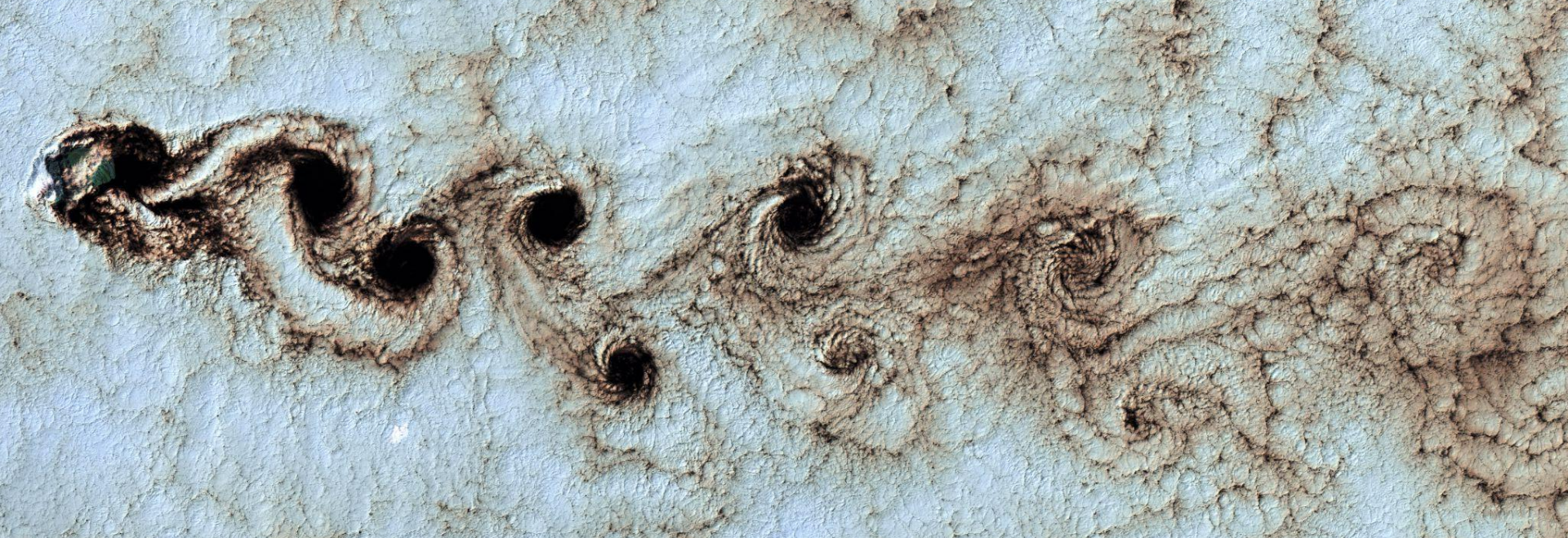


EDS 223: Geospatial Analysis & Remote Sensing

Week 5

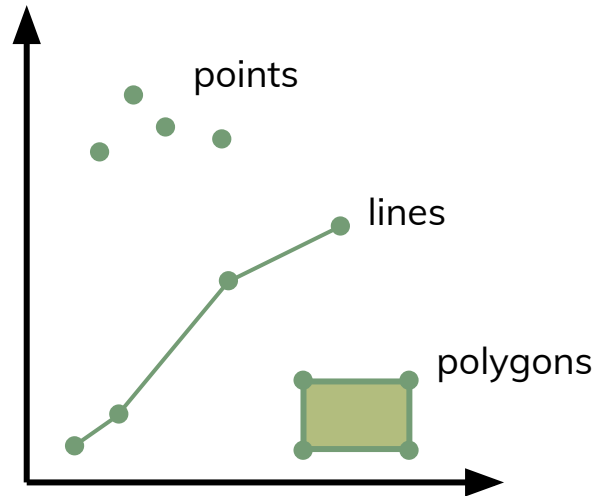


Welcome!

- **Course logistics**
- **Building a spatial analysis workflow**
 - Subsetting
 - Aggregating
 - Summarizing
 - Simplifying

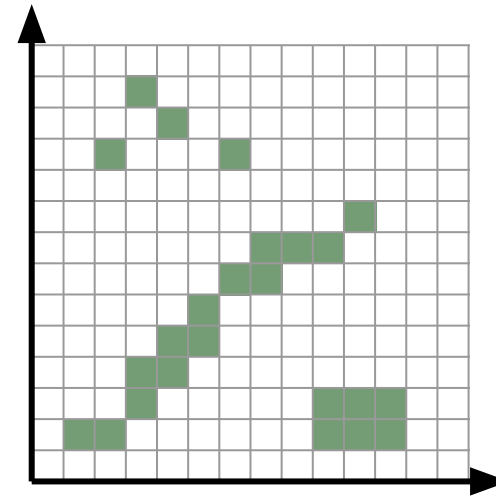
Spatial data models

vector



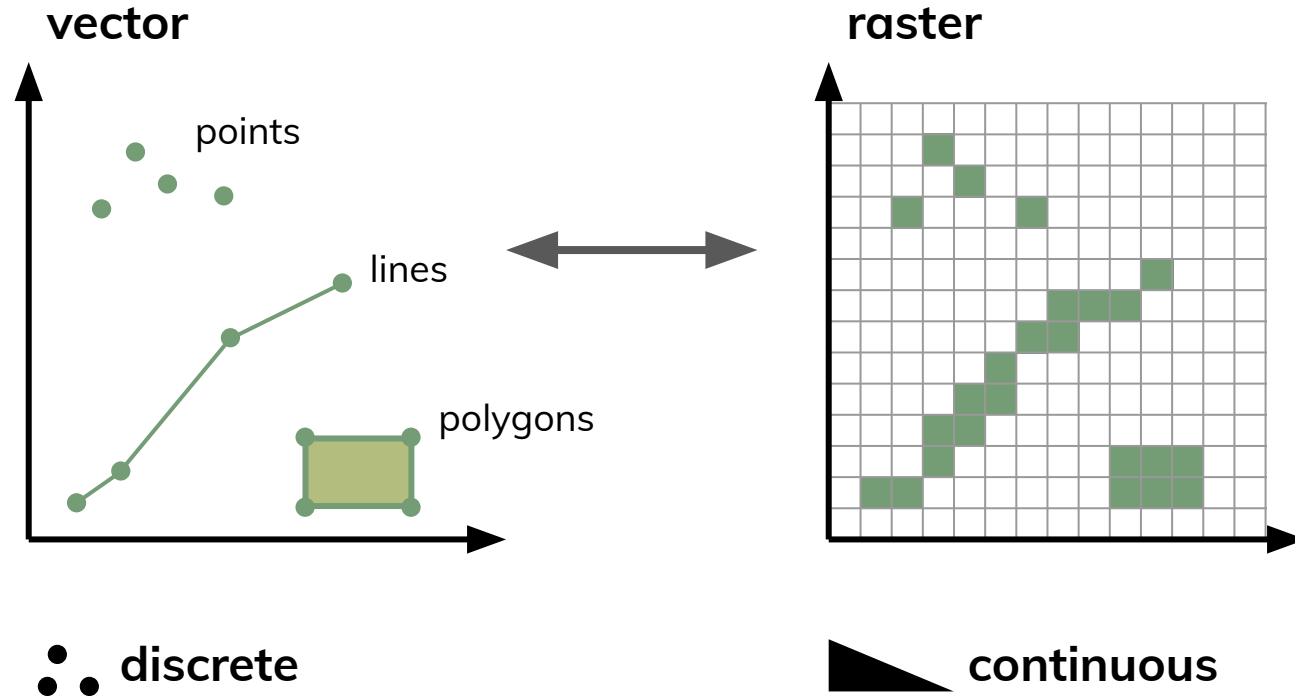
•• discrete

raster



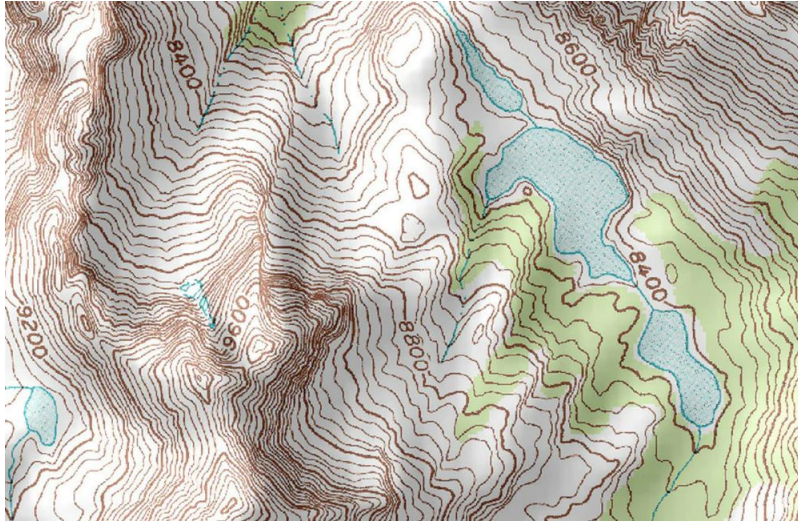
▴ continuous

Spatial data models

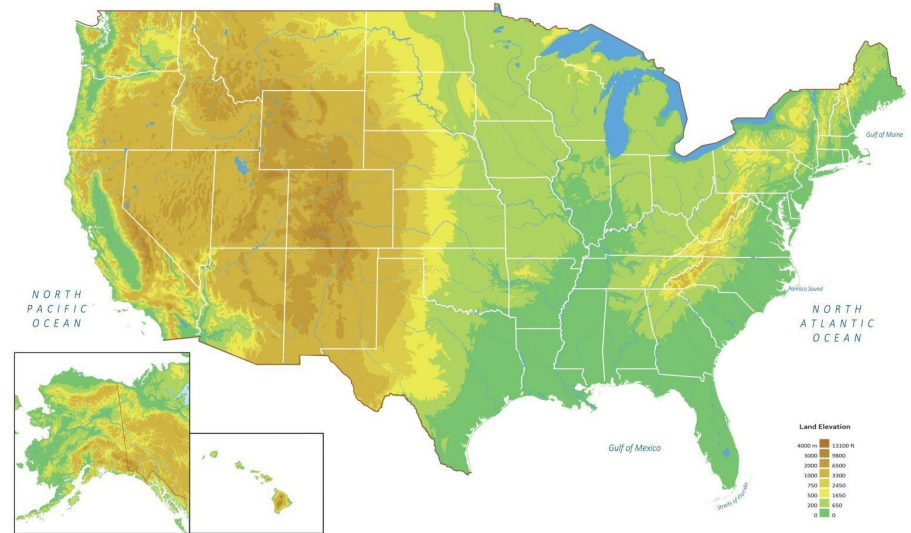


Spatial data models

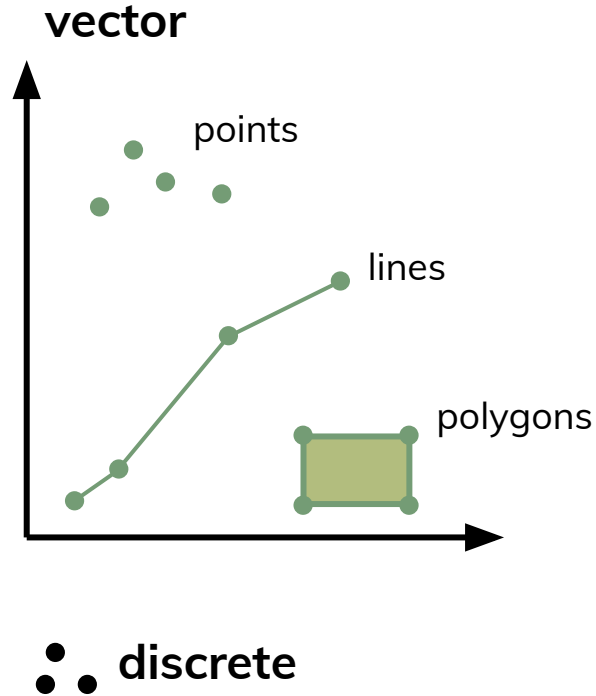
vector



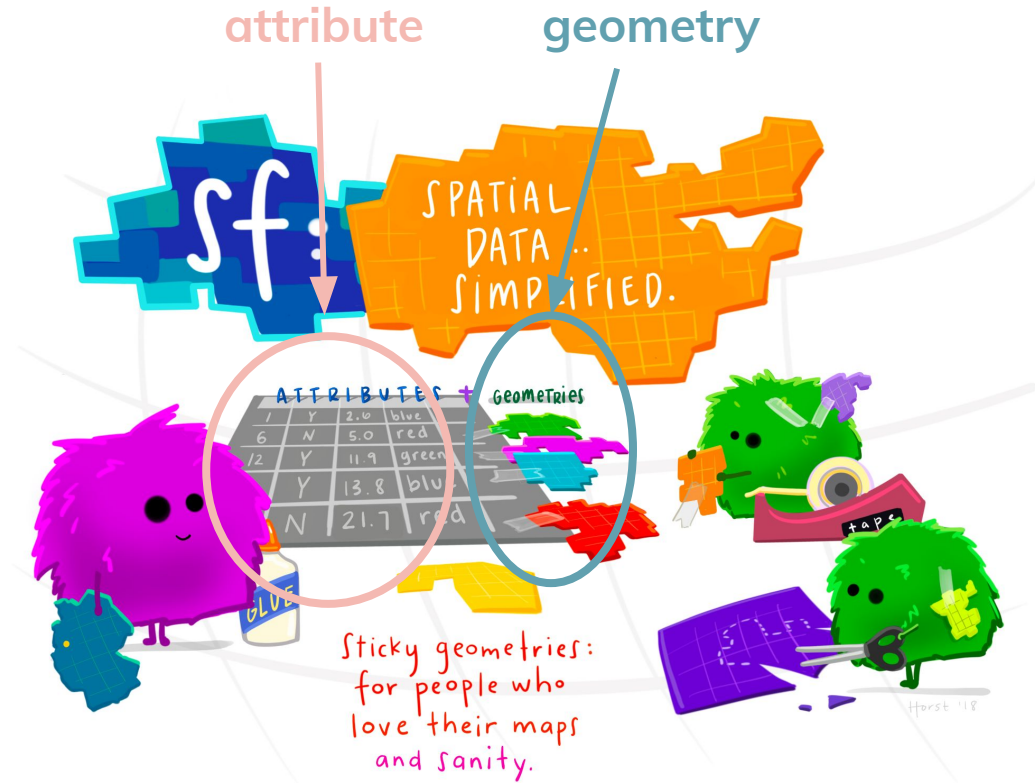
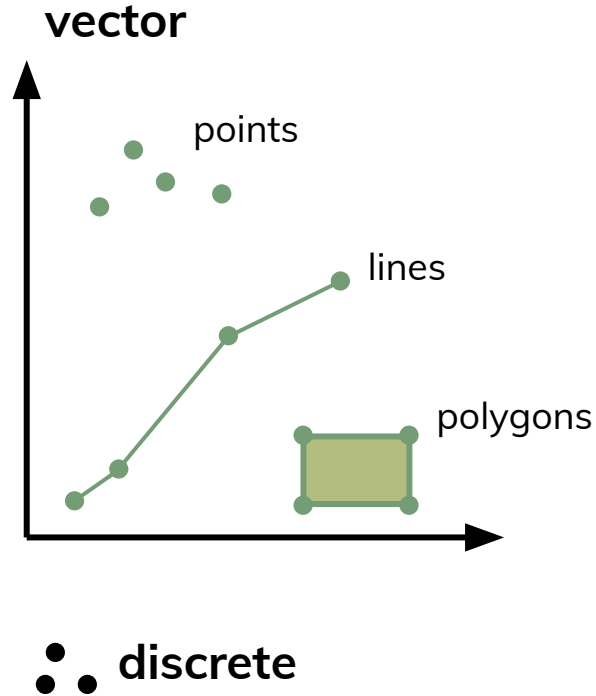
raster



Vector data models

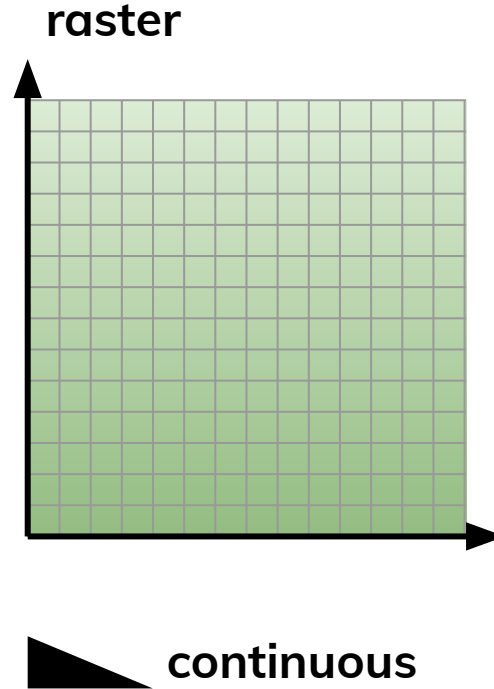


Vector data models



Raster data models

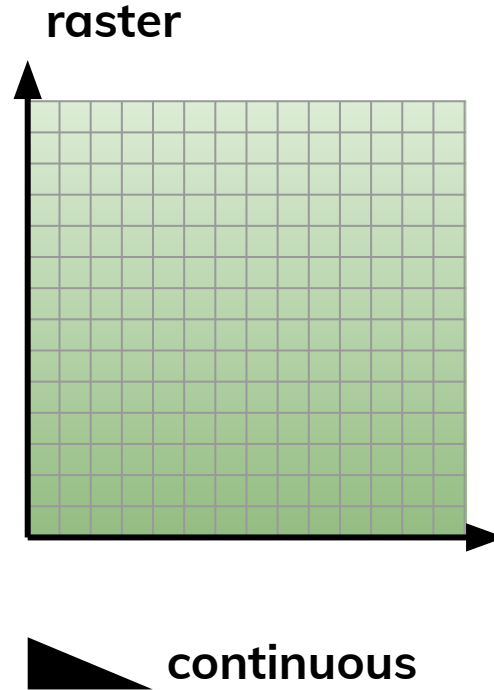
ID	Species	Age
1	Poplar	11
2	Oak	2
3	Beech	12
4	Cedar	15



Raster data models

geometry

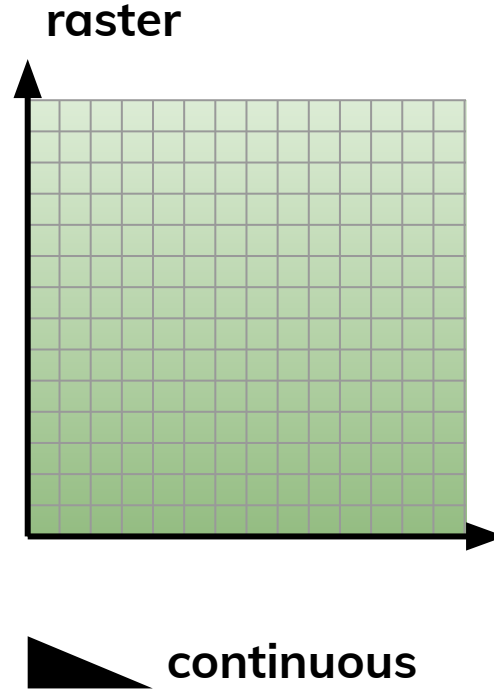
- ?



Raster data models

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS



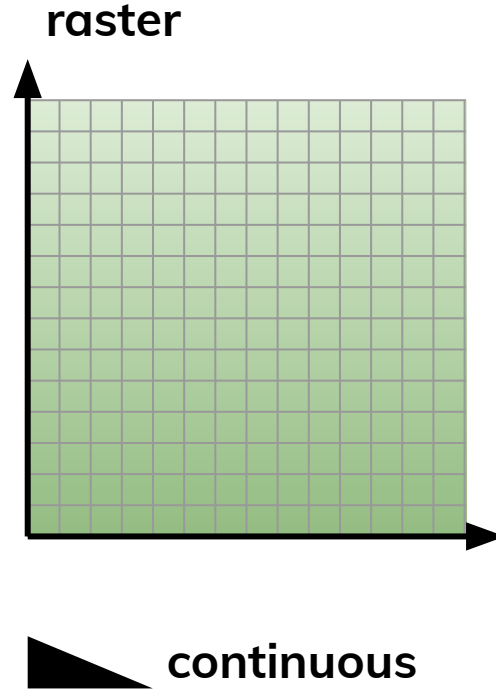
Raster data models

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

- One value per cell
- Categorical, numerical, logical



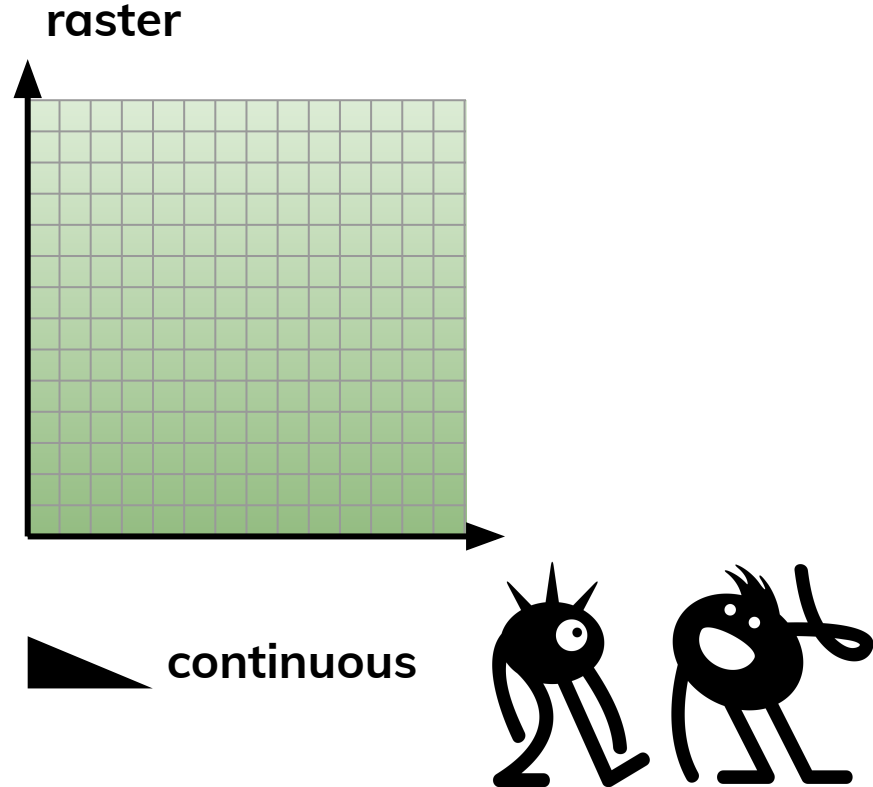
Raster data models

geometry

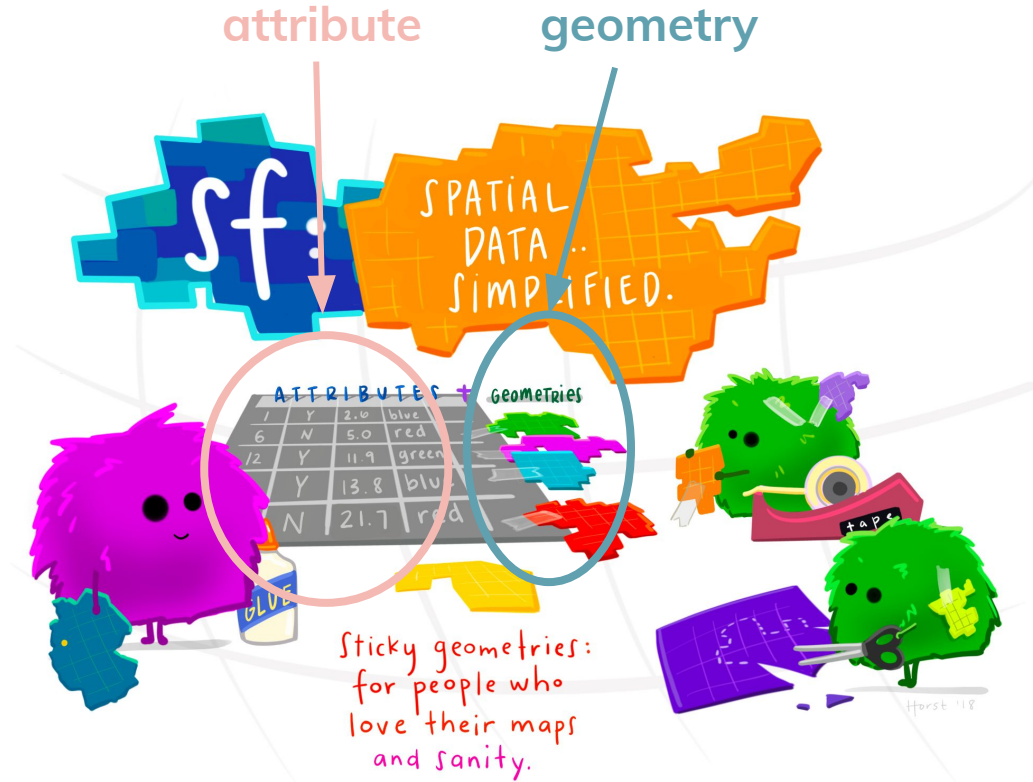
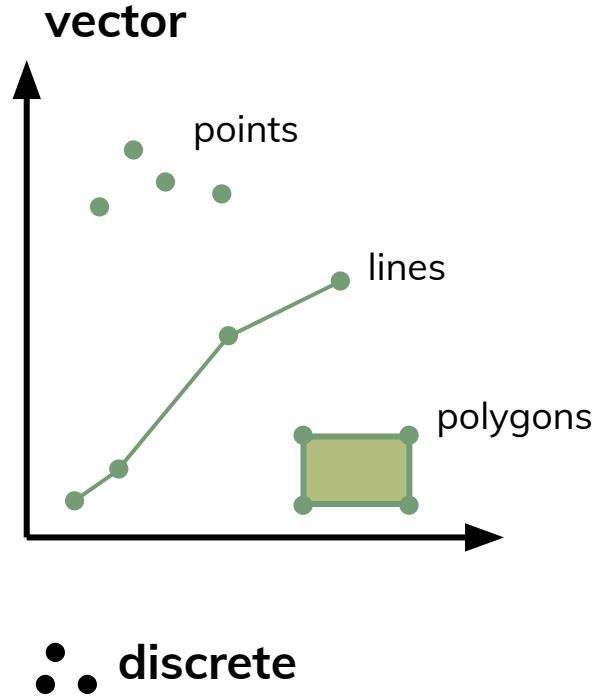
- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

- One value per cell
- Categorical, numerical, logical



Vector data models



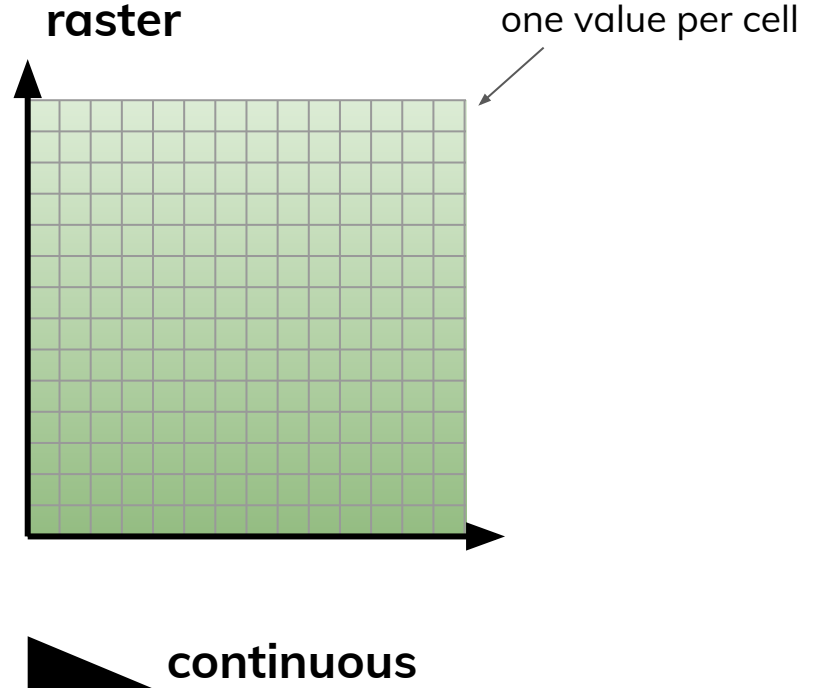
Raster data models

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

- One value per cell
- Categorical, numerical, logical



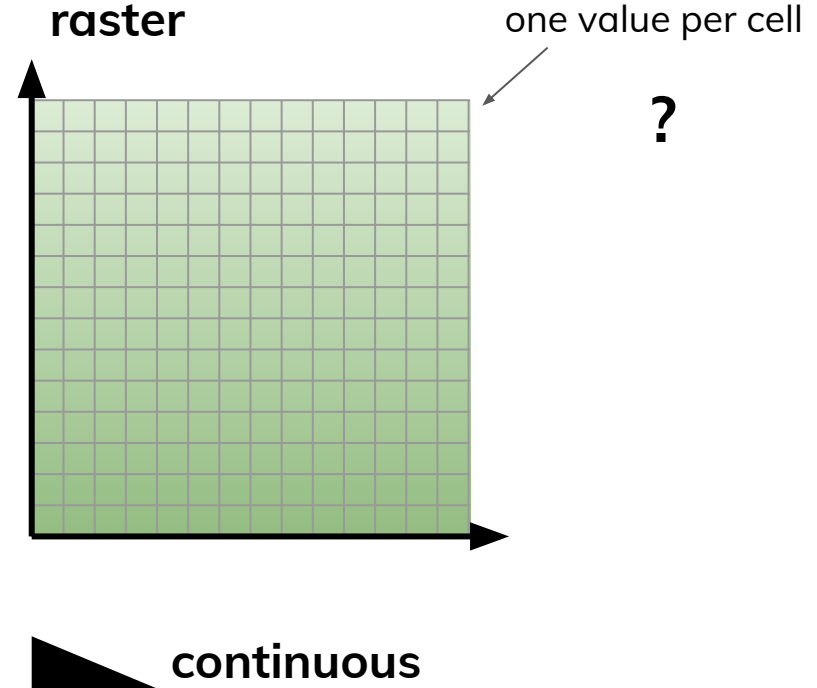
Raster data models

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

- One value per cell
- Categorical, numerical, logical



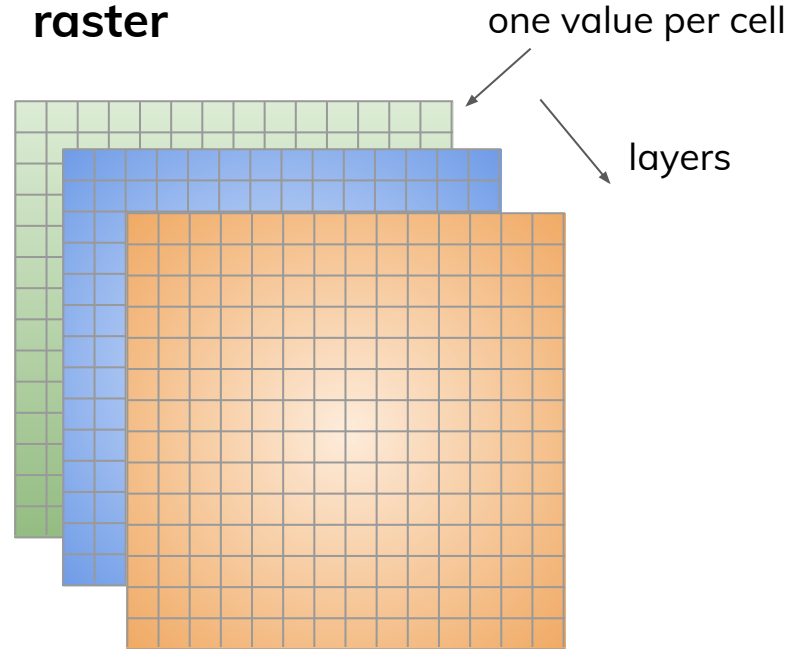
Raster data models

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

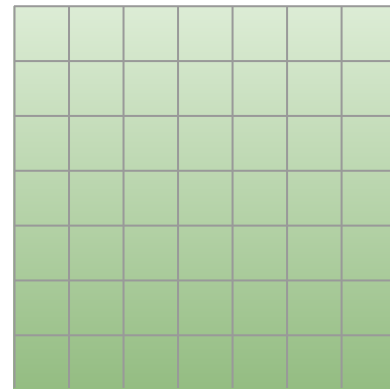
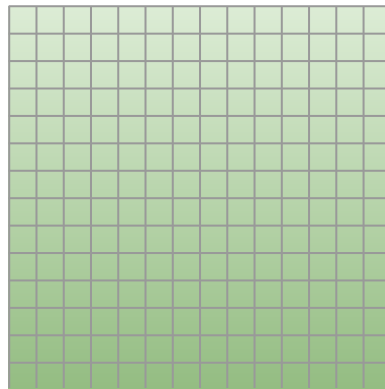
- One value per cell
- Categorical, numerical, logical



Raster data model

geometry

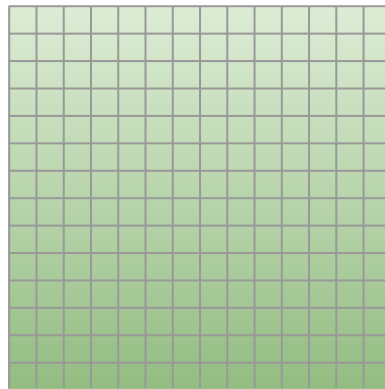
- Cell size
 - Number of rows/columns
 - Cell origin
 - CRS
- resolution



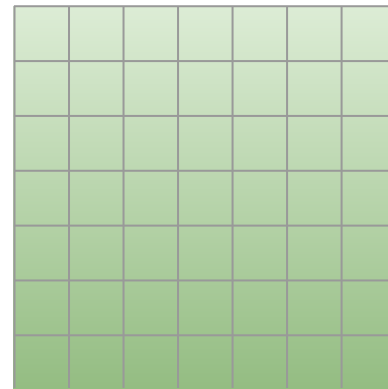
Raster data model

geometry

- Cell size
 - Number of rows/columns
 - Cell origin
 - CRS
- resolution



- “finer”
- “higher”



- “coarser”
- “lower”

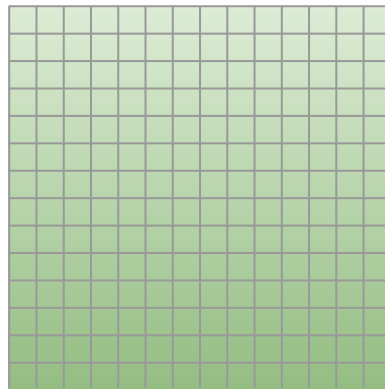
Raster data model

geometry

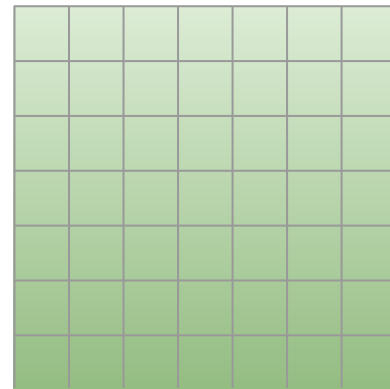
- Cell size
- Number of rows/columns
- Cell origin
- CRS



resolution



- “finer”
- “higher”
- 1 km

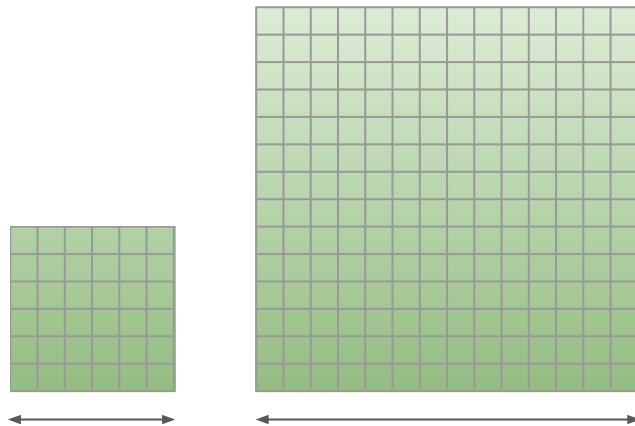


- “coarser”
- “lower”
- 5 km

Raster data model

geometry

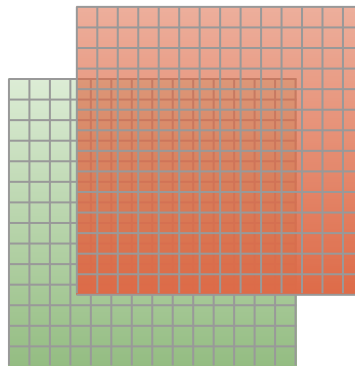
- Cell size
- Number of rows/columns → extent
- Cell origin
- CRS



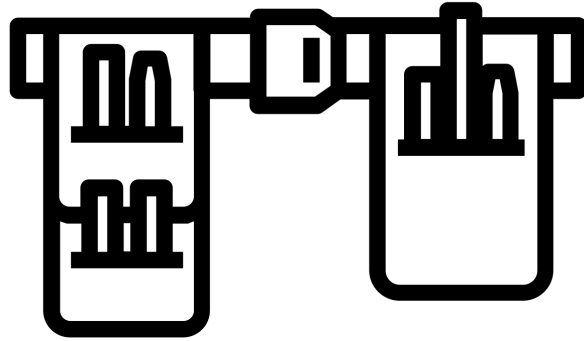
Raster data model

geometry

- Cell size
- Number of rows/columns
- Cell origin \longrightarrow position
- CRS



Toolbelt for solving spatial problems

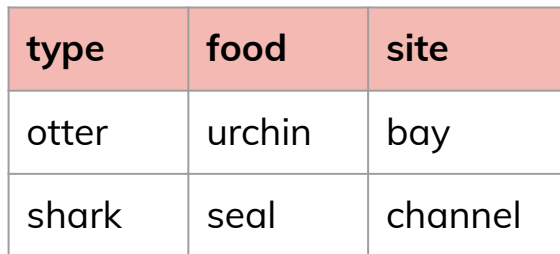


New tools for a new data type

data frame

attributes

observations



A diagram illustrating a data frame structure. It features a 3x3 grid. The top row is highlighted in light red and contains the headers 'type', 'food', and 'site'. The bottom two rows are white and contain the data: 'otter', 'urchin', 'bay' and 'shark', 'seal', 'channel'. To the left of the grid is a vertical arrow pointing upwards, labeled 'observations'. Above the grid is a horizontal arrow pointing to the right, labeled 'attributes'.

type	food	site
otter	urchin	bay
shark	seal	channel

New tools for a new data type

data frame

attributes

observations

type	food	site
otter	urchin	bay
shark	seal	channel

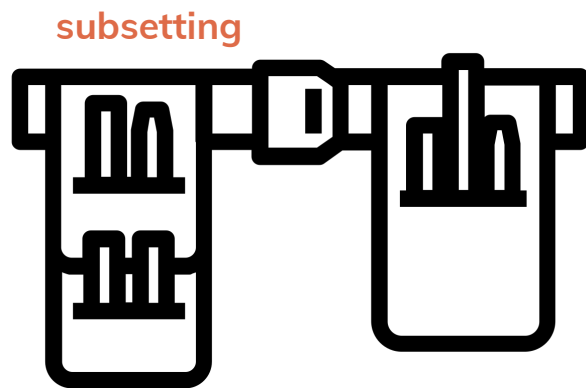
matrix

columns

rows

1	4	8
10	7	3
2	5	1

Toolbelt for solving spatial problems



New tools for a new data type

dplyr: go wrangling



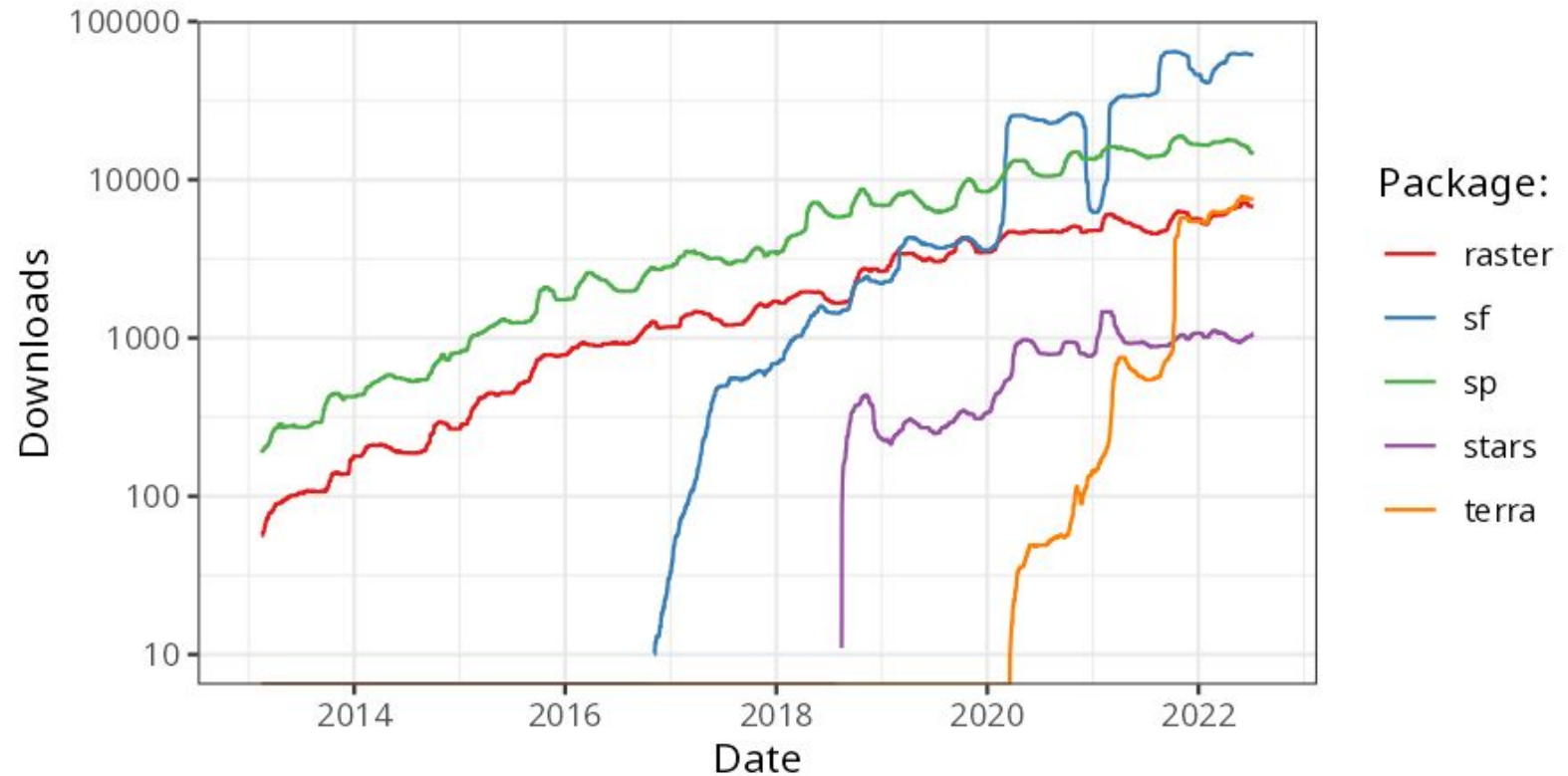
dplyr::filter() KEEP ROWS THAT satisfy your CONDITIONS

keep rows from... this data... ONLY IF... type is "otter" AND site is "bay"
filter(df, type == "otter" & site == "bay")

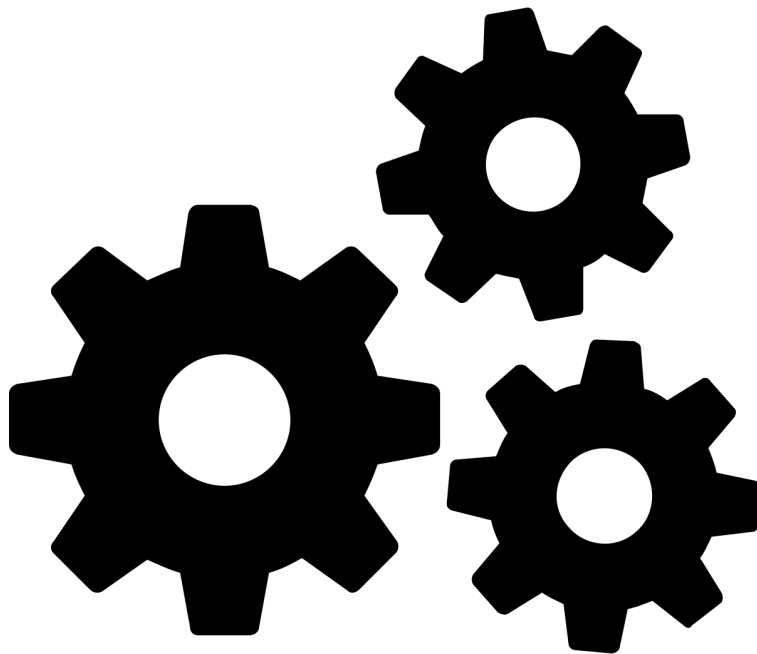
type	food	site
otter	urchin	bay
Shark	seal	channel
otter	abalone	bay
otter	crab	wharf

The illustration shows an orange character holding a map of a bay area. To the right, a purple character and a green character stand next to a table. The table has three columns: 'type', 'food', and 'site'. The rows are: 'otter' with 'urchin' and 'bay', 'Shark' with 'seal' and 'channel', 'otter' with 'abalone' and 'bay', and 'otter' with 'crab' and 'wharf'. The 'Shark' row and the 'wharf' cell are highlighted with orange lines. Checkmarks and X marks are next to the 'bay' and 'wharf' cells respectively.

R's spatial ecosystem

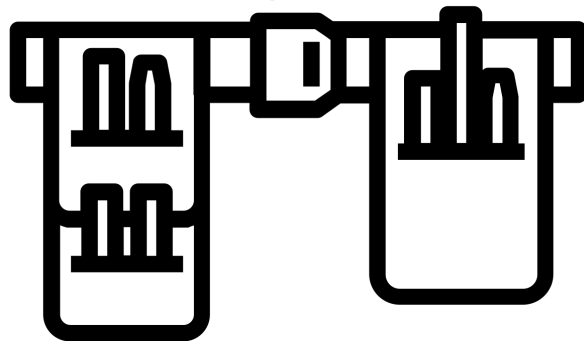


Switching gears...



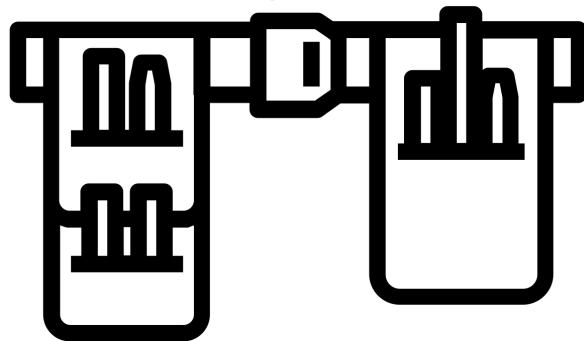
Toolbelt for solving spatial problems

spatial subsetting



Toolbelt for solving spatial problems

spatial subsetting



Topological relationships

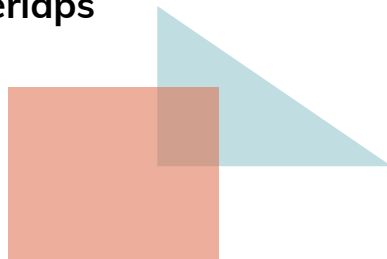
intersects

Yes or No

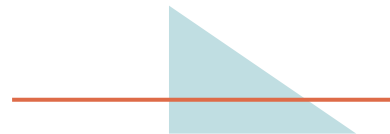
touches



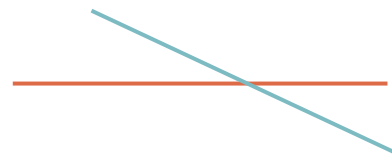
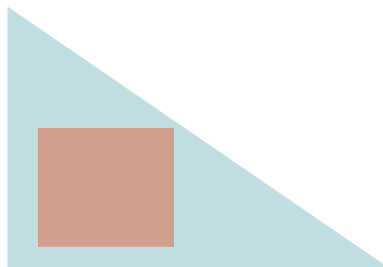
overlaps



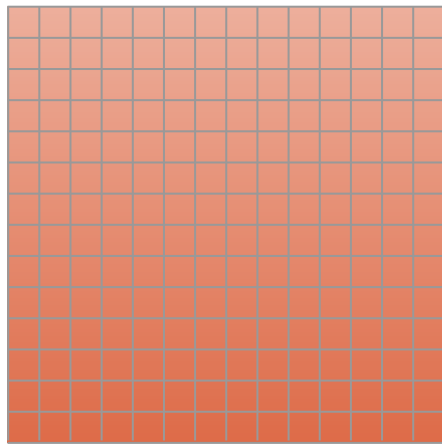
crosses



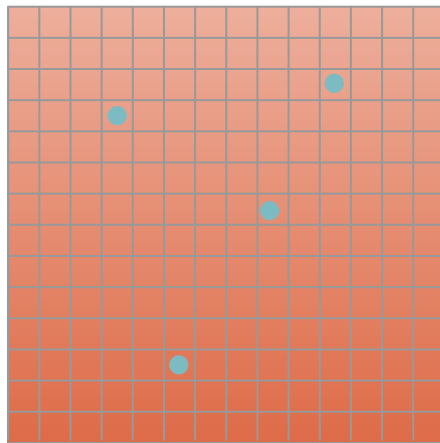
within



Spatial subsetting

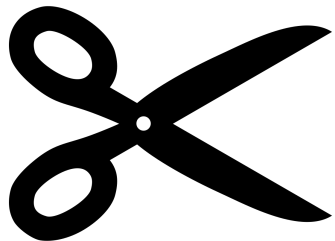
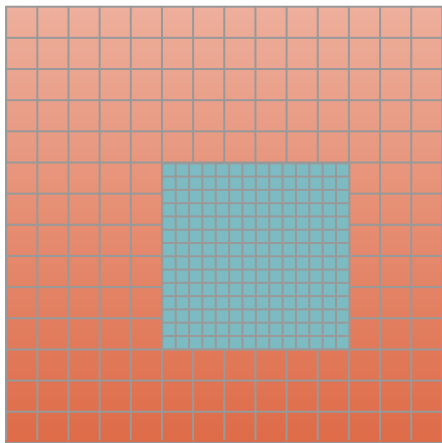


Spatial subsetting

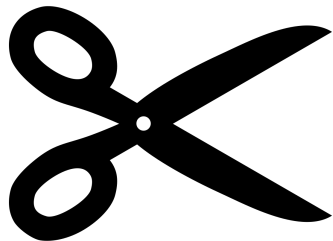
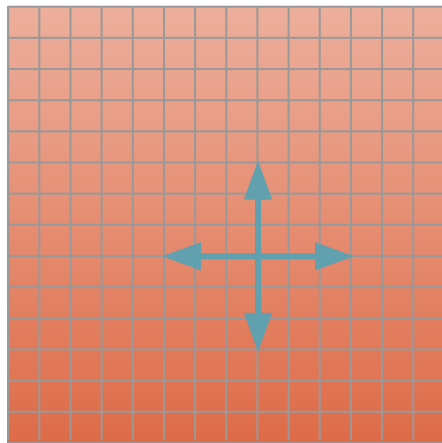


- 1
- 4
- 7
- 15

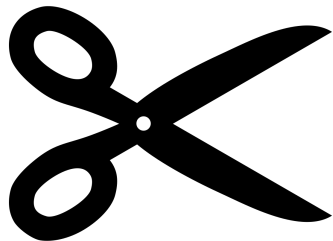
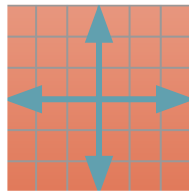
Spatial subsetting: clipping



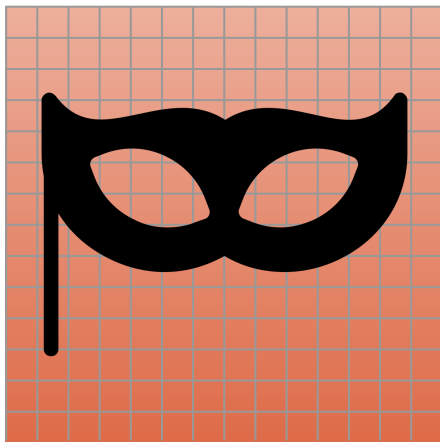
Spatial subsetting: clipping



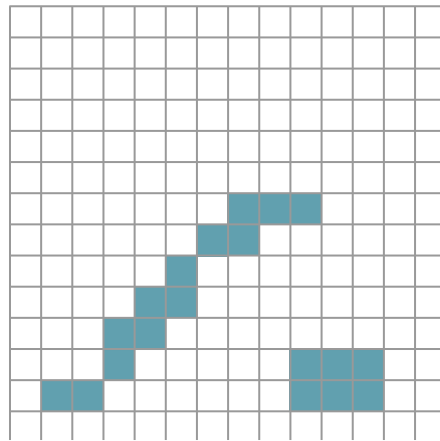
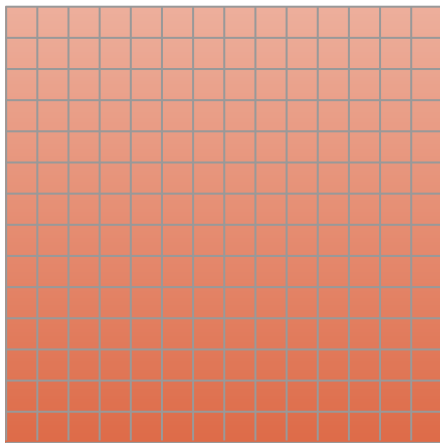
Spatial subsetting: clipping



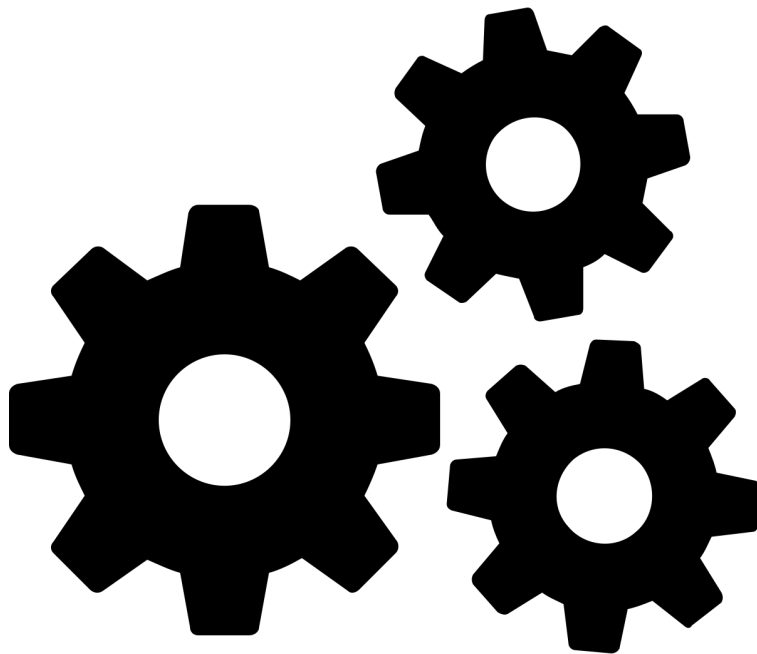
Spatial subsetting: masking



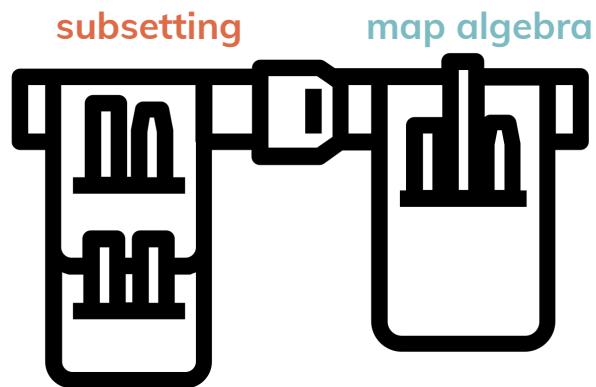
Spatial subsetting: masking



Switching gears...



Toolbelt for solving spatial problems

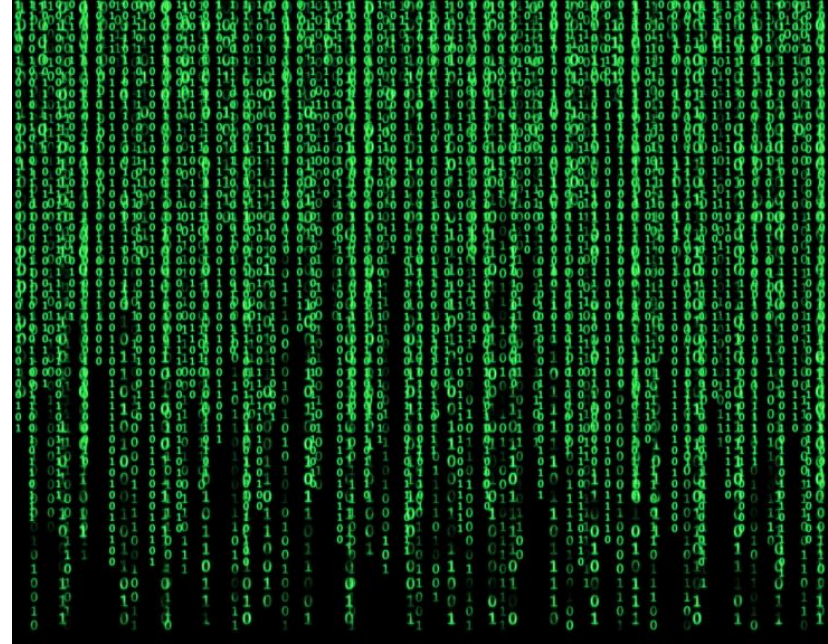


Map algebra

- Operations that modify or summarize raster cell values

Map algebra

- Operations that modify or summarize raster cell values
- Power of the Matrix



Map algebra

- Operations that modify or summarize raster cell values
- Power of the ~~Matrix~~, matrix

matrix

columns →

↑ rows

1	4	8
10	7	3
2	5	1

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

Map algebra

- Operations that modify or summarize raster cell values
- Power of the ~~Matrix~~, matrix
- “Raster is faster, vector is corrector”

matrix

columns →

↑ rows

1	4	8
10	7	3
2	5	1

geometry

- Cell size
- Number of rows/columns
- Cell origin
- CRS

Map algebra

- Local
- Focal
- Zonal
- Global

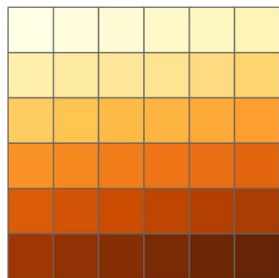


Scale or number of cells

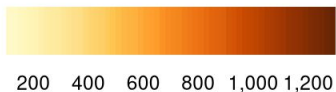
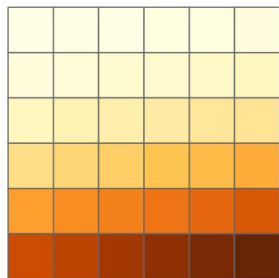
Map algebra

- **Local**
 - Cell-by-cell operations in one or several layers

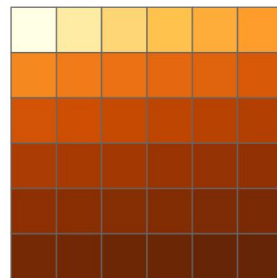
elev + elev



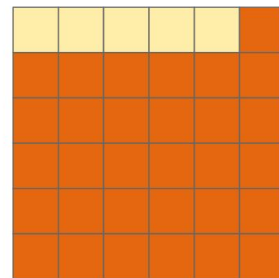
elev^2



log(elev)

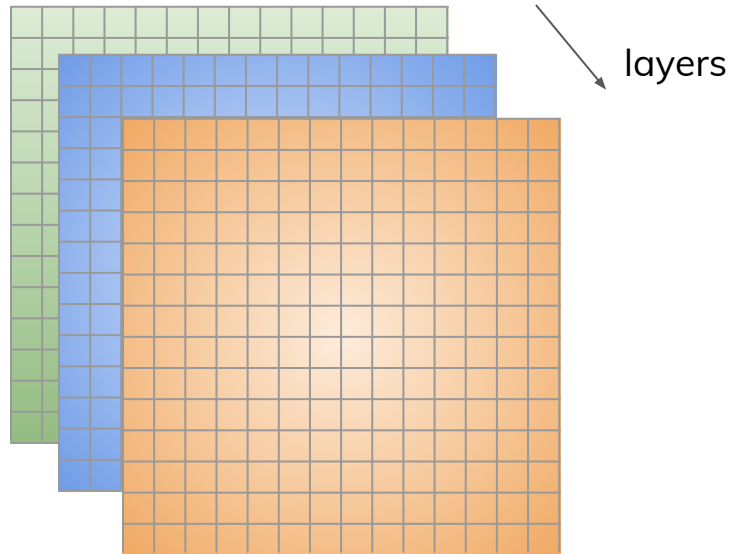


elev > 5



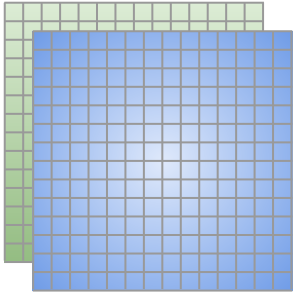
Map algebra

- **Local**
 - Cell-by-cell operations in one or several layers



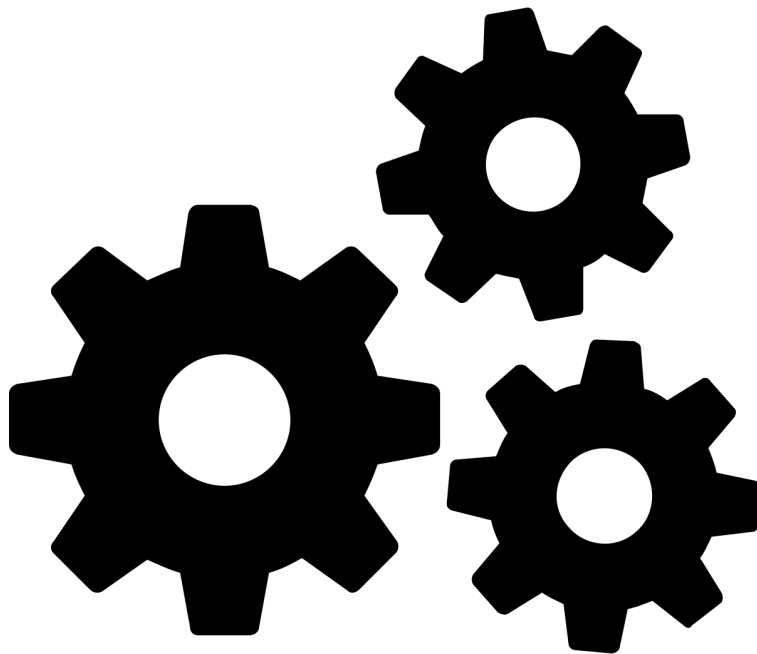
Map algebra

- **Local**
 - Cell-by-cell operations in one or several layers



$$\text{Normalized Difference Vegetation Index} = \frac{\text{NIR} - \text{Red}}{\text{NIR} + \text{Red}}$$

Switching gears...



Map algebra

- Local
- Focal
- Zonal
- Global



Scale or number of cells

Map algebra

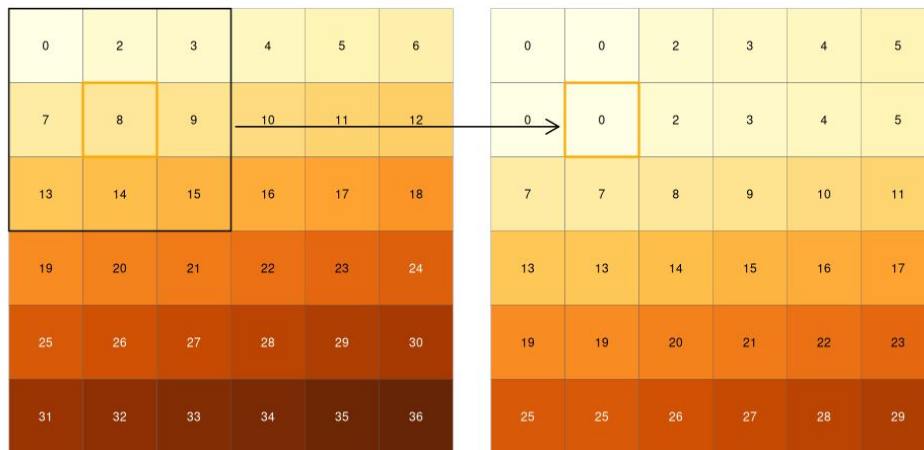
- **Focal**

- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell

Map algebra

- **Focal**

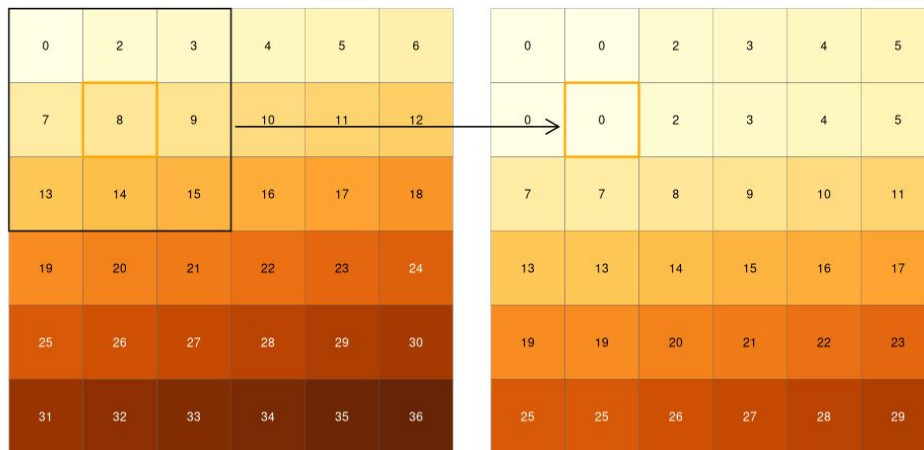
- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell



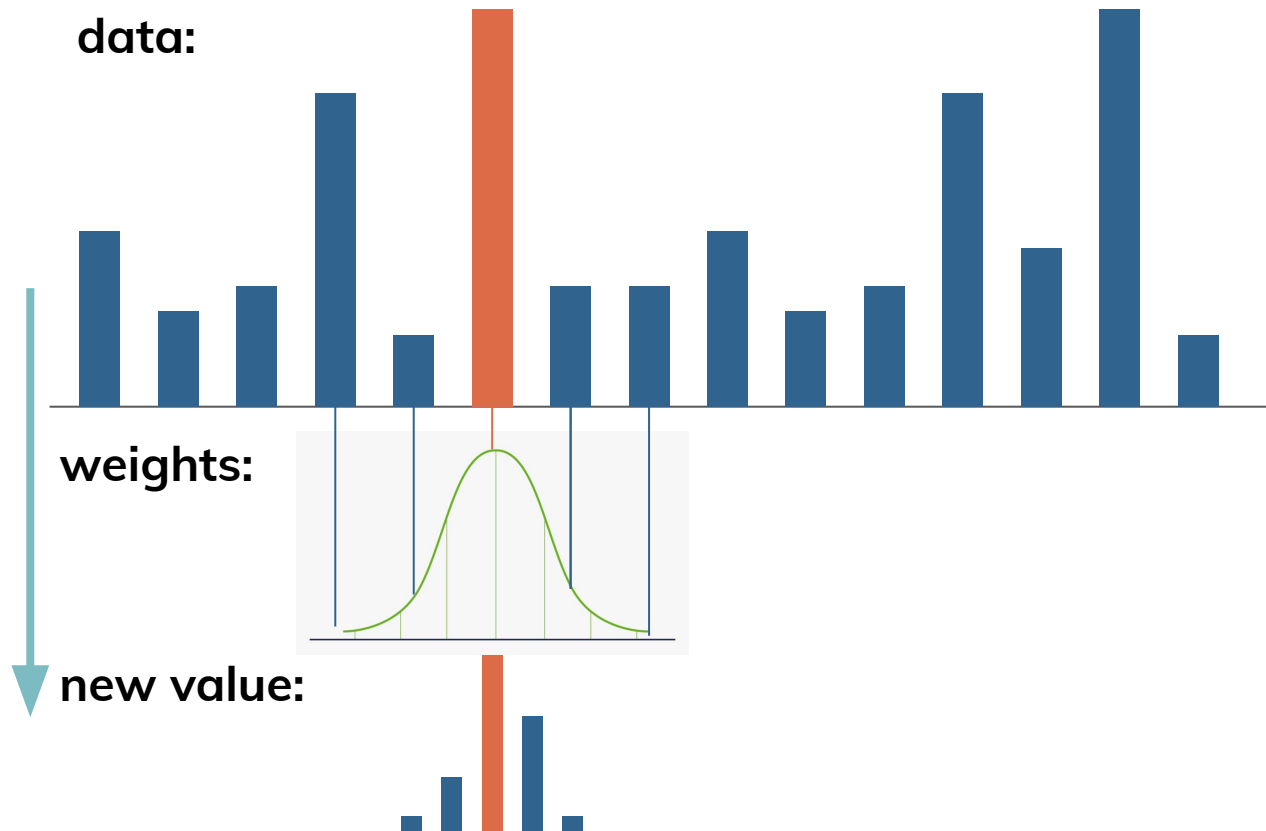
Map algebra

- **Focal**

- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell



Smoothing: Gaussian kernel

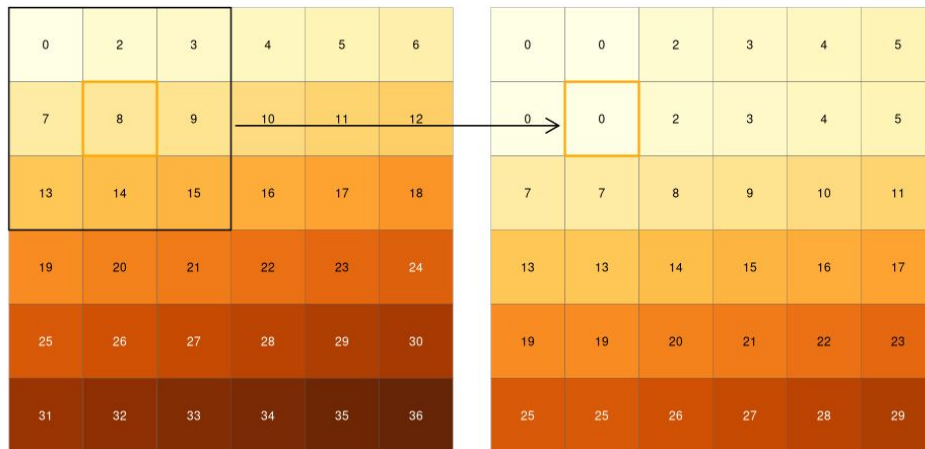


Map algebra

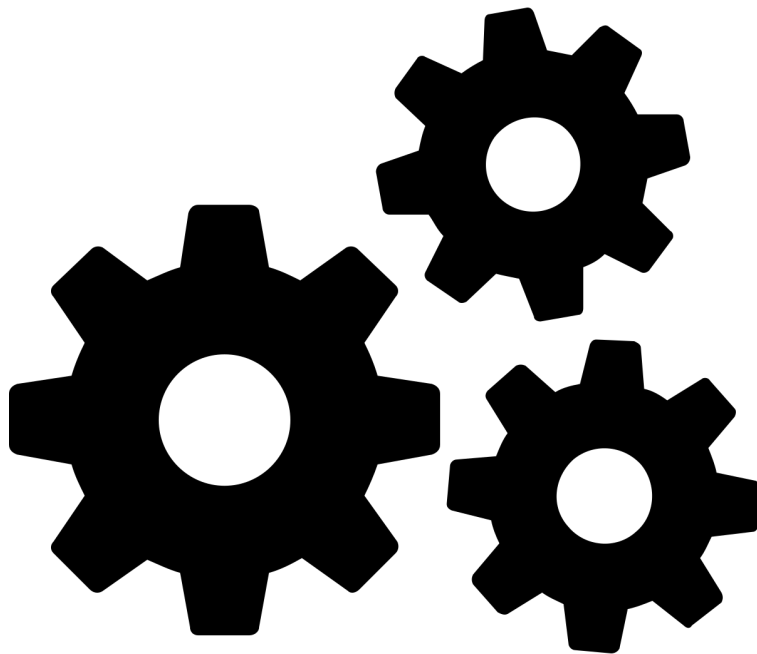
- **Focal**

- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell

kernel,
filter,
moving window



Switching gears...



Map algebra

- Local
- Focal
- Zonal
- Global



Scale or number of cells

Map algebra

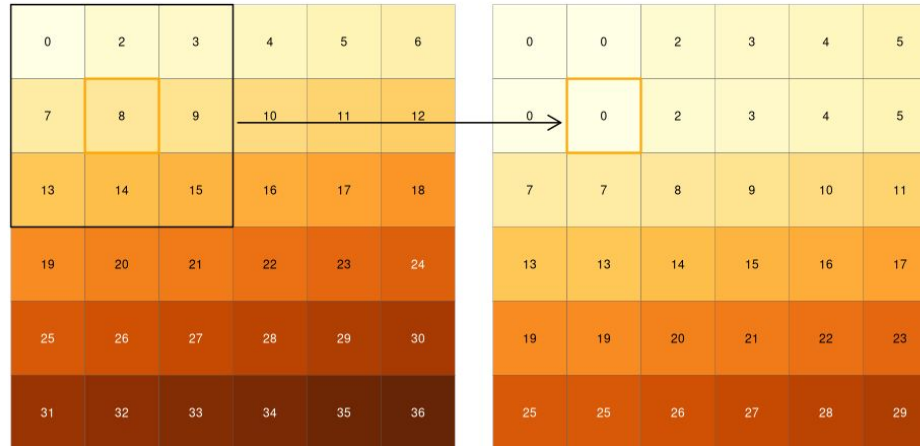
- **Zonal**

- Applies an aggregation function to multiple cells based on a grouping variable

Map algebra

- **Zonal**

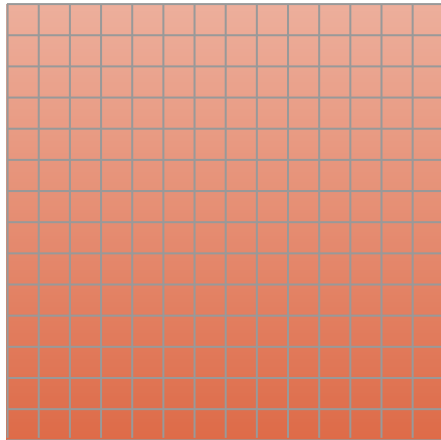
- Applies an aggregation function to multiple cells based on a grouping variable



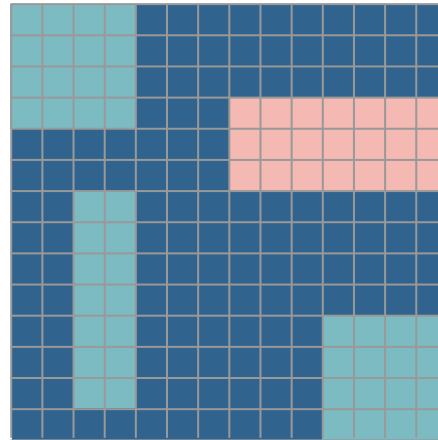
Map algebra

- **Zonal**

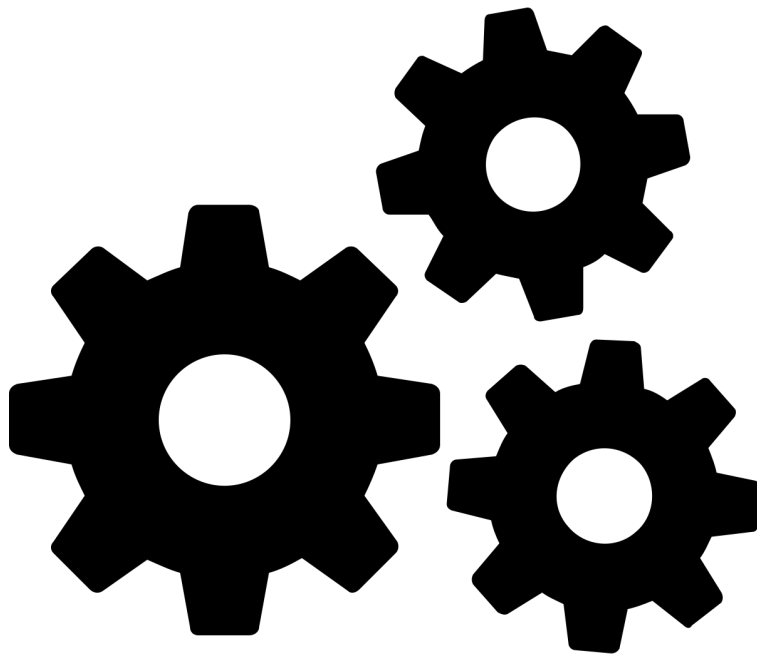
- Applies an aggregation function to multiple cells based on a grouping variable



“zones”



Switching gears...



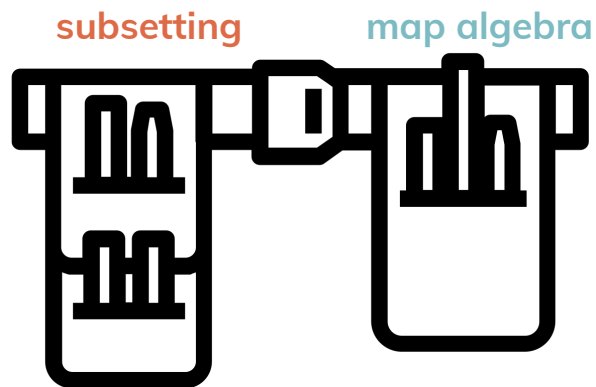
Map algebra

- Local
- Focal
- Zonal
- Global

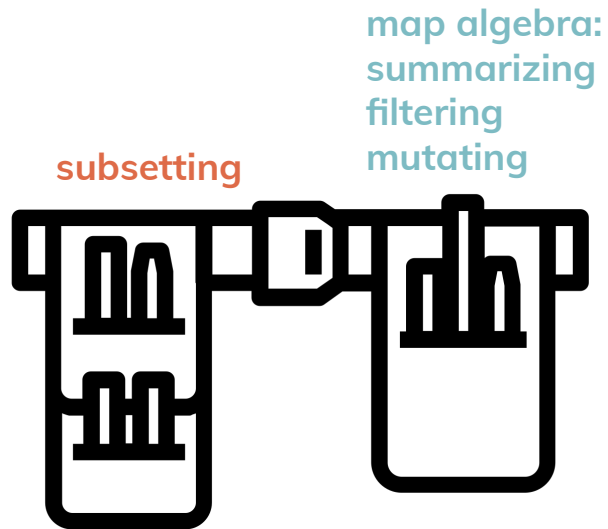


Scale or number of cells

Toolbelt for solving spatial problems

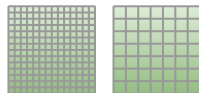


Toolbelt for solving spatial problems

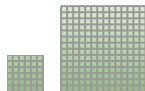


Raster data model

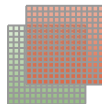
- Resolution



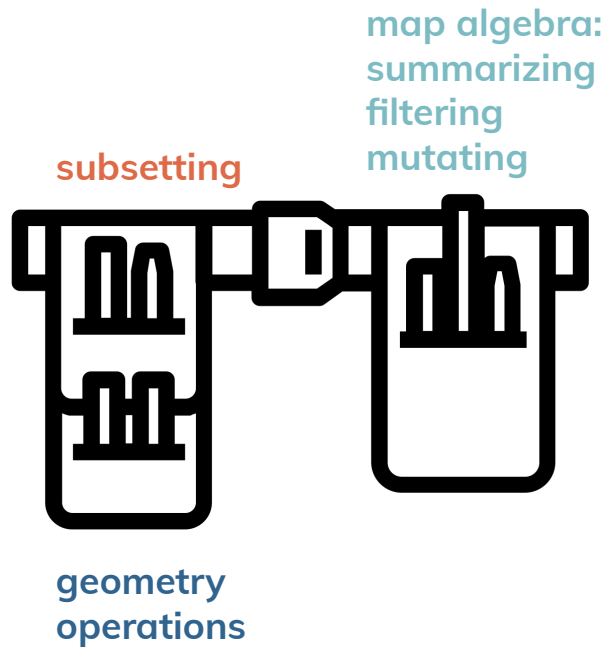
- Extent



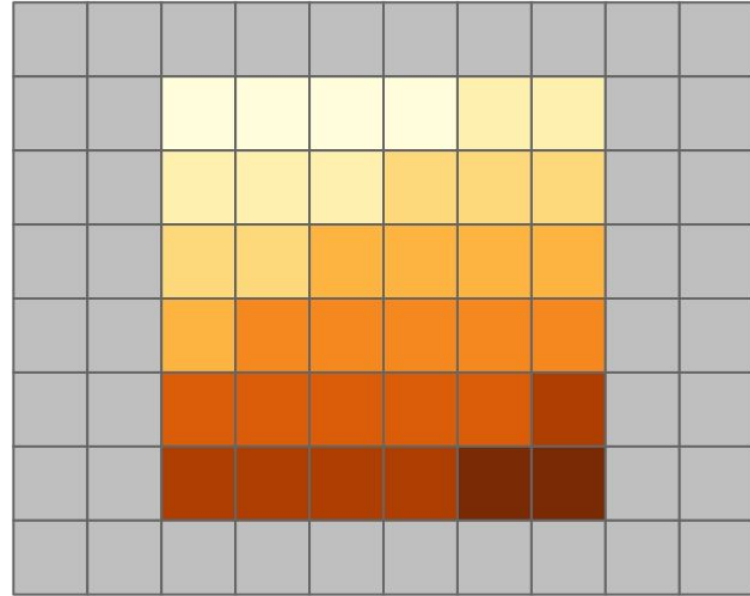
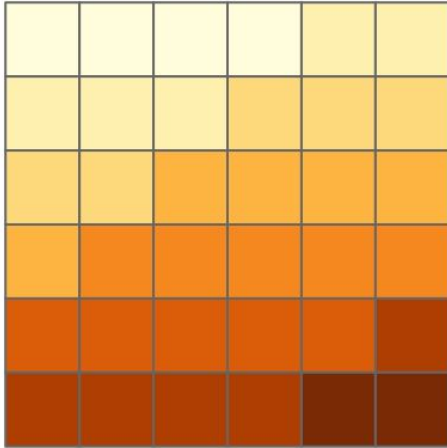
- Position



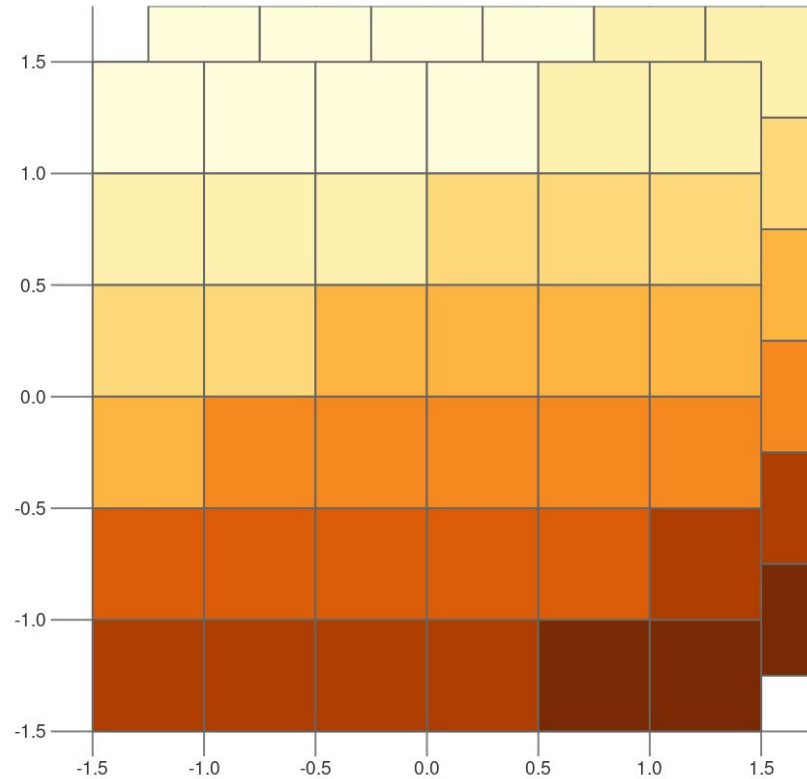
Toolbelt for solving spatial problems



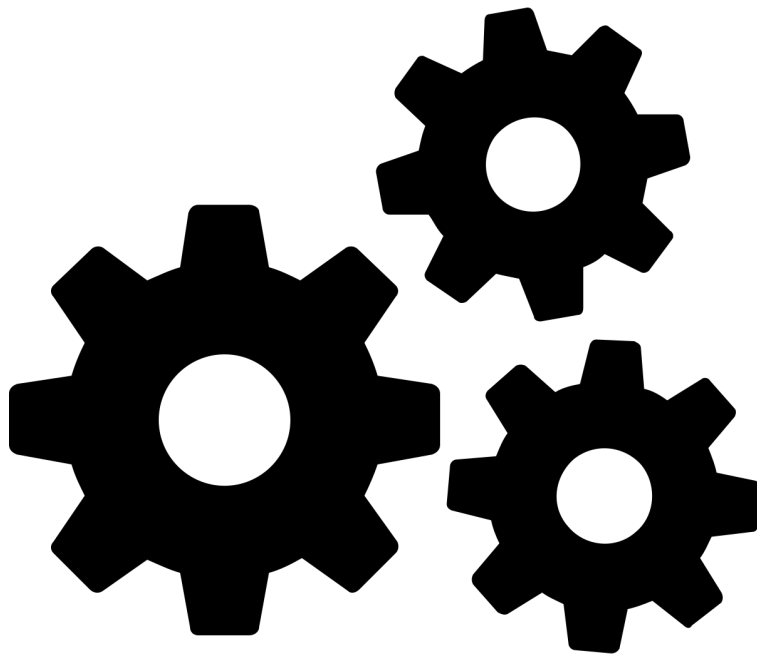
Changing extent and origin



Changing extent and origin

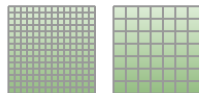


Switching gears...

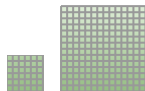


Raster data model

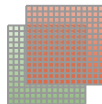
- Resolution



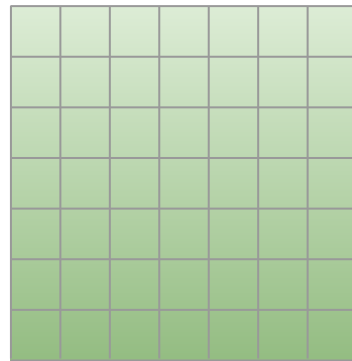
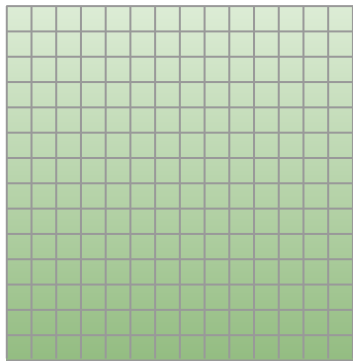
- Extent



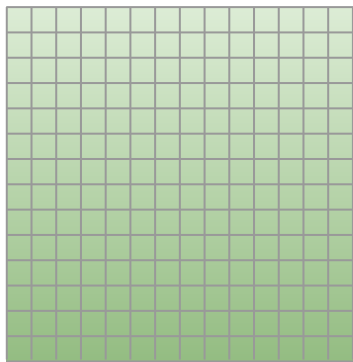
- Position



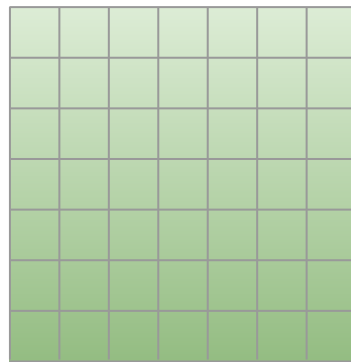
Changing resolution



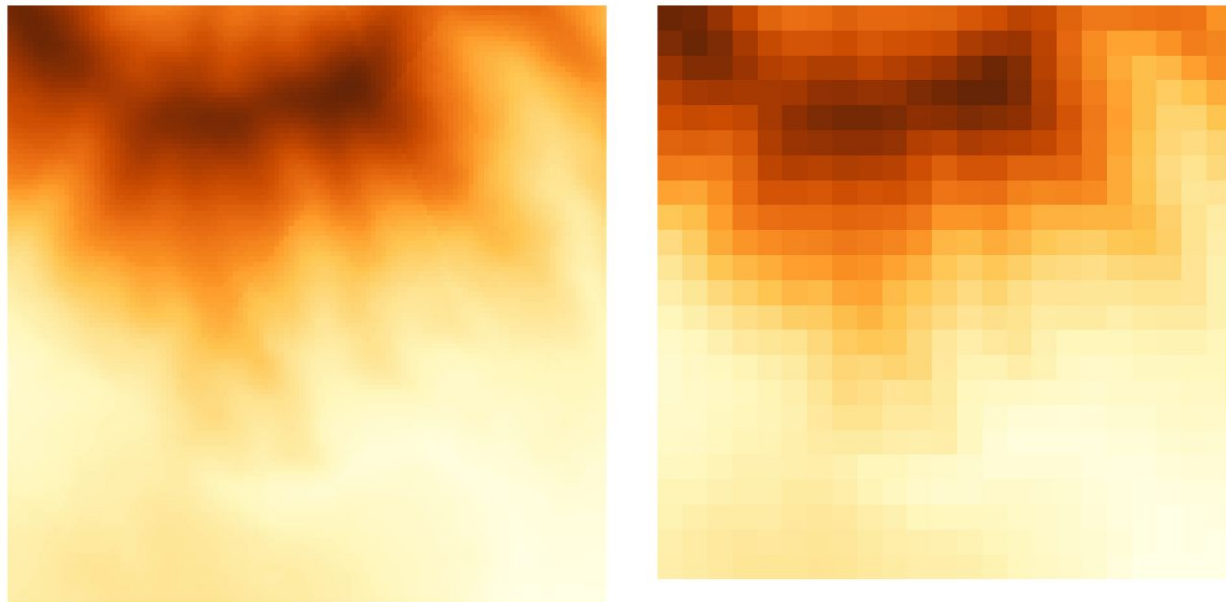
Changing resolution



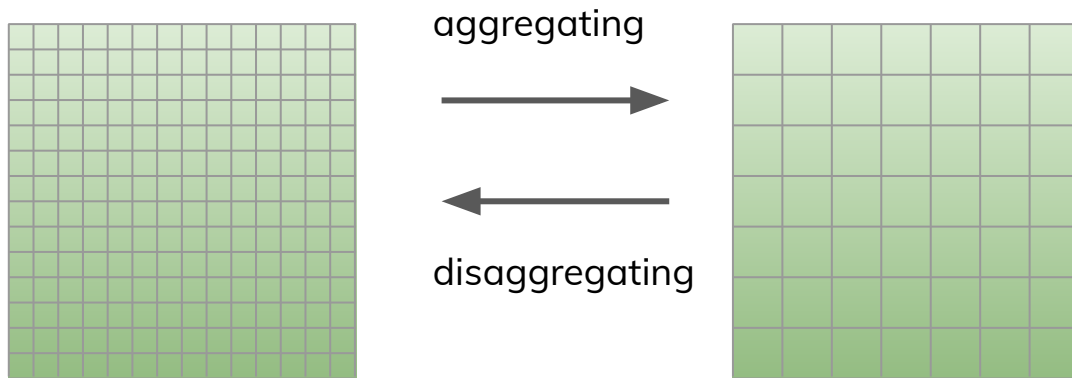
aggregating



Changing resolution



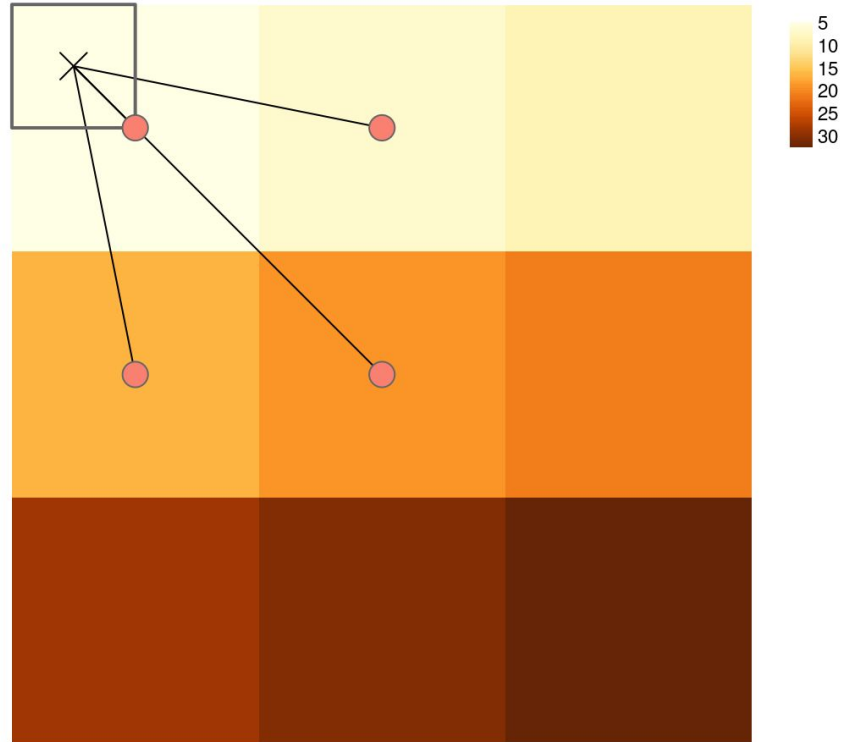
Changing resolution



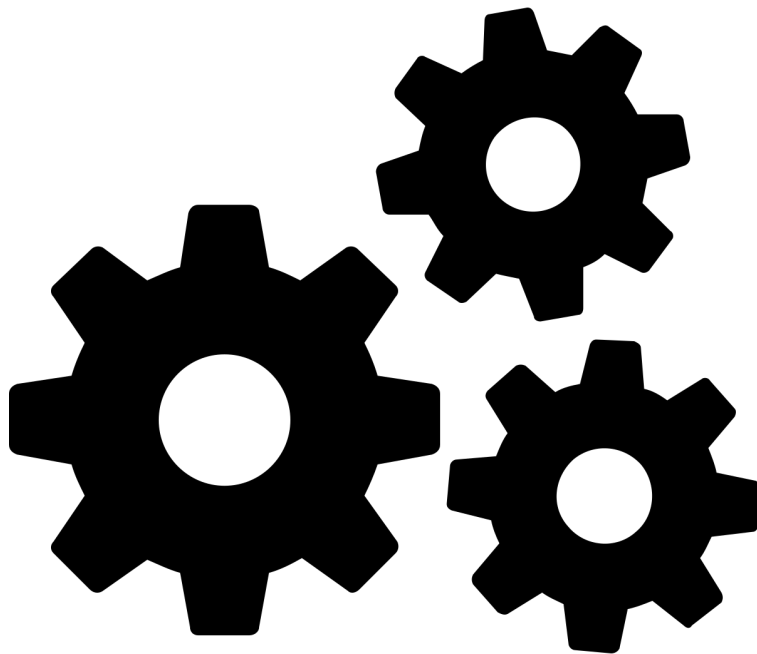
Changing resolution

Nearest neighbor

Bilinear interpolation

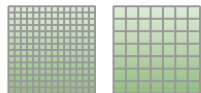


Switching gears...

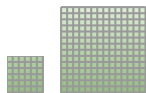


Raster data model

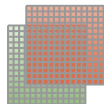
- Resolution



- Extent

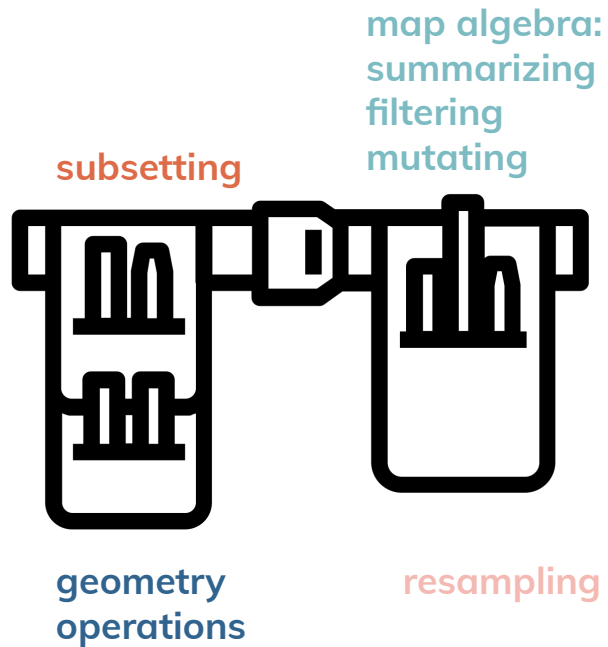


- Position

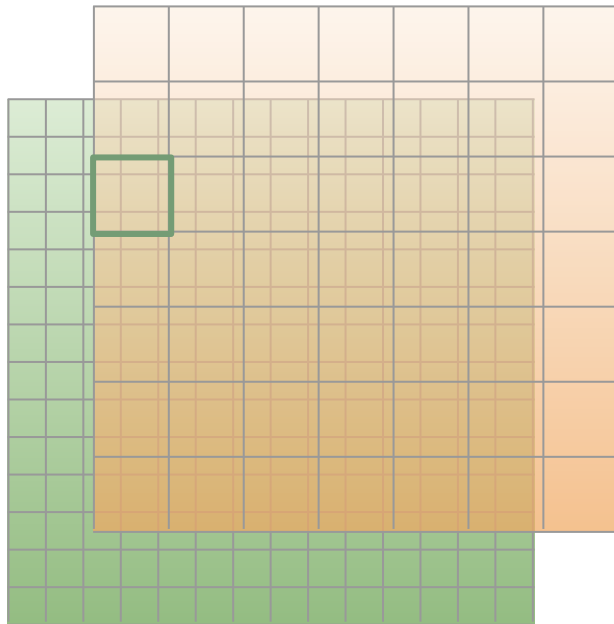


mismatch!

Toolbelt for solving spatial problems



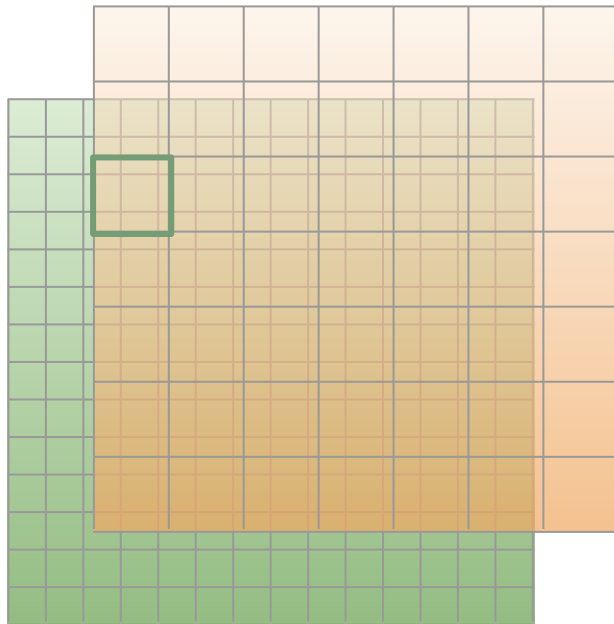
Resampling



Resampling

Nearest neighbor

Bilinear interpolation



Switching gears...

