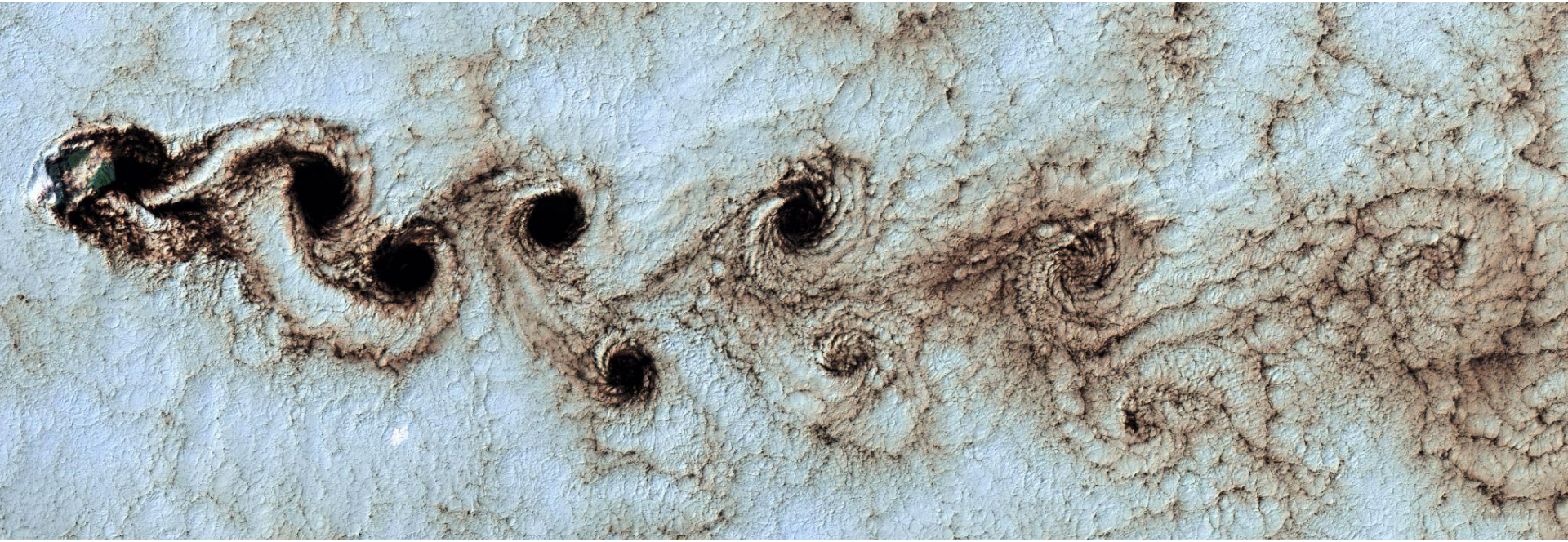
EDS 223: Geospatial Analysis & Remote Sensing
Week 5

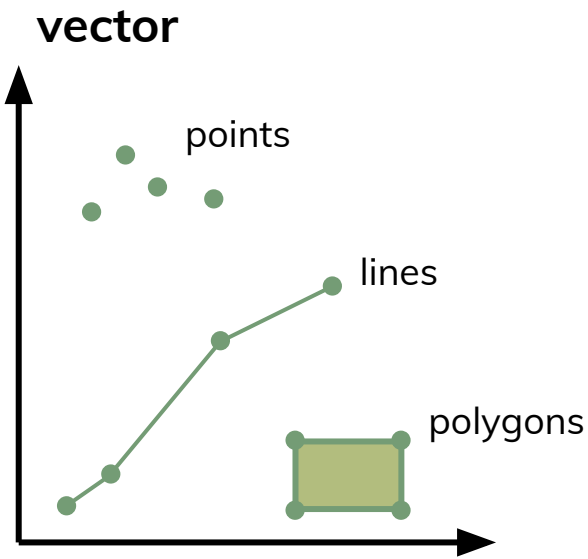


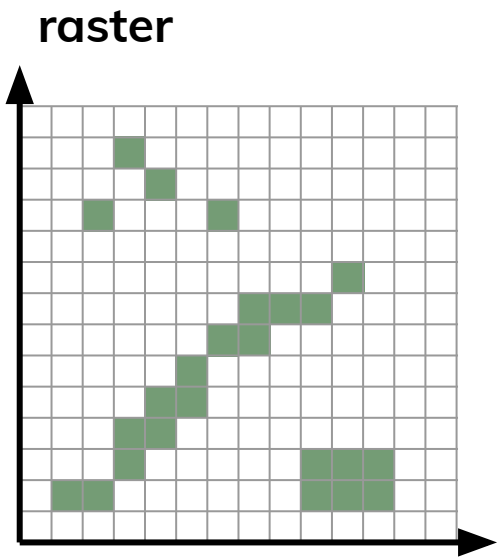
USGS via Unsplash

Welcome!

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

Spatial data models



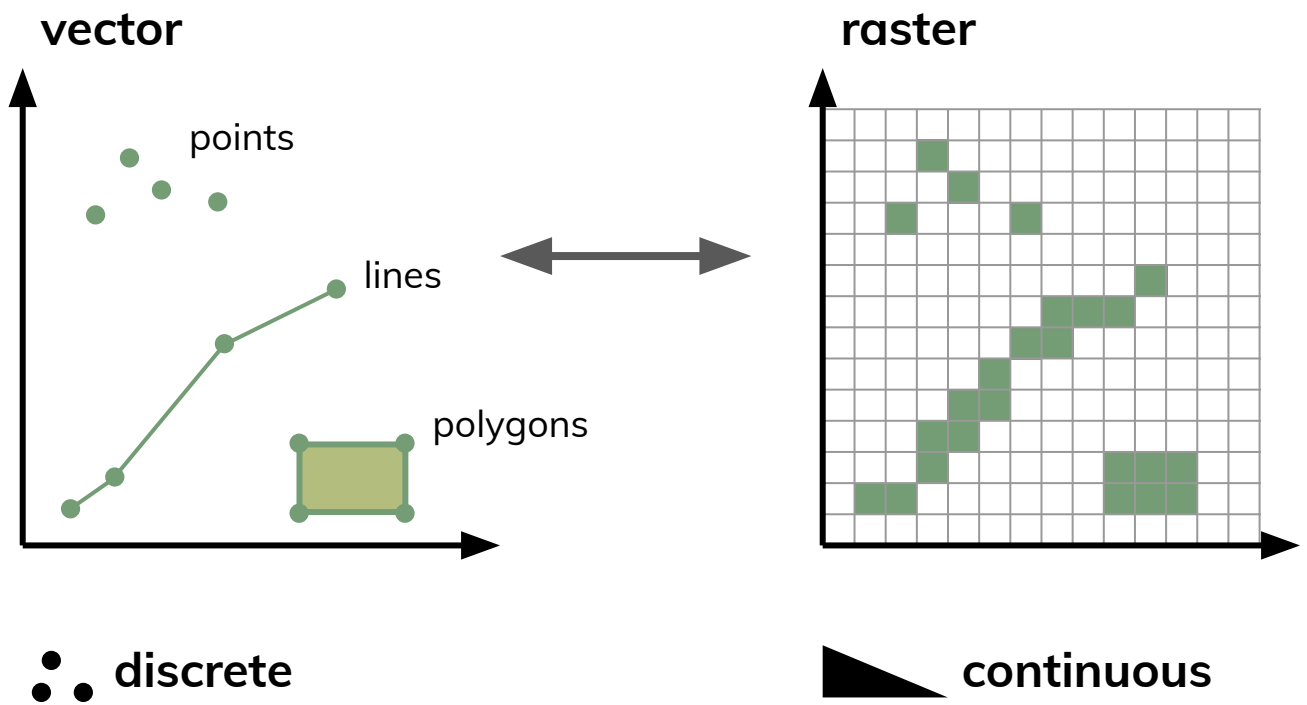


discrete

continuous

Modified from: GIS Fundamentals, Paul Bolstad

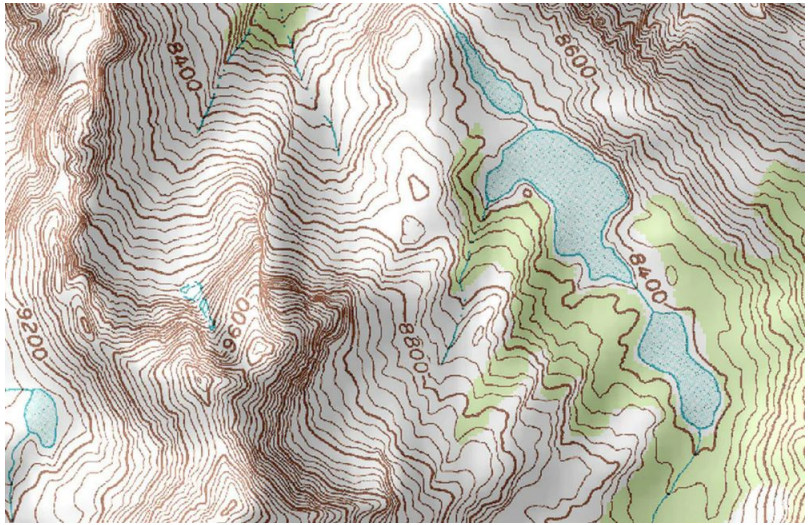
Spatial data models



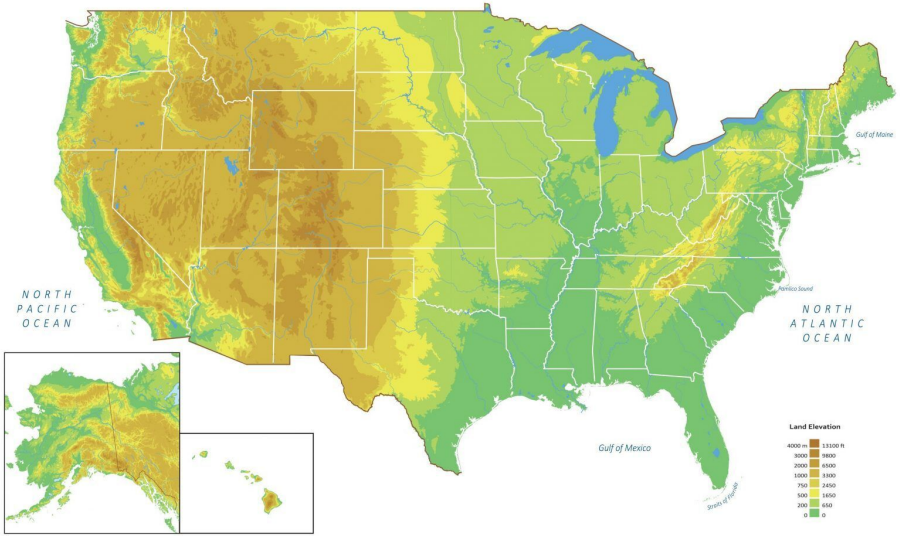
Modified from: GIS Fundamentals, Paul Bolstad

Spatial data models

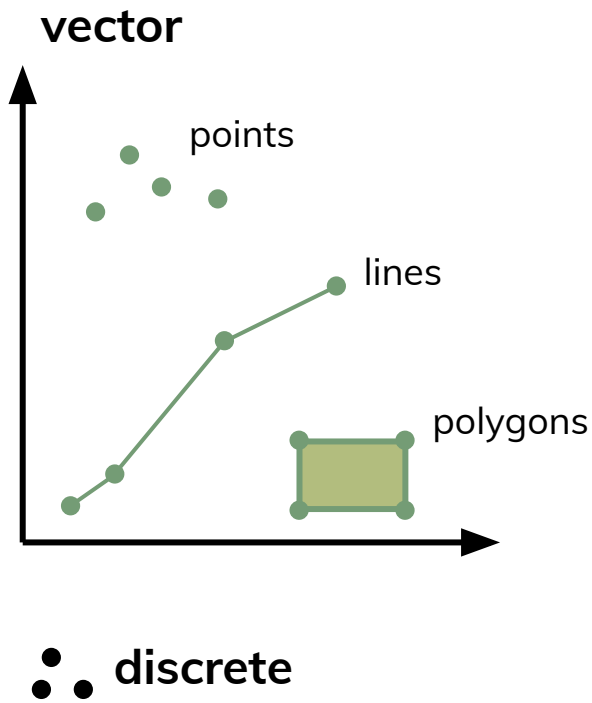
vector



raster



Vector data models



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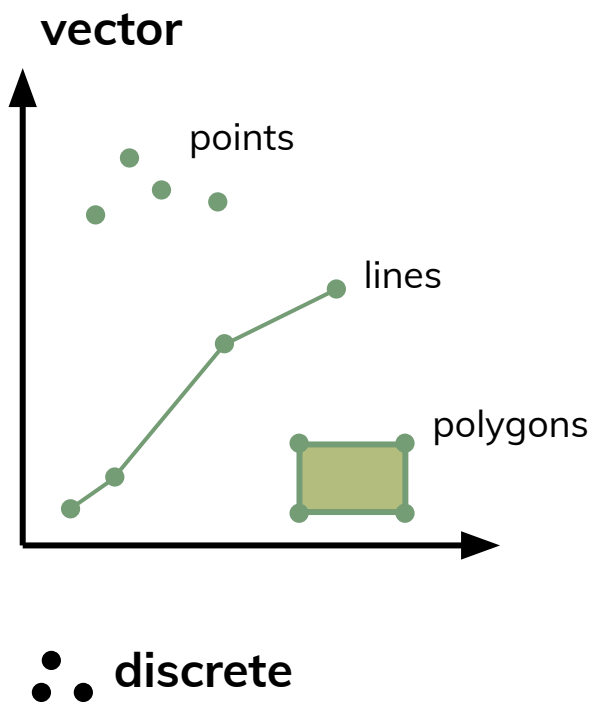
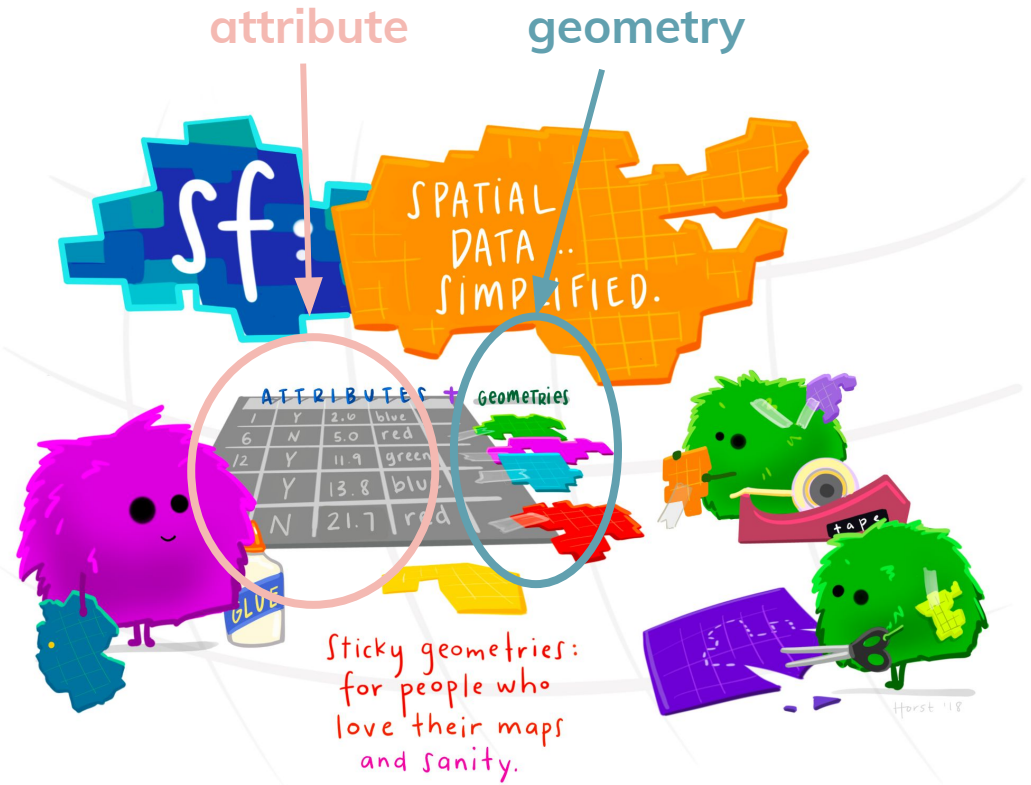
Vector data models

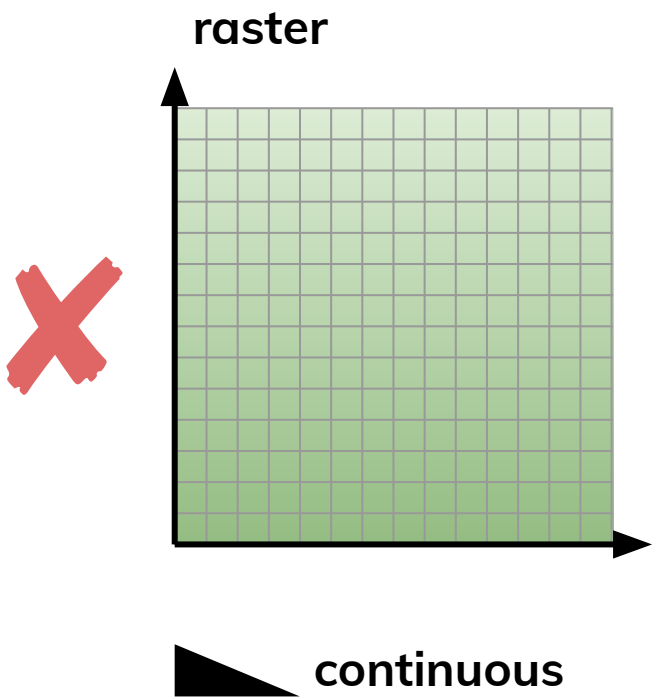




Modified from: GIS Fundamentals, Paul Bolstad

Raster data models

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



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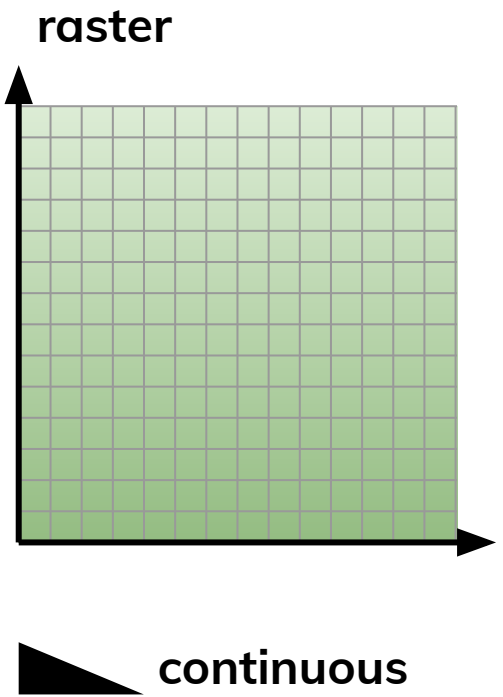
Raster data models

geometry

- ?

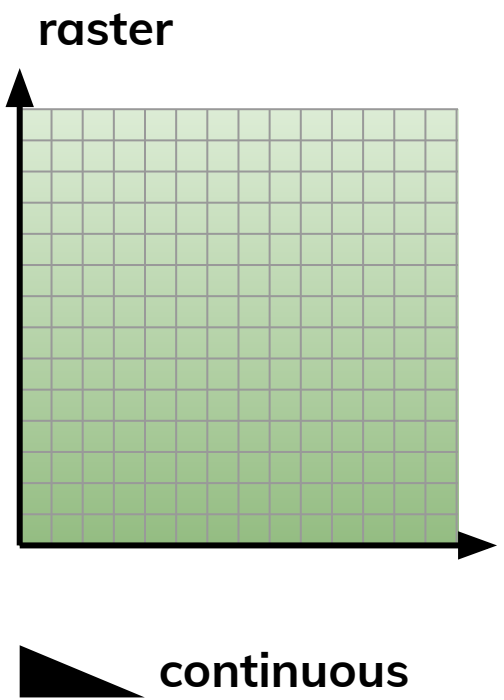


Modified from: GIS Fundamentals, Paul Bolstad

Raster data models

geometry

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



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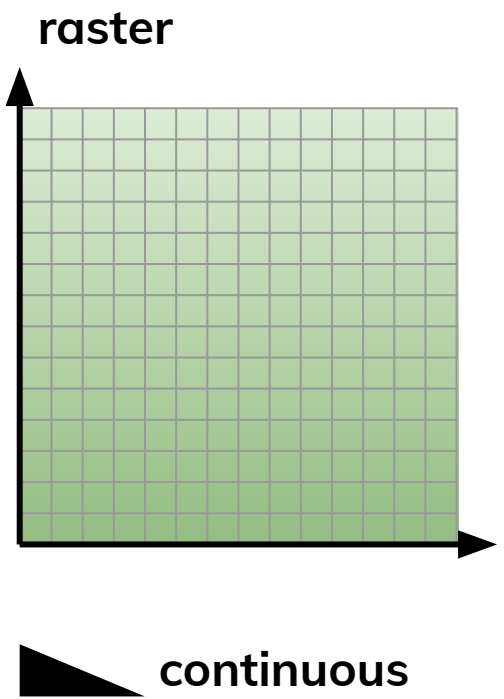
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



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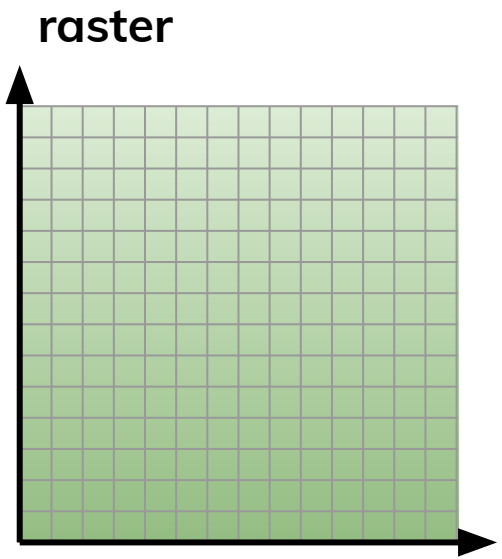

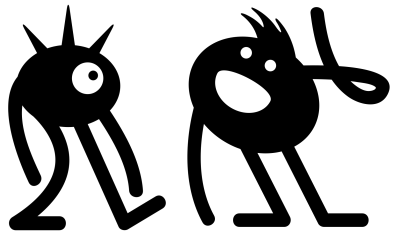

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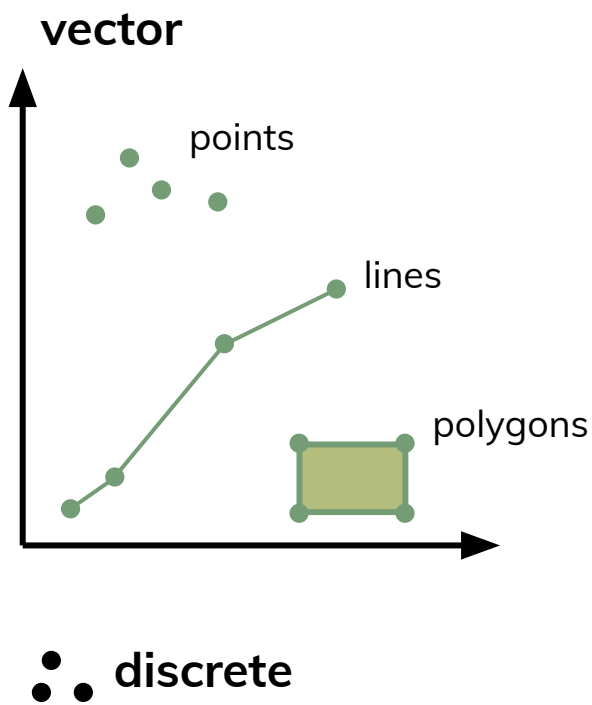
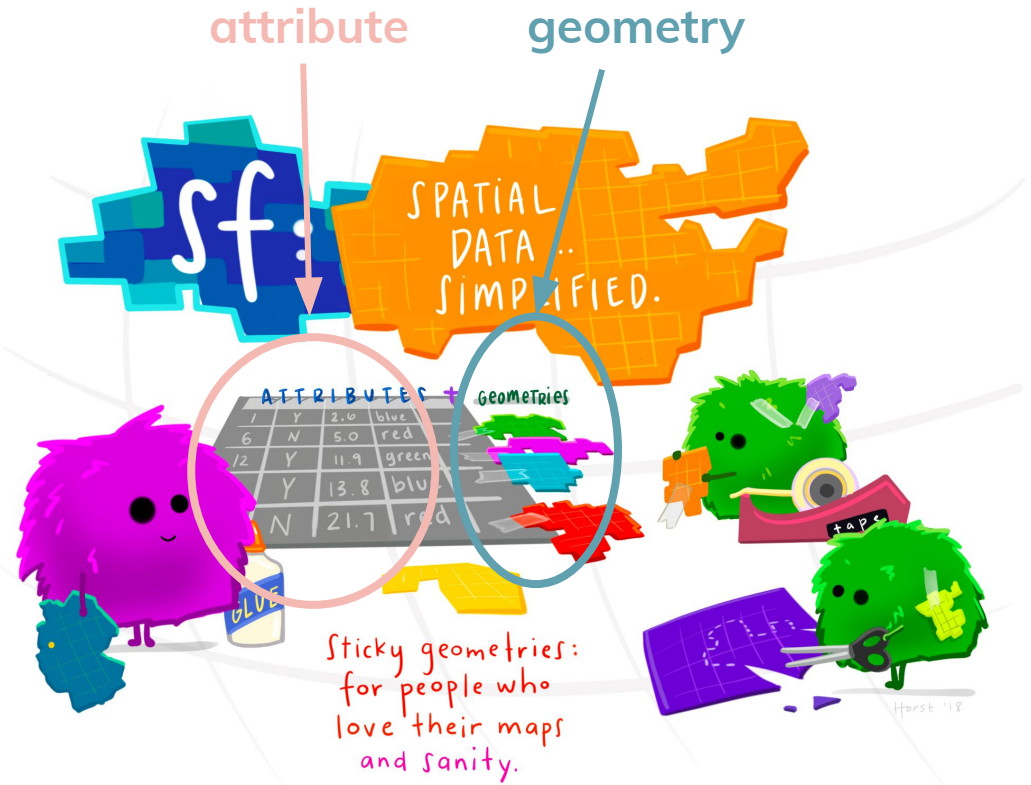
Vector data models





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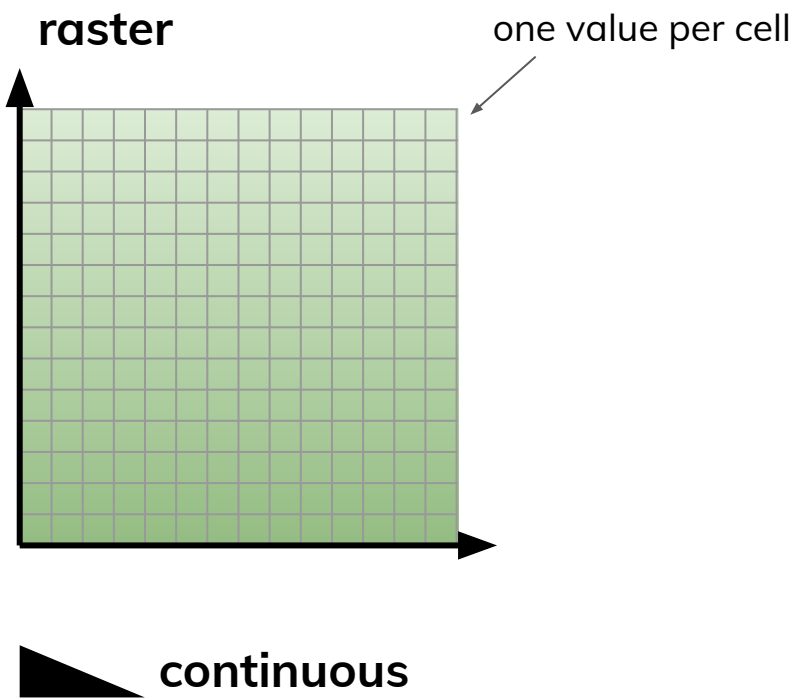

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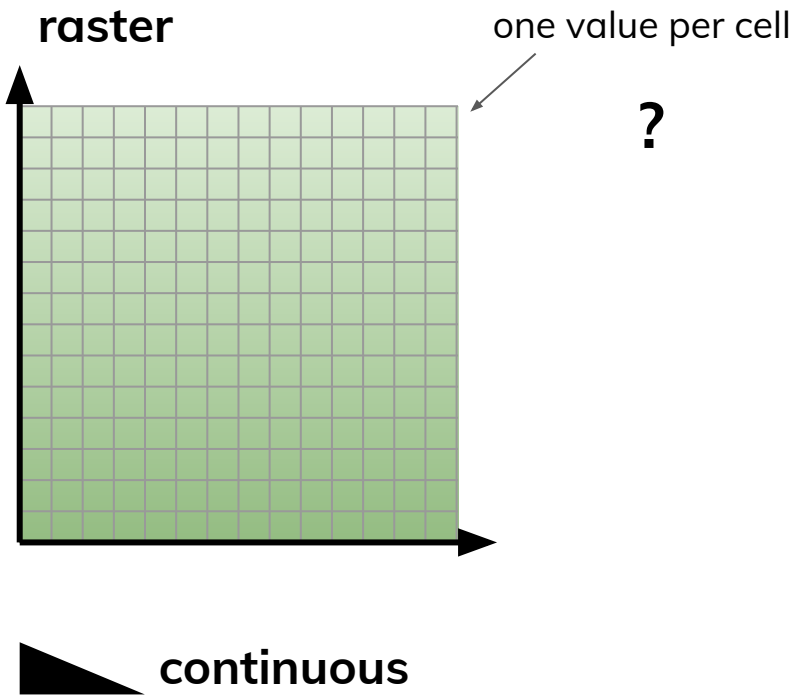

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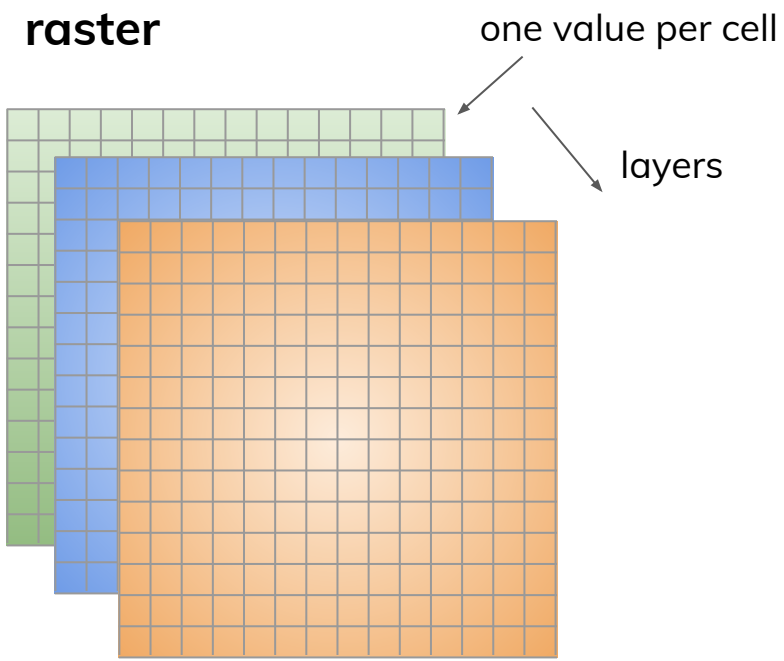


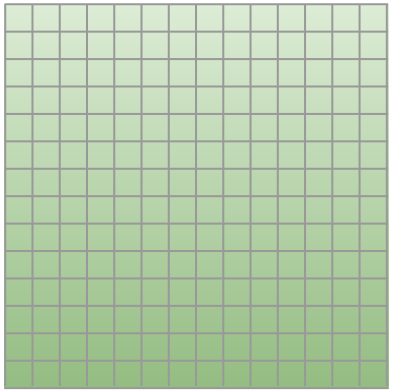
Modified from: GIS Fundamentals, Paul Bolstad

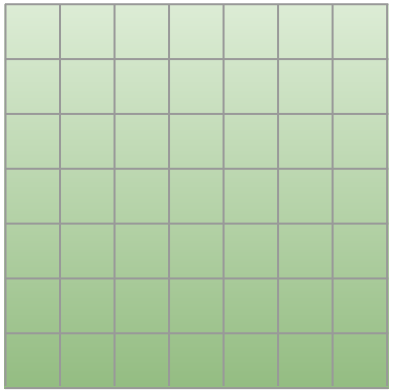
Raster data model

geometry

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

→ **resolution**



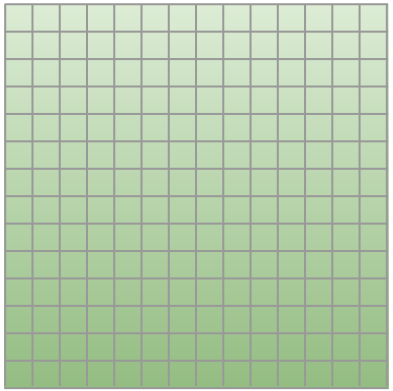


Raster data model

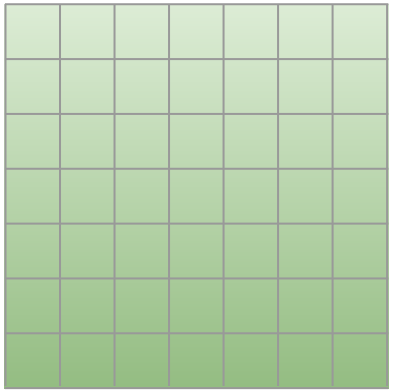
geometry

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

→ **resolution**



- “finer”
- “higher”



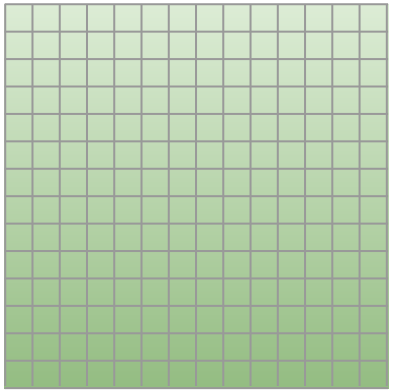
- “coarser”
- “lower”

Raster data model

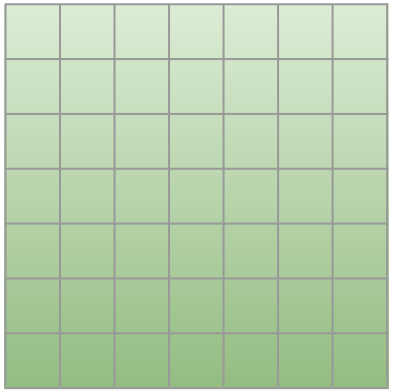
geometry

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

→ **resolution**



- “finer”
- “higher”
- 1 km

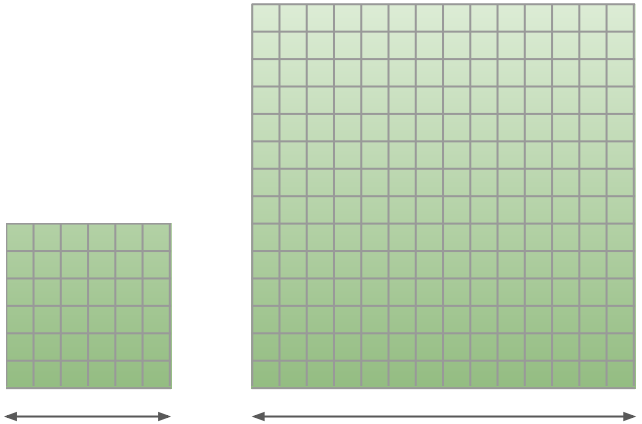


- “coarser”
- “lower”
- 5 km

Raster data model

geometry

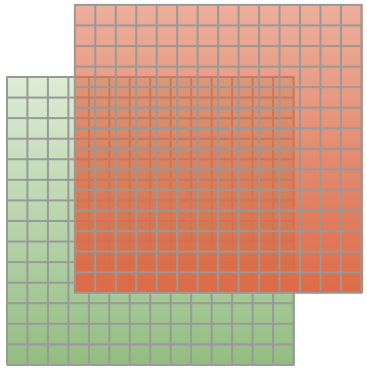
- Cell size
- Number of rows/columns → **extent**
- Cell origin
- CRS



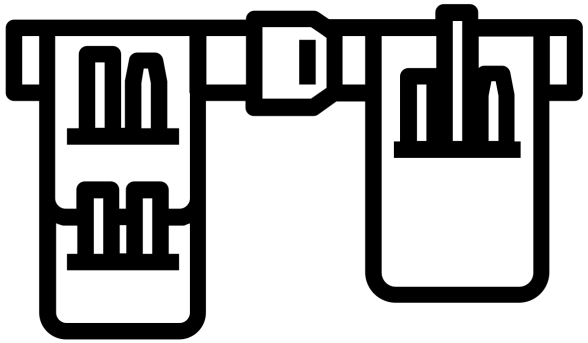
Raster data model

geometry

- Cell size
- Number of rows/columns
- Cell origin → **position**
- CRS



Toolbelt for solving spatial problems



New tools for a new data type

data frame

attributes

observations

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

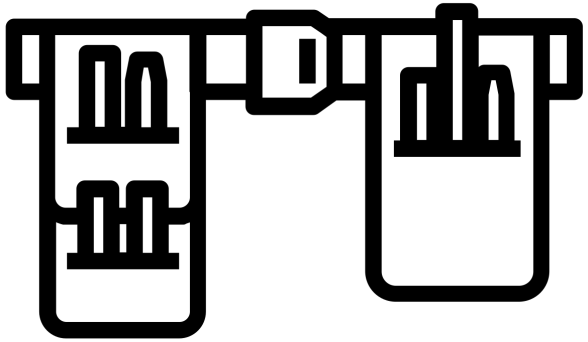
columns

rows

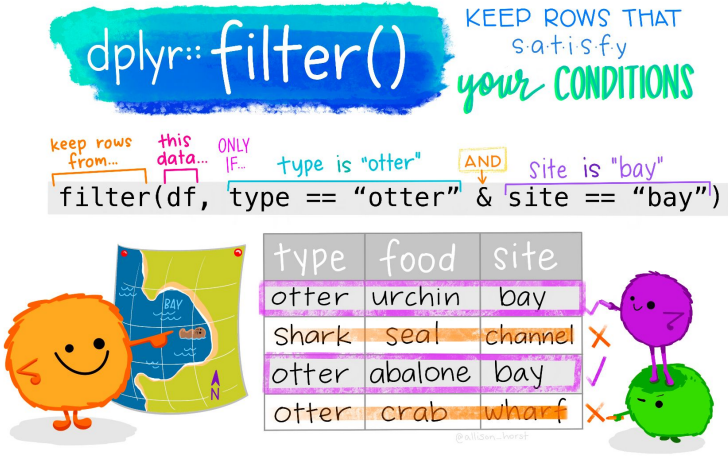
1	4	8
10	7	3
2	5	1

Toolbelt for solving spatial problems

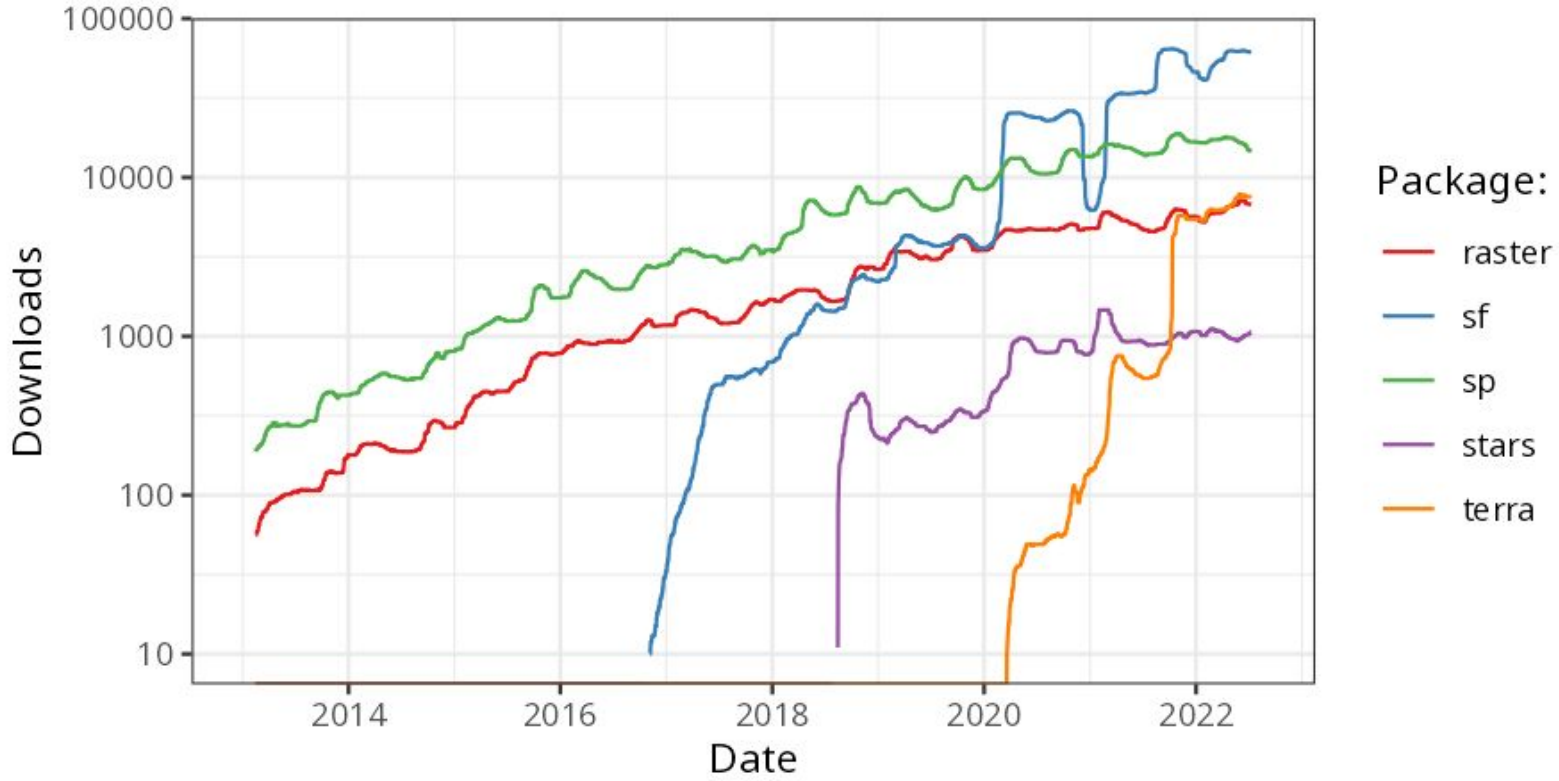
subsetting



New tools for a new data type

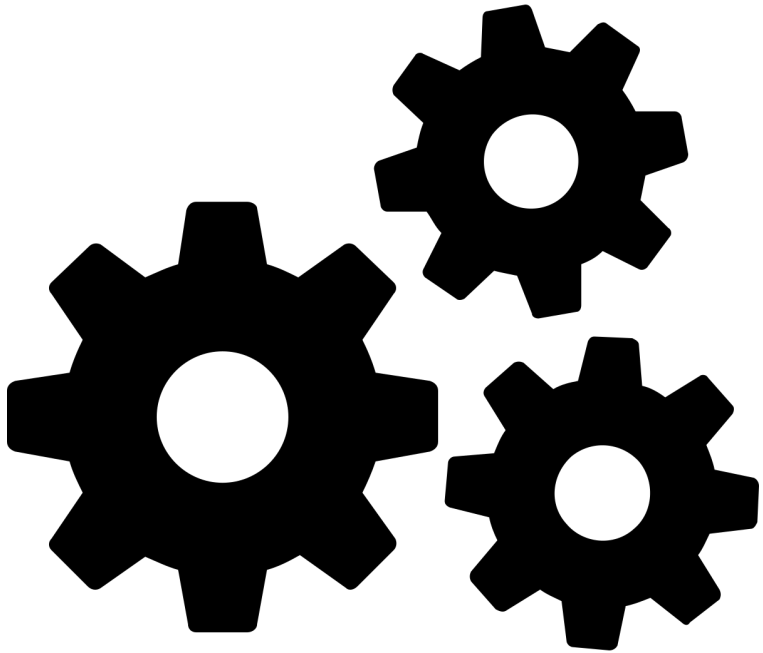


R's spatial ecosystem



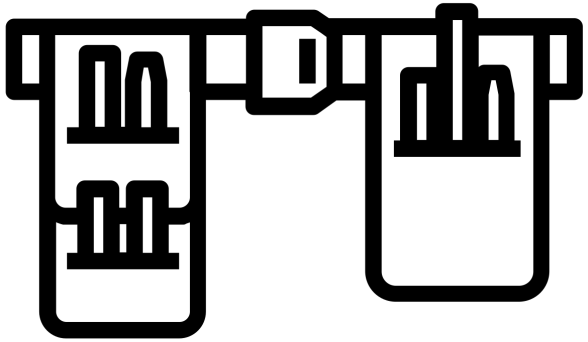
Source: Geocomputation with R

Switching gears...



Toolbelt for solving spatial problems

spatial subsetting



Toolbelt for solving spatial problems

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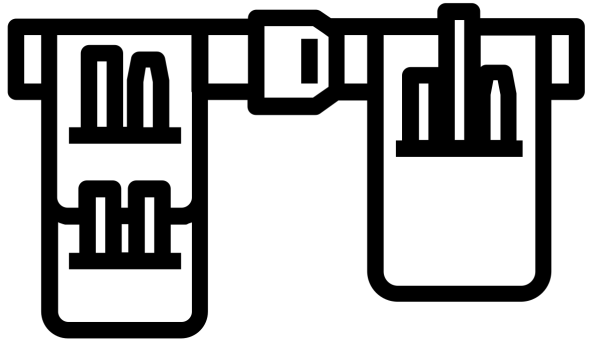
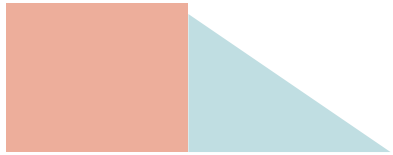


Topological relationships

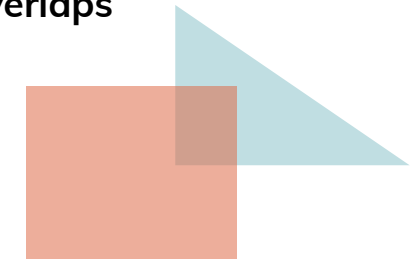
intersects

Yes or No

touches

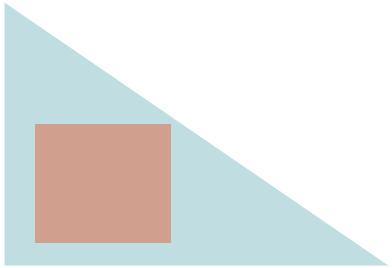


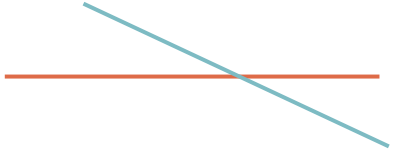
overlaps



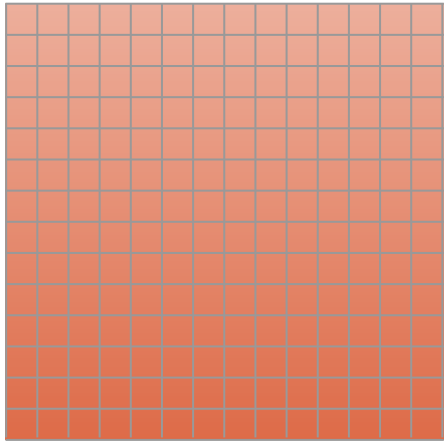
crosses

within





Spatial subsetting



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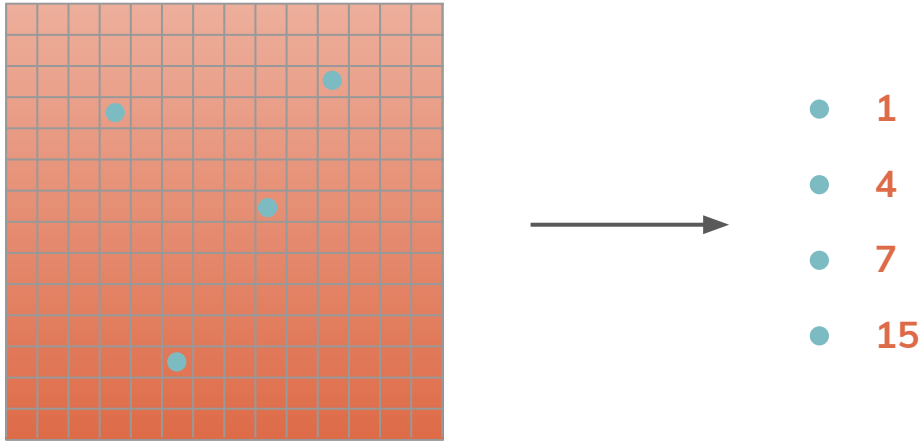
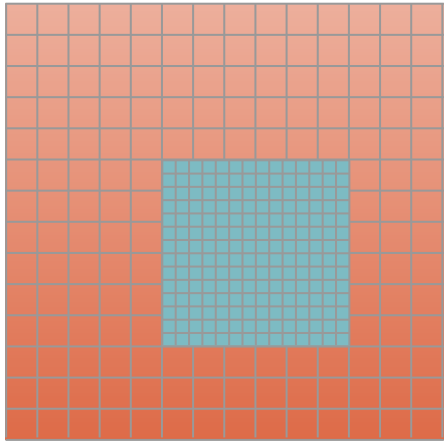
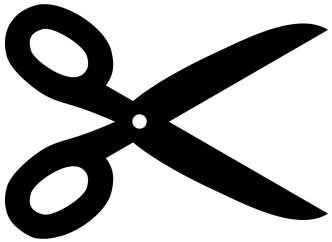


Spatial subsetting: clipping





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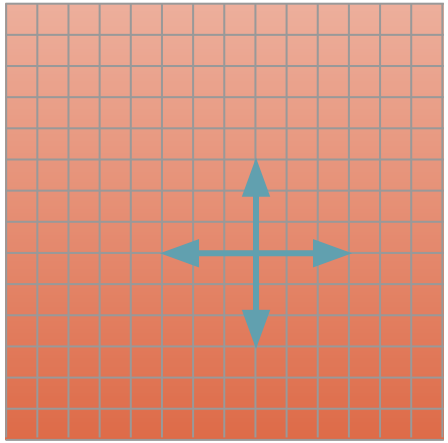

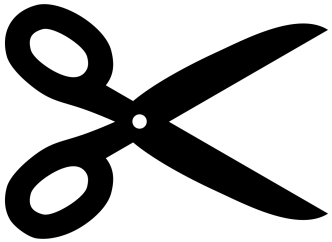

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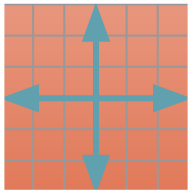
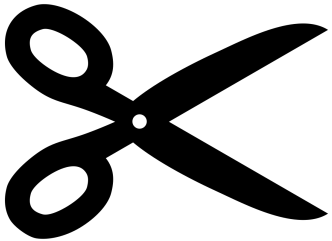
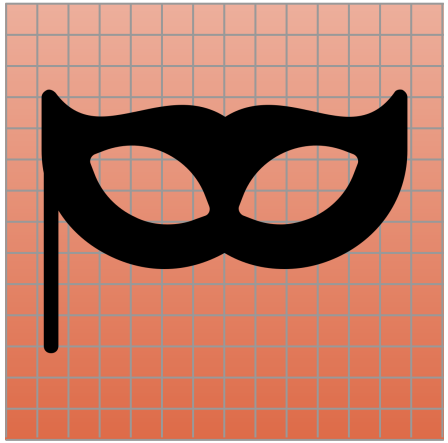




Spatial subsetting: masking



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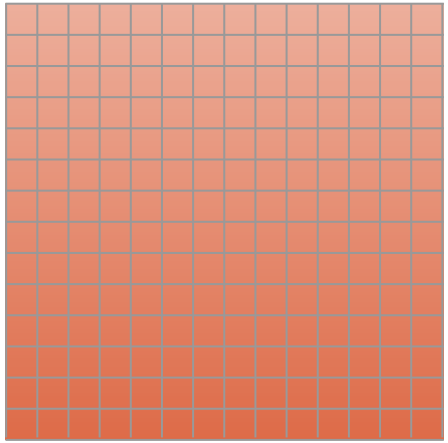
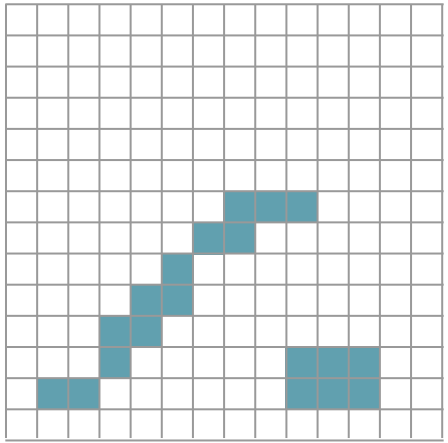
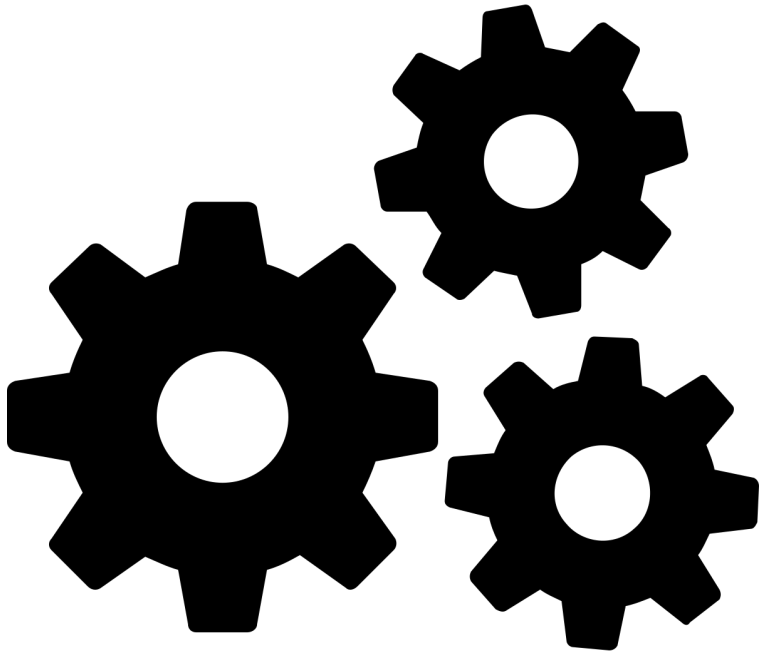
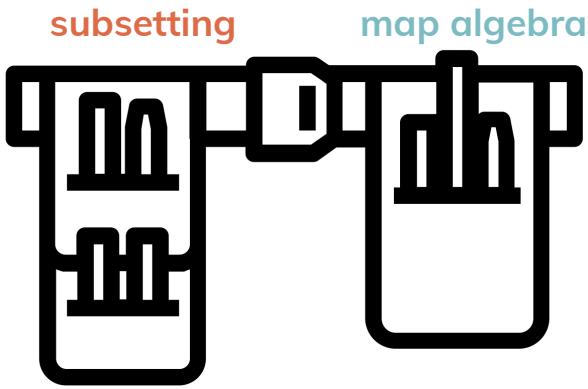




Switching gears...



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

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10	7	3
2	5	1

geometry

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- Cell origin
- CRS

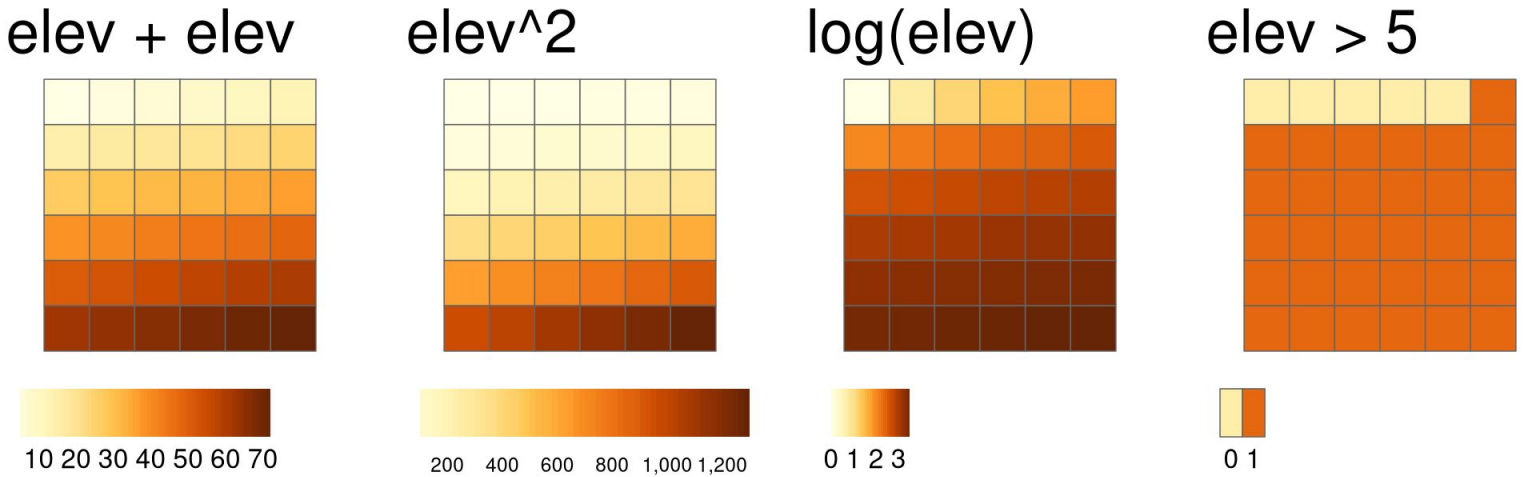
Map algebra

- Local
- Focal
- Zonal
- Global

Scale or number of cells

Map algebra

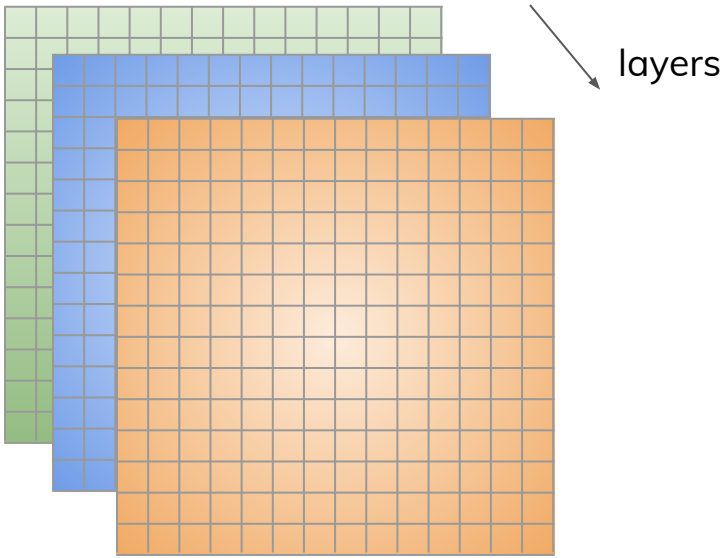
- **Local**
  - Cell-by-cell operations in one or several layers



Source: Geocomputation with R, chapter 4

Map algebra

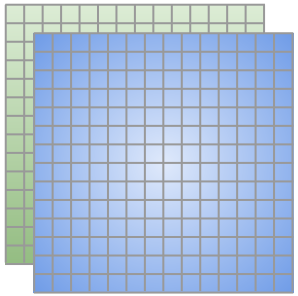
- **Local**
  - Cell-by-cell operations in one or several layers



Source: Geocomputation with R, chapter 4

Map algebra

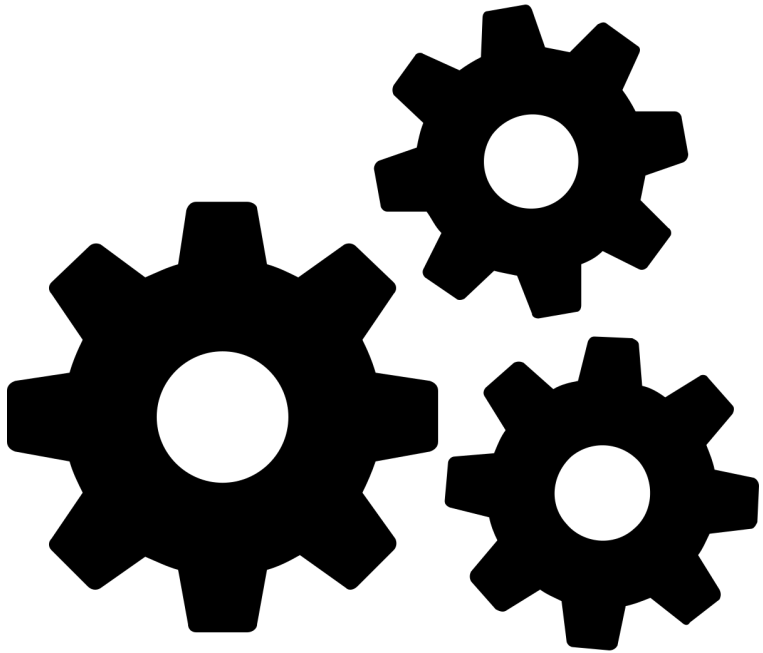
- **Local**
  - Cell-by-cell operations in one or several layers



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

Source: Geocomputation with R, chapter 4

Switching gears...



Map algebra

- Local
- Focal
- Zonal
- Global

Scale or number of cells

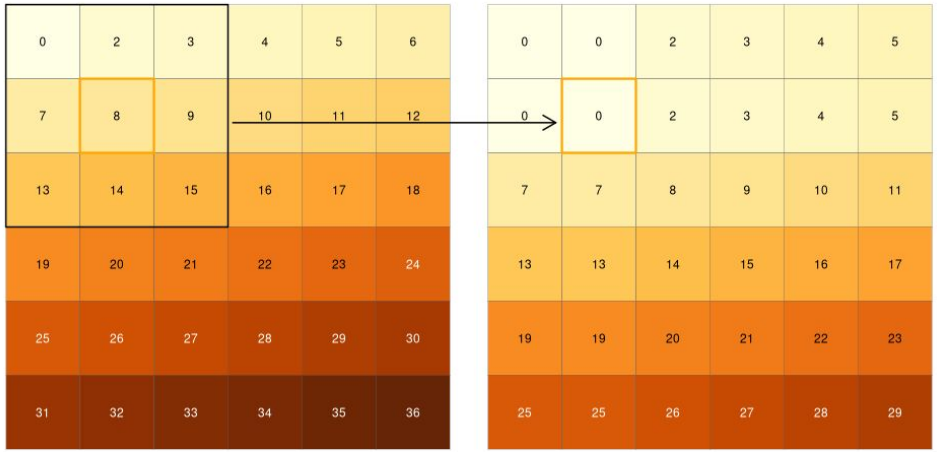
Map algebra

- **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

Source: Geocomputation with R, chapter 4

Map algebra

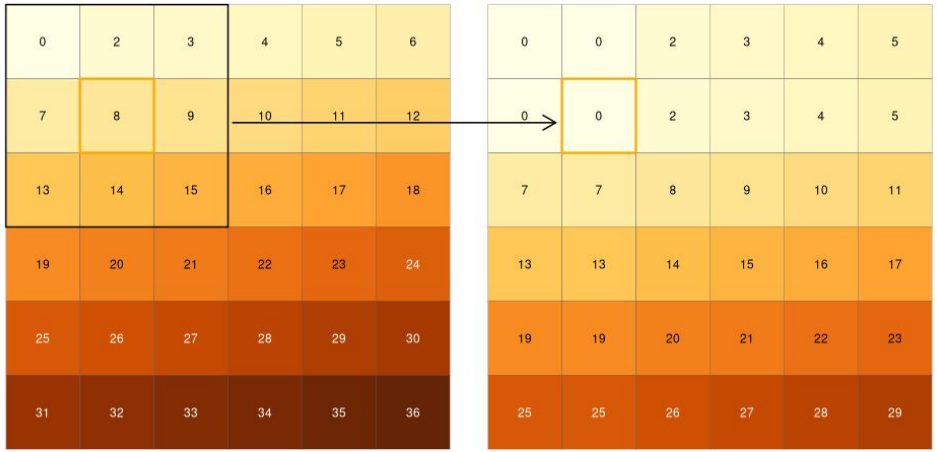
- **Focal**
  - Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell



Source: Geocomputation with R, chapter 4

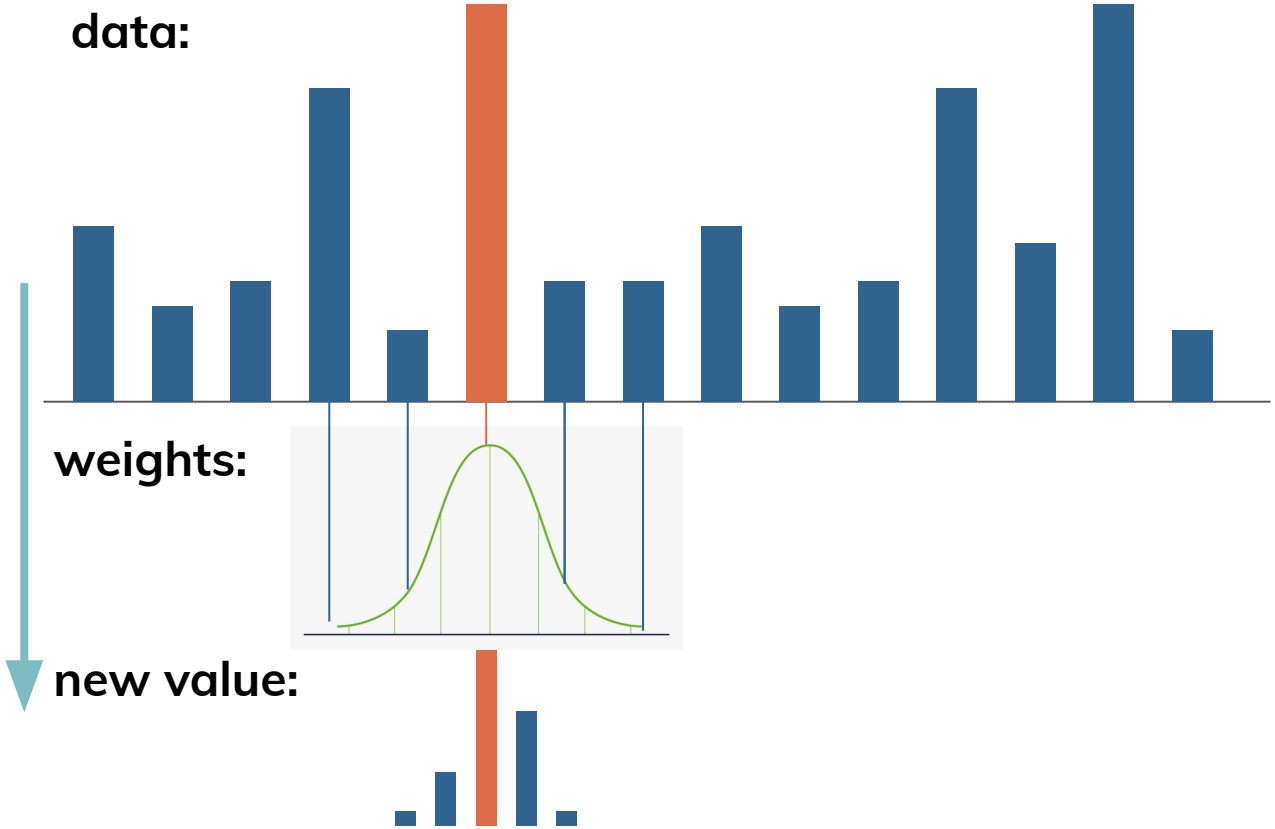
Map algebra

- **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



Source: Geocomputation with R, chapter 4

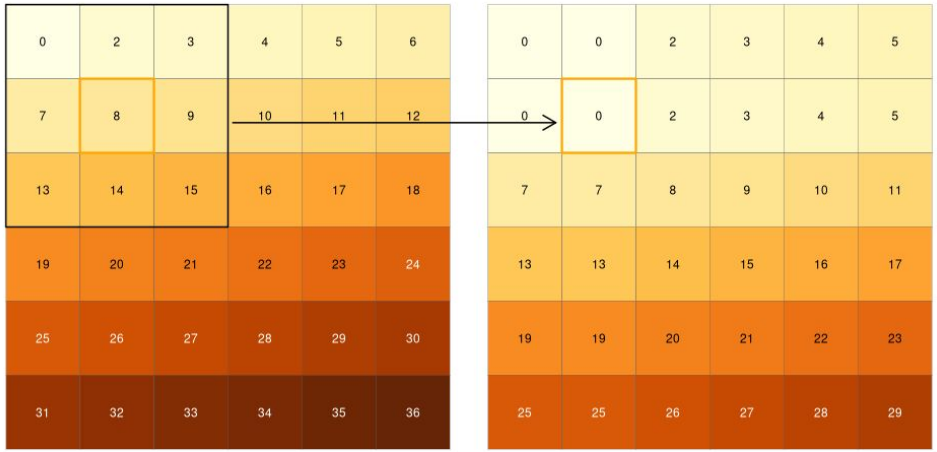
Smoothing: Gaussian kernel



Map algebra

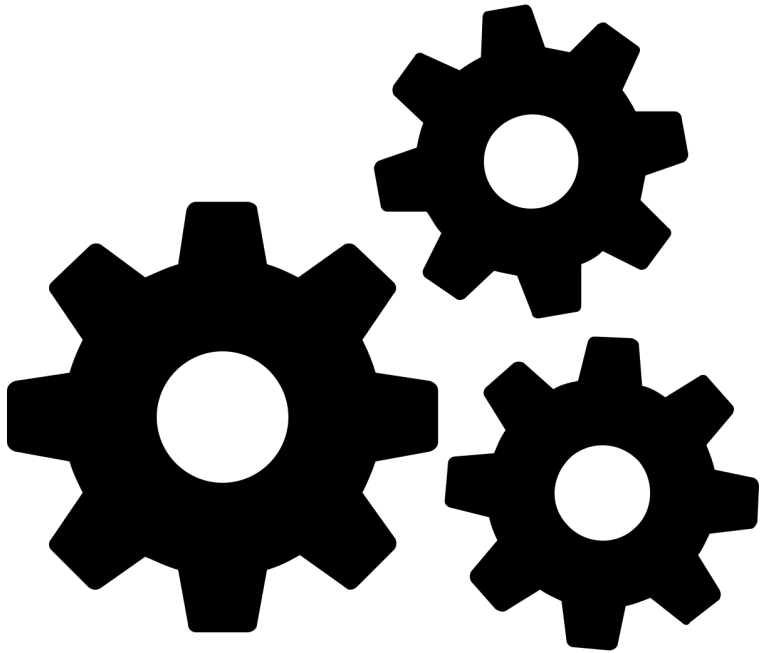
- **Focal**
  - Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell

kernel,
filter,
moving window



Source: Geocomputation with R, chapter 4

Switching gears...



Map algebra

- Local
- Focal
- Zonal
- Global

Scale or number of cells

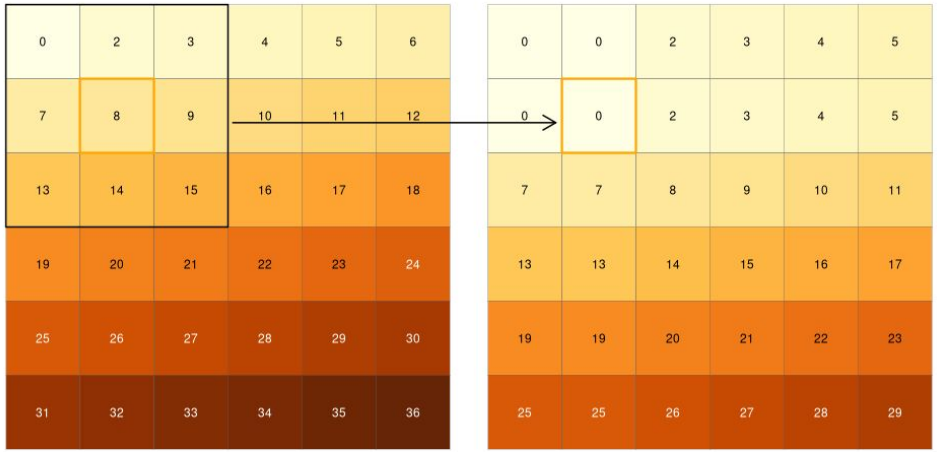
Map algebra

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

Source: Geocomputation with R, chapter 4

Map algebra

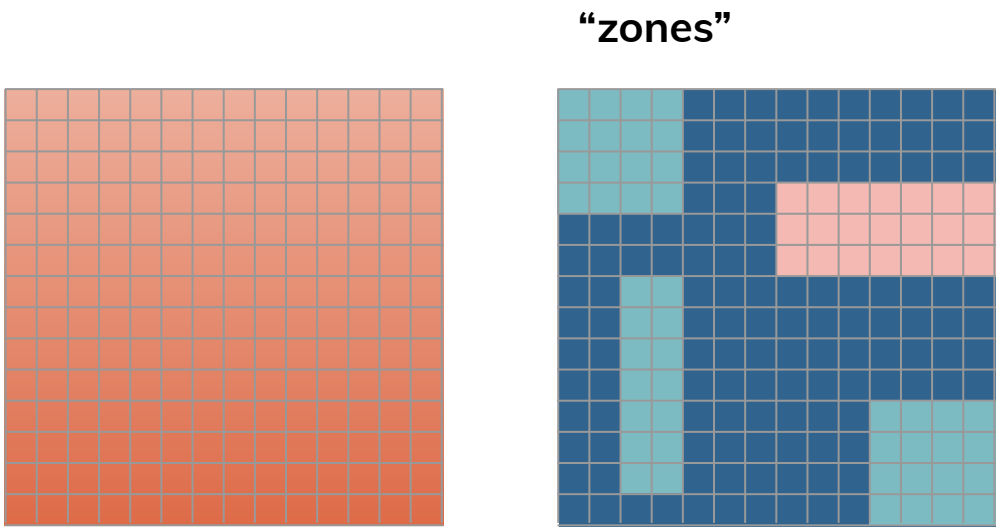
- **Zonal**
  - Applies an aggregation function to multiple cells based on a grouping variable



Source: Geocomputation with R, chapter 4

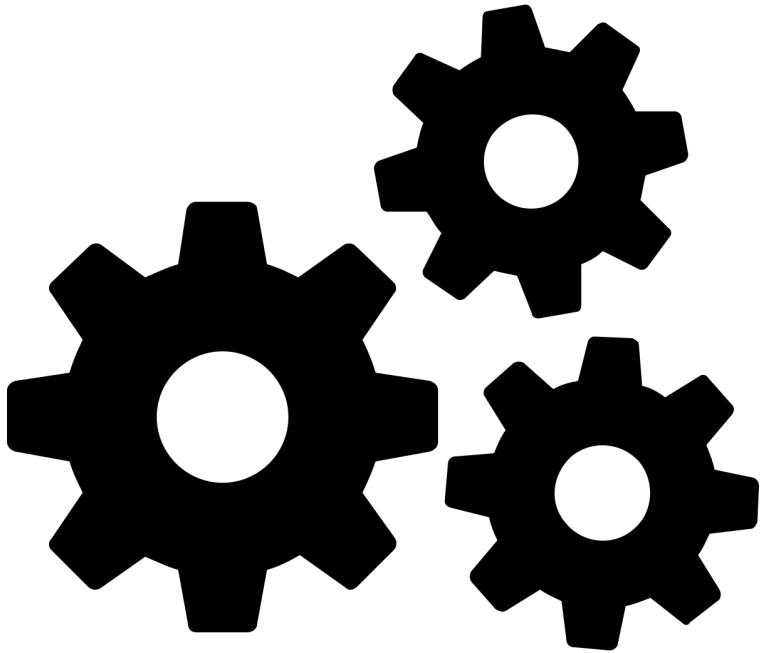
Map algebra

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



Source: Geocomputation with R, chapter 4

Switching gears...

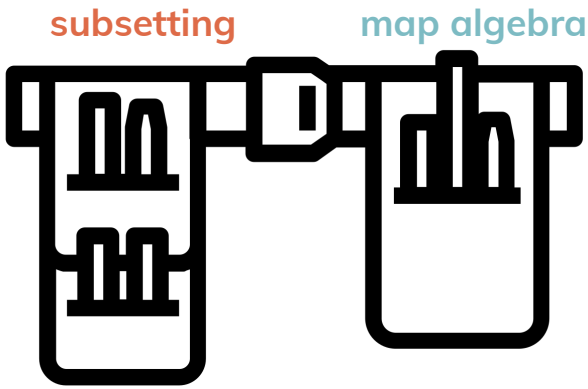


Map algebra

- Local
- Focal
- Zonal
- Global

Scale or number of cells

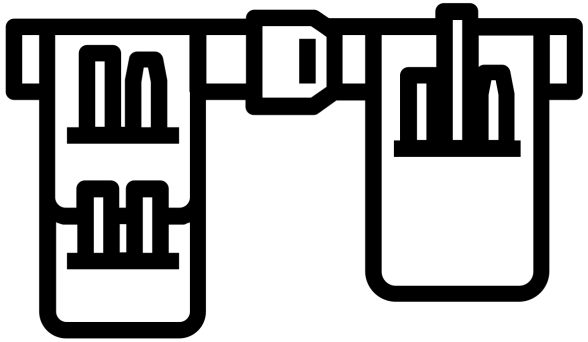
Toolbelt for solving spatial problems



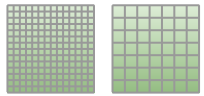
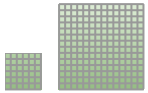
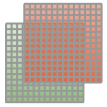
Toolbelt for solving spatial problems

map algebra:
summarizing
filtering
mutating

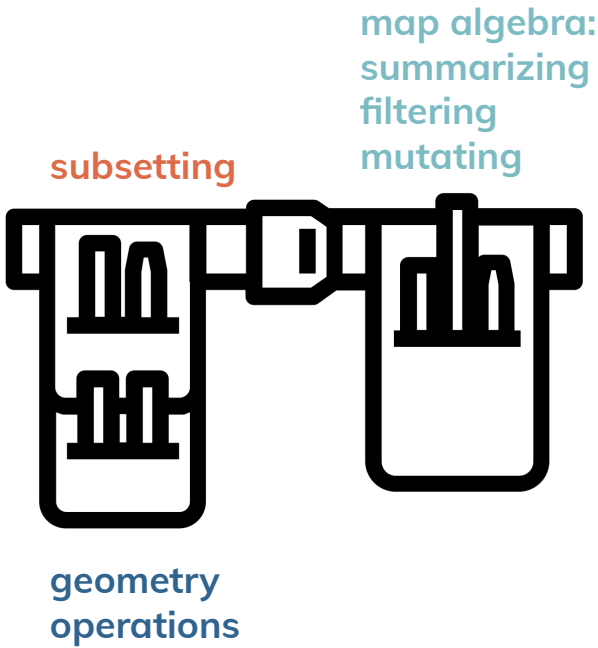
subsetting



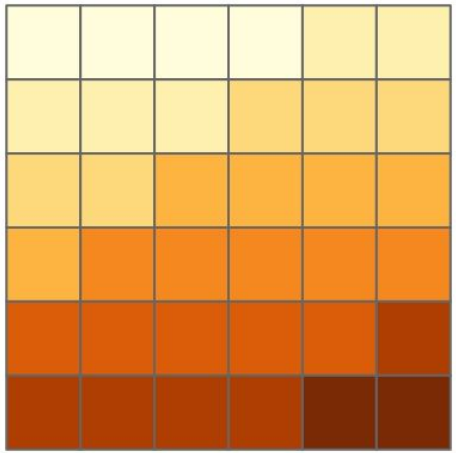
Raster data model

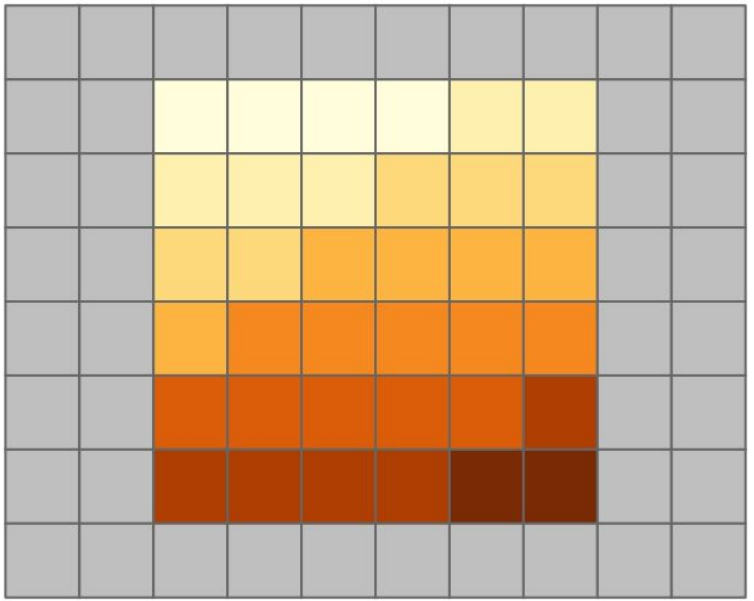
- Resolution 
- Extent 
- Position 

Toolbelt for solving spatial problems



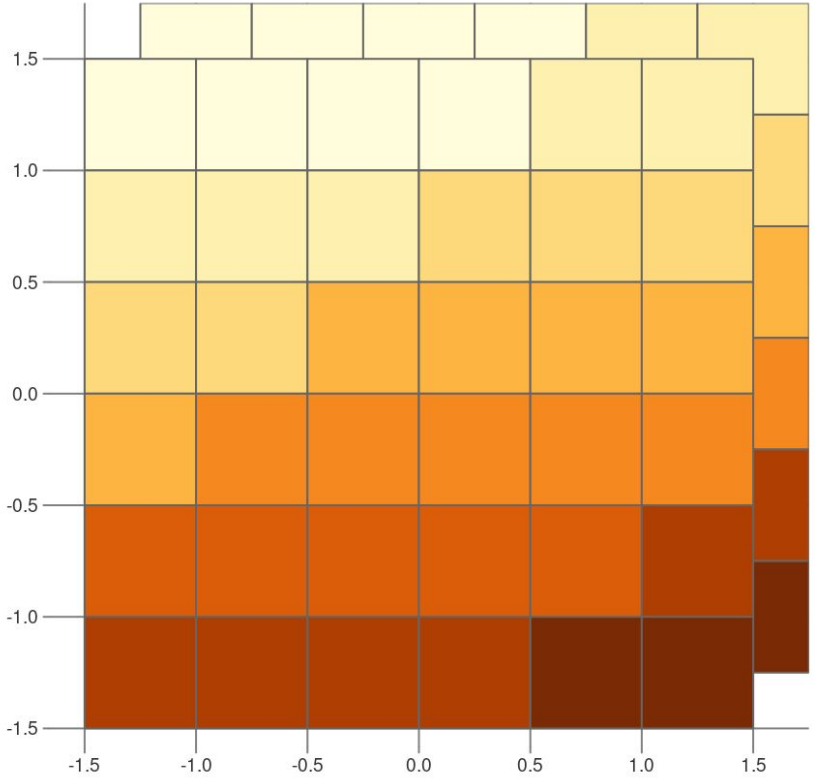
Changing extent and origin





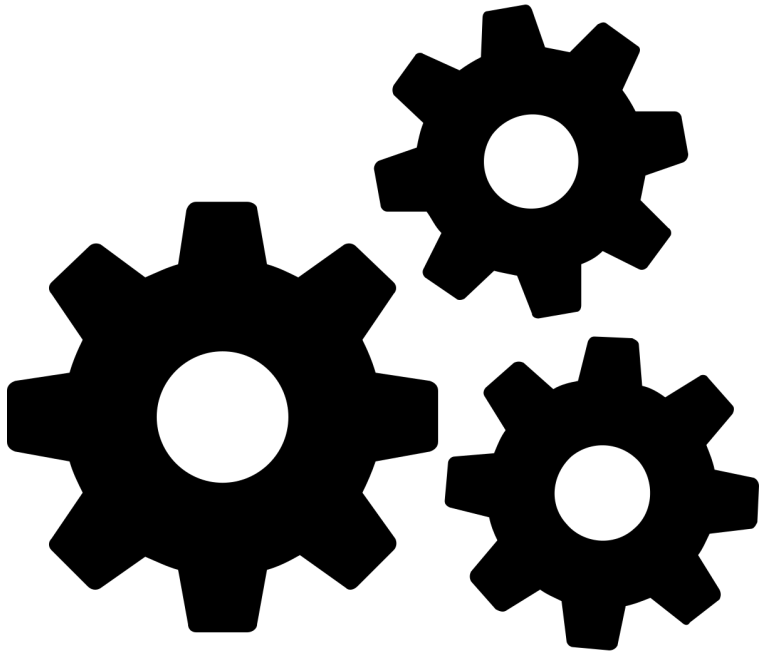
Source: Geocomputation with R, chapter 4

Changing extent and origin

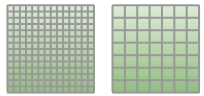
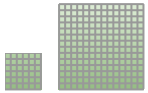
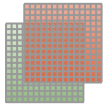


Source: Geocomputation with R, chapter 4

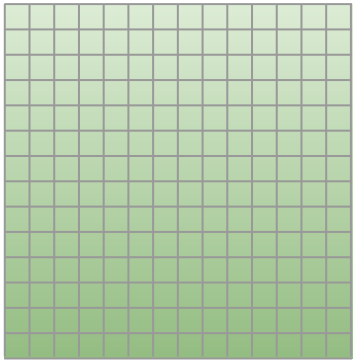
Switching gears...

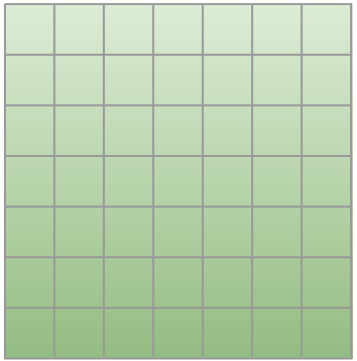


Raster data model

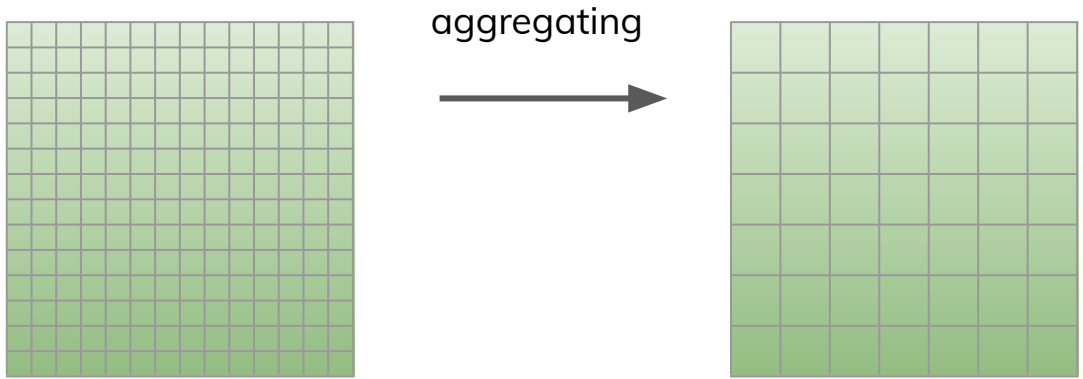
- Resolution 
- Extent 
- Position 

Changing resolution

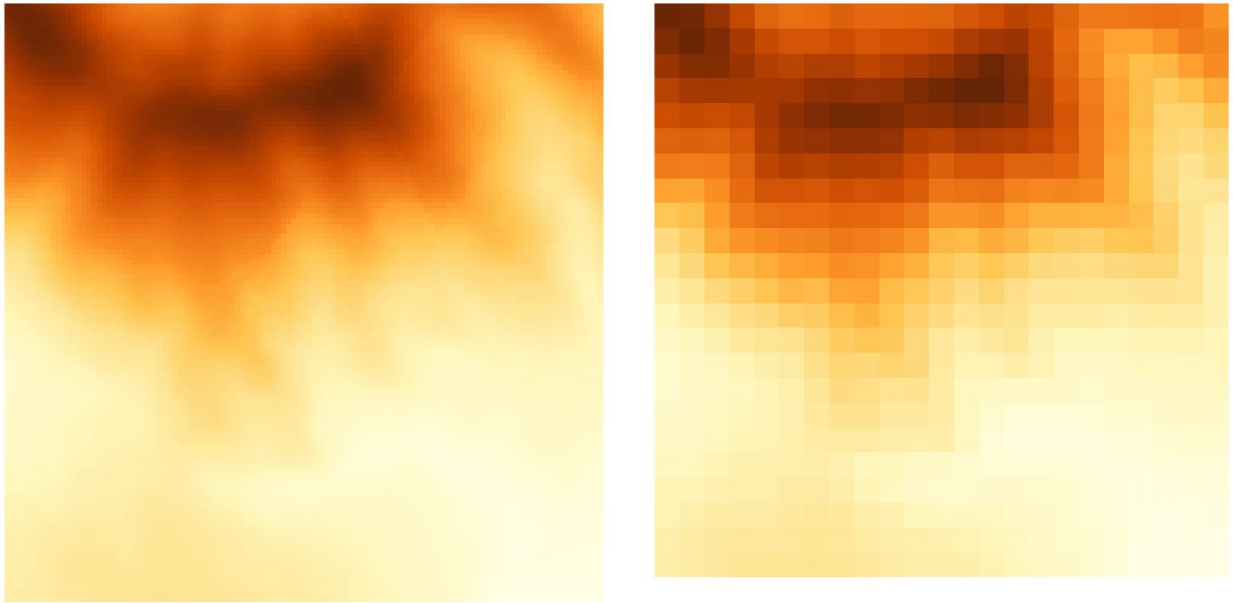




Changing resolution

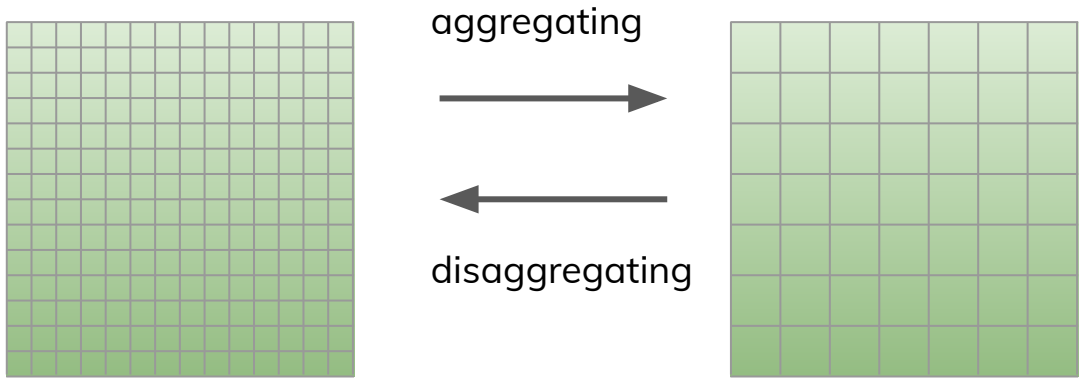


Changing resolution



Source: Geocomputation with R, chapter 5

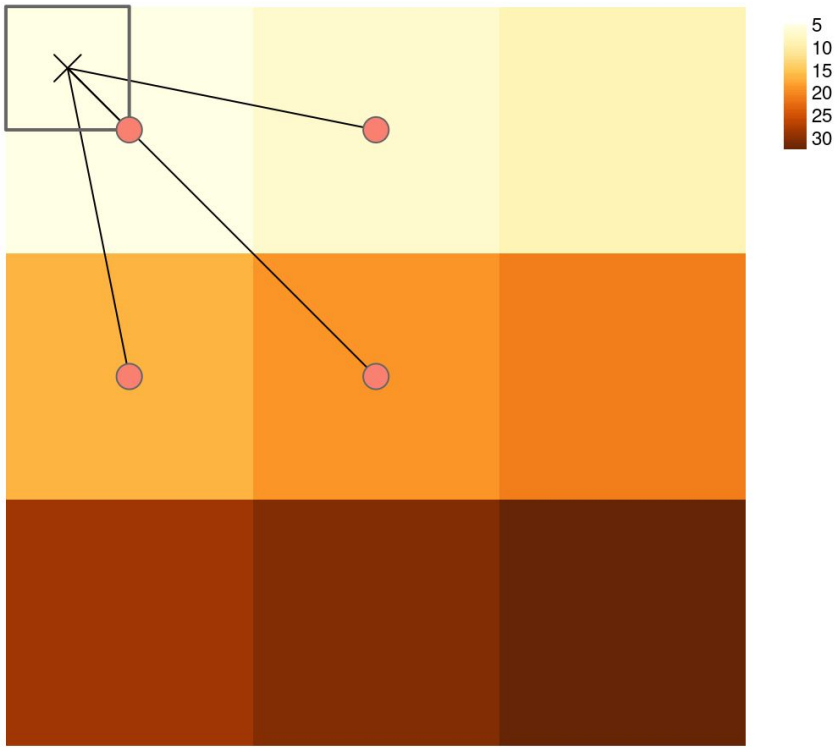
Changing resolution



Changing resolution

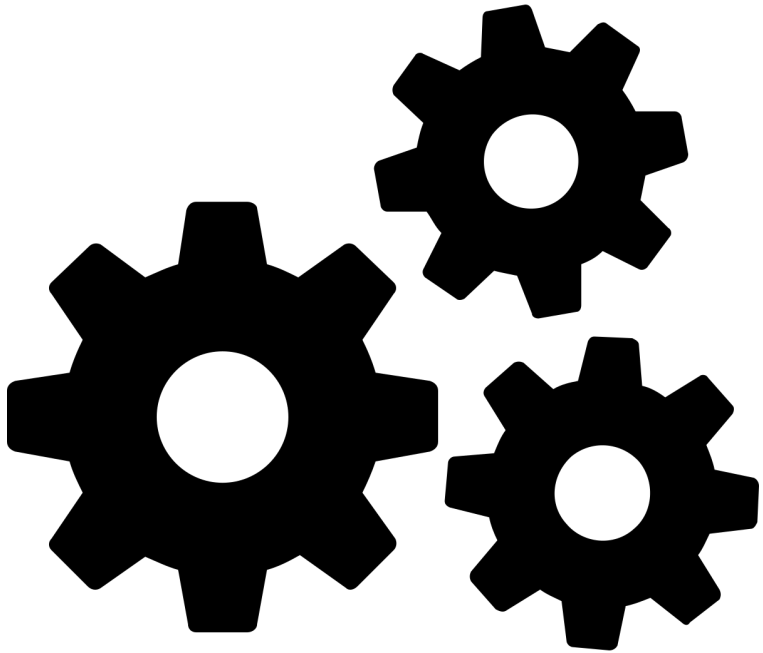
Nearest neighbor

Bilinear interpolation



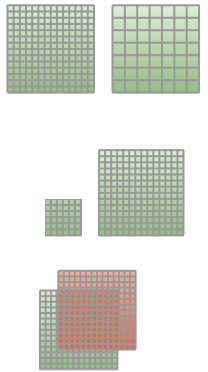
Source: Geocomputation with R, chapter 5

Switching gears...



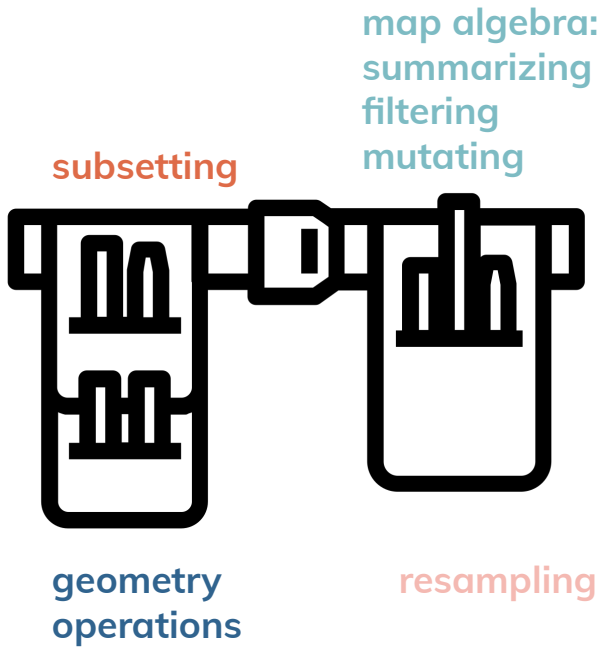
Raster data model

- Resolution
- Extent
- Position

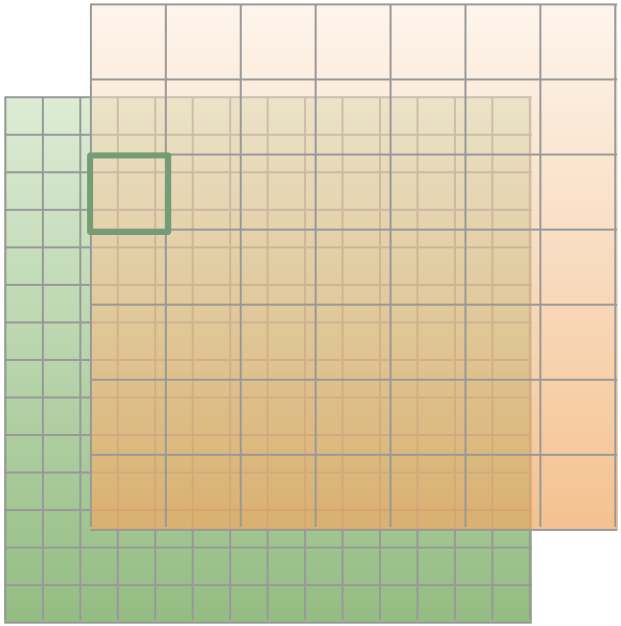


mismatch!

Toolbelt for solving spatial problems



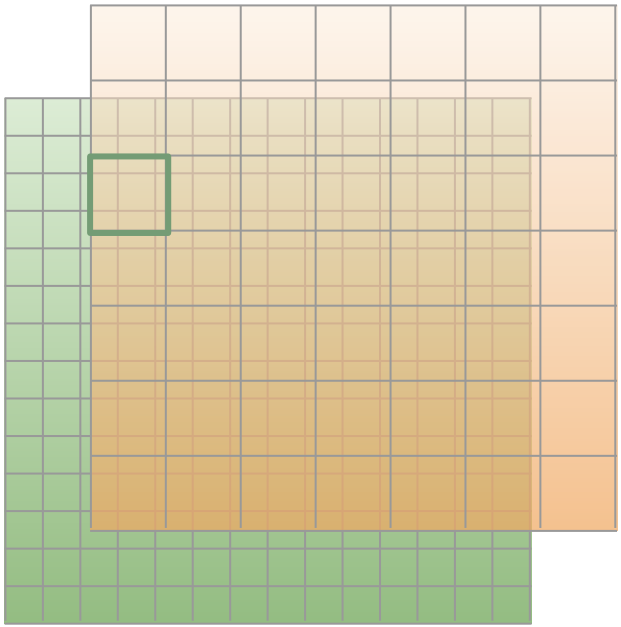
Resampling



Resampling

Nearest neighbor

Bilinear interpolation



Switching gears...