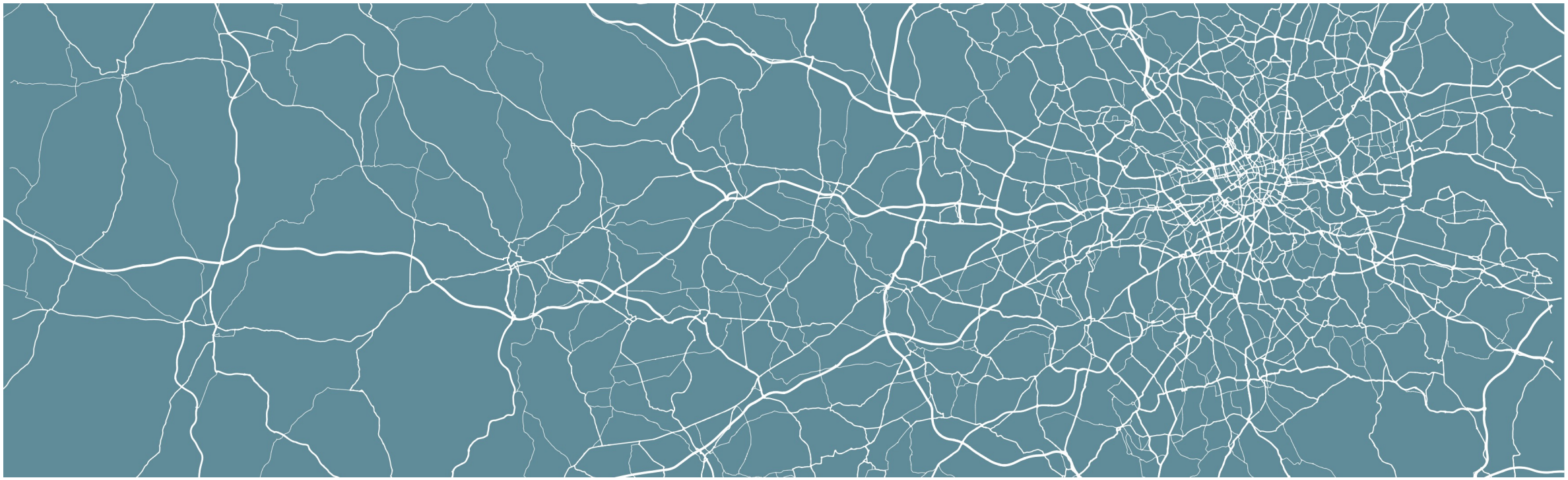
Geocomputation

W6 – Geometric Operations and Spatial Queries



UCL

Where are we at?

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	

Where are we at?

Part II: *Core Spatial Analysis*

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

Part III: *Advanced Spatial Analysis*

W9	Rasters, Zonal Statistics and Interpolation	R
W10	Transport Network Analysis	

This week

Before we start

- Go to www.menti.com
- Use code: 1334 8681

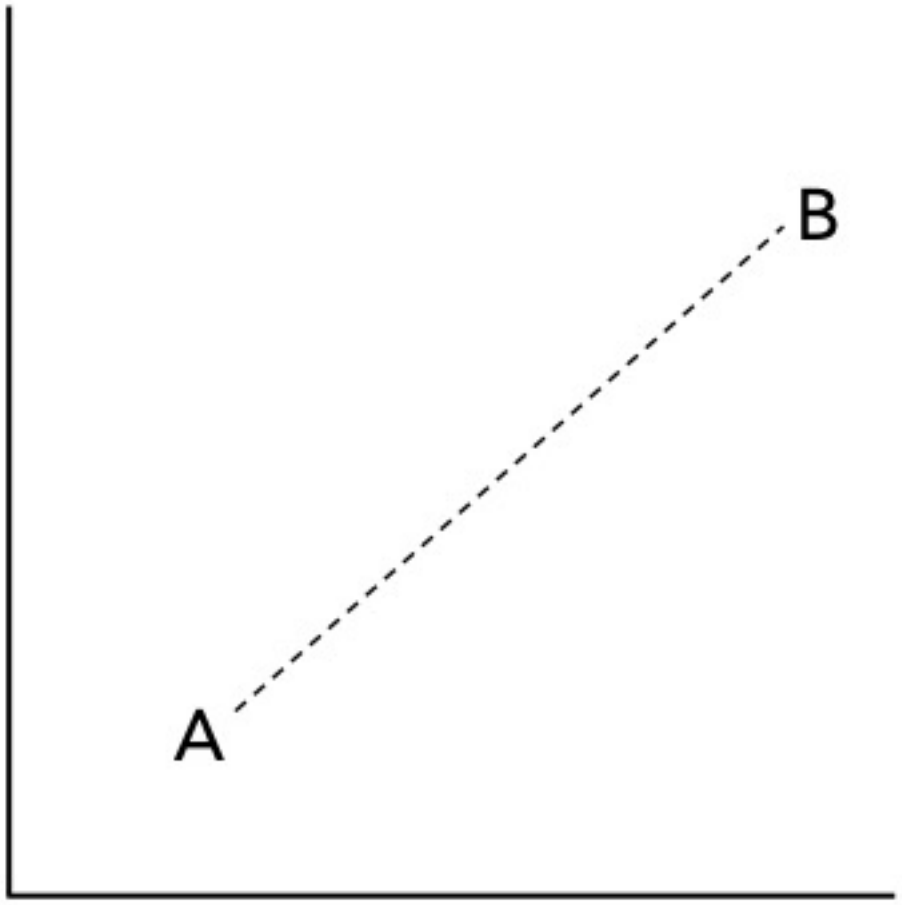
This week

- Spatial properties
- Spatial operations
- Spatial relationships
- Example: Querying large spatial data

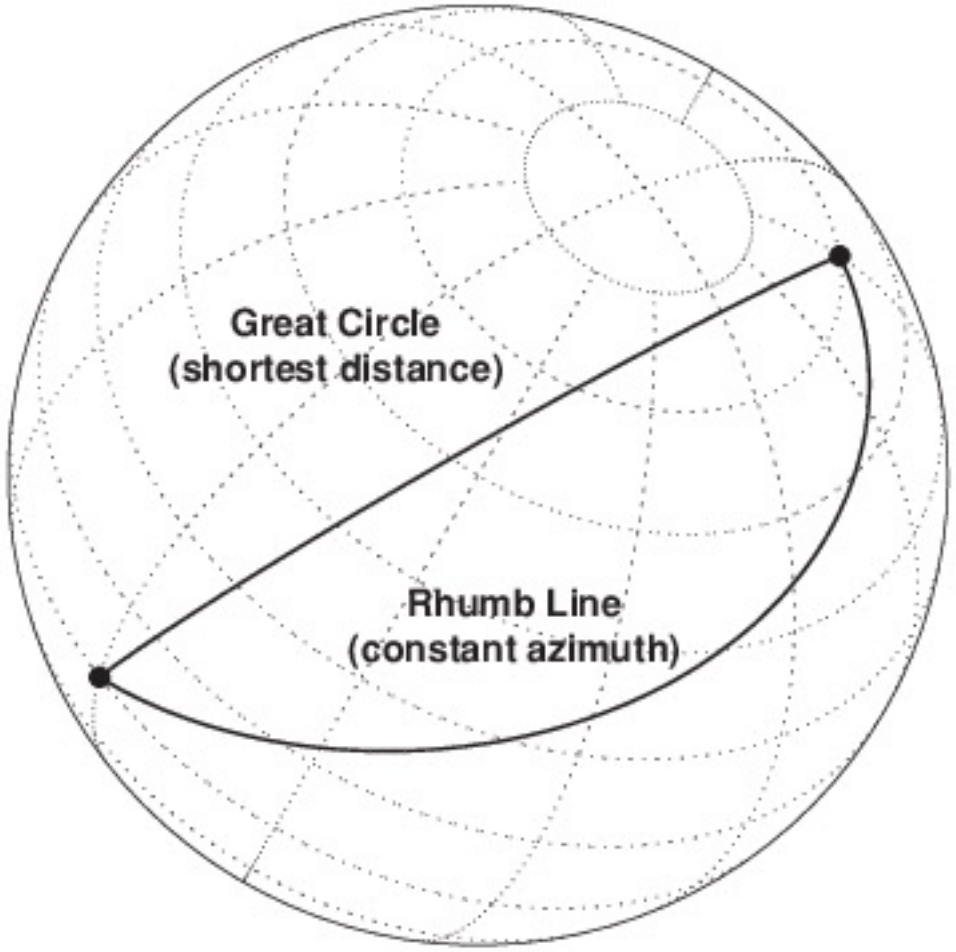
Spatial properties

- Much of spatial data involves the execution of spatial maths on spatial properties.
- We typically work with *“things”* like distance, area, and shape.
- Different ways to think about these properties and how to conceptualise them.

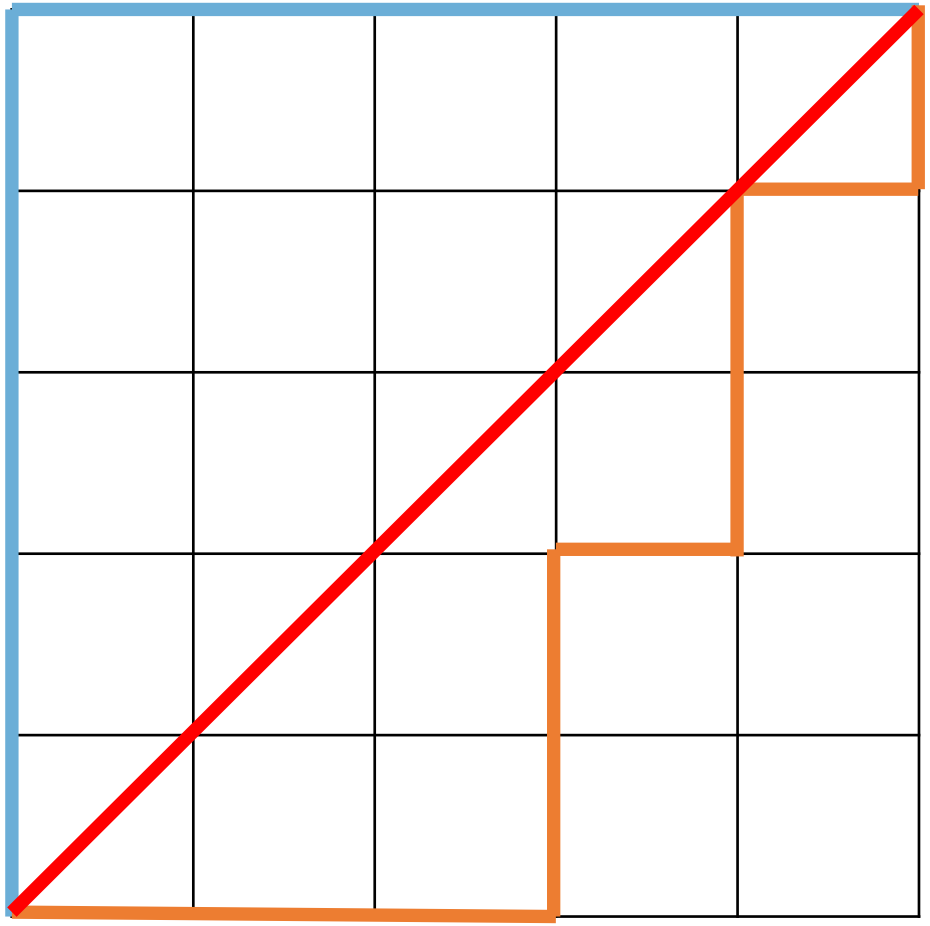
Distance I



Distance II


Great Circle
(shortest distance)
Rhumb Line
(constant azimuth)

Distance III

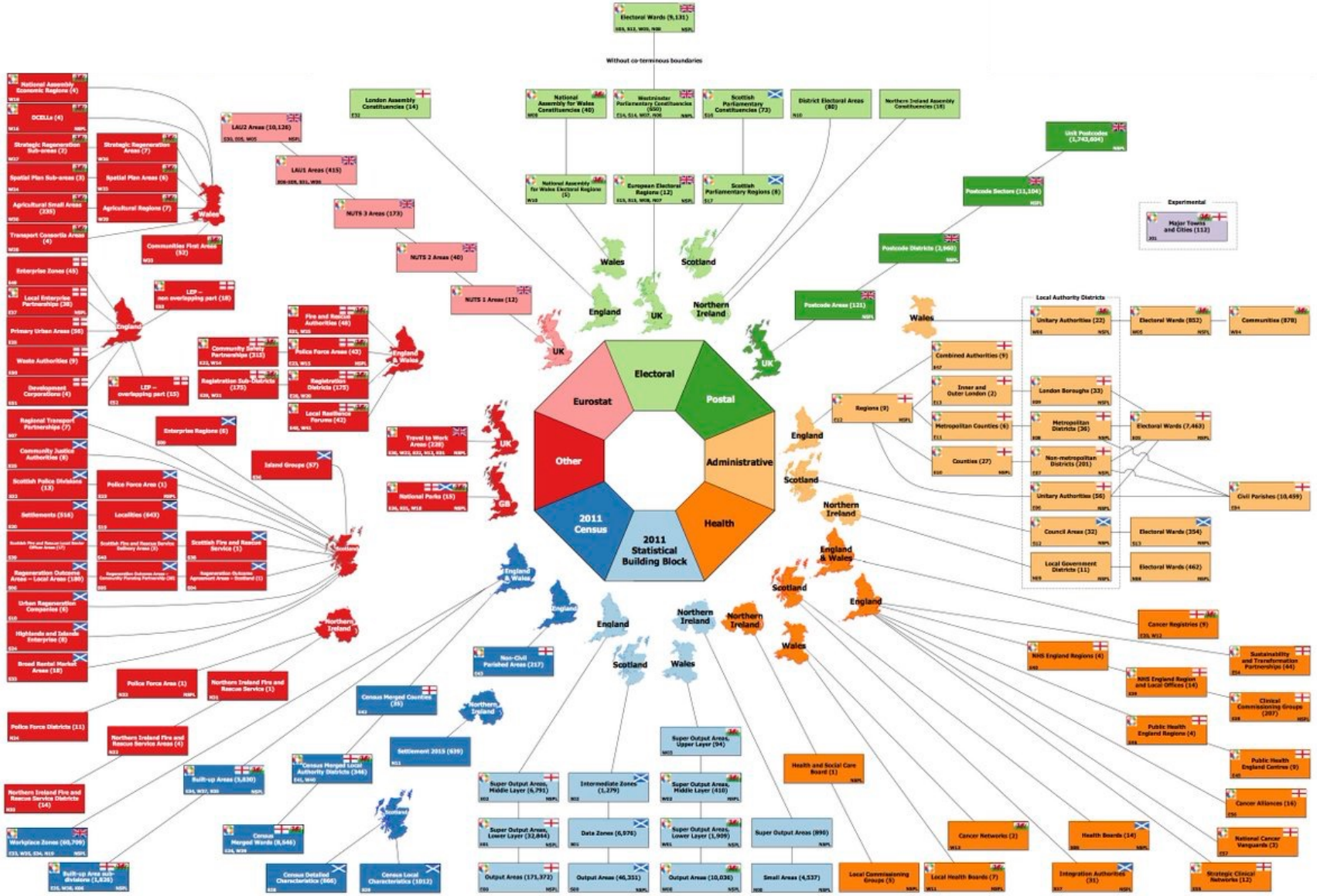


Area I

Area II

- Precision of the data source will affect calculations (e.g. simplified topology).
- Decision of which geography to use is crucial and depends on what you want to investigate – and keep in mind MAUP.

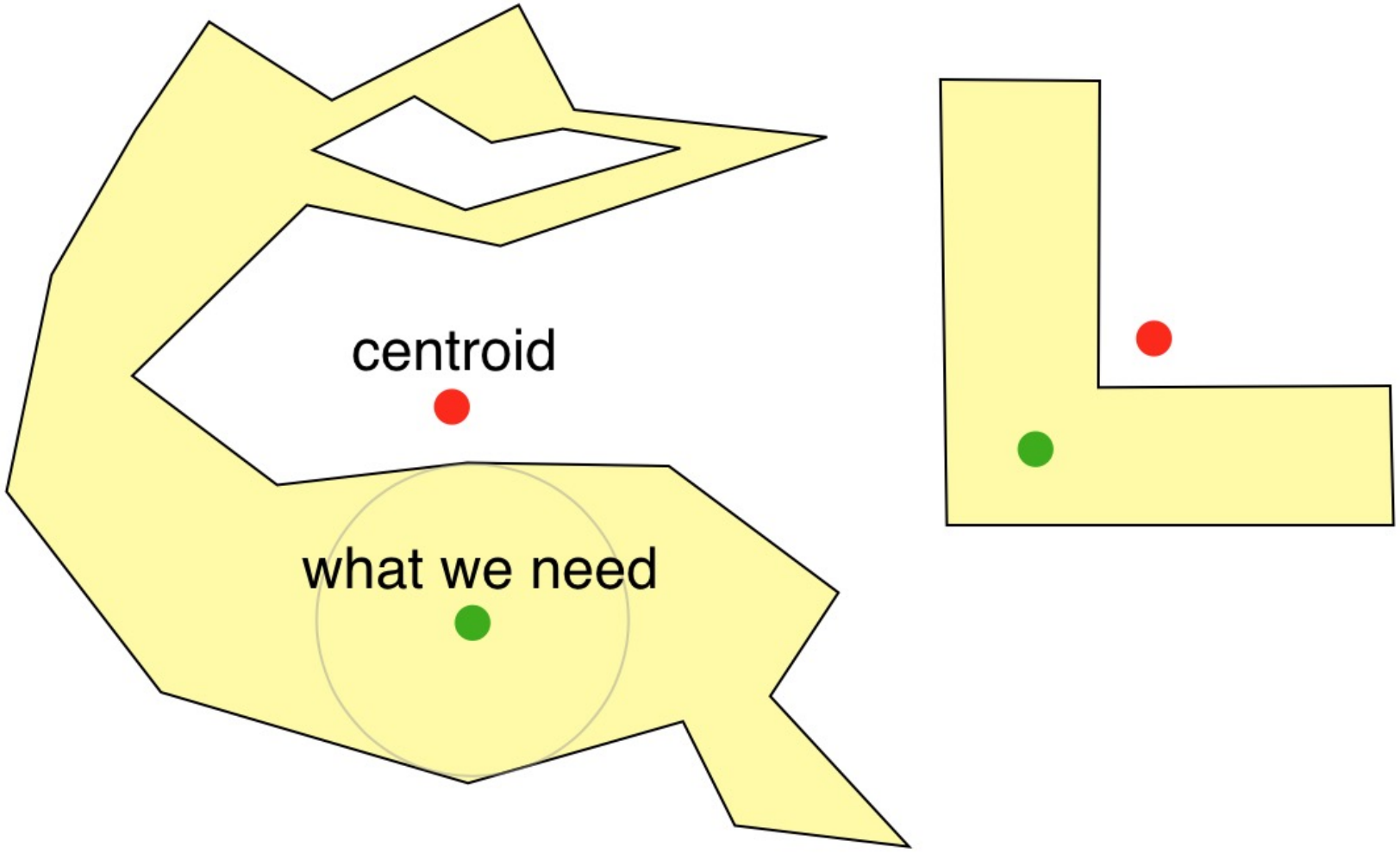
Area III


Electoral Wards (9,131)
Without co-terminous boundaries
Electoral
Postal
Administrative
Health
2011 Statistical Building Block
2011 Census
Other
Eurostat
Wales
Scotland
England
UK
Northern Ireland
England & Wales
GB
Local Authority Districts
Experimental
Major Towns and Cities (112)
Unit Postcodes (1,743,604)
Postcode Sectors (11,104)
Postcode Districts (2,960)
Postcode Areas (121)
Electoral Wards (852)
Communities (870)
Unitary Authorities (22)
Combined Authorities (9)
Inner and Outer London (2)
London Boroughs (33)
Metropolitan Districts (36)
Metropolitan Counties (6)
Non-metropolitan Districts (201)
Counties (27)
Unitary Authorities (56)
Council Areas (32)
Local Government Districts (11)
Electoral Wards (7,463)
Electoral Wards (354)
Electoral Wards (462)
Civil Parishes (10,459)
Regions (9)
Cancer Registries (9)
NHS England Regions (4)
NHS England Region and Local Offices (14)
Public Health England Regions (4)
Sustainability and Transformation Partnerships (44)
Clinical Commissioning Groups (207)
Public Health England Centres (9)
Cancer Alliances (16)
National Cancer Vanguards (3)
Strategic Clinical Networks (12)
Health Boards (14)
Integration Authorities (31)
Local Health Boards (7)
Cancer Networks (2)
Local Commissioning Groups (9)
Health and Social Care Board (1)
Super Output Areas, Upper Layer (94)
Super Output Areas, Middle Layer (6,791)
Super Output Areas, Middle Layer (416)
Intermediate Zones (1,279)
Super Output Areas, Lower Layer (32,844)
Super Output Areas, Lower Layer (1,909)
Data Zones (6,976)
Super Output Areas (890)
Output Areas (171,372)
Output Areas (46,351)
Output Areas (10,036)
Small Areas (4,537)
Non-Civil Parished Areas (217)
Settlement 2015 (639)
Census Merged Councils (35)
Census Merged Local Authority Districts (346)
Census Merged Wards (8,546)
Census Detailed Characteristics (866)
Census Local Characteristics (1012)
Built-up Areas (5,830)
Built-up Area sub-divisions (1,836)
Workplace Zones (60,709)
Northern Ireland Fire and Rescue Service Areas (14)
Northern Ireland Fire and Rescue Service Areas (4)
Northern Ireland Fire and Rescue Service (1)
Police Force Districts (31)
Police Force Area (1)
Police Force Area (1)
Localities (643)
Scottish Fire and Rescue Service (1)
Scottish Fire and Rescue Service Delivery Areas (3)
Regeneration Outcome Agreement Areas – Scotland (1)
Settlements (516)
Island Groups (57)
Travel to Work Areas (228)
National Parks (15)
Enterprise Regions (8)
Community Safety Partnerships (315)
Registration Sub-Districts (175)
Fire and Rescue Authorities (48)
Police Force Areas (43)
Registration Districts (175)
Local Resilience Forums (42)
LEP – overlapping part (15)
LEP – non overlapping part (18)
Enterprise Zones (48)
Local Enterprise Partnerships (38)
Primary Urban Areas (56)
Waste Authorities (9)
Development Corporations (4)
Regional Transport Partnerships (7)
Community Justice Authorities (8)
Scottish Police Divisions (13)
Regeneration Outcome Areas – Local Areas (100)
Urban Regeneration Companies (6)
Highlands and Islands Enterprise (8)
Broad Rental Market Areas (18)
National Assembly Economic Regions (4)
OCEALLs (4)
Strategic Regeneration Sub-areas (2)
Spatial Plan Sub-areas (3)
Agricultural Small Areas (335)
Transport Consortia Areas (4)
Strategic Regeneration Areas (7)
Spatial Plan Areas (6)
Agricultural Regions (7)
Communities First Areas (52)
LAU2 Areas (10,126)
LAU1 Areas (415)
NUTS 3 Areas (173)
NUTS 2 Areas (40)
NUTS 1 Areas (12)
London Assembly Constituencies (14)
National Assembly for Wales Constituencies (40)
Westminster Parliamentary Constituencies (650)
Scottish Parliamentary Constituencies (73)
District Electoral Areas (80)
Northern Ireland Assembly Constituencies (18)
National Assembly for Wales Electoral Regions (5)
European Electoral Regions (12)
Scottish Parliamentary Regions (8)

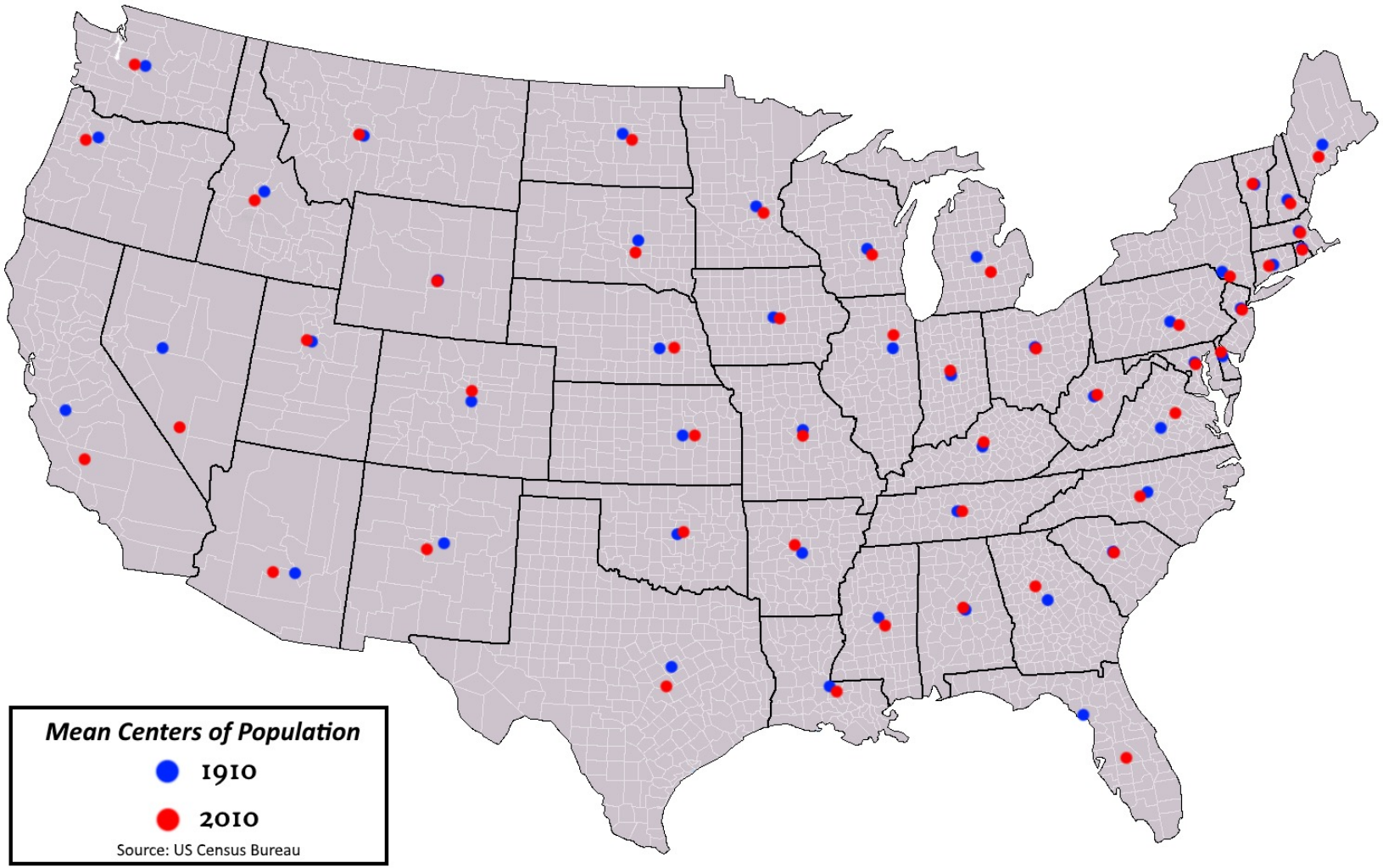
Shape I

- Identify and characterise a shape, e.g. following a process of spatially clustering individual objects or geometries.
- Quantifiable with a compactness ratio or perimeter/area ratio.
- Shape can be important to consider when calculating geometric centroids.

Shape II



Shape II

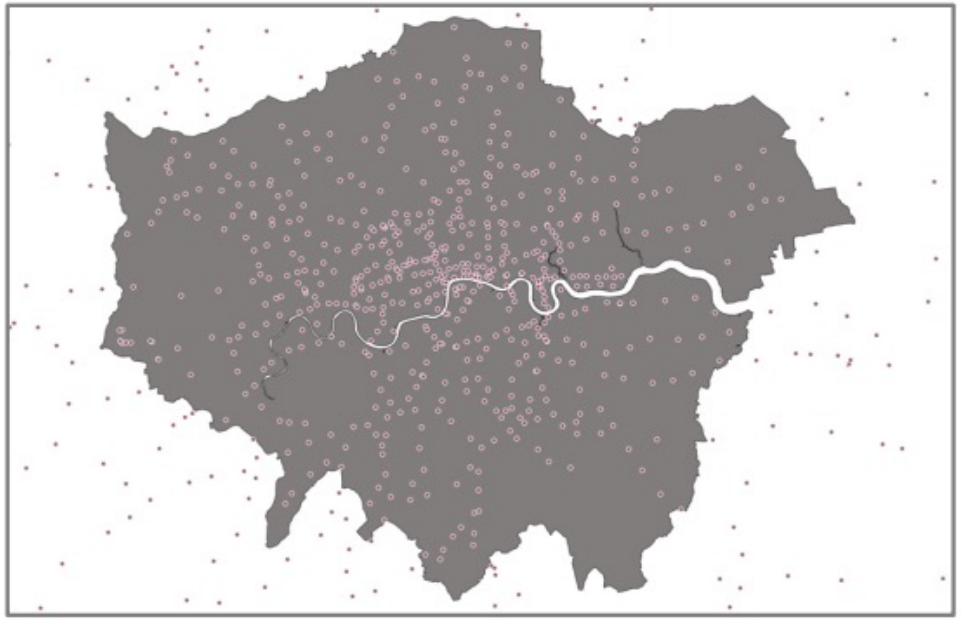

Mean Centers of Population
1910
2010
Source: US Census Bureau

Spatial operations I

- Building blocks of spatial data analysis: selecting, filtering, reducing, and merging different geometries.
- Using spatial properties like distance, area, and shape.

Spatial operations II

?



Spatial operations III

Use of spatial relationships to take data as an input, “do something” with the data and then produce output data that is a derivative of the analysis performed on the input data.

Spatial operations III

Use of spatial relationships to take data as an input, “do something” with the data and then produce output data that is a derivative of the analysis performed on the input data.

Spatial relationships I

- Spatial relationships define how exteriors, interiors, and boundaries of different geometries interact with one another.
- Known as topological relationship.
- Evaluates adjacency, connectivity, and / or containment.

Spatial relationships II

Equals A is the same as B	
Touches A touches B	
Overlaps A and B have multiple points in common	
Contains A contains B	
Disjoint A shares nothing with B	
Covers A covers B (or vice versa)	
Crosses A and B have at least one point in common	

Spatial relationships III

- There is some spatial maths behind calculating the topological relationships between spatial objects.
- *“Does polygon A overlap with Polygon B?”*

  1 Establish exterior, interior and boundaries of the geometries of each the object.

  2 Calculate the number of times these three properties intersect with one another.

  3 Follow the requirements of the function to understand if it is TRUE or FALSE.

Spatial analysis

`Spatial properties` + `Spatial Relationships` =

`Spatial Analysis`

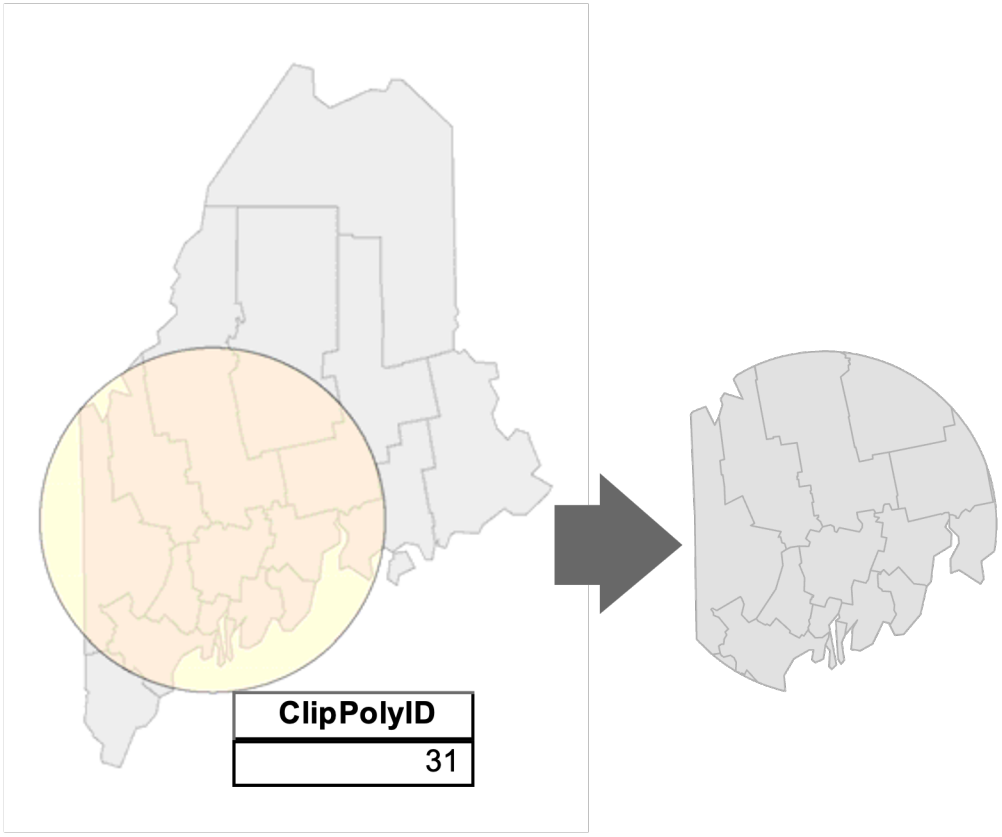
Spatial analysis

`Spatial analysis` =

`Geometric Operations` + `Spatial Queries`

Vector operations I - Clip

NAME
Androscoggin
Aroostook
Cumberland
Franklin
Hancock
Kennebec
Knox
Lincoln
Oxford
Penobscot
Piscataquis
Sagadahoc
Somerset
Waldo
Washington
York



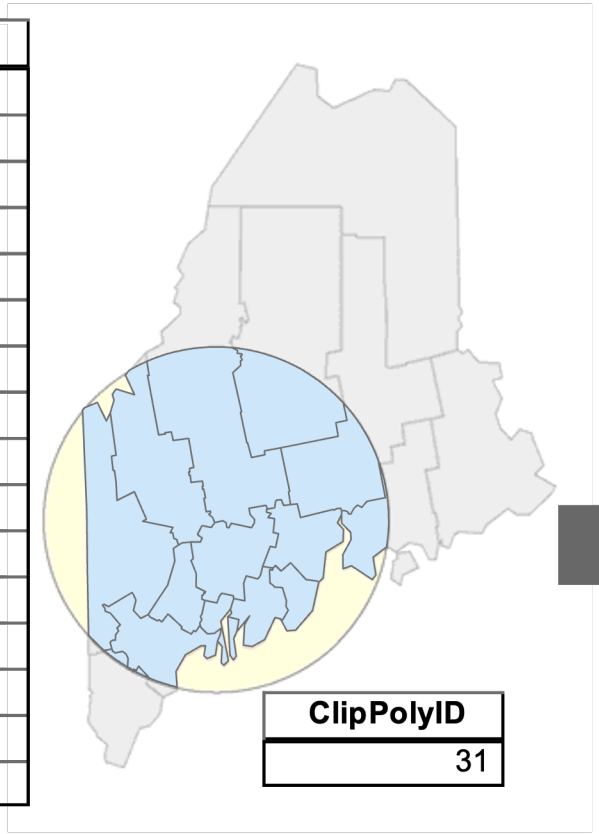
ClipPolyID
31

NAME
Androscoggin
Cumberland
Franklin
Hancock
Kennebec
Knox
Lincoln
Oxford
Penobscot
Piscataquis
Sagadahoc
Somerset
Waldo
York

Gimdond, M. 2021. Intro to GIS and Spatial Analysis. [online] https://mgimond.github.io/Spatial/introGIS.html

Vector operations II - Intersect

NAME
Androscoggin
Aroostook
Cumberland
Franklin
Hancock
Kennebec
Knox
Lincoln
Oxford
Penobscot
Piscataquis
Sagadahoc
Somerset
Waldo
Washington
York



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Penobscot	31
Piscataquis	31
Sagadahoc	31
Somerset	31
Waldo	31
York	31

Gimdond, M. 2021. Intro to GIS and Spatial Analysis. [online]
https://mgimond.github.io/Spatial/introGIS.html

Vector operations III - Union

NAME
Androscoggin
Aroostook
Cumberland
Franklin
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Kennebec
Knox
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Penobscot
Piscataquis
Sagadahoc
Somerset
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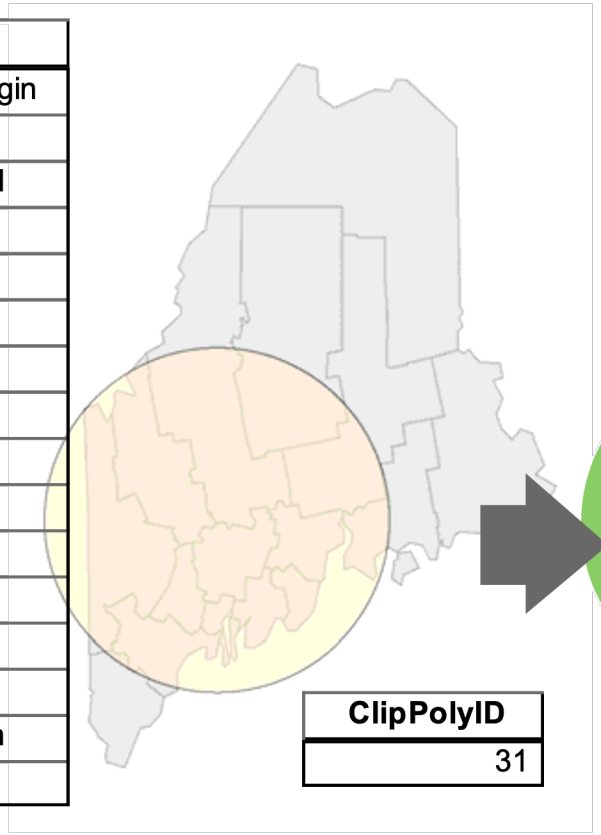

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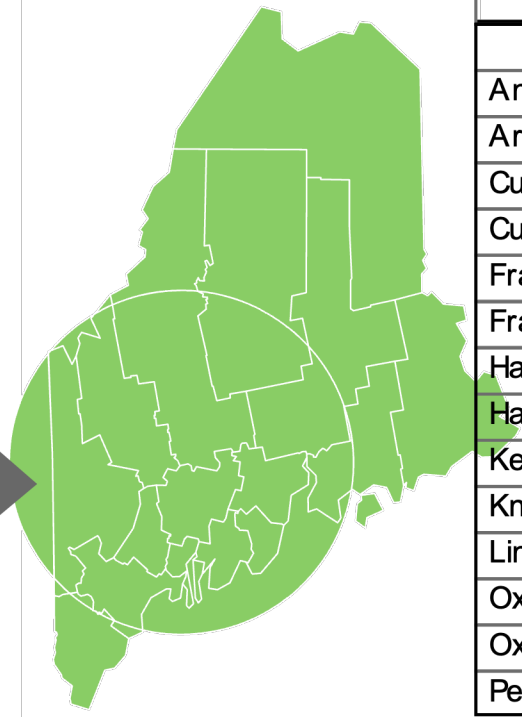

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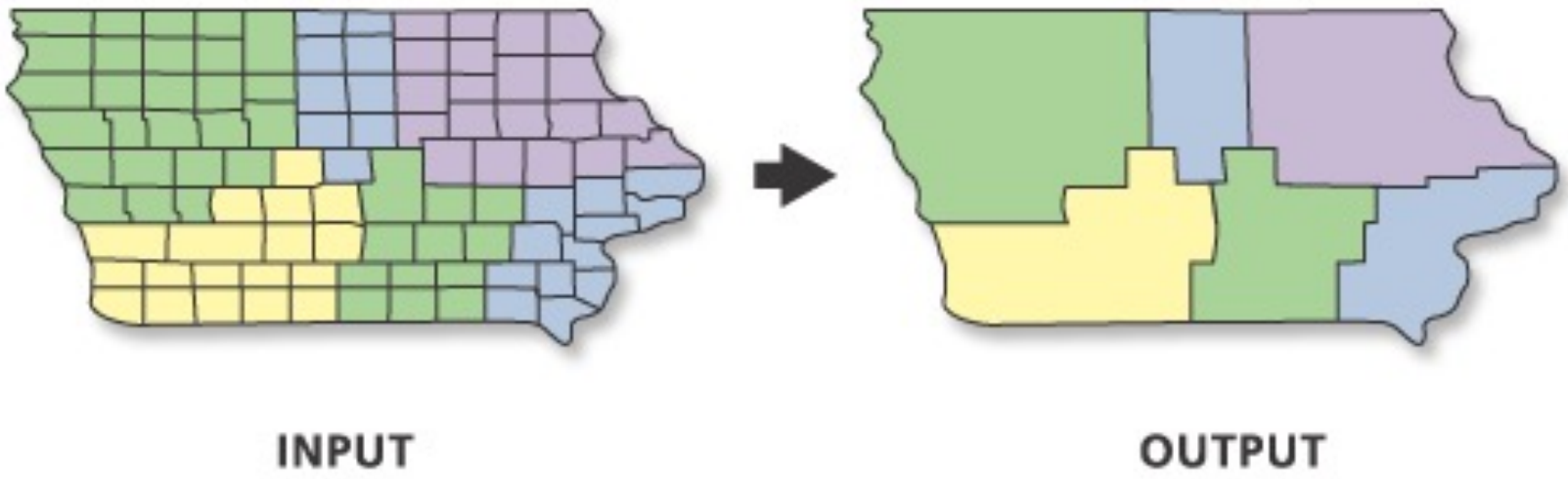
Kennebec	31
Knox	31
Lincoln	31
Oxford	0
Oxford	31
Penobscot	0

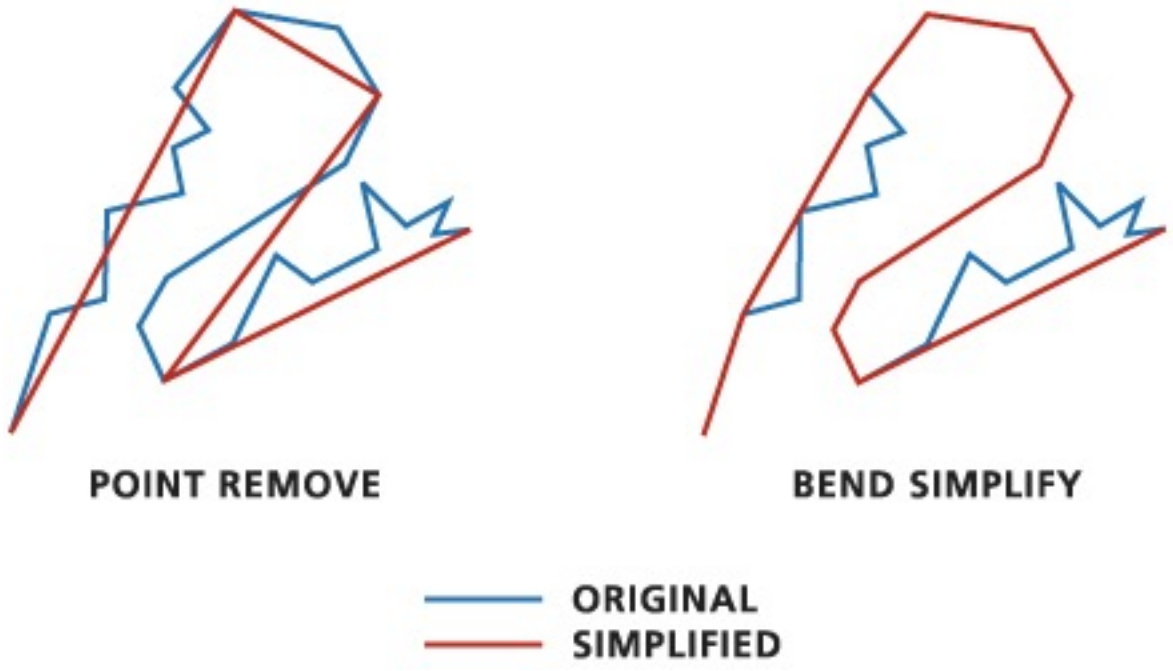
Gimdond, M. 2021. Intro to GIS and Spatial Analysis. [online]
https://mgimond.github.io/Spatial/introGIS.html

Vector operations IV - Dissolve



ESRI. 2021. Dissolve. [online]
https://pro.arcgis.com/en/pro-app/latest/tool-reference/data-management/dissolve.htm

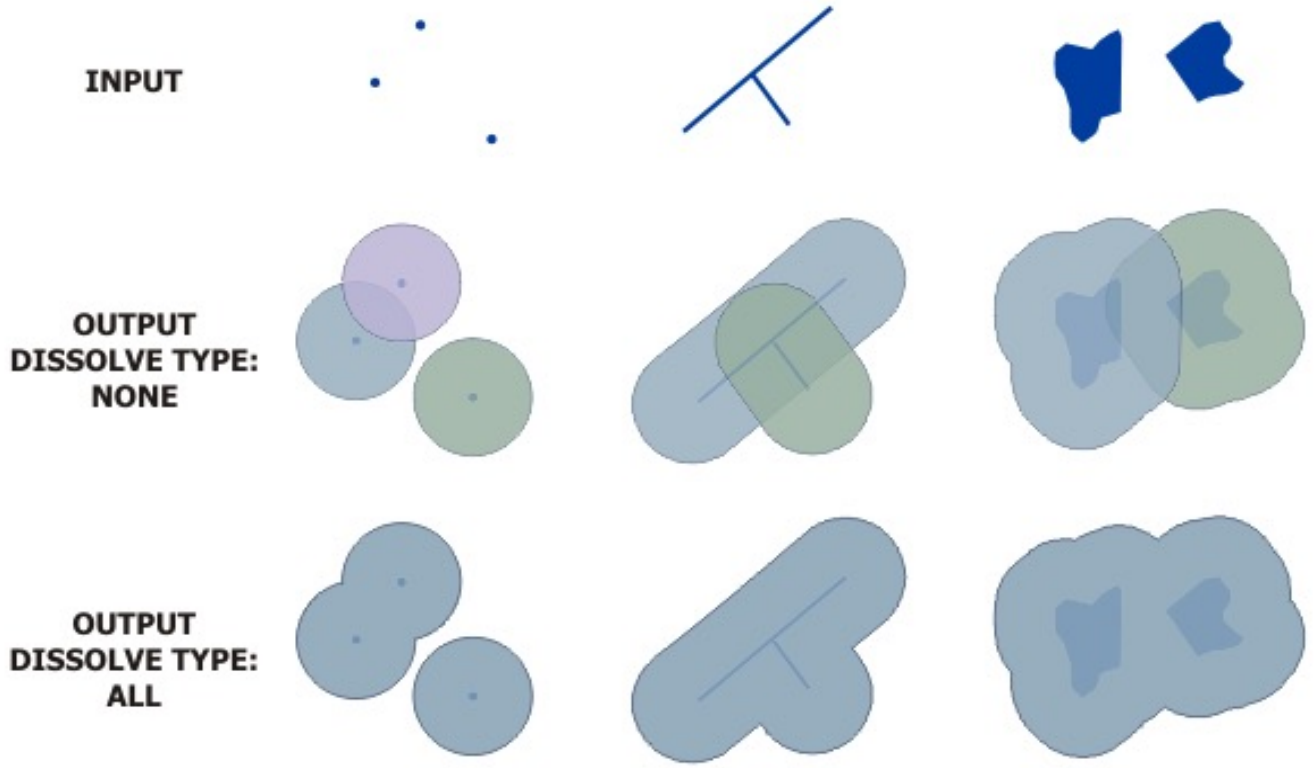
Vector operations V - Simplify



ESRI. 2021. Simplify line. [online]
https://desktop.arcgis.com/en/arcmap/10.3/tools/cartography-toolbox/simplify-line.htm

Vector operations V - Simplify

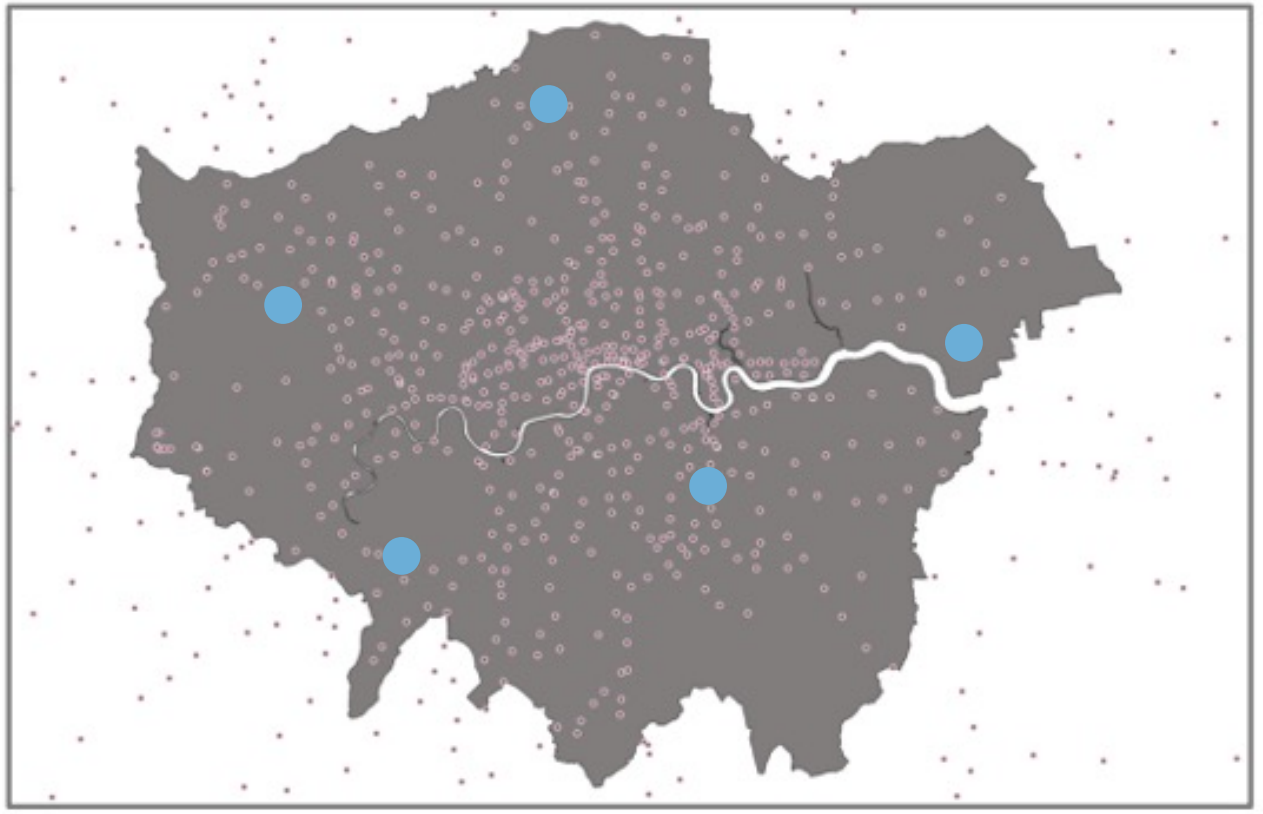
Vector operations VI - Buffer



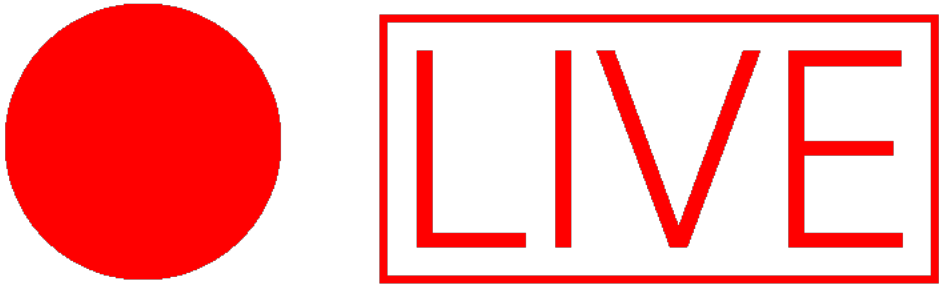
ESRI. 2021. Buffer. [online]
https://pro.arcgis.com/en/pro-app/latest/tool-reference/analysis/buffer.htm

Vector operations VII – Spatial query

Vector operations VIII – Attribute query



RStudio



Conclusion

- The core of spatial analysis comes down to executing geometric operations and spatial queries.
- Spatial analysis relies therewith on the spatial properties of an object as well as on the spatial relationships both *within* and *between* spatial objects.

Computer tutorial

- Today: conducting geometric operations and spatial queries with yet another case study of London.
- Carefully read the instructions although there *may* be small deviations in the syntax.
- Assignment: no need to hand-in but if you want to leave before the end of the computer tutorial you should be able to show your results.

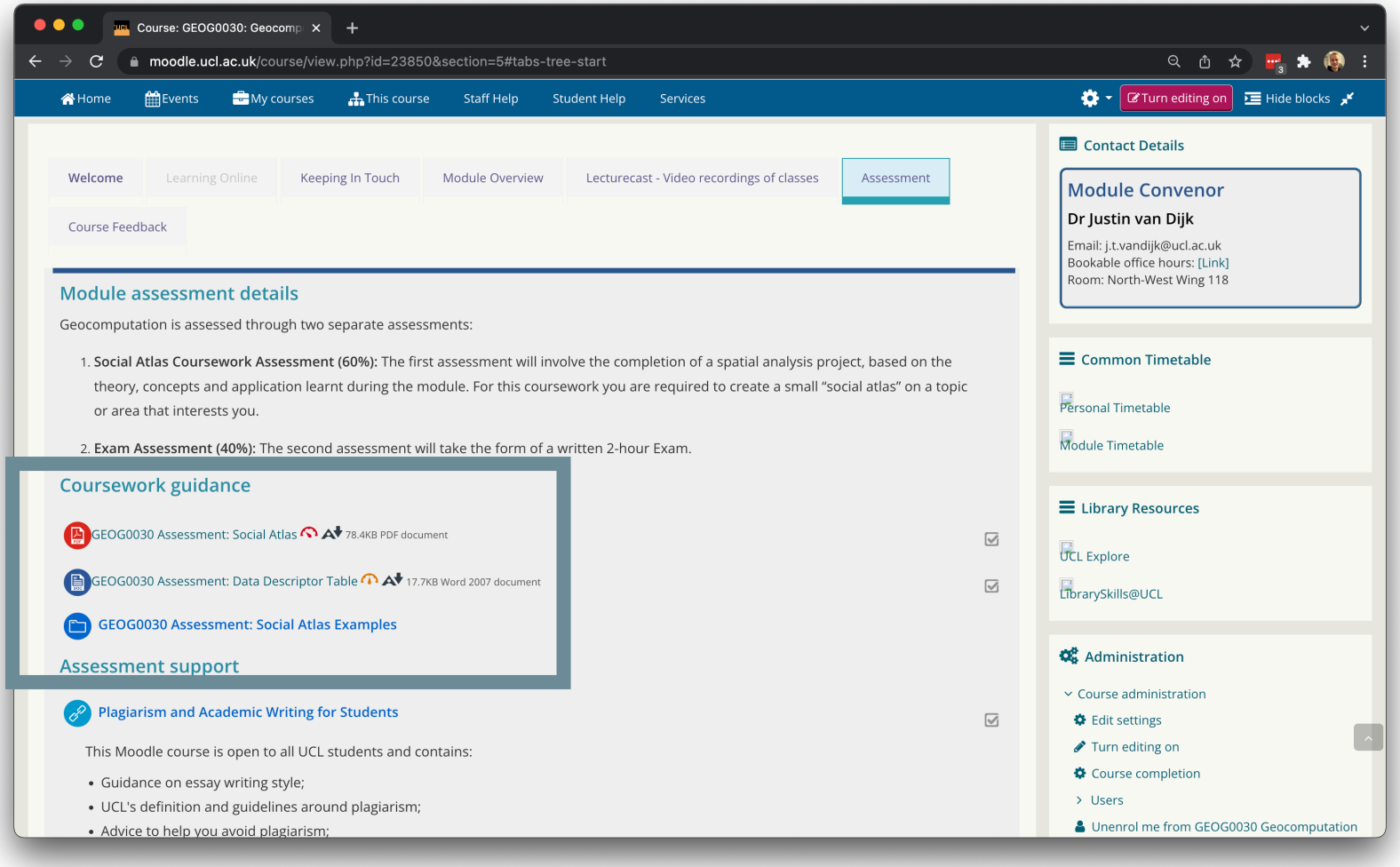
Assessment

- 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.
- On Moodle: guidance as well as examples.

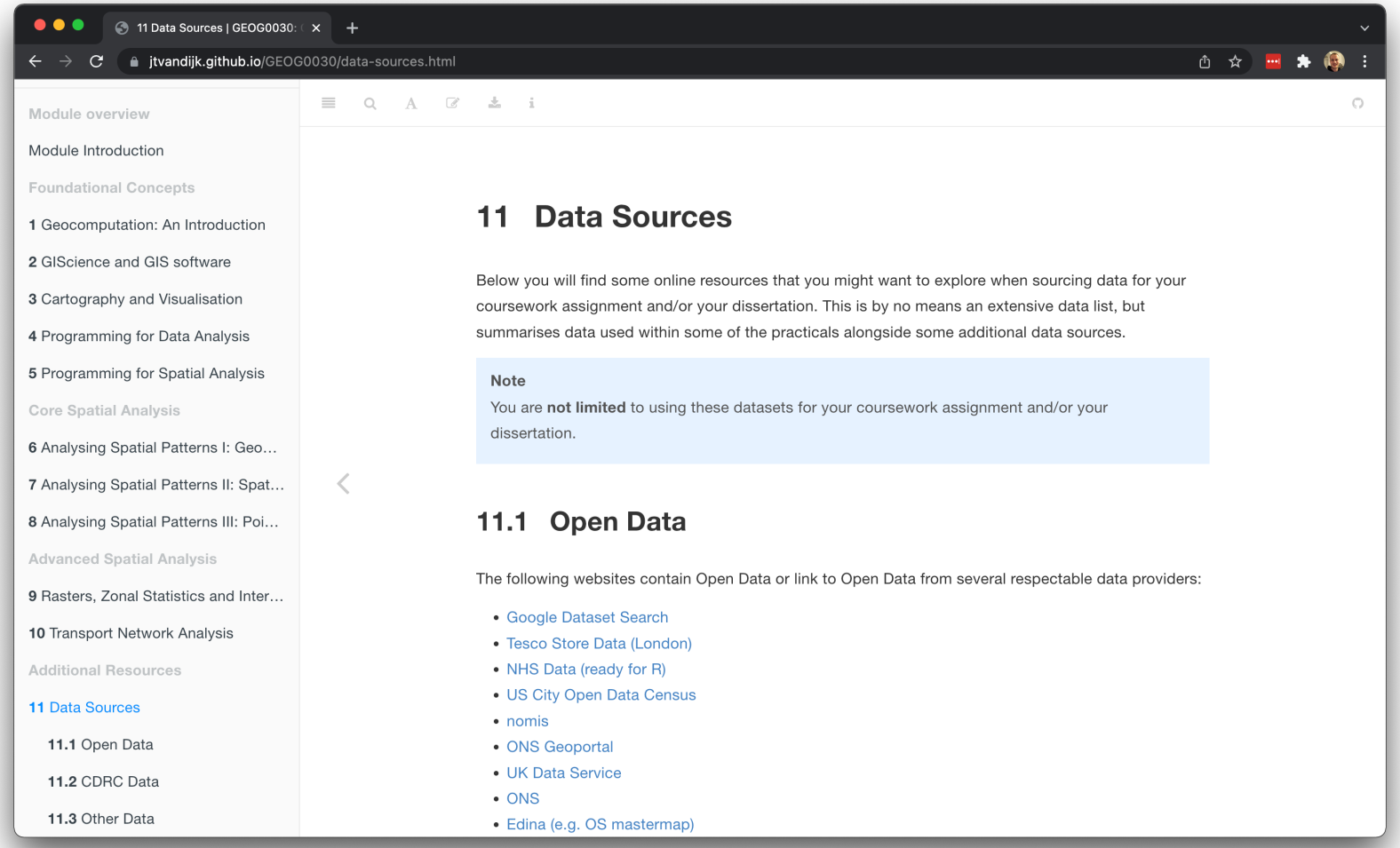
Assessment

- You should create a minimum of 8 maps - and a maximum of 10 - and not exceed 1,500 words.
- You can choose a specific theme, e.g. “Healthy Living” or “COVID19 impact across England”, or create a research question to answer.
- You should aim to utilise a range of different techniques taught in the Geocomputation module to explore your topic – but make sure you apply the techniques in appropriate manner and with the right data types.

Assessment


Course: GEOG0030: Geocomp
moodle.ucl.ac.uk/course/view.php?id=23850&section=5#tabs-tree-start
Home
Events
My courses
This course
Staff Help
Student Help
Services
Turn editing on
Hide blocks
Welcome
Learning Online
Keeping In Touch
Module Overview
Lecturecast - Video recordings of classes
Assessment
Course Feedback
Module assessment details
Geocomputation is assessed through two separate assessments:
1. 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.
2. Exam Assessment (40%): The second assessment will take the form of a written 2-hour Exam.
Coursework guidance
GEOG0030 Assessment: Social Atlas 78.4KB PDF document
GEOG0030 Assessment: Data Descriptor Table 17.7KB Word 2007 document
GEOG0030 Assessment: Social Atlas Examples
Assessment support
Plagiarism and Academic Writing for Students
This Moodle course is open to all UCL students and contains:
• Guidance on essay writing style;
• UCL's definition and guidelines around plagiarism;
• Advice to help you avoid plagiarism;
Contact Details
Module Convenor
Dr Justin van Dijk
Email: j.t.vandijk@ucl.ac.uk
Bookable office hours: [Link]
Room: North-West Wing 118
Common Timetable
Personal Timetable
Module Timetable
Library Resources
UCL Explore
LibrarySkills@UCL
Administration
Course administration
Edit settings
Turn editing on
Course completion
Users
Unenrol me from GEOG0030 Geocomputation

Assessment


11 Data Sources | GEOG0030:
jtvandijk.github.io/GEOG0030/data-sources.html
Module overview
Module Introduction
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: Geo…
7 Analysing Spatial Patterns II: Spat…
8 Analysing Spatial Patterns III: Poi…
Advanced Spatial Analysis
9 Rasters, Zonal Statistics and Inter…
10 Transport Network Analysis
Additional Resources
11 Data Sources
11.1 Open Data
11.2 CDRC Data
11.3 Other Data
11 Data Sources
Below you will find some online resources that you might want to explore when sourcing data for your coursework assignment and/or your dissertation. This is by no means an extensive data list, but summarises data used within some of the practicals alongside some additional data sources.
Note
You are not limited to using these datasets for your coursework assignment and/or your dissertation.
11.1 Open Data
The following websites contain Open Data or link to Open Data from several respectable data providers:
Google Dataset Search
Tesco Store Data (London)
NHS Data (ready for R)
US City Open Data Census
nomis
ONS Geoportal
UK Data Service
ONS
Edina (e.g. OS mastermap)

Assessment

TL;DR story of at most 1,500 words tied together by 8-10 related maps.

Questions

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