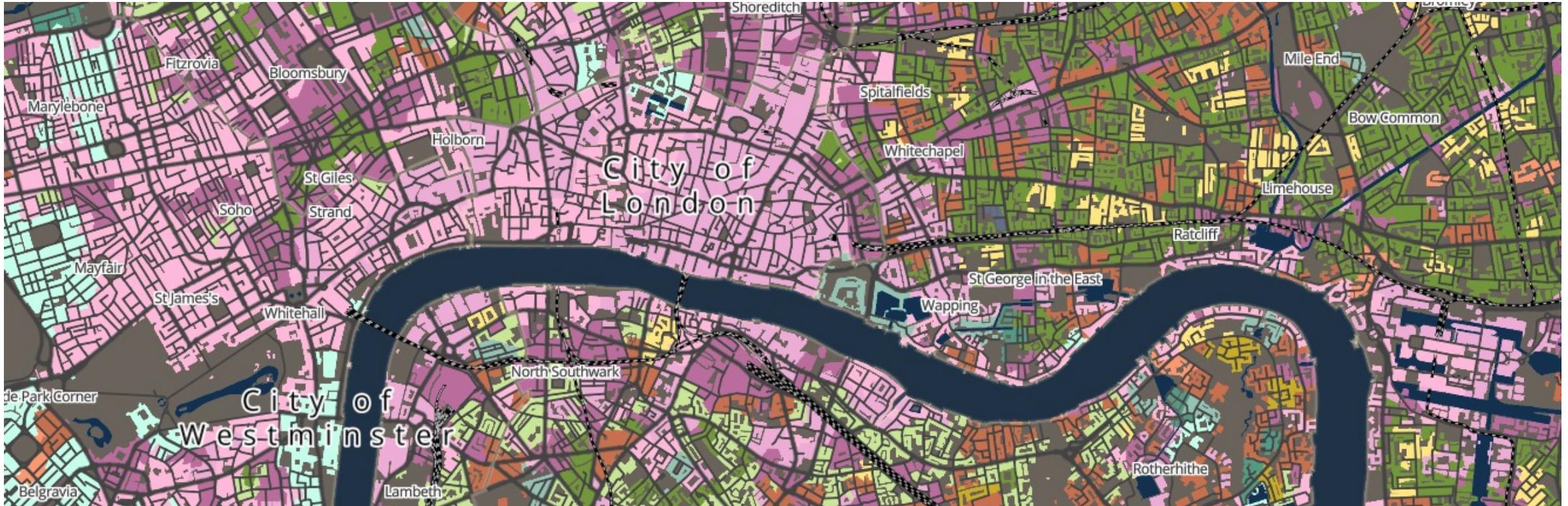


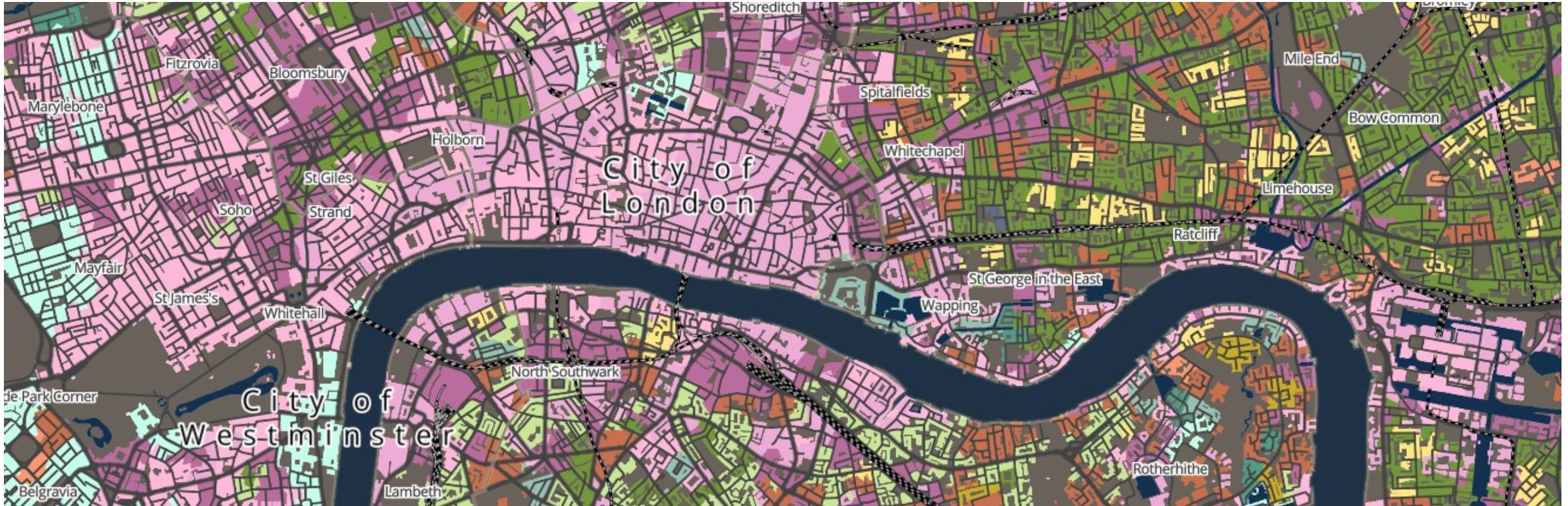
# Geocomputation

## Welcome



# Geocomputation

## Module Overview



# About this module

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

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

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

# Outline

## *Part I: Foundational Concepts*

W1 Geocomputation: An Introduction

W2 GIScience and GIS software

W3 Cartography and Visualisation



QGIS

W4 Programming for Data Analysis

W5 Programming for Spatial Analysis



R

# Outline

## *Part II: Core Spatial Analysis*

W6 Geometric Operations and Spatial Queries

W7 Point Pattern Analysis

W8 Spatial Autocorrelation



R

## *Part III: Advanced Spatial Analysis*

W9 Rasters, Zonal Statistics and Interpolation

W10 Transport Network Analysis



R

# Module structure

- This module consists of ten lectures (Monday afternoon) and ten supervised computer tutorials (Group A: Monday afternoon, Group B: Tuesday morning).
- Each week will have its own reading list. *Reading lists and instructions for the computer tutorial get published on the dedicated GEOG0030 Geocomputation workbook. The link to this workbook is available on Moodle.*
- Several additional optional **Geocomputation Help** sessions are scheduled: Week 05, 08, 09, 10 and the week prior to assignment submission (BYOC).

# Workbook

## GEOG 0030

Module overview

- Welcome

Foundational Concepts

- 1 Geocomputation: An Introduction
- 2 GIScience and GIS software
- 3 Cartography and Visualisation
- 4 Programming for Data Analysis
- 5 Programming for Spatial Analysis

Core Spatial Analysis

- 6 Analysing Spatial Patterns I: Geometric Operations and Spatial Queries
- 7 Analysing Spatial Patterns II: Point Pattern Analysis
- 8 Analysing Spatial Patterns III: Spatial Autocorrelation

## GEOG0030 Geocomputation 2023-2024



### Welcome

Welcome to **Geocomputation**. This module will introduce you both to the principles of spatial analysis as well as provide you with a comprehensive introduction to the use of programming. Over the next ten weeks, you will learn about the theory, methods and tools of spatial analysis through relevant case studies. We will start by using QGIS before moving to the R programming language. You will learn how to find, manage and clean spatial, demographic and socioeconomic datasets, and then analyse them using core spatial analysis techniques.

On this page

- GEOG0030 Geocomputation 2023-2024
- Welcome
- Moodle
- Module overview
- Troubleshooting
- Acknowledgements
- Major updates

Report an issue

# Workbook

The screenshot shows a web browser window with the title "GEOG 0030" and the URL "jtvdijk.github.io/GEOG0030/01-introduction.html". The page content is organized into sections:

- 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. [\[Link\]](#)
    - Singleton, A. and Arribas-Bel, D. 2019. Geographic Data Science. *Geographical Analysis* 53(1): 61-75. [\[Link\]](#)
  - Suggested readings**
    - Miller, H. and Goodchild, M. 2015. Data-driven geography. *GeoJournal* 80: 449–461. [\[Link\]](#)
    - Goodchild, M. 2009. Geographic information systems and science: Today and tomorrow. *Annals of GIS* 15(1): 3-9. [\[Link\]](#)
    - Worobey, M. et al. 2022. The Huanan Seafood Wholesale Market in Wuhan was the early epicenter of the COVID-19 pandemic. *Science* 377(6609): 951-959. [\[Link\]](#)
- On this page**
  - 1 Geocomputation: An Introduction
  - 1.1 Lecture slides
  - 1.2 Reading list**
  - 1.3 Getting started
  - 1.4 Software
  - 1.5 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 [Lecturecast](#).
- During the computer tutorials you are expected to work independently through the assignments in the workbook – with the opportunity to ask questions.
- Links to more advanced content: W04 – W10.

# 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 Mondays 11h00-13h00 [in person] and Wednesdays 10h00-11h00 [online]. 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 22 2024.
- Specific Coursework guidance on Moodle (including examples with indicative grades), general introduction in W06.
- Exam Assessment (40%): The second assessment will take the form of a written two-hour Exam.

# Troubleshooting

Spatial analysis can yield fascinating insights into geographical relationships. However, at times it can be difficult to work with - particularly when we combine this with learning how to program at the same time. You are likely to get lots of [error messages](#) and have software crash, you will end up with bugs in your code that are difficult to find, and you may spend a whole day trying to track down a single data set.

**SAY "IT WORKS IN MY  
MACHINE"**

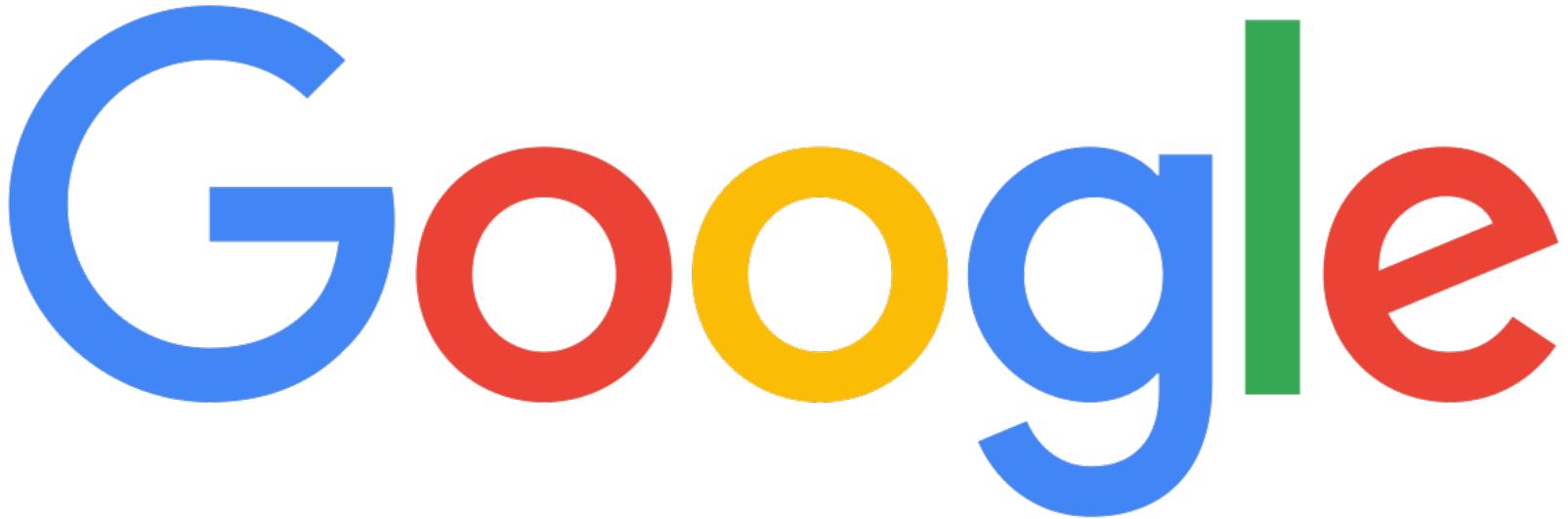
**ONE MORE TIME**

MemesHappen

# Troubleshooting

- Ask a question at the end of a plenary lecture.
- Ask a question during a computer tutorial.
- Attend the scheduled optional **Geocomputation Help** sessions in Week 05, 08, 09, 10 and the week prior to assignment submission (BYOC).

# Troubleshooting



# Questions

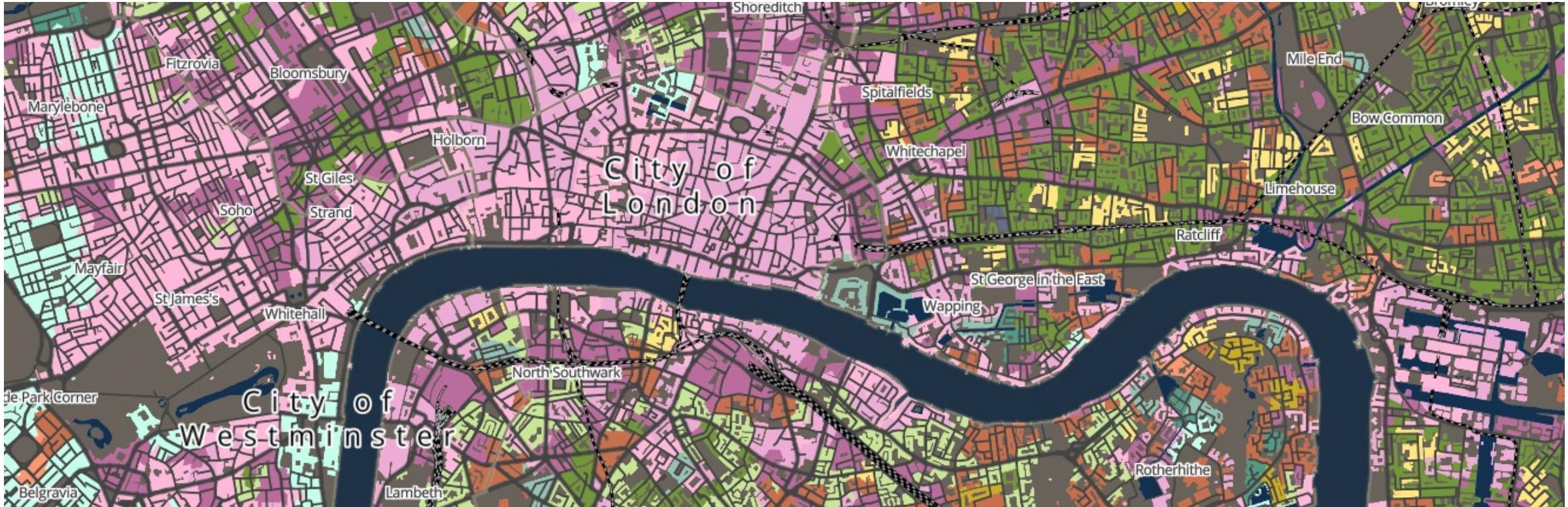
Justin van Dijk

j.t.vandijk@ucl.ac.uk



# Geocomputation

## Geocomputation: An Introduction



# Where are we at?

## *Part I: Foundational Concepts*

W1      **Geocomputation: An Introduction**

W2      GIScience and GIS software

W3      Cartography and Visualisation



QGIS

W4      Programming for Data Analysis



R

W5      Programming for Spatial Analysis

# This week

- What is GIScience?
- What is Geocomputation?

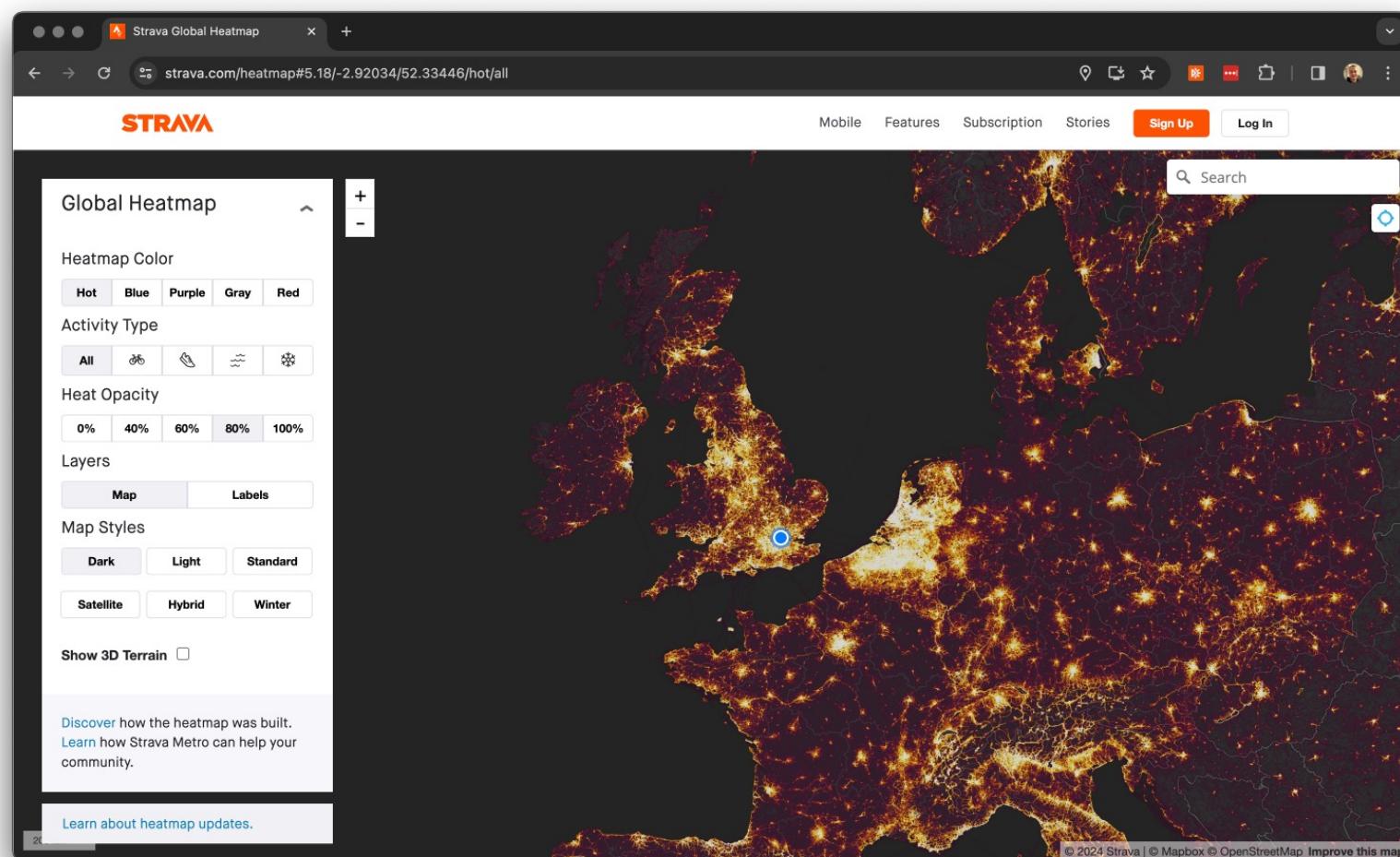
# Before we start

- Go to [www.menti.com](http://www.menti.com)
- Use code: 7696 2366

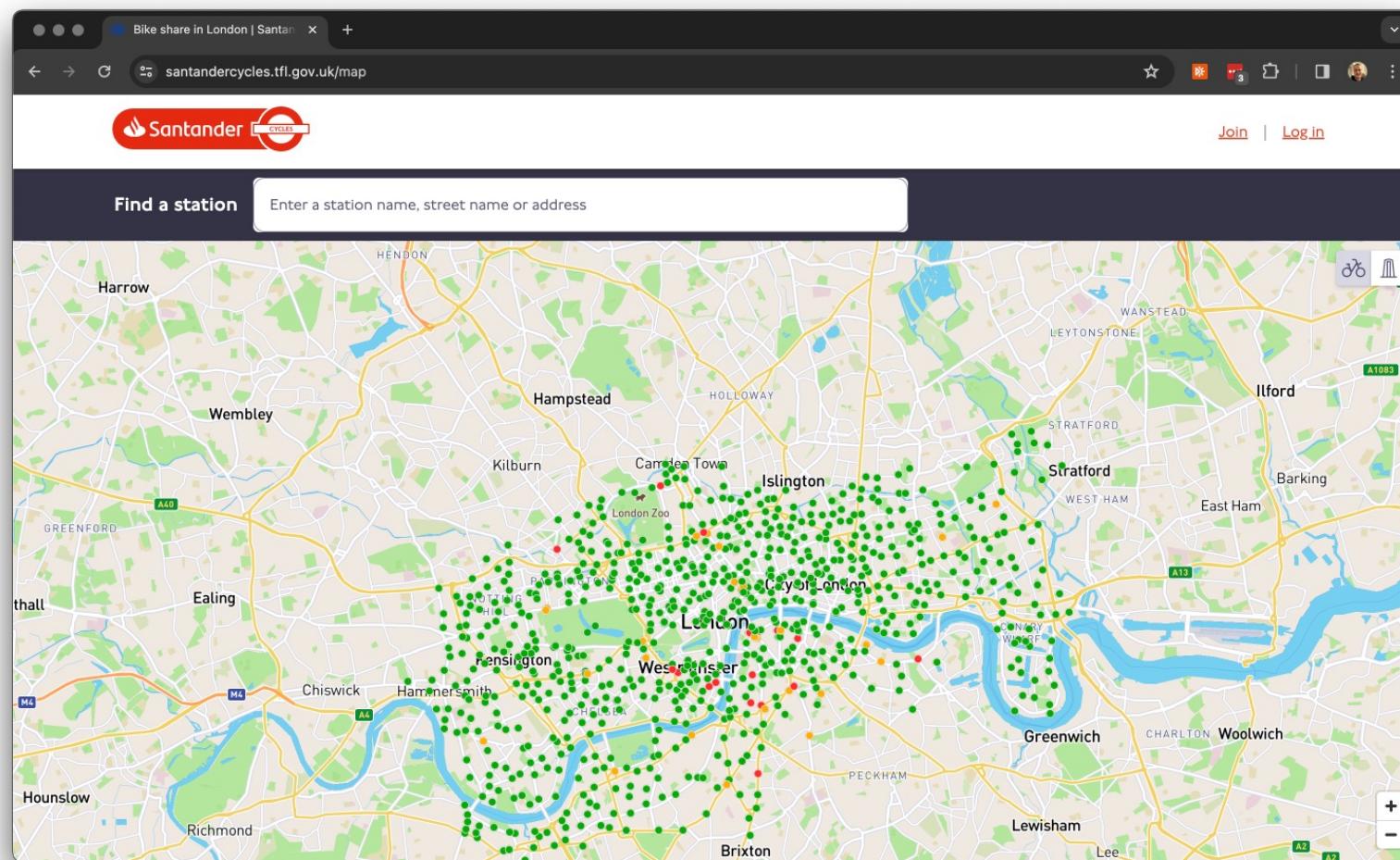
# GIScience

- 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?

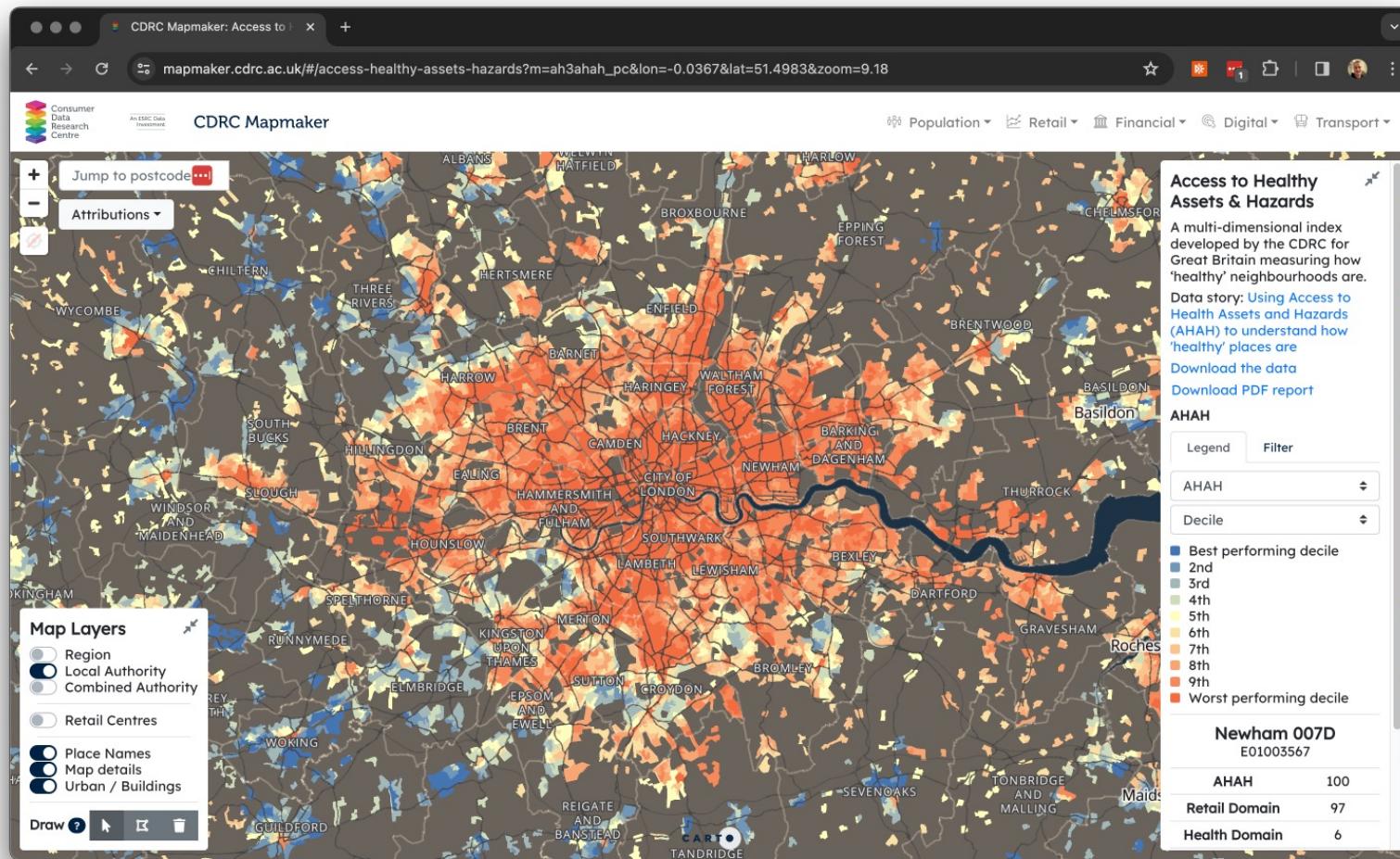
# Running in Western-Europe



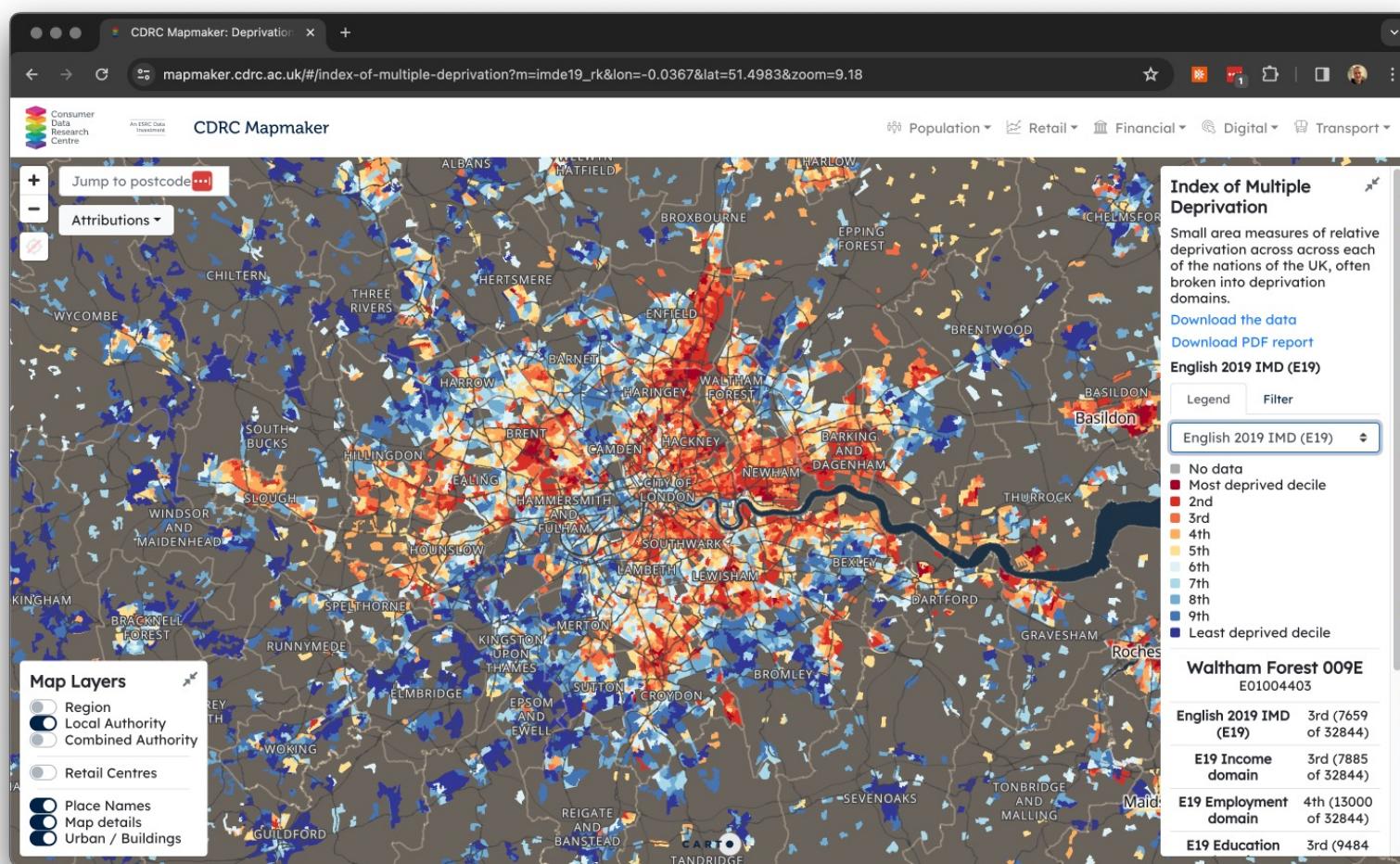
# Bicycle docking stations in London



# Access to Healthy Assets and Hazards in the UK



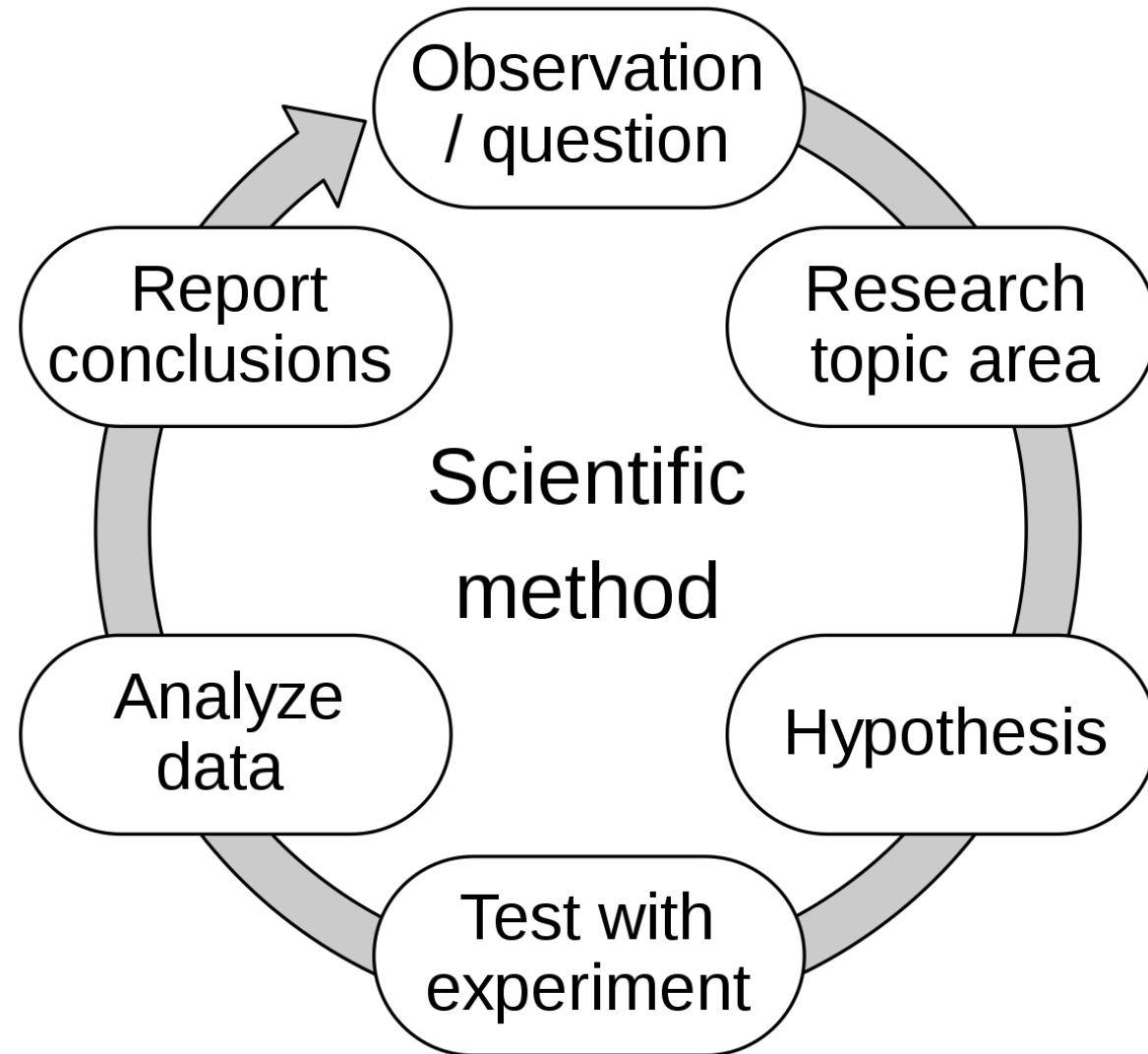
# Index of Multiple Deprivation in England



# The Universal Visitation Law of Human Mobility



# Scientific method



# Scientific method

- Spatial information requires methods and tools that can deal with spatial properties.
- To do this we need to be able to:
  - Collect data that represents our phenomena of study
  - Store this data in a way that we can access it and interact with it
  - Conduct analyses on our data
  - Present our 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 accurate and rigorous analysis of spatial data to discover spatial patterns, processes and relationships (including taking into account the 'special' properties of spatial phenomena).

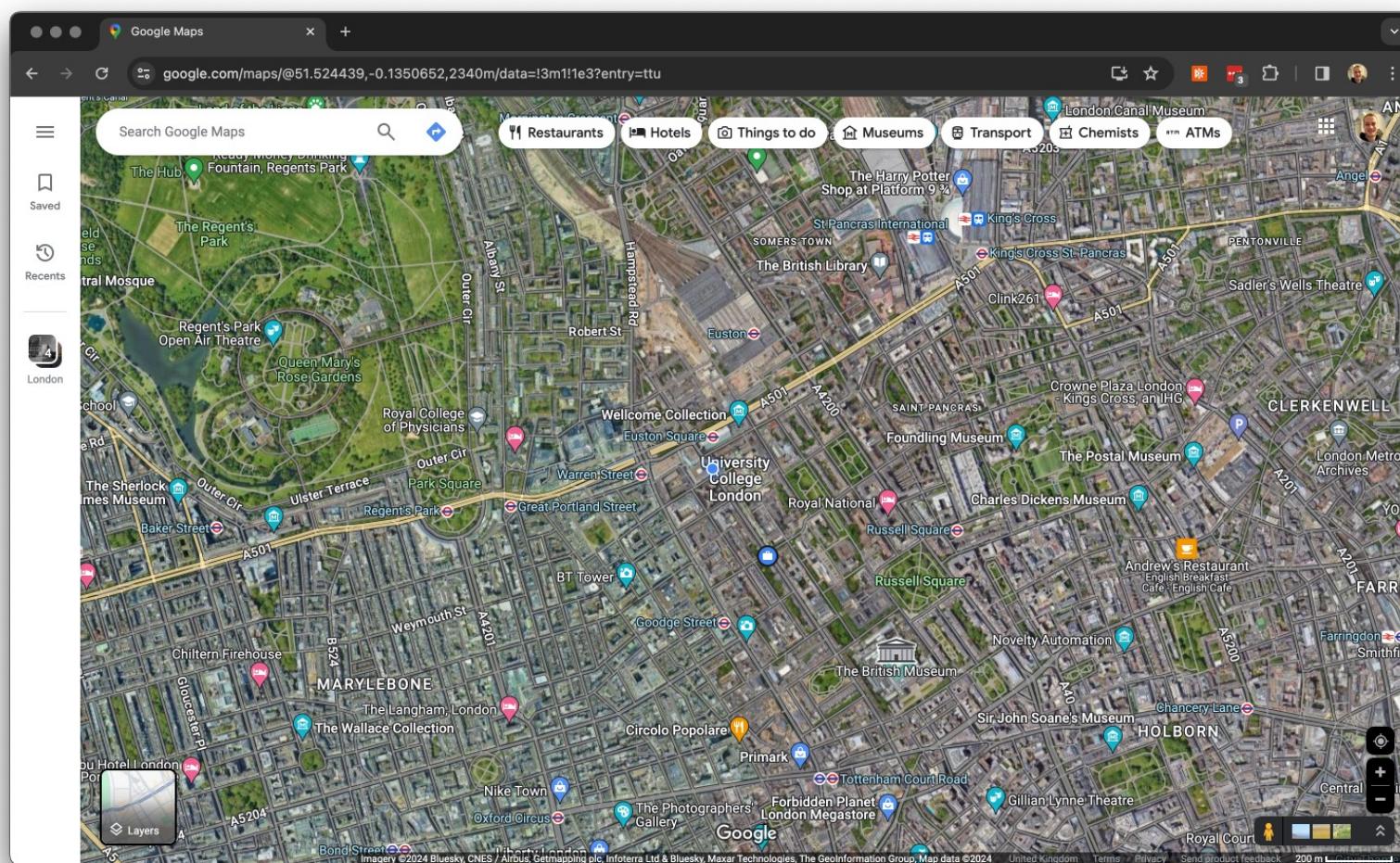
## *(4) Cartography and visualisation:*

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

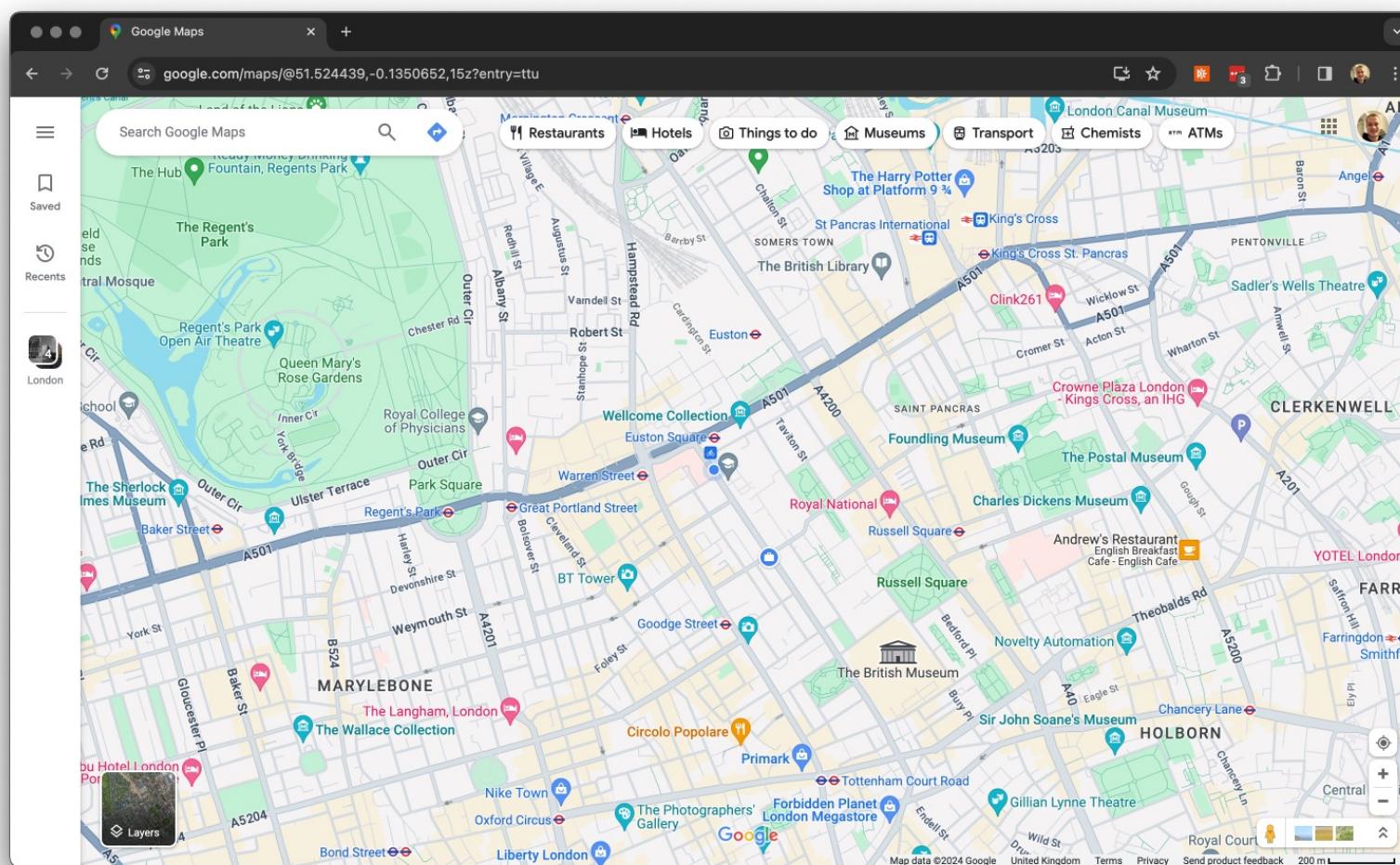
## Spatial modelling and digital representation



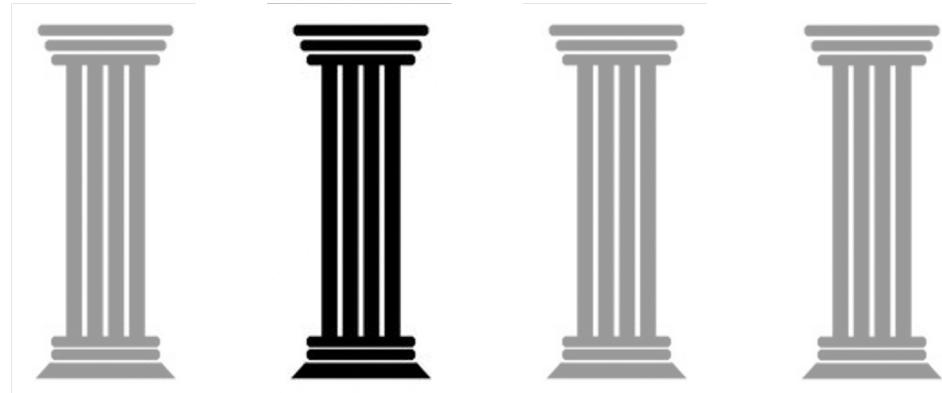
# Spatial modelling and digital representation



# Spatial modelling and digital representation



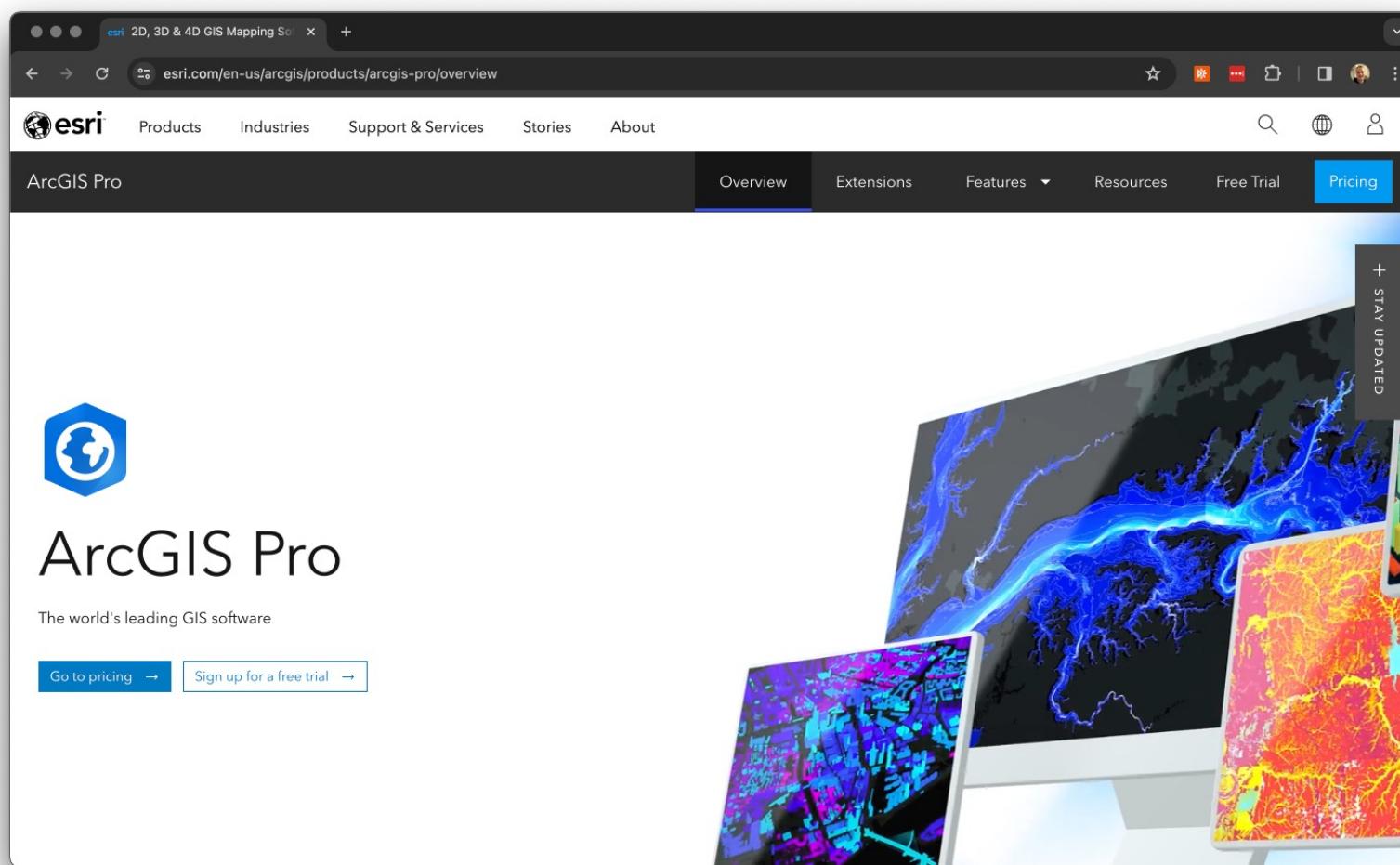
# Geographic Information Systems



# Geographic Information Systems

- GI systems help us to manage spatial data: organisation, storage, access and retrieval, and manipulation.
- We have increasingly changing expectations from these software interfaces and our demands from GI science and systems.
- Dedicated GIS software: ArcGIS, QGIS, GeoDa
- Software that has GIS functionality: R, Python

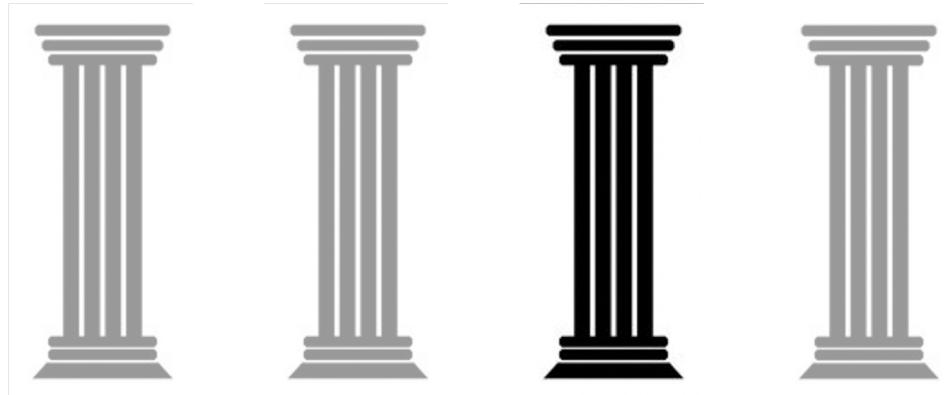
# Geographic Information Systems



# Geographic Information Systems



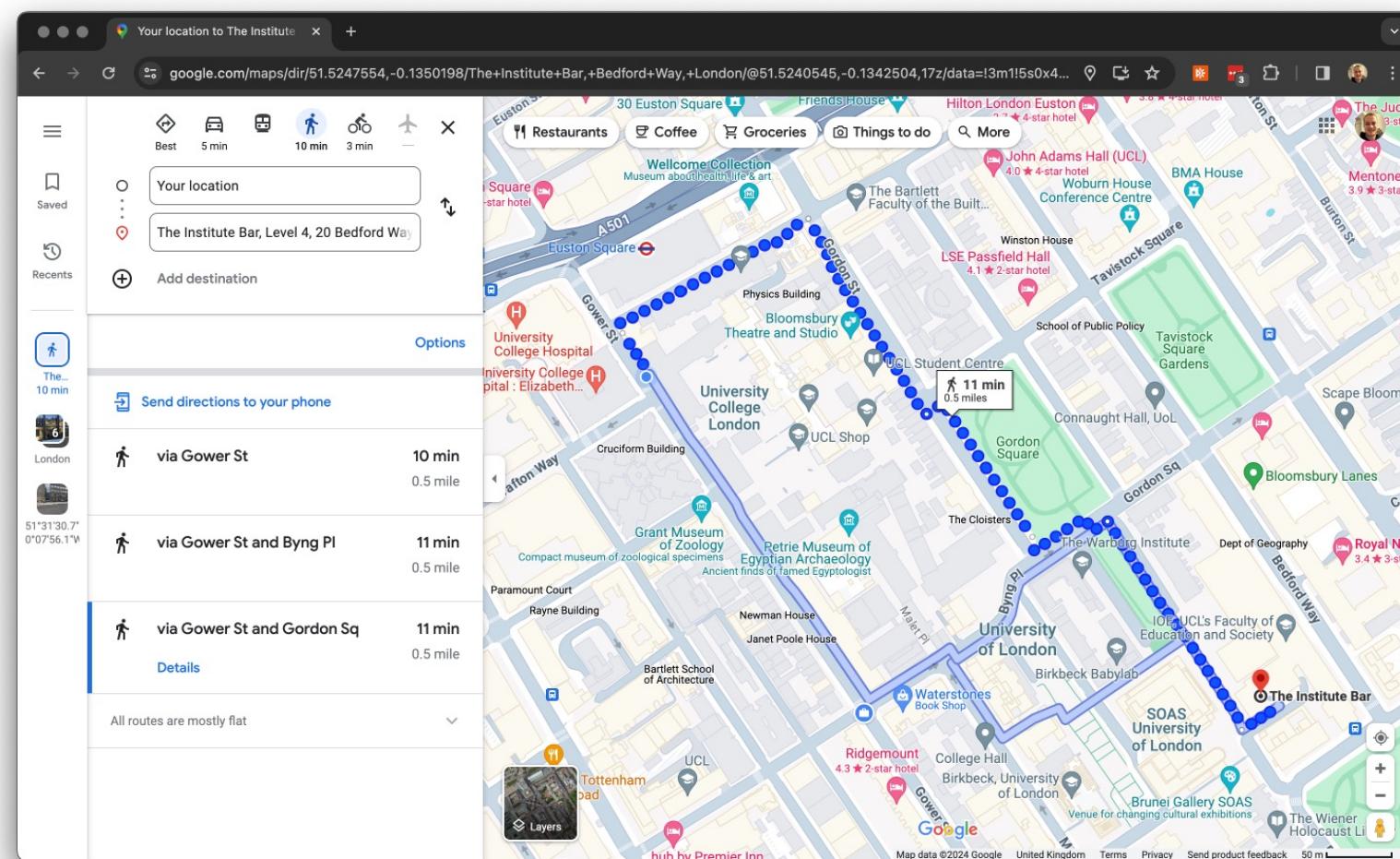
## Spatial analysis



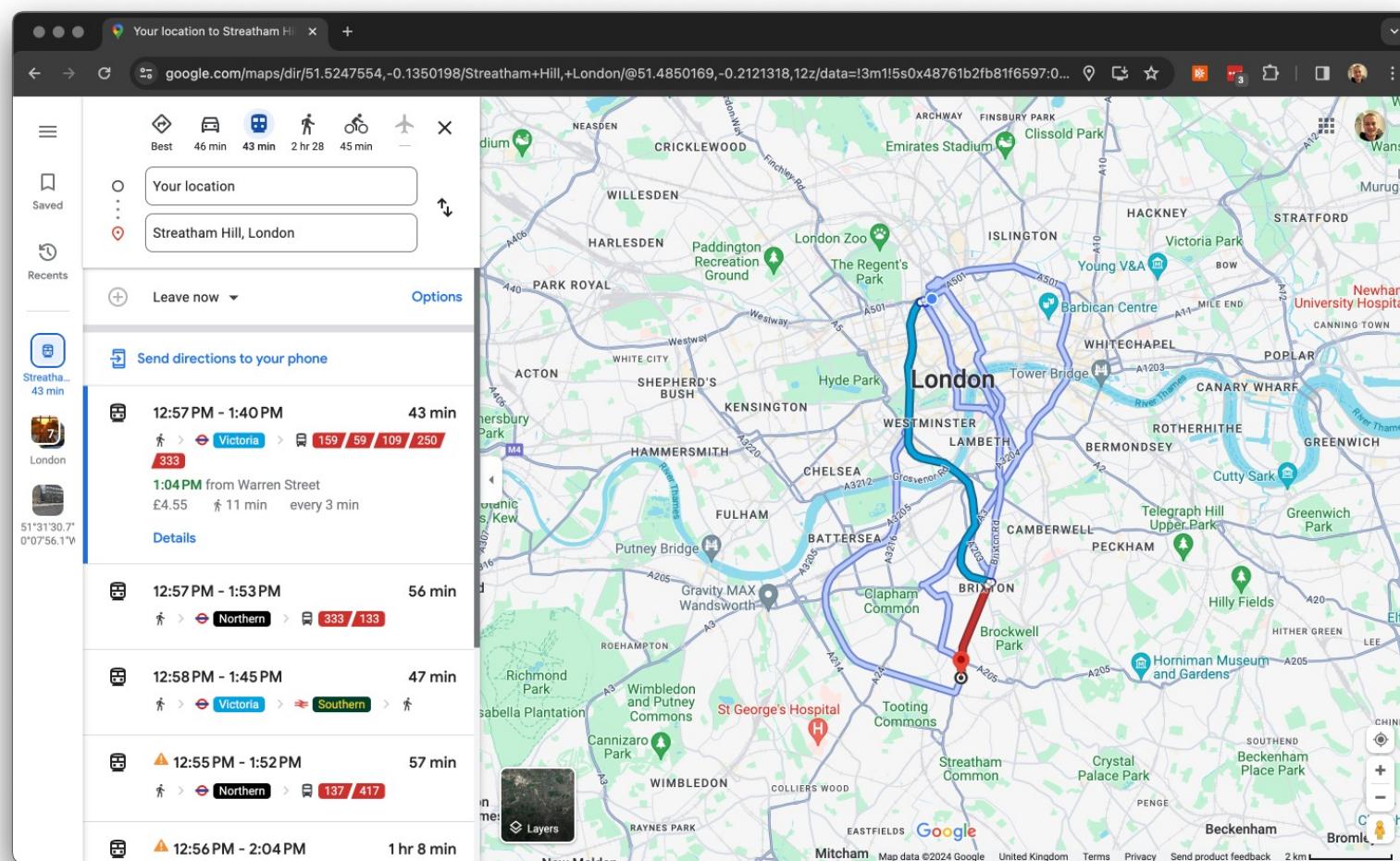
# Spatial analysis

- The theory, principles, and techniques that enable accurate and rigorous analysis of spatial data to discover spatial patterns, processes and relationships (including taking into account the 'special' properties of spatial phenomena).
- The application of formal techniques to analyse specific phenomena or entities, that are represented by spatial data, using their topological, geometric or geographic properties.

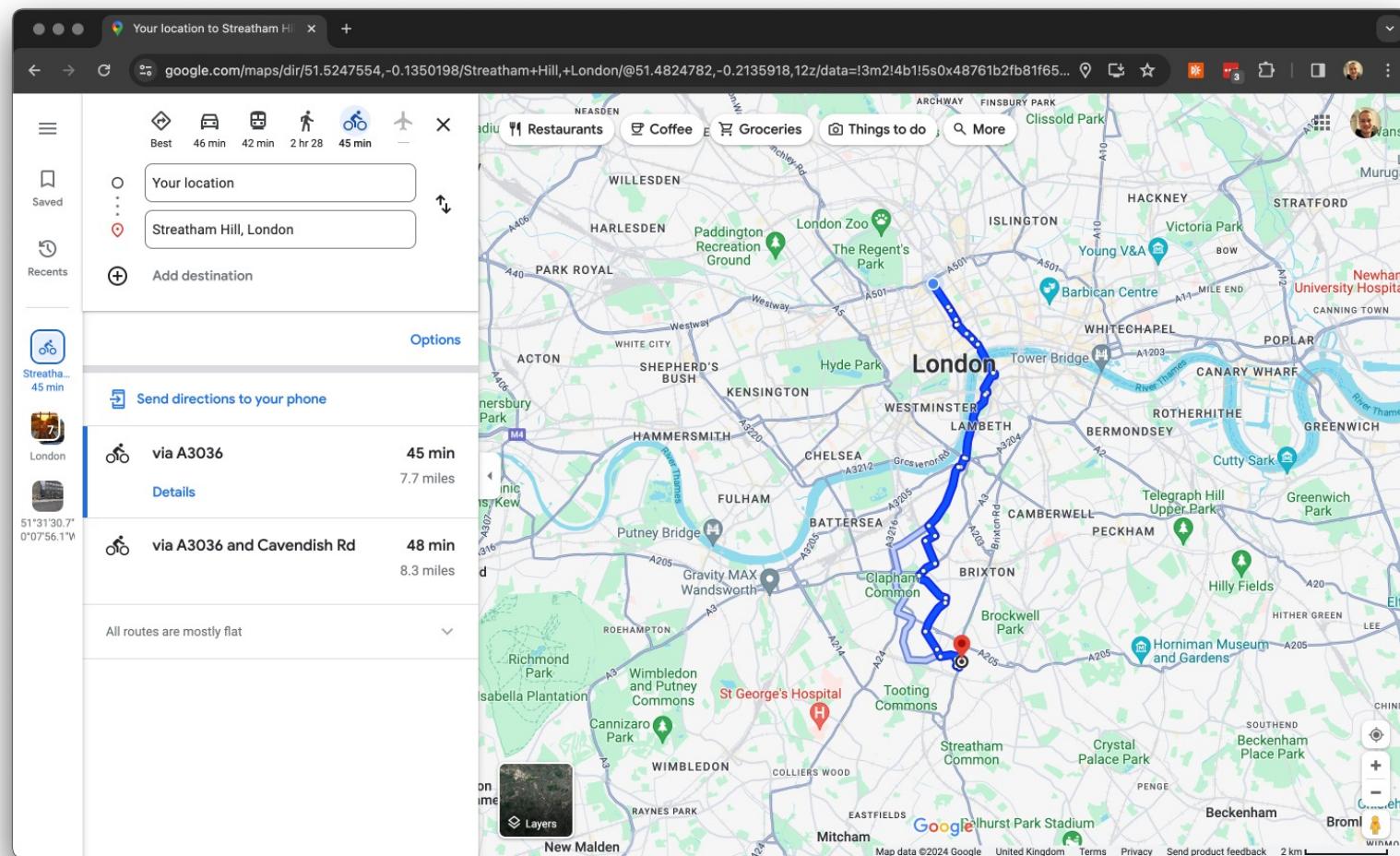
# Spatial analysis



# Spatial analysis



# Spatial analysis

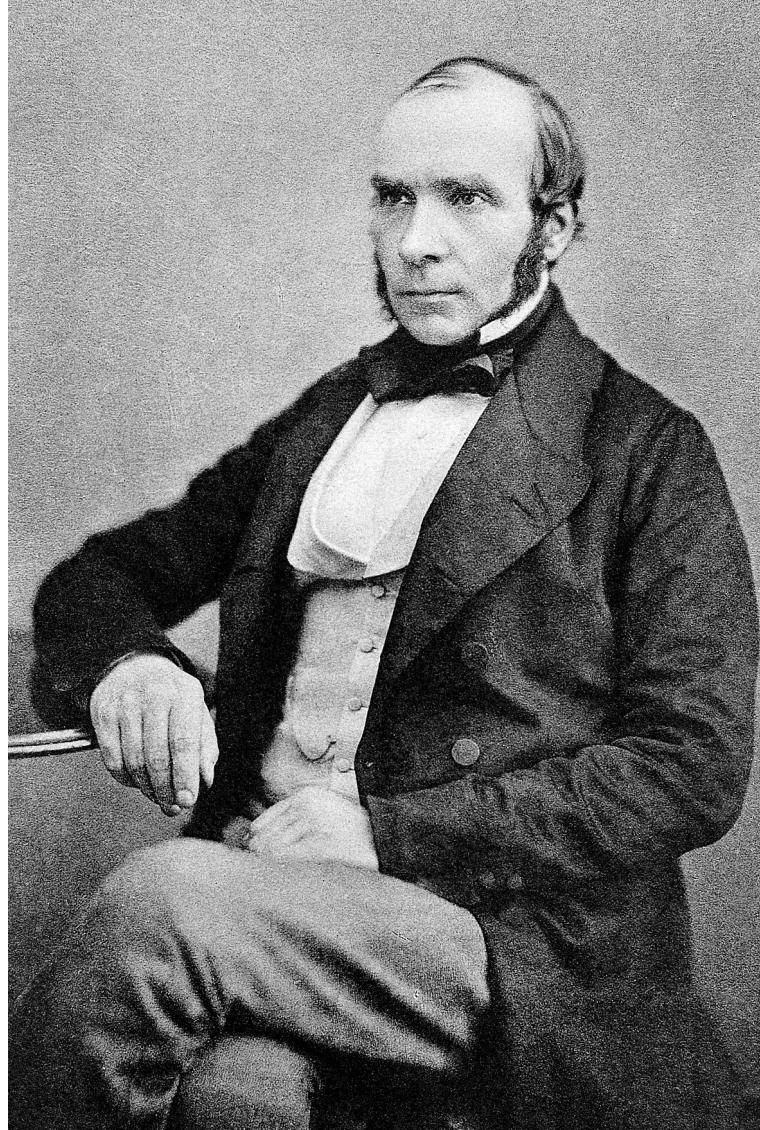


# Spatial analysis

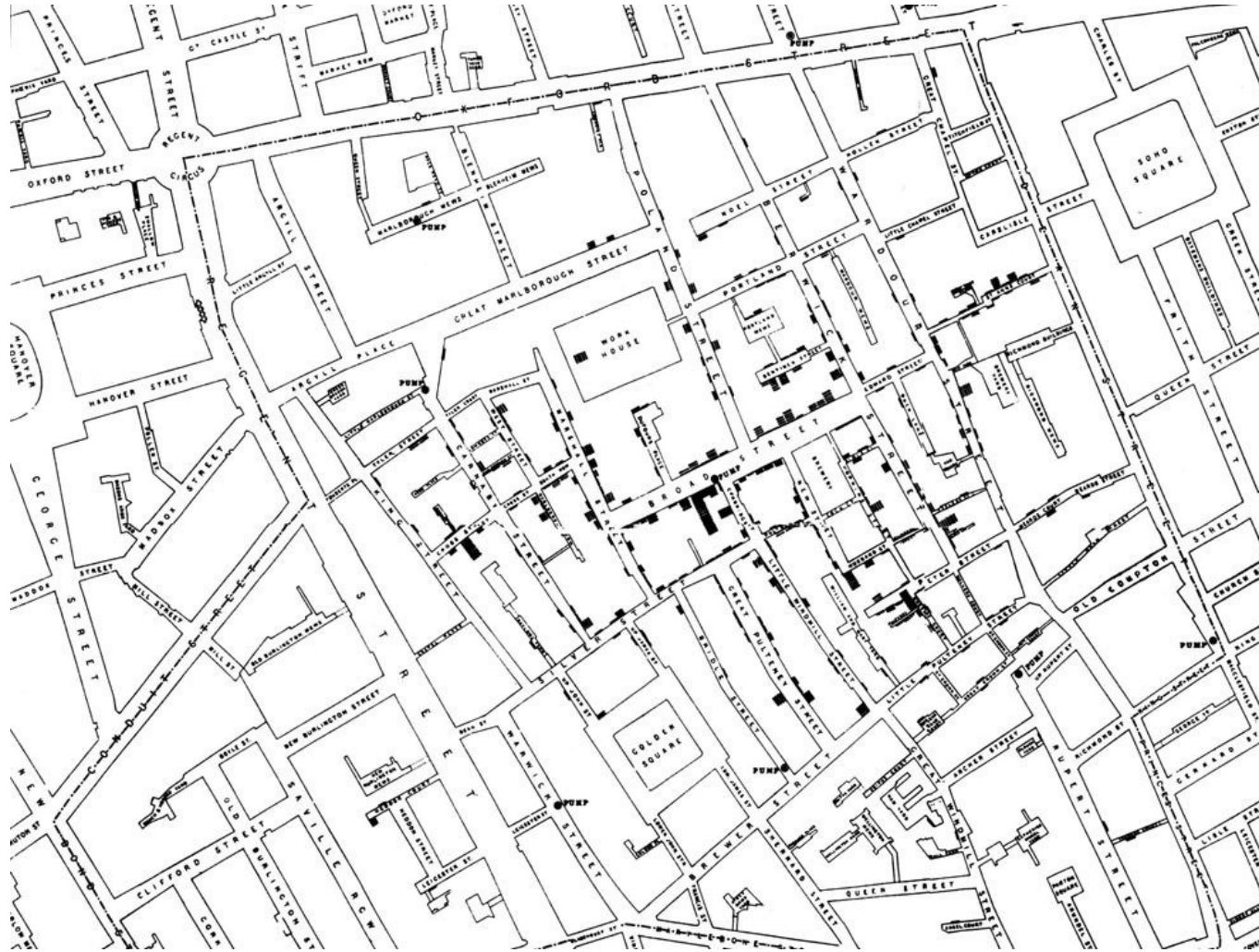
Spatial analysis looks to provide knowledge on the world by transforming data into information by quantifying “things” like distributions and spatial processes.

This quantification is made possible by a variety of techniques that are all underpinned by key laws of geography and spatial principles and properties.

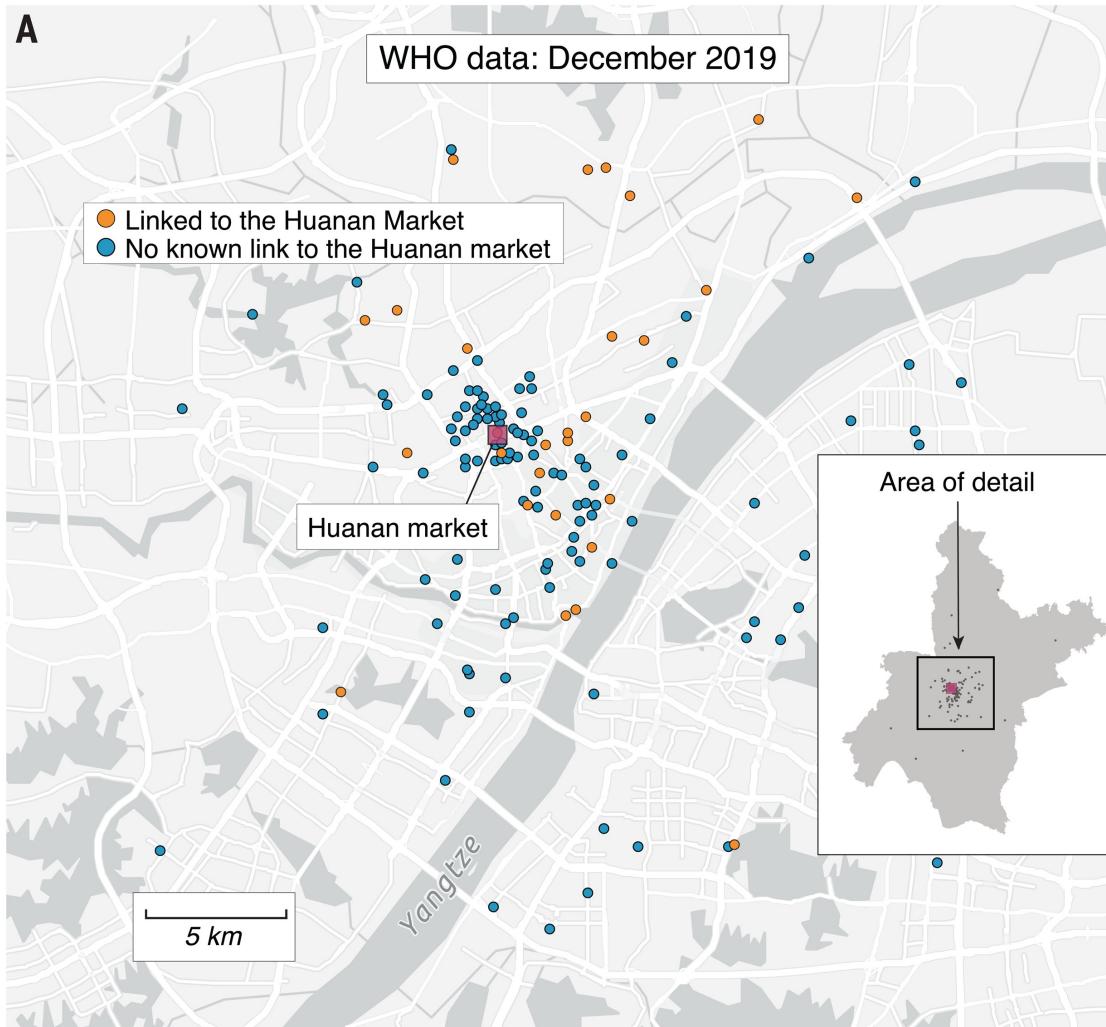
# Spatial analysis



# Spatial analysis



# Spatial analysis

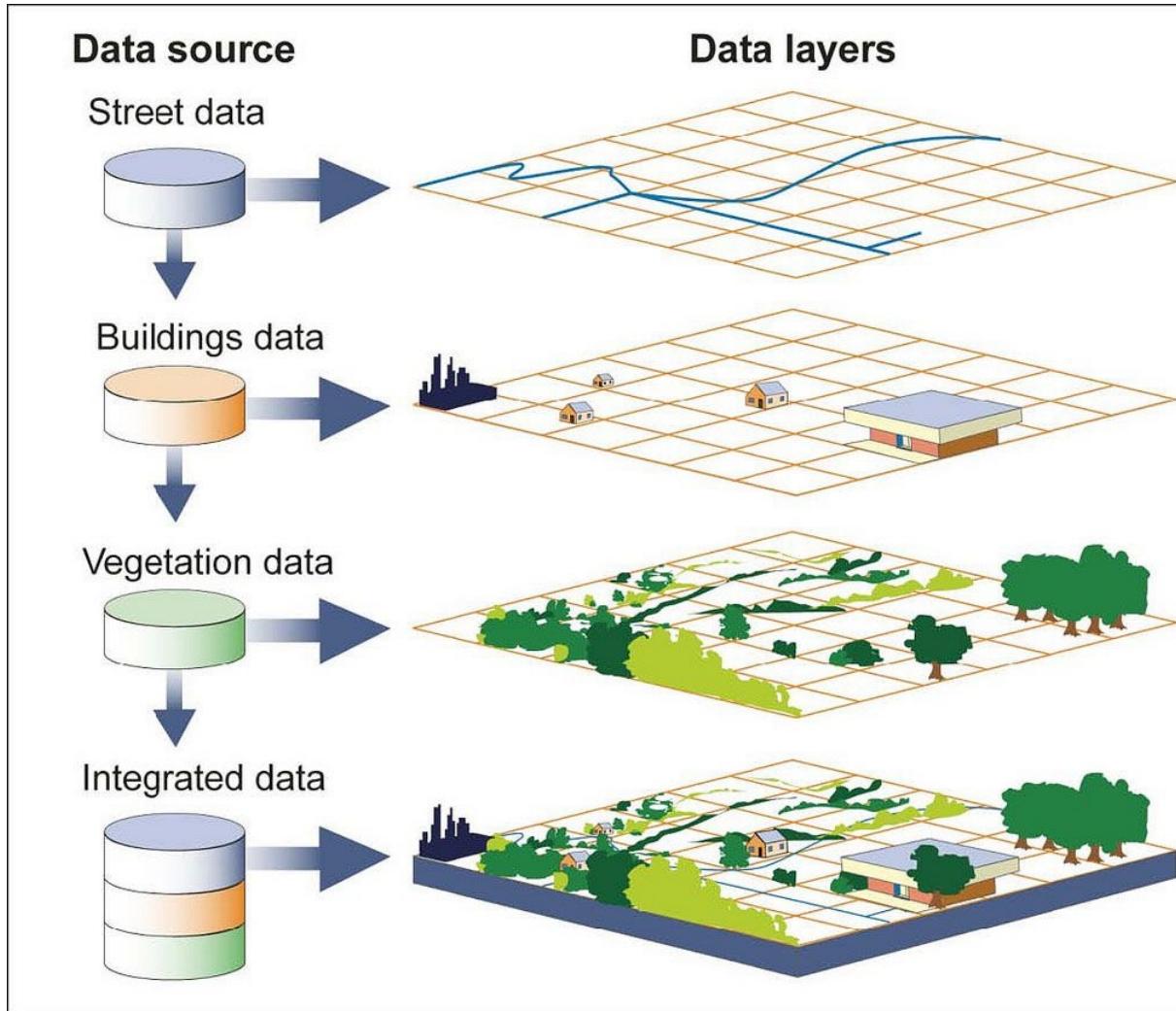


Worobey *et al.* 2022

# Spatial analysis

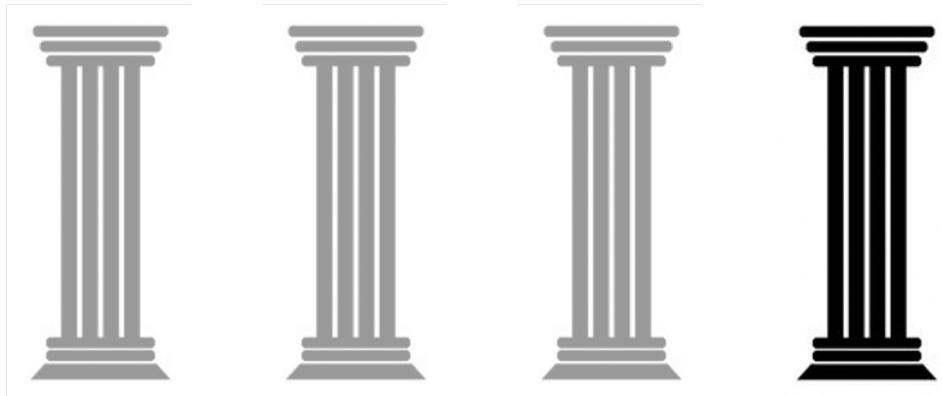
Ultimately, the purpose of spatial analysis is to seek explanations for patterns of human behaviour through its spatial expression in terms of mathematics and geometry in both geographic and non-geographic spaces.

# Spatial analysis



Source: GAO.

# Cartography and visualisation



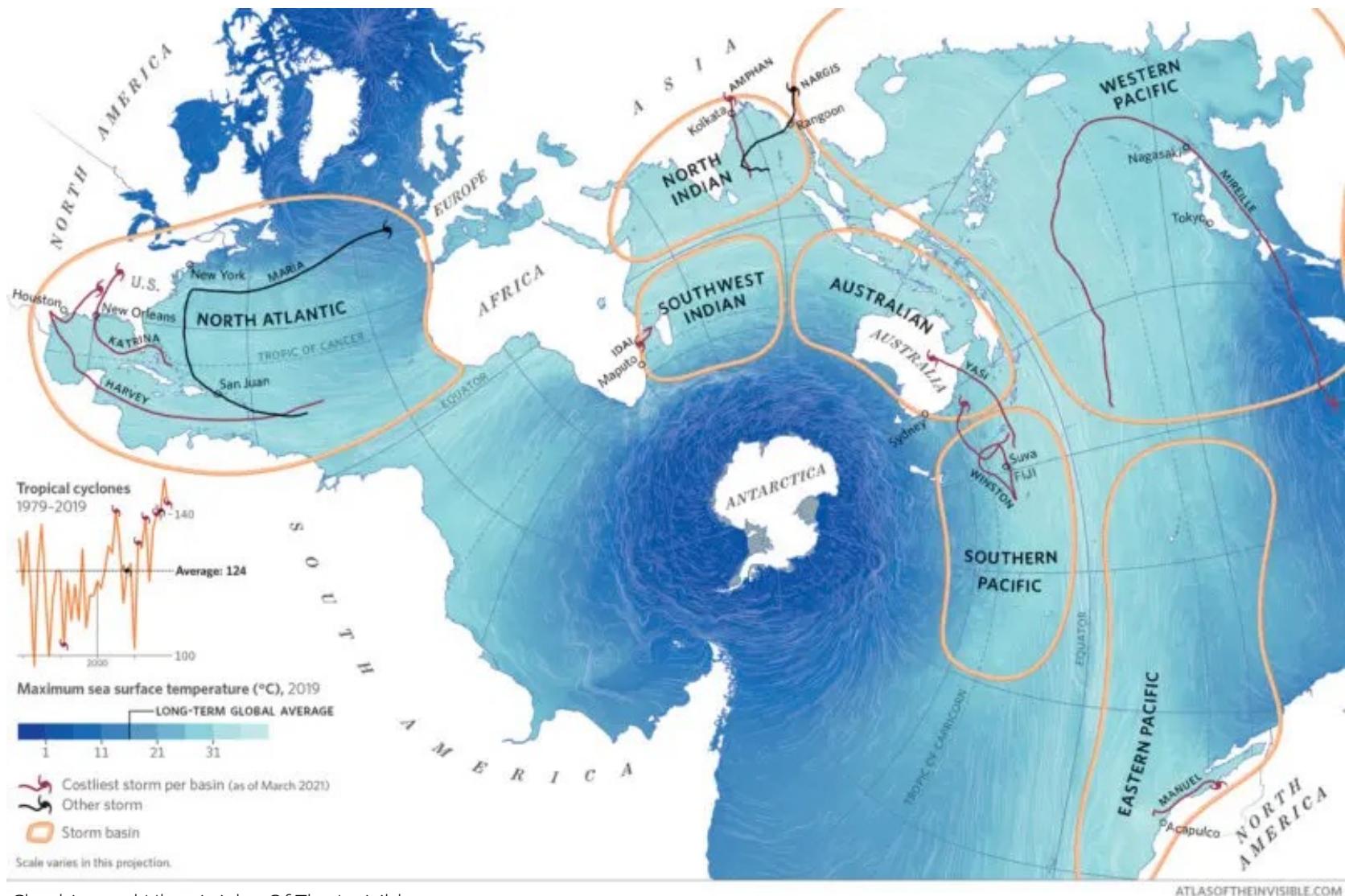
# Cartography and visualisation



Cheshire and Uberti. Atlas Of The Invisible

ATLASOFTHEINVISIBLE.COM

# Cartography and visualisation



# Geocomputation

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

# Geocomputation

"Spatial analysis is currently entering a period of rapid change leading to what is termed intelligent spatial analysis (sometimes referred to as Geocomputation). The driving forces are a combination of huge amounts of digital spatial data from the GIS data revolution (with 100,000 to millions of observations), the availability of attractive soft computing tools, the rapid growth in computational power, and the new emphasis on exploratory data analysis and modeling."

Fischer 2001

# Geocomputation

- An increasingly important part of scientific research is that it can be easily repeated and reproduced by those not working on the project, e.g. to verify your results.
- Research is increasingly prioritising open-source and, preferably, programmatical approaches to analysis.
- We also now have: more and bigger data, more advanced information systems, data mining and artificial intelligence, better visualisation techniques and capabilities.
- Using programming languages, like R, to conduct **reproducible spatial analysis**.

# 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 2020

# 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.
- Working with geographic data in a computational way, focusing on code, reproducibility and modularity: **Geocomputation**

# Questions

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