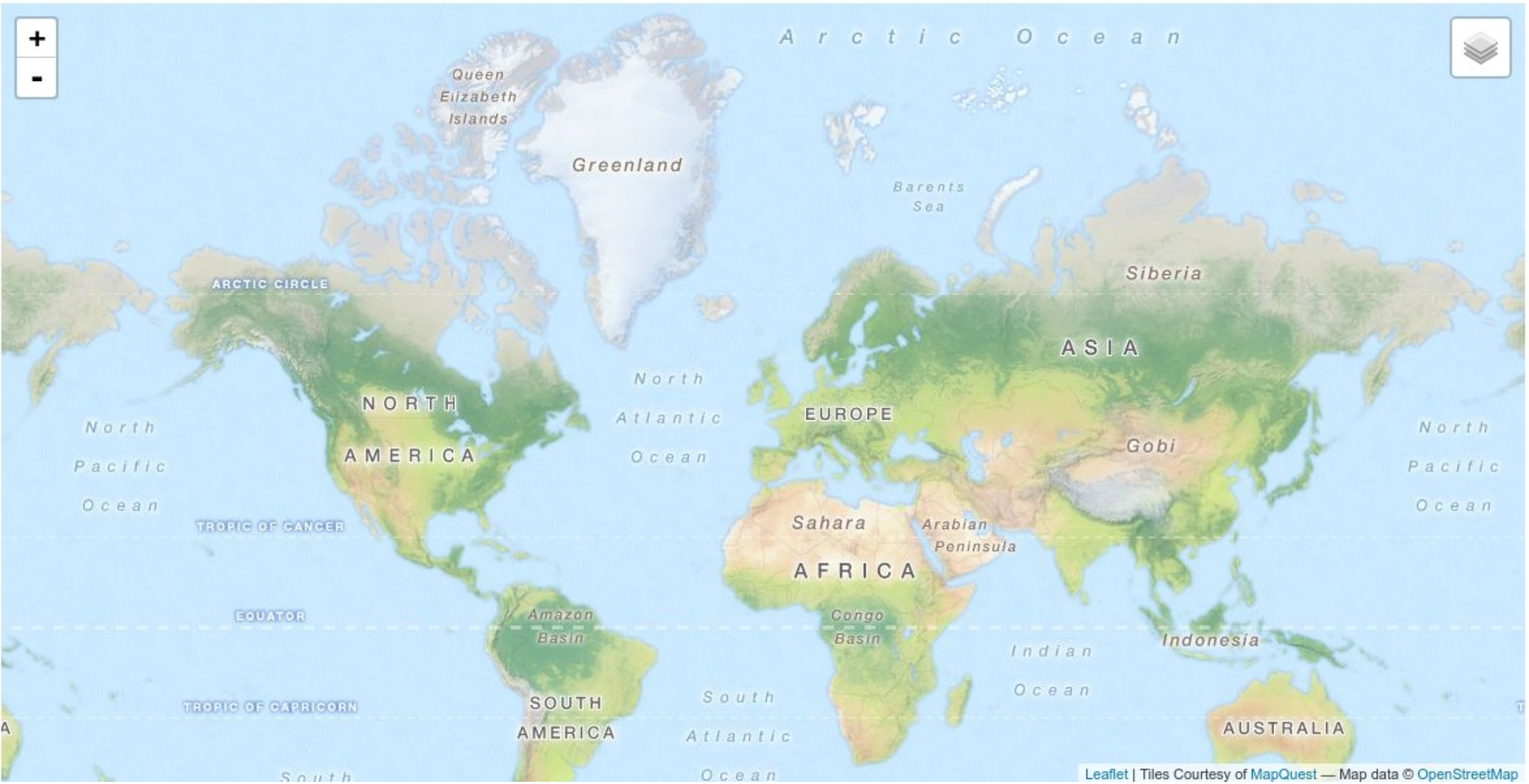


Zoom Levels in Web Maps

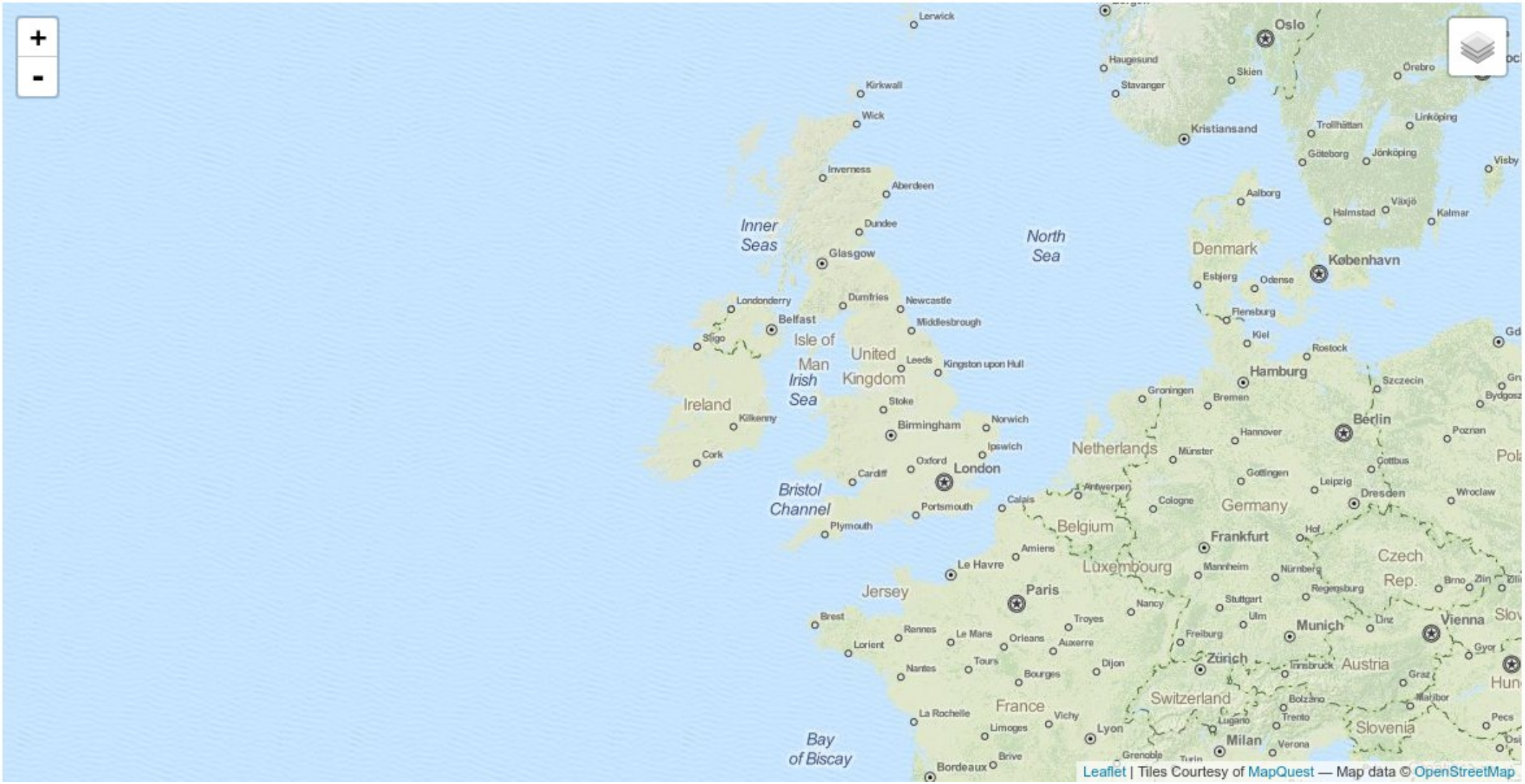
- Zoom Levels in web based maps are very simple to understand.
-
- Usually Zoom Levels go from Level = 1 (very very far away) to Level 18 (very very close to the ground)
- Let's have a look at an example

Zoom Level 1 (very very far away)

Zoom Level 2 (still far far away)

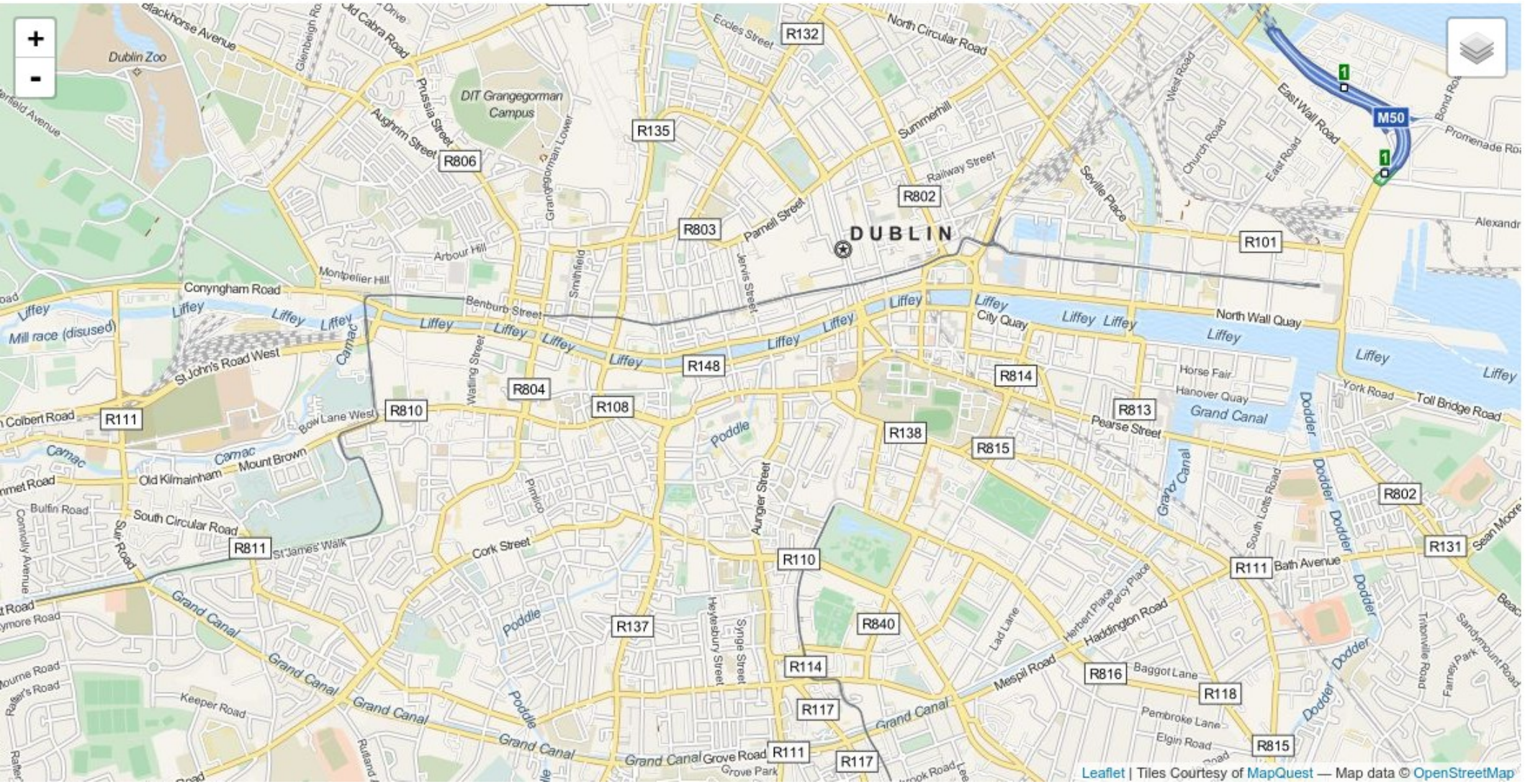


Zoom Level 5 (at continent level)

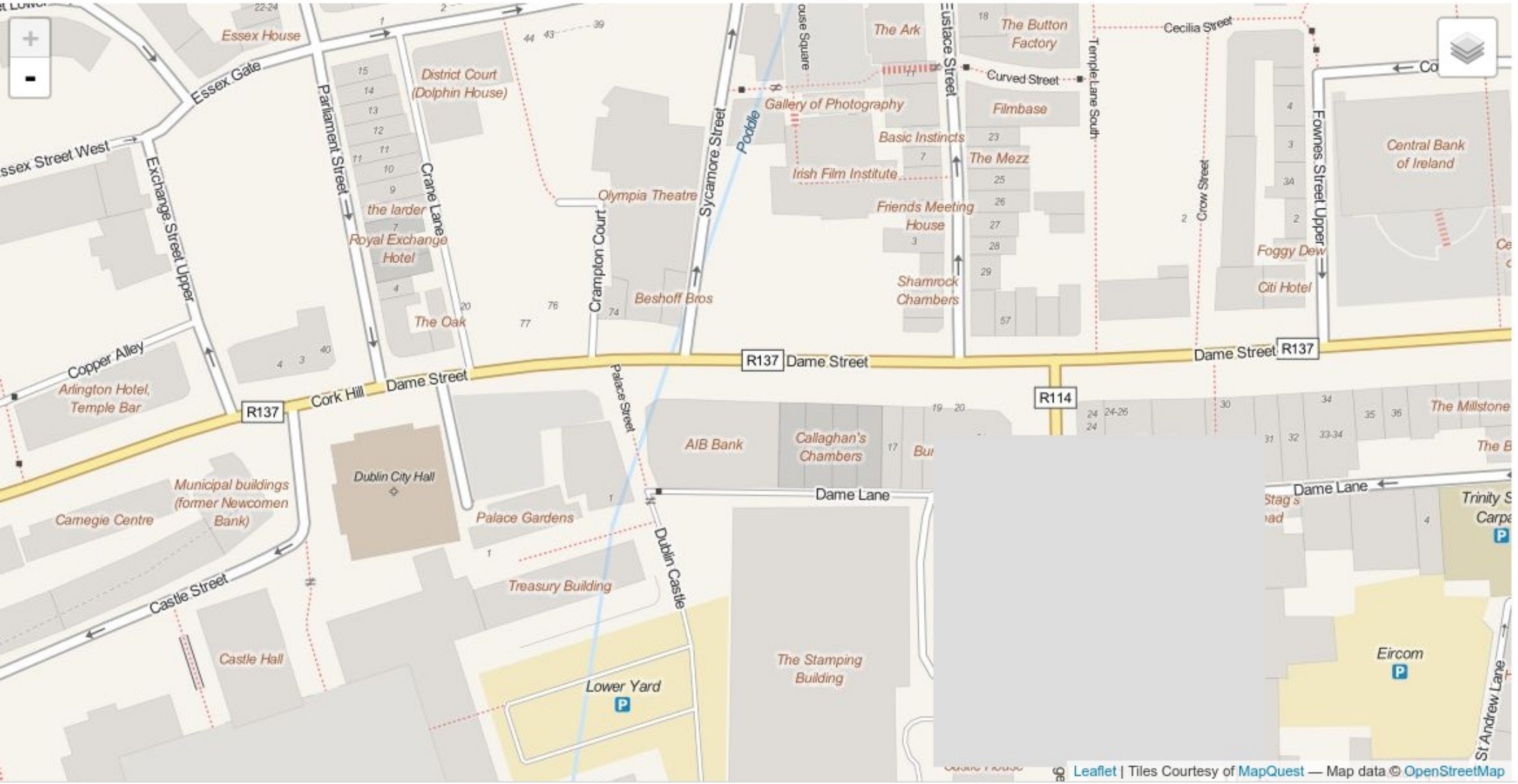


Zoom Level 8 (at country level)

Zoom Level 14 (at city level)



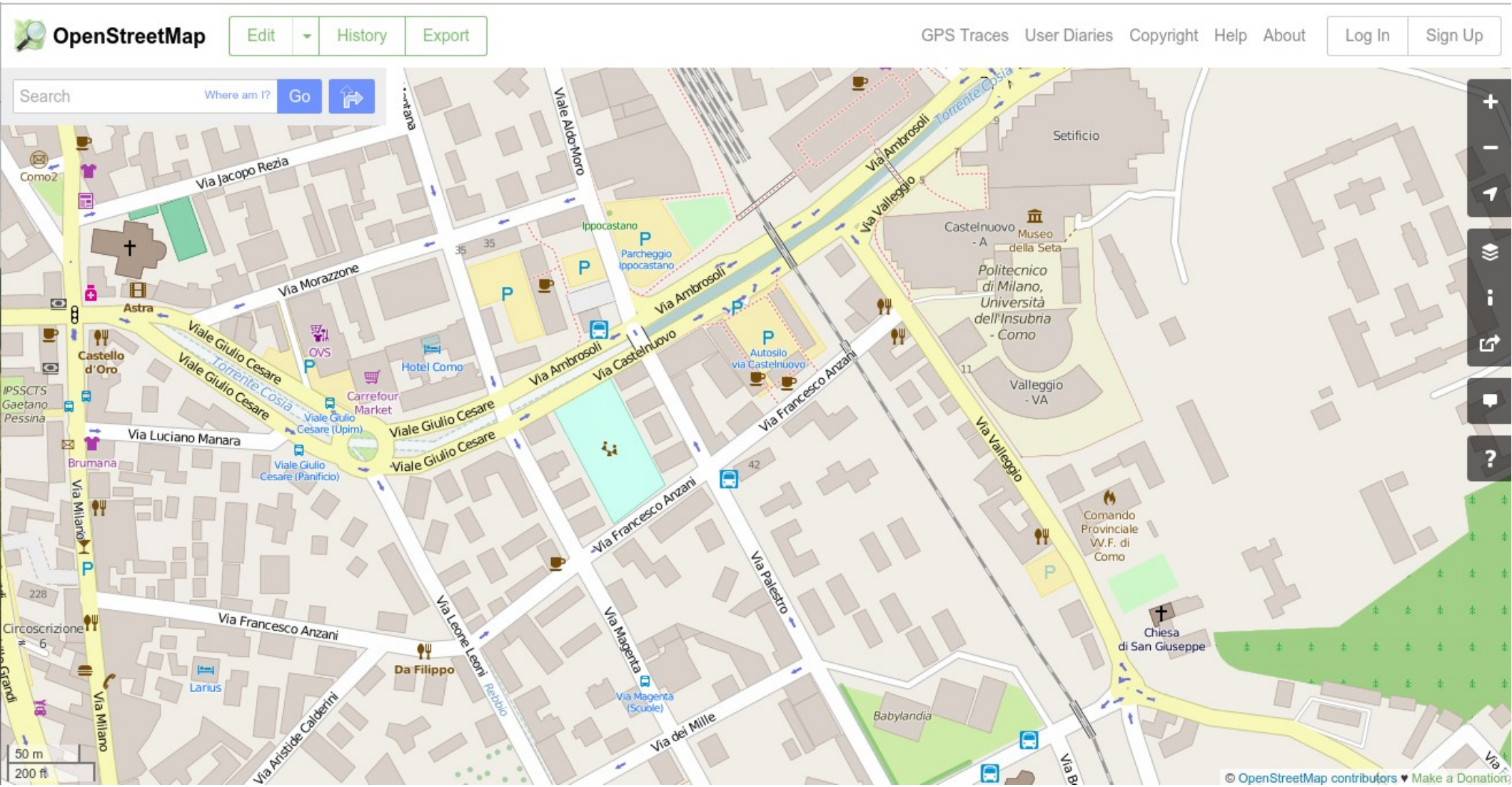
Zoom Level 17 (at ground level)

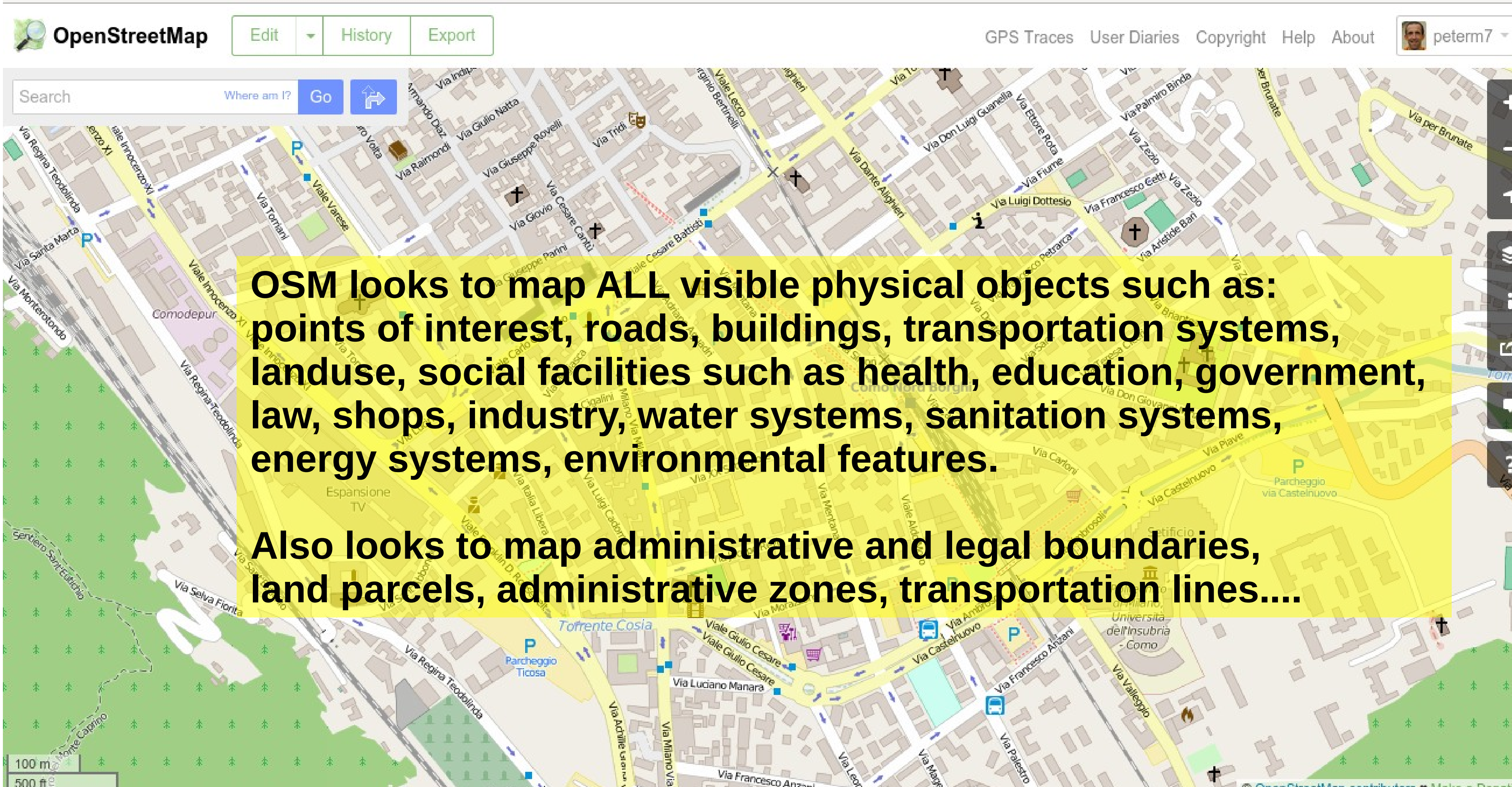


So ZOOM level goes from 1 (furthest away) to 17 (closest to the ground)

A little bit about OpenStreetMap

OpenStreetMap is more than just a map...



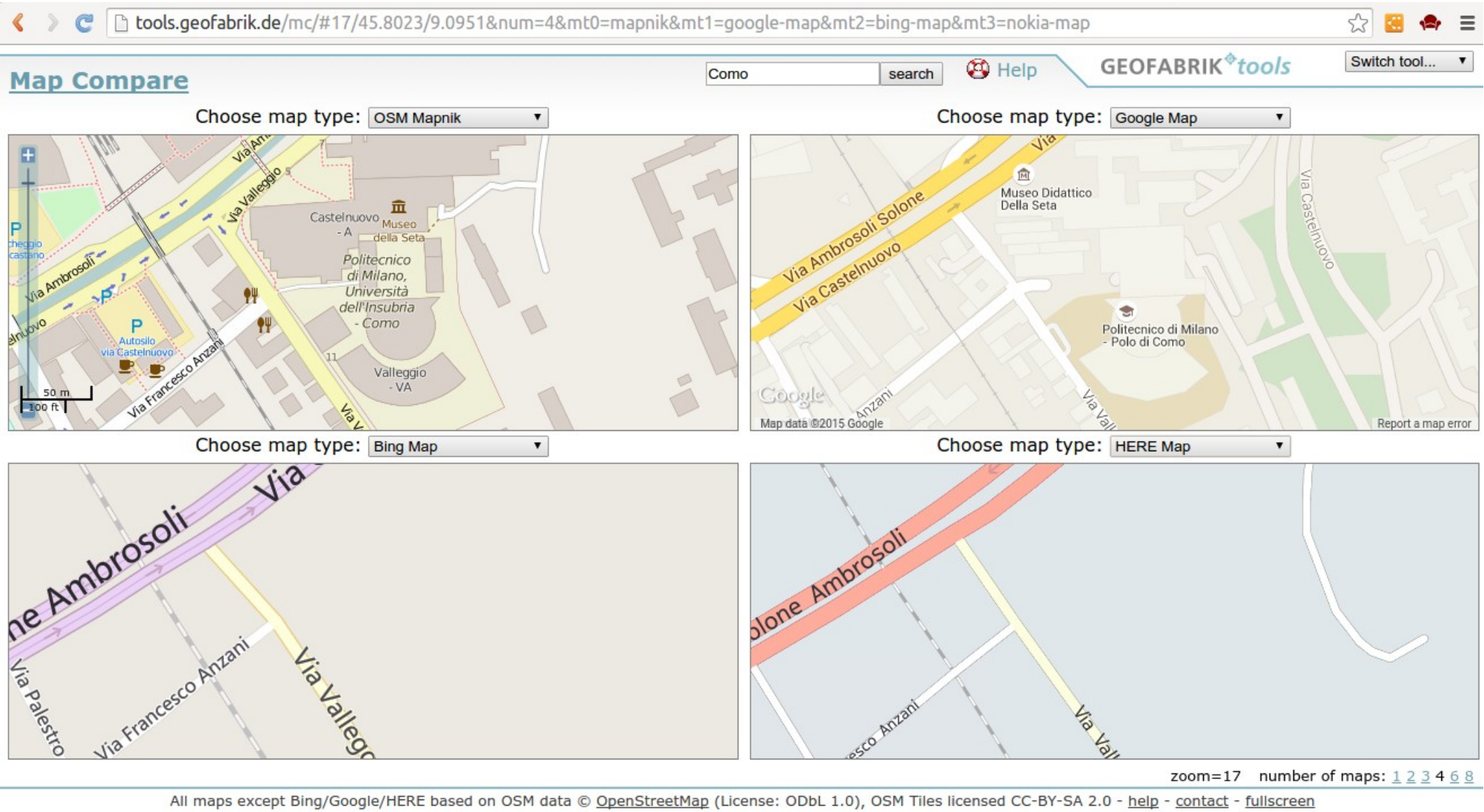


OSM looks to map ALL visible physical objects such as: points of interest, roads, buildings, transportation systems, landuse, social facilities such as health, education, government, law, shops, industry, water systems, sanitation systems, energy systems, environmental features.

Also looks to map administrative and legal boundaries, land parcels, administrative zones, transportation lines....

OpenStreetMap is actually a massive spatial database

Map Compare



http://tools.geofabrik.de/mc/

Exercise with Map Compare

- Let's look at Map Compare for an area which you are very familiar with – your home, your university, your favourite town, etc
- **Exercise and Discussion:** Use Map Compare to make a visual comparison of OSM in this area with Google Maps, Bing etc.
- Can you make some statements about: coverage, missing data, overall quality of the map data?

What web technologies are we using today for the lecture?

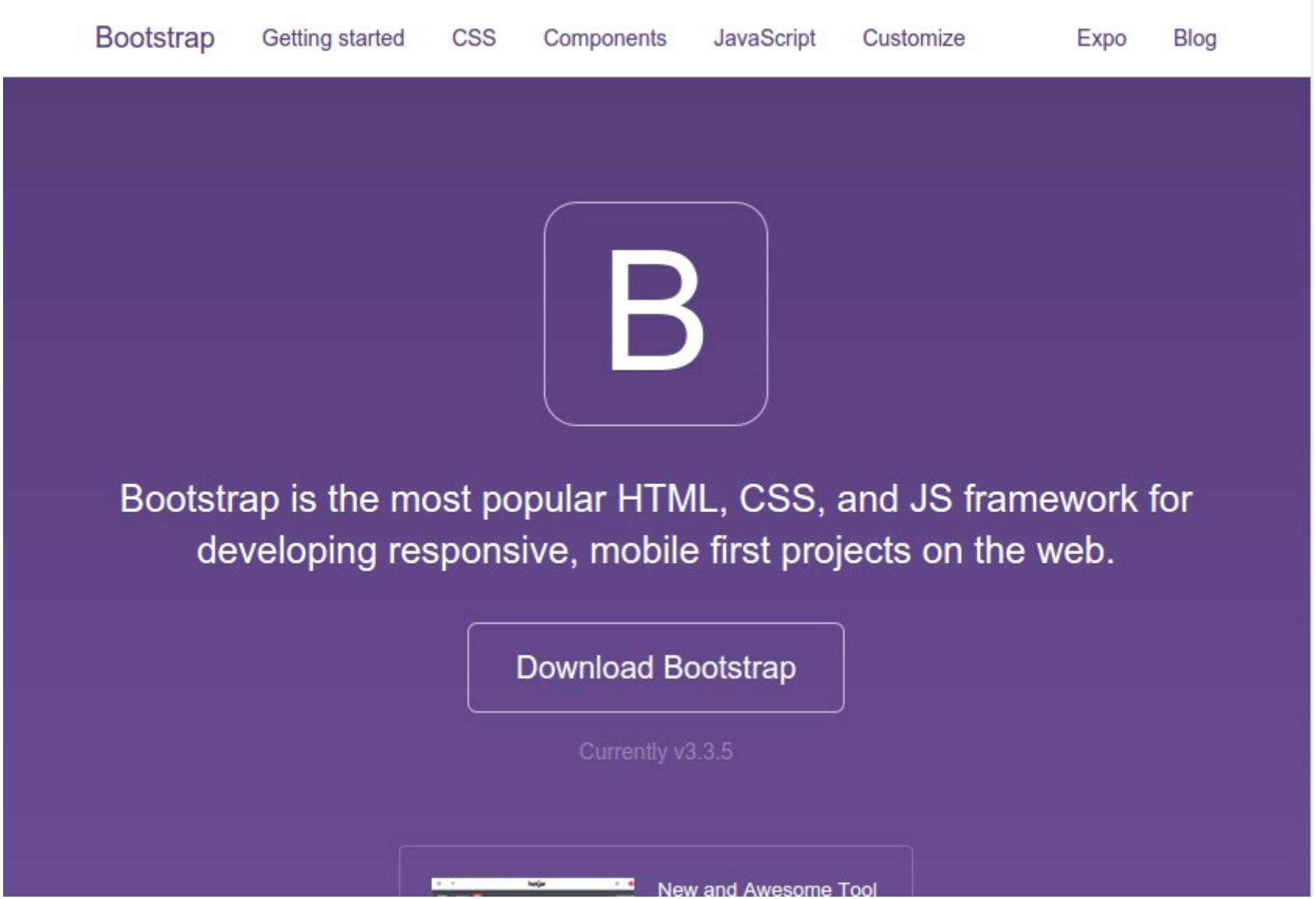
We are using Leaflet for our map container Javascript

an open-source JavaScript library
for mobile-friendly interactive maps

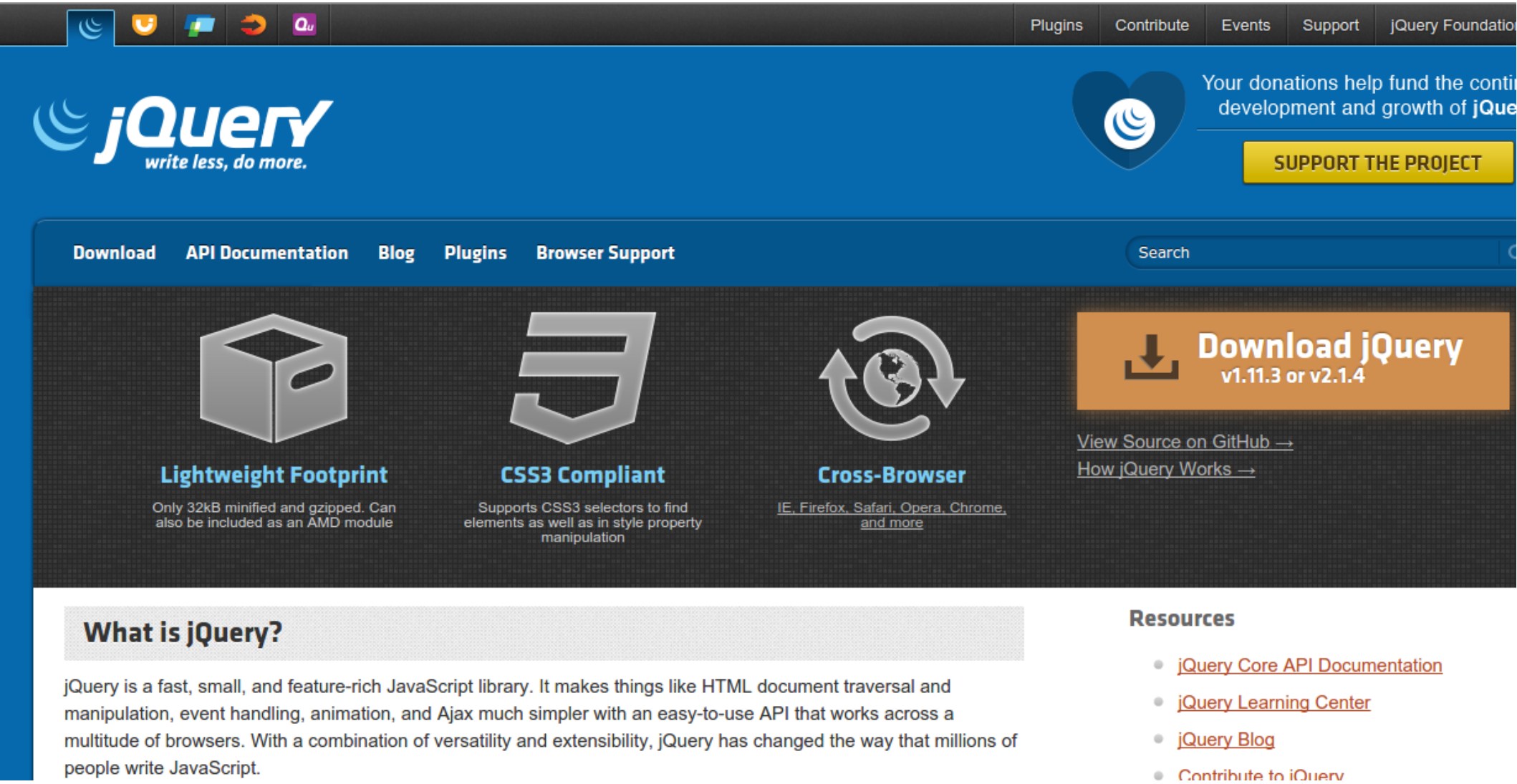
Overview Tutorials Docs Download Plugins Blog

Leaflet is the leading open-source JavaScript library for mobile-friendly interactive maps. Weighing just about 33 KB of JS, it has all the mapping features most developers ever need.

We are using Bootstrap to make our pages display in a responsive way



Jquery provides LOTS of very useful Javascript functionality

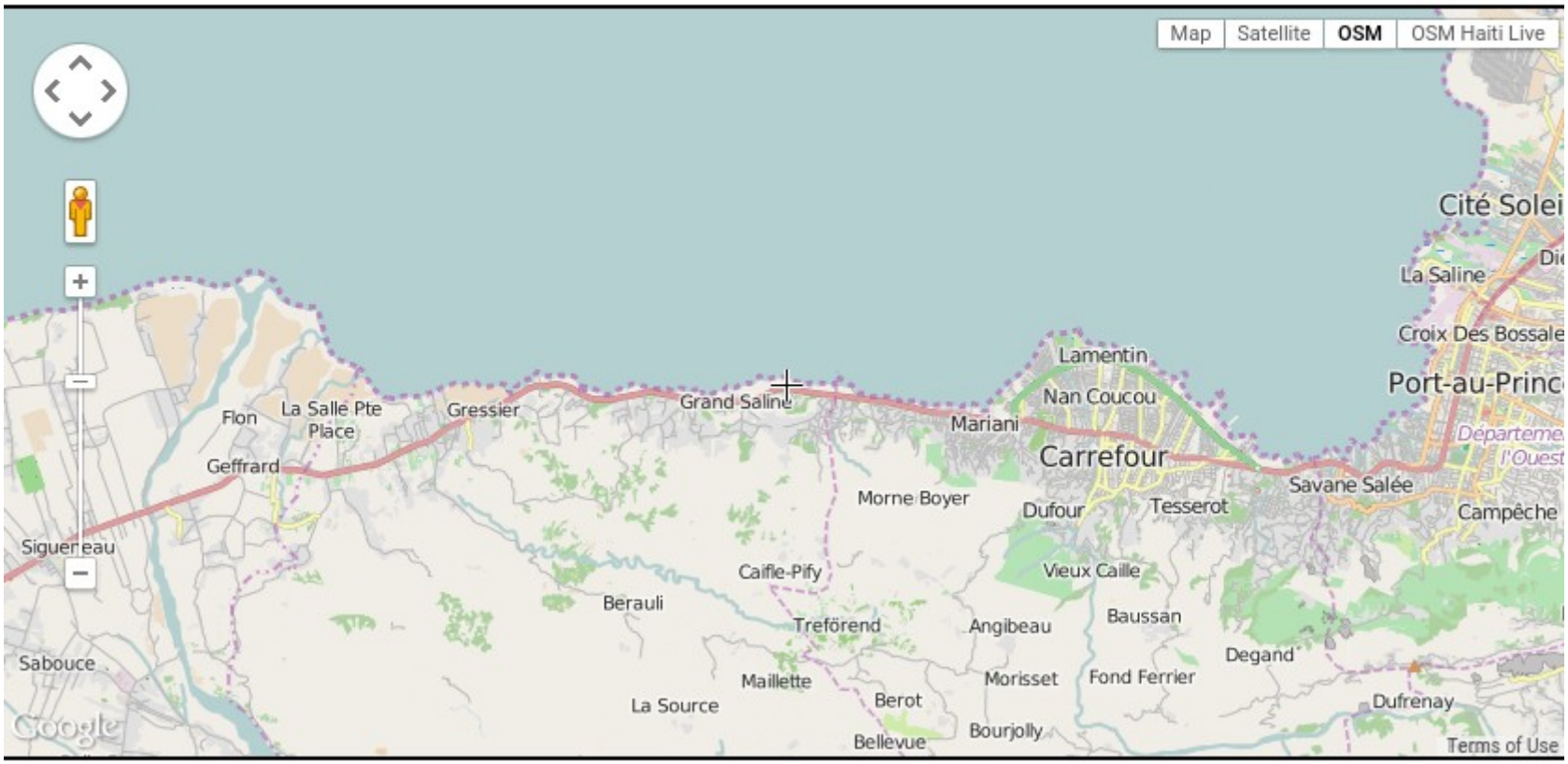


Finding the Latitude Longitude of any point will be very useful today

Get Lat Lon

Find the latitude and longitude of a point on a map.

Place name: Zoom to place

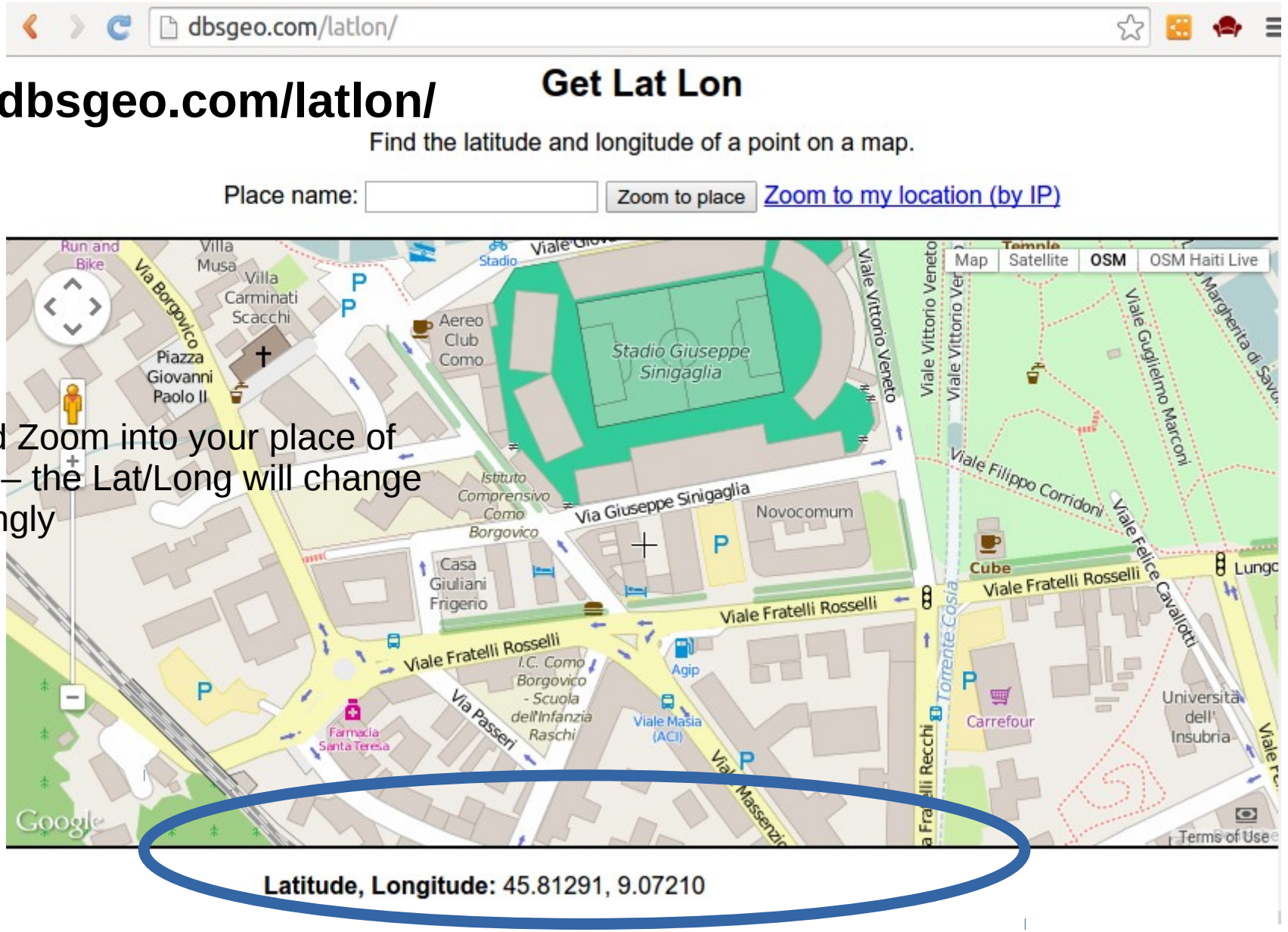


Latitude, Longitude: 18.54732, -72.46788

Getting Started

Get the Latitude Longitude of ANY point on the earth

http://dbsgeo.com/latlon/

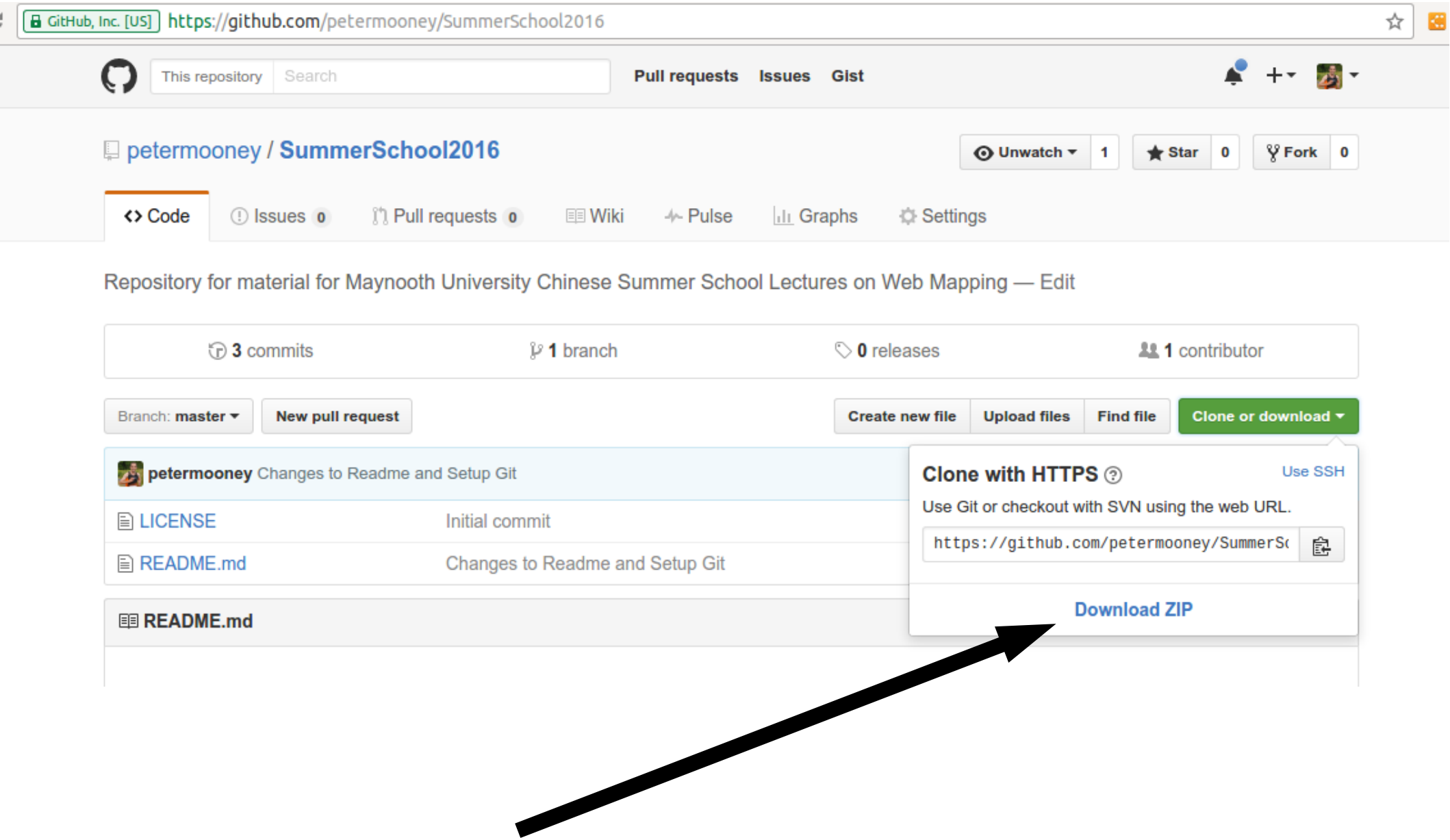


Pan and Zoom into your place of interest – the Lat/Long will change accordingly

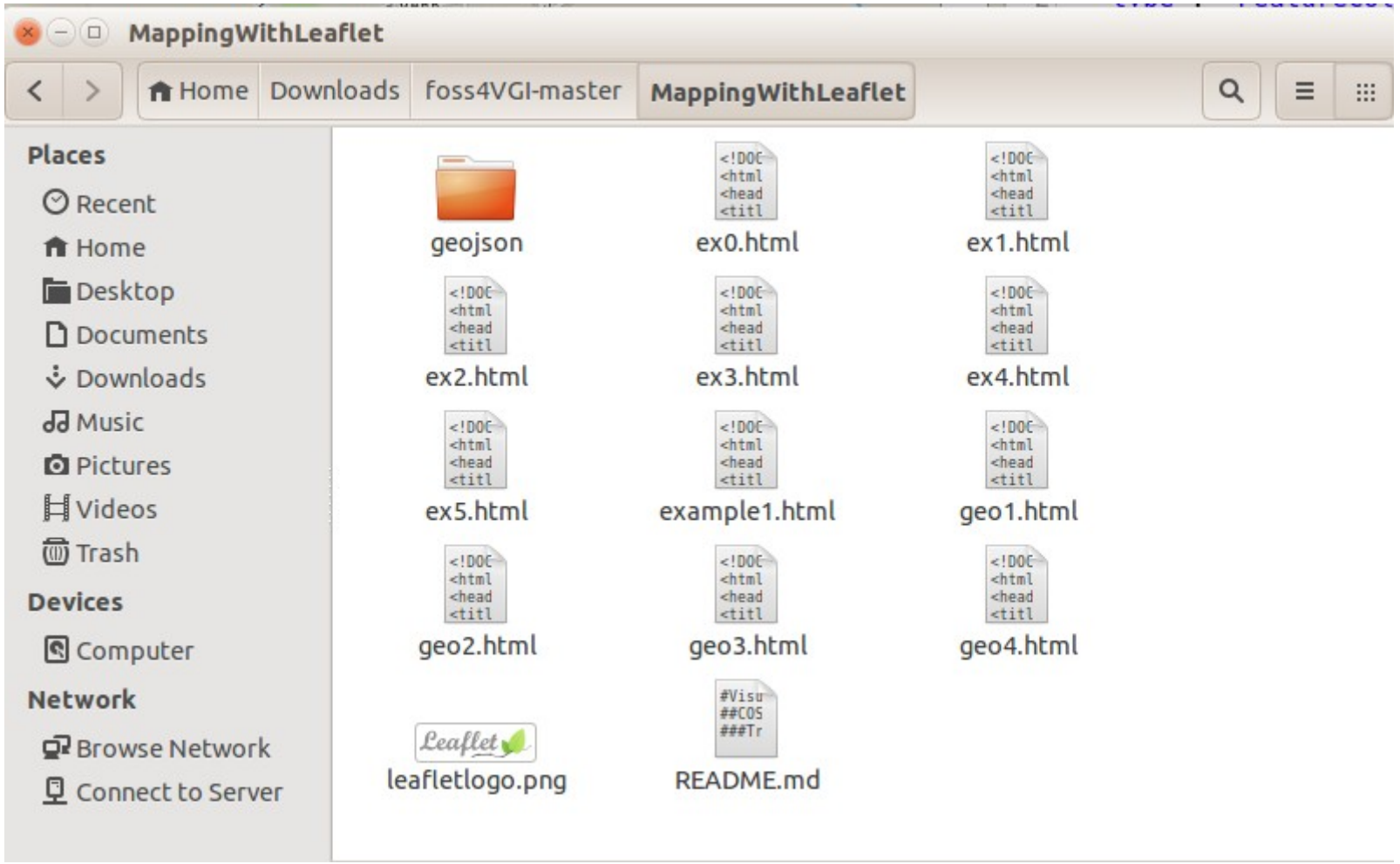
Getting our material together

- We will need to download all of the materials from GitHUB
- You will unzip these materials into a folder on your computer.
- You then need to copy the Mongoose executable into this folder. [LATER ON]
- **DO NOT CHANGE the names of any files or folders within this new folder.**

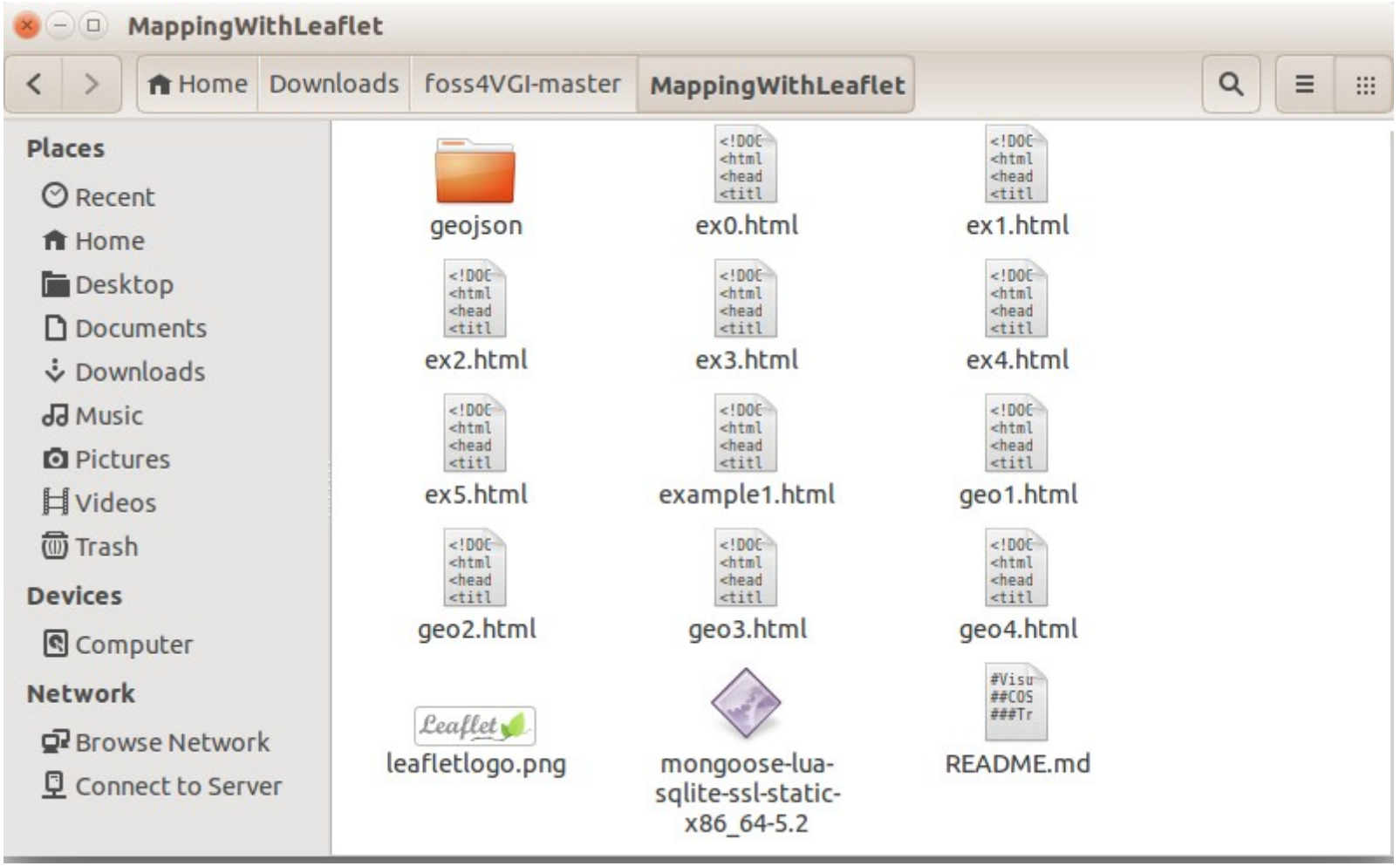
Download from GitHub



The Unzipped Files in a Folder



And look – there is the Mongoose Executable Included now!



Every webpage in the world has the same structure regardless of what the webpage actually does

A webpage at it's most fundamental has a <head> and has a <body>

The <body> is what you see in your web-browser. The <head> helps to support the technical details of how the <body> is managed and displayed.

Unfortunately – we do not have enought time to go into the deeper details of web page development

- So we are going to take a few things for granted and make some assumptions.
- In our examples – the <HEAD> of our pages WILL NOT CHANGE except for the <TITLE>
- In our examples – the <BODY> of our pages will change but we are not trying to design very fancy beautiful webpages.
- **The focus today is on DISPLAYING MAPS WITH GEODATA in a webpage and NOT webpage development.**

Let's open ex0.html in your text editor which you installed

- We are going to step through this very carefully so we can see the <HEAD> and the <TITLE> and the <BODY>

The <HEAD> of our Web Pages

```
2  <html>
3  <head>
4      <title>FOSS4VGI - Leaflet Lectures - Example 0</title>
5  <!-- This part of our web page should hardly change over the course of lecture today -->
6  <!-- This part of the web-page tells the web-browser it will need certain functionality
7  to make the page display/function as the programmer intended -->
8  <!-- There should be no need for you to change any of the links below -->
9
10 <meta charset="utf-8" />
11 <meta name="viewport" content="width=device-width, initial-scale=1">
12
13 <!-- Bootstrap CSS -->
14 <link rel="stylesheet" href=
   "https://maxcdn.bootstrapcdn.com/bootstrap/3.3.5/css/bootstrap.min.css">
15
16 <!-- Bootstrap Optional theme -->
17 <link rel="stylesheet" href=
   "https://maxcdn.bootstrapcdn.com/bootstrap/3.3.5/css/bootstrap-theme.min.css">
18 <!-- JQuery - which is needed by Bootstrap and Leaflet -->
19 <script src="https://code.jquery.com/jquery-1.11.3.min.js"></script>
20 <!-- Latest compiled and minified JavaScript for Bootstrap -->
21 <script src="https://maxcdn.bootstrapcdn.com/bootstrap/3.3.5/js/bootstrap.min.js"></script>
22
23 <!-- Include Leaflet -->
24 <script src="http://cdnjs.cloudflare.com/ajax/libs/leaflet/0.7.3/leaflet.js"></script>
25 <link rel="stylesheet" href=
   "http://cdnjs.cloudflare.com/ajax/libs/leaflet/0.7.3/leaflet.css" />
26
27 </head>
```

The <BODY> of our Web Pages

```
<body>
<div class="container">
    <!-- start the row of content -->
<div class="row">
    <h1>This is Example 0</h1>  <!-- We can change this piece of text each time -->
    <div id="map" style="width: 100%; height: 600px"></div>
</div><!-- close the row of content-->

<script><!-- This is where our mapping code starts -->
// This is our base layer - you should not need to change this in many examples
var OpenStreetMap_Mapnik = L.tileLayer('http://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png',
{maxZoom: 19, attribution: '&copy; <a
href="http://www.openstreetmap.org/copyright">OpenStreetMap</a>'});

// Notice how the MAP is centered at a particular point - notice the ZOOM level
var map = L.map('map', {center: [45.81288, 9.07454], zoom: 19,layers: [OpenStreetMap_Mapnik
]});

var baseMaps = {"OpenStreetMap_Mapnik":  enStreetMap_Mapnik};

var overlayMaps = { };

L.control.layers(baseMaps, overlayMaps).addTo(map);

// This is a marker pin on a particular spot. It does not have to be the center
L.marker([45.81288, 9.07454]).addTo(map).bindPopup("<b>Hello Everyone</b><br/>This is the
Cube Cafe in Como.").  Popup();

</script><!-- This is  ere our mapping code ends -->
</div><!-- close the c tainer -->
</body>
</html>
```

Exercise A: Let's put some marker pins on our favourite places

- Copy the file ex0.html and rename the file exerciseA.html *(stay in the same folder)*
- Open exerciseA.html in your text editor.
- Using the 'get lat long' web page – find the lat/longitude of your favourite places – change the code in your file so that the marker pins are changed.
- CREATE THREE MARKERS
- Change also the <TITLE> and the <h1> text
- SAVE the file and then look at **exerciseA.html**

Exercise B: Let's put multiple marker pins on a map using our own data

- Copy the file ex1.html and rename the file exerciseB.html *(stay in the same folder)*
- Open exerciseB.html in your text editor
- Use Get Lat Long to find the locations of FOUR TRAIN STATIONS close to MAYNOOTH
- You will need to also test and find an appropriate center for your map.
- You will need to fina an appropriate zoom
- **Result at exerciseB.html**

The code for adding more markers to your map is very simple

```
42
43  // Notice how the MAP is centered at a particular point - notice the ZOOM level
44  var map = L.map('map', {center: [45.80880, 9.08367], zoom: 15,layers: [OpenStreetMap_Mapnik]});
45
46  var baseMaps = {"OpenStreetMap_Mapnik": OpenStreetMap_Mapnik};
47
48  var overlayMaps = { };
49
50  L.control.layers(baseMaps, overlayMaps).addTo(map);
51
52  // This is a marker pin on a particular spot. It does not have to be the center
53  L.marker([45.81288, 9.07454]).addTo(map).bindPopup("<b>Hello Everyone</b><br/>This is the Cube Cafe in Como.");
54
55  L.marker([45.81413, 9.08407]).addTo(map).bindPopup("<b>Hello Train Users</b><br/>This is the Como Lago Nord train
    station.");
56
57  L.marker([45.80168, 9.08913]).addTo(map).bindPopup("<b>Hello Shoppers</b><br/>This is the Carrefour Supermarket in
    the south of Como city.");
58
59
```

NOTICE that the CENTER of the map is different to the locations of the 3 markers which we have added

Let's look at example0.html in your text editor – multiple markers

- You can have multiple markers on your map – it's no problem. You can actually have hundreds of marker icons on your map if you need.
- **Decision 1:** When you have more than one marker – you will need to decide where to center the map
- **Decision 2:** You will also need to decide upon the appropriate zoom level
- **Decision 3:** You might need to use a different LAT/LONG for your center

Exercise B: Let's put multiple marker pins on a map using our own data

- Copy the file exampleA.html and rename the file exerciseB.html *(stay in the same folder)*
- Open exerciseB.html in your text editor
- Use Get Lat Long to find the locations of FOUR TRAIN STATIONS close to MAYNOOTH
- You will need to also test and find an appropriate center for your map.
- You will need to find a an appropriate zoom and center
- **Result at exerciseB.html**

But figuring out the best center and zoom is tricky – what happens if there are lots of points or markers?

Let's look at ex1.html in the text editor window

```
// Notice here now that we do not specify the zoom or the center.
var mymap = L.map('map', {
    layers: listOfLayers
});

L.control.layers(baseMaps).addTo(mymap);

// We can add actually make Leaflet handle the centering of the map.

var marker1Coords = L.latLng(53.38389, -6.57733);
var marker1 = L.marker(marker1Coords).addTo(mymap);
marker1.bindPopup("This is Marker 1");

var marker2Coords = L.latLng(53.3865, -6.56723);
var marker2 = L.marker(marker2Coords).addTo(mymap);
marker2.bindPopup("This is Marker 2");

var marker3Coords = L.latLng(53.2765, -6.58700);
var marker3 = L.marker(marker3Coords).addTo(mymap);
marker3.bindPopup("This is Marker 3");

var marker4Coords = L.latLng(53.1865, -6.72710);
var marker4 = L.marker(marker4Coords).addTo(mymap);
marker4.bindPopup("This is Marker 4");

// We can use the latLngBounds method (which takes an array of coordinates)
var mapBounds =  L.latLngBounds([marker1Coords, marker2Coords,marker3Coords,marker4Coords]);

// The map will be fitted to these boundaries.
mymap.fitBounds(mapBounds);
```

Creating multiple markers

Creating an array of coordinates

Then use the Leaflet function to fitBounds()

Exercise C: Using Leaflet MapBounds function

- Copy **ex1.html** and rename it as **exerciseC.html**
- Pick 5 cities in the UK and Ireland – find a train station in each city.
- Create LatLong coordinates for each and put some marker text in each popup.
- Use the **ex1.html** code to get Leaflet to calculate the correct bounds

Changing the Background Layers

Let's look at e2.html – where we have TWO layers

```
49
50  var OpenStreetMap_Mapnik = L.tileLayer('http://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {
51      maxZoom: 19,
52      attribution: '&copy; <a href="http://www.openstreetmap.org/copyright">OpenStreetMap</a>'
53  });
54  var Esri_WorldImagery = L.tileLayer('http://server.arcgisonline.
        com/ArcGIS/rest/services/World_Imagery/MapServer/tile/{z}/{y}/{x}', {
55      attribution: 'Tiles &copy; Esri &mdash; Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping,
            Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community'
56  });
57
58  var listOfLayers = [Esri_WorldImagery,OpenStreetMap_Mapnik];
59
60  var baseMaps = {
61      "ESRI Aerial": Esri_WorldImagery,
62      "OpenStreetMap Streets": OpenStreetMap_Mapnik
63  };
64
65  // Notice here now that we do not specify the zoom or the center.
66  var mymap = L.map('map', {
67      layers: listOfLayers
68  });
69
```

If we wanted to change an existing layer – or add new ones – where would we need to make changes?

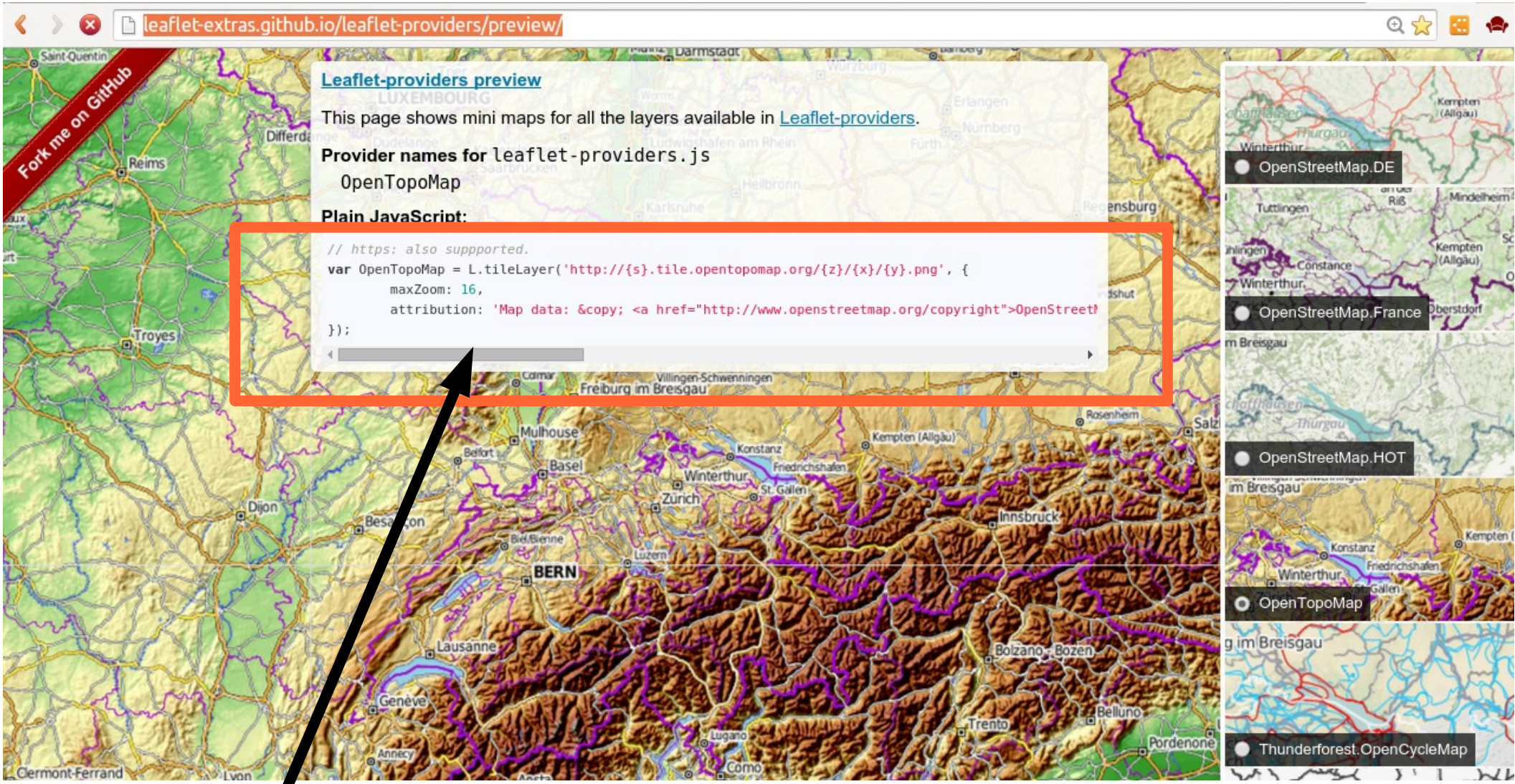
We would make changes in THREE places in our code

```
49
50  var OpenStreetMap_Mapnik = L.tileLayer('http://{s}.tile.openstreetmap.org/{z}/{x}/{y}.png', {   1
51      maxZoom: 19,
52      attribution: '&copy; <a href="http://www.openstreetmap.org/copyright">OpenStreetMap</a>'
53  });
54  var Esri_WorldImagery = L.tileLayer('http://server.arcgisonline.
        com/ArcGIS/rest/services/World_Imagery/MapServer/tile/{z}/{y}/{x}', {
55      attribution: 'Tiles &copy; Esri &mdash; Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping,
            Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community'
56  });
57
58  var listOfLayers = [Esri_WorldImagery,OpenStreetMap_Mapnik];   2
59
60  var baseMaps = {
61      "ESRI Aerial": Esri_WorldImagery,                          3
62      "OpenStreetMap Streets": OpenStreetMap_Mapnik
63  };
64
65  // Notice here now that we do not specify the zoom or the center.
66  var mymap = L.map('map', {
67      layers: listOfLayers
68  });
69
```

Choosing a background layer

- We are going to look at some choices of background layers
- REMEMBER
- You will choose a layer which is appropriate to your data – you need to make sure that you users can easily understand the data and understand the significance of the background layer
- GO TO (this link is on the GitHub page) http://leaflet-extras.github.io/leaflet-providers/preview/

Leaflet Layer Providers



YOU WILL NEED TO COPY THIS EXACTLY

Exercise D: Changing the background layer in Leaflet

- Copy the file **exerciseB.html** and rename the file **exerciseC.html** *(stay in the same folder)*
- Open **exerciseC.html** in your text editor
- Pick your favourite layer from the Leaflet Layer Providers page
- Copy this code and REPLACE the Mapnik Definition. You will also need to change the line containing '`var baseMaps`'

If you want you can ADD a THIRD or FOURTH layer....

This is one example of a different background layer

Adding Polygons to Leaflet

It is easy to add polygons to Leaflet using similar code to that of points

```
var polygon1 = L.polygon([
    [51.509, -0.08],
    [51.503, -0.06],
    [51.502, -0.05],
    [51.51, -0.047],
    [51.509, -0.08]
]).addTo(mymap);
```

REMEMBER: A polygon is a closed object – so the start and end nodes must be the same!

Example E: Adding a polygon

- We can use a tool such as 'Get Lat Long' to help us get the points we need to make up a polygon. Look at **e3.html** in your text editor

```
65  <!-- Here is the CENTER coordinates of our map -->
66
67  var LatitudeCenter = 51.509;
68
69  var LongitudeCenter = -0.05;
70
71  <!-- here is the starting zoom level of our map -->
72
73  var ZoomLevel = 14;
74
75  var mymap = L.map('map', {
76      center: [LatitudeCenter,  LongitudeCenter],
77      zoom: ZoomLevel,
78      layers: listOfLayers
79  });
80
81  L.control.layers(baseMaps).addTo(mymap);
82
83  // Here we can create a Polygon Object and add it to the map
84  var polygon1 = L.polygon([
85      [51.509, -0.08],
86      [51.503, -0.06],
87      [51.502, -0.05],
88      [51.51, -0.047],
89      [51.509, -0.08]
90  ]).addTo(mymap);
91
```

Exercise E: Adding more Polygons

- Copy **e3.html** and rename it as **exerciseD.html**
- **AIM:**
- Use 'Get Lat Long' to help create TWO NEW POLYGONS (you can fully delete the polygon which is already in **e3.html**)
- The TWO NEW POLYGONS will represent TWO Educational facilities in your town, city or Region. You will need to find an appropriate center for the map. You will need to provide text for the popup windows.

OK! Let's take a break from Polygons for a moment

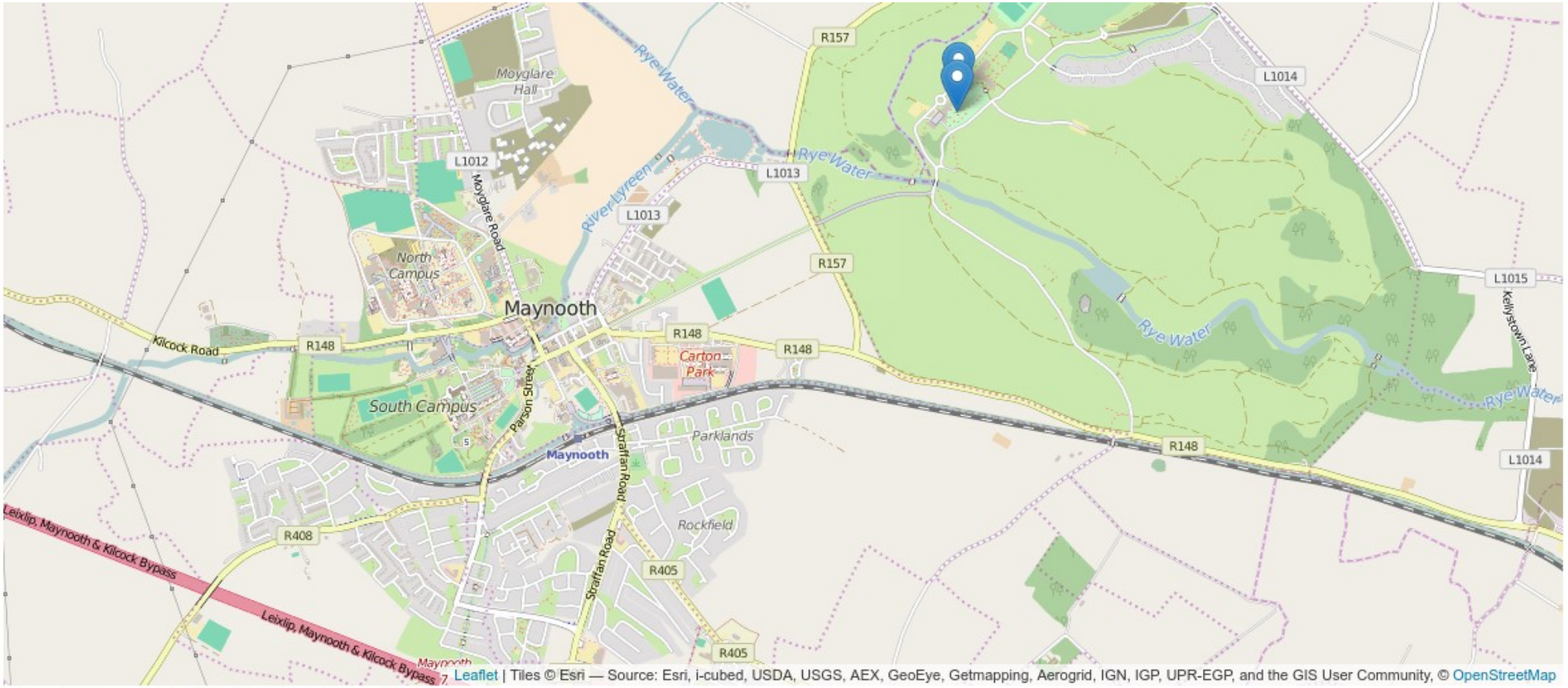
Let's create our very own simple version of Get Lat Long for ourselves

E4.html – Open this file in your text editor and view it in the browser

- Open **e4.html** in your text editor
- Check out **e4.html** in the browser
- **We have added some code – but it is a really useful piece of code**

```
93
94  // This is the where Javascript is connected to the map when you 'click' on the map
95  mymap.on('click', onMapClick);
96
97  // THIS IS NEW. This is a special FUNCTION from Javascript.
98  // Leaflet has lots of functionality that we can use. This is very useful to display information about the map
99  function onMapClick(e) {
100     var theDateAndTime = new Date();
101     var mapCenter = map.getCenter();
102     $("#mycoordinates").html("<p class = 'lead'>The Maynooth MyGetLatLong Says:<br/> At " + theDateAndTime + "<
            br/>You clicked the map at Coordinates " + "(Lat, Lon) = " + e.latlng.lat + "," + e.latlng.lng +"<br/>
            Also the map is at Zoom level "+ map.getZoom() + "<br/>The CENTER of the map is currently at
            Coordinates " + "(Lat,Lon) = " + mapCenter.lat + "," + mapCenter.lng + "</p>");
103 }
104
```

This is the output from E4.html



The Maynooth MyGetLatLong Says:

At Wed Aug 03 2016 14:46:14 GMT+0100 (IST)

You clicked the map at Coordinates (Lat, Lon) = 53.37411237125759,-6.545276641845702

Also the map is at Zoom level 14

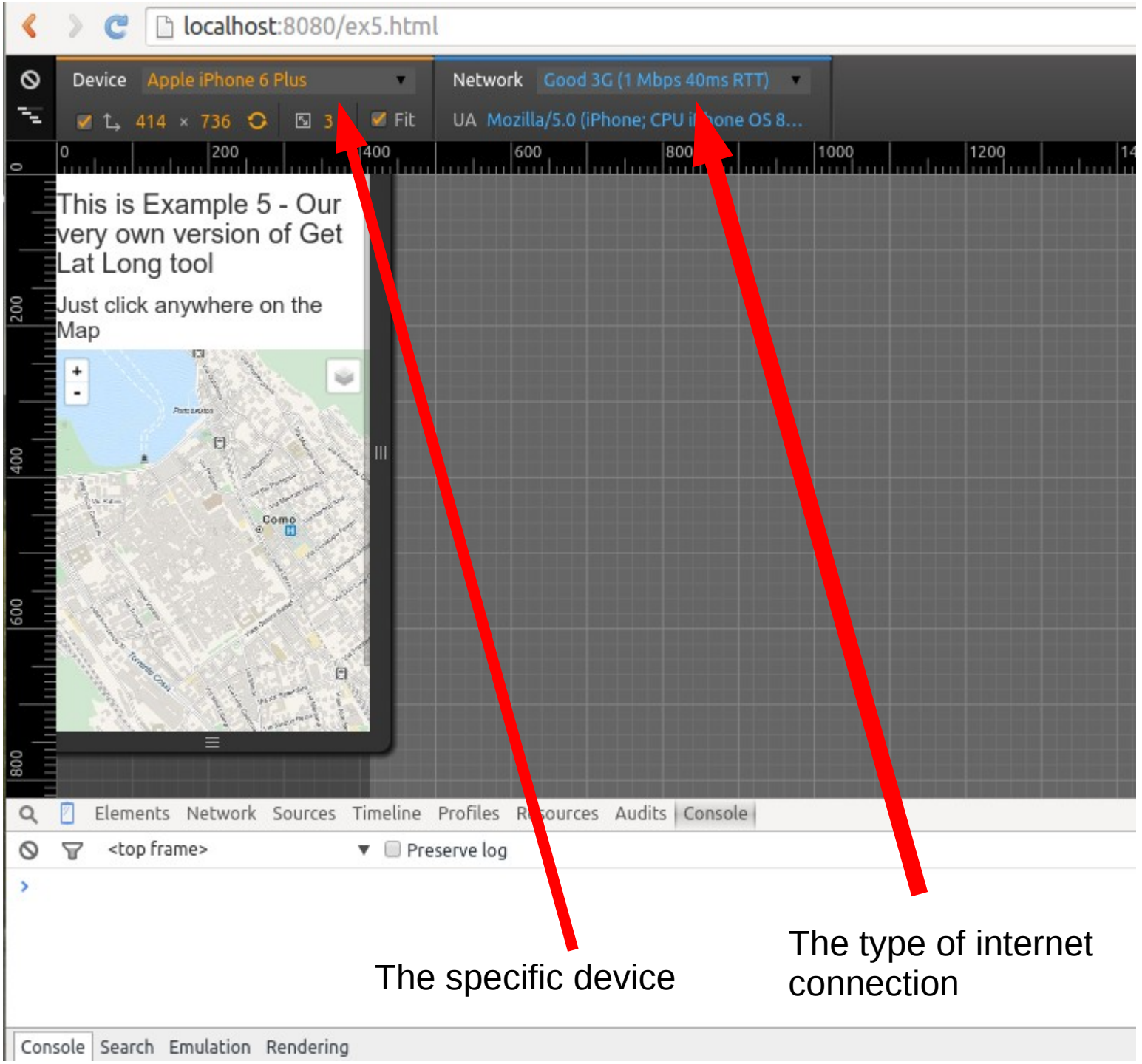
The CENTER of the map is currently at Coordinates (Lat,Lon) = 53.38389,-6.57733

How does all this look on your mobile phone?

Can we test how this will all look on your smartphone or tablet?

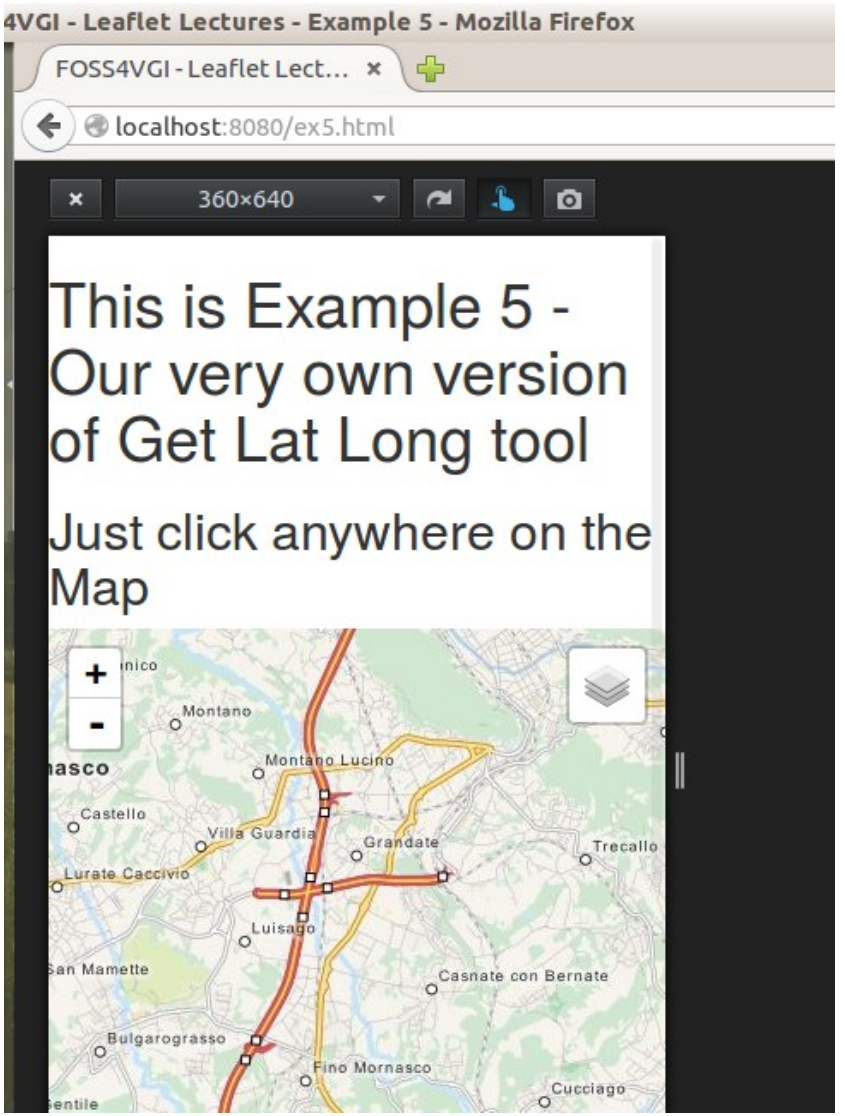
If you are using Google Chrome

- Open up **e4.html** in your Google Chrome
- Go to the options menu
- Then go to More Tools
- Then go to Developer Tools
- Click on the little smartphone icon in the left hand corner.


localhost:8080/ex5.html
Device
Apple iPhone 6 Plus
414 × 736
Fit
Network
Good 3G (1 Mbps 40ms RTT)
UA Mozilla/5.0 (iPhone; CPU
This is Example 5 - Our very own version of Get Lat Long tool
Just click anywhere on the Map
Como
Elements
Network
Sources
Timeline
Profiles
Audits
Console
<top frame>
Preserve log
Console
Search
Emulation
Rendering
The specific device
The type of internet connection

If you are using Firefox

- Go to options
- Go to Developer
- Go to 'Responsive Design View”

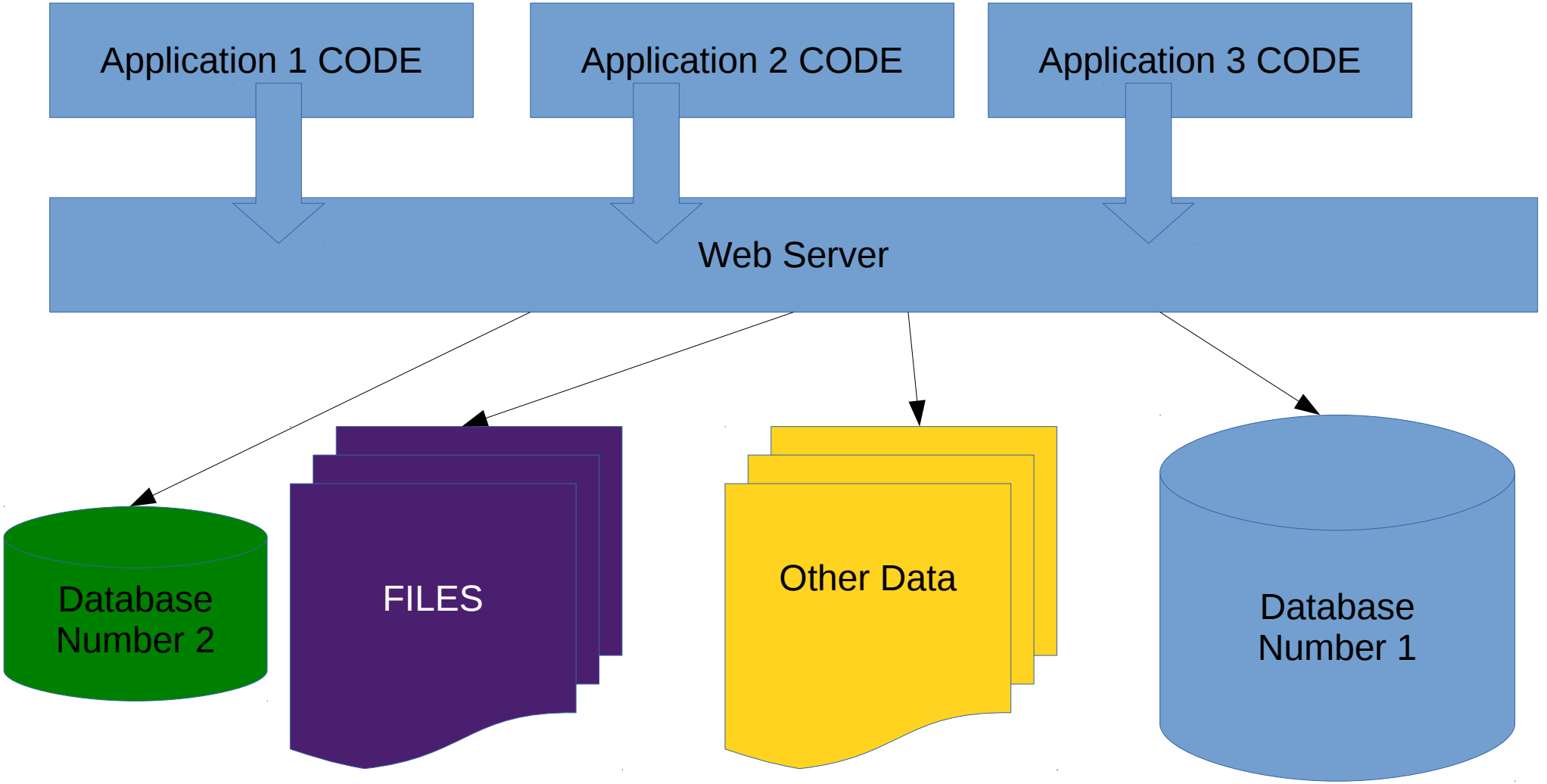


WEB SERVERS

We are going to need to have a web-server to run some of the examples today

- A web server is a special piece of software which provides the software technology to make data and content available on the Internet
- There are millions of web servers running around the world but very often we don't even think about them or what they do!

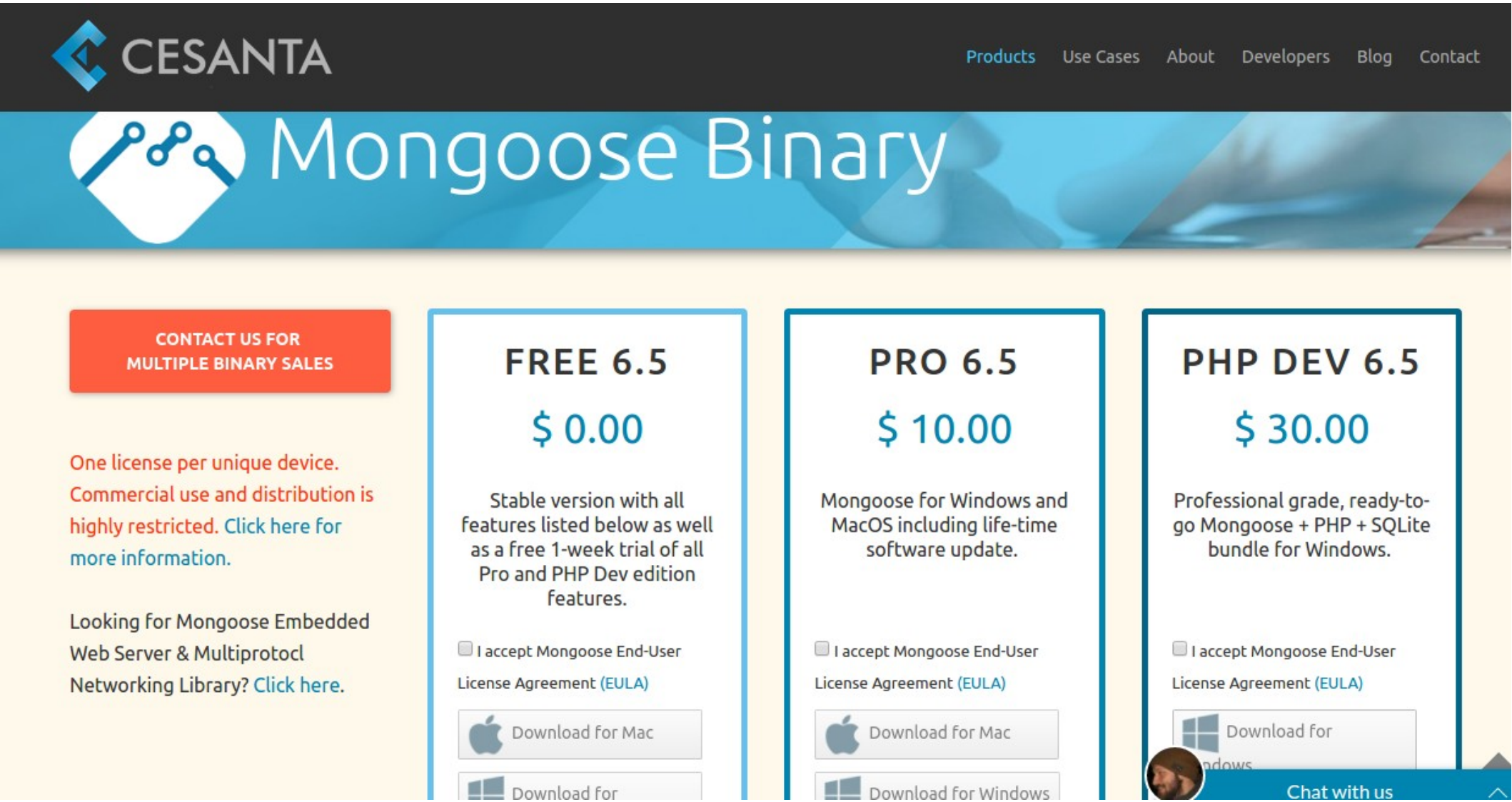
A very simplistic view of what a web-server actually does



We will need a web server for some of the more advanced examples

- There are LOTS of choices for this.
- The BEST solution (in my opinion) would be to use Apache Server
- It is probably the best web-server available (and it is Open Source)
- But it can be tricky to install when we are dealing with lots of different machines and operating systems.

Download Mongoose Free

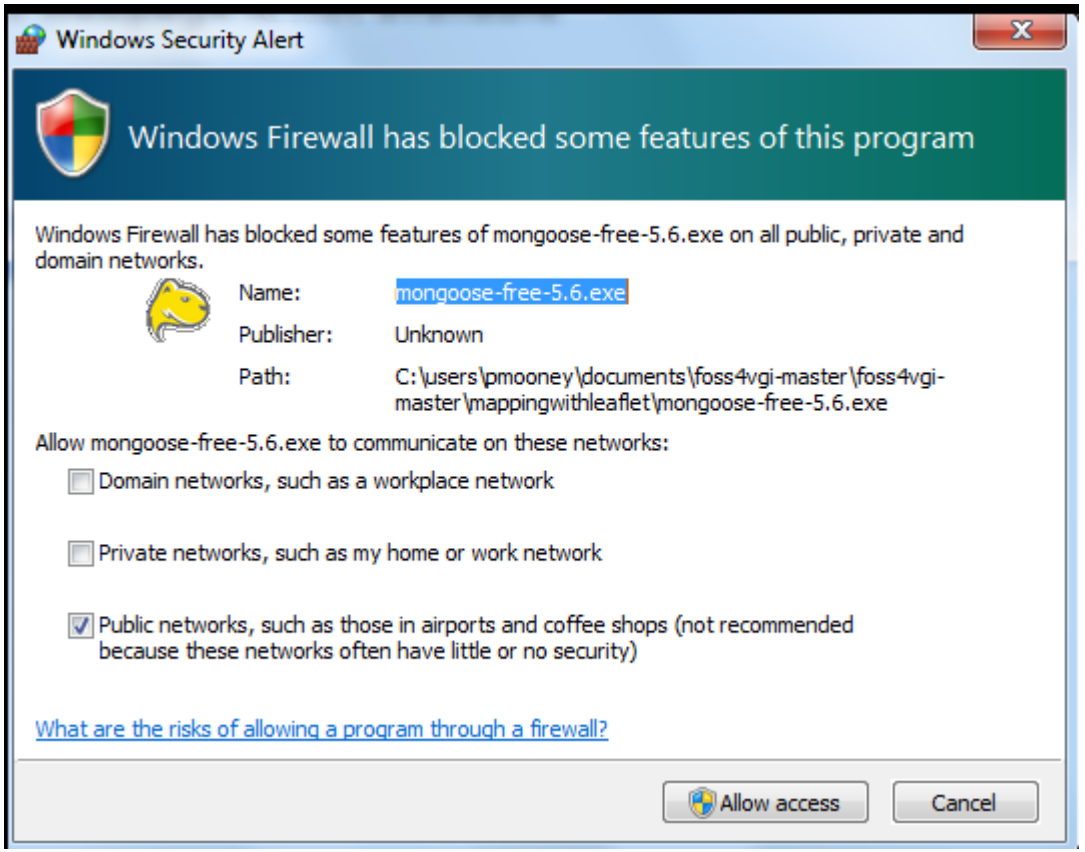


We've made the Windows executable available for download in the GitHub download

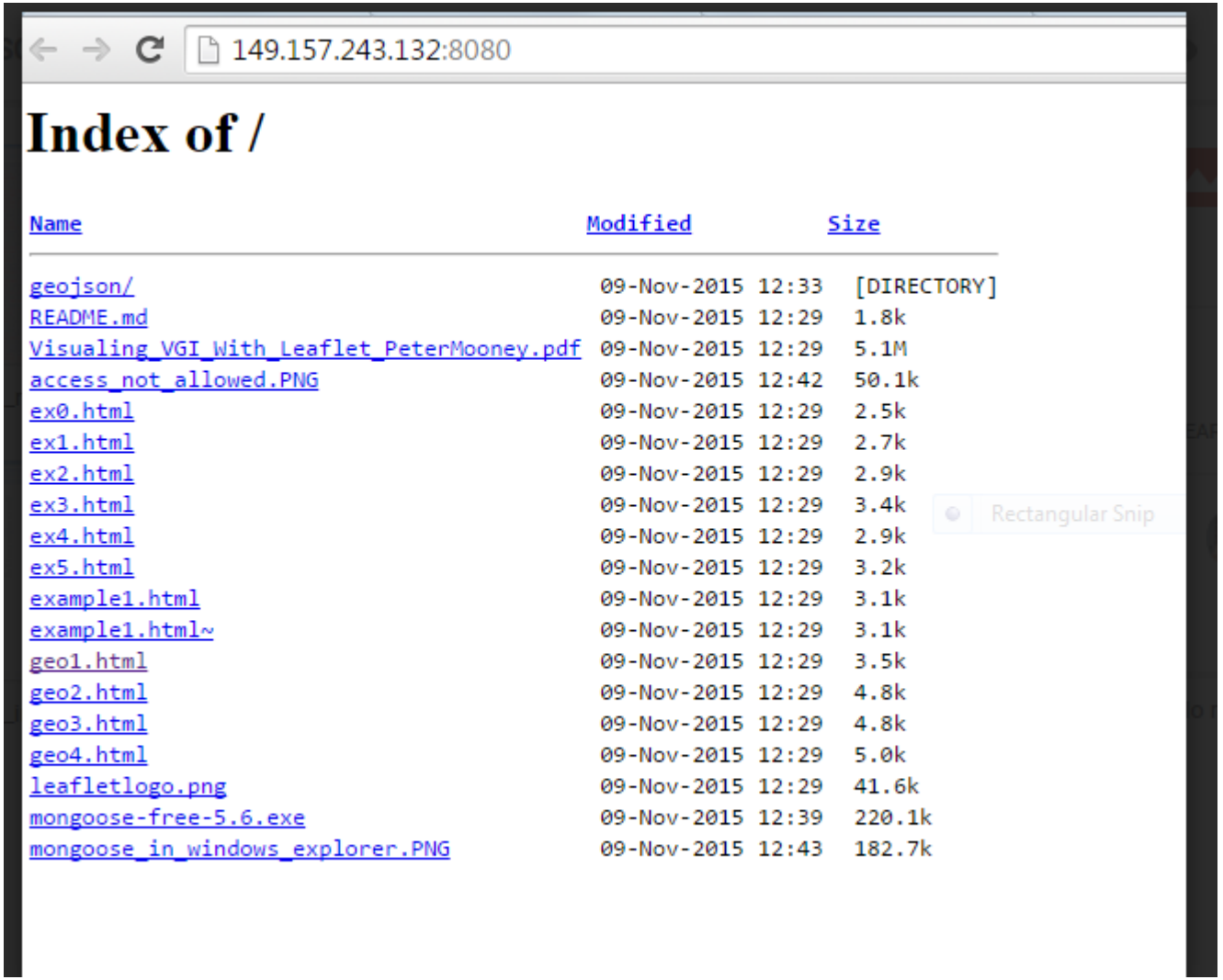
Mongoose – Windows Users

- Double click on the EXE file
- Ensure that when you run the file that you do so as administrator (check that Windows has not prevented you from running it)
- Check in your browser that the URL http://127.0.0.1:8080 or http://localhost:8080 work

Mongoose Windows Users



When Mongoose starts up you should see something like this

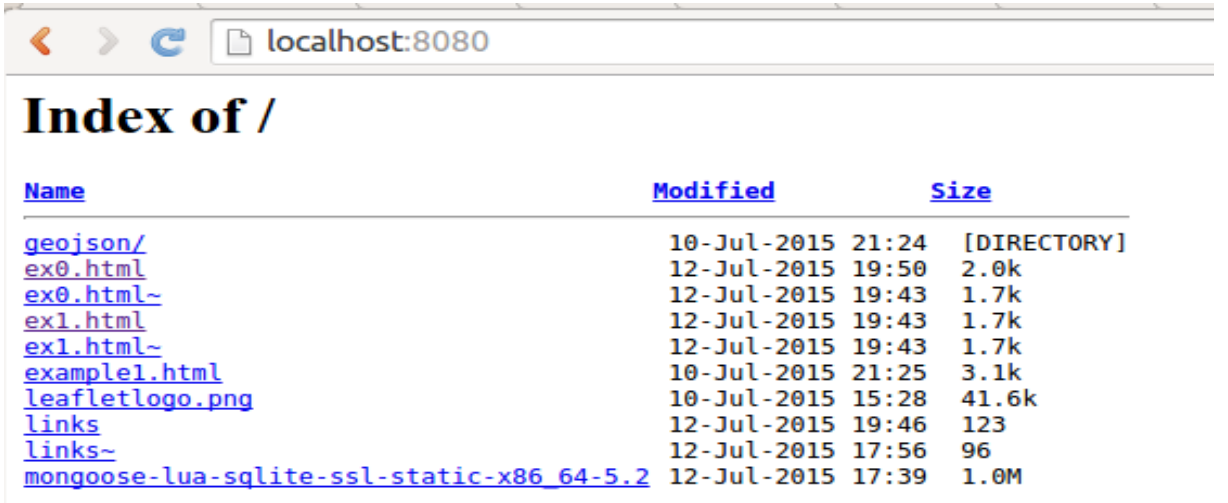


Windows and Linux Users

- DO NOT DELETE the Mongoose file
- As this is just a TEST ENVIRONMENT it is OK here – but this technique should not be used in a production environment
- However that's a different set of lecture notes!

We have a special web address now that Mongoose is operational

- We can now type in the address http://127.0.0.1:8080 or http://localhost:8080 into your browser
- You should be given a list of the files in the folder.
- Just click on “ex0.html” and wait for the lecture slides to catch up



We cannot proceed beyond this point unless you have Mongoose running successfully!

Leave Mongoose Running!

Starting with GeoJSON and Leaflet

GeoJSON and Leaflet are made for each other :-)

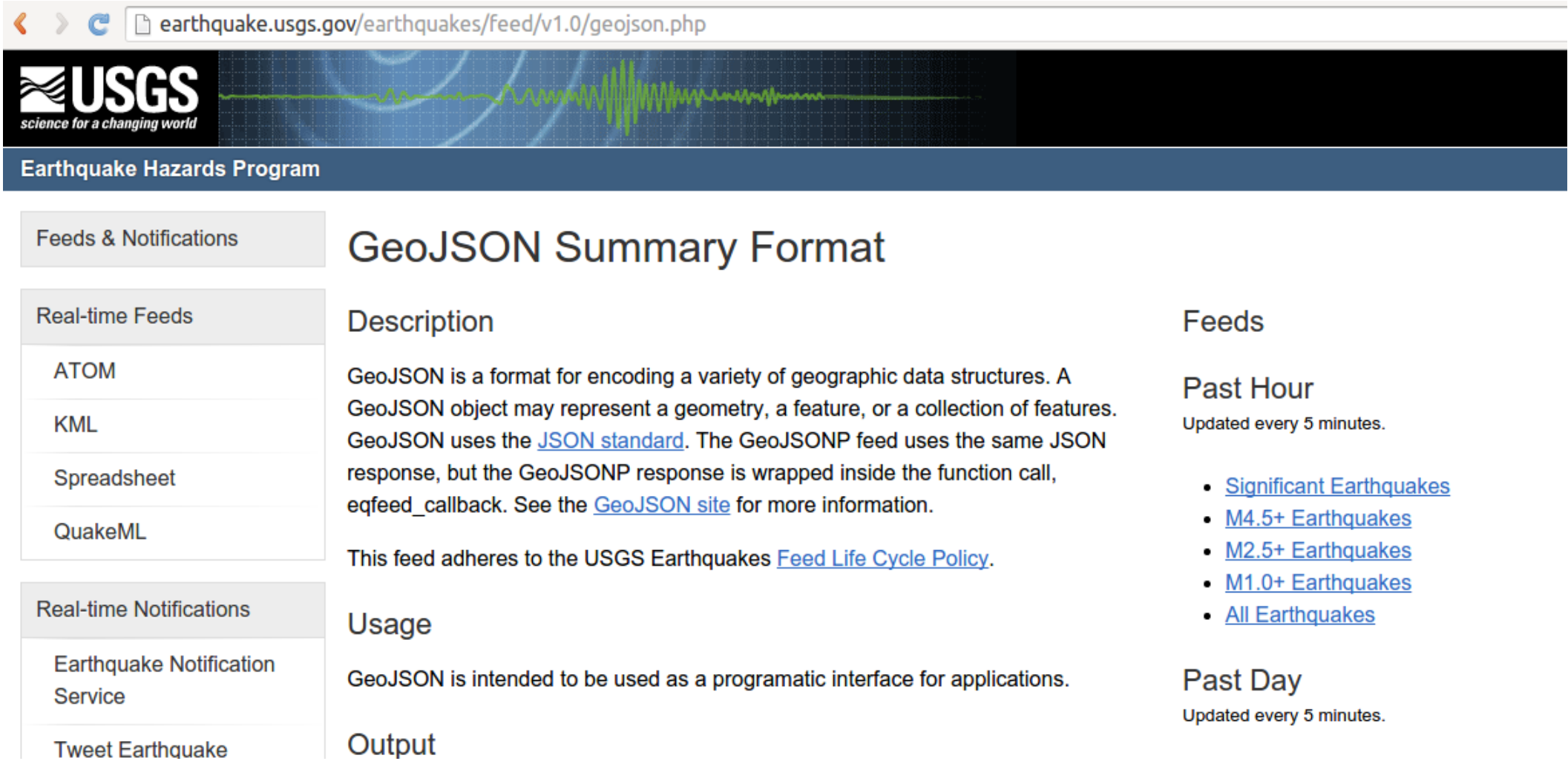
- **Leaflet is able to process, manipulate and display GeoJSON data**
- So it is in our best interests (because it is very efficient) to try to format our spatial data in GeoJSON format so that Leaflet can display it for us on a web map

Remember: Every GeoJSON file is a dataset in its own right

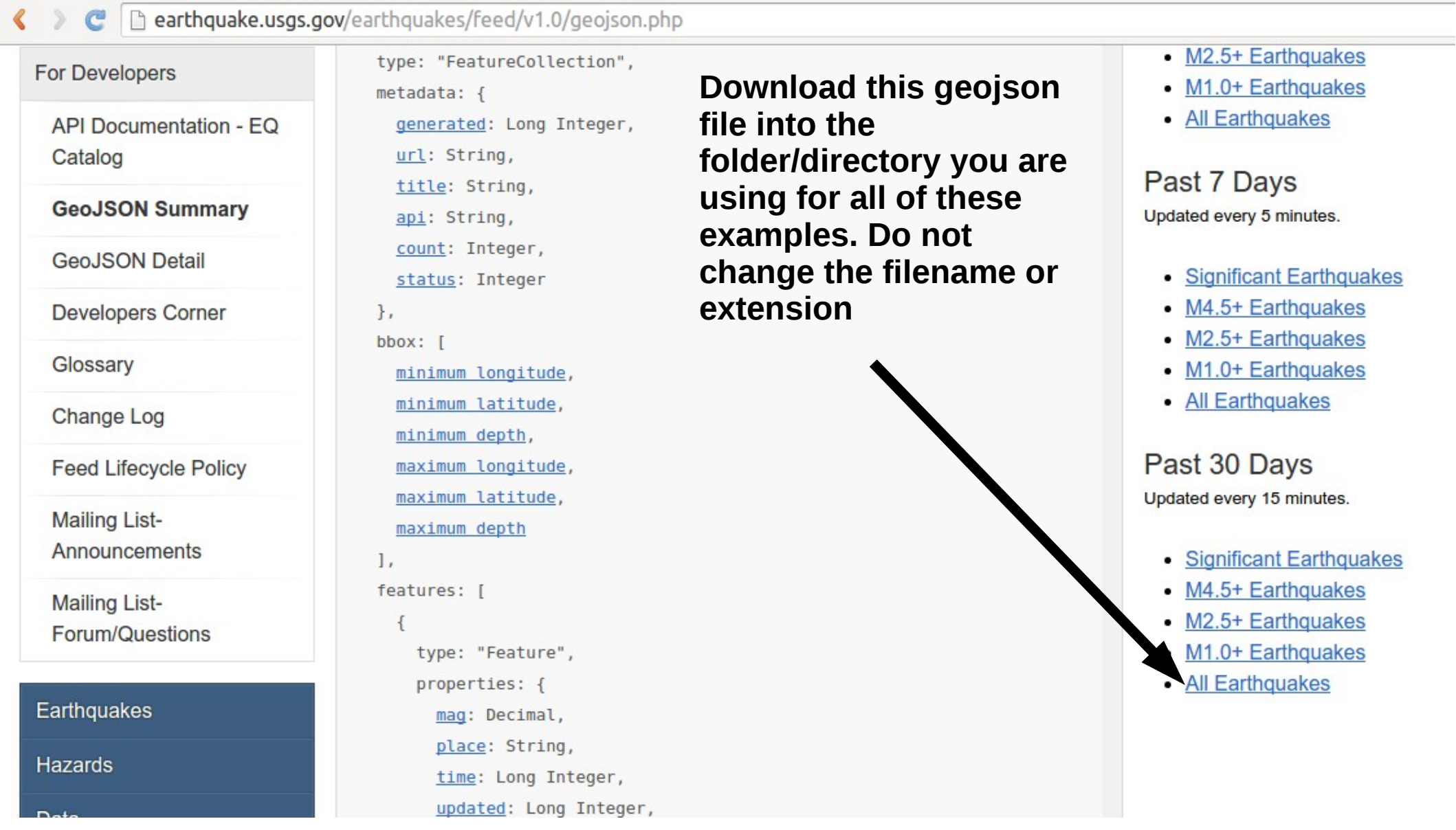
- This is an important consideration.
- We cannot just “throw” the GeoJSON file at Leaflet and expect Leaflet to display the file.
- **We will have to understand what the data contents of our GeoJSON file is in order to generate the best way to display our data**
- We shall start off with a GeoJSON file from the web and then proceed to OpenStreetMap data

geo1.html – US Geological Survey EarthQuake Data

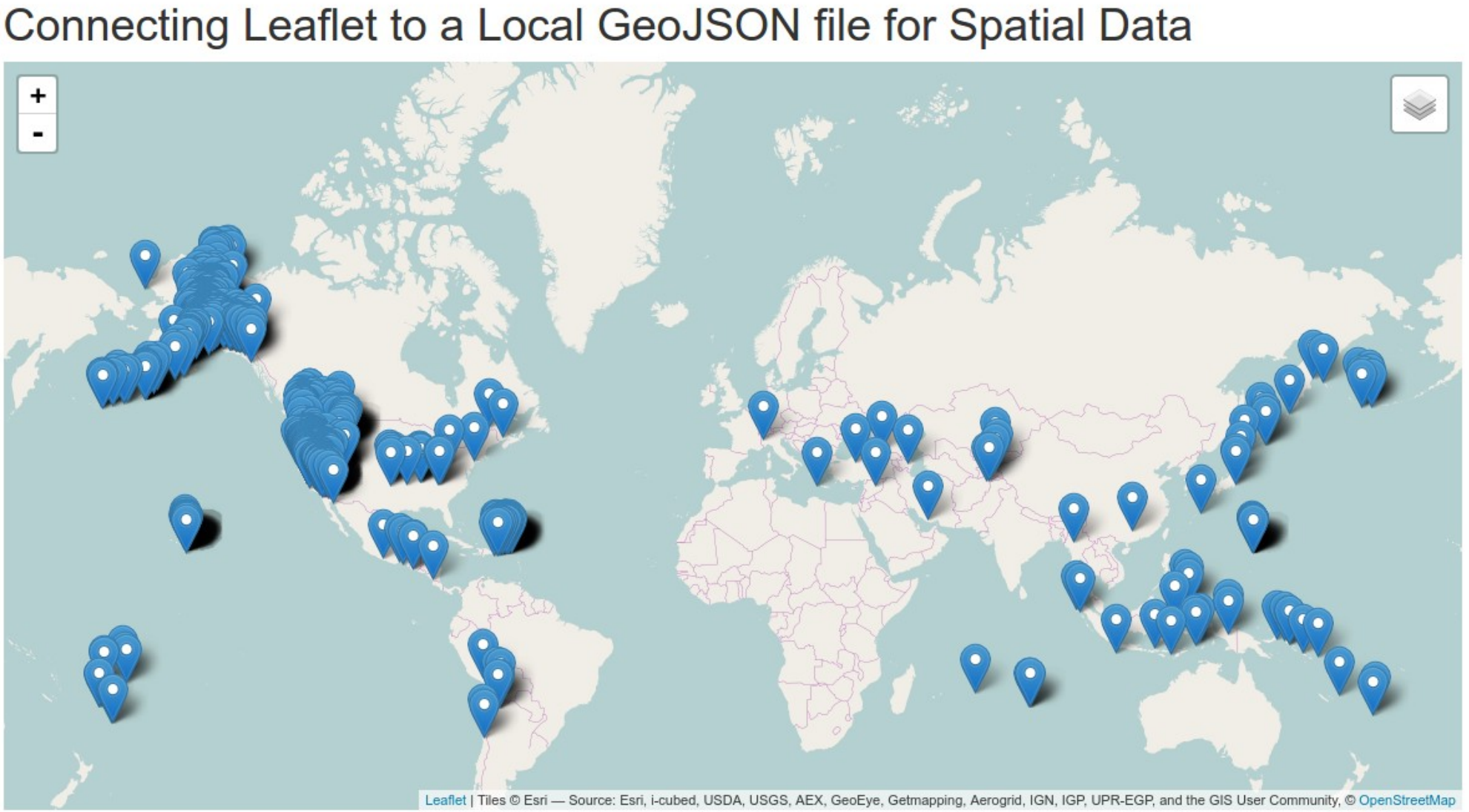
- http://earthquake.usgs.gov/earthquakes/feed/v1.0/geojson.php



geo1.html – please scroll to the bottom of this page and download the Past 7 Days 'All Earthquakes'



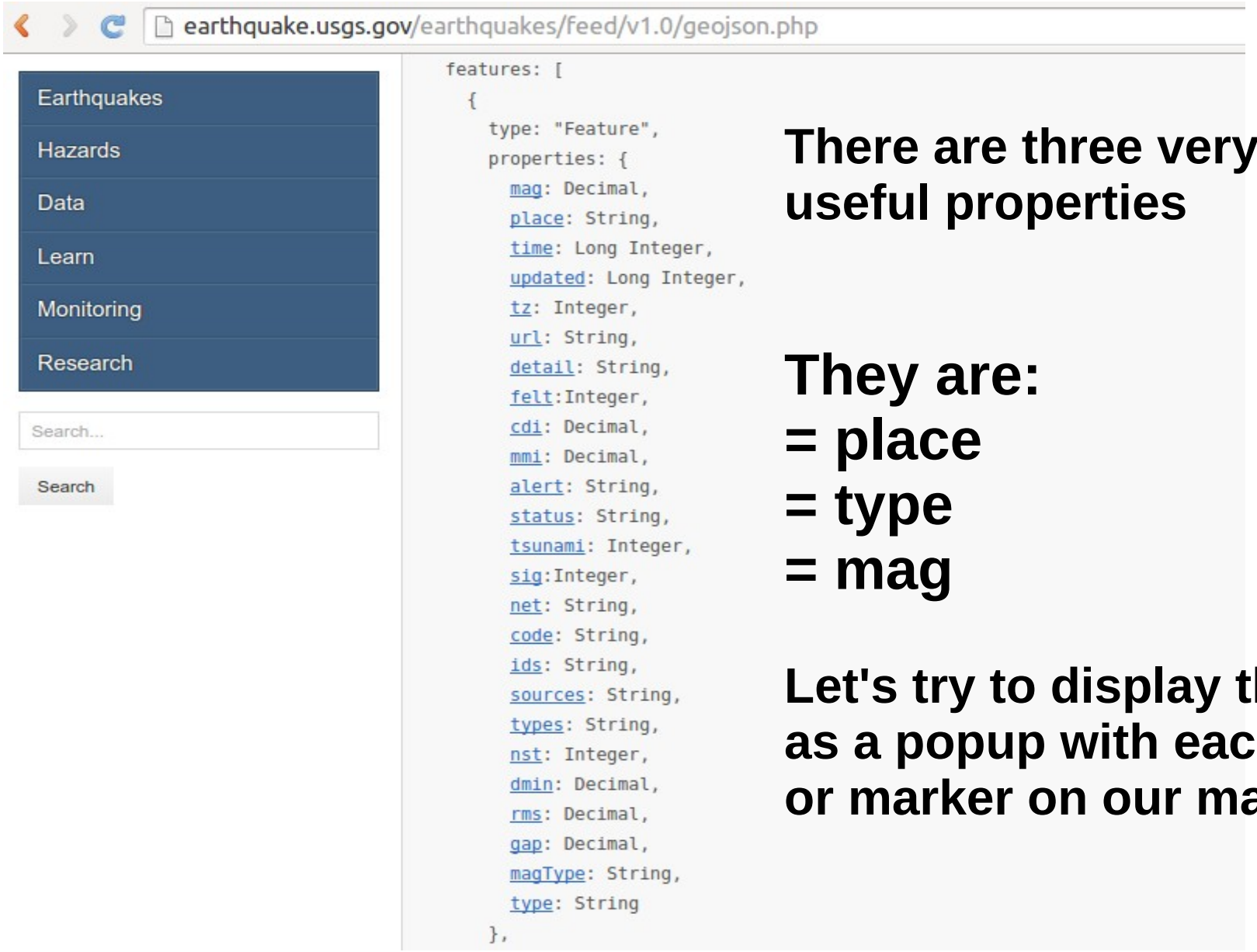
If you downloaded the data correctly – the link http://localhost:8080/geo1.html should look like this



Unfortunately there is one major problem with the map we have created

- If you look at the map – it is just a bunch of pins or markers
- YES – We state on the page that it is a USGS dataset
- We need to make those pins or markers 'clickable'
- We need to display some information about each pin.
- **We need to revisit the specification for the GeoJSON file on the USGS Website first.**

Here is the specification of the PROPERTIES of the GeoJSON data



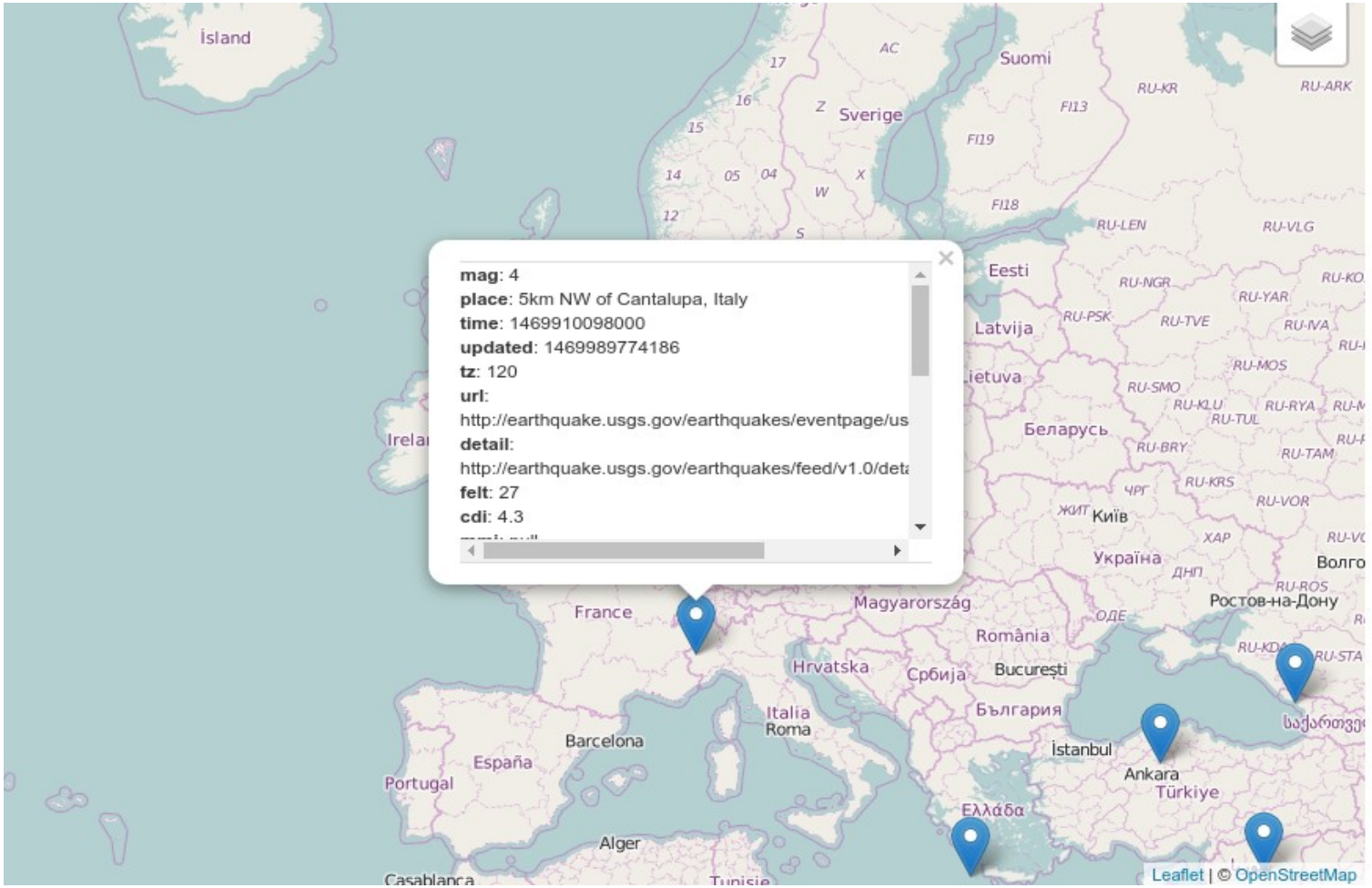
There are three very useful properties

They are:
= place
= type
= mag

Let's try to display these as a popup with each pin or marker on our map

Let's open up geo2.html in your text editor and look at it in the browser

- REMEMBER to view it at http://localhost:8080/geo2.html

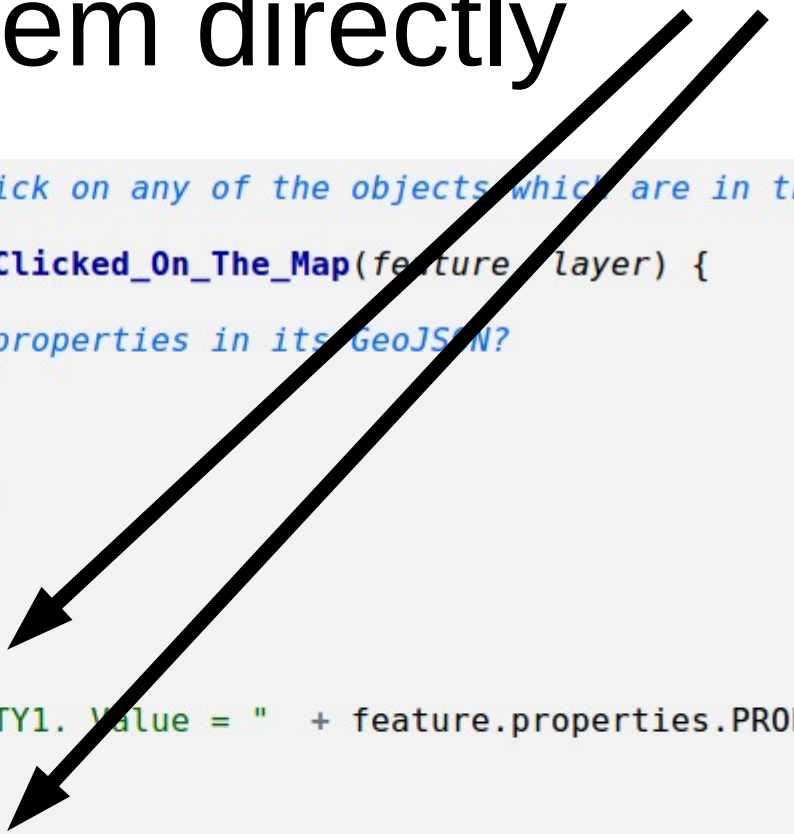


It's very important for you to undertand the link between the Javascript in Leaflet and the PROPERTIES in the GeoJSON

- There is a VERY IMPORTANT new piece of code in the Javascript. We will REUSE this for all of our GeoJSON

```
114 // This is where Leaflet will go if you click on any of the objects which are in the
115 // GeoJSON file
116 function action_To_Perform_When_Marker_Is_Clicked_On_The_Map(feature, layer) {
117
118     // does this clicked feature have any properties in its GeoJSON?
119     if (feature.properties)
120     {
121         // the text for the Popup
122         // Each feature in the GeoJSON dataset has a Feature Object.
123         // This object has a list of properties (an array). We get
124         // Javascript to map these to a string. We put some HTML formatting in the string
125         // This is then bound to the popup.
126         // There is the option to access specific attributes (properties) by name
127         // For example: feature.properties.place for the place attribute
128         
129         layer.bindPopup(
130             Object.keys(feature.properties).map(
131             function(k) {
132                         return "<b>" + k + "</b>" + ": " + feature.properties[k];
133                         }
134                     ).join("<br />"),
135
136                     {
137                         maxHeight: 200
138                     });
139
140     } // end if
141 } // end of function
142
```

If we know the PROPERTIES in our GeoJSON very well then we can access them directly



```
114 // This is where Leaflet will go if you click on any of the objects which are in the
115 // GeoJSON file
116 function action_To_Perform_When_Marker_Is_Clicked_On_The_Map(feature, layer) {
117
118     // does this clicked feature have any properties in its GeoJSON?
119     if (feature.properties)
120     {
121         // the text for the Popup
122         // We can pick specific properties
123
124         var PopUpText=[];
125
126         if (feature.properties.PROPERTY1)
127         {
128             PopUpText.push("We have PROPERTY1. Value = "  + feature.properties.PROPERTY1);
129         }
130
131         if (feature.properties.PROPERTYX)
132         {
133             PopUpText.push("We have PROPERTYX. Value = "  + feature.properties.PROPERTYX);
134         }
135
136         layer.bindPopup(PopUpText.join());
137
138     } // end if
139 } // end of function
140
```

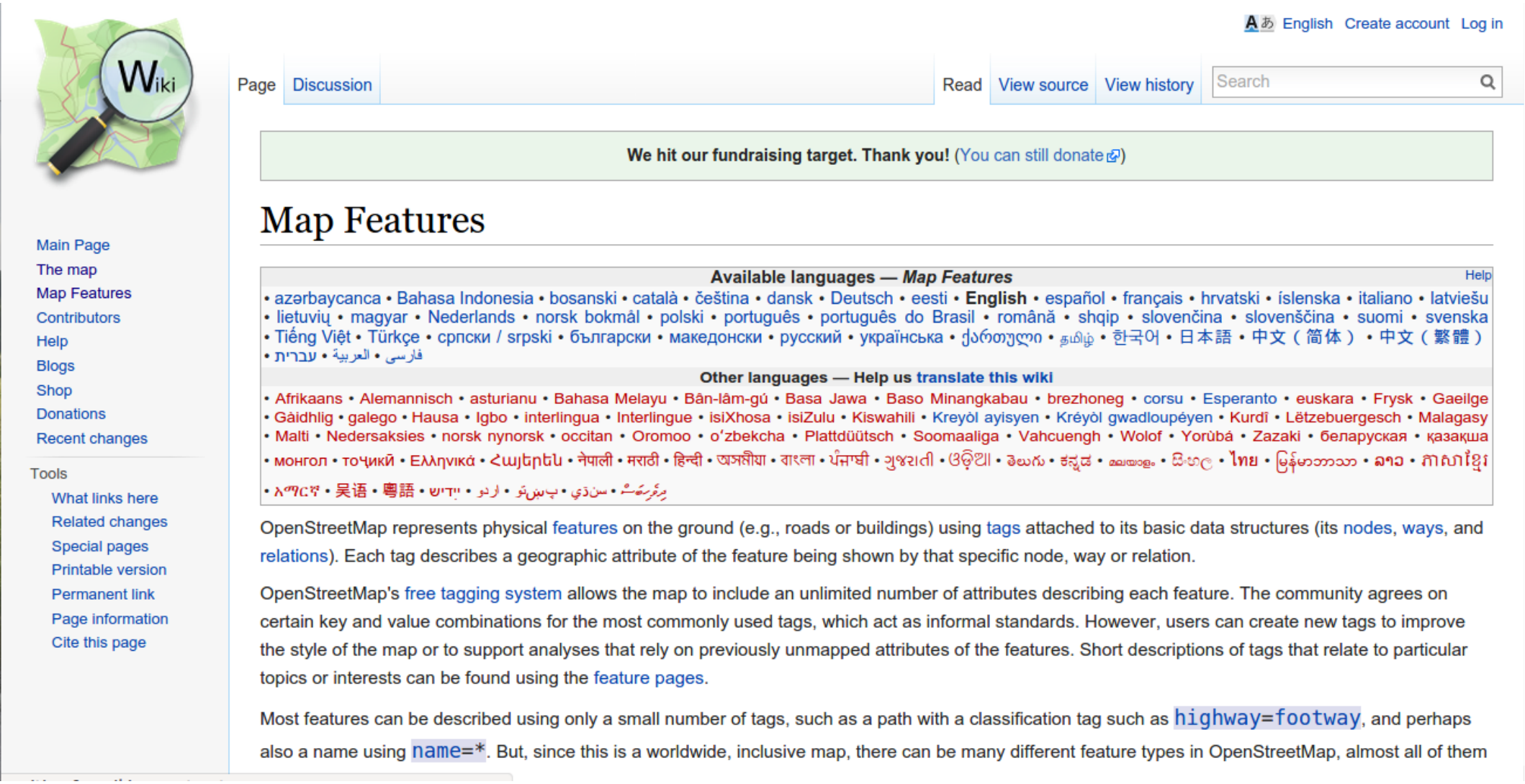
Attribute information on Geographical Objects in OpenStreetMap

Tagging in OpenStreetMap

- Tagging is one of the most important aspects of OpenStreetMap
- It also provokes the most debate, conversation, chat, discussion, disagreement, etc
- Tagging in OpenStreetMap is very flexible
- It is very different to the type of tagging (or ontology) that one would find in databases such as those used by National Mapping Agencies

The “Map Features” Page – one of the cornerstones of OSM

http://wiki.openstreetmap.org/wiki/Map_Features



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Page Discussion Read View source View history Search

We hit our fundraising target. Thank you! (You can still donate)

Map Features

Available languages — *Map Features* Help

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Main Page
The map
Map Features
Contributors
Help
Blogs
Shop
Donations
Recent changes

Tools
What links here
Related changes
Special pages
Printable version
Permanent link
Page information
Cite this page

OpenStreetMap represents physical features on the ground (e.g., roads or buildings) using tags attached to its basic data structures (its nodes, ways, and relations). Each tag describes a geographic attribute of the feature being shown by that specific node, way or relation.

OpenStreetMap's free tagging system allows the map to include an unlimited number of attributes describing each feature. The community agrees on certain key and value combinations for the most commonly used tags, which act as informal standards. However, users can create new tags to improve the style of the map or to support analyses that rely on previously unmapped attributes of the features. Short descriptions of tags that relate to particular topics or interests can be found using the feature pages.

Most features can be described using only a small number of tags, such as a path with a classification tag such as `highway=footway`, and perhaps also a name using `name=*`. But, since this is a worldwide, inclusive map, there can be many different feature types in OpenStreetMap, almost all of them

Tags can be considered as the attributes of an object

- An object can have at minimum 1 attribute (tag) – and there is no upper limit.
- There are no strict rules on how many attributes any object should have
- This flexibility means that you must use your own judgement in regards to how many attributes you provide

Let's look at the OSM tag for restaurants

Tag:amenity=restaurant

Main Page
The map
Map Features
Contributors
Help
Blogs
Shop
Donations
Recent changes

Tools
What links here
Related changes
Special pages
Printable version
Permanent link
Page information
Cite this page

Available languages — *Tag:amenity=restaurant* Help
• Deutsch • **English** • español • français • italiano • português do Brasil • русский • 日本語
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`amenity=restaurant` is for a generally formal place with sit-down facilities selling full meals served by waiters and often licensed (where allowed) to sell alcoholic drinks.

Contents [hide]

amenity = restaurant v · d · e

Description

Is for a generally formal place with sit-down facilities selling full meals served by waiters and often licensed (where allowed) to sell alcoholic drinks.

Used on these elements

How to Map

Add a node at the centre of the building and add `amenity=restaurant` to it. You can name it with `name=*`. If the whole building is used for this feature and its footprint is present in OSM, you can apply the tags on the area if you prefer.

Optionally, you can further classify it using the `cuisine=*` tag with a value suitable for your nation's environment

We use the amenity = restaurant tag and others where applicable

`Amenity` = restaurant
`Name` = Peter's Italian Place
`Cuisine` = Italian
`Smoking` = no
`internet_access` = wlan

In OSM we try to supply an appropriate number of tags to an object/feature

- We try to use the tags to supply as much accurate and timely attribute information about the object/feature as we can
- **ALWAYS USE MAP FEATURES FOR GUIDANCE WHEN USING TAGS**
- In the case of many tags there are suggested accompanying tags you should use

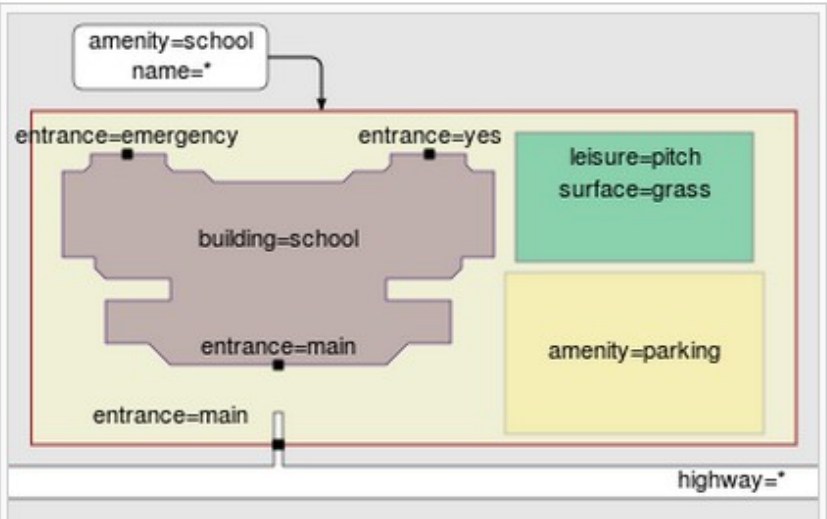
Example: Amenity = School

How to map

Mark the boundary of the school using an Area or place a Node in the middle of the site if you are in a hurry (or don't have access to information about the boundary and it is not obvious from aerial imagery).

This area should envelop the full grounds of the school including all the buildings, sports facilities and grounds. For schools with multiple sites the multipolygon relation can be used. Tag the element with `amenity=school` and `name=*` for the name of school. Suggested additional tags include:

- `operator=*` - Name of operator, often the local education authority.
- `addr=*` - Address details
- `capacity=*`, for the number of pupils taught at the school
- `isced:level=*`, for the educational level (proposed tags)
- `fee=yes` if the the school makes a direct charge for core services.
- `religion=*`, if the school is associated with a particular religion (also `denomination=*`)
- `wikipedia=*`, for a link to a Wikipedia article about the school
- `ref=*`, if schools are numbered
- `contact=*`, for contact details including the schools website, email and phone number



School buildings should be tagged with `building=school` where they are used generally, and optional also with details of use with appropriate additional tags, for example `amenity=swimming_pool`.

Consider adding `entrance=*` and if appropriate `barrier=gate` to the points where roads, paths or other access routes into the school grounds cross the boundary of the school (which is tagged with `amenity=school`.

Description

Institution designed for learning under the supervision of teachers.

Group: Education features

Used on these elements

Useful combination

- `name=*`
- `operator=*`
- `isced:level=*`

Status: Approved

taginfo [More...]

	334 305	6.60 %
	315 360	10.11 %
	8 017	21.19 %

Tools for this tag

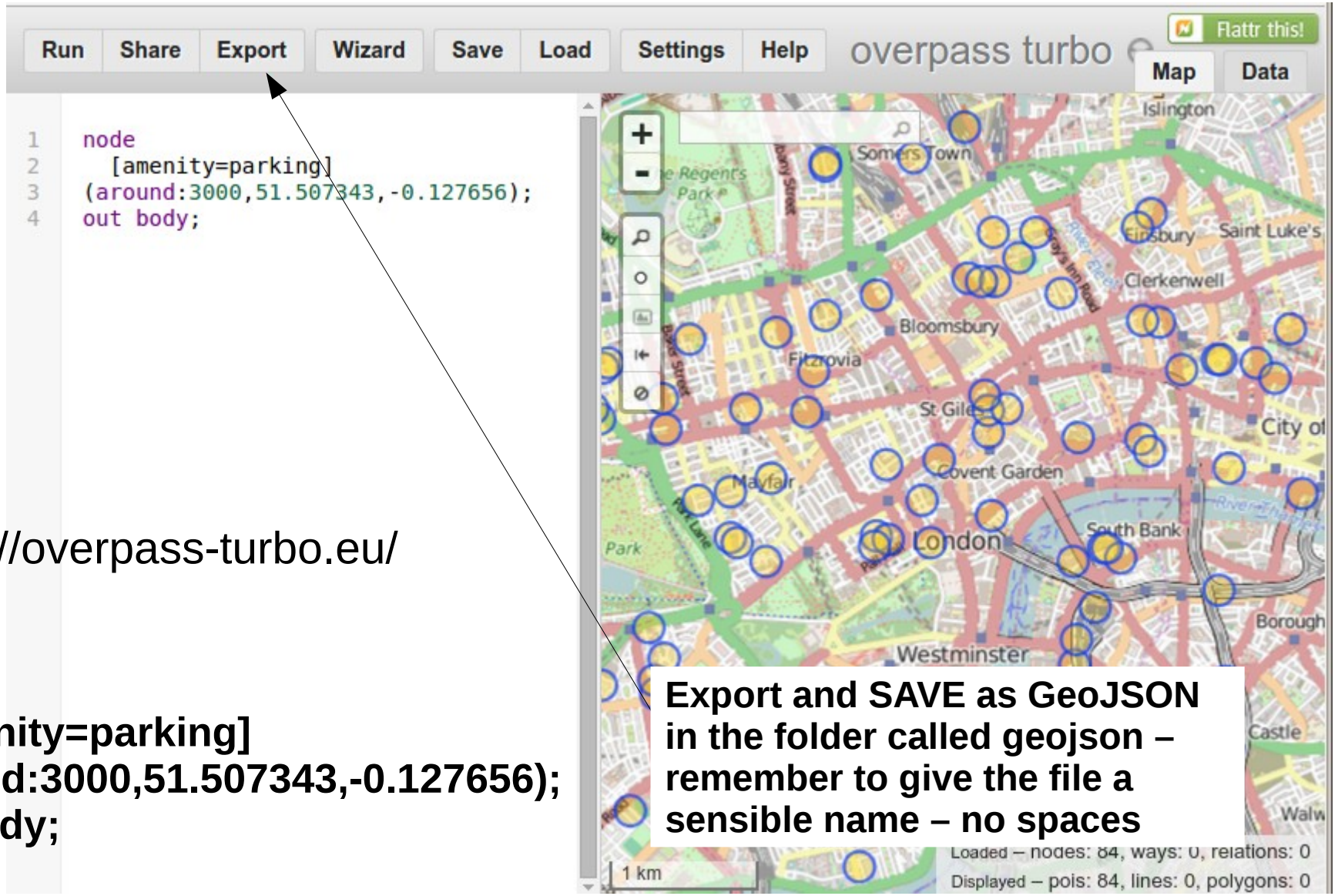
- taginfo, fr, uk, ie, us
- overpass-turbo

Choosing the correct tags is not an easy task

- Choosing the correct tags requires you to think about the object/feature you are mapping
- As you get more experienced with mapping you will become more familiar with tagging
- **Remember** – you should always use tags which you can **VERIFY**
- **Remember** – you should use the Map Features guidance on the popular combinations of tags

Let's get some OSM GeoJSON data from OVERPASS

Suppose we are feeling crazy and decide to drive our car into central London



http://overpass-turbo.eu/

node
[amenity=parking]
(around:3000,51.507343,-0.127656);
out body;

When downloaded and in correct folder – let's open it in a text editor


```
},
{
  "type": "Feature",
  "id": "node/368044118",
  "properties": {
    "@id": "node/368044118",
    "amenity": "parking",
    "capacity": "233",
    "capacity:disabled": "5",
    "covered": "yes",
    "fee": "yes",
    "name": "Baynard House",
    "operator": "Corporation of London",
    "website":
    "http://www.cityoflondon.gov.uk/services/transport-and-streets/parking/where-to-park/car-parks/Pages/Baynar
    d-House-car-park.aspx"
  },
  "geometry": {
    "type": "Point",
    "coordinates": [
      -0.1000953,
      51.5118468
    ]
  }
},
{
```


Look CAREFULLY at the properties of each Feature/Object/Node
Notice – each node has a different number of tags

Let's choose three: name operator capacity

Check Map Features if you need more information

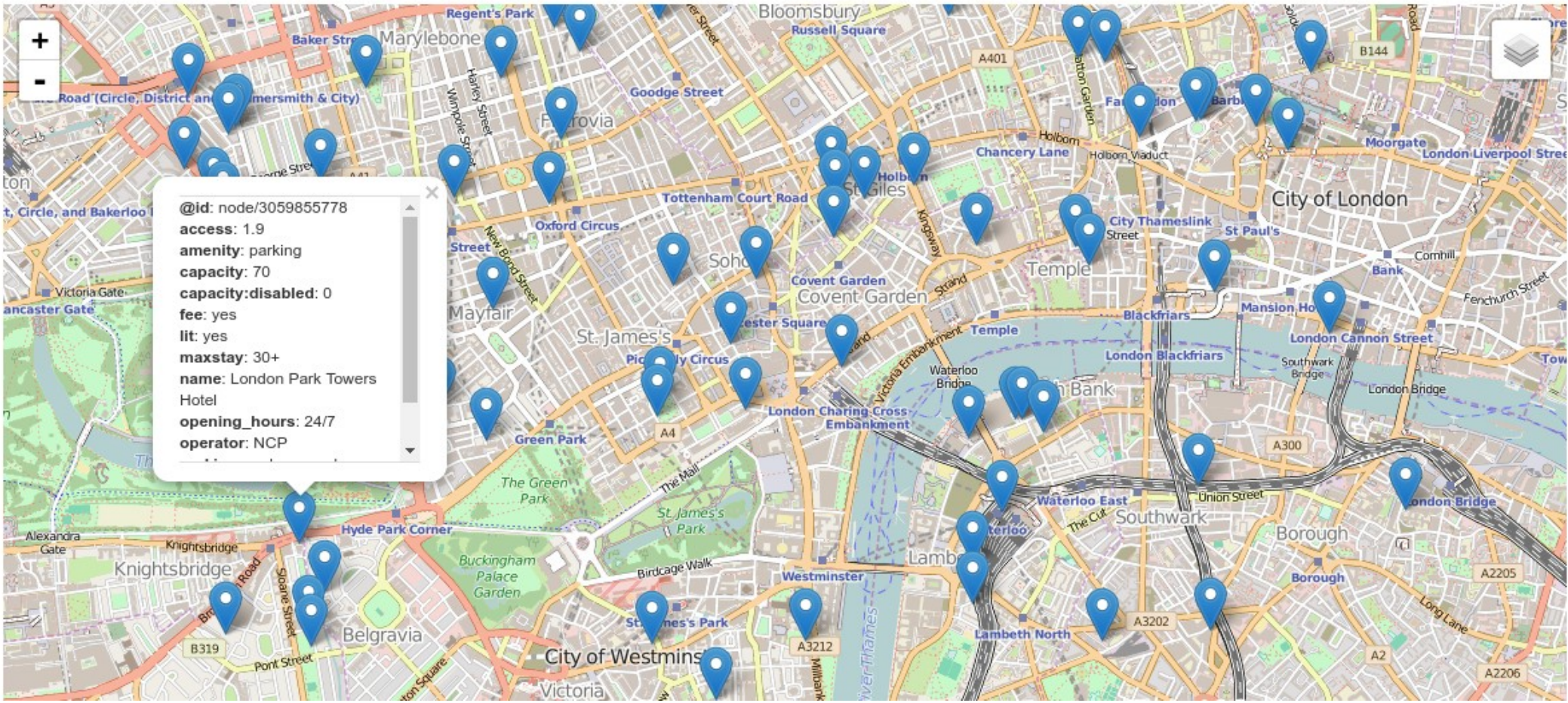
Open the file geo3.html in your text editor AND your browser

- You'll need to check out one very important detail
- You will need to change the filename of the geojson file to the name you used
- You will then save the file and refresh the page in your browser
- Otherwise ..... you won't see any car parks!!!

This is what http://localhost:8080/geo3.html should look like!

Notice – that this parking node has LOTS of attributes/properties

Connecting Leaflet to a Local GeoJSON file for Spatial Data - Using OpenStreetMap as a Data Source



Notice – that this parking node has only TWO attributes/properties

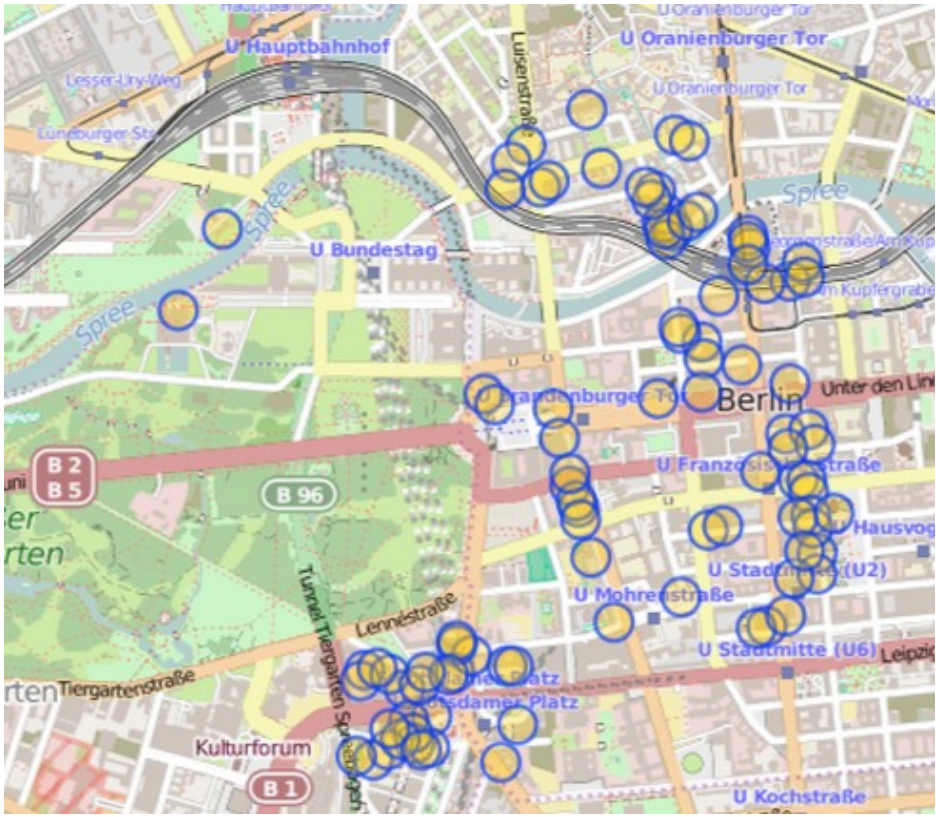
We can easily query NODES in Overpass Turbo

```
node
  [amenity=restaurant]
(around:3000,51.507343,-0.127656);
out body;
```

```
node
  [highway=bus_stop]
(around:2000,51.507343,-0.127656);
out body;
```

GeoJSON Exercise on your own!

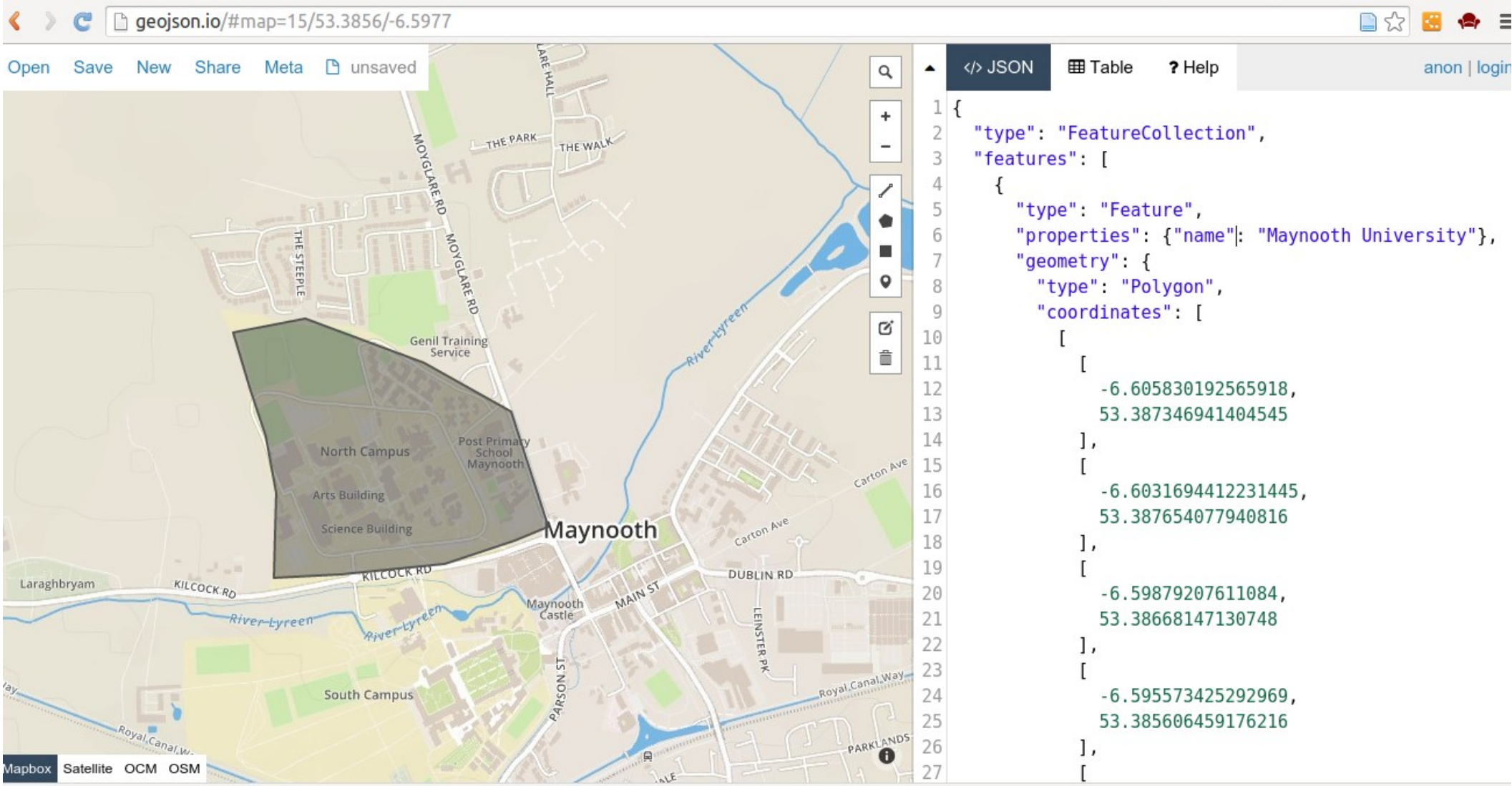
Exercise: Map of places to eat in Berlin, Germany



- Using the Overpass API generate GeoJSON representing all `amenity=restaurant` around 1000m radius of the Brandenburg Gate in Berlin
- Use `name, cuisine, opening_hours, wheelchair` as properties
- Center and zoom the map appropriately
- You can use geo3.html as your starting point

You can easily make your own GeoJSON

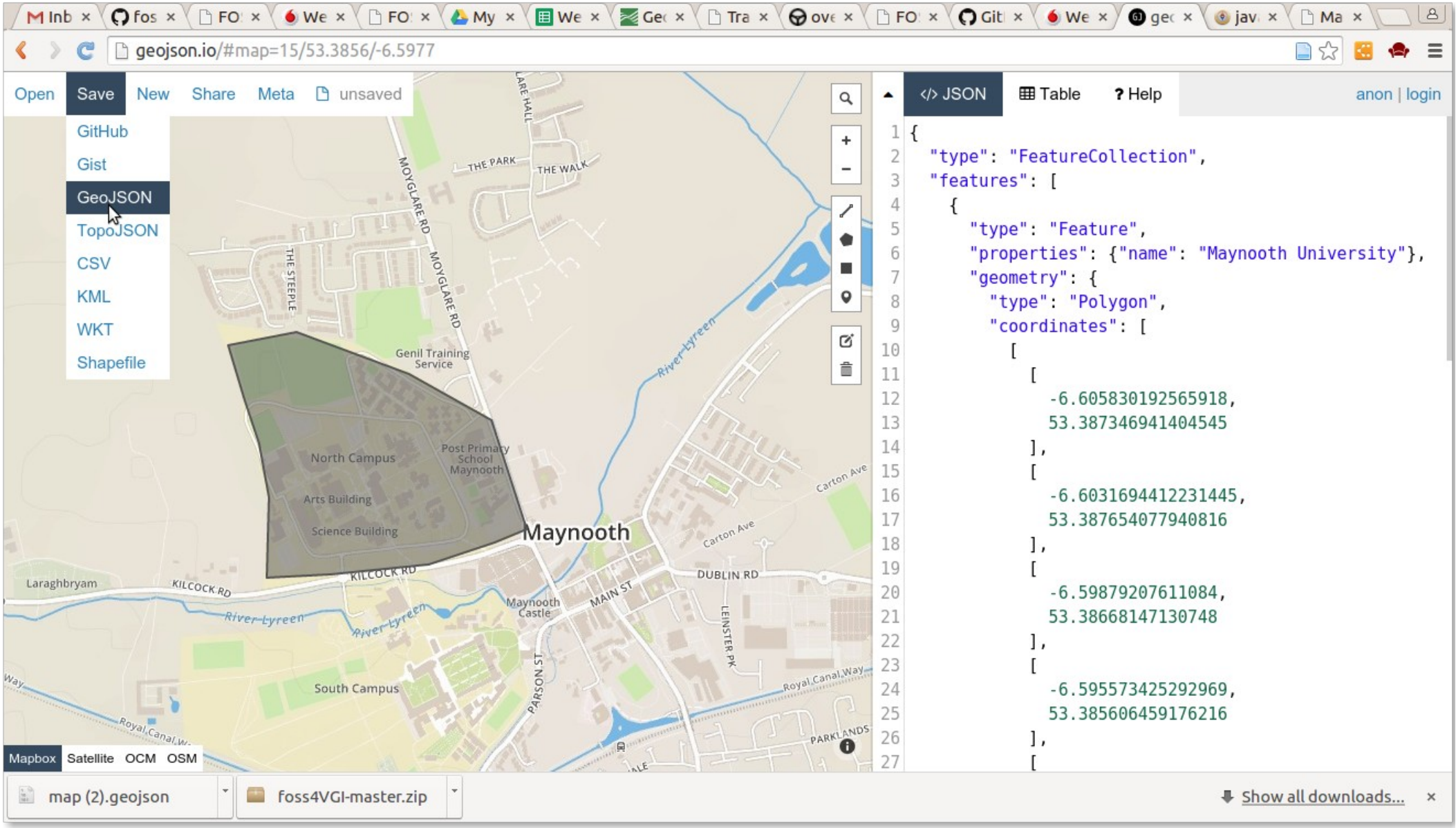
Go to GeoJSON.io



You can make really nice GeoJSON datasets here

- Remember PROPERTIES – the name of the property and the value MUST always have double quotes
- For example “population”: “200,000”
- You can have a mixture of polylines, polygons and points

You can easily SAVE the data you create as GeoJSON




```
{
  "type": "FeatureCollection",
  "features": [
    {
      "type": "Feature",
      "properties": {"name": "Maynooth University"},
      "geometry": {
        "type": "Polygon",
        "coordinates": [
          [
            [
              -6.605830192565918,
              53.387346941404545
            ],
            [
              -6.6031694412231445,
              53.387654077940816
            ],
            [
              -6.59879207611084,
              53.38668147130748
            ],
            [
              -6.595573425292969,
              53.385606459176216
            ],
            [
```

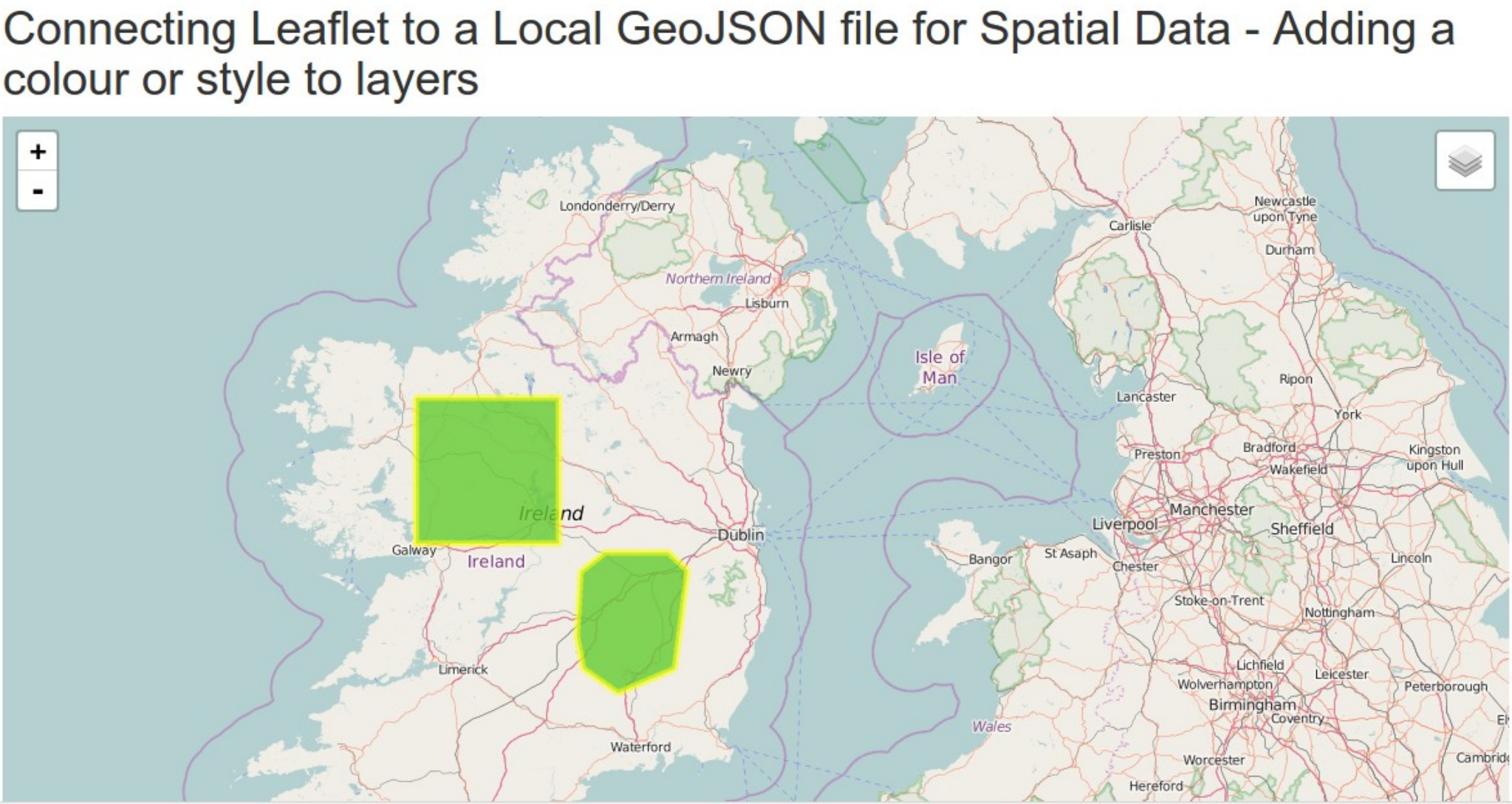
Adding multiple overlay layers

We need to create a new LayerGroup and add to the overlayMaps variable

```
83  <!-- This is where we are going to get Javascript to gather the GeoJSON and make it available-->
84  <!-- so that Leaflet can display it -->
85  <!-- We need to make a special LAYER for our GeoJson -->
86  <!-- We are going to make a group for our 'top layers' -->
87
88  var myGeoJSONLayers = L.layerGroup();
89
90  var layerVariableName = L.layerGroup();
91
```

```
102 // Notice that we have made a change here also.
103 // We have added the myGeoJSONLayers variable so that Leaflet knows that you
104 // want to include the GeoJSON as a layer on the map
105 // Notice that we also make a place where we can switch on/off the layer
106 var overlayMaps = {"London Parking": myGeoJSONLayers,
107                    "Layer 2" : layerVariableName
108 };
```

Can we add some STYLE to our GeoJSON layers?

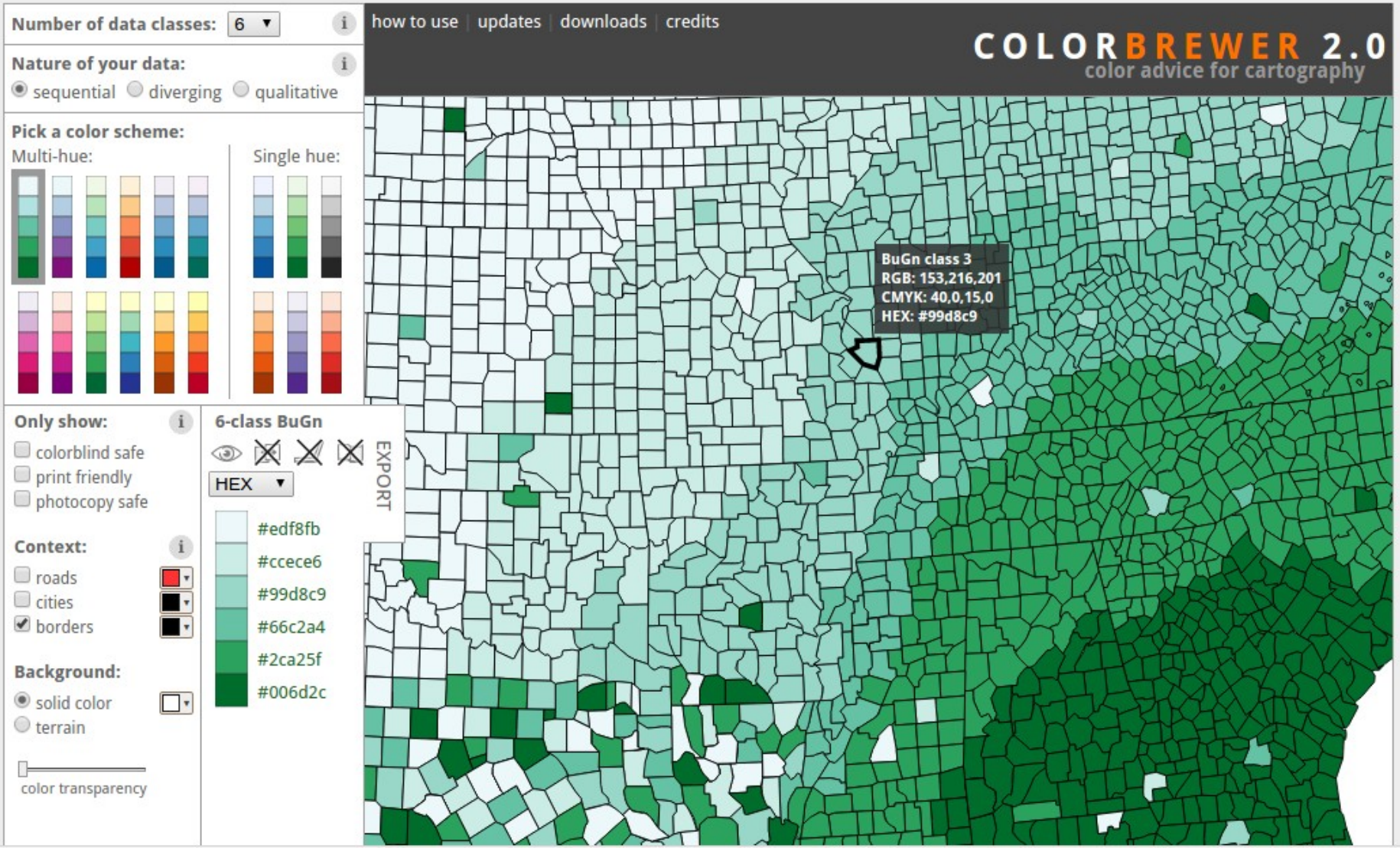


Let's look at geo4.html

```
93
94  <!-- create a style for the geojson layer -->
95  var myGeoJSONLayerStyle = {
96      "color": "#FFFF00",
97      "weight": 5,
98      "opacity": 0.6,
99      "dashArray": 3,
100     "fillColor": "#66CC33",
101     "fillOpacity": 0.8
102 }
```

```
// we include our style definition here as part of the Layer Definition

$.getJSON("./map.geojson",
    function(data) {
        // tell Leaflet to go to the function action_To_Perform_When_Marker_Is_Clicked_On_The_Map
        // when someone clicks on one of the objects in the GeoJSON layer
        var geojson = L.geoJson(data,{onEachFeature: action_To_Perform_When_Marker_Is_Clicked_On_The_Map,
            style:myGeoJSONLayerStyle
        });
        <!-- add our new layer to the group of top layers -->
        myGeoJSONLayers.addLayer(geojson);
    }
);
```


Number of data classes: 6
Nature of your data:
sequential
diverging
qualitative
Pick a color scheme:
Multi-hue:
Single hue:
Only show:
colorblind safe
print friendly
photocopy safe
Context:
roads
cities
borders
Background:
solid color
terrain
color transparency
6-class BuGn
EXPORT
HEX
#edf8fb
#ccece6
#99d8c9
#66c2a4
#2ca25f
#006d2c
how to use
updates
downloads
credits
COLORBREWER 2.0
color advice for cartography
BuGn class 3
RGB: 153,216,201
CMYK: 40,0,15,0
HEX: #99d8c9

But can we apply different styles to features within a GeoJSON datasets depending on the value(s) of a given property or attribute?

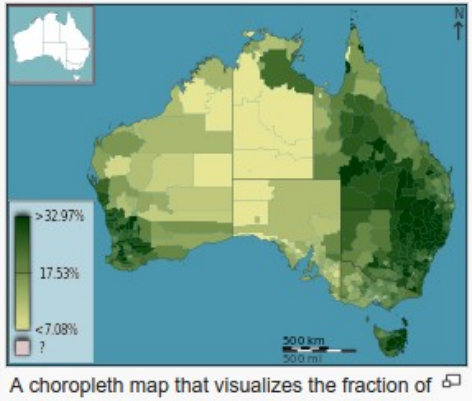
Choropleth map

From Wikipedia, the free encyclopedia

This article **needs additional citations for verification**. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed. *(March 2009) (Learn how and when to remove this template message)*

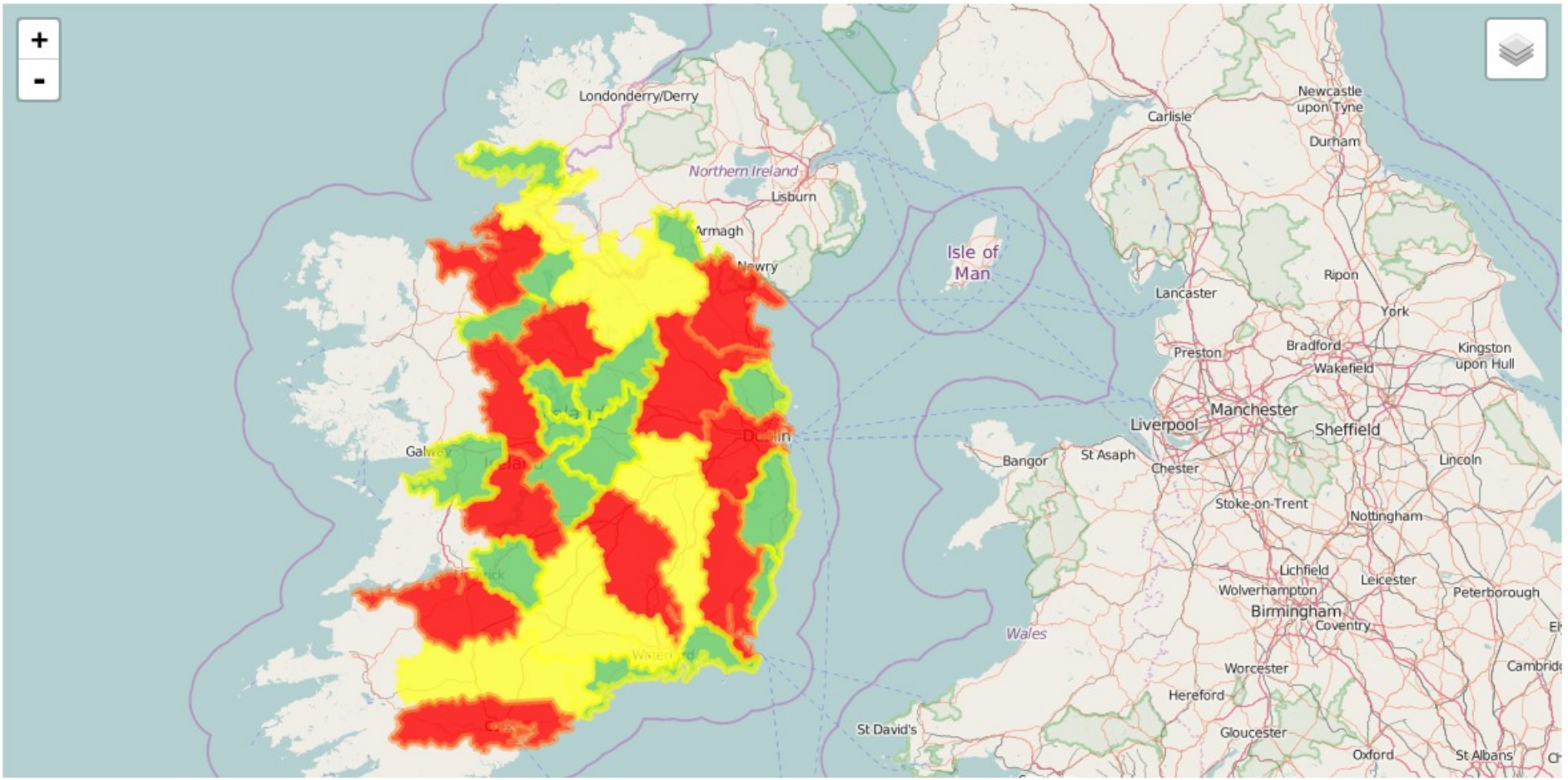
A **choropleth map** (from Greek χώρο ("area/region") + πλήθος ("multitude")) is a thematic map in which areas are shaded or patterned in proportion to the measurement of the statistical variable being displayed on the map, such as population density or per-capita income.

The choropleth map provides an easy way to visualize how a measurement varies across a geographic area or it shows the level of variability within a region.



A choropleth map that visualizes the fraction of Australians that identified as Anglican at the 2011 census

Let's look at geo5.html



We can setup a series of different layer styles for different features

```
94  <!-- create a set of styles for the geojson layer -->
95  var myGeoJSONLayerStyle1 = {
96      "color": "#ffff33",
97      "weight": 5,
98      "opacity": 0.6,
99      "dashArray": 3,
100     "fillColor": "#ffff33",
101     "fillOpacity": 0.8
102 };
103
104 var myGeoJSONLayerStyle2 = {
105     "color": "#fd8d3c",
106     "weight": 5,
107     "opacity": 0.6,
108     "dashArray": 3,
109     "fillColor": "#FF0000",
110     "fillOpacity": 0.8
111 };
112
113 var myGeoJSONLayerStyle3 = {
114     "color": "#FFFF00",
115     "weight": 5,
116     "opacity": 0.6,
117     "dashArray": 3,
118     "fillColor": "#66CC66",
119     "fillOpacity": 0.8
120 };
```

We add a function – to make the decision on which style to apply to a given feature based on the Area_km2 property

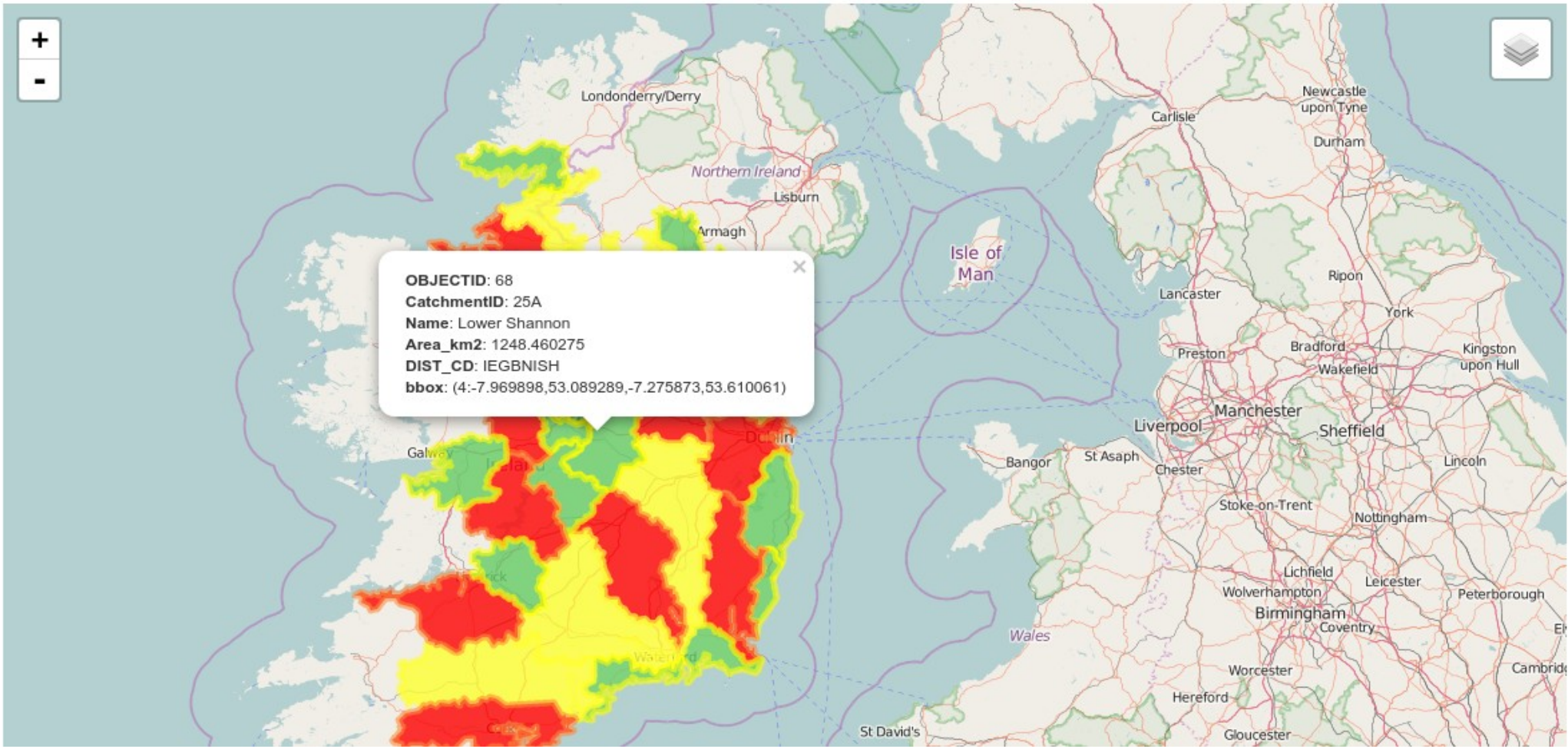
```
121
122 // This function checks every feature in the GeoJSON and looks at the Area_km2 property (careful - it is case
    sensitive)
123 function specific_style_for_geojsonfeatures(feature) {
124             if (feature.properties.Area_km2) {
125                 if (feature.properties.Area_km2 > 3000.00)
126                     return myGeoJSONLayerStyle1;
127                 else if ((feature.properties.Area_km2 > 1500.00) && (feature.properties.Area_km2 <= 3000.00))
                            return myGeoJSONLayerStyle2;
128                 else
129                     return myGeoJSONLayerStyle3; // this is when we don't know the property value
130                 // or it is different to the ones above
131             }
132         }
133
```

Then simply tell Leaflet that you want to apply this function to handle the style for the GeoJSON layer

```
135  // we include our style definition here as part of the Layer Definition
136
137  $.getJSON("./catchments2016.geojson",
138     function(data) {
139         // tell Leaflet to go to the function action_To_Perform_When_Marker_Is_Clicked_On_The_Map
140         // when someone clicks on one of the objects in the GeoJSON layer
141        var geojson = L.geoJson(data,{onEachFeature: action_To_Perform_When_Marker_Is_Clicked_On_The_Map,
142            style:specific_style_for_geojsonfeatures
143        });
144        <!-- add our new layer to the group of top layers -->
145        myGeoJSONLayers.addLayer(geojson);
146     }
147  );
```

This type of visualisation is very useful for online mapping

Connecting Leaflet to a Local GeoJSON file for Spatial Data - Adding a colour or style to individual features in a layer depending on properties



I'm happy to help with questions at peter.mooney@nuim.ie