

# RM03: SPATIAL ANALYSIS AND MODELLING

Supervision 1: Quantum GIS (QGIS) for  
data analysis

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# Material for supervision1

- Sup1-exercises (12-13 February, 2020)
- Sup1-assignment (13 February, 2020)
- Sup1-answers (20 February, 2020)

- Cambridge Moodle: RM03  
<https://www.vle.cam.ac.uk/course/view.php?id=179012#section-2>
- Online:  
<https://hn303.github.io/CamLandEc-RM03/>

[Preview dark color scheme](#)

## RM03: Spatial Analysis and Modelling

Welcome to 2020 lent term module RM03 : Spatial Analysis and Modelling.  
This repo is created by [Haifeng Niu](#) and contributed by Heeseo Rain Kwon and Paul Scherer\*. Materials of supervision could be found here.

### Course outline

Lectures	Topic	Lecturers
Lecture 1	Introduction: Concepts, theory and practice in spatial analysis using GIS and data science	(Elisabete A. Silva)
Lecture 2	Data types of data, data collection and processing: from census to new live data harvesting in a digital age of big data	(Elisabete A. Silva)
Lecture 3	GIS and Data Processing: vector/raster/image data sets	(Elisabete A. Silva)
Lecture 4	Spatial metrics & analysis: static and dynamic environments	(Elisabete A. Silva & José Reis)
Supervision 1	QGIS - data analysis <a href="#">[Slides]</a> <a href="#">[Exercises]</a> <a href="#">[Assignment]</a>	(H. Niu, H. R. Kwon)
Lecture 5	Urban and Environmental Dynamic Modelling	(Elisabete A. Silva )
Lecture 6	Dynamic simulation models SA, MCA, ABM, CA, GA and NN: development, calibration, validation	(Elisabete Silva)



# Spatial data

## Why spatial feature matters?

- What makes spatial special?
  - First law of geography – spatial autocorrelation  
“Everything is related to everything else, but near things are more related than distant things.” -- [Waldo Tobler](#)
- Real problems that spatial data may help
  - Urban Traffic (TfL, GoogleMap, ...)
  - Healthcare (Body censor, GP location, ...)
  - Politics (Propaganda, ...)
  - Business Intelligence/Market (Uber, Deliveroo, Strava, ...)
  - City Operation (Smart Bus, Facilities, ...)



**FOURSQUARE**



**STRAVA**

**NHS**

**Uber**

 **smart**  
**CAMBRIDGE**  
Solutions for the city and beyond



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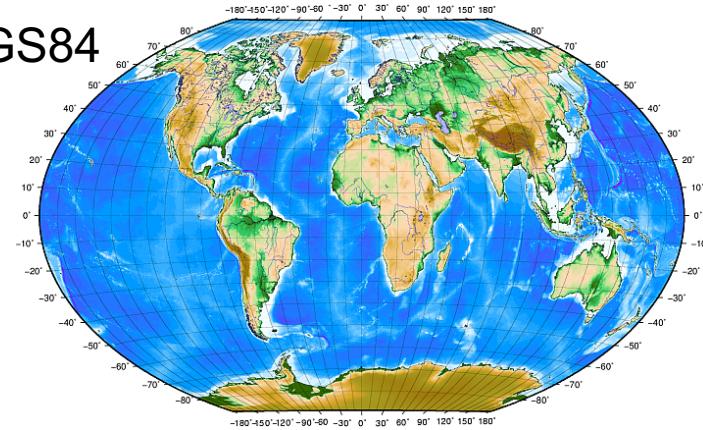


# Spatial Data

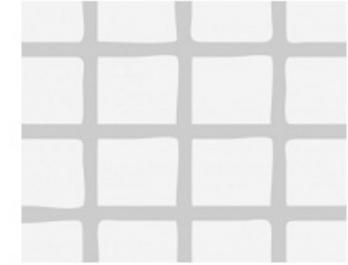
## What makes data spatial?

- Location, Coordinates and Georeferencing
- Coordinate reference system (CRS)
  - Definition: with the help of coordinates, how the two-dimensional, projected map in your GIS is related to real places on the earth.
  - Map projection
  - Two types:
    - Geographic Coordinate Systems
    - Projected coordinate reference systems

WGS84

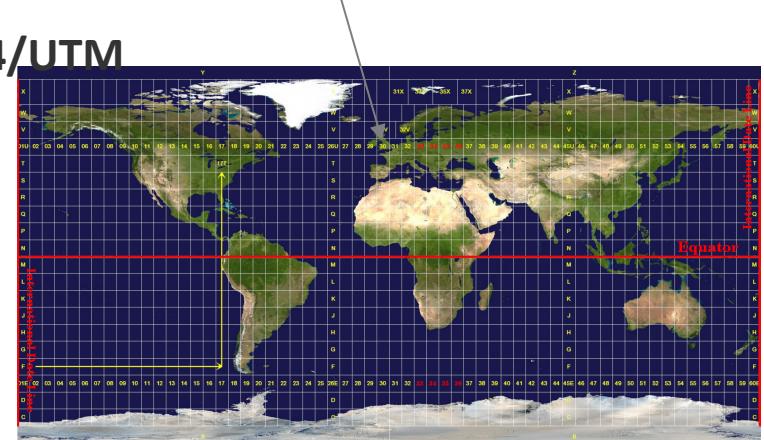


Geographic (3D)



Projected (2D)

WGS84/UTM

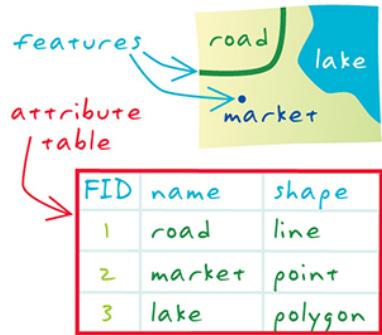


UK: WGS84/UTM 30N

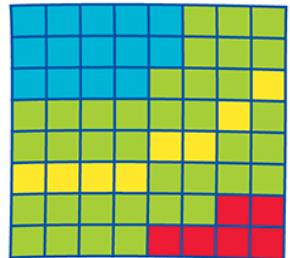


# Spatial Data

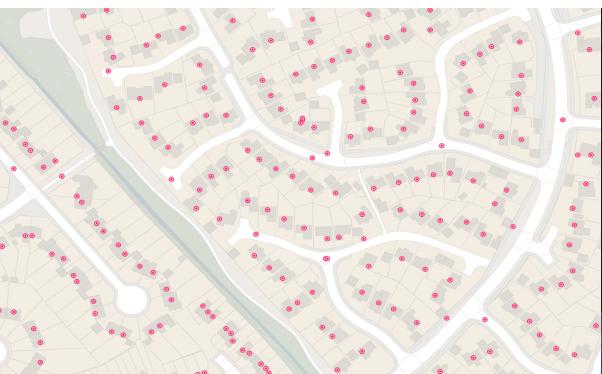
## Vector Data and Raster Data



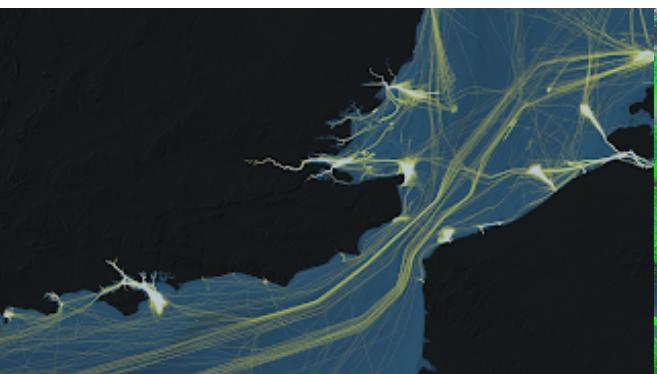
- Main categories:
  - Vector (Points, Polylines and Polygon)
    - Shapefile, GeoJSON, Geopackage, Geodatabase
    - Map features + attributes table
  - Raster Data
    - GeoTIFF, JPEG2000
    - Pixel + value



Legend:  
■ agriculture   ■ lake  
■ residential   ■ road



Geolocation of properties in UK @ Ordnance Survey



Port service traffic is quite busy in the English Channel@ ALASDAIR RAE



LiDAR data @ Leica CityMapper



# Spatial Data

## Shapefile

- **Three main files:**
  - **shp** — Main file (mandatory); a direct access, variable-record-length file in which each record describes a shape with a list of its vertices.
  - **shx** — Index file (mandatory). In the index file, each record contains the offset of the corresponding main file record from the beginning of the main file. The index file (.shx) contains a 100-byte header followed by 8-byte, fixed-length records.
  - **dbf** — dBASE Table file (mandatory); a constrained form of **DBF** that contains feature attributes with one record per feature. The one-to-one relationship between geometry and attributes is based on record number. Attribute records in the dBASE file must be in the same order as records in the main file.
- Others:
  - **prj** — Projections Definition file; stores coordinate system information.
  - ...

<sup>1</sup> What is shapefile?:

<https://gislounge.com/what-is-a-shapefile/>



# GIS Software

## Why use QGIS?



- QGIS (Quantum GIS) is a major open-source GIS platform
  - Free and open-source: cost you zero money
  - Cross platform: macOS, Windows and Linux
  - User community: tons of plugins and help resources<sup>1</sup>.
  - Programming language support: PyQGIS, R and so on.



<sup>1</sup> Geographic Information Systems in Stack Exchange:  
<https://gis.stackexchange.com/?tags=qgis>



# How to involve QGIS in your research?

## Pre-processing/ Analysis/ Visualization

- Data preprocessing
  - Selection 
  - Extraction 
  - Calculation 
  - Clip 
  - Join 
- Spatial Analysis
  - Geoprocessing 
  - Spatial autocorrelation
  - Spatial interpolation
  - Spatial categorization
  - Network Analysis
- Geo-Visualization
  - Digitalization Map 
  - Mapping 



covered in supervision and assignment



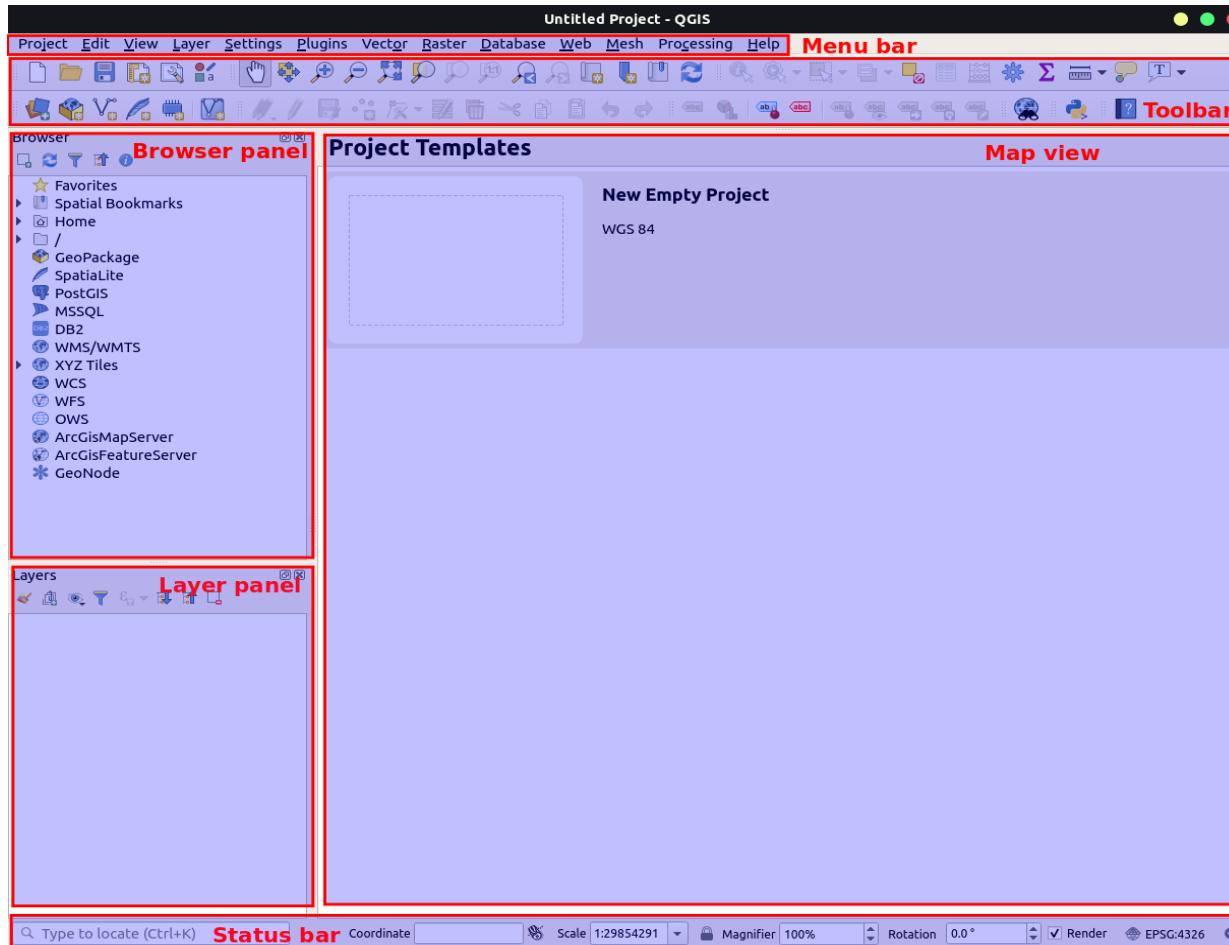
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# QGIS

## Interface



- Menu bar
- Toolbar
- Browser panel
- Layer panel
- Map window
- Status bar



# QGIS

## Exercises

- Practice QGIS exercises with the [instruction](#).

CamLandEc-RM03

Search CamLandEc-RM03

Home Supervision 1 Dark color scheme

## Supervision 1 (12-13 February, 2020)

### Instructions

- 1 Read through the instruction carefully. You may face problems if you overlook any of the steps.
- 2 Remember to save the QGIS document regularly.
- 3 When running tasks on QGIS, leave the settings as the default unless instructed.  
Note: functions and filename are **highlighted** in this document.

### Supervision overview

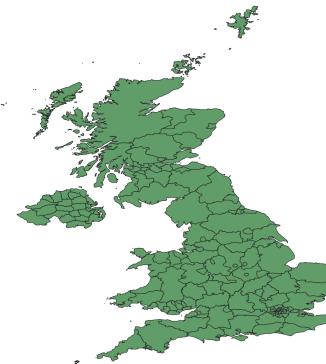
In this exercise, you will familiarise yourself with the basic features of QGIS software and geoprocessing exercises with vector data and raster data.



# Coordinate reference system

How to deal with CRS in your project?

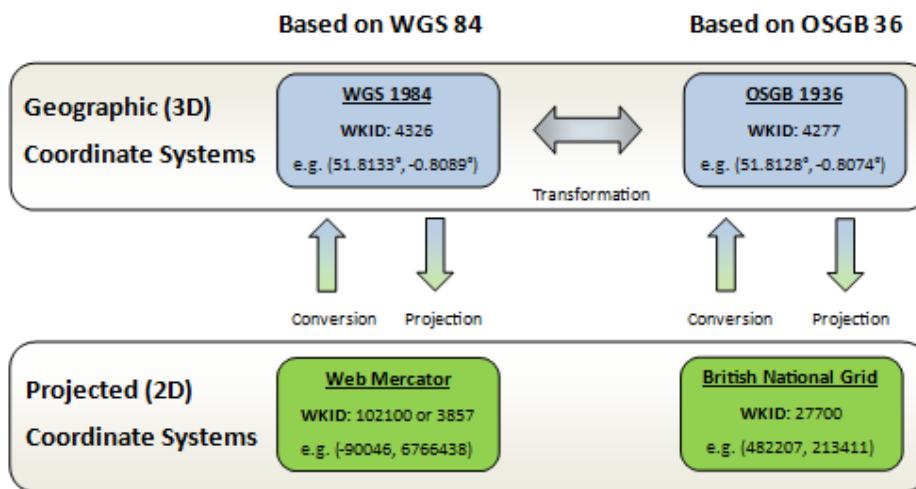
- Different units
  - Degree/Meters
- Setting CRS
  - Project CRS
  - Layer CRS
  - Export CRS



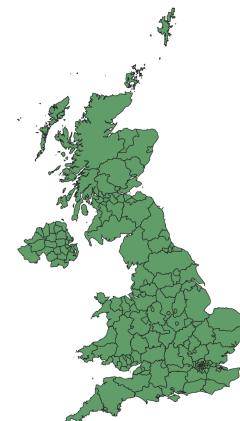
WGS84



OSGB 1936



British National Grid



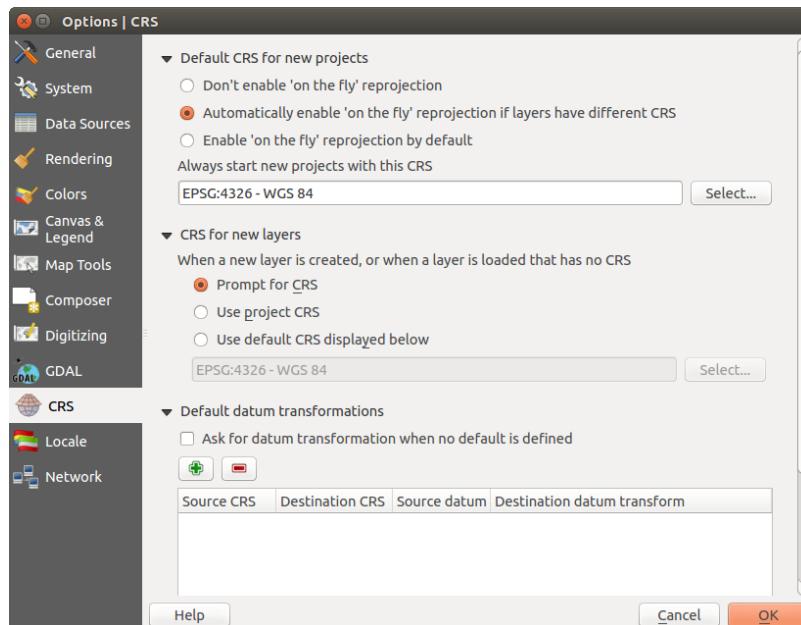
WGS UTM 30N



# Coordinate reference system

## How to deal with CRS in your project?

- **On-The-Fly Projection**
  - QGIS supports “on the fly” CRS transformation for both raster and vector data. This means that regardless of the underlying CRS of particular map layers in your project, they will always be automatically transformed into the common CRS defined for your project.



- **Global**
  - WGS 84 (Geographic)
  - UTM (Projected)
- **UK**
  - OSGB 36 (Geographic)
  - British National Grid (Projected)



# Join

## How to join layer?

- Shapefile and Table (By unique identifier)
- Shapefile and shapefile (By unique identifier)

The screenshot shows the QGIS interface with two tables joined together. On the left, the 'Cambridge-City-Ward-Po...' table is displayed in the 'Table' view, with its data shown in a grid. A red box highlights the 'Ward name' column. On the right, the 'Cam\_City' shapefile is shown in the 'Shapefile' view, with its attribute table below it. A red box highlights the 'Ward name' column in this table as well. Red arrows point from the highlighted columns in both tables towards each other, indicating they are being compared or joined.

Unique Identifier

Ward Code	Ward name	Y2011	Y2016	Y2021
E05002709	Market	7150	7960	8390
E05002710	Newnham	7970	8040	8170
E05002711	Petersfield	8300	8900	9560
E05002712	Queen Edith's	9180	9530	11310
E05002705	Cherry Hinton	8780	9170	10550
E05002706	Coleridge	9370	9850	10130
E05002707	East Chestert...	9460	9490	9450
E05002708	King's Hedges	9320	9550	9420
E05002702	Abbey	9850	10230	10320
E05002703	Arbury	9110	9360	10440
E05002704	Castle	9850	9880	14810

wd15cd	wd15nmw	lad15cd	lad15nm	objectid	st_lengths	st_area
E05002702	Abbey	E07000008	Cambridge	2104	12290.67605...	3954412
E05002703	Arbury	E07000008	Cambridge	2105	8369.027813...	1499807
E05002704	Castle	E07000008	Cambridge	2106	11757.587099...	3403905
E05002705	Cherry Hinton	E07000008	Cambridge	2107	12069.51826...	3677252
E05002706	Coleridge	E07000008	Cambridge	2108	7997.078634...	1925010
E05002707	East Chestert...	E07000008	Cambridge	2109	10093.25911...	2606339
E05002708	King's Hedges	E07000008	Cambridge	2110	6036.89026...	1571741.9
E05002709	Market	E07000008	Cambridge	2111	5605.922040...	1693591
E05002710	Newnham	E07000008	Cambridge	2112	11475.421763...	4447800
E05002711	Petersfield	E07000008	Cambridge	2113	5155.561243...	1055920
E05002712	Queen Edith's	E07000008	Cambridge	2114	9676.176314...	4510353
E05002713	Romsey	E07000008	Cambridge	2115	6559.007335...	1486406



# Join

What if there is no identifier?

- Shapefile and shapefile (By location)

