



Exercise 1. - MAPS

VITMMA09 – SmartCity MSc specialization

- Map basics
 - Sphere (3D) to plane (2D)
 - Coordinates
 - GPS basics
 - GPS coordinates, conversions
 - Latitude / longitude
 - Geocoding
 - Storage
 - Bitmap vs vector
 - Tile, zoom
 - Online (API) vs Offline, cache
 - Map and API providers
- Web API
 - HTTP basics
 - GET, POST, codes
 - XSS
 - Web programs
 - Java, Flash
 - Server side: CGI, PHP
- Client side: Javascript
 - Server side JS
 - Web API, API libraries
- Authentication, Authorization
 - HTTP basic AUTH, OAUTH
- JavaScript basics
 - HTML basics
 - HEAD, BODY, SCRIPT, DIV
 - JavaScript basics
 - vars, functions, events
 - REST
 - Connecting HTML-JS
- MAP API
 - Google maps
 - Overpass API ?
 - LeafletJS

- https://www.w3schools.com/graphics/google_maps_intro.asp
- <https://developer.here.com/lp/mapAPIs>
- <https://www.programmableweb.com/news/top-10-mapping-apis-google-maps-microsoft-bing-maps-and-mapquest/analysis/2015/02/23>

Map basics

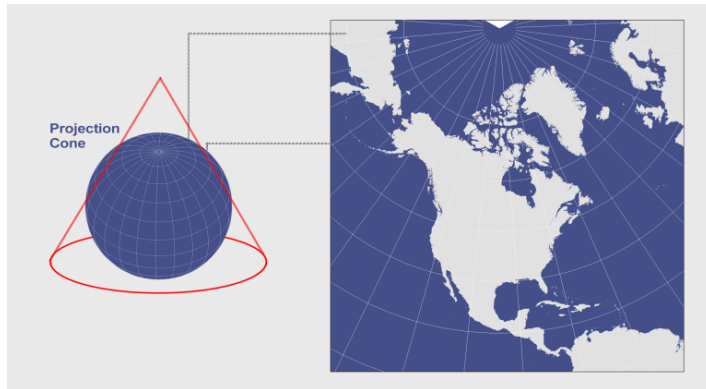
Map projections

- Shape if the Earth is geoid
- Projections

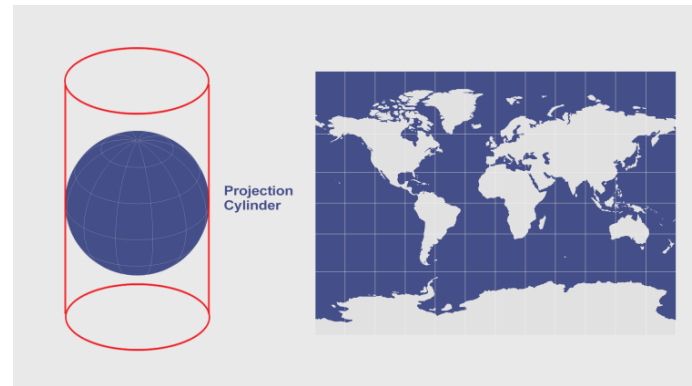
Orange peel map



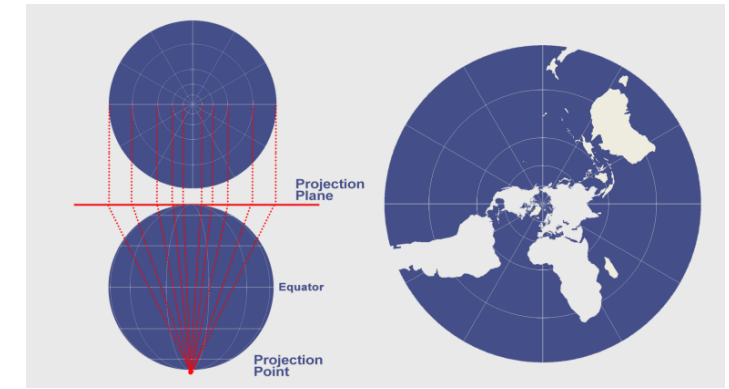
Conic projection



Cylindrical projection



Azimuthal projection

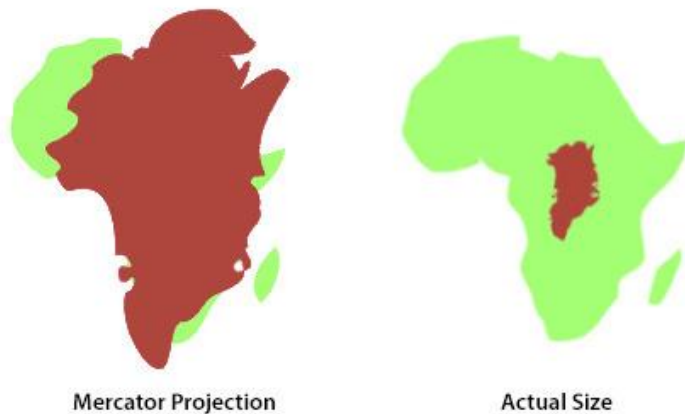


<http://gisgeography.com/map-projections/>
<https://www.jasondavies.com/maps/transition/>

Mercator projection

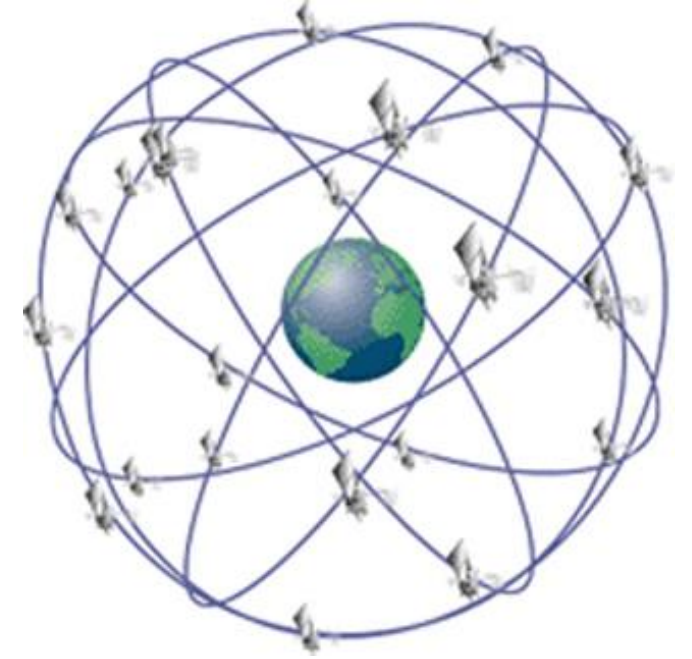
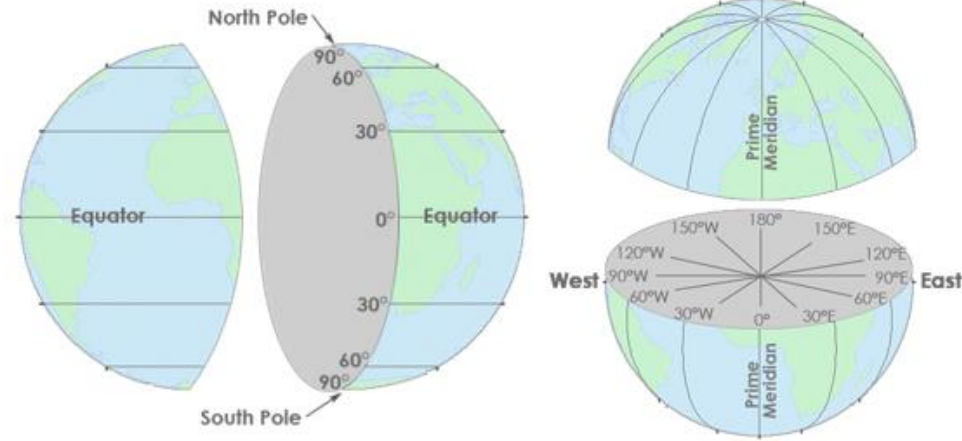
- North is up
- Shapes looks ok
- BAD areas!
- EPSG 4326 (WGS84)
- EPSG 3857

Greenland vs Africa



Coordinates

- Latitude
- Longitude
- Elevation
- GPS devices
 - Triangulation



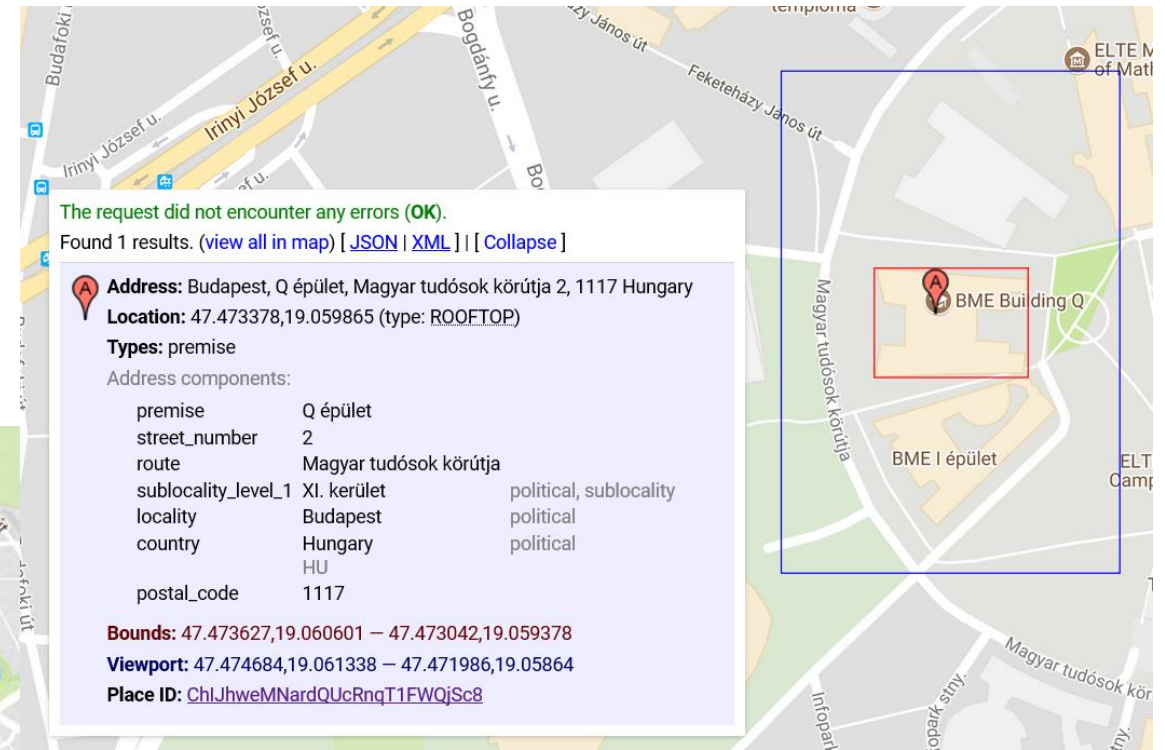
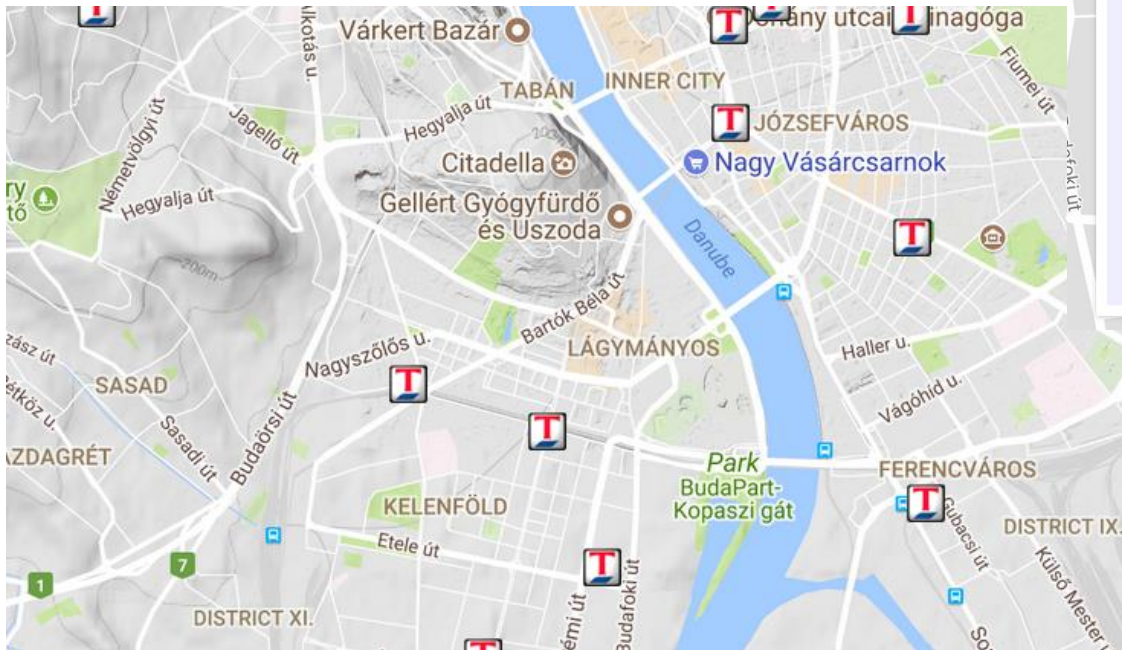
- DMS format (Degrees Minutes Seconds)
- **Decimal format (popular today)**
 - BME I building: 47.472627,19.059887 = 47° 28' 21.4572" N 19° 3' 35.5932" E

http://www.trimble.com/gps_tutorial/howgps.aspx

<http://www.latlong.net/lat-long-dms.html>

Geocoding

- Street address to coordinates
- POI - Points of Interests
 - Databases



The request did not encounter any errors (OK).
Found 1 results. (view all in map) [JSON] [XML] | [Collapse]

Address: Budapest, Q épület, Magyar tudósok körútja 2, 1117 Hungary
Location: 47.473378,19.059865 (type: ROOFTOP)
Types: premise
Address components:

premise	Q épület
street_number	2
route	Magyar tudósok körútja
sublocality_level_1	XI. kerület
locality	Budapest
country	Hungary
postal_code	1117

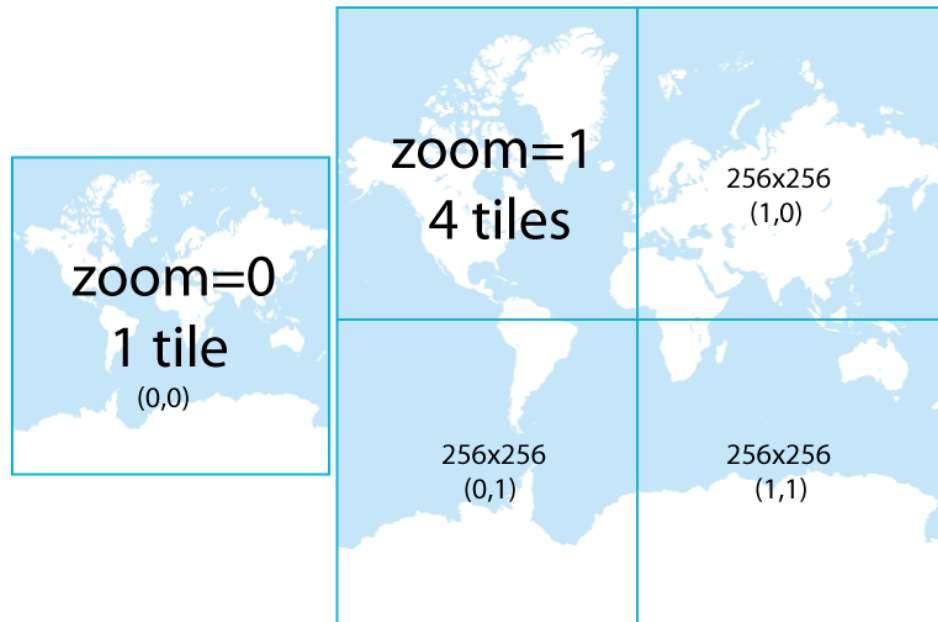
Bounds: 47.473627,19.060601 — 47.473042,19.059378
Viewport: 47.474684,19.061338 — 47.471986,19.05864
Place ID: [ChIJhweMNardQUcRnqT1FWQjSc8](#)

<https://google-developers.appspot.com/maps/documentation/utils/geocoder/>
<http://www.gpsvisualizer.com/geocode>
<https://poi plaza.com/>

Map storage

Tiles, zoom

- Tiles
 - Map divided into smaller rectangles
- Zoom level 0-19



Level	Degree	Area	m / pixel	~Scale	# Tiles
0	360	whole world	156,412	1:500 million	1
1	180		78,206	1:250 million	4
2	90		39,103	1:150 million	16
3	45		19,551	1:70 million	64
4	22.5		9,776	1:35 million	256
5	11.25		4,888	1:15 million	1,024
6	5.625		2,444	1:10 million	4,096
7	2.813		1,222	1:4 million	16,384
8	1.406		610.984	1:2 million	65,536
9	0.703	wide area	305.492	1:1 million	262,144
10	0.352		152.746	1:500,000	1,048,576
11	0.176	area	76.373	1:250,000	4,194,304
12	0.088		38.187	1:150,000	16,777,216
13	0.044	village or town	19.093	1:70,000	67,108,864
14	0.022		9.547	1:35,000	268,435,456
15	0.011		4.773	1:15,000	1,073,741,824
16	0.005	small road	2.387	1:8,000	4,294,967,296
17	0.003		1.193	1:4,000	17,179,869,184
18	0.001		0.596	1:2,000	68,719,476,736
19	0.0005		0.298	1:1,000	274,877,906,944

Bitmap vs vector maps

- Bitmap maps

- Raster tiles
- Tiles stored as picture (256x256)
- JPG or PNG format

Fast, but large storage space

- Vector maps

- Vector tiles
- Points, Lines, polygons, ...
- Human readable formats (e.g. GeoJSON)
- Binary format (e.g. Mapbox Vector Tile Specification)

Compact, but more processing

Online and offline maps

Online maps

- Internet connection
- Many free sources
 - Limited functionality or limited usage
- Cached (limited) for speed
- Raster format fits for many apps

More functions by the server. Geocoding, routing, POI, ... using API

Offline maps

- Could be faster than online
- No Internet connection – foreign use
- Paid maps (Mostly used in navigation apps)
- Limited free availability
 - Functions provided by the apps
- Vector formats (due to space limits)

Overlay maps. Drawing more maps (or objects) on the same space

Web API

HTTP basics

- HTTP commands:
 - **GET, POST**
 - HEAD, PUT, DELETE, CONNECT, OPTIONS, TRACE, PATCH
- HTTP responses
 - 200 OK, 404 Not Found
- Cookies
- Tamper Data
- HTTP requester
- Developer / Web console

HTML basics

- Hyper Text Markup Language
- HTML tags
 - html, body, div, a, input, button, ...
- HTML editors
 - Notepad ?
 - Online testers / Browsers
- CSS
 - Cascading Style Sheets
- Hosting on web servers
 - Free web hosting possible
 - Testing on local files

```
<!DOCTYPE html>
<html>
<body>

<h1>My First Heading</h1>

<p>My first paragraph.</p>

</body>
</html>
```

https://www.w3schools.com/html/tryit.asp?filename=tryhtml_basic_document

Dynamic pages

- Interaction with web pages
 - Server side processing
 - Server side scripting
 - CGI - Common Gateway Interface
 - C, Perl executed by the operating system
 - On-line scripting
 - Execute code on the web server (modules)
 - PHP, ASP, Ruby
 - Client side processing
 - Java applet and Flash
 - JavaScript
 - Server side JavaScript (node.js)

<https://phpfiddle.org/>
<https://jsfiddle.net/>

```
<!DOCTYPE html>
<html>
<body>

<h1>My first PHP page</h1>

<?php
echo "Hello World!";
?>

</body>
</html>
```

REST

- Representational state transfer
 - Access and change the representation of a web resource
- RESTful API / Web service
 - Resource URI
 - XML / HTML / JSON response
 - HTTP commands: GET, POST, PUT, DELETE

<https://apigee.com/console/others>

<https://apiary.io>

JavaScript and Web page basics

- Script language
 - Very common in frontend (also popular backend)
 - C like syntax
 - Interpreted by web browsers (there are differences also!)
- Web page is an object
 - HTML DOM Document Object
 - Everything is a node
 - Document
 - Window
 - Events on web pages (user input)

<https://learnxinyminutes.com/docs/javascript/>

```
<!DOCTYPE html>
<html>
<body>

<h2>What Can JavaScript Do?</h2>

<p id="demo">JavaScript can change
HTML content.</p>

<button type="button"
onclick='document.getElementById("d
emo").innerHTML = "Hello
JavaScript!'">Click Me!</button>

</body>
</html>
```

MAP API

Google Maps API

- https://www.w3schools.com/graphics/google_maps_intro.asp
- <https://developer.mapquest.com/>
- <http://leafletjs.com/examples.html>