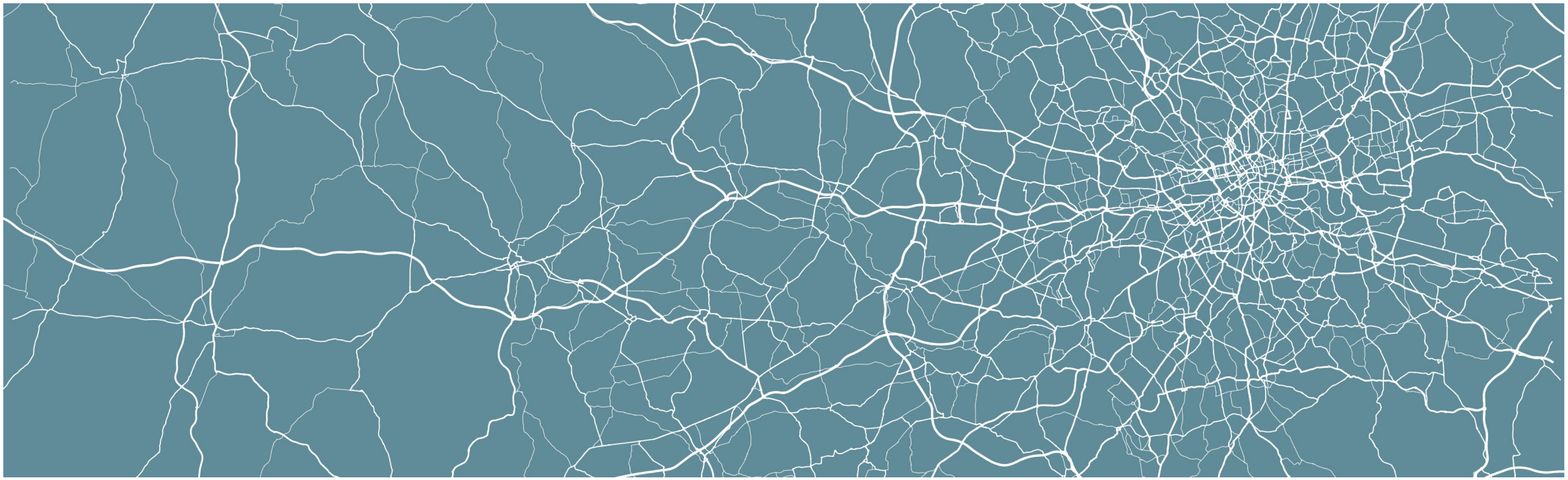
Geocomputation

Module overview



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About this Module I

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

About this Module II

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 data sets, and then analyse them using core spatial and statistical analysis techniques.

Outline I

Part I: Foundational Concepts

W1	Geocomputation: An Introduction	
W2	GIScience and GIS software	QGIS
W3	Cartography and Visualisation	
W4	Programming for Data Analysis	R
W5	Programming for Spatial Analysis	

Outline II

Part II: Core Spatial Analysis

W6 Geometric Operations and Spatial Queries
W7 Spatial Autocorrelation
W8 Point Pattern Analysis

] R

Part III: Advanced Spatial Analysis

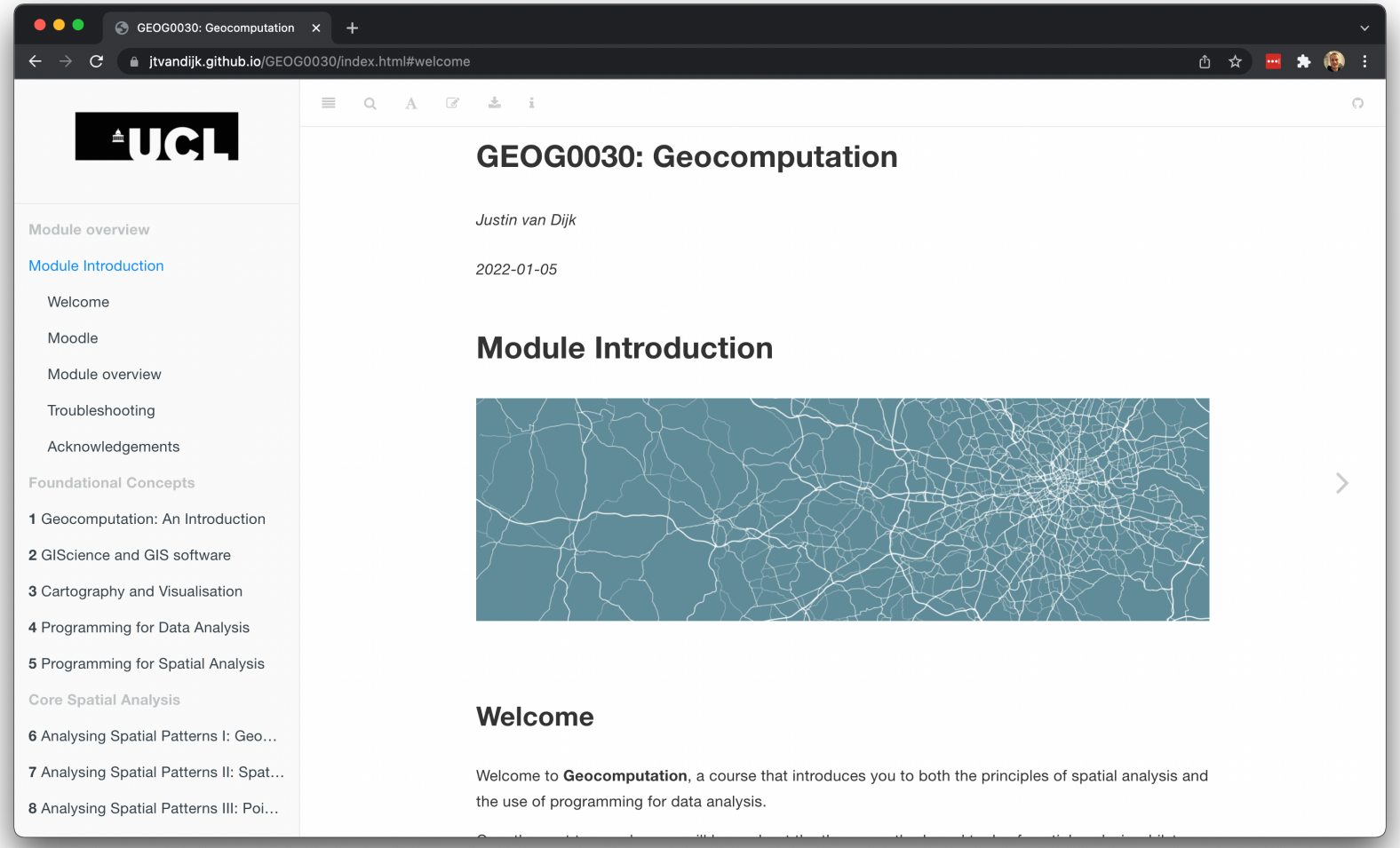
W9 Rasters, Zonal Statistics and Interpolation
W10 Transport Network Analysis

] R

Module structure

- This module consists of ten lectures (Monday afternoons) and ten supervised computer tutorials (Monday afternoons).
- Bi-weekly PGTA support hour. *Thursdays 14h00-15h00 in Week 2, 4, 6, 8, 10 in Foster Court 215.*
- 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.*

Workbook I


GEOG0030: Geocomputation
jtvandijk.github.io/GEOG0030/index.html#welcome
UCL
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Module Introduction
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Moodle
Module overview
Troubleshooting
Acknowledgements
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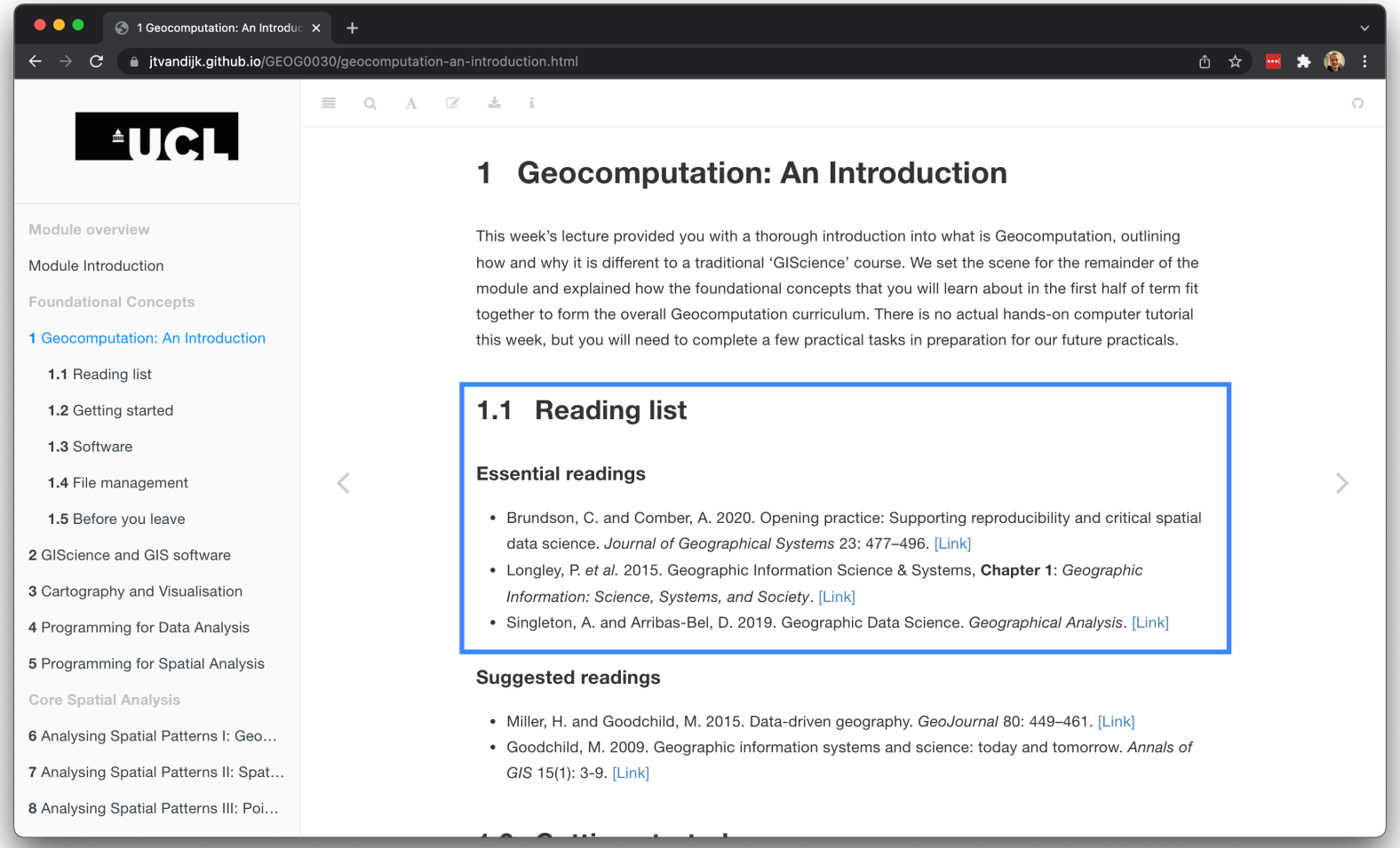
1 Geocomputation: An Introduction
2 GIScience and GIS software
3 Cartography and Visualisation
4 Programming for Data Analysis
5 Programming for Spatial Analysis
Core Spatial Analysis
6 Analysing Spatial Patterns I: Geo…
7 Analysing Spatial Patterns II: Spat…
8 Analysing Spatial Patterns III: Poi…
GEOG0030: Geocomputation
Justin van Dijk
2022-01-05
Module Introduction
Welcome
Welcome to Geocomputation, a course that introduces you to both the principles of spatial analysis and the use of programming for data analysis.

Workbook II


1 Geocomputation: An Introduc
jtvandijk.github.io/GEOG0030/geocomputation-an-introduction.html
UCL
Module overview
Module Introduction
Foundational Concepts
1 Geocomputation: An Introduction
1.1 Reading list
1.2 Getting started
1.3 Software
1.4 File management
1.5 Before you leave
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: Geo…
7 Analysing Spatial Patterns II: Spat…
8 Analysing Spatial Patterns III: Poi…
1 Geocomputation: An Introduction
This week's lecture provided you with a thorough introduction into what is Geocomputation, outlining how and why it is different to a traditional 'GIScience' course. We set the scene for the remainder of the module and explained how the foundational concepts that you will learn about in the first half of term fit together to form the overall Geocomputation curriculum. There is no actual hands-on computer tutorial this week, but you will need to complete a few practical tasks in preparation for our future practicals.
1.1 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]
Longley, P. et al. 2015. Geographic Information Science & Systems, Chapter 1: Geographic Information: Science, Systems, and Society. [Link]
Singleton, A. and Arribas-Bel, D. 2019. Geographic Data Science. Geographical Analysis. [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]

Practicalities

- Plenary lectures will take place in person, but will also be streamed and recorded using Lecturecast to accommodate anyone who is self-isolating. The link to the livestreams and recordings can be found on Moodle. *Lecture slides will be made available after each lecture on the GEOG0030 Geocomputation workbook webpage.*
- Supervised computer tutorials will take in person. Computer tutorials will not be streamed or recorded. You are expected to work independently through the assignments in the workbook – with the opportunity to ask questions/explanations/clarifications to us.

Communication

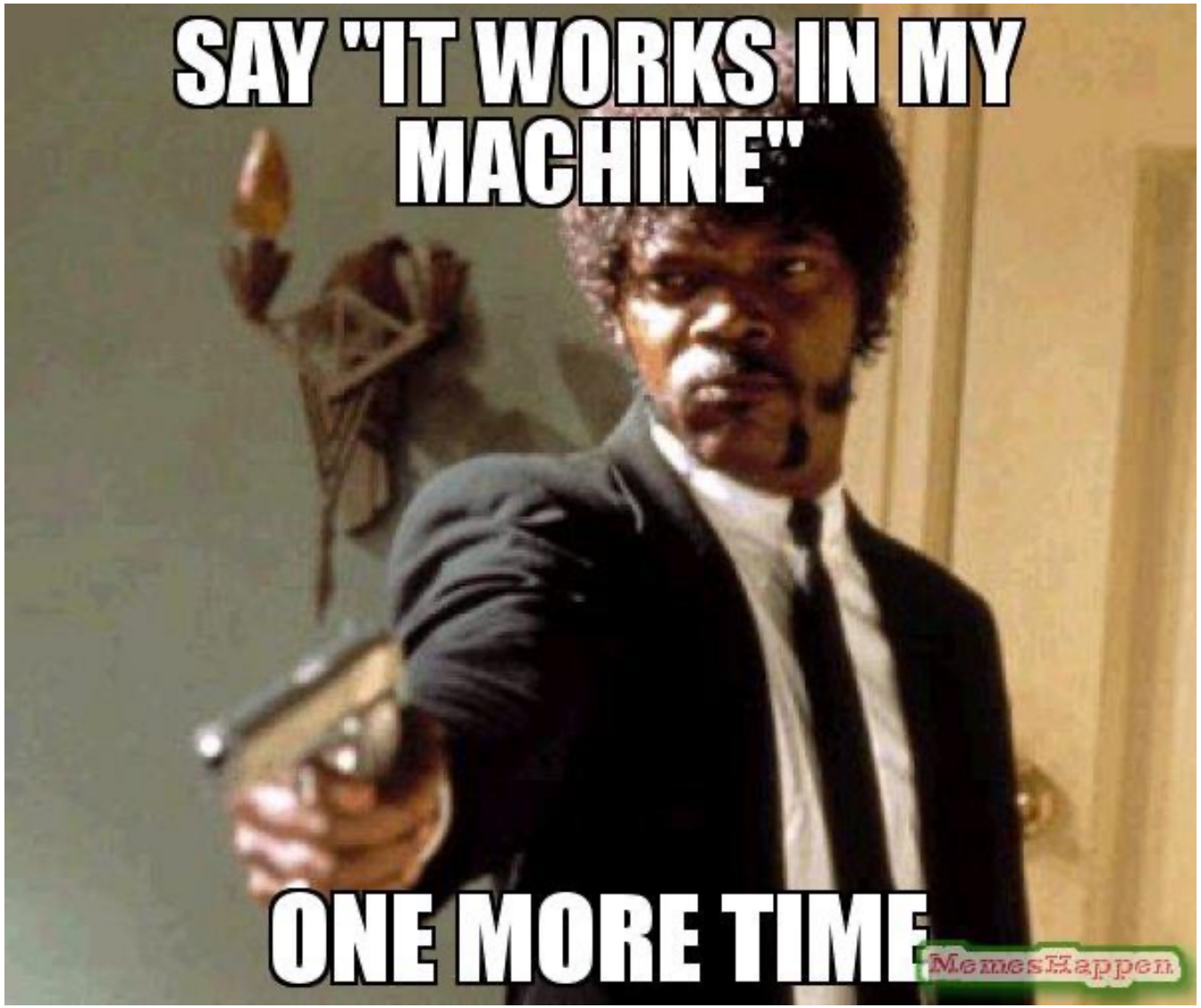
- All important information will be communicated through Moodle.
- The *Geocomputation* Microsoft Teams channel can be used as a forum for discussions and asking questions. Self-enroll code: **d72yq4t**
- For specific questions on the module, my Academic Support and Feedback (ASF) Office Hours are scheduled on Friday afternoon (14h00-17h00), 20-minutes 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 25 2022.
- Exam Assessment (40%): The second assessment will take the form of a written 2-hour Exam.
- Full details and guidance on your assessments will be released by Reading Week.

Troubleshooting I

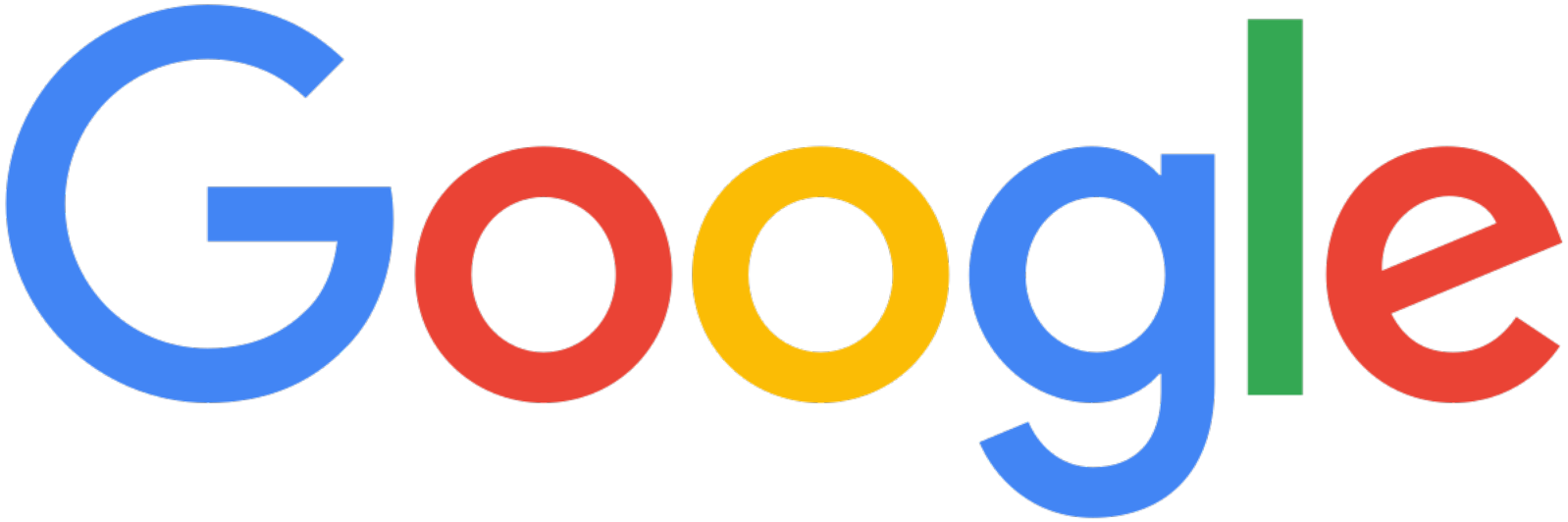
Spatial analysis can yield fascinating insights into geographical relationships. However, at times it can be difficult to work with - particularly when we combine this with learning how to program at the same time. You are likely to get lots of error messages and have software crash, you will end up 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 II

- Ask a question at the end of a plenary lecture or during a computer tutorial.
- Attend the bi-weekly Geocomputation Help sessions to ask questions directly to the PGTA. *Thursdays 14h00-15h00 in Week 2, 4, 6, 8, 10 in Foster Court 215.*
- Attend the Geography Department's Coding Therapy sessions that are run on a weekly basis.
- Post your question in the *Discussion* channel within the Geocomputation Team. *This Discussion channel is for student peer-to-peer support and will only be lightly moderated where necessary.*

Troubleshooting III



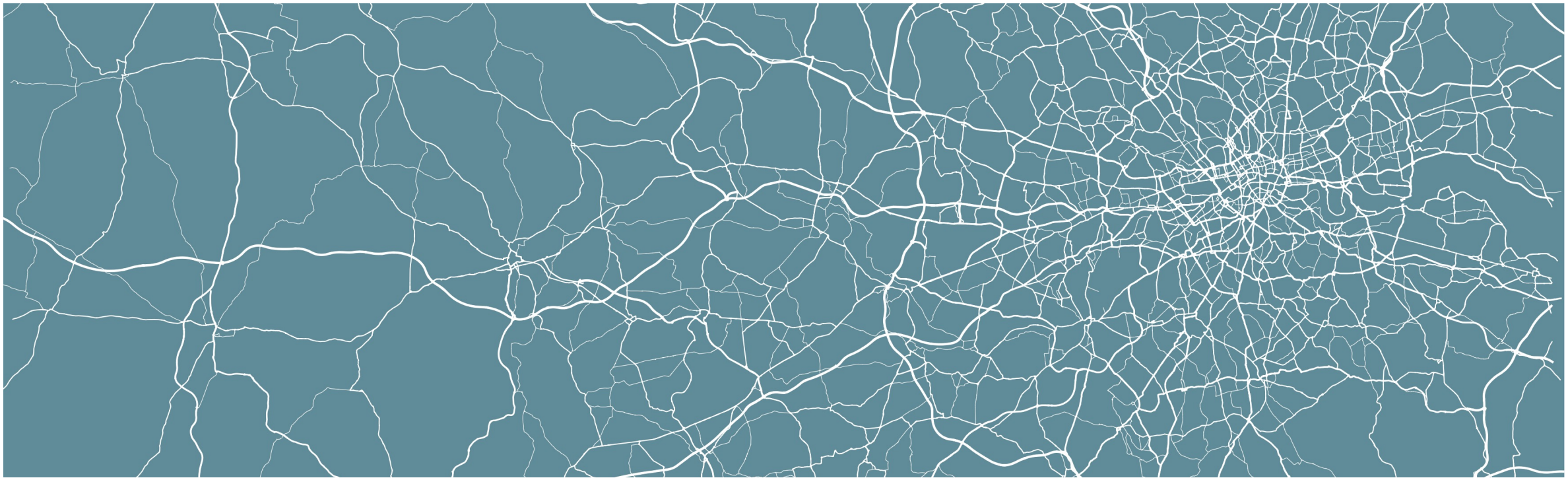
Questions

Justin van Dijk

j.t.vandijk@ucl.ac.uk

Geocomputation

W1 – Geocomputation: An Introduction



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Where are we at?

Part I: Foundational Concepts

W1	**Geocomputation: An Introduction**	
W2	GIScience and GIS software	QGIS
W3	Cartography and Visualisation	QGIS
W4	Programming for Data Analysis	R
W5	Programming for Spatial Analysis	R

This week

- What is GIScience?
- What is Geocomputation?

Before we start

- Go to www.menti.com
- Use code: 5658 0960

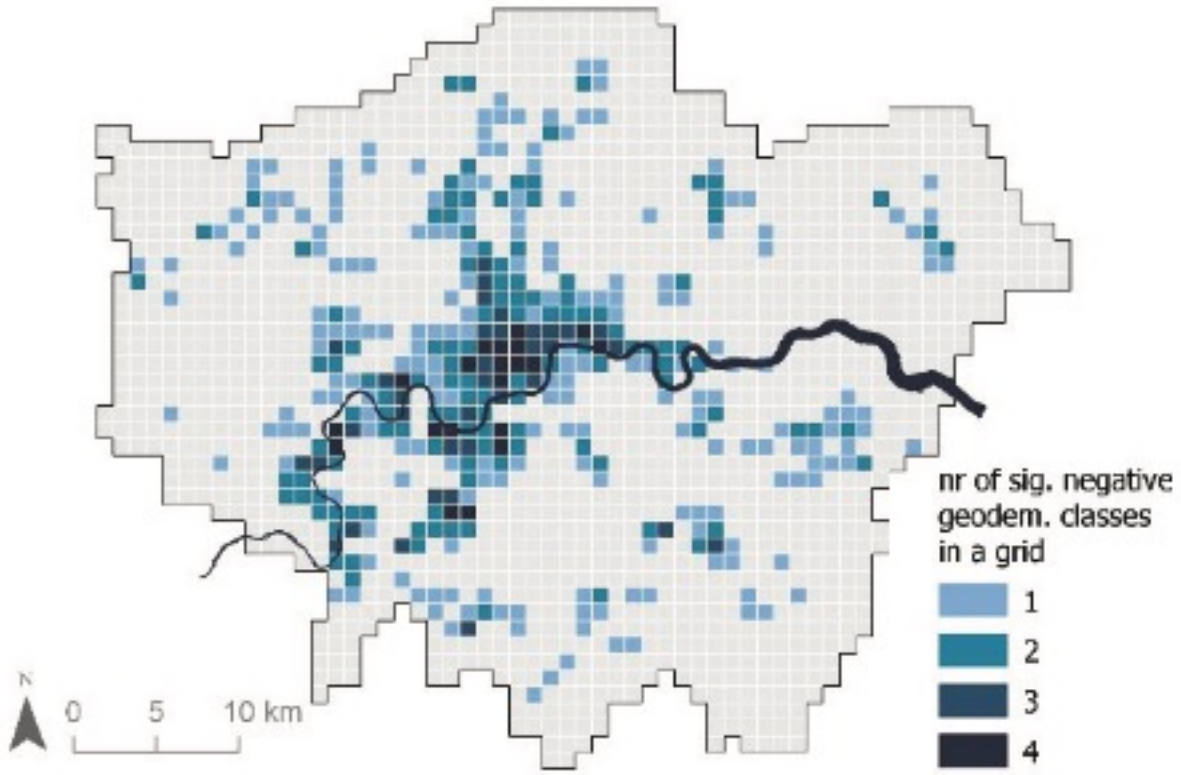
GIScience

- The Geocomputation module is designed to provide you with an introduction to the principles of GIScience, 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?

Covid Cases in the UK

Mobility in London during lockdown

Significantly **less decline** than average



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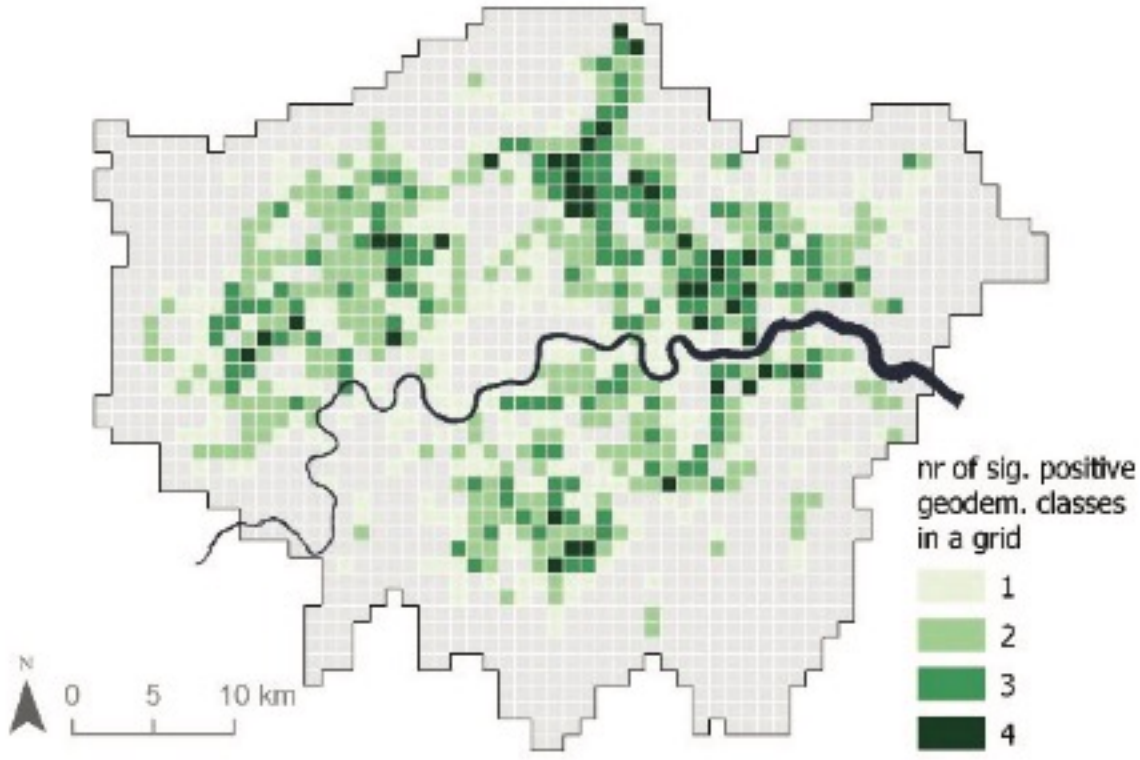
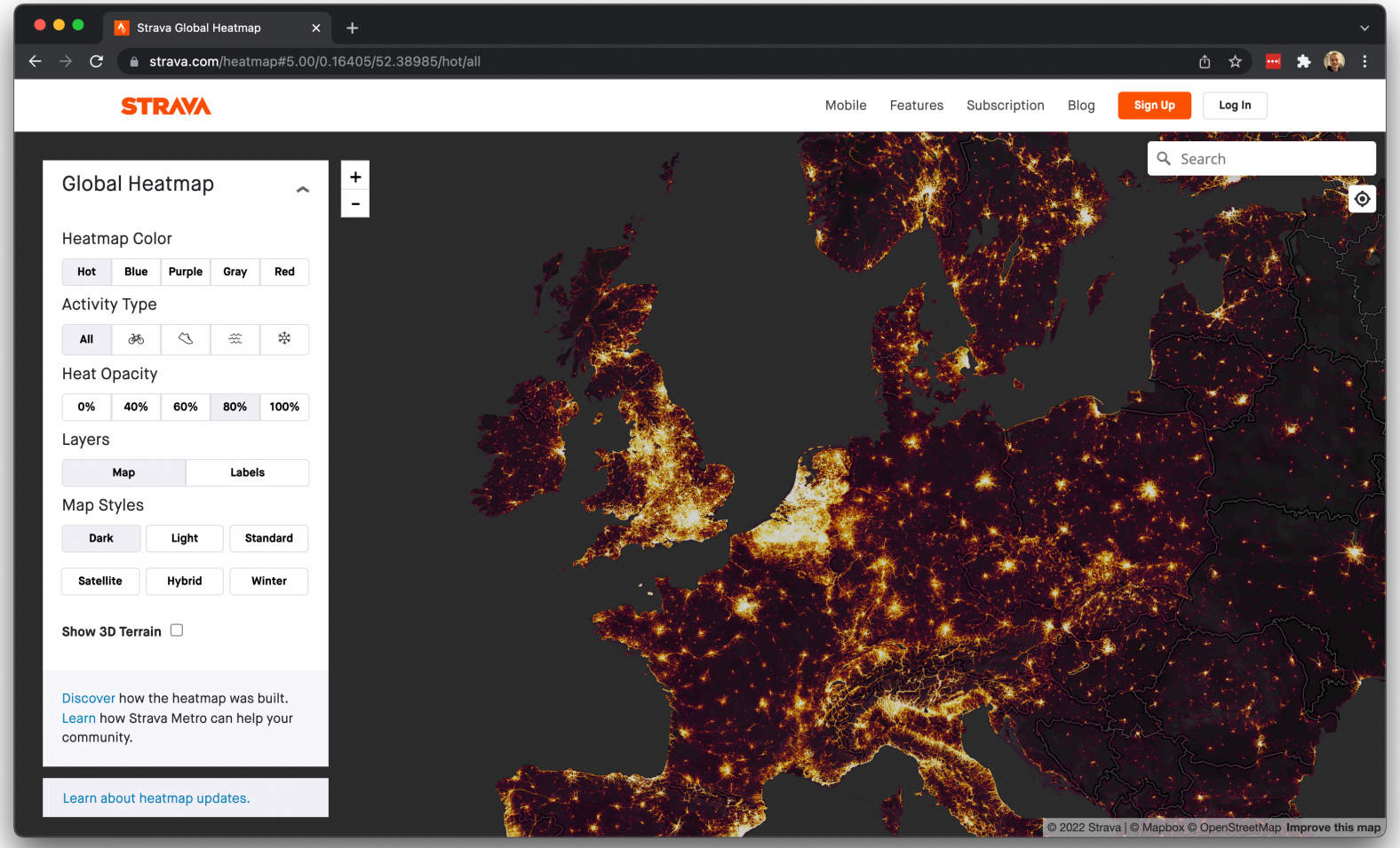
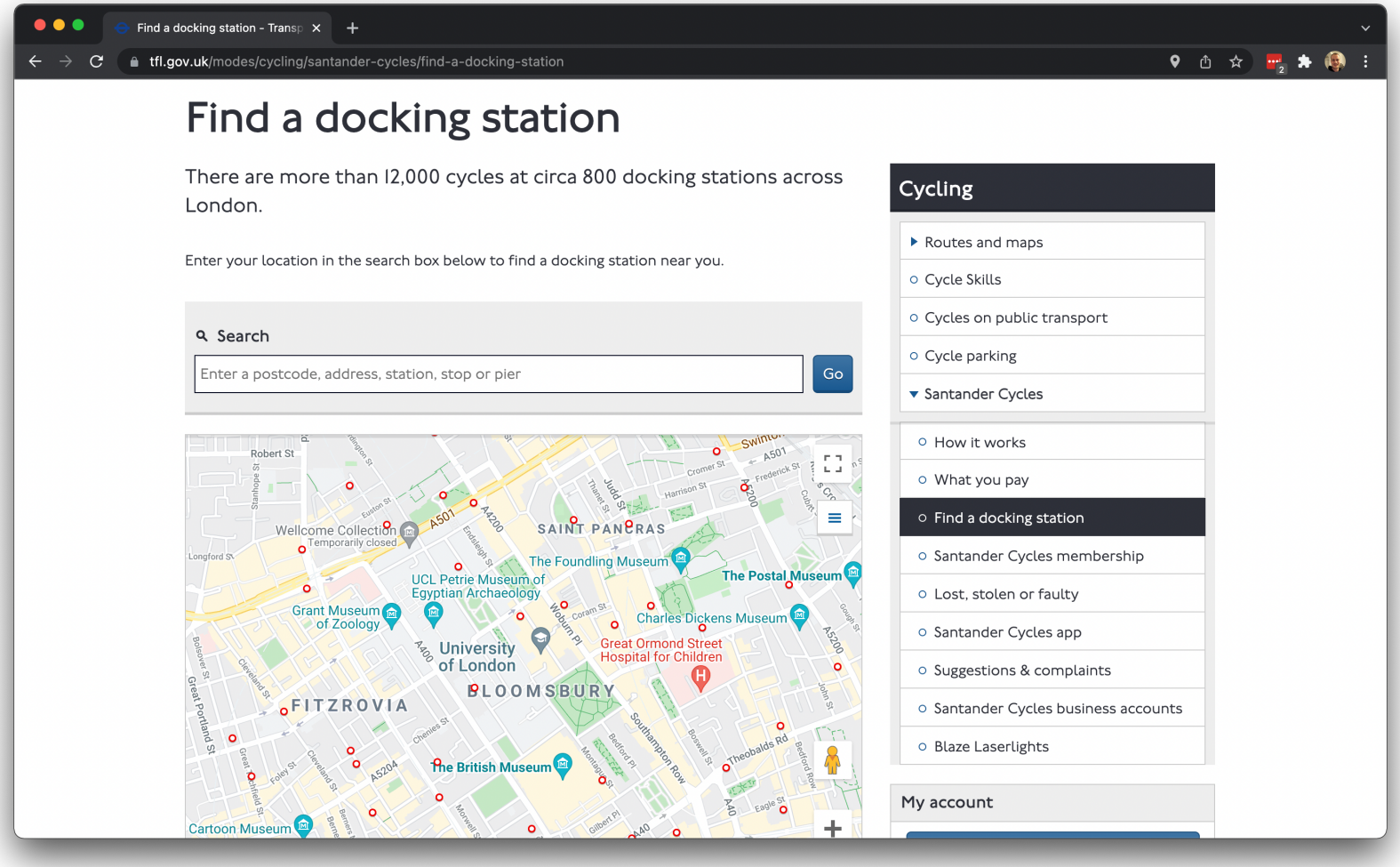


Trasberg and Cheshire 2021

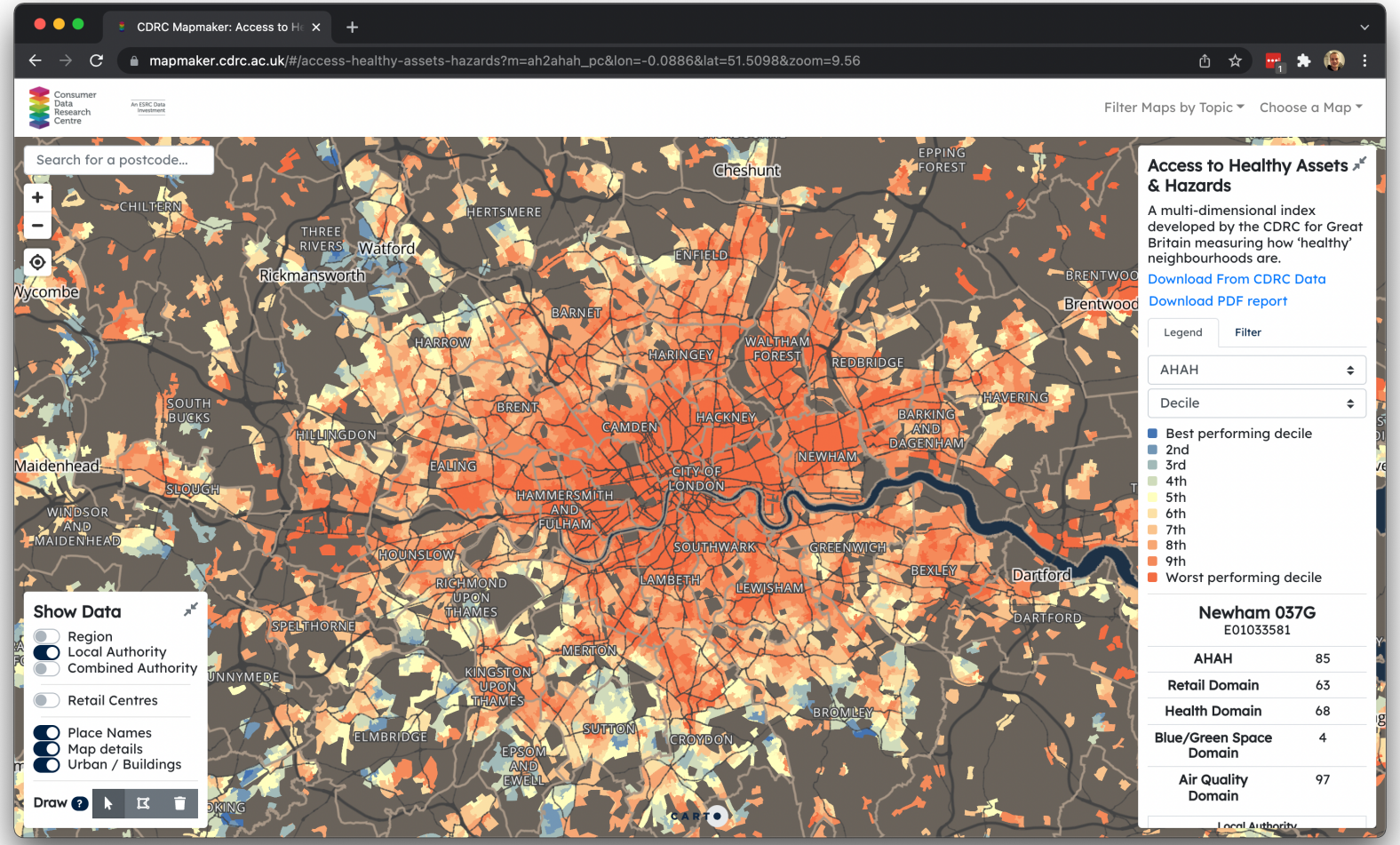
Running in Western-Europe



Bicycle docking stations in London



Access to Healthy Assets and Hazards in the UK

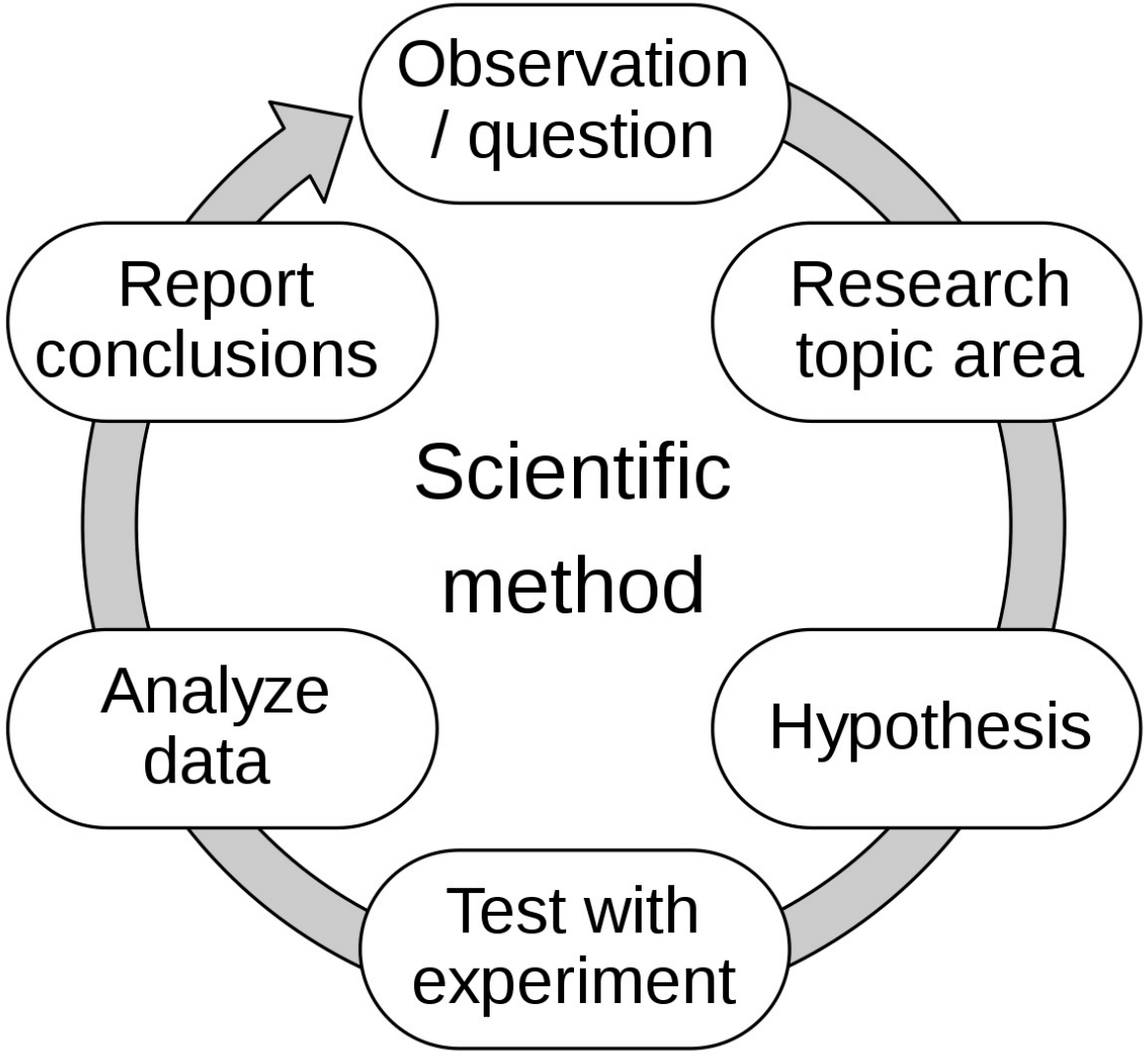


The Universal Visitation Law of Human Mobility

Scientific method I

Scientific enquiry and knowledge production in Geography requires following the established scientific method, which involves collecting and analysing data to draw conclusions.

Scientific method II



Scientific method III

- 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 sound analyses on our data
  - Present our results with accuracy and precision to create information
- Four pillars of GIScience.

Foundations of GIScience I

(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 I

(3) Spatial analysis:

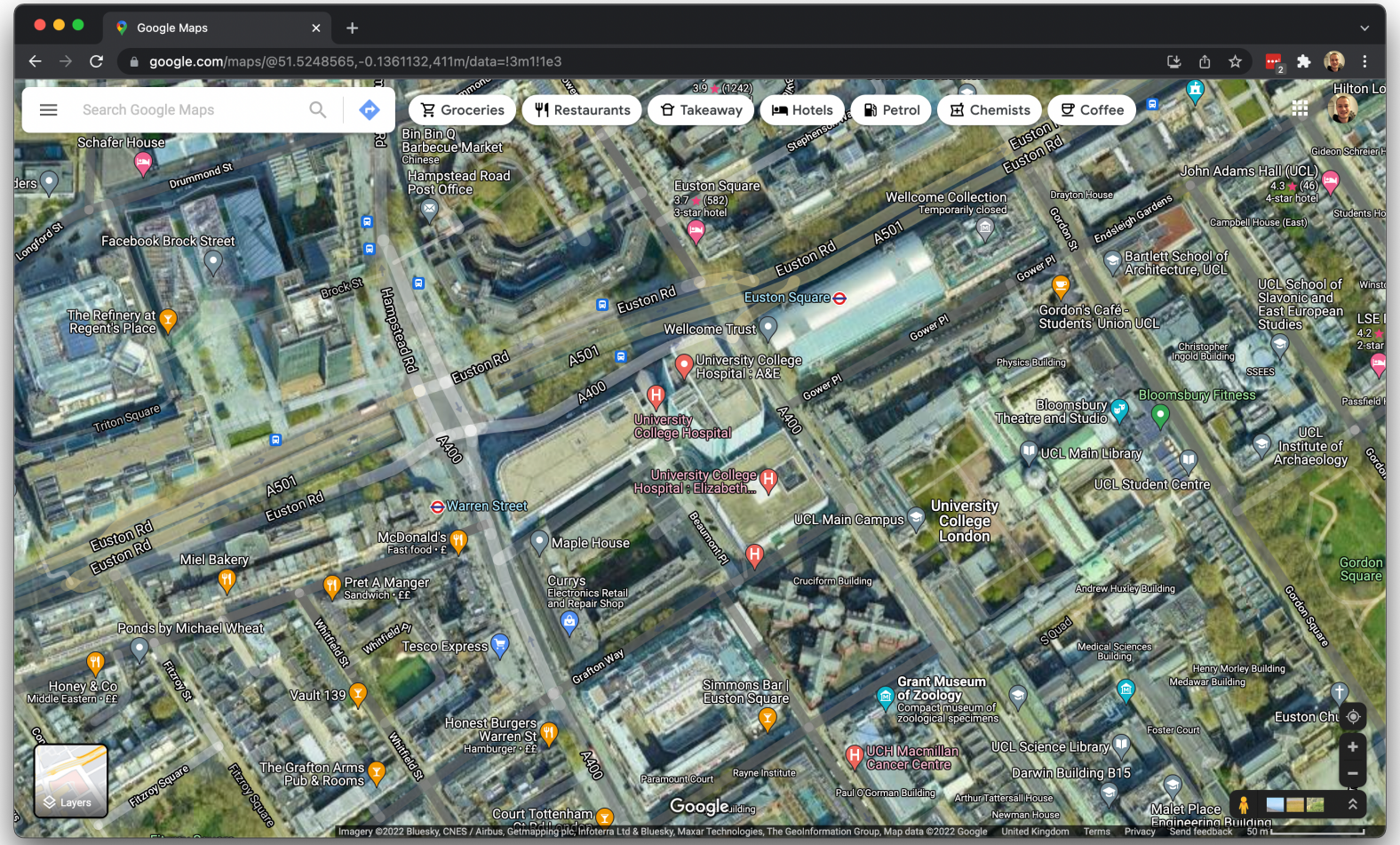
The theory, principles, and techniques that enable accurate and rigorous analysis of spatial data to discover spatial patterns, processes and relationships (including taking into account the 'special' properties of spatial phenomena).

(4) Cartography and visualisation:

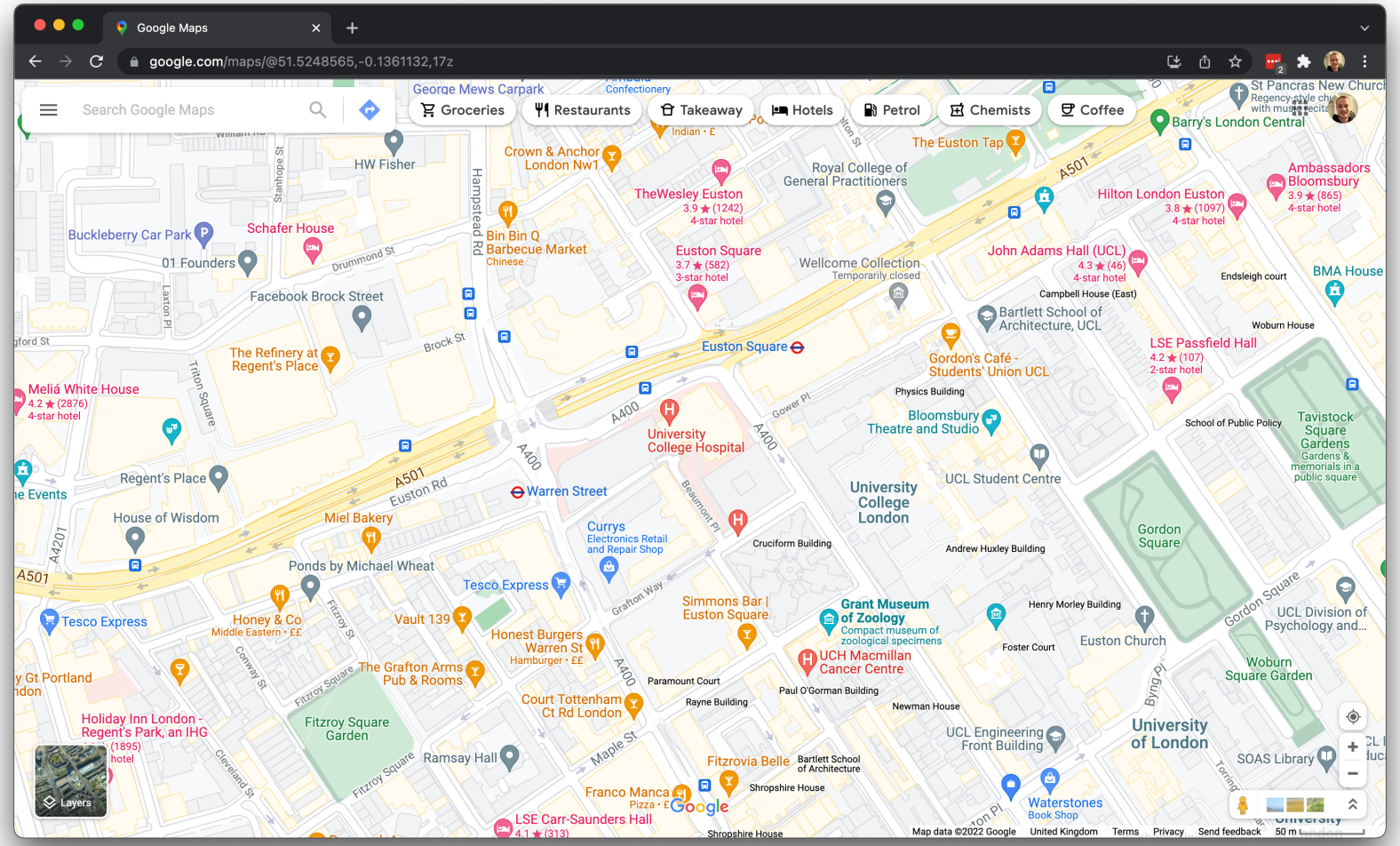
How to present spatial data and the results from spatial analysis to communicate results accurately and precisely (including projections and map conventions).

Spatial modelling and digital representation

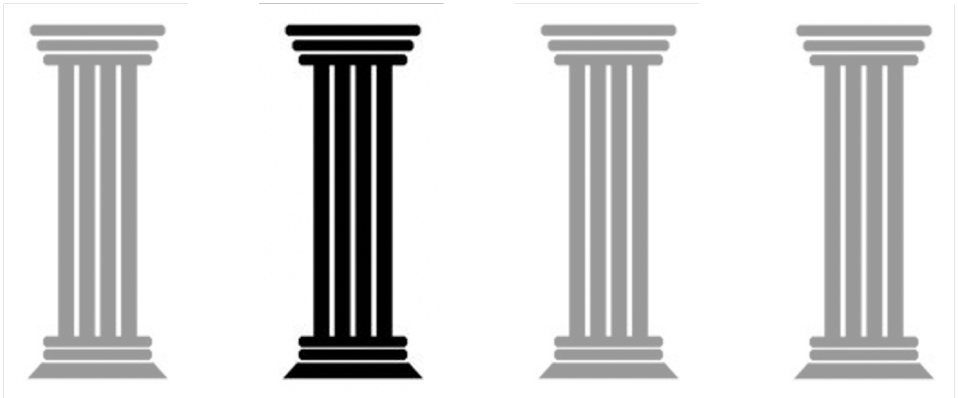
Spatial modelling and digital representation I



Spatial modelling and digital representation II



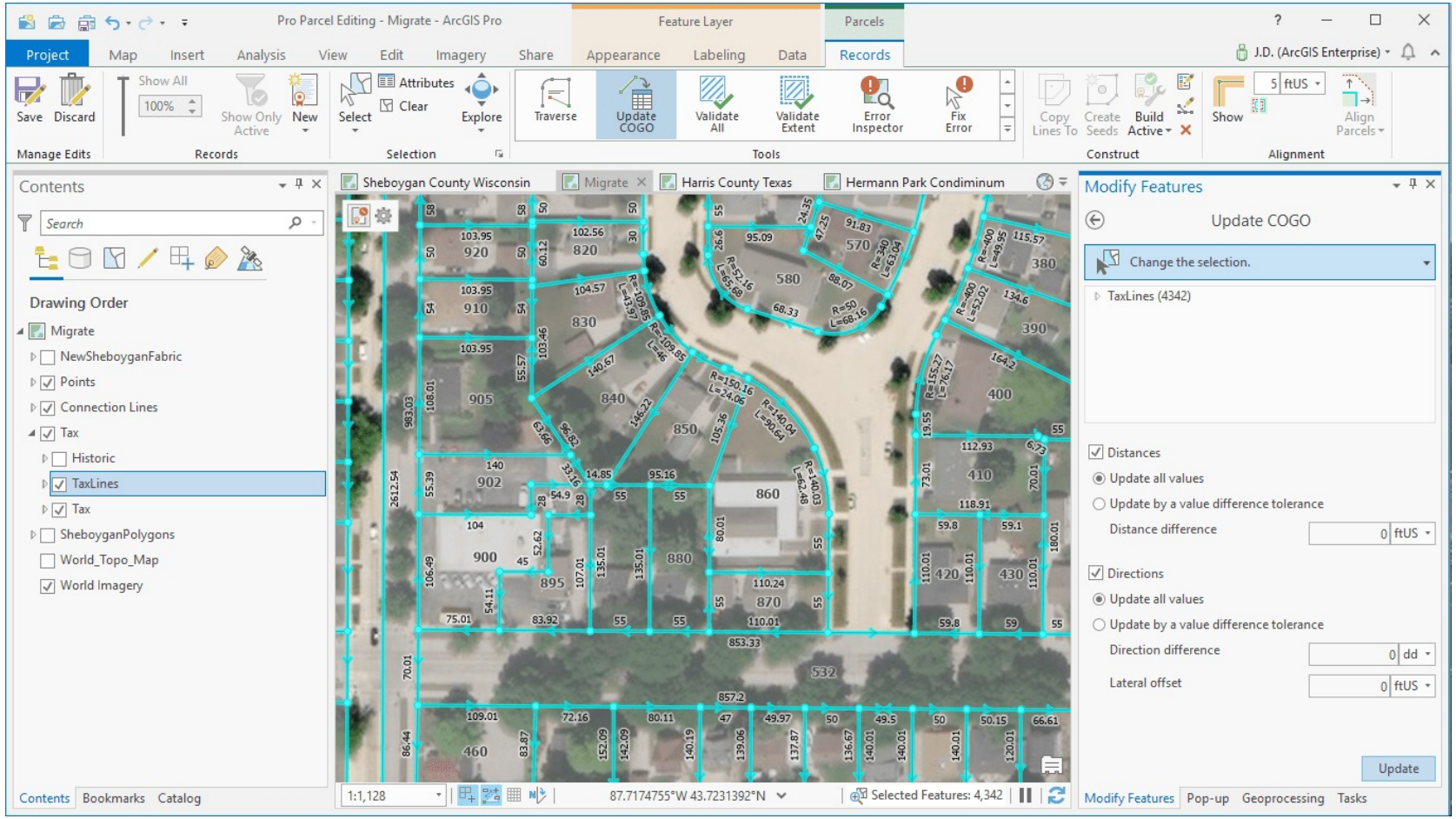
Geographic Information Systems



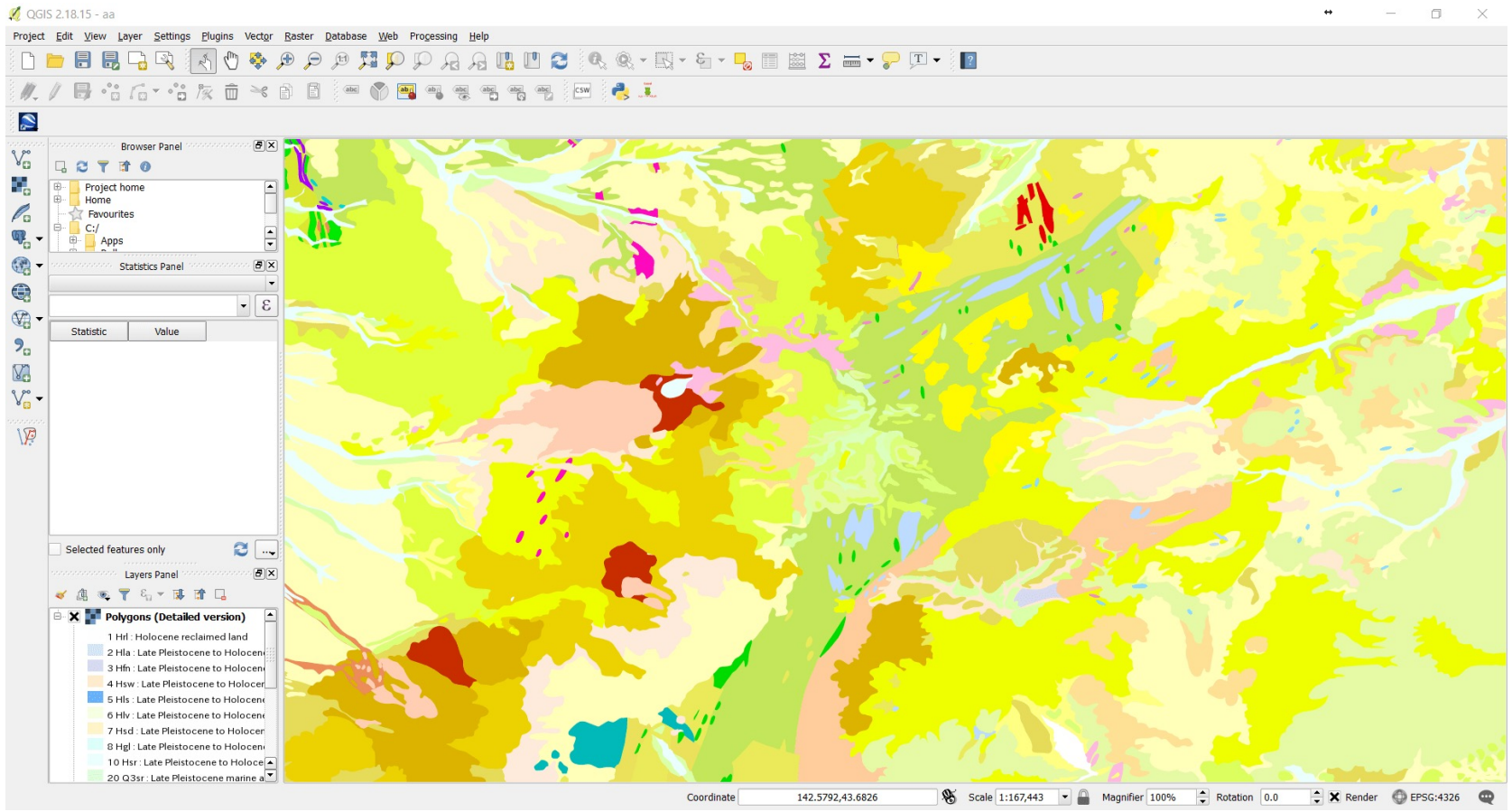
Geographic Information Systems I

- 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 can function as a GIS: R, Python

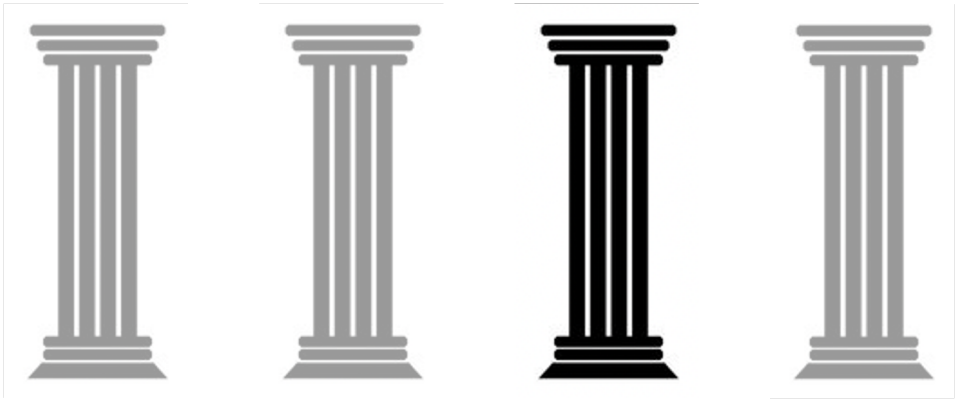
Geographic Information Systems II



Geographic Information Systems III



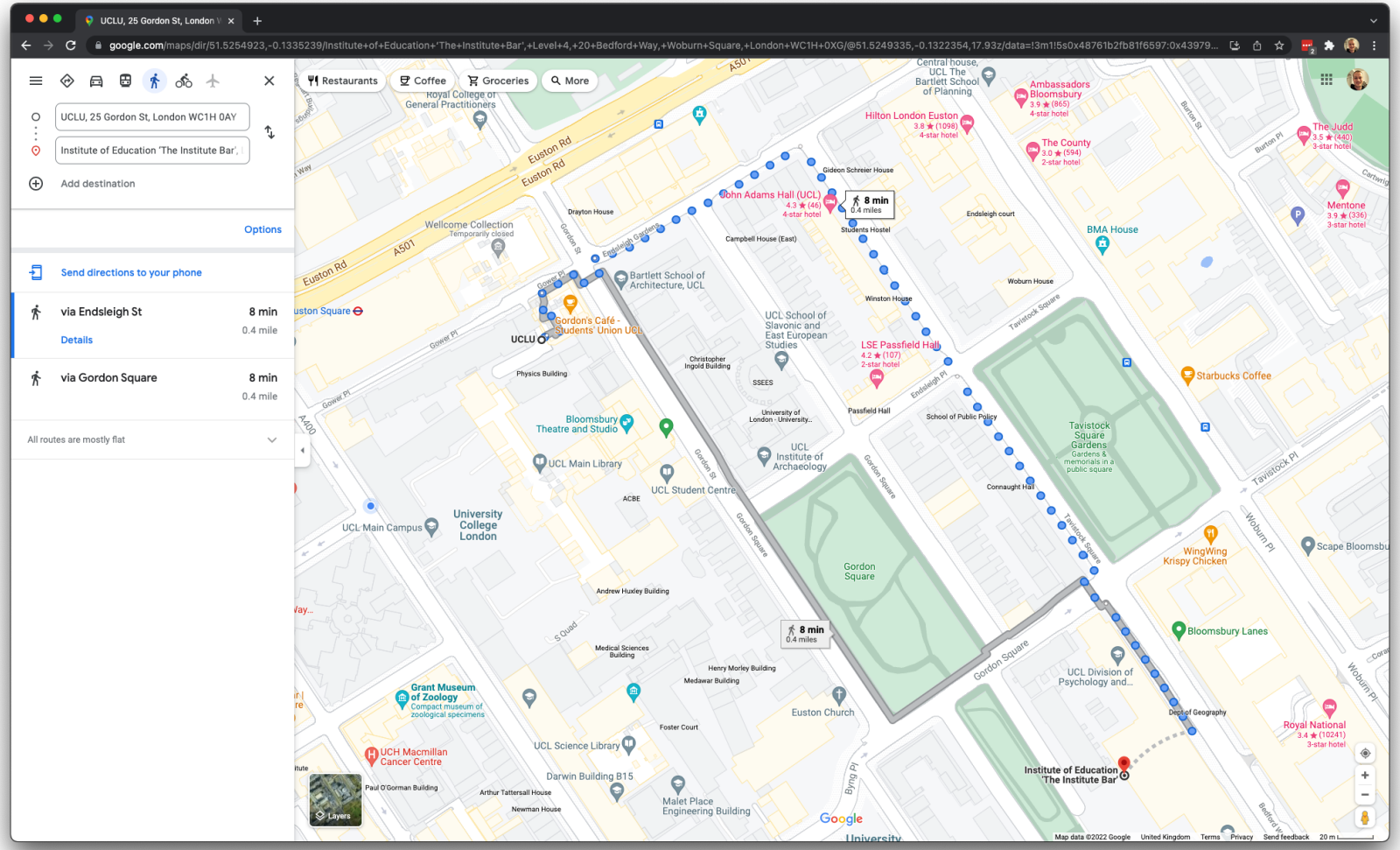
Spatial analysis



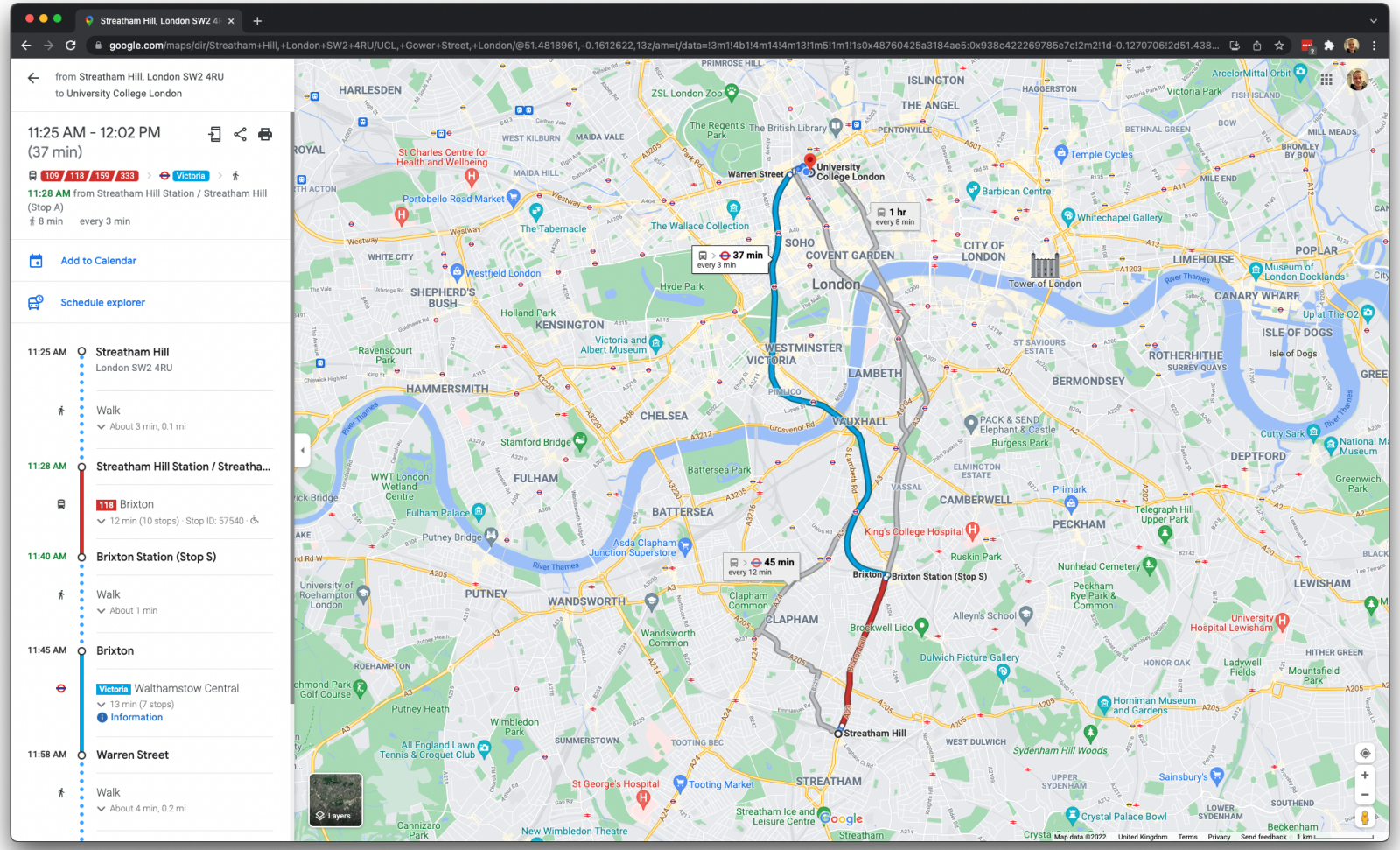
Spatial analysis I

- 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.

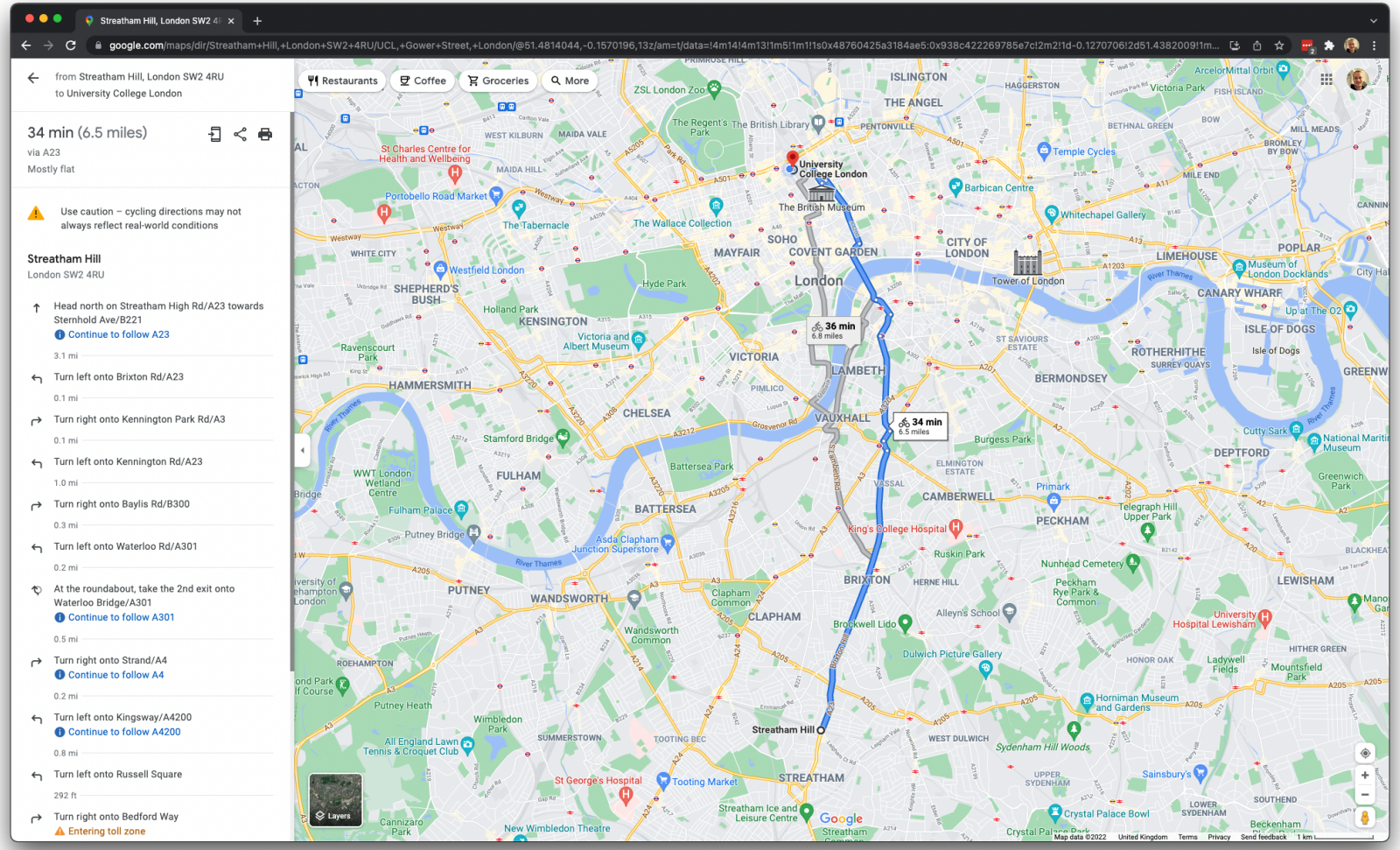
Spatial analysis II



Spatial analysis III



Spatial analysis III

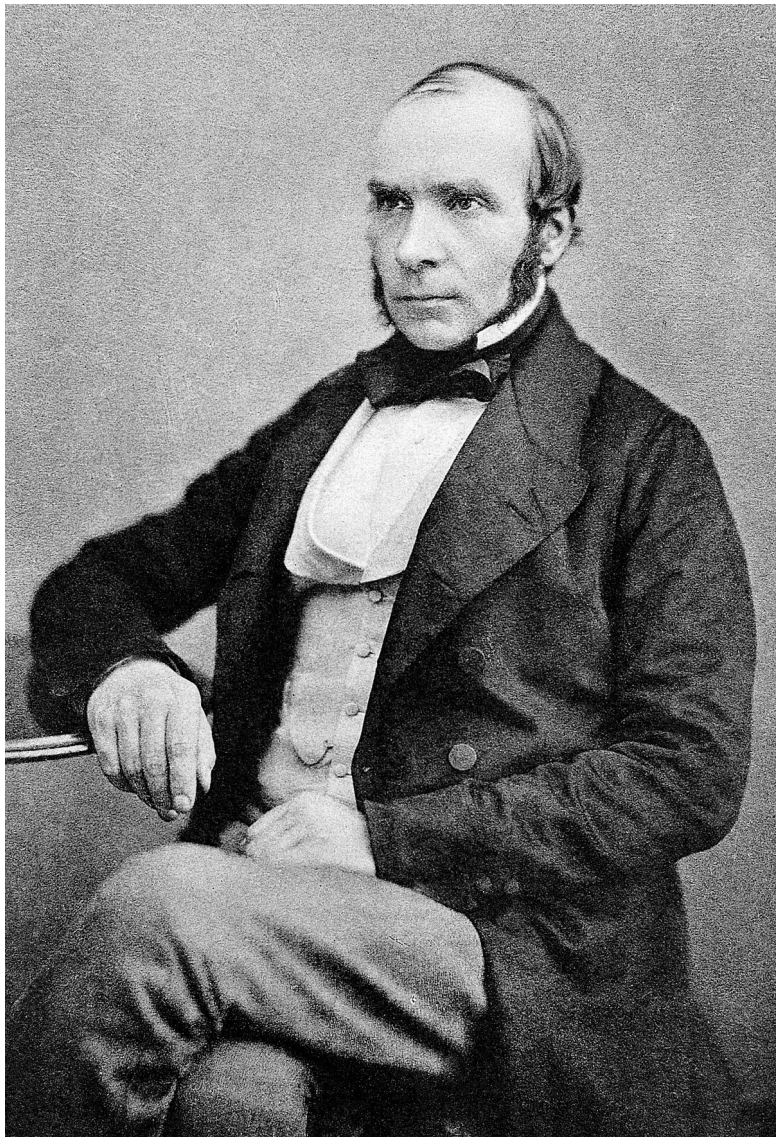


Spatial analysis IV

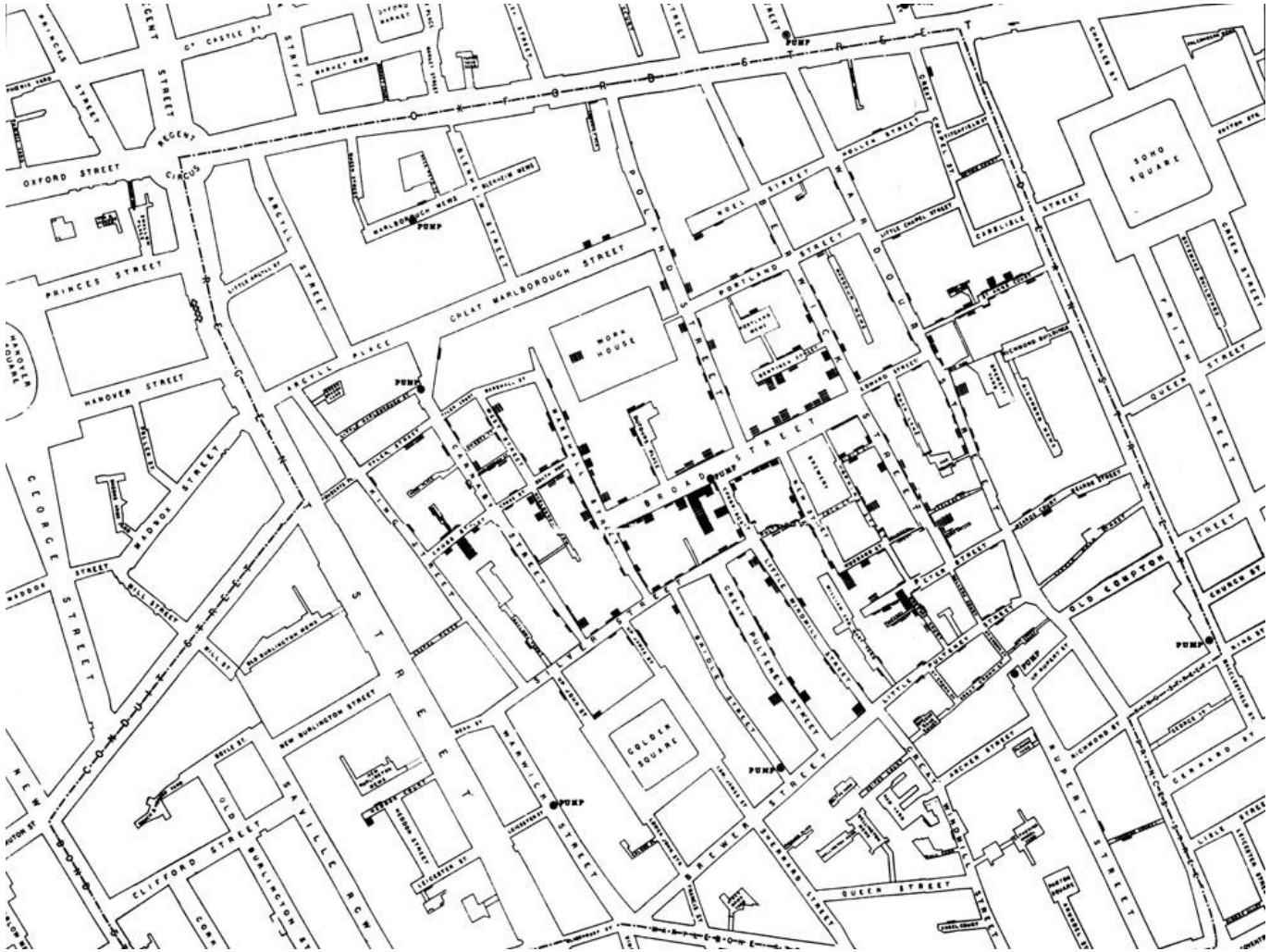
Spatial analysis looks to provide knowledge on the world by transforming data into information by quantifying “things” like distributions and spatial processes.

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 V



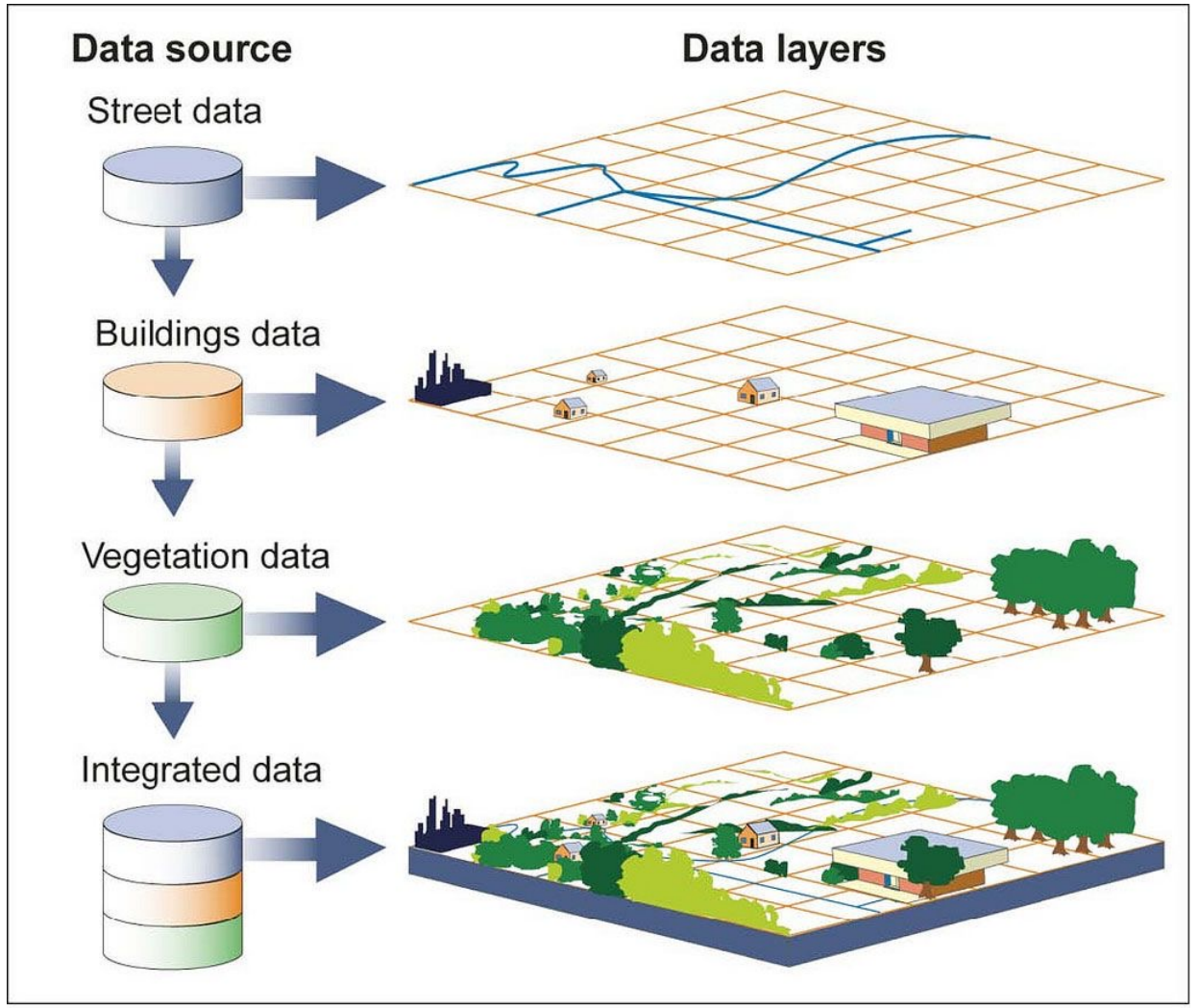
Spatial analysis VI



Spatial analysis VII

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 VII



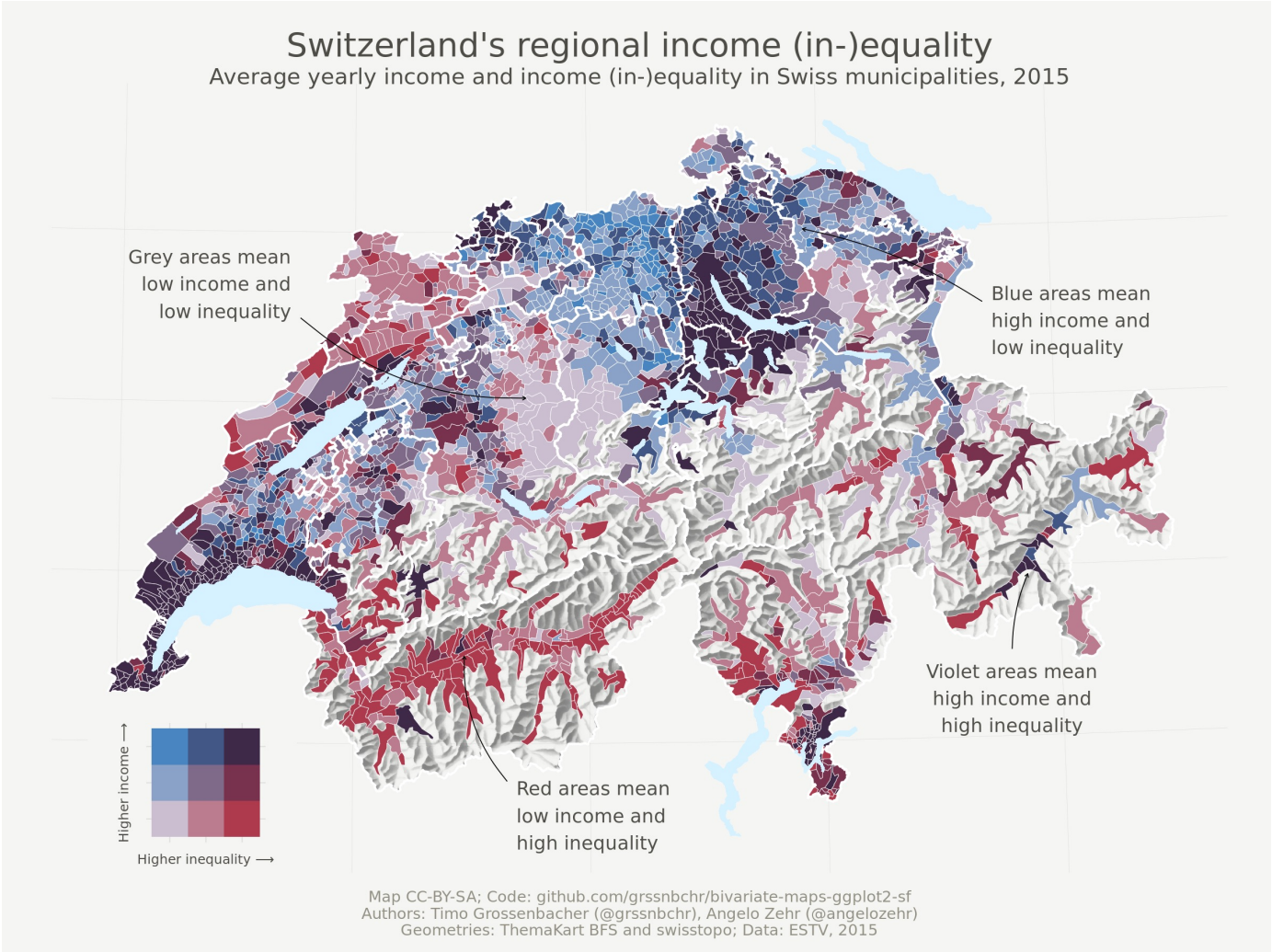
Source: GAO.

Cartography and visualisation

Cartography and visualisation I

Atlas Of The Invisible

Cartography and visualisation II



https://timogrossenbacher.ch/2019/04/bivariate-maps-with-ggplot2-and-sf/

Geocomputation I

Lots of pillars, but what then is this Geocomputation?

Geocomputation II

"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 III

- 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 IV

“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.

  Geocomputation: working with geographic data in a computational way, focusing on code, reproducibility and modularity.

Computer tutorial

There is no actual hands-on computer tutorial diving into QGIS or R this week, but you will need to complete a few practical tasks in preparation for our future tutorials.

Questions

Justin van Dijk

j.t.vandijk@ucl.ac.uk