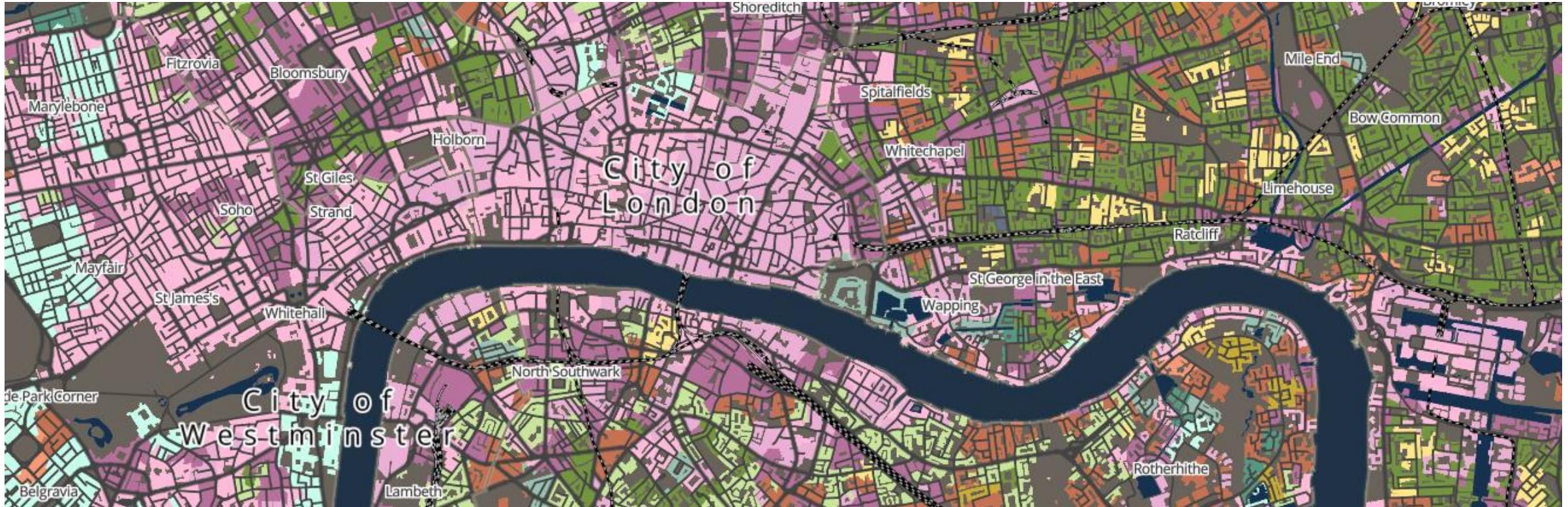


# Geocomputation

## Welcome

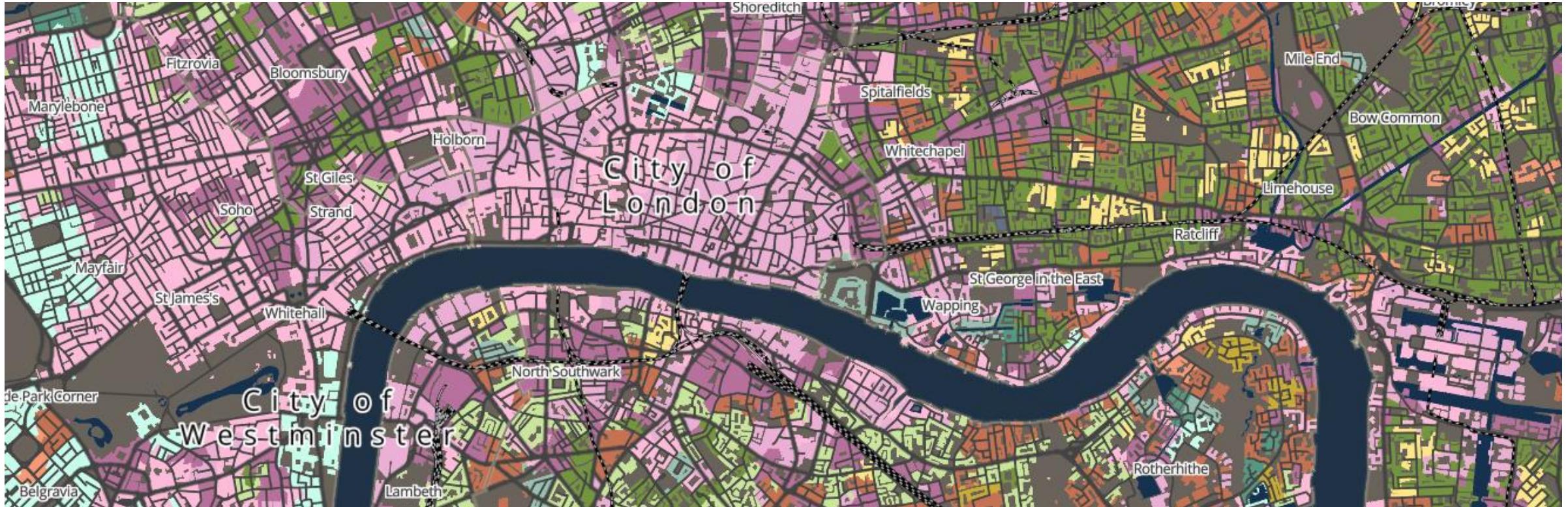


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# Geocomputation

## Module Overview



 Dr Justin van Dijk  
 j.t.vandijk@ucl.ac.uk



# Module aims

Geocomputation provides you with an introduction to the principles of GIScience, spatial analysis, and the use of programming for spatial data analysis.

Over the next ten weeks, you will learn about the theory, methods and tools of spatial analysis using the R programming language within the RStudio software environment.

You will further learn how to find, clean, and manage demographic, socio-economic, and environmental datasets, and analyse them using core spatial analysis techniques.

# Module outline

- W1 Reproducible Spatial Analysis
- W2 Spatial Queries and Geometric Operations
- W3 Point Pattern Analysis
- W4 Spatial Autocorrelation
- W5 Spatial Models
- W6 Raster Data Analysis
- W7 Geodemographic Classification
- W8 Accessibility Analysis
- W9 Beyond the Choropleth
- W10 Complex Visualisations



Core Spatial Analysis

Applied Spatial Analysis

Data Visualisation

# Module structure

- This module consists of ten lectures (Monday morning) and ten supervised computer tutorials (Group A: Tuesday morning, Group B: Tuesday afternoon).
- Each week will have its own reading list. Reading lists and instructions for the computer tutorial are published on the dedicated GEOG0030 Geocomputation Workbook. The link to this workbook is available on Moodle.

# Workbook

# GEOG 0030

**Geocomputation**

**Welcome**

Welcome to Geocomputation. This module offers a deep dive into the principles of spatial analysis and data visualisation while providing a thorough introduction to reproducible research. Over the next ten weeks, you will explore the theory, methods, and tools of spatial analysis through engaging case studies. You will gain hands-on experience in sourcing, managing, cleaning, analysing and presenting spatial, demographic, and socioeconomic

On this page

- Geocomputation
- Welcome**
- Prerequisites
- Moodle
- Module overview
- Troubleshooting
- Major updates
- Acknowledgements

Report an issue

# Workbook

The screenshot shows a web browser window with the URL [jtvdijk.github.io/GEOG0030/01-spatial.html](https://jtvdijk.github.io/GEOG0030/01-spatial.html). The page is titled "1.1 Lecture slides". Below it, a section titled "1.2 Reading list" is highlighted with a pink border. This section contains two subsections: "Essential readings" and "Suggested readings", each with a list of academic articles. The sidebar on the left lists various module topics, and the right sidebar shows a "On this page" navigation menu.

**1.1 Lecture slides**

You can download the slides of this week's lecture here: [\[Link\]](#).

**1.2 Reading list**

**Essential readings**

- Brundson, C. and Comber, A. 2020. Opening practice: Supporting reproducibility and critical spatial data science. *Journal of Geographical Systems* 23: 477–496. [\[Link\]](#)
- Franklin, R. 2023. Quantitative methods III: Strength in numbers? *Progress in Human Geography*. Online First. [\[Link\]](#).
- Longley, P. et al. 2015. *Geographic Information Science & Systems, Chapter 1: Geographic Information: Science, Systems, and Society*, pp. 1-32. [\[Link\]](#)

**Suggested readings**

- Goodchild, M. 2009. Geographic information systems and science: Today and tomorrow. *Annals of GIS* 15(1): 3-9. [\[Link\]](#)
- Franklin, S., Houlden, V., Robinson, C. et al. 2021. Who counts? Gender, Gatekeeping, and Quantitative Human Geography. *The Professional Geographer* 73(1): 48-61. [\[Link\]](#)
- Schurr, C., Müller, M. and Imhof, N. 2020. Who makes geographical knowledge? The gender of Geography's gatekeepers. *The Professional Geographer* 72(3): 317-331. [\[Link\]](#)
- Yuan, M. 2001. Representing complex geographic phenomena in GIS. *Cartography and Geographic Information Science* 28(2): 83-96. [\[Link\]](#)

On this page

- 1 Reproducible Spatial Analysis
- 1.1 Lecture slides
- 1.2 Reading list**
- Essential readings
- Suggested readings
- 1.3 Europeans in London
- 1.4 Styling spatial data
- 1.5 Assignment
- 1.6 Before you leave

[Report an issue](#)

# Refresher

The screenshot shows a web browser window with the title bar "GEOG0018". The address bar contains the URL "jtvandijk.github.io/GEOG0018/00-installation.html". The page content is as follows:

**GEOG 0018**

**Getting started**

R is a programming language originally designed for conducting statistical analysis and creating graphics. The major advantage of using R is that it can be used on any computer operating system, and is free for anyone to use and contribute to. Because of this, it has rapidly become the statistical language of choice for many academics and has a large user community with people constantly contributing new packages to carry out all manner of statistical, graphical, and geographical tasks. In this tutorial, we will guide you through installing R on your computer and review the basics of interacting with the language and its functions.

**Installation of R**

Installing R takes a few relatively simple steps involving two pieces of software. First there is the R programming language itself. Follow these steps to get it installed on your computer:

1. Navigate in your browser to the download page: [\[Link\]](#)
2. If you use a Windows computer, click on *Download R for Windows*. Then click on *base*. Download and install **R 4.5.x for Windows**. If you use a Mac computer, click on *Download R for macOS* and download and install **R-4.5.x.arm64.pkg** for [Apple silicon Macs](#) or **R-4.5.x.x86\_64.pkg** for older [Intel-based Macs](#).

That is it! You now have successfully installed R onto your computer. To make working with the R language a little bit easier we also need to install something called an [Integrated Development Environment \(IDE\)](#). We will use [RStudio Desktop](#):

1. Navigate to the official webpage of RStudio: [\[Link\]](#)
2. Download and install RStudio on your computer.

**On this page**

- Getting started
- Installation of R
- Customisation of R
- Getting started with R
- Before you leave

[Report an issue](#)

# Practicalities

- Lecture slides will be made available on the GEOG0030 Geocomputation workbook webpage before each lecture. Lectures are recorded using [Panopto](#).
- During the computer tutorials you are expected to work independently through the assignments in the workbook with the opportunity to ask questions.

# Communication

- All important information will be communicated through **Moodle**.
- For specific questions on the module, my Academic Support and Feedback (ASF) Office Hours are scheduled on Monday 14h00-16h00 and Thursday 13h00-14h00. Slots can be booked through Microsoft Bookings: [\[Link\]](#)

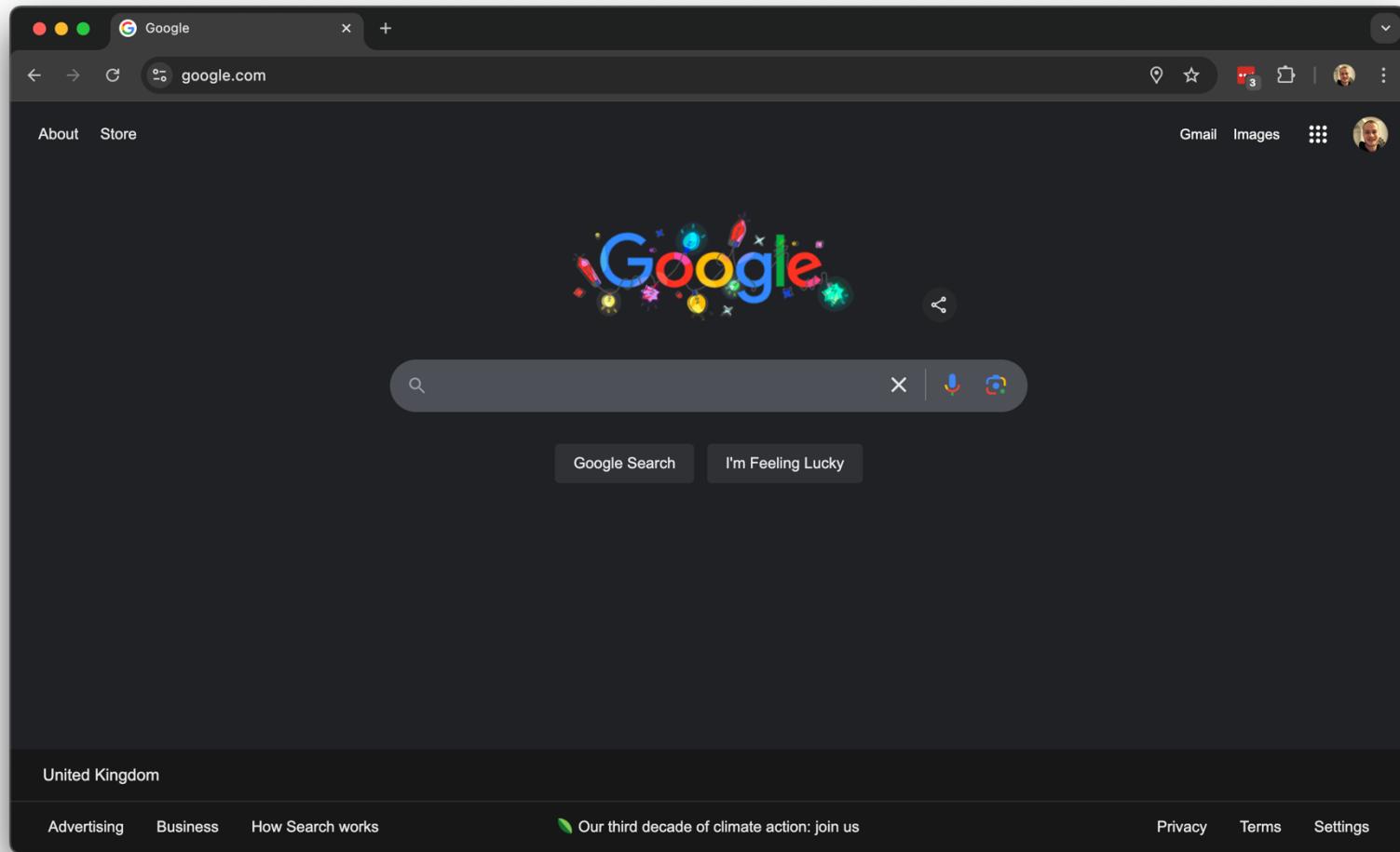
# Assessment

- Social Atlas Coursework Assessment (60%): The first assessment will involve the completion of a spatial analysis project, based on the theory, concepts and application learnt during the module. For this coursework you are required to create a small *social atlas* on a topic or area that interests you. Deadline: April 27, 2026.
- Specific Coursework guidance on Moodle (including past examples with indicative grades), further attention to this in W05's Lecture.
- Exam Assessment (40%): The second assessment will take the form of a written two-hour Exam, further attention to this in W10's Lecture.

# Troubleshooting

- Refresher [GEOG0018 Methods in Human Geography](#).
- Ask a question at the end of a plenary lecture.
- Ask a question during a computer tutorial.
- Attend the optional BYOC [Geocomputation Help](#) sessions:
  - W02: NWW 3.05 12h00 – 14h00
  - W05: NWW 3.05 11h00 – 13h00
  - W08: NWW 3.05 11h00 – 13h00
  - W09: NWW 3.05 11h00 – 13h00
  - W10: NWW 3.05 11h00 – 13h00

# Troubleshooting



# Troubleshooting

The screenshot shows a Microsoft Edge browser window with a dark theme. The title bar reads "Chat | M365 Copilot". The address bar shows the URL "m365.cloud.microsoft.com/chat?auth=2&origindomain=microsoft365". The page content is a troubleshooting session:

> Can you explain the following R code:# join attrib

Here is what that R code is doing, step by step:

```
1 # join attribute data onto spatial data
2 msoa21 <- msoa21 |>
3   left_join(msoa_eur, by = c('msoa21cd' = 'msoa21cd'))
```

**Plain-English explanation**

- |> is the base R pipe. It passes the object on the left as the first argument to the function on the right. So this takes `msoa21` and feeds it into `left_join(...)`.
- `left_join(msoa_eur, by = c('msoa21cd' = 'msoa21cd'))` joins two tables by a common key.
  - The **left** table is the one being piped in, `msoa21`.
  - The **right** table is `msoa_eur`.
  - The join key is the column `msoa21cd` in both tables.
- Because it is a **left join**, the result keeps all rows from `msoa21`. For each row, it looks up the matching row(s) in `msoa_eur` where `msoa21cd` matches.

What if `msoa_eur` has multiple rows per key? How to handle duplicate keys before joining?

+

0

AI-generated content may be incorrect

# Questions

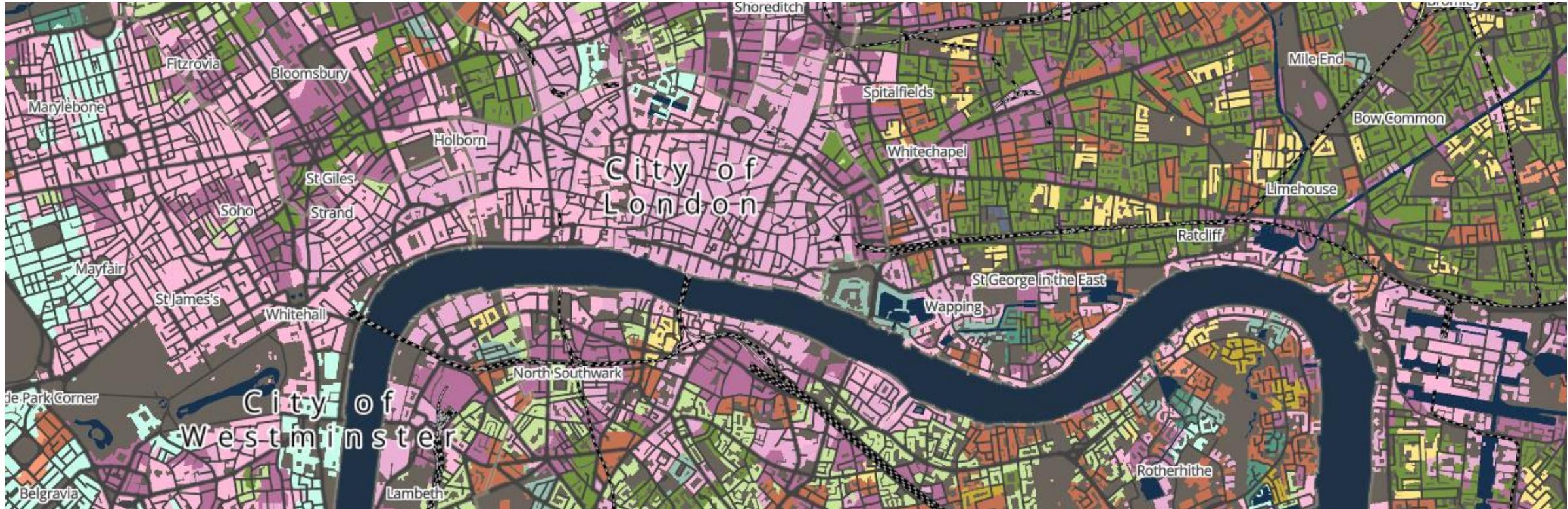
Justin van Dijk

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# Geocomputation

## Reproducible Spatial Analysis



# Module outline

- W1 Reproducible Spatial Analysis
- W2 Spatial Queries and Geometric Operations
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- W10 Complex Visualisations



Core Spatial Analysis

Applied Spatial Analysis

Data Visualisation

# This week

- What is GIScience?
- What is Geocomputation?

# Before we start

- Go to [www.menti.com](http://www.menti.com)
- Use code: 1677 3492

# GIScience

- The Geocomputation module is designed to provide you with an introduction to the principles of GIS, spatial analysis and the use of programming for data analysis.
- GIS: Geographical Information System / Geographical Information Science
- Why do we need a science of Geographical Information?

# Pubs in Bloomsbury

pub - Google Maps

google.com/maps/search/pub/@51.5226195,-0.1365354,15.97z/data=!4m2!2m1!6e5?hl=en&entry=ttu&g\_ep=EgoYMDI0MTAyMC...

Price Rating Hours All filters

Results

Sponsored :

**Marlborough Arms**  
4.1 ★★★★☆ (1,271) ⏲ £10–20  
Pub · ⚖ · 36 Torrington Pl  
Old-fashioned pub with simple food menu  
Open · Closes 11 pm  
✓ Dine-in · ✗ Takeaway · ✗ Delivery

**The Court**  
4.6 ★★★★★ (2,804) ⏲ £10–20  
Pub · ⚖ · 108a Tottenham Ct Rd, Greater  
Spacious modern corner pub  
Open · Closes 12 am  
Dine-in · No takeaway · No delivery

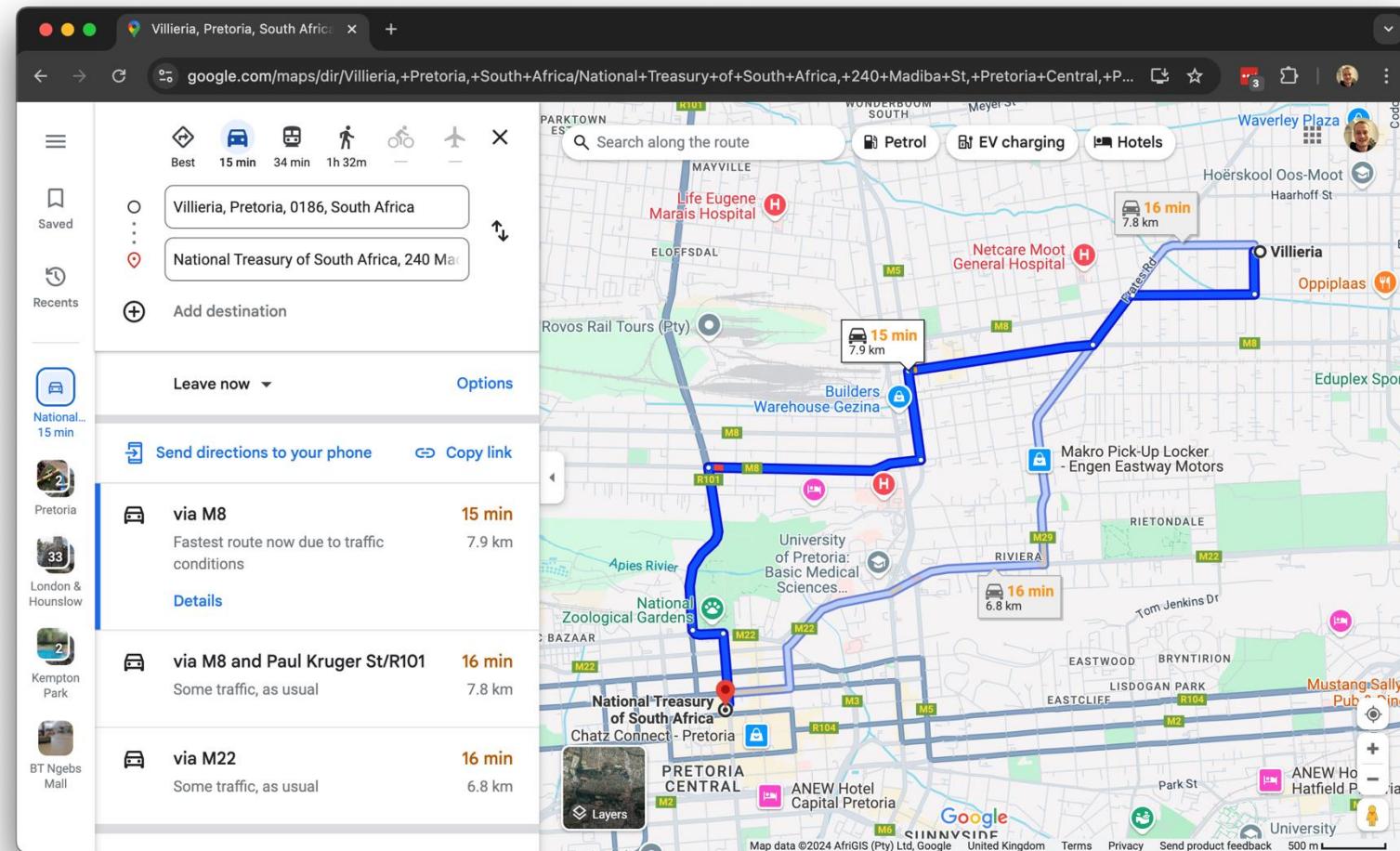
**The Northumberland Arms**  
4.0 ★★★★☆ (675) ⏲ £10–20

Visit site RESERVE A TABLE Layers

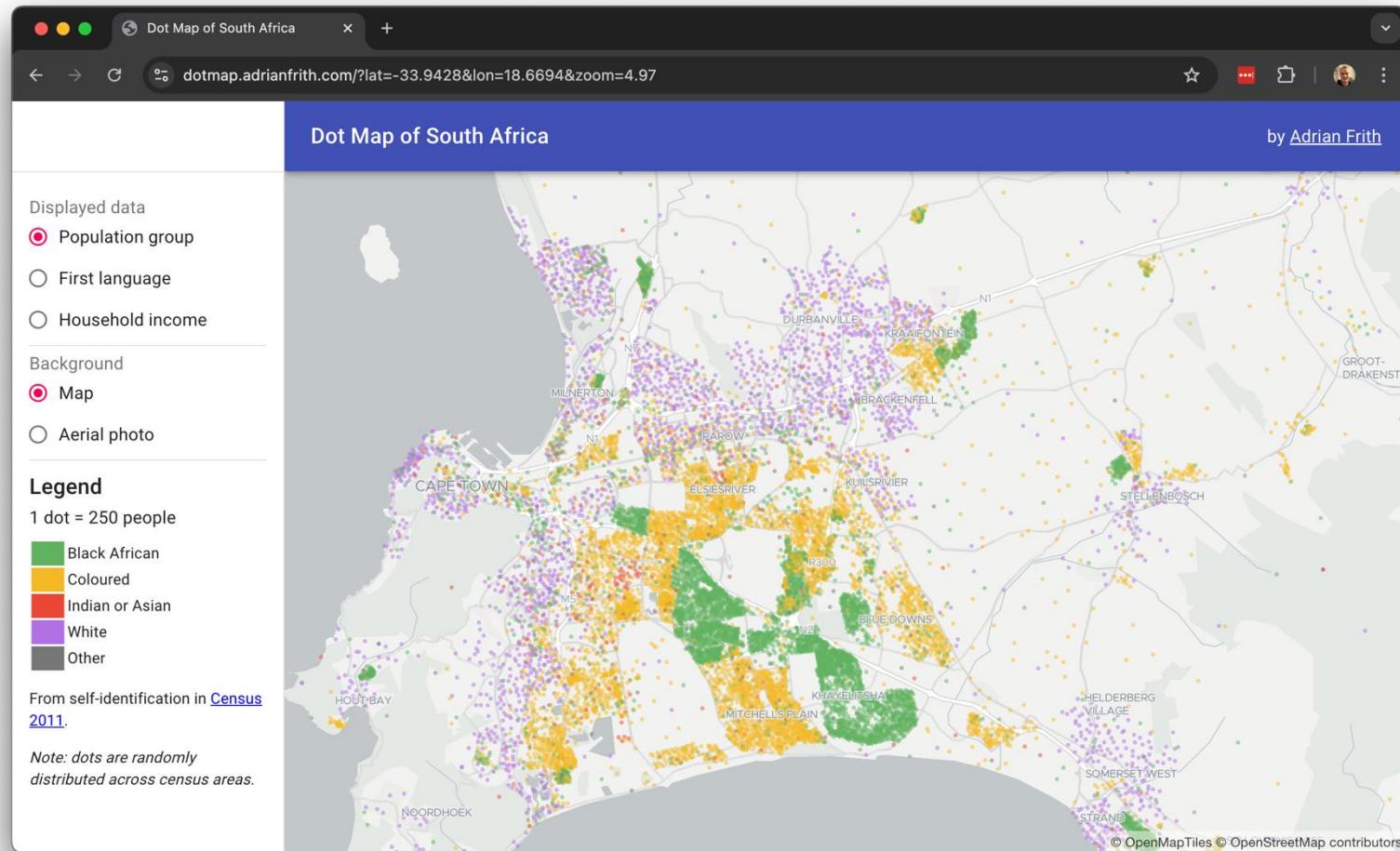
Update results when map moves

Map data ©2024 United Kingdom Terms Privacy Send product feedback 100 m

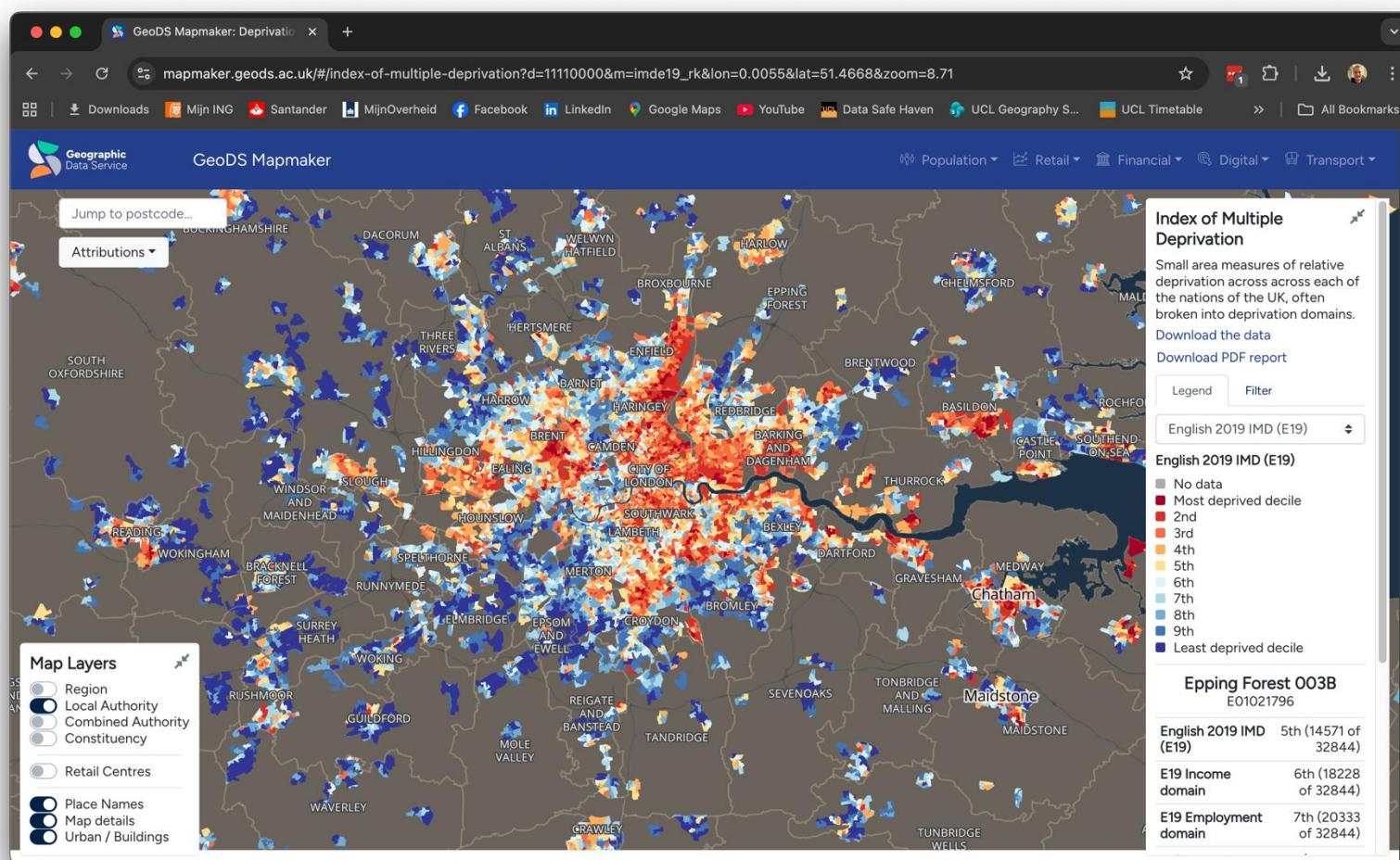
# Finding your way abroad



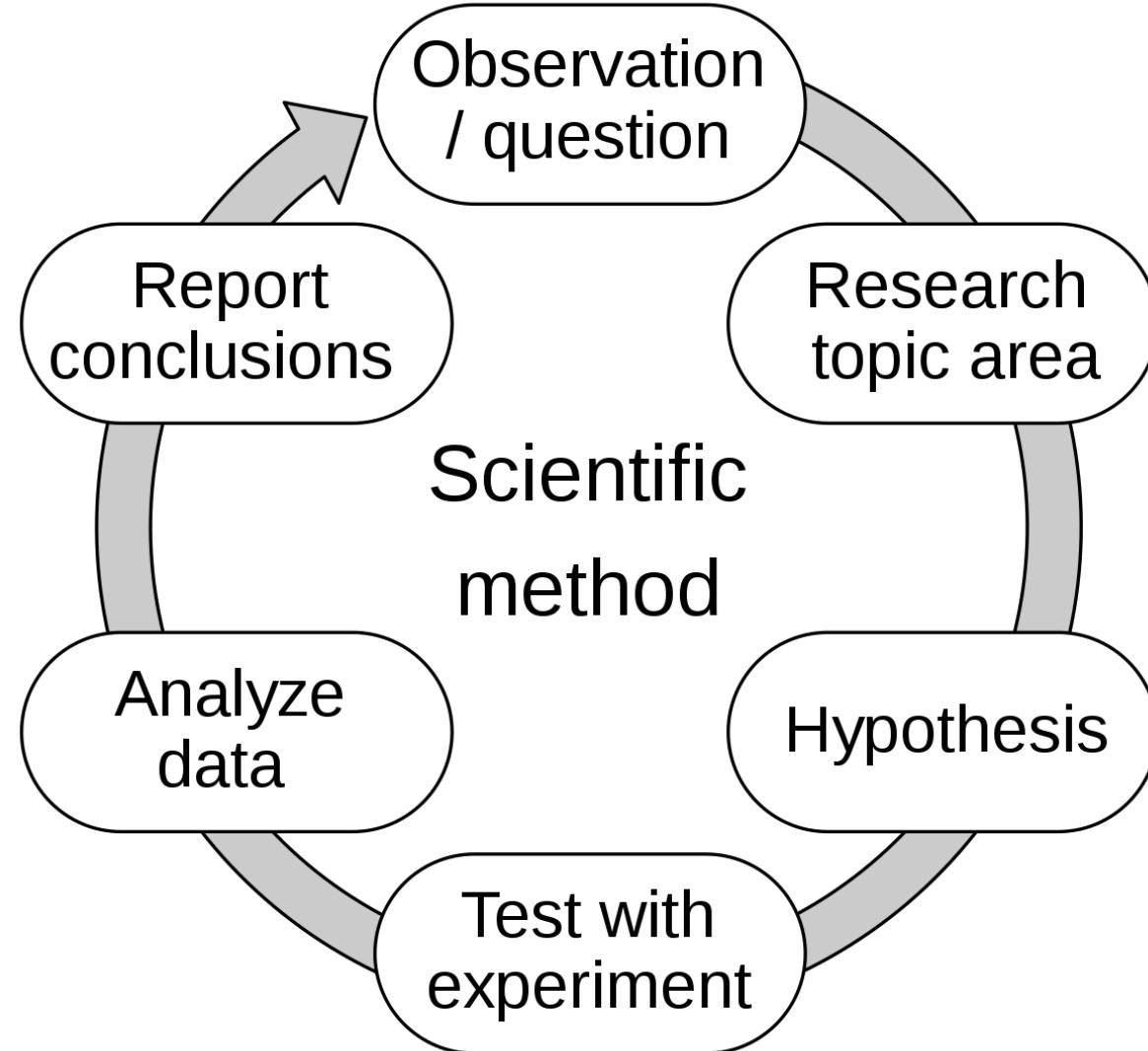
# Segregation in Cape Town



# Index of Multiple Deprivation in England



# Foundations of GIScience



# Foundations of GIScience

- Spatial information requires specialised methods and tools to handle its unique properties. To work effectively with spatial data, we need to:
  - Represent spatial data accurately in a digital format.
  - Store and organise spatial data for easy access and interaction.
  - Perform analyses to extract insights from spatial data.
  - Communicate results effectively
- Together they constitute the four **pillars** of GIScience.

# Foundations of GIScience

*(1) Spatial modelling and digital representation:*

How to represent spatial phenomena digitally?

*(2) Geographic Information Systems:*

How to store, manage, retrieve, query, analyse and visualise these digital spatial phenomena.

# Foundations of GIScience

## *(3) Spatial analysis:*

The theory, principles, and techniques that enable analysis of spatial data to look at spatial patterns, processes, and relationships.

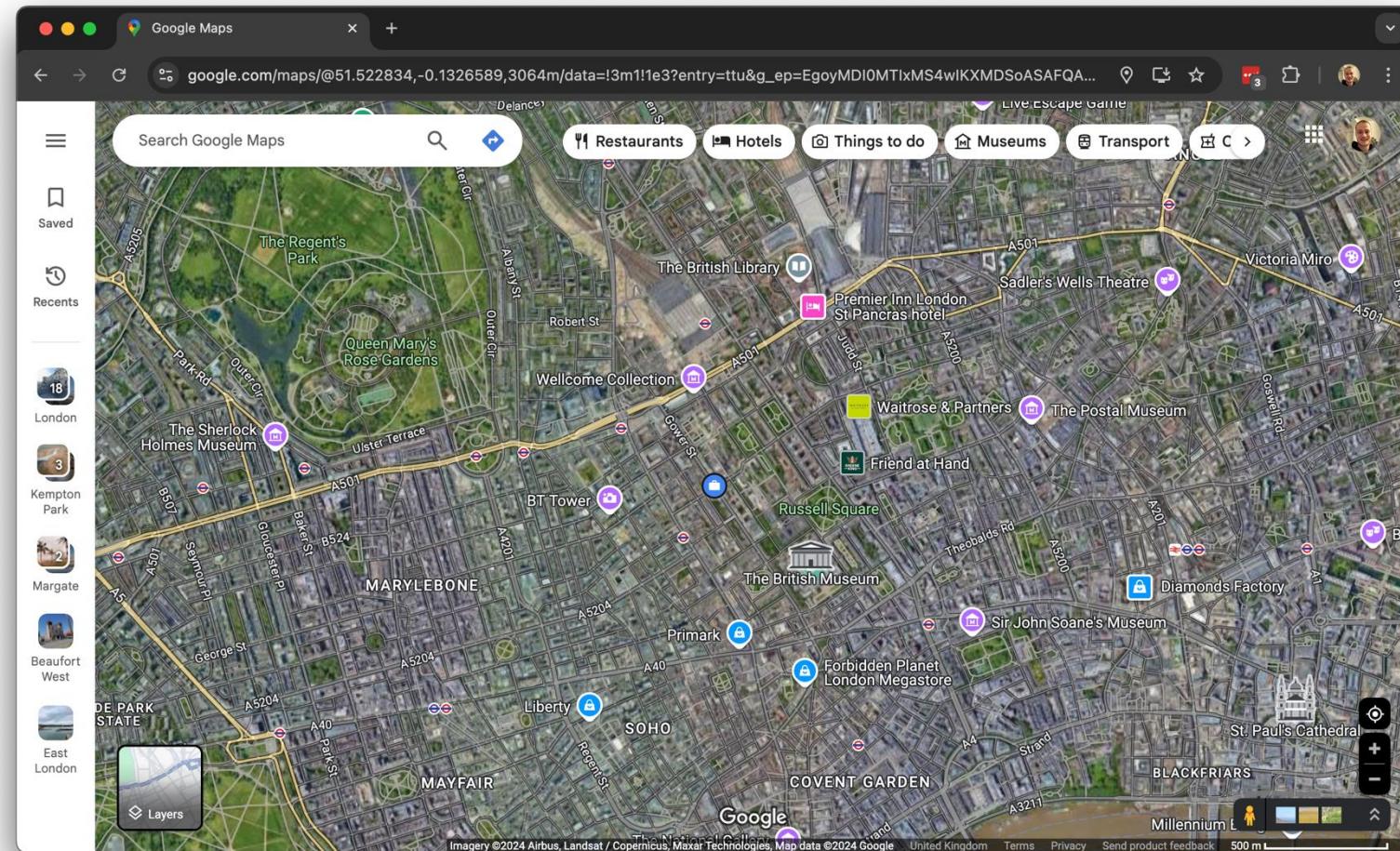
## *(4) Cartography and visualisation:*

How to present spatial data and the results from spatial analysis to communicate results (including projections and map conventions).

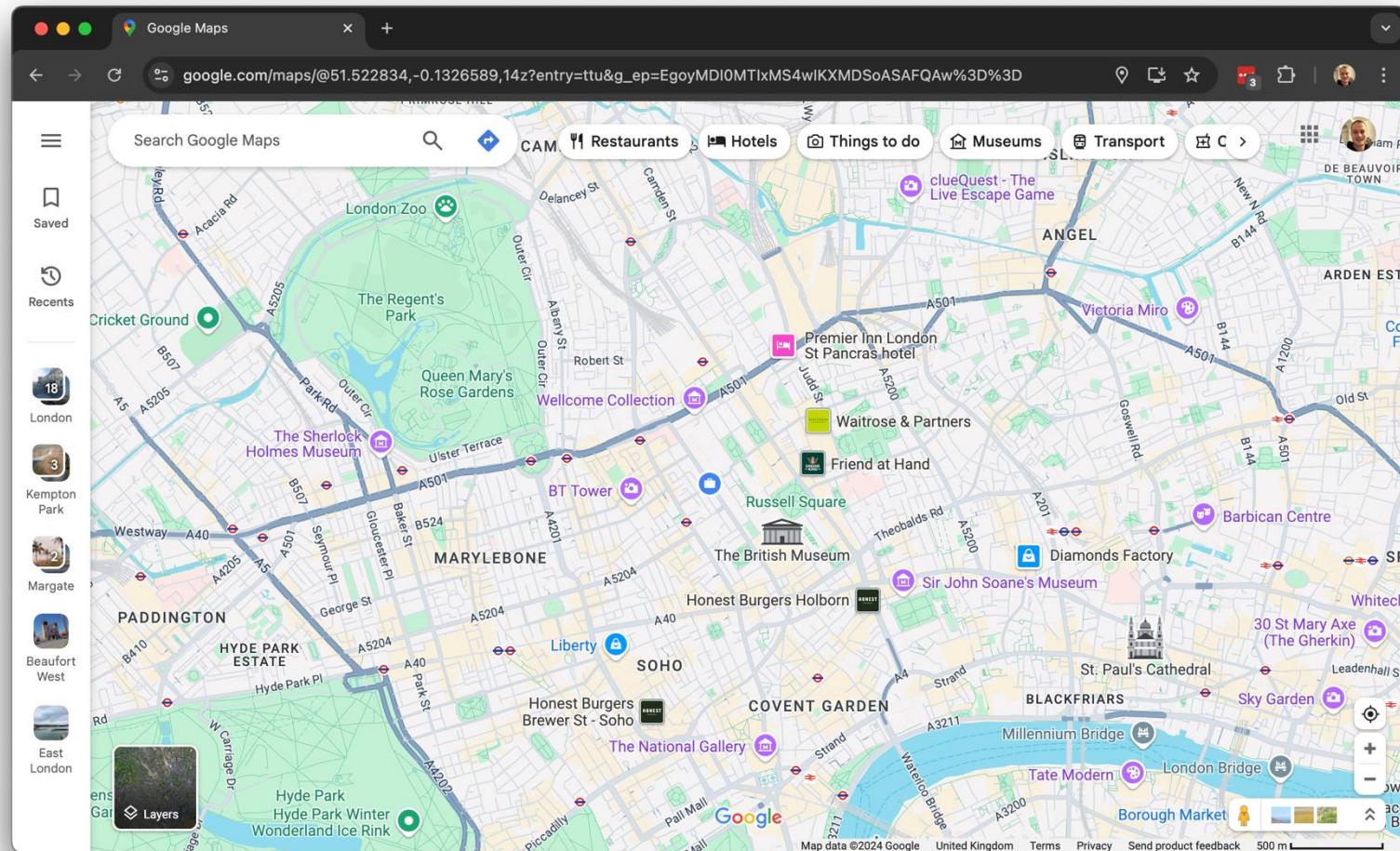
Spatial modelling and digital representation



# Spatial modelling and digital representation



# Spatial modelling and digital representation



# Spatial modelling and digital representation

- GIScience relies on representing spatial information in a digital format.
- Traditionally, geographic information is conveyed in two primary ways:

**Vector** This method uses a finite set of discrete geometric objects, such as points, lines, and polygons, to represent spatial features.

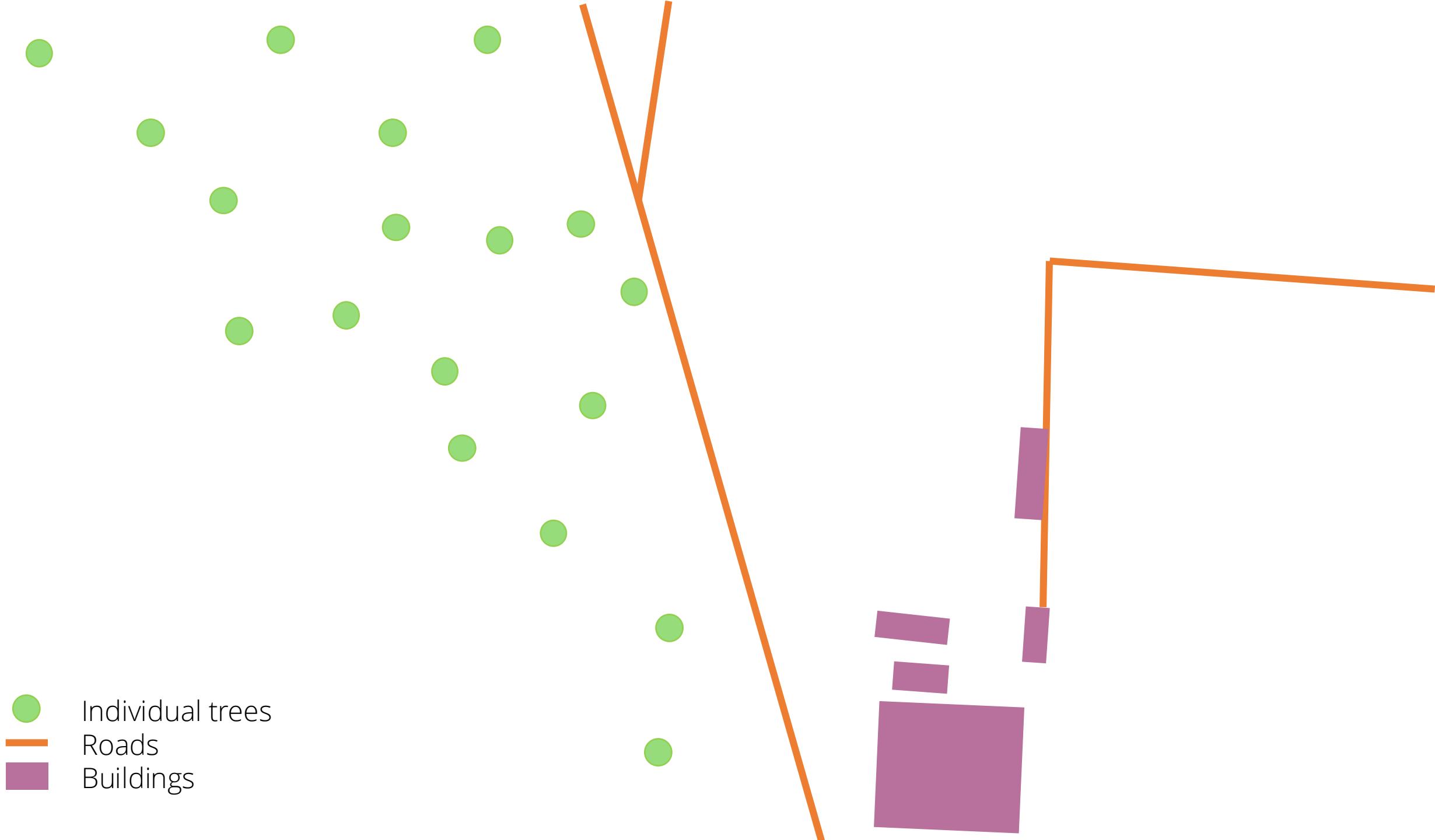
**Raster** This approach employs images or grids to represent surfaces, with each cell or pixel holding a value, often indicating attributes like colors or measurements.



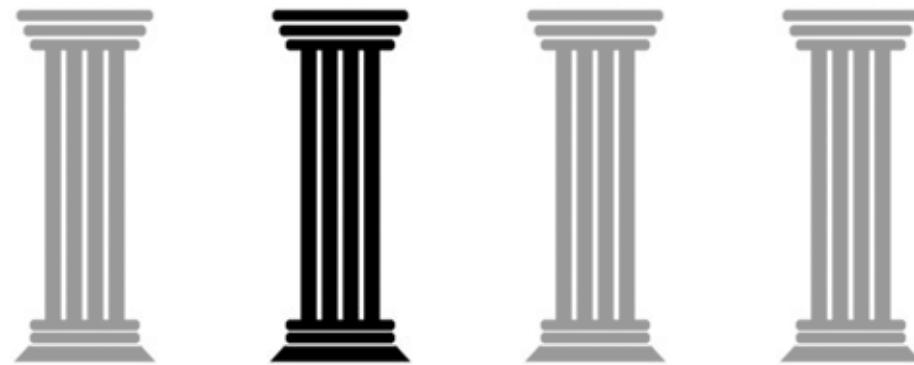








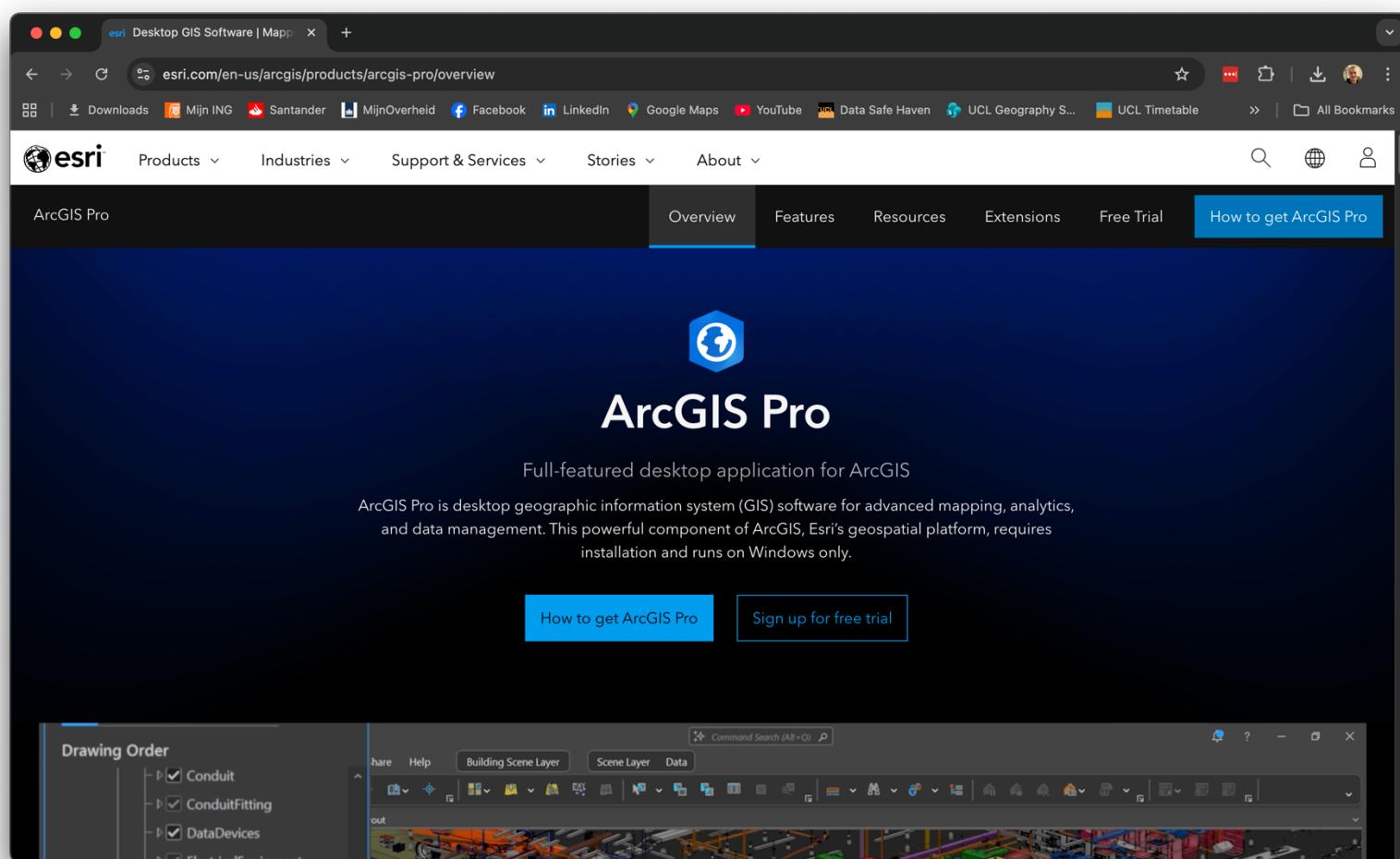
# Geographic Information Systems



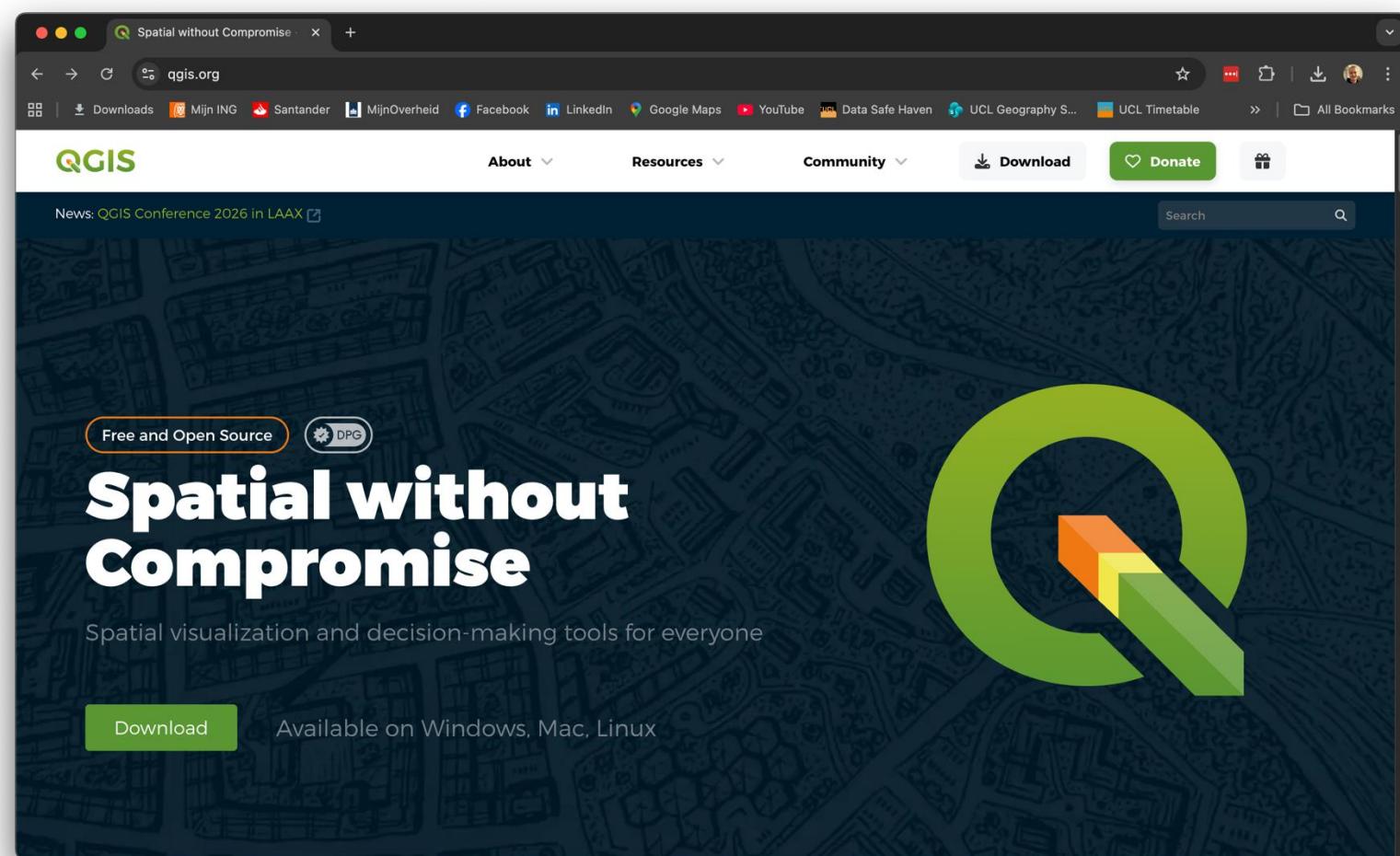
# Geographic Information Systems

- GI systems help us to manage spatial data: organisation, storage, access and retrieval, and manipulation.
- Dedicated GIS software: ArcGIS Pro, QGIS, GeoDa
- Software that has GIS functionality: R, Python

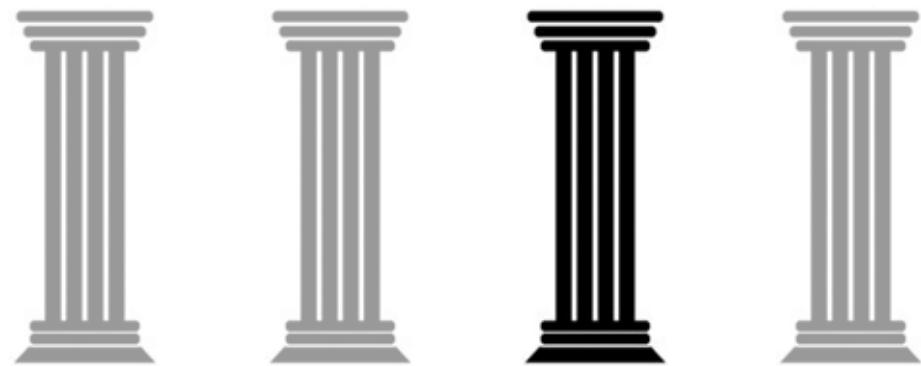
# Geographic Information Systems



# Geographic Information Systems



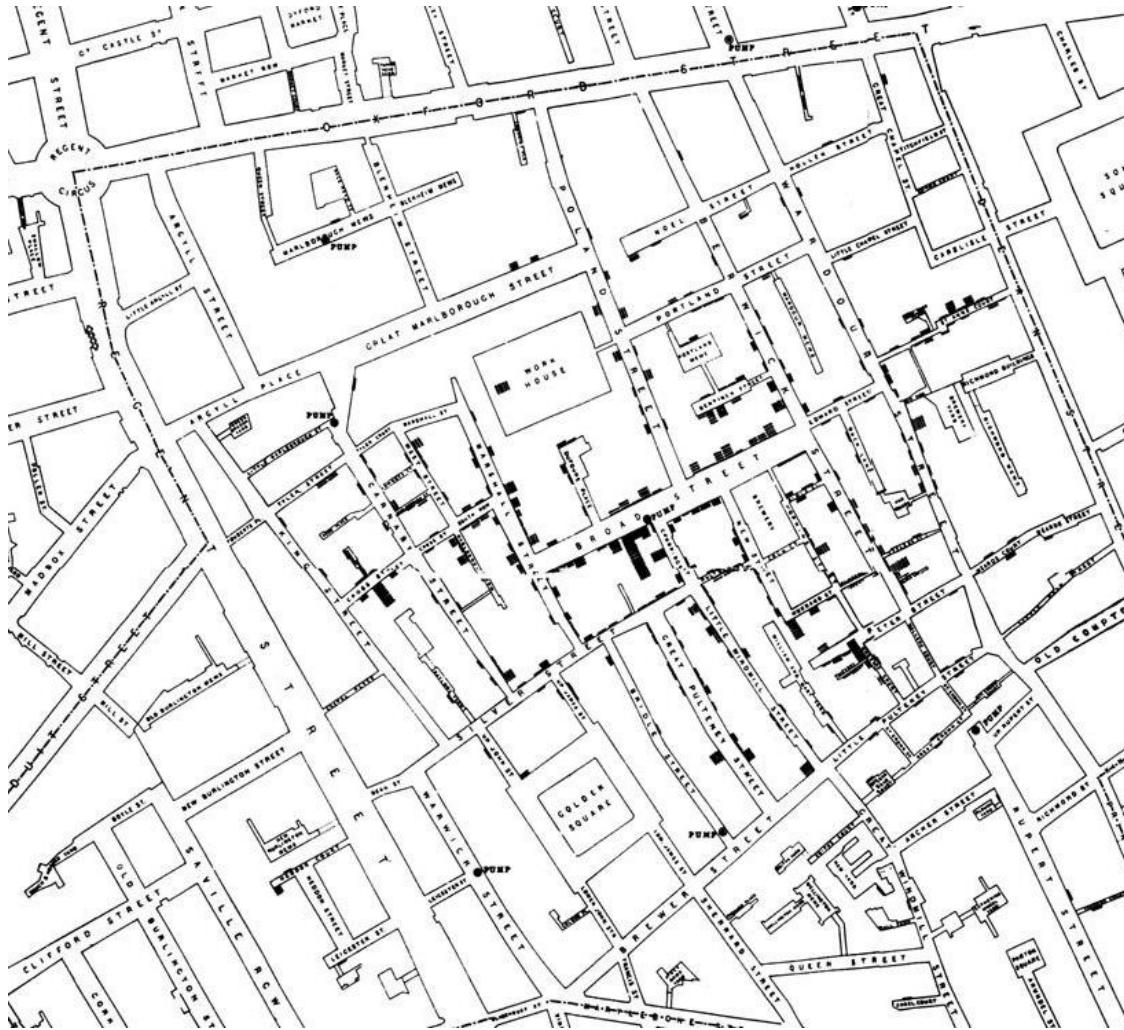
## Spatial analysis



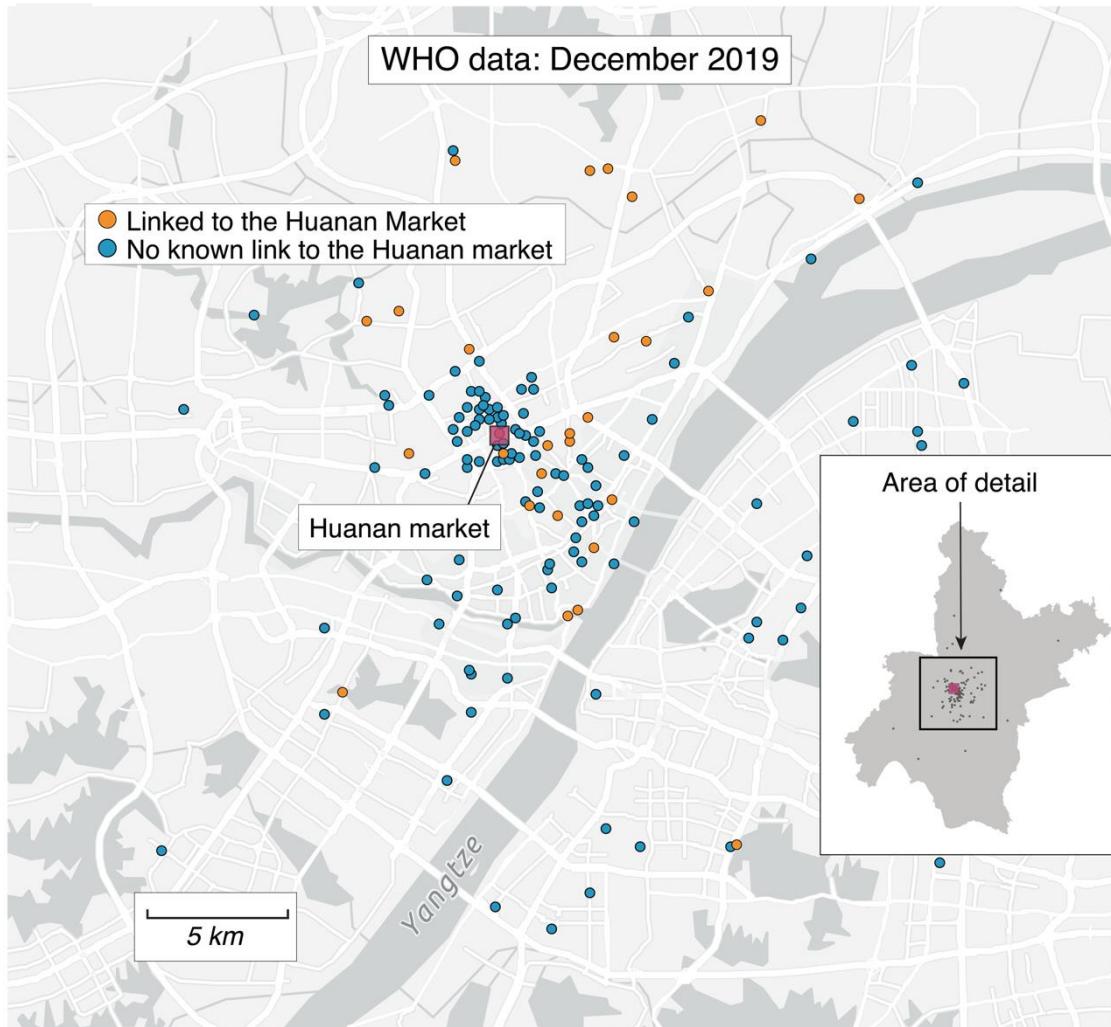
# Spatial analysis

- The theory, principles, and techniques that enable analysis of spatial data to discover spatial patterns, processes and relationships.
- Spatial analysis seeks to enhance our understanding of the world by transforming data into meaningful information, quantifying elements such as distributions and spatial processes.

# Spatial analysis

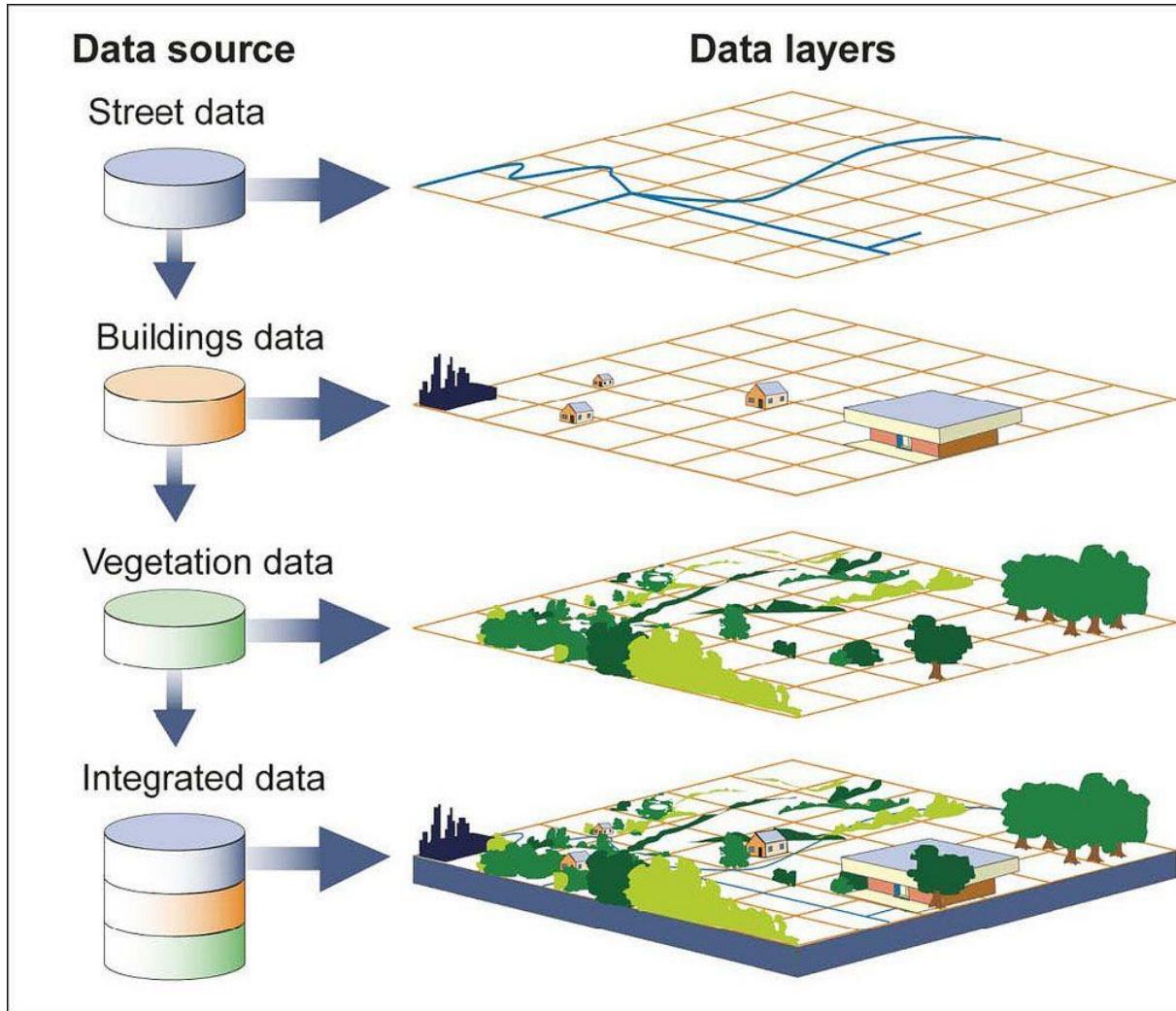


# Spatial analysis



Worobey *et al.* 2022

# Spatial analysis



Source: GAO.

Cartography and visualisation

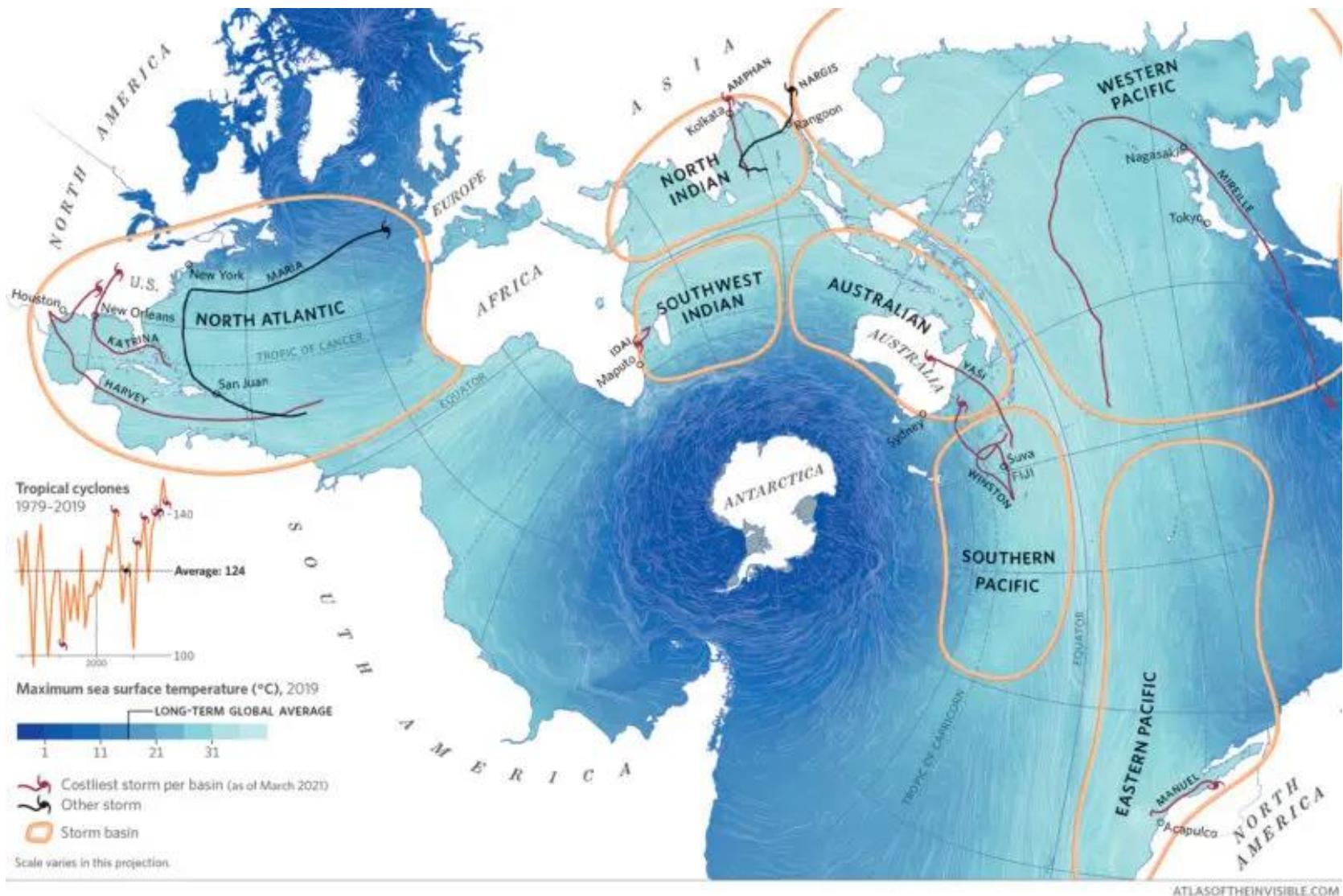


# Cartography and visualisation



Cheshire and Uberti. Atlas Of The Invisible

# Cartography and visualisation



# Geocomputation

Lots of pillars, but what then is this **Geocomputation?**

# Geocomputation

- Scientific research emphasises reproducibility, allowing others to verify results.
- Open-source and programmatic approaches to analysis are increasingly important, partially due to technological advances.
- Advances include access to larger datasets, improved information systems, data mining, AI, and enhanced visualisation techniques.
- Programming languages like R enable **reproducible** spatial analysis.

# Geocomputation

## Repeatability

The same methodology will produce the same (or nearly the same) outputs given the same inputs.

## Reproducibility

Work can be easily redone or completed by someone else.

## Collaboration

Easy to share work with others and collaborate, preferably in real-time, with others, alongside easy integration with version control.

## Scalability

Basic: Re-run work easily, adjusting variables and parameters.

Intermediate: Expand on work to include larger datasets.

Advanced: Suitable for distributed computing.

# Geocomputation

"Everyone does need to learn to code. It is no longer sufficient for a GI Scientists to just work with a standard GIS interface: menus, buttons and black boxes."

Brunsdon and Comber 2021

# Conclusion

- A science of Geographic Information is needed to help us create geographic data that can be analysed to turn it into information that can be used as evidence to provide knowledge and thus insight to our biggest – and smallest - geographic challenges and problems.
- Geocomputation emphasises working with geographic data through coding, reproducibility, and modular approaches to deliver robust and transparent analyses.

# Questions

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