Geocomputation

Raster Data Analysis

UCL

Module outline

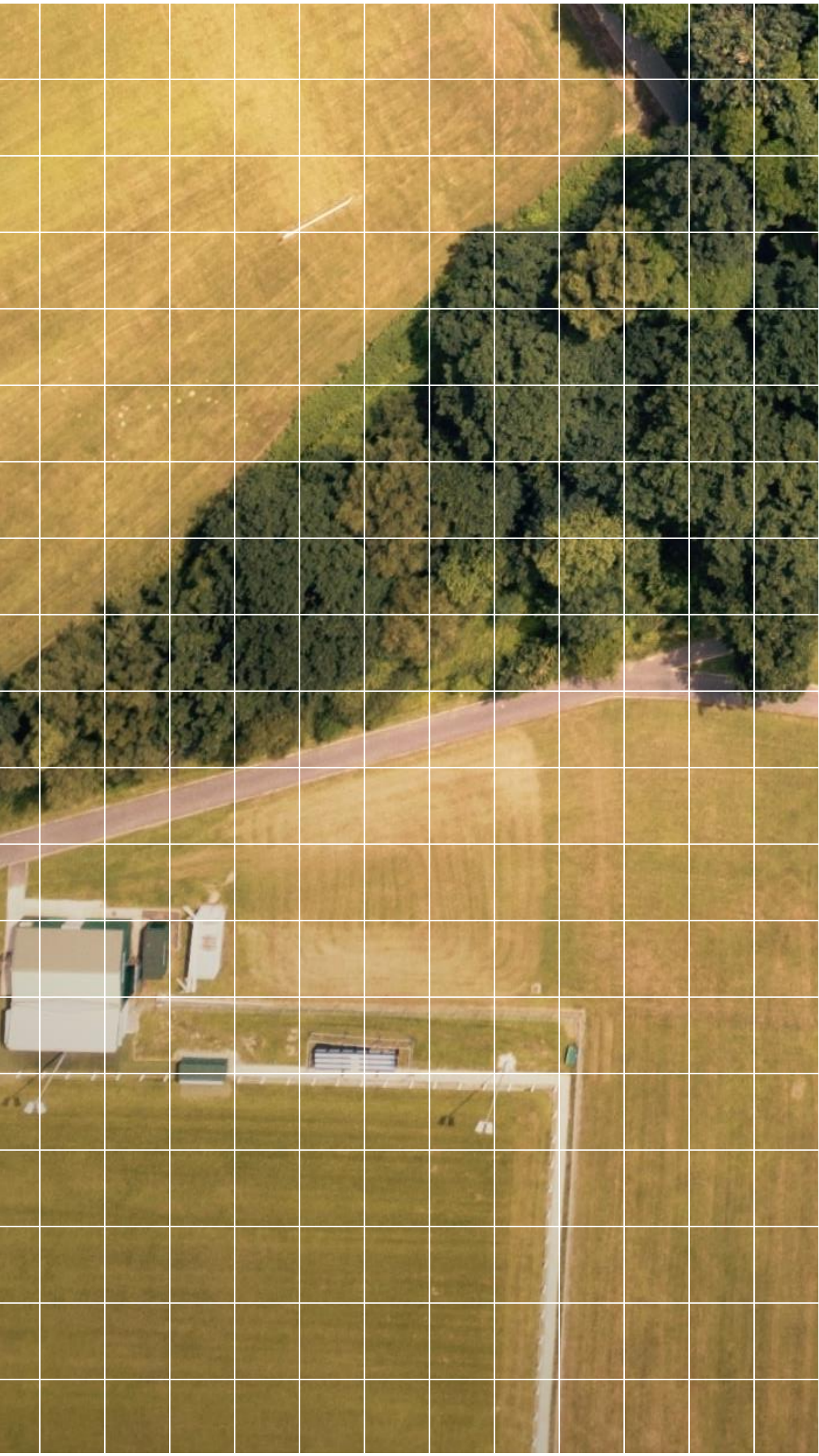
W1	Reproducible Spatial Analysis	Core Spatial Analysis
W2	Spatial Queries and Geometric Operations	
W3	Point Pattern Analysis	
W4	Spatial Autocorrelation	
W5	Spatial Models	
W6	Raster Data Analysis	Applied Spatial Analysis
W7	Geodemographic Classification	
W8	Accessibility Analysis	
W9	Beyond the Choropleth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

This week

- Raster GIS data model.
- Raster-specific functions and operations.
- Spatial data interpolation.

Before we start - CMD

- Go to www.menti.com
- Use code: 5952 5321



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2	5	8	8	9	9	10	0	0	0	1	5	0	0	0	0	0	0	1
2	4	6	8	8	9	0	0	0	1	5	0	0	5	5	5	0	0	1
0	3	6	8	8	0	0	0	0	5	0	5	5	5	5	5	0	0	0
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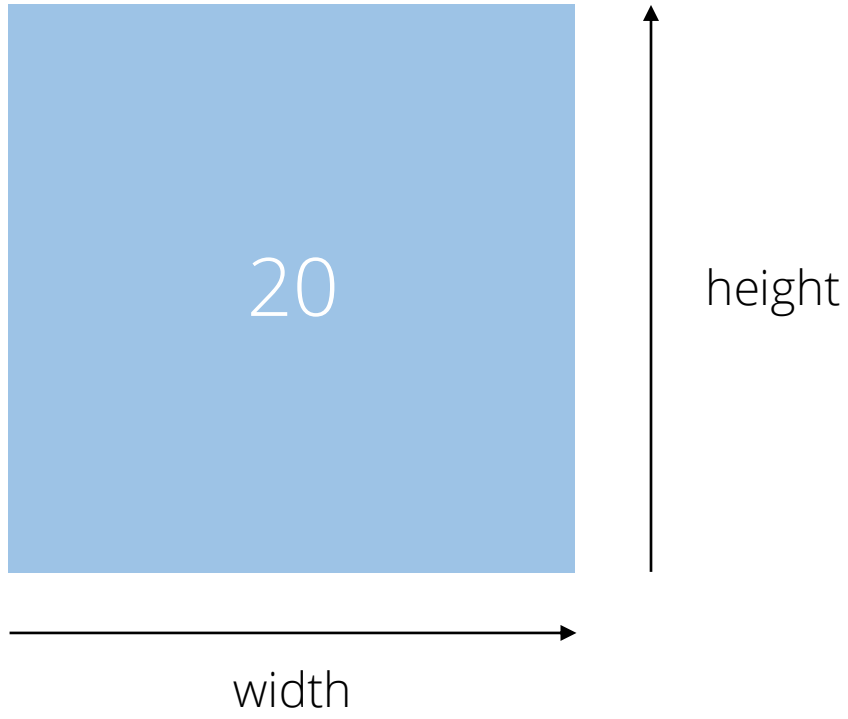
0	0	1	1	2	2	2	2	3	3	3	3	3	3	3	4	0	3	0
1	1	1	1	2	2	3	3	3	3	1	1	1	1	1	2	3	4	3

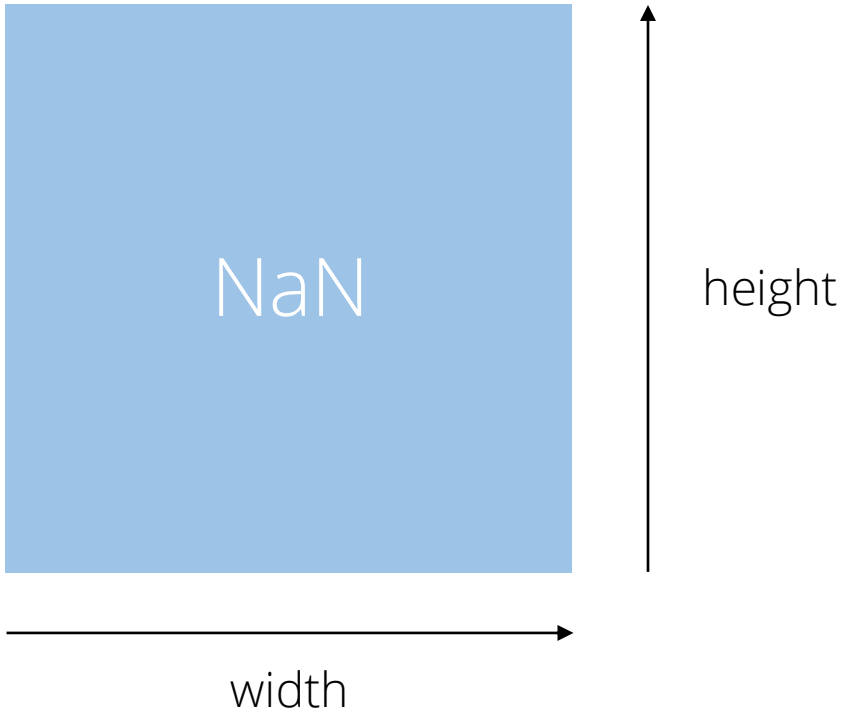
Raster data

- Unlike vector data, raster data represents features as continuous surfaces, showing gradients of change rather than discrete measurements.
- Raster data is organised as a matrix of pixels or grid cells, each containing a numeric or textual value representing a feature.
- It consists of rows and columns, with each pixel or grid cell defined by its resolution (height and width).

Raster data



Raster data



Vector versus raster

- Why not vectorise everything? After all, we can add as many attributes as needed?
- “Raster is faster, but vector is corrector" highlights the trade-offs between these data models.
- The choice between raster and vector data depends on your specific application and the type of analysis you intend to perform.

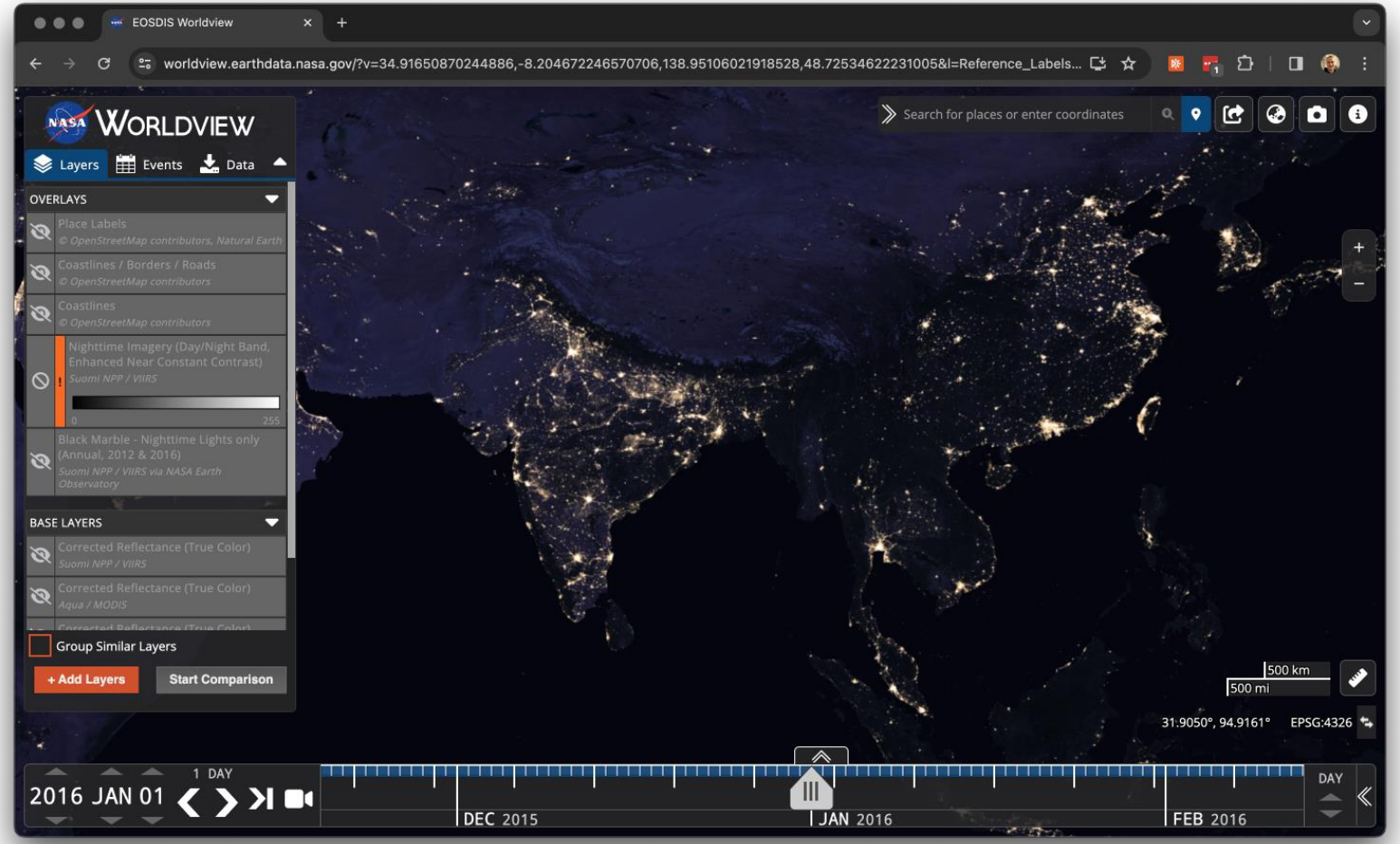
Raster data

- Raster data are commonly found in applications where every location has one value.
- Variable can be continuous (temperature, elevation, air pollution), categorical (land use), or imagery (reflectance values).
- Cell size is constant across the raster surface.
- When do we typically encounter raster data:
  - Remote sensing
  - Outcome of spatial analysis

Raster versus vector

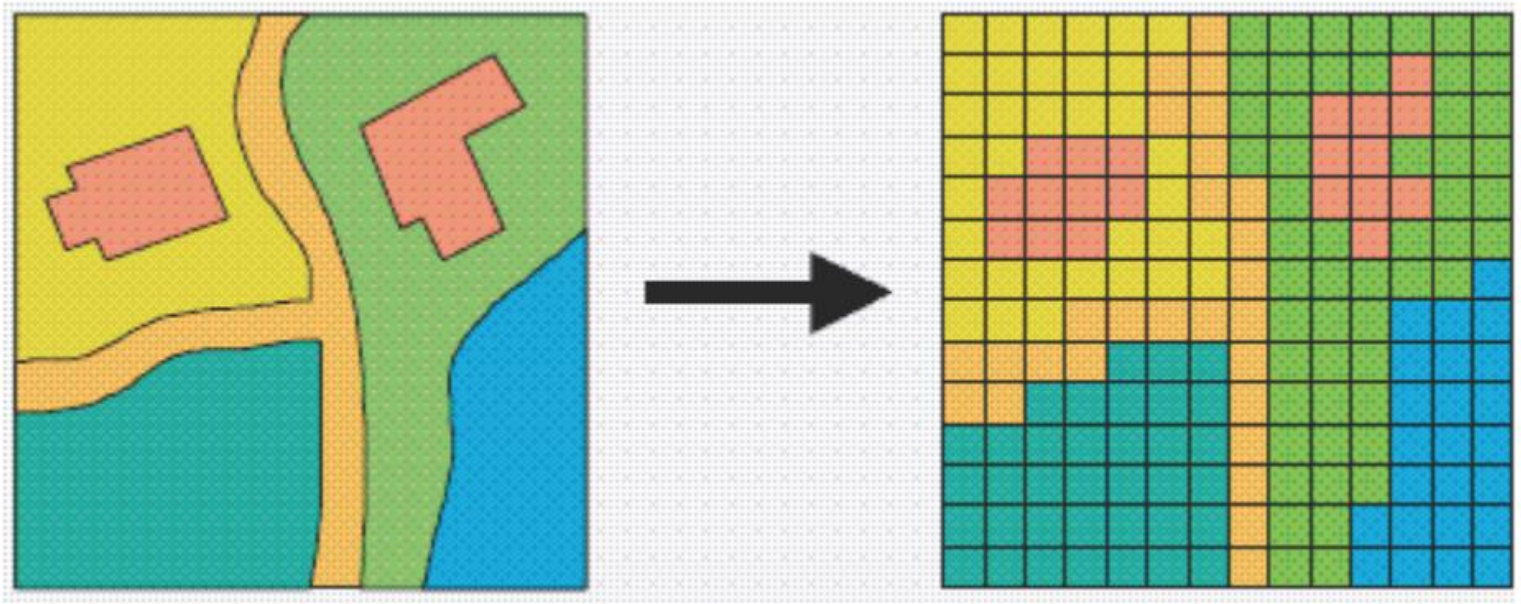
	Advantages	Disadvantages
Raster	Map Algebra with raster data is usually quick and easy to perform	Linear features and paths are difficult to display
	Some specific use cases can only be achieved with raster data (e.g. modeling water flow over the land surface)	Subject to a pixelated look and feel
		Datasets can become very large because they record values for each cell
Vector	Graphical output is generally more aesthetically-pleasing	Continuous data is poorly stored and displayed
	Higher geographic accuracy because data isn't dependent on grid size	Needs a lot of work and maintenance to ensure that it is accurate and reliable

Raster data



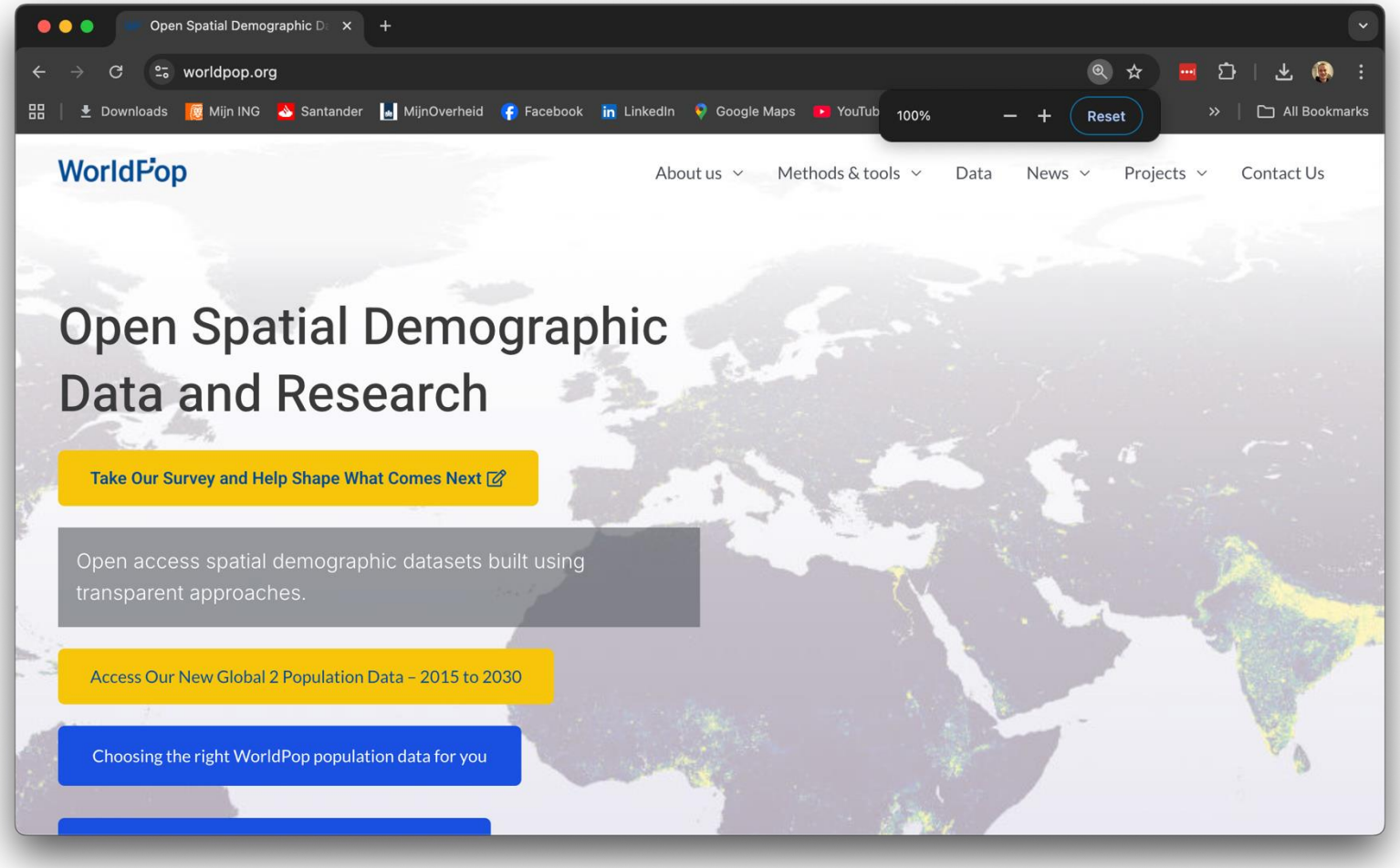
Continuous (numerical value of data)

Raster data

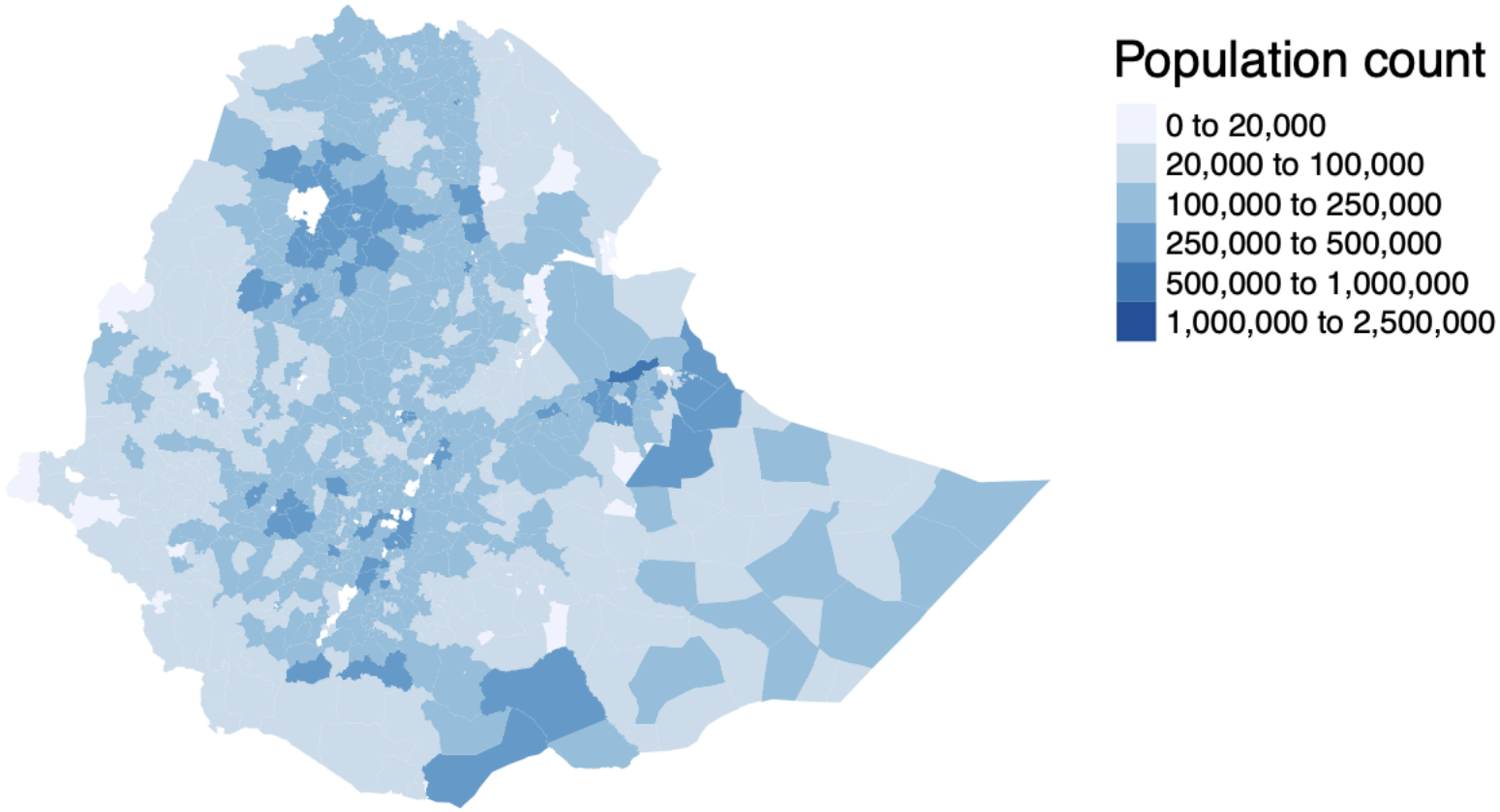


Categorical (number represent category)

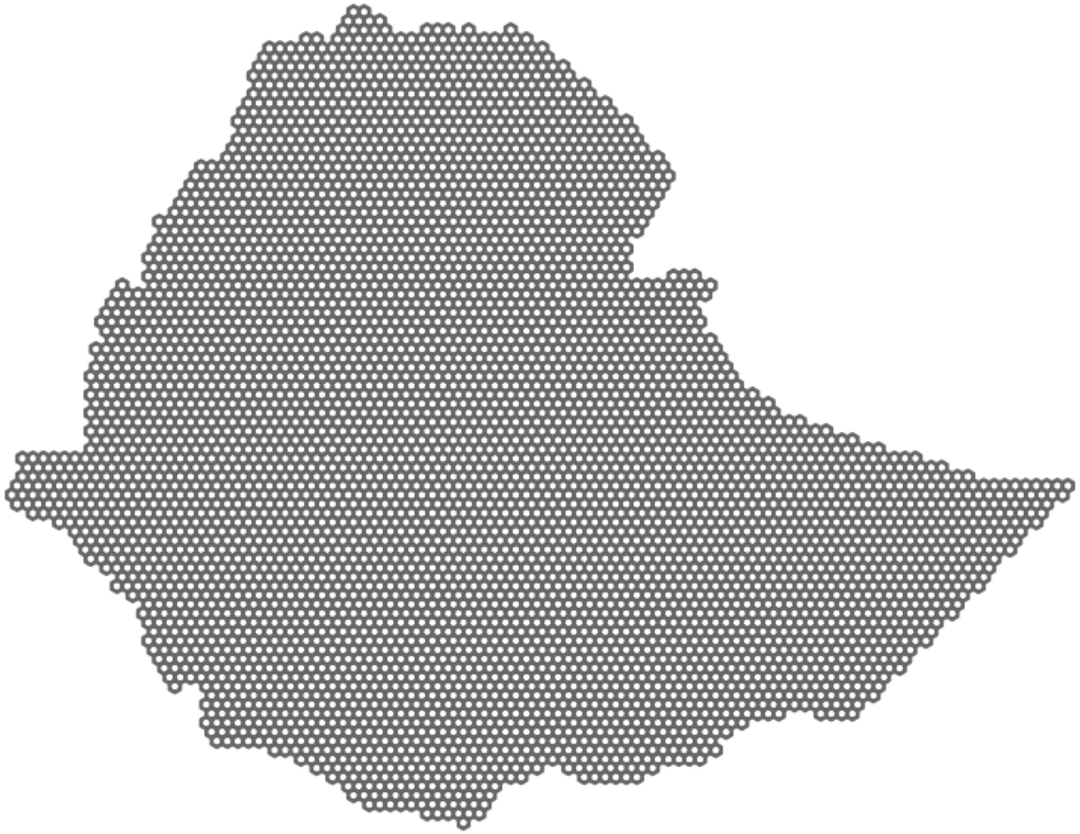
Raster data


Open Spatial Demographic D
worldpop.org
Downloads
Mijn ING
Santander
MijnOverheid
Facebook
LinkedIn
Google Maps
YouTub
100%
Reset
All Bookmarks
WorldPop
About us
Methods & tools
Data
News
Projects
Contact Us
Open Spatial Demographic Data and Research
Take Our Survey and Help Shape What Comes Next
Open access spatial demographic datasets built using transparent approaches.
Access Our New Global 2 Population Data – 2015 to 2030
Choosing the right WorldPop population data for you

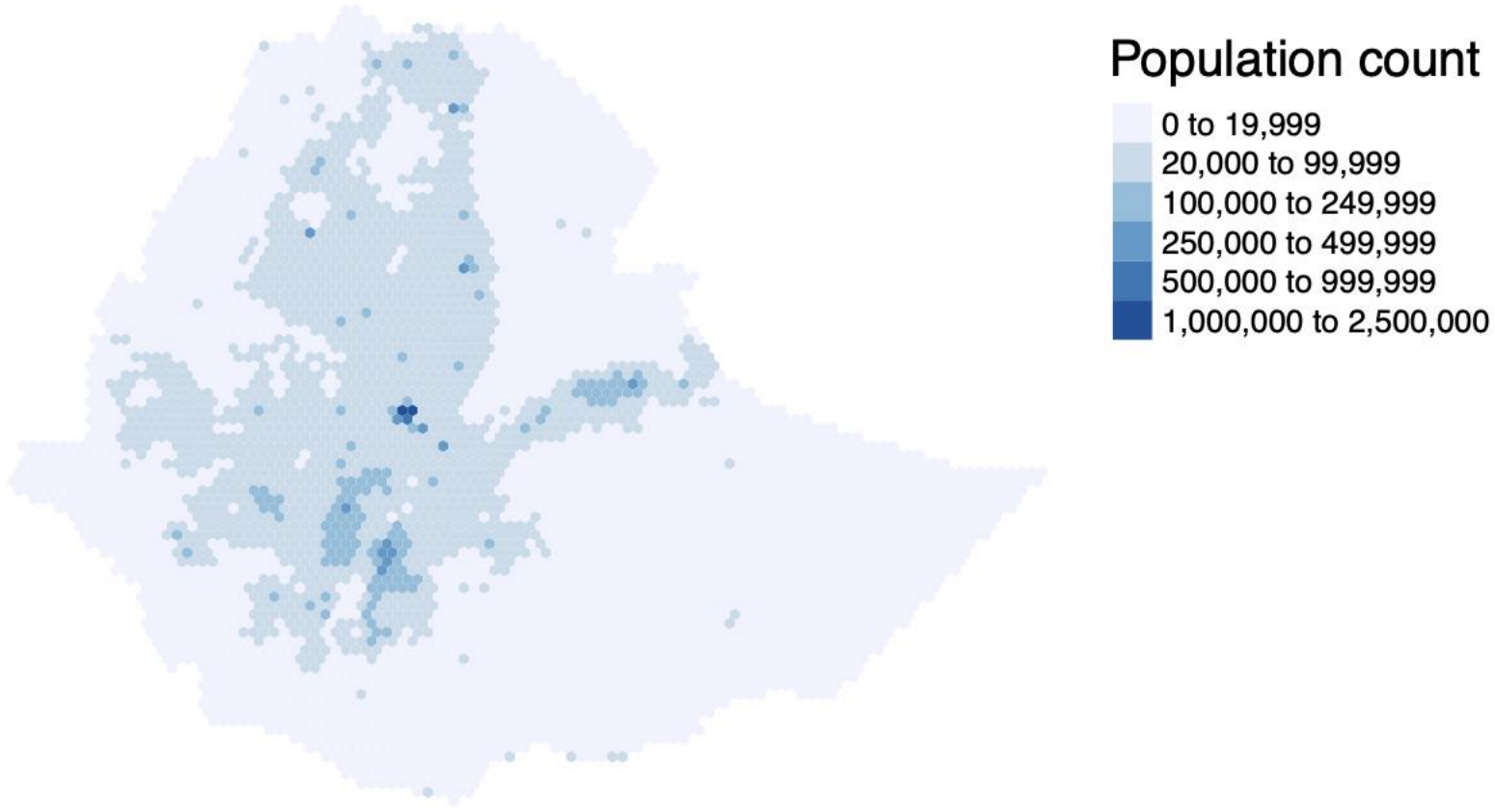
Raster data


Population count
0 to 20,000
20,000 to 100,000
100,000 to 250,000
250,000 to 500,000
500,000 to 1,000,000
1,000,000 to 2,500,000

Raster data



Raster data


Population count
0 to 19,999
20,000 to 99,999
100,000 to 249,999
250,000 to 499,999
500,000 to 999,999
1,000,000 to 2,500,000

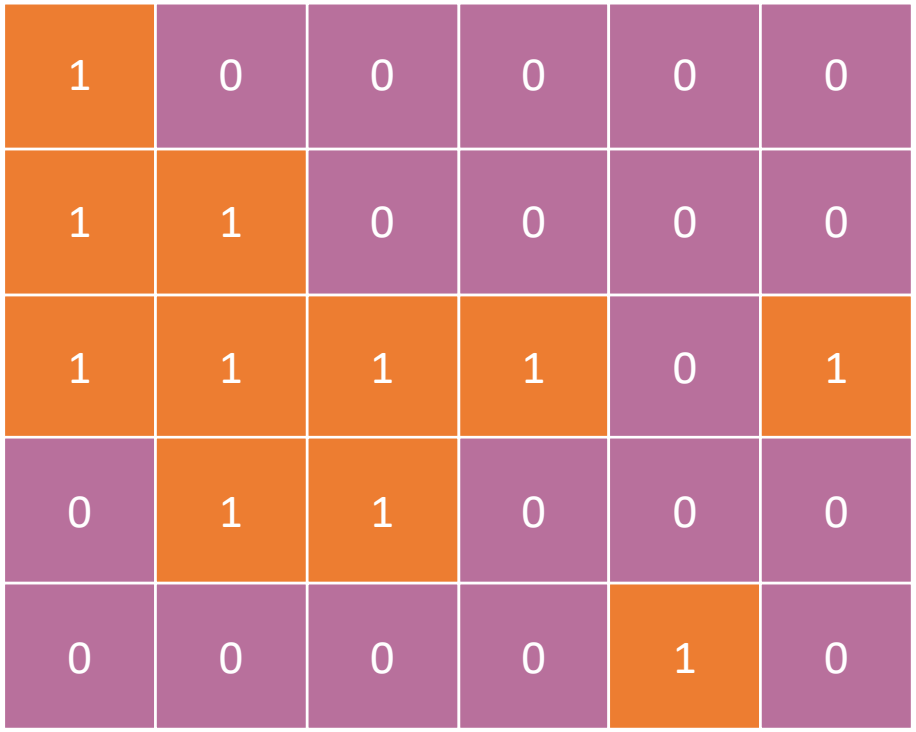
Raster data

- Multiple data formats, including GeoTIFF, ASCII Grid, Esri Grid and GIF.
- Must be georeferenced (i.e. have a CRS) to plot properly.
- Using raster data also means we should use raster-specific functions and operations.

Raster data

- Local operations — applied to each individual cell and only involve those cells sharing the same location
- Focal operations — assign to the output cells some summary value of the neighbouring cells
- Zonal operations — computes a new summary value from aggregated cells
- Global operations — make use of some or all input cells when computing an output cell

Raster data



basic raster

Local operations and functions

1	0	0	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1
0	1	1	0	0	0
0	0	0	0	1	0

multiplication * 2

2	0	0	0	0	0
2	2	0	0	0	0
2	2	2	2	0	2
0	2	2	0	0	0
0	0	0	0	2	0

1	0	0	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1
0	1	1	0	0	0
0	0	0	0	1	0

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

addition

2	0	0	0	0	0
2	3	0	0	0	0
2	3	2	2	0	2
0	3	2	0	0	0
0	0	0	0	2	0

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

logical

0	0	0	0	0	0
0	2	0	0	0	0
0	2	0	0	0	0
0	2	0	0	0	0
0	0	0	0	0	0

1	0	0	0	0	0
1	1	0	0	0	0
1	1	1	1	0	1
0	1	1	0	0	0
0	0	0	0	1	0

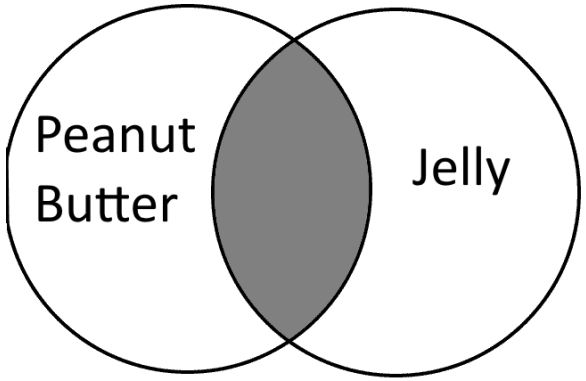
1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

Boolean AND

1	1	1	1	1	1
1	0	1	1	1	1
1	0	1	1	1	1
1	0	1	1	1	1
1	1	1	1	1	1

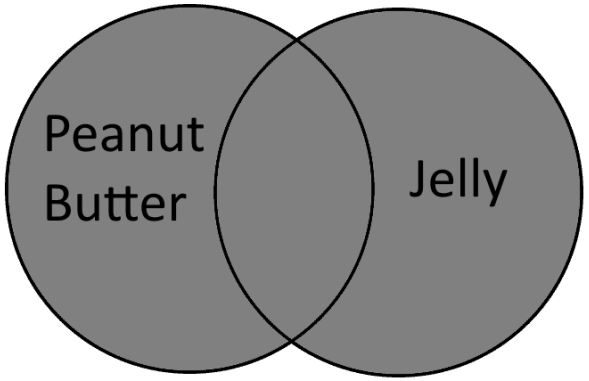
Boolean operators

Truth evaluation using Boolean operators



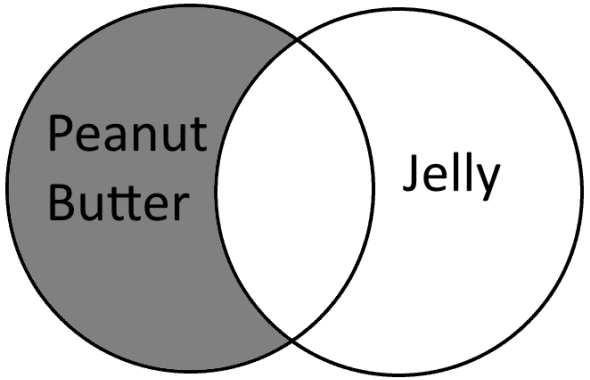
AND

Using AND, this search would only retrieve results with Peanut Butter and Jelly.



OR

Using OR, this search would retrieve results with peanut butter, with jelly, and with both.



NOT

Using NOT, this search would retrieve results with peanut butter, and exclude those with jelly or PB with jelly.

Focal operations and functions

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

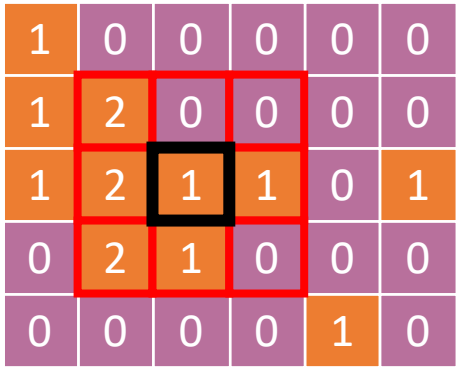
focal (sum)

3	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

focal (sum)

3	0	0	0	0	0
6	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0



focal (sum)

3	0	0	0	0	0
6	0	0	0	0	0
0	0	8	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

Zonal operations and functions

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

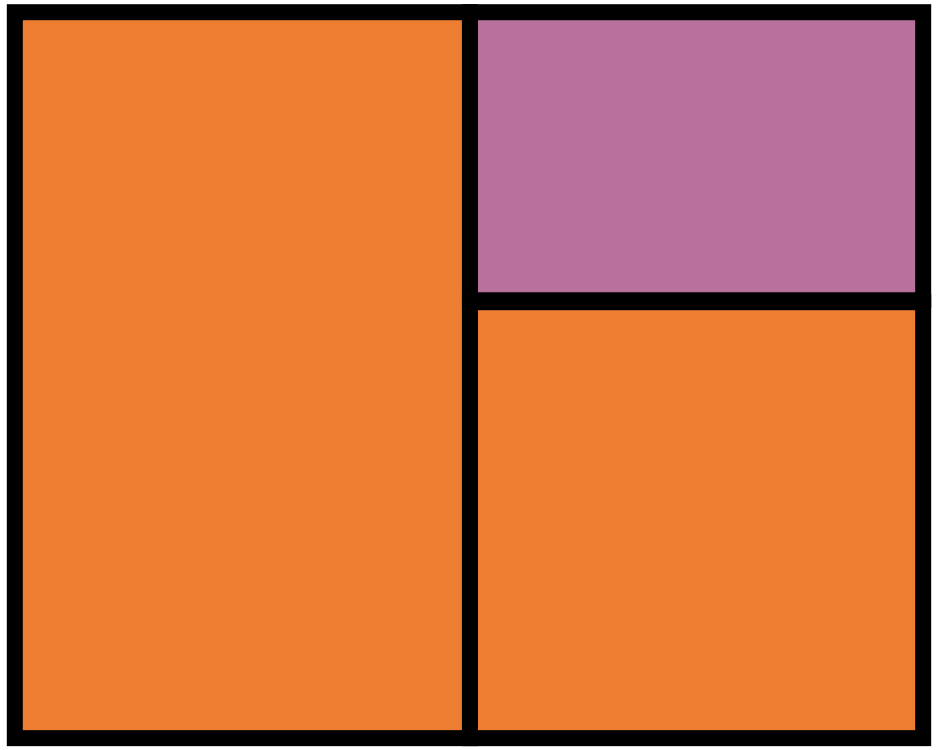
zonal

11	11	11	0	0	0
11	11	11	0	0	0
11	11	11	3	3	3
11	11	11	3	3	3
11	11	11	3	3	3

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

1	0	0	0	0	0
1	2	0	0	0	0
1	2	1	1	0	1
0	2	1	0	0	0
0	0	0	0	1	0

zonal



Global operations and functions

Contents lists available at ScienceDirect

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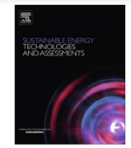
journal homepage: www.elsevier.com/locate/seta



Original Research Article

Multi-criteria decision support system for wind farm site selection using GIS

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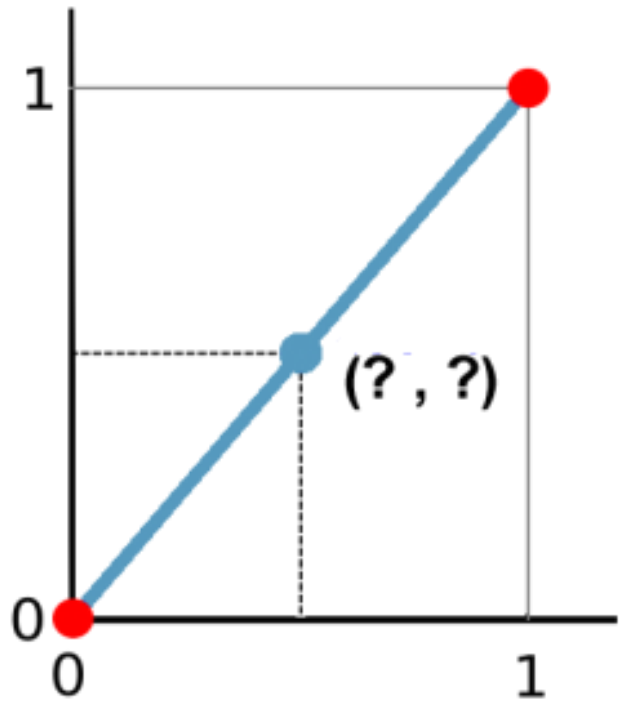
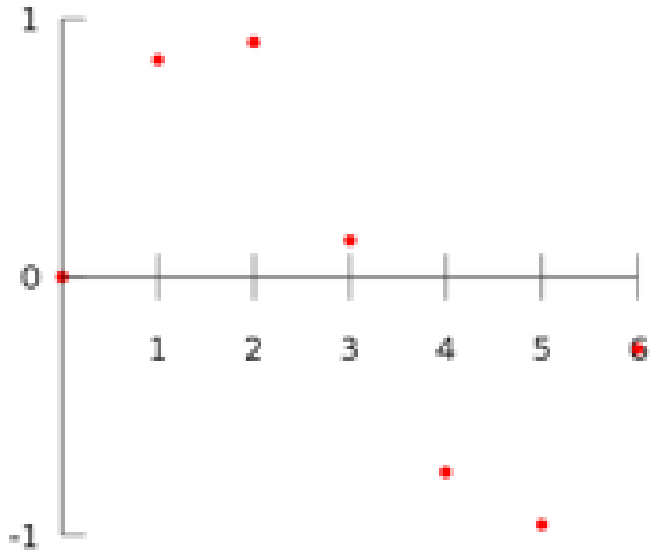
ABSTRACT

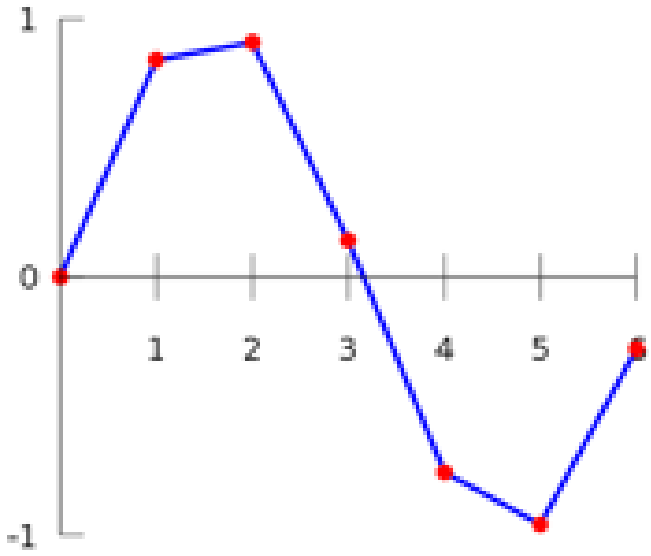
The present study analyzed a multi-criteria decision support system to define wind energy resources in western Iran. Clean domestic renewable energy can be the best option in consideration of intense economic development and its accompanying increase in energy consumption. The most important barrier to wider deployment of renewable resources in Iran is the price of fossil fuels, which is the lowest in the world. The government has recently decided to remove subsidies for fossil fuel, meaning that its price will increase and will make the cost of green energies more attractive.

Wind power is an option for improved economic conditions in the region and low environmental impacts. This study applied geographic information system to determine the potential of wind energy in Markazi province in western Iran. The multiple criteria decision making method and site selection criterion for wind resources assessment is explained and developed for the study area. Criteria of equal importance were investigated, including technical, environmental, economic and geographic standards. The results were favorable for electricity production in accordance with international standards from wind in western Iran. The results show that 28% of the study area has capacity for installing large wind farms.

Data interpolation


1
(? , ?)
0
0
1


1
0
-1
1
2
3
4
5
6


1
0
-1
1
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3
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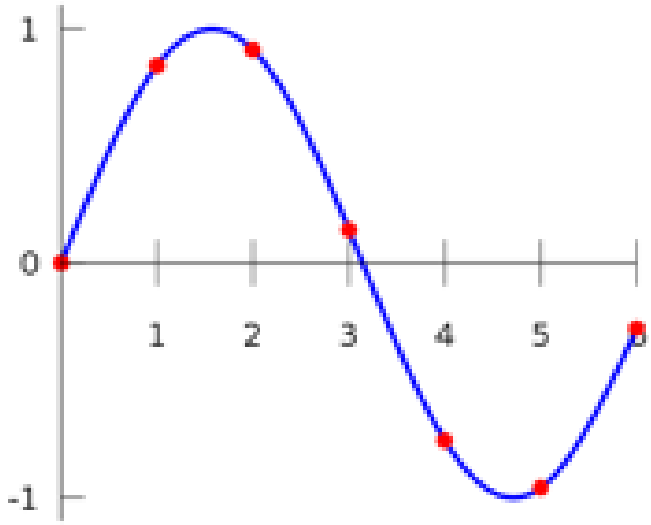
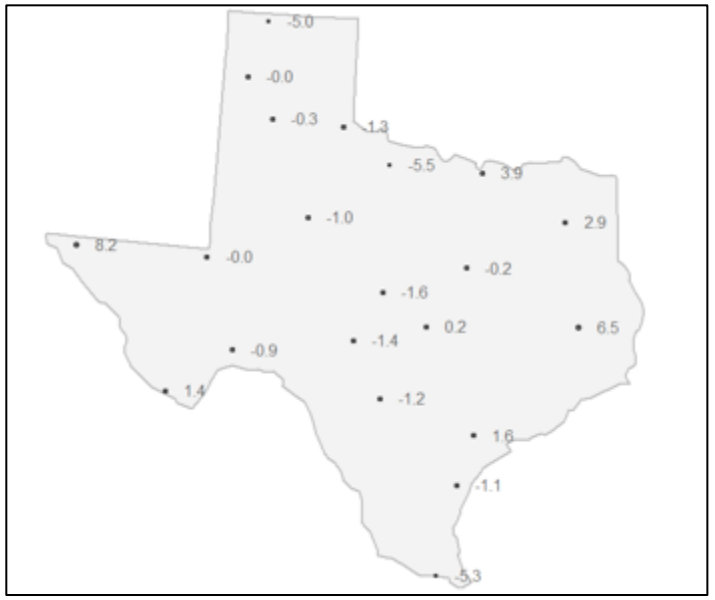
5
6

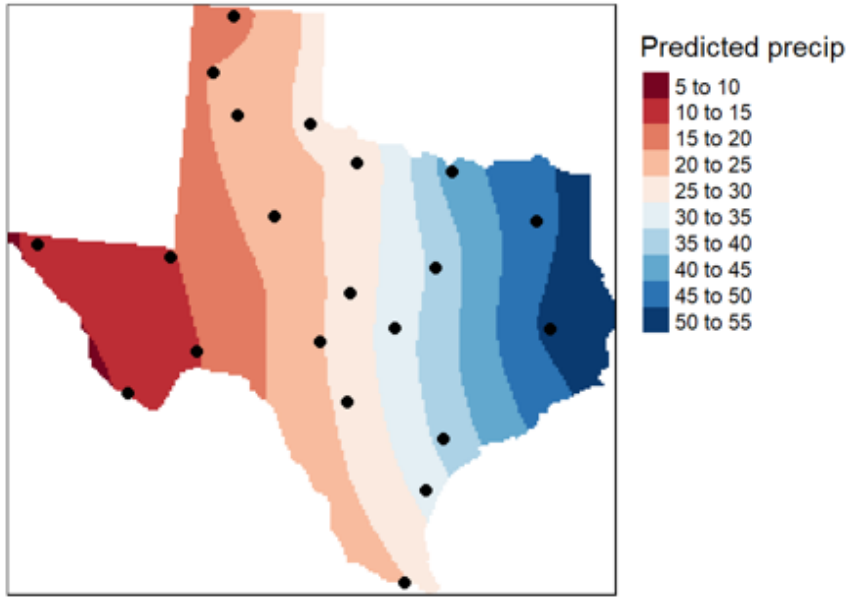

1
0
-1
1
2
3
4
5
6

Spatial data interpolation

- Similar to 'regular' data interpolation, but in two dimensions, accounting for spatial relationships.
- Commonly used for phenomena that are difficult to measure directly, such as spatial concentrations.
- Utilises regularly distributed or sampled points to creates a continuous (predictive) surface from these sampled point values.
- There are various methods available to derive interpolated values, depending on the data and application.

Spatial data interpolation





Gimond, M. 2020. *Geodesic geometry*. [online] https://mgimond.github.io/

Spatial data interpolation

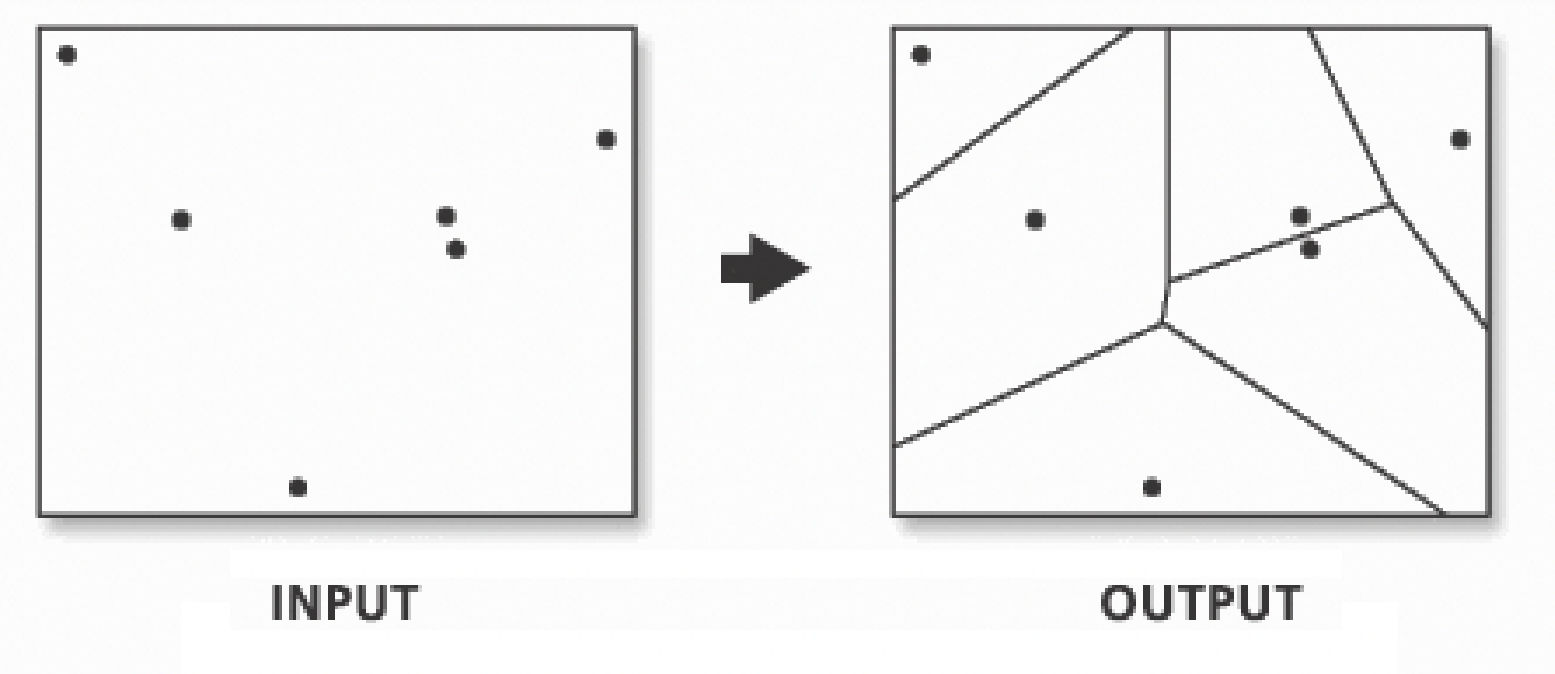
Deterministic methods

- These type of models have parameter values that are typically arbitrarily defined.

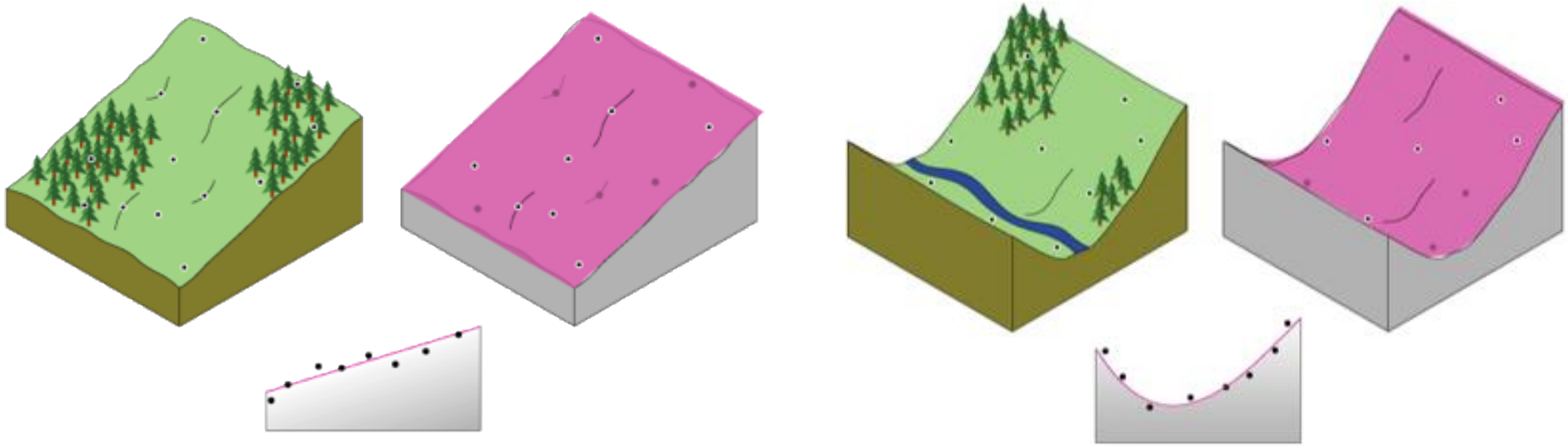
Geostatistical methods

- The parameter values for these models have to be estimated.

Spatial data interpolation: Nearest neighbour



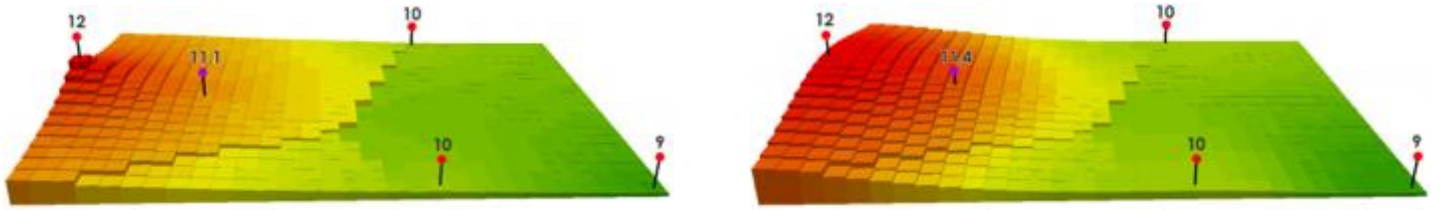
Spatial data interpolation: Trend



Spatial data interpolation: IDW

- IDW: Inverse Distance Weighting (“Tobler’s Law”).
- Assumes near points are more alike than far points (distance decay).
- Spatial autocorrelation is the underlying assumption of IDW.

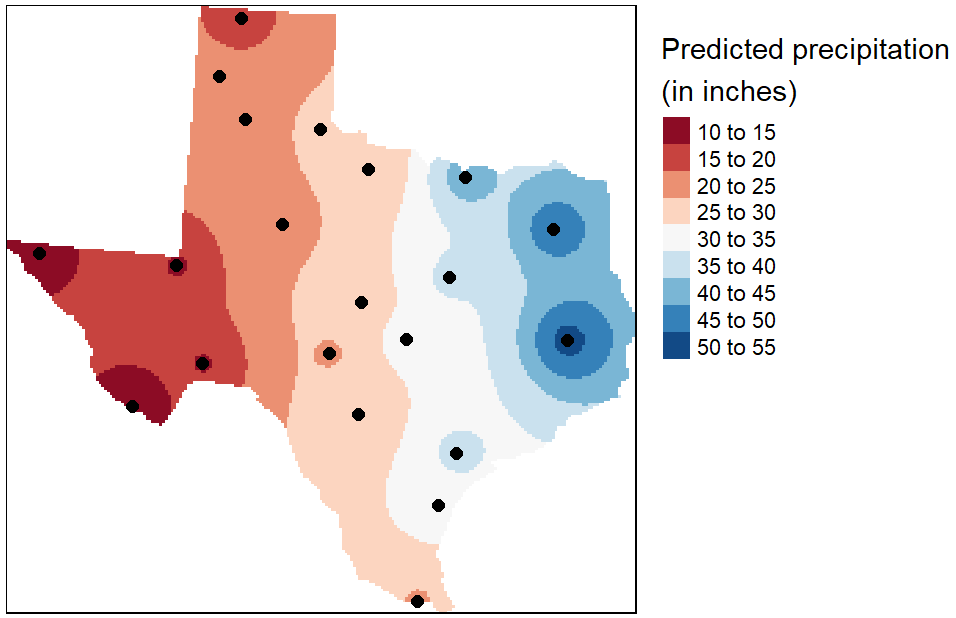
Spatial data interpolation: IDW



IDW with different power settings

$$z_p = \frac{\sum_{i=1}^{n} \left(\frac{z_i}{d_i^p} \right)}{\sum_{i=1}^{n} \left(\frac{1}{d_i^p} \right)}$$

Spatial data interpolation: IDW

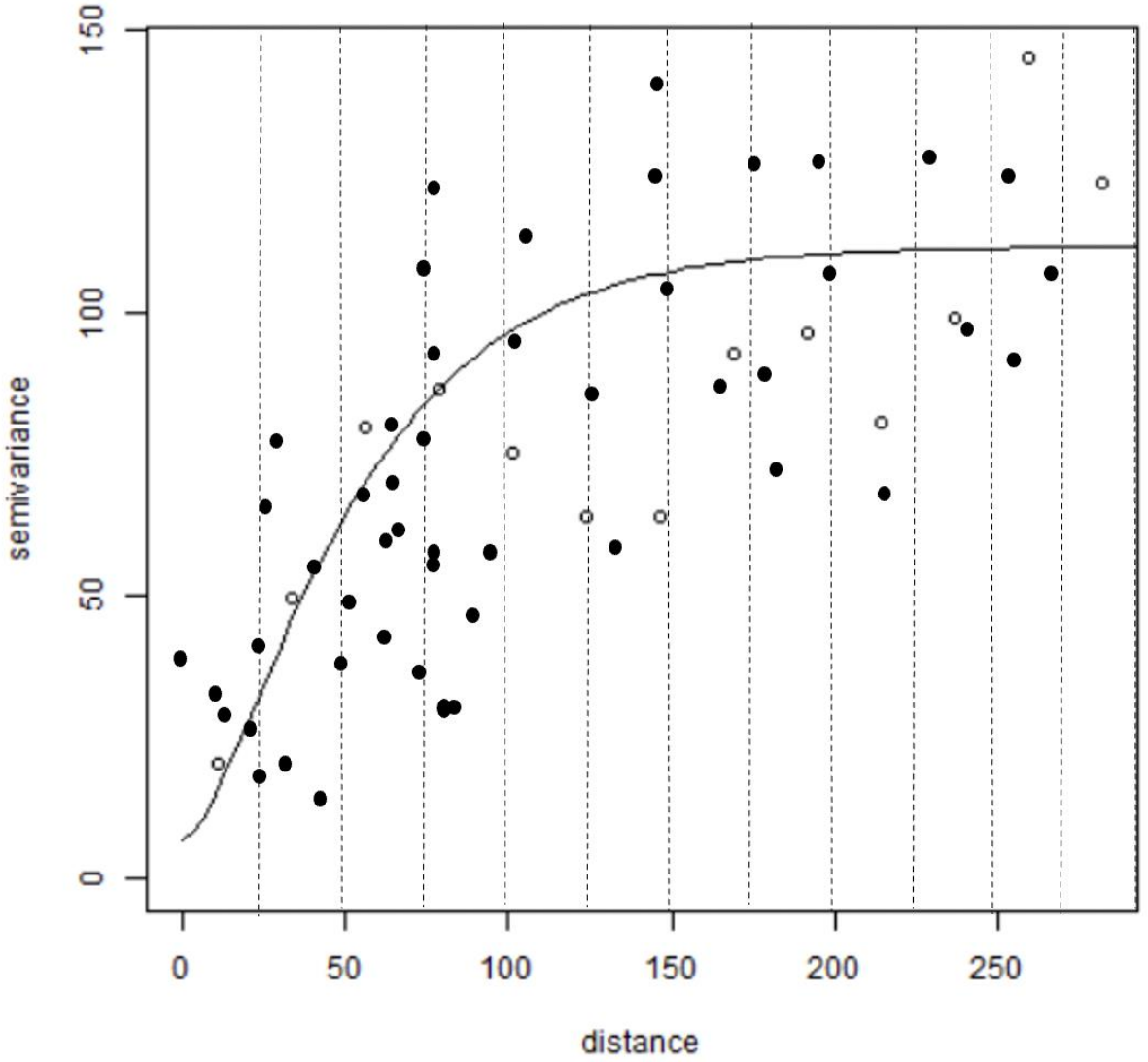


Gimond, M. 2020. *Geodesic geometry*. [online] https://mgimond.github.io/

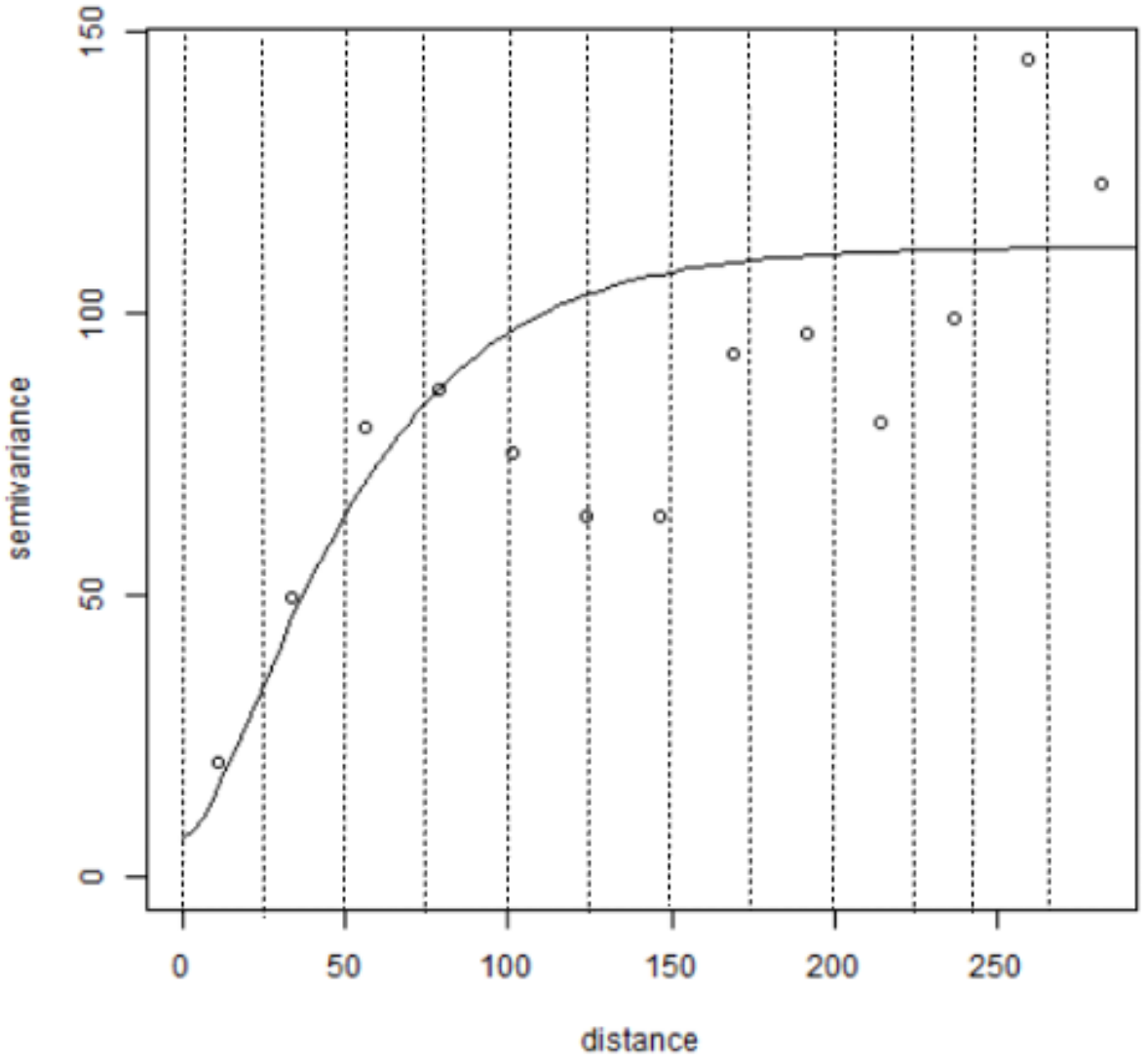
Spatial data interpolation: Kriging

- Considers both distance and degree of variation between known data points when estimating values in unknown areas.
- Kriging is a complex, multistep process starting with a semi-variogram.

Spatial data interpolation: Kriging



Spatial data interpolation: Kriging



Spatial data interpolation: IDW versus Kriging

- IDW (Inverse Distance Weighting) assumes that spatial autocorrelation between neighbouring points is inversely proportional to the distance between them, and this relationship can be defined by a distance-based function.
- Kriging assumes that both distance and directionality between sample points influence spatial autocorrelation. It fits functions to describe the correlation between points and explains the variation across the surface.

Conclusion

- Raster data model is essential for representing categorical and continuous data.
  Raster data come with their own set of functions and operations.
- Spatial data interpolation is the idea to estimate unknown values of a phenomenon.
  Spatial data interpolation creates a continuous surface, requiring the use of the raster data model.
- Multiple methods for interpolation (e.g., IDW, Kriging) that vary in assumptions.

Questions

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