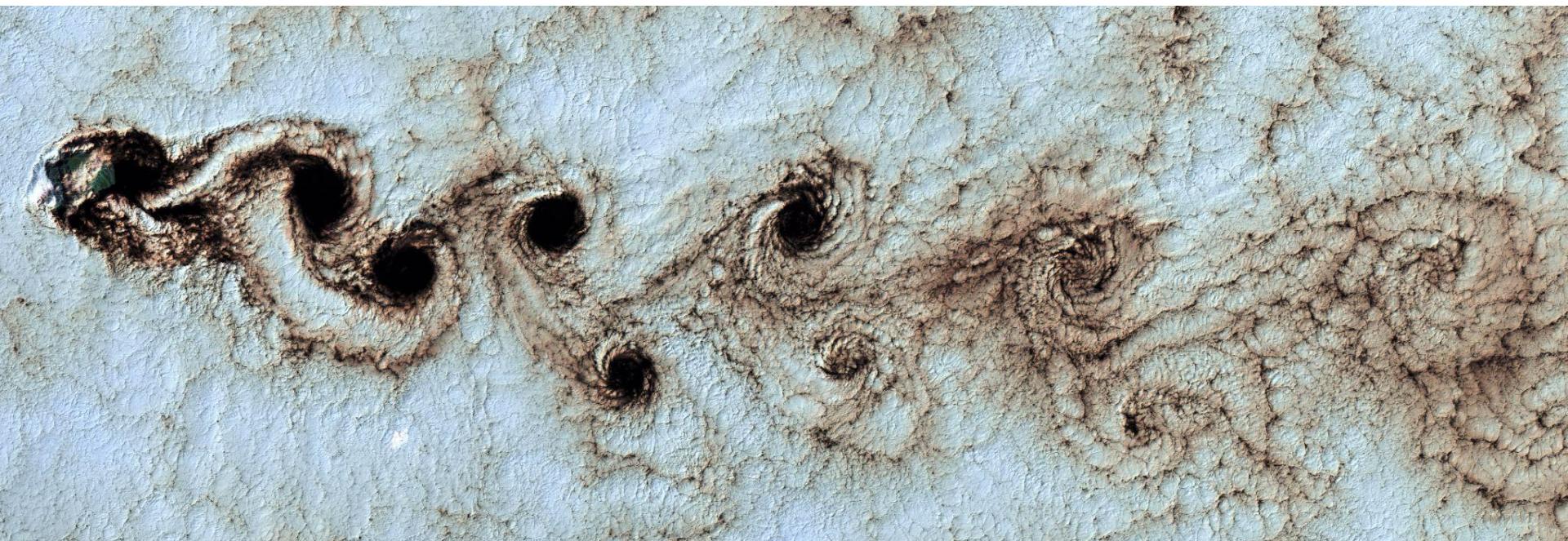


EDS 223: Geospatial Analysis & Remote Sensing

Week 4



USGS via Unsplash

Welcome!

- **Course logistics**
 - Course expectations
 - Upcoming and past events
 - Plans for next week
- **Building a spatial analysis workflow**

How to get unstuck

Start here

| | Resource | Steps |
|--|------------|---|
| | Yourself | <ul style="list-style-type: none">• Review the lecture/lab/discussion materials• Review the background reading• Google! |
| | Your peers | <ul style="list-style-type: none">• Talk to a friend• Ask the #eds-223-geospatial Slack channel |
| | TA | <ul style="list-style-type: none">• Ask questions in discussion section• Attend office hours• Send a message over Slack |
| | Instructor | <ul style="list-style-type: none">• Attend office hours• Send a message over Slack |

Course preparation



How to solve an environmental data science problem

- Break the problem into parts
 - What data do you need?
 - What tools do you need?

- Make a plan
 - What are your inputs?
 - What outputs do you want to create?
 - How can you apply your tools to turn your inputs into outputs?
 - Create a diagram

- Develop your plan
 - Turn our diagram into code

- Test your plan
 - What are the outputs at each step?
 - Do they look right?



Catch up on blogging

The screenshot shows a Quarto website page. At the top right, there is a navigation bar with links: home, about, talks & workshops, projects, and posts. The main title of the page is "Adding a blog to your existing Quarto website". Below the title, a subtext says "Got a Quarto website, but no blog? We can fix that!". There are three small buttons at the bottom of this section: QUARTO, R, and MEDS. The main content area has two columns. The left column contains "AUTHOR" (Samantha Csik), "PUBLISHED" (October 24, 2022), and a paragraph about the author's motivation for writing a blog post. The right column contains "AFFILIATION" (Master of Environmental Data Science Program @ The Bren School (UCSB) & The National Center for Ecological Analysis and Synthesis) and "MODIFIED" (October 22, 2023). Below the main content, there is a bulleted list of reasons why blogging is beneficial, such as building an online profile, sharing ideas, and staying updated with trends. To the right of the main content, there is a sidebar titled "On this page" with a numbered list of links to other pages on the site.

home about talks & workshops projects posts

Adding a blog to your existing Quarto website

Got a Quarto website, but no blog? We can fix that!

QUARTO R MEDS

| AUTHOR | AFFILIATION |
|---------------|---|
| Samantha Csik | Master of Environmental Data Science Program @ The Bren School (UCSB) & The National Center for Ecological Analysis and Synthesis |

| PUBLISHED | MODIFIED |
|------------------|------------------|
| October 24, 2022 | October 22, 2023 |

About a year ago, I wrote my first ever blog post ~ about blogging ~ and tbh I'm a *little* embarrassed that this is only my third post here (does it count that I have *ideas* for blog posts squirreled away at least??). Regardless, you should trust me¹ when I say that blogging is a great exercise for you to practice as regularly as you can – it can help you to:

- build your online profile/portfolio
 - "...sharing anything is almost always better than sharing nothing" - [@drob](#) in his post, [Advice to aspiring data scientists: start a blog](#)
- practice your writing & communication skills
- stay atop data science trends
- solicit feedback from the community
- network
- learn something new and/or solidify your understanding

On this page

- I. Before we chat about blogs...
- II. What's the difference between a website and a blog?
- III. Adding a blog to your personal Quarto website
- IV. Add a blog post to your blog
- V. Some additional authoring features to explore
- VI. A note on adding an additional blog (or more) to your site
- VII. Blogs to follow (+ one post from each that I've particularly enjoyed)
- VIII. Additional Resources



UC SANTA BARBARA

Bren School of Environmental Science & Management

About

Master's Programs

PhD Program

Career Services

Bren Life

Research

EVENTS | COMMUNITY EVENT

Mantell Symposium in Environmental Justice and Conservation Innovation 2023

Advancing Environmental Justice and Conservation Innovation: Global Challenges, Local Solutions

Oct 26 2023 | 1:00pm PST

Bren Hall 1414 / Online



Expert panel on spatial data science



Jessica Couture
Conservation International



Emily Gaston
Rincon Consulting



Julie Padilla
USGS



Alessandra Vidal Meza
Audubon Society

Expert speaker on conservation decision making



Millie Chapman
NCEAS

EDS 223: week 4

THIS IS NOT A TEST!! The following are questions meant to gauge how well the class overall is digesting material. You will not be graded for correctness. This is just to figure out where everyone is at!

last name *

Short answer text

first name *

Short answer text

What is a coordinate reference system and what are its key components? *

Short answer text

What is a projection? *

Short answer text

Describe the differences between geographic and projected coordinate reference systems. *

Short answer text

Describe the difference between vector and raster data models. *

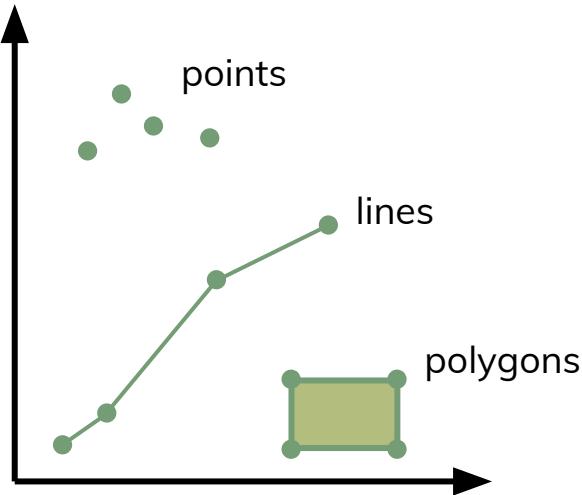
Long answer text



Due tonight by midnight!

Spatial data models

vector



points

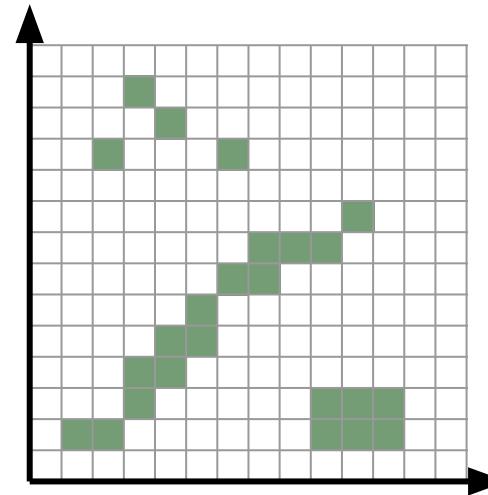
lines

polygons



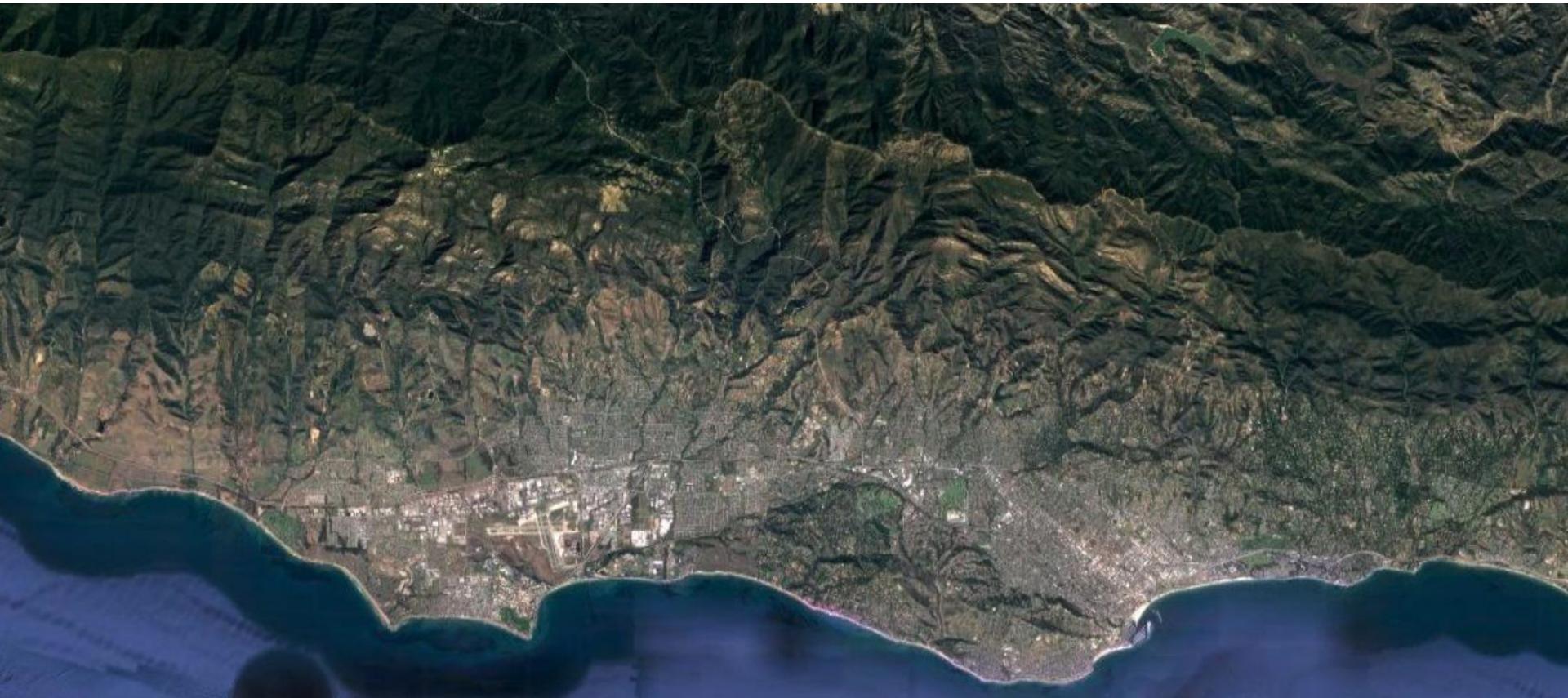
discrete

raster

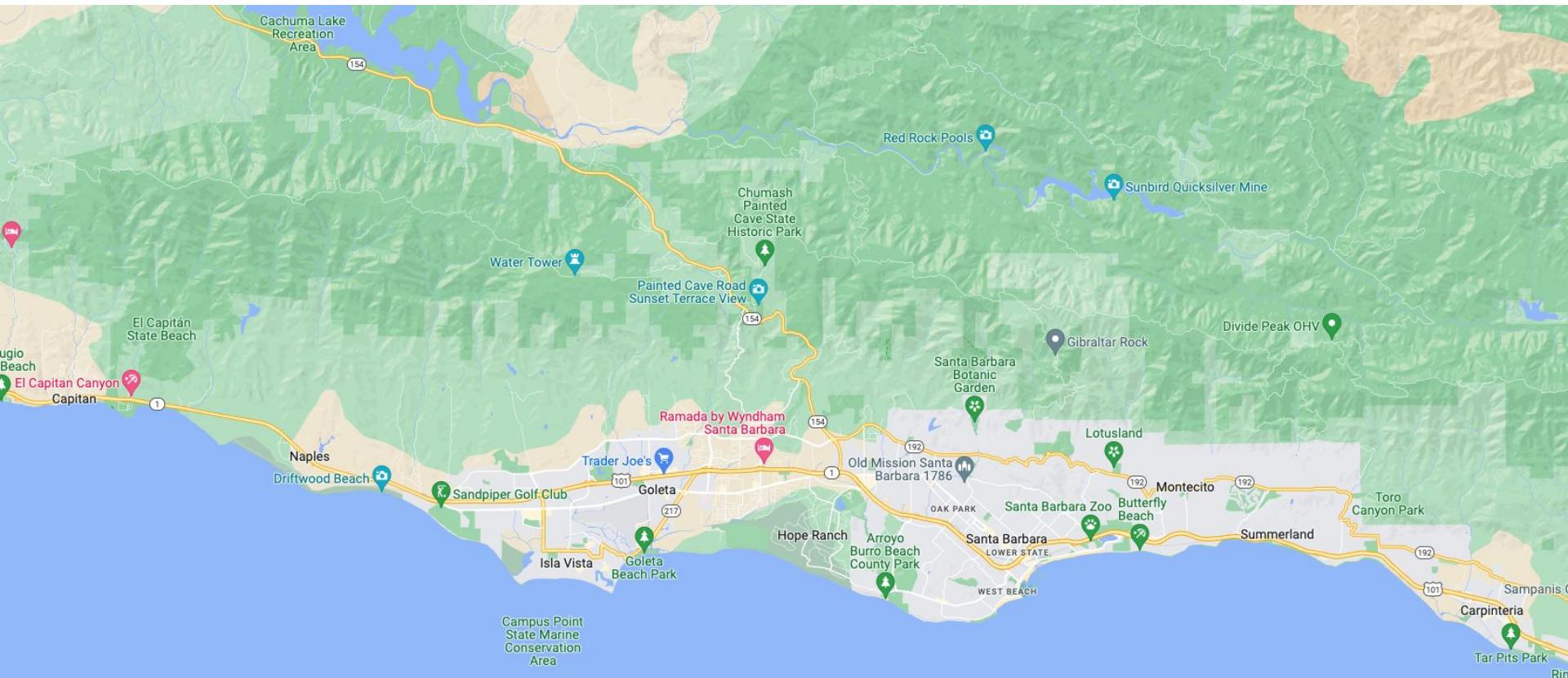


continuous

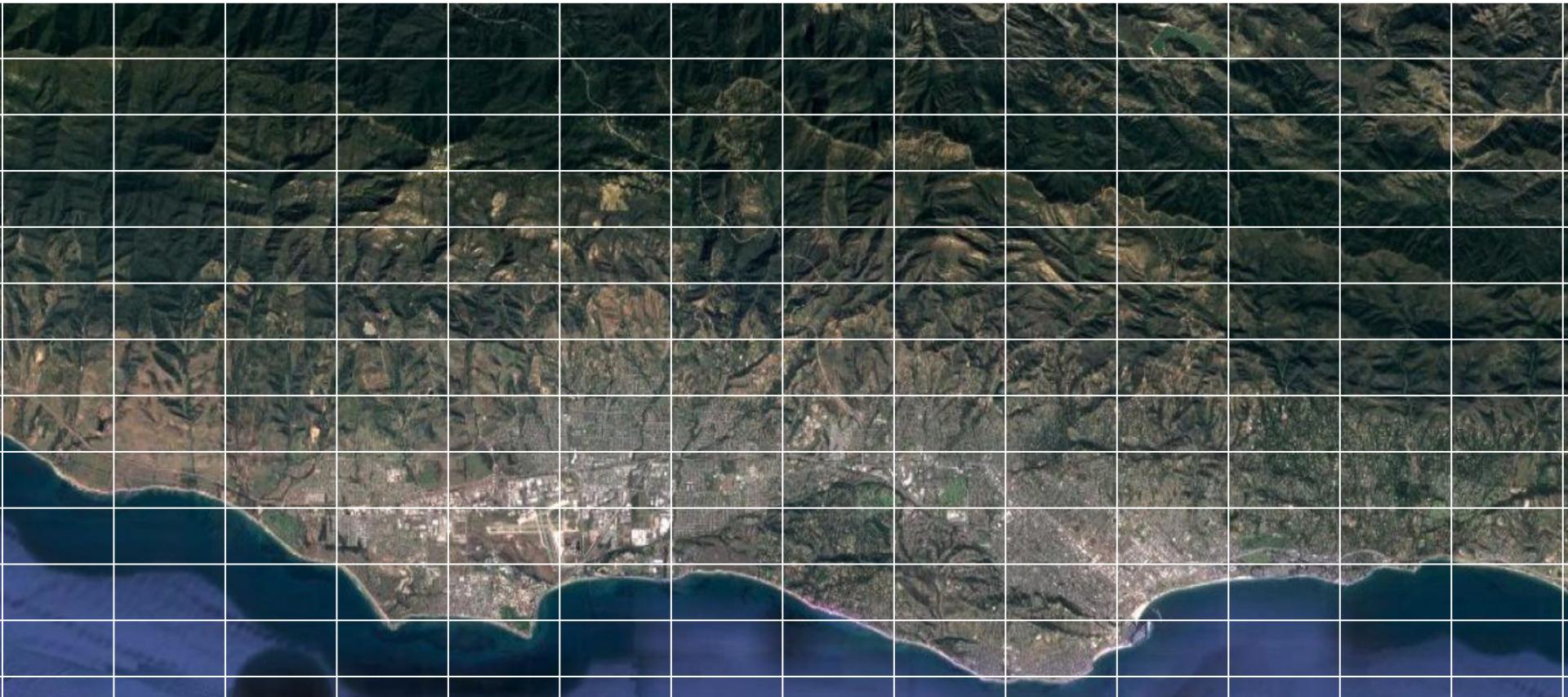
Spatial data models



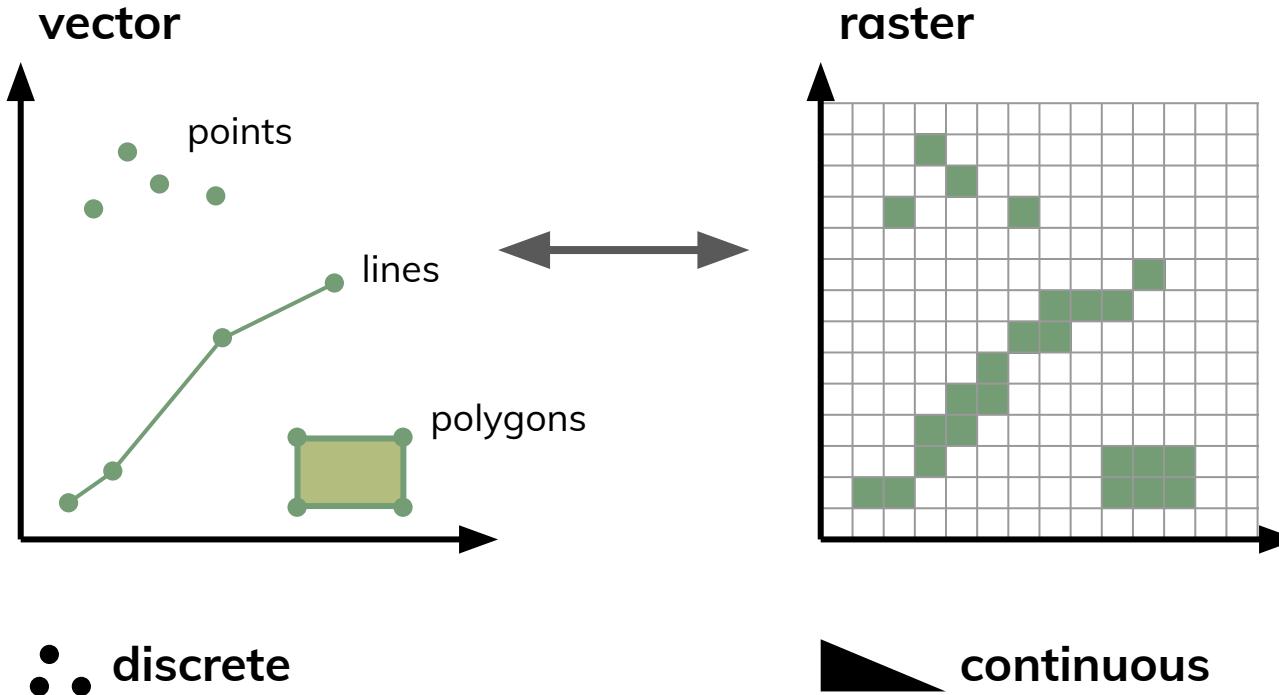
Spatial data models



Spatial data models



Spatial data models

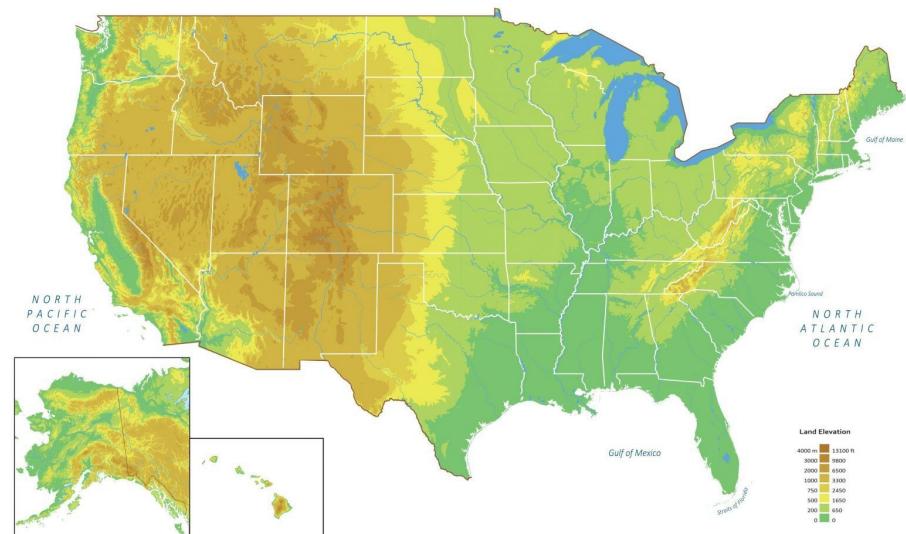


Spatial data models

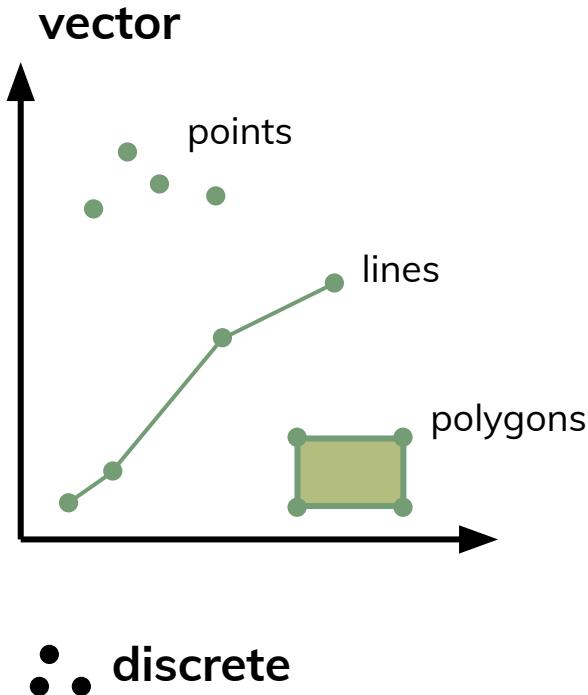
vector



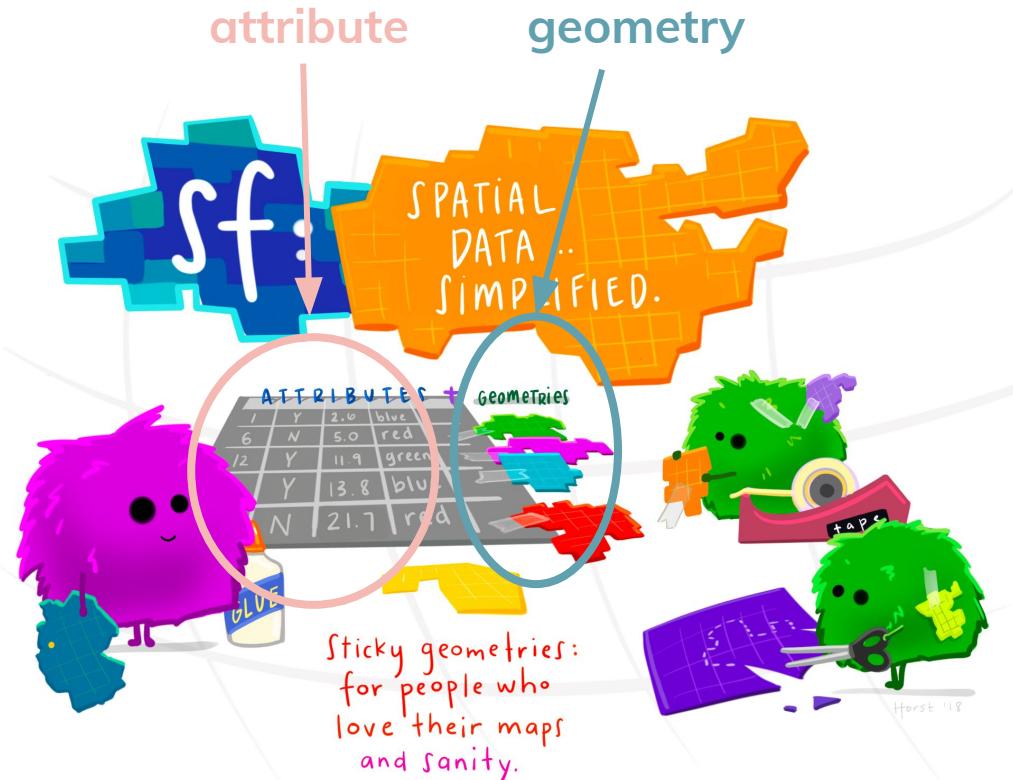
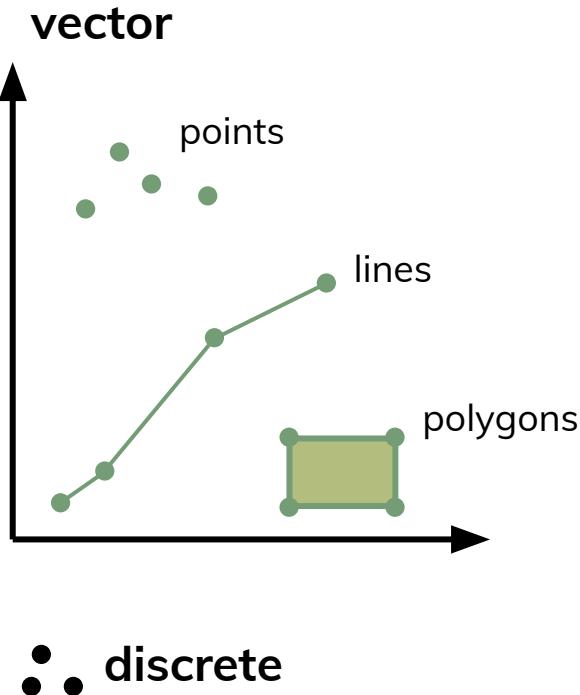
raster



Vector data models

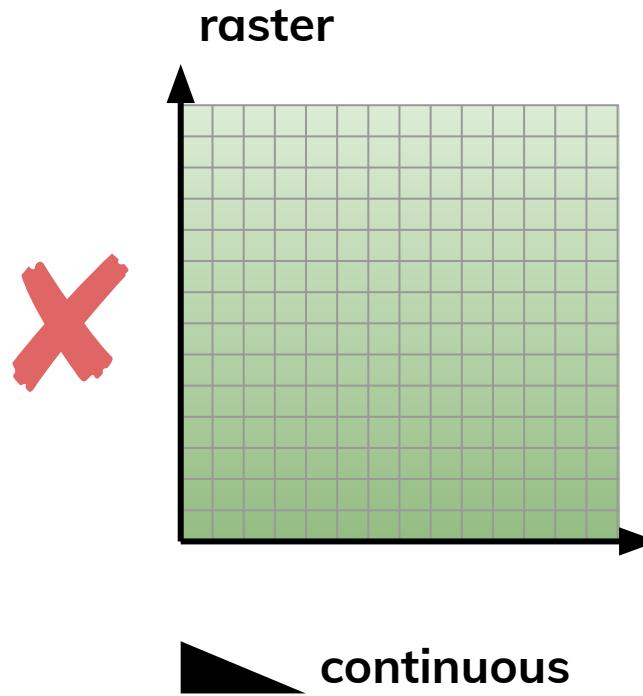


Vector data models



Raster data models

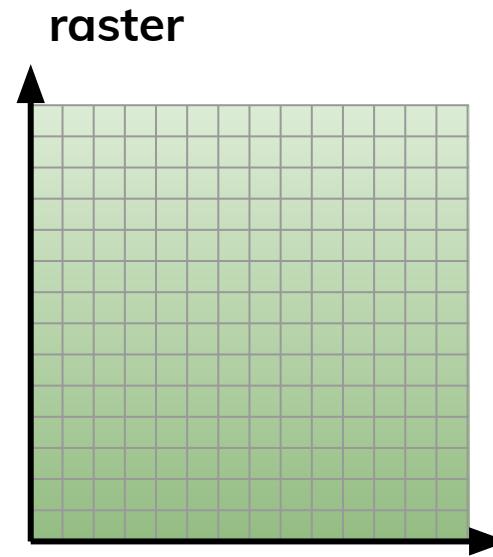
| ID | Species | Age |
|----|---------|-----|
| 1 | Poplar | 11 |
| 2 | Oak | 2 |
| 3 | Beech | 12 |
| 4 | Cedar | 15 |



Raster data models

geometry

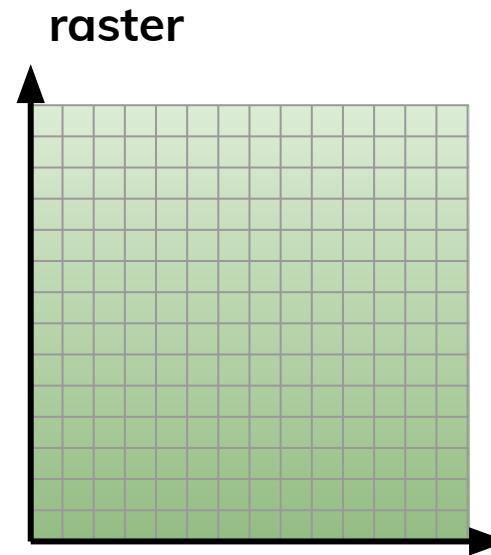
- ?



Raster data models

geometry

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



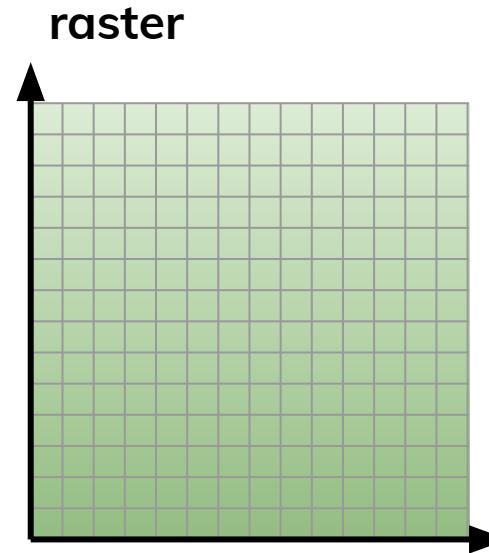
Raster data models

geometry

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

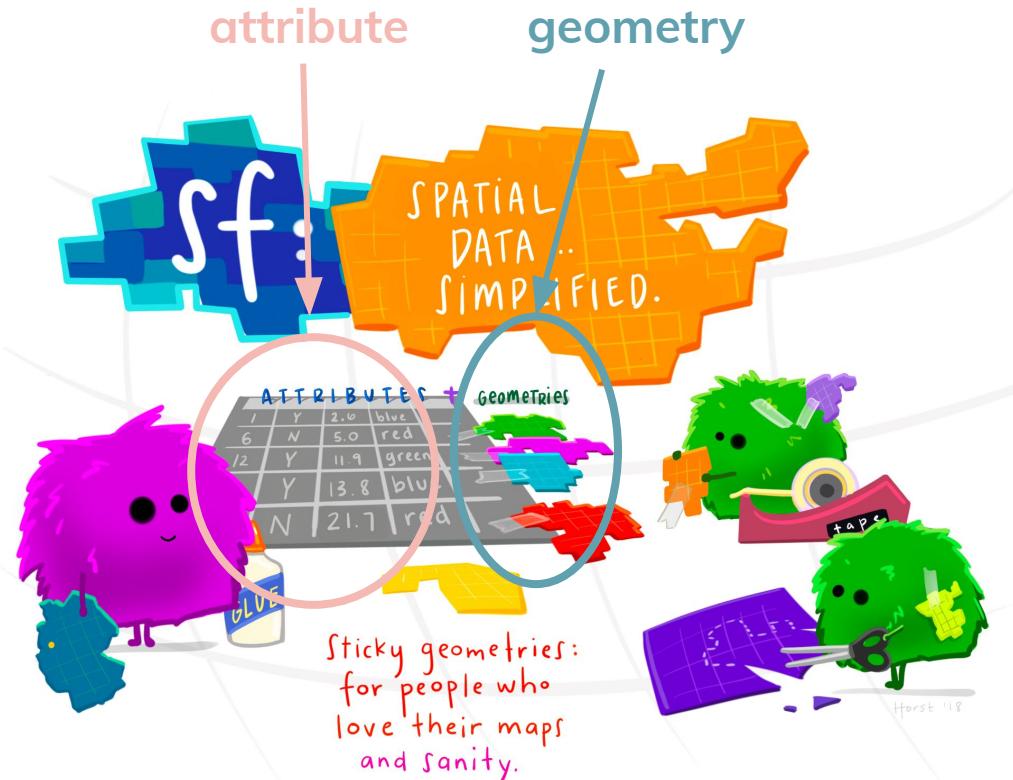
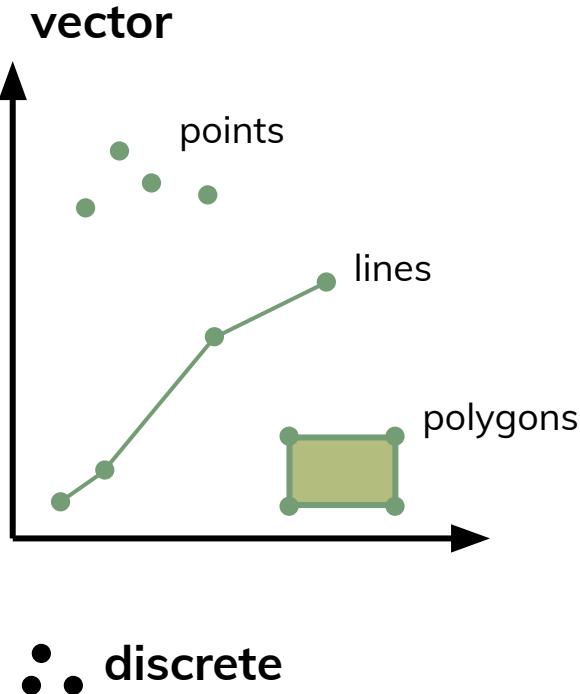
attribute

- One value per cell
- Categorical, numerical, logical



continuous

Vector data models



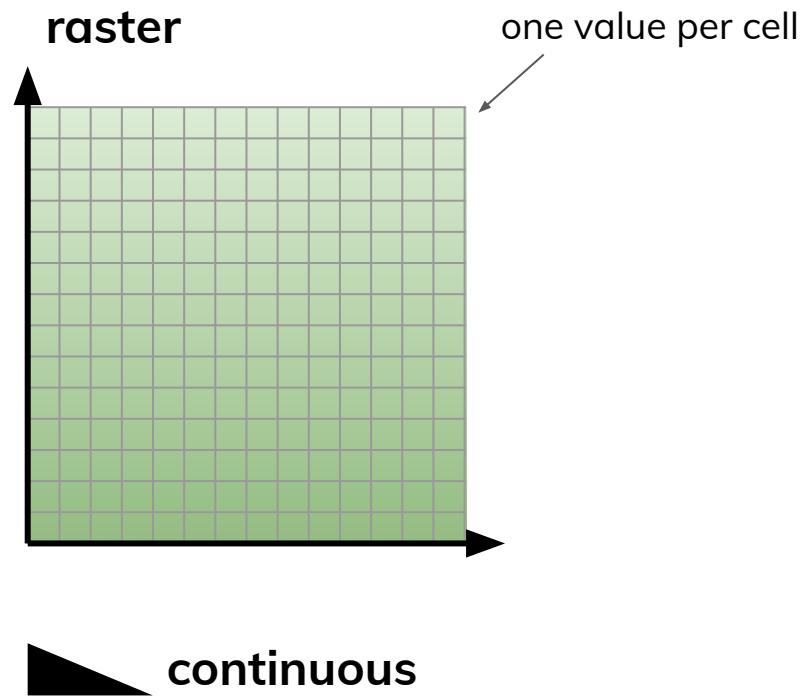
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



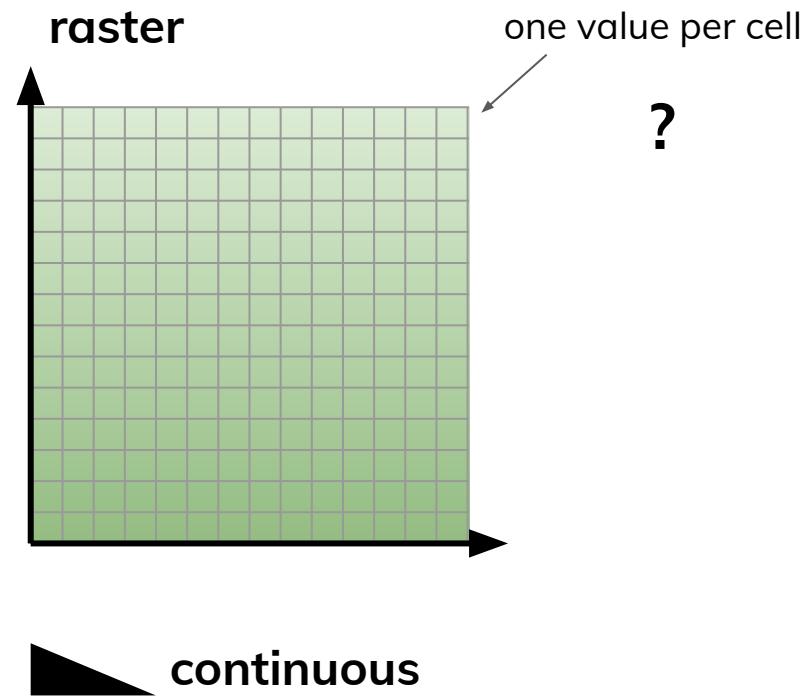
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



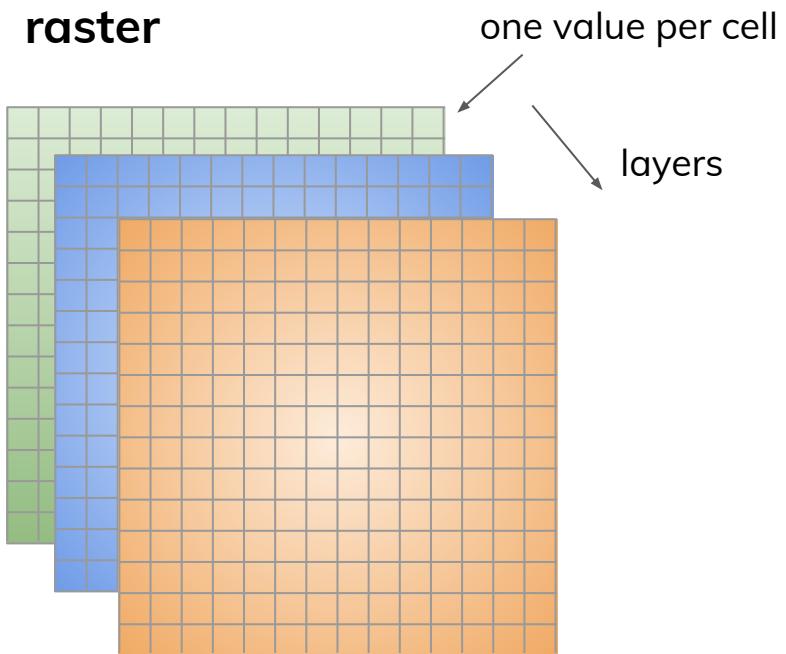
Raster data models

geometry

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

attribute

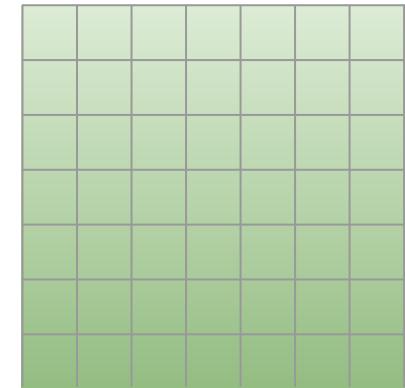
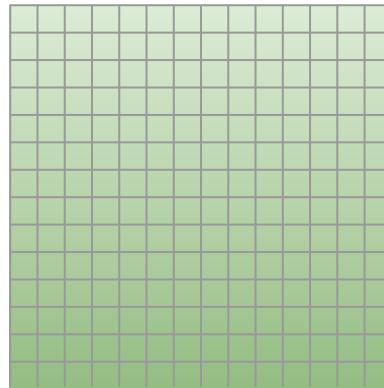
- One value per cell
- Categorical, numerical, logical



Raster data model

geometry

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

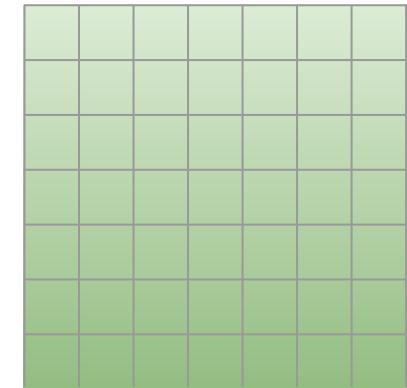
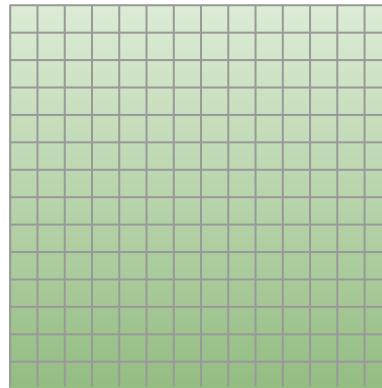


Raster data model

geometry

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

→ resolution



- “finer”
- “higher”

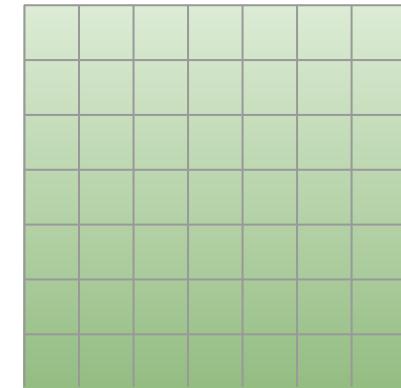
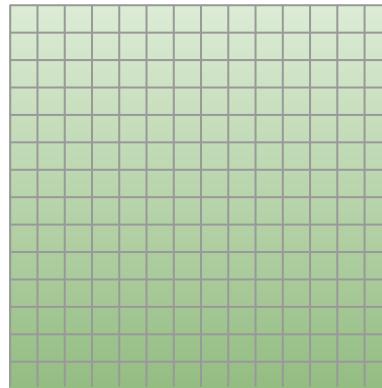
- “coarser”
- “lower”

Raster data model

geometry

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

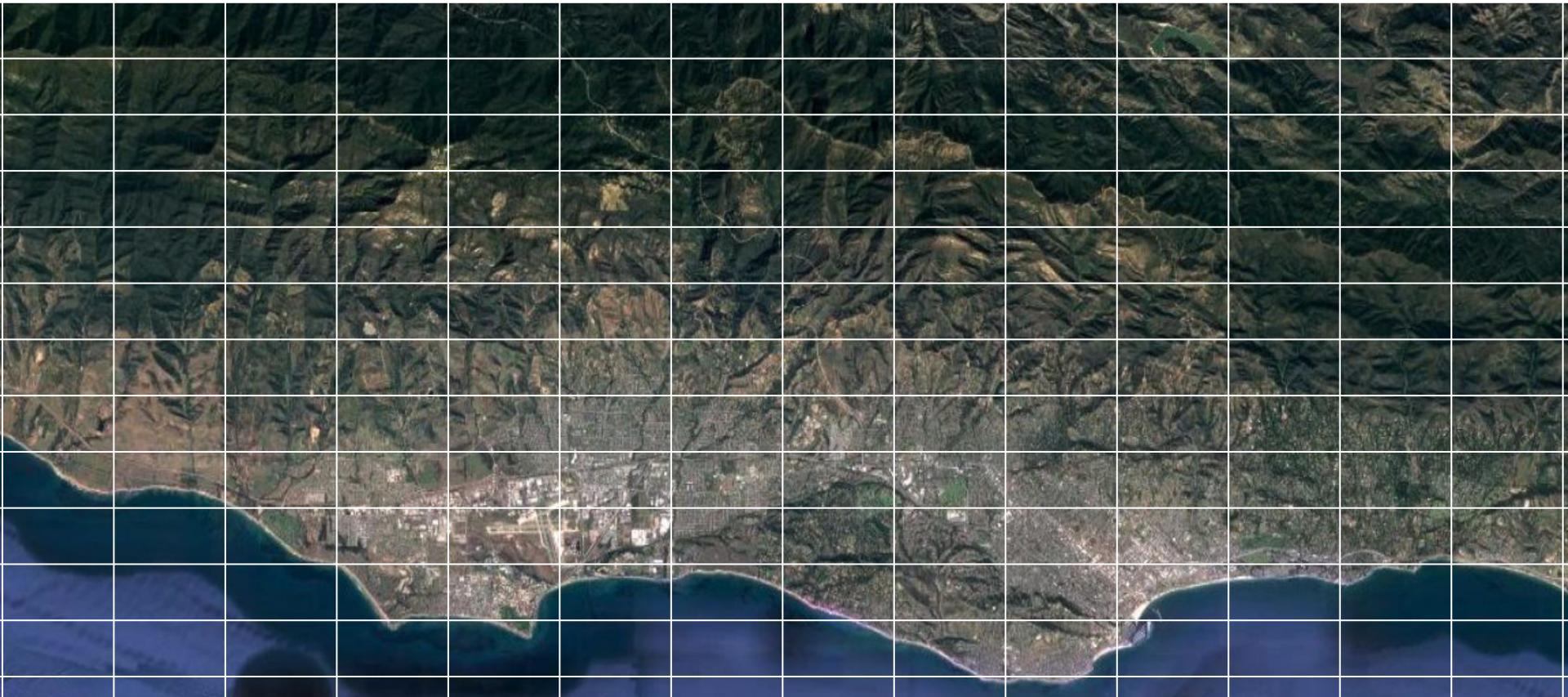
→ resolution



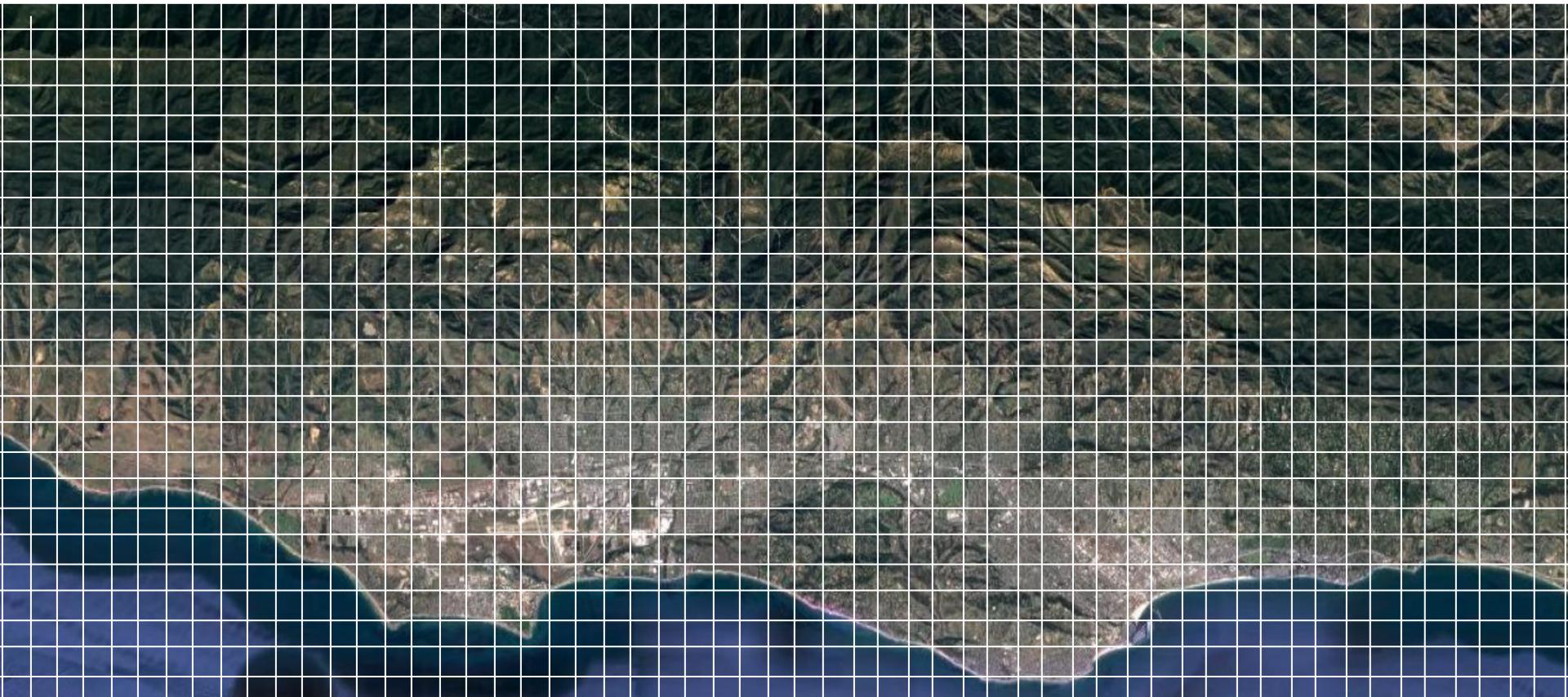
- “finer”
- “higher”
- 1 km

- “coarser”
- “lower”
- 5 km

Spatial data models



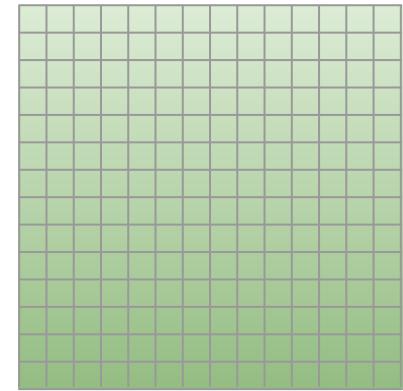
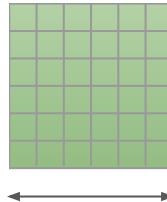
Spatial data models



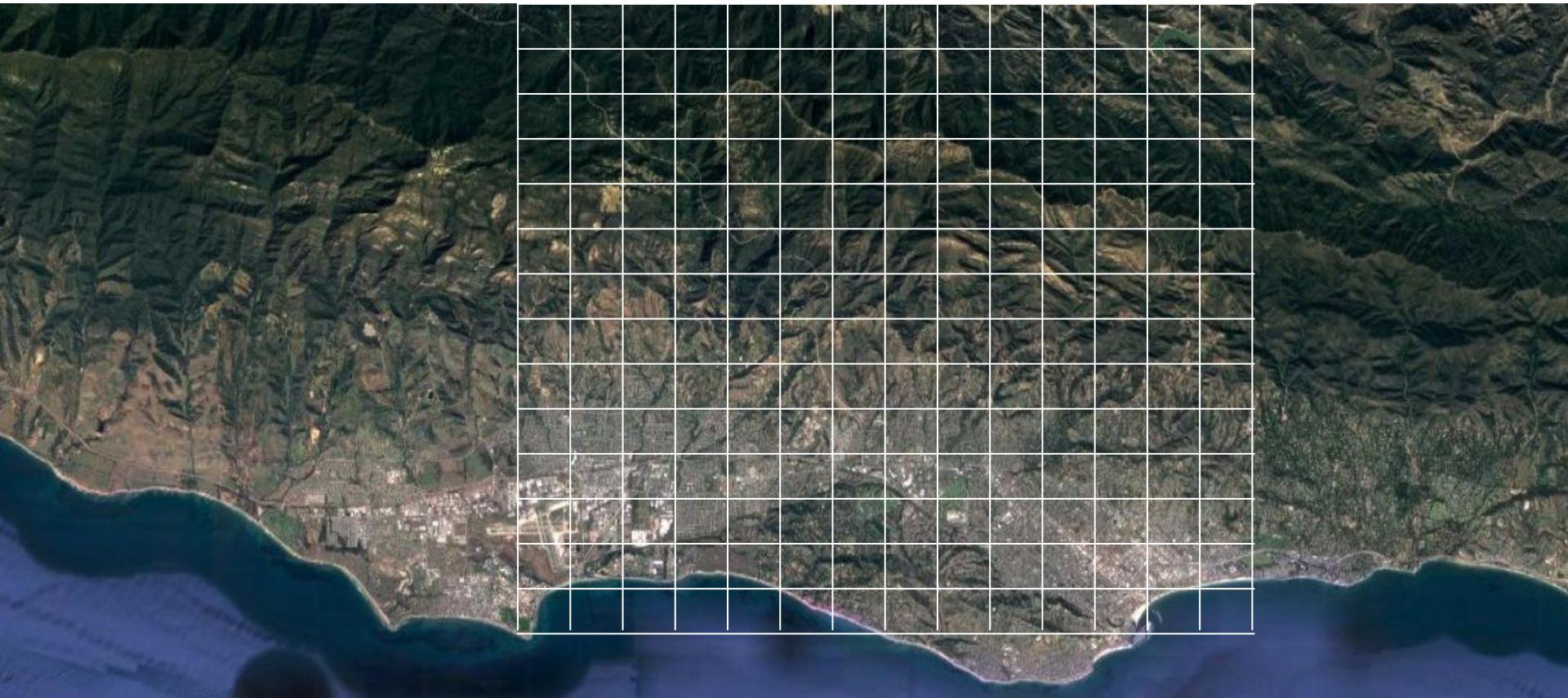
Raster data model

geometry

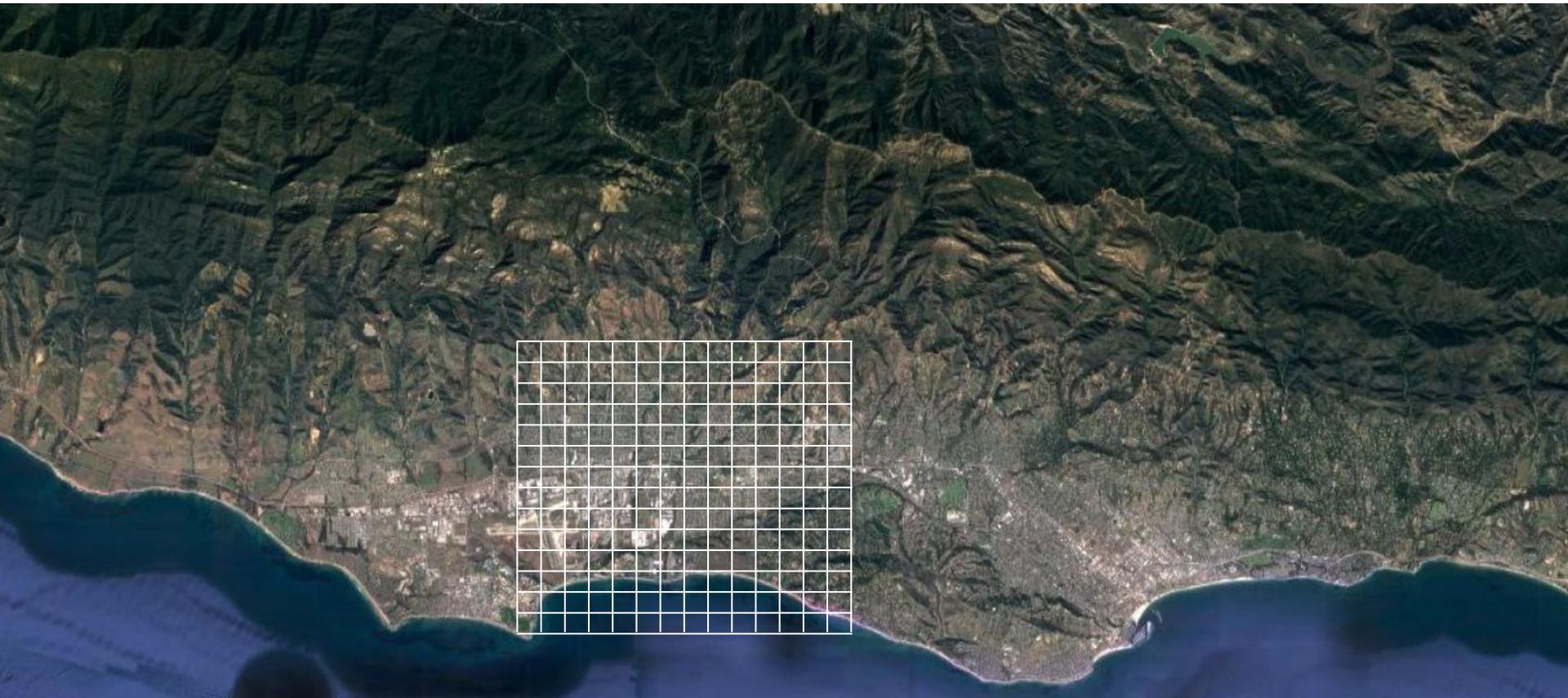
- Cell size
- Number of rows/columns → extent
- Cell origin
- CRS



Spatial data models



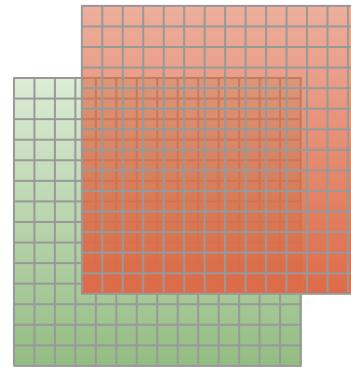
Spatial data models



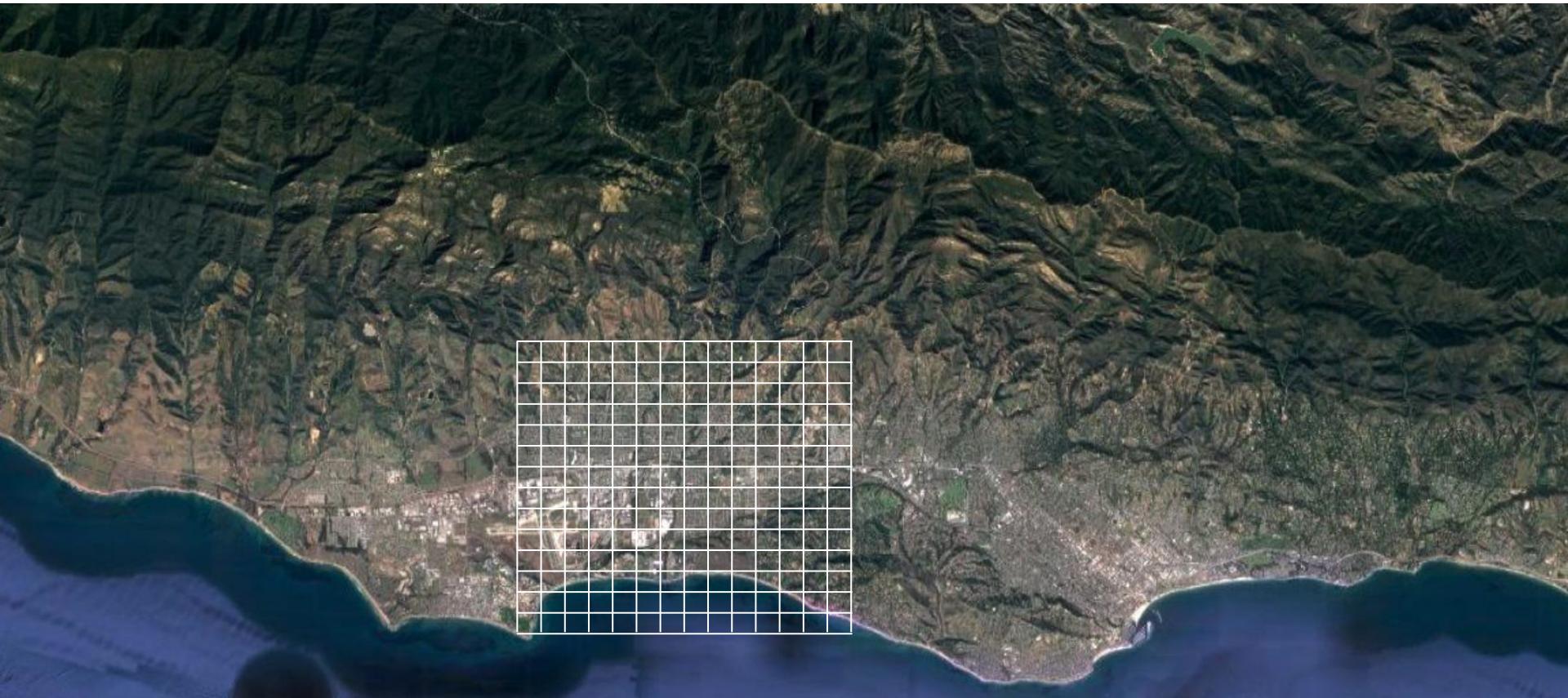
Raster data model

geometry

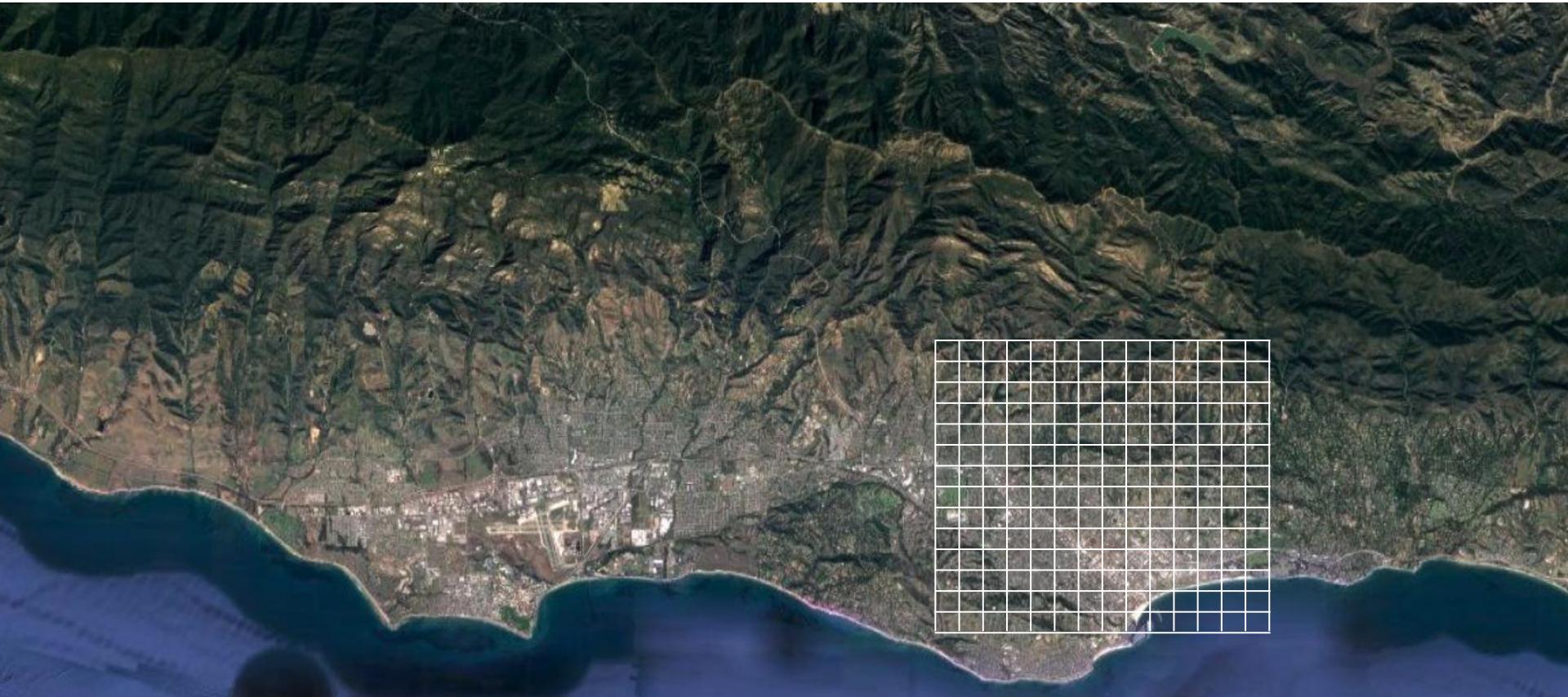
- Cell size
- Number of rows/columns
- Cell origin —————→ position
- CRS



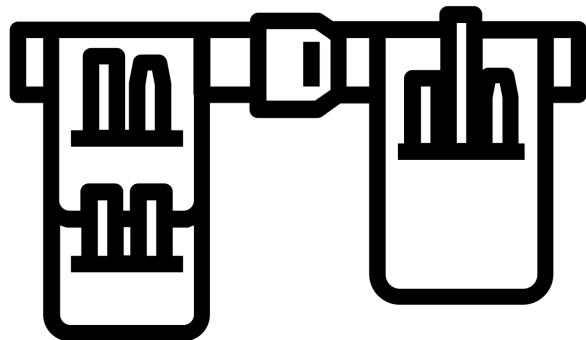
Spatial data models



Spatial data models



Toolbelt for solving spatial problems



New tools for a new data type

data frame

attributes

| type | food | site |
|-------|--------|---------|
| otter | urchin | bay |
| shark | seal | channel |

observations

New tools for a new data type

data frame

attributes

observations ↓

| type | food | site |
|-------|--------|---------|
| otter | urchin | bay |
| shark | seal | channel |

matrix

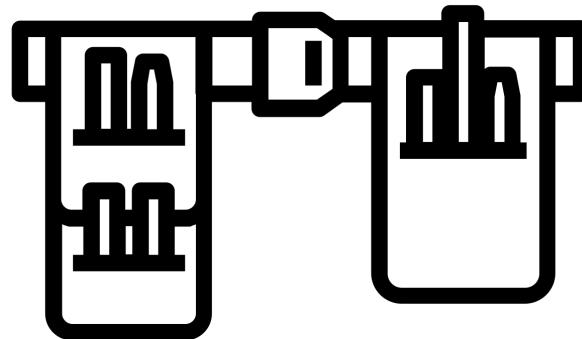
columns

rows ↓

| | | |
|----|---|---|
| 1 | 4 | 8 |
| 10 | 7 | 3 |
| 2 | 5 | 1 |

Toolbelt for solving spatial problems

subsetting



New tools for a new data type

dplyr : go wrangling



dplyr::filter()

KEEP ROWS THAT
satisfy
your CONDITIONS

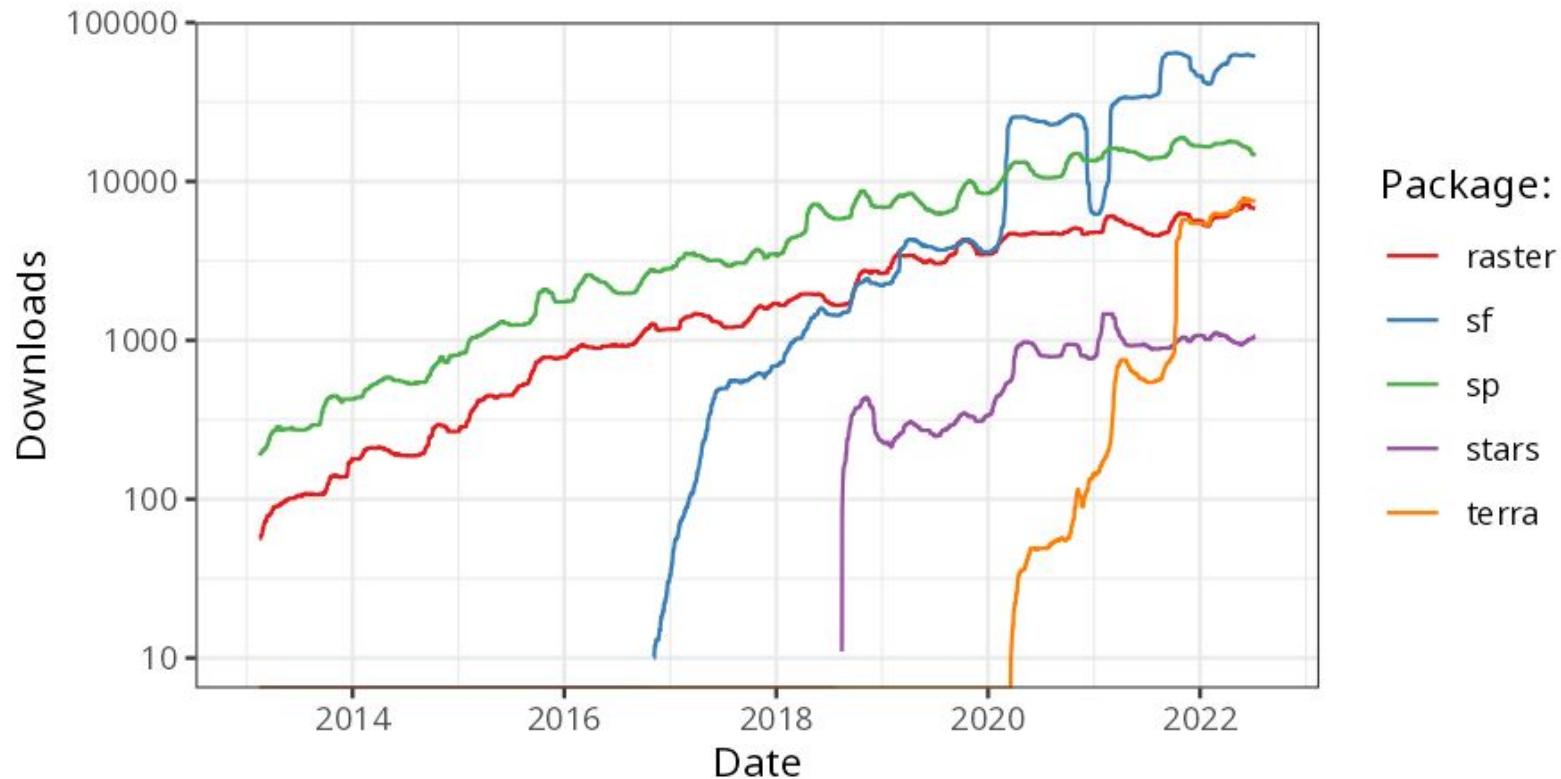
keep rows from... this data... ONLY IF... type is "otter" AND site is "bay"
filter(df, type == "otter" & site == "bay")



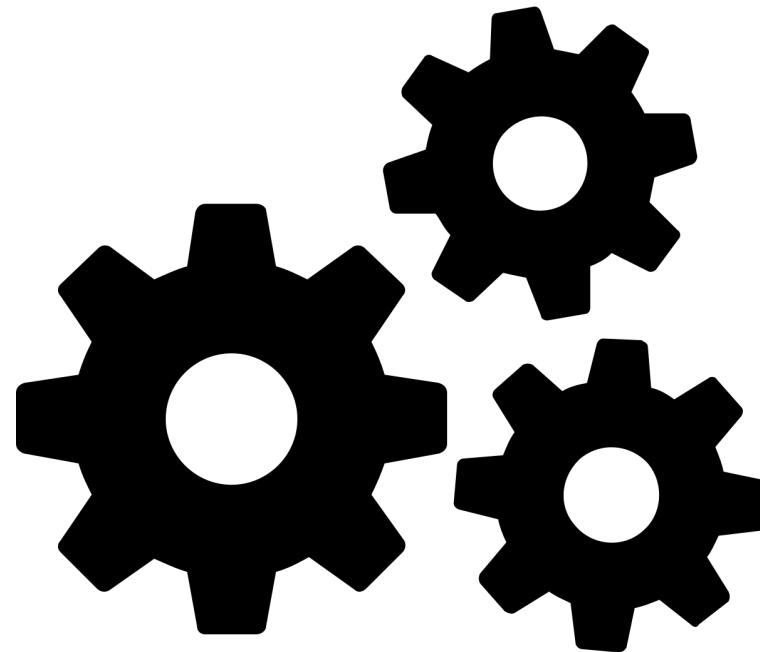
| type | food | site |
|-------|---------|---------|
| otter | urchin | bay |
| Shark | seal | channel |
| otter | abalone | bay |
| otter | crab | wharf |



R's spatial ecosystem

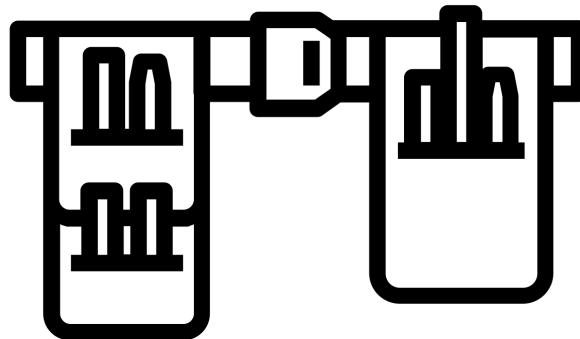


Switching gears...



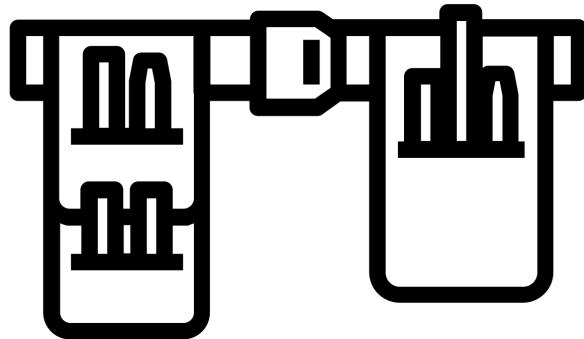
Toolbelt for solving spatial problems

spatial subsetting



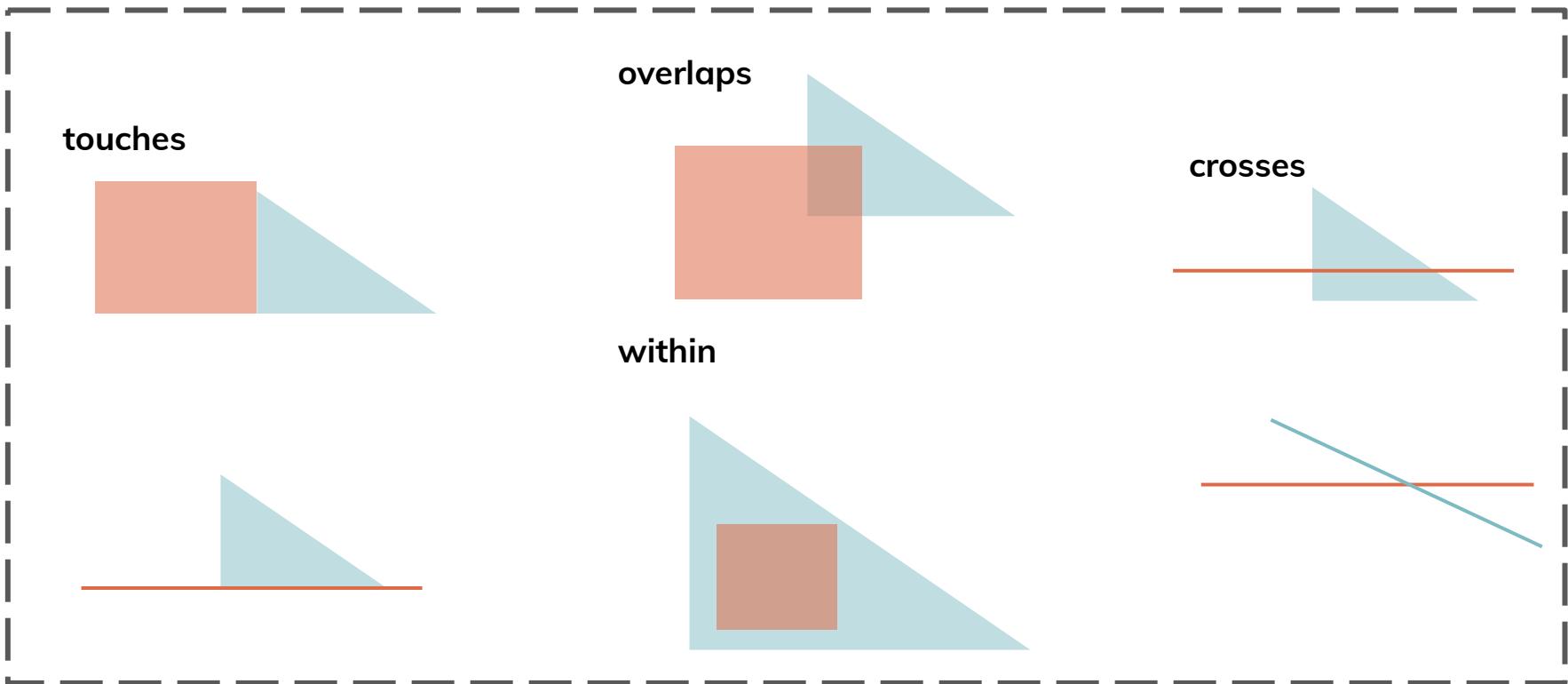
Toolbelt for solving spatial problems

spatial subsetting



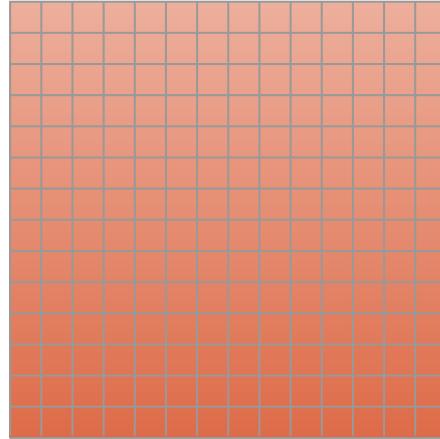
Topological relationships

intersects

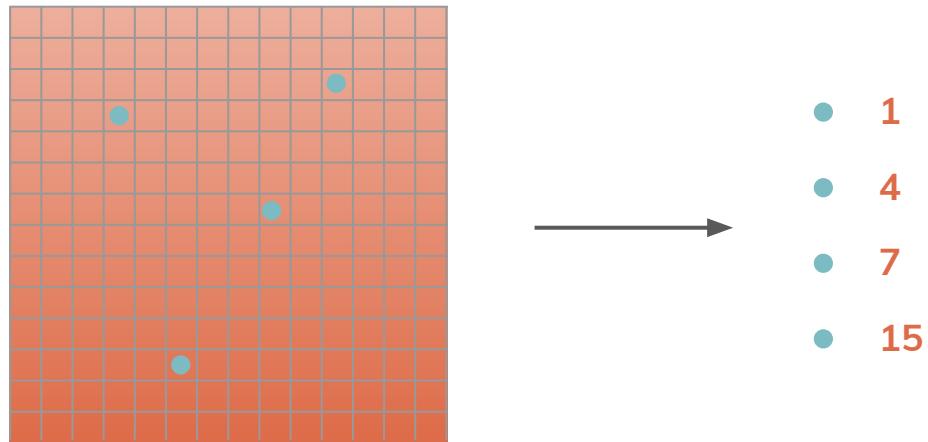


Yes or No

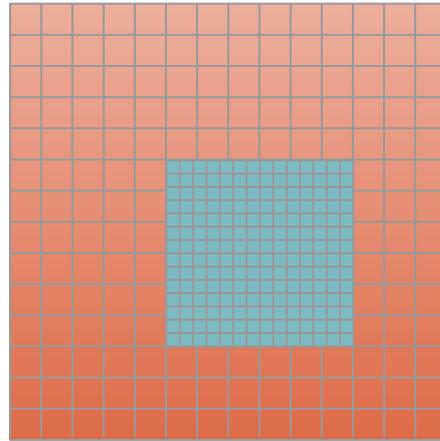
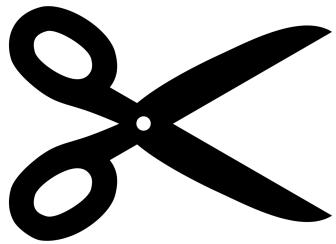
Spatial subsetting



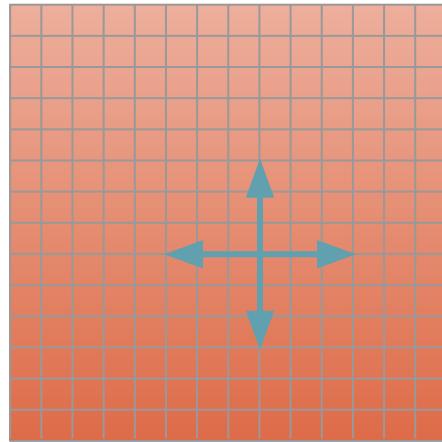
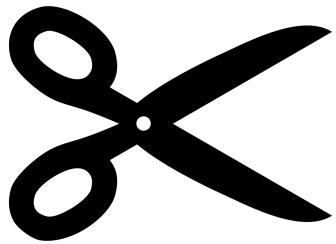
Spatial subsetting



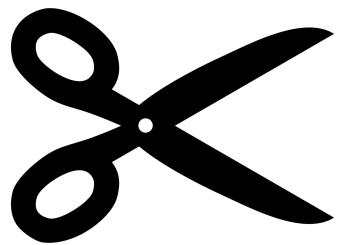
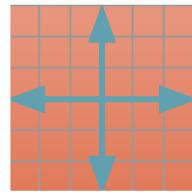
Spatial subsetting: clipping



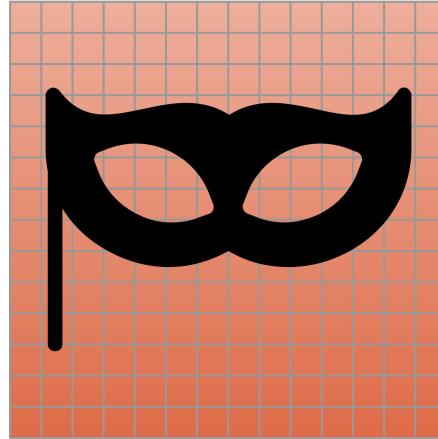
Spatial subsetting: clipping



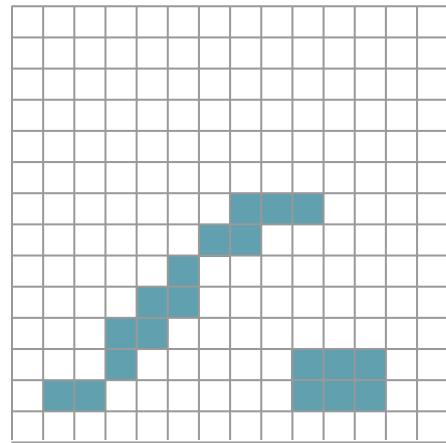
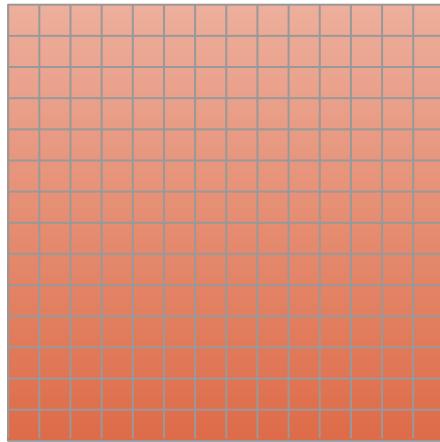
Spatial subsetting: clipping



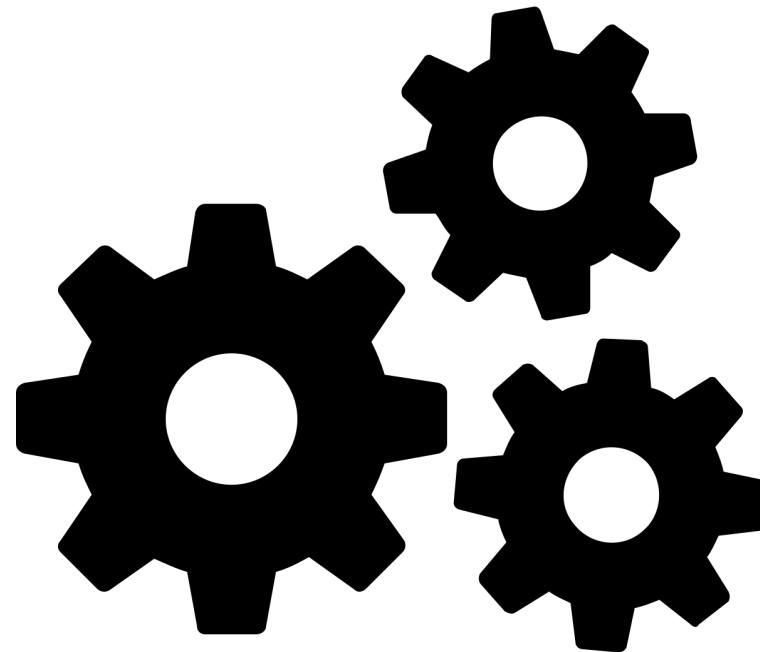
Spatial subsetting: masking



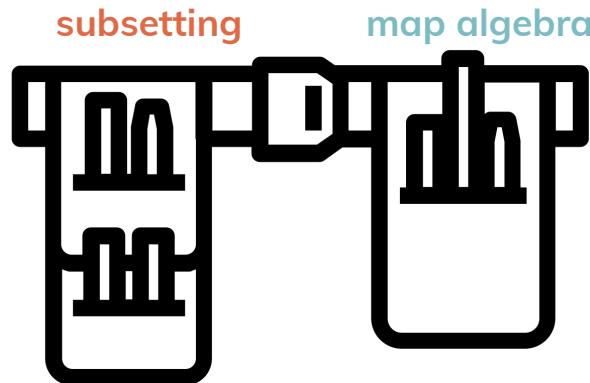
Spatial subsetting: masking



Switching gears...



Toolbelt for solving spatial problems

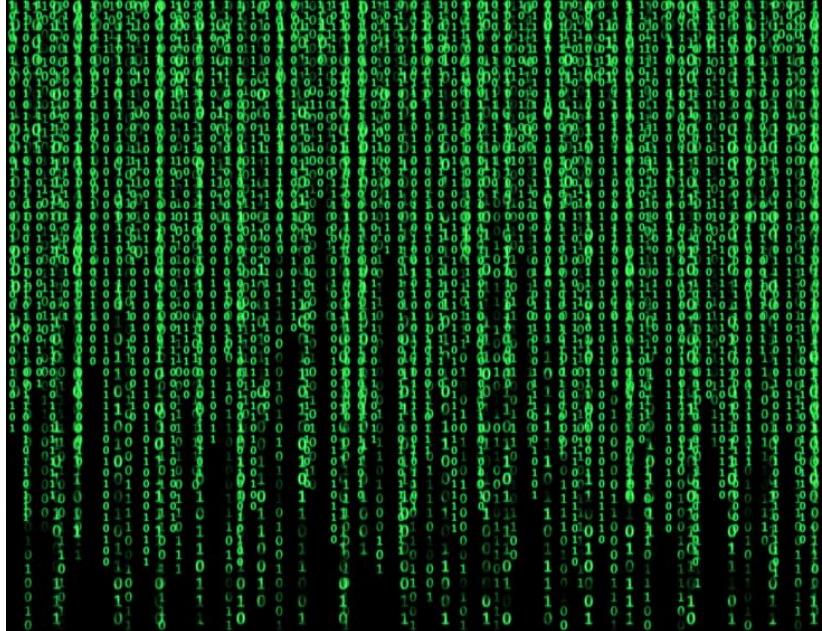


Map algebra

- 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

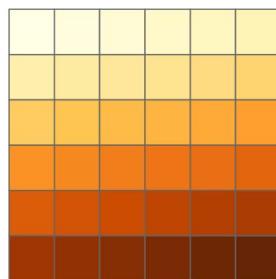


Scale or number of cells

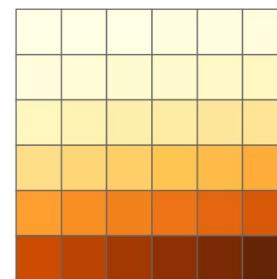
Map algebra

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

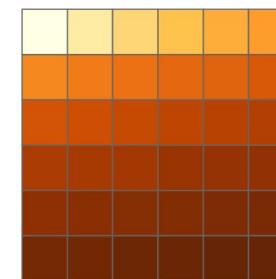
$\text{elev} + \text{elev}$



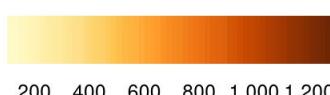
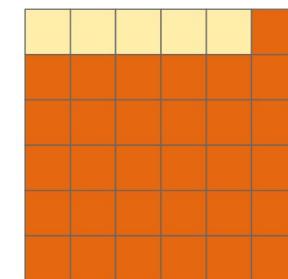
elev^2



$\log(\text{elev})$

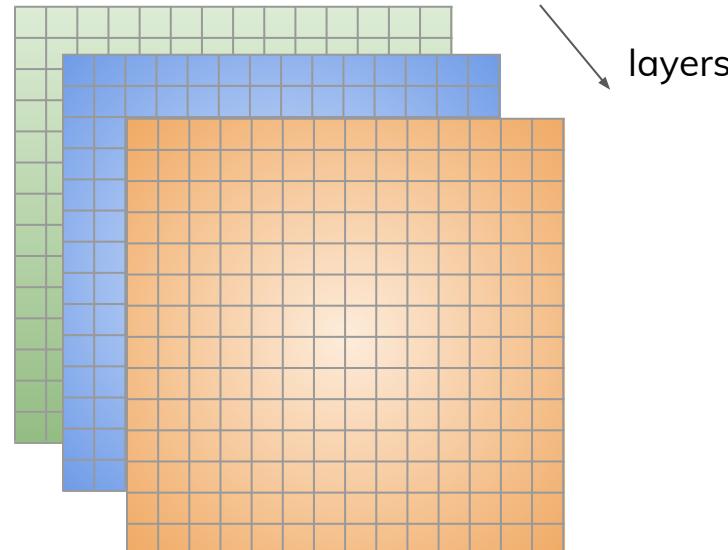


$\text{elev} > 5$



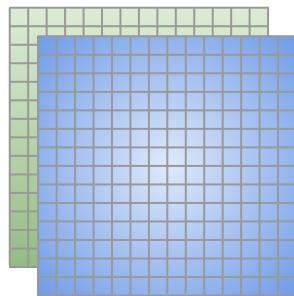
Map algebra

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



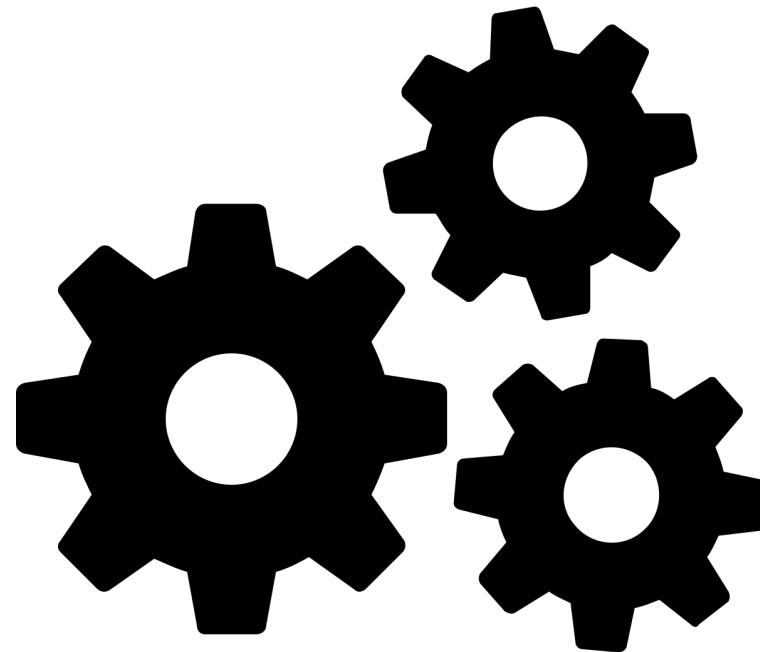
Map algebra

- 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

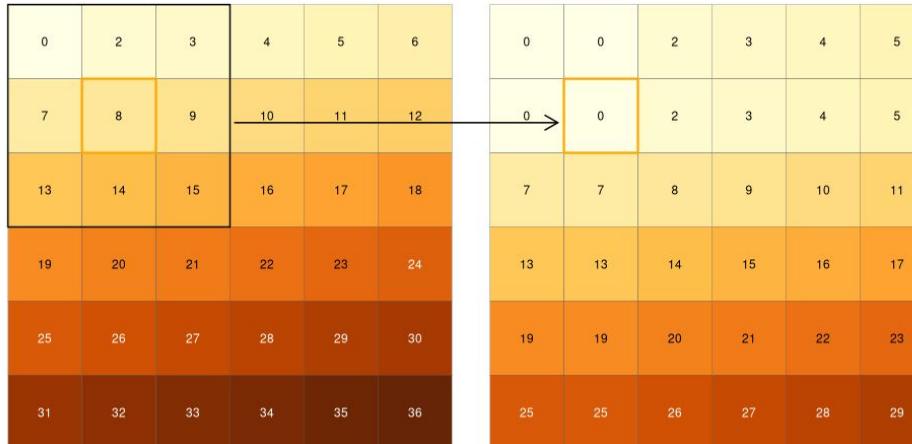
Map algebra

- **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

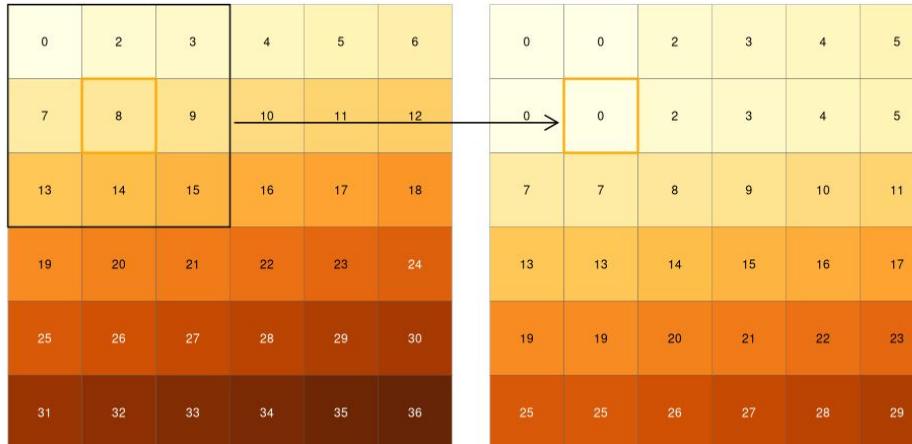
- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell



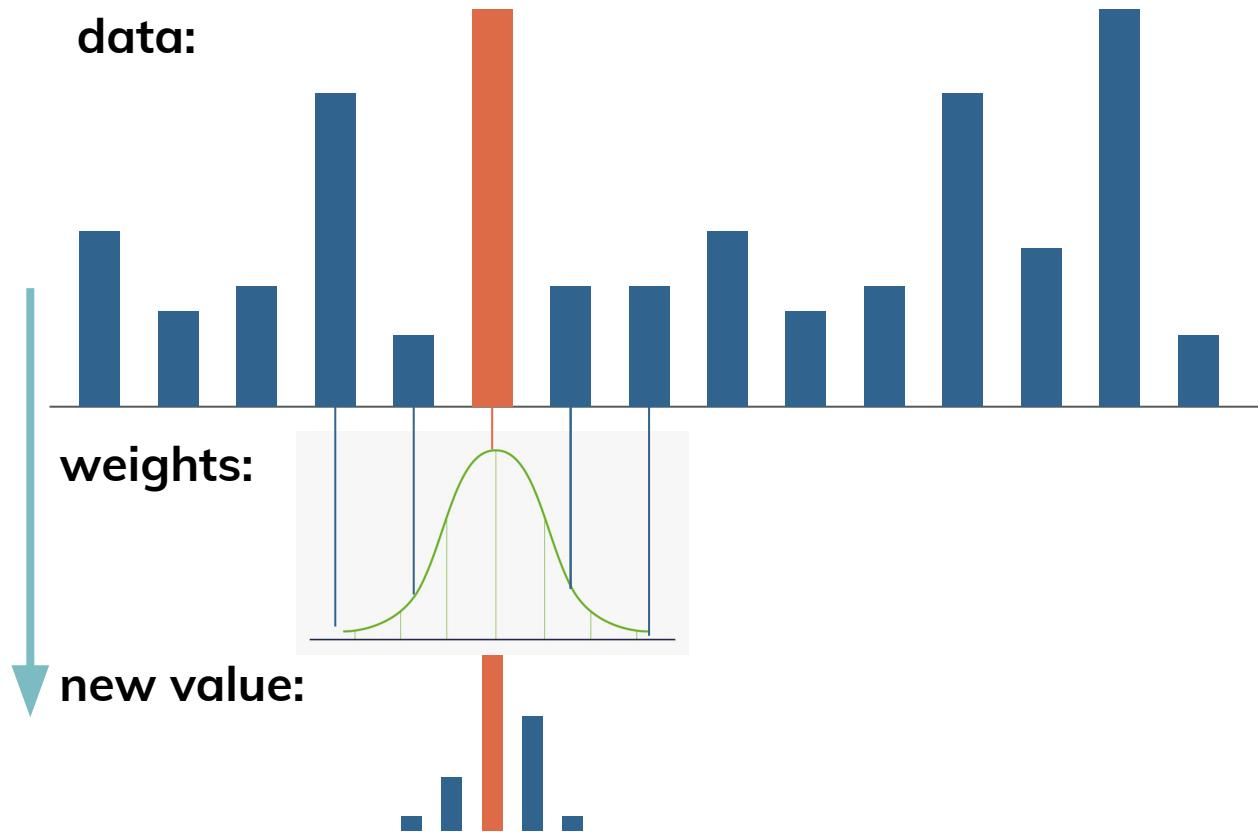
Map algebra

- **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

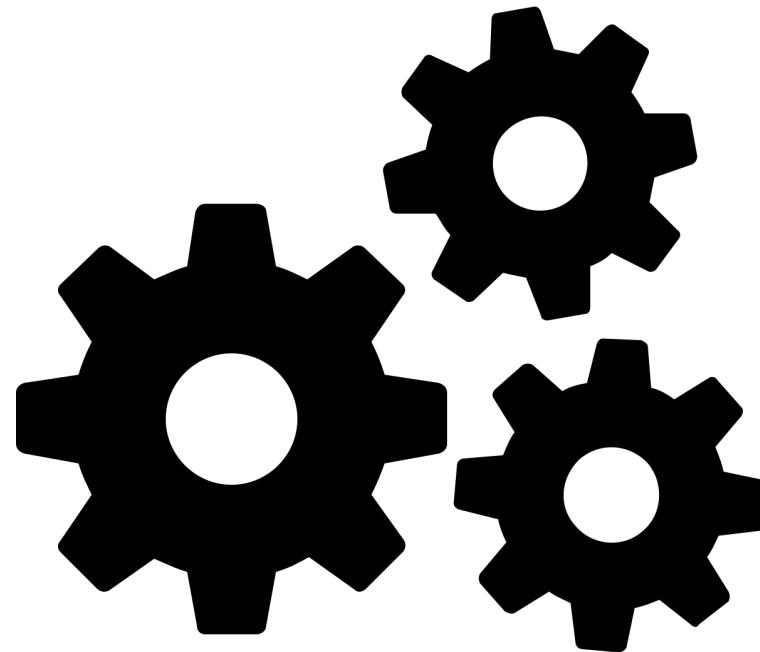


| | | | | | |
|----|----|----|----|----|----|
| 0 | 2 | 3 | 4 | 5 | 6 |
| 7 | 8 | 9 | 10 | 11 | 12 |
| 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 | 36 |

| | | | | | |
|----|----|----|----|----|----|
| 0 | 0 | 2 | 3 | 4 | 5 |
| 0 | 0 | 2 | 3 | 4 | 5 |
| 7 | 7 | 8 | 9 | 10 | 11 |
| 13 | 13 | 14 | 15 | 16 | 17 |
| 19 | 19 | 20 | 21 | 22 | 23 |



Switching gears...



Map algebra

- Local
- Focal
- Zonal
- Global



Scale or number of cells

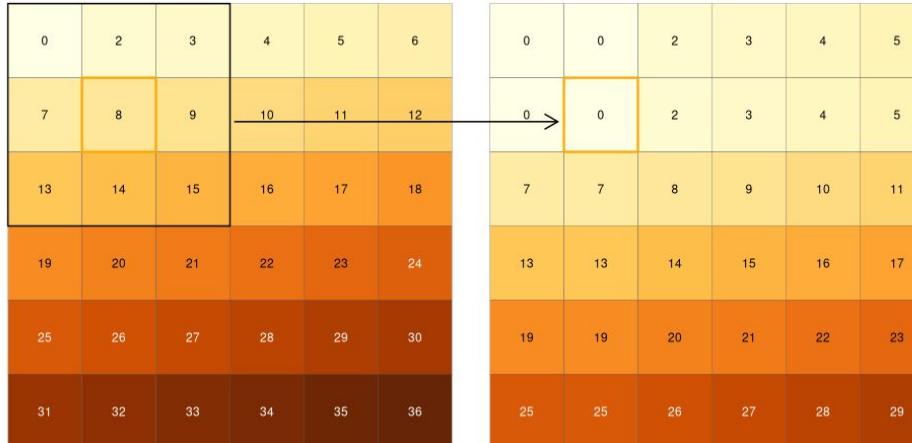
Map algebra

- **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

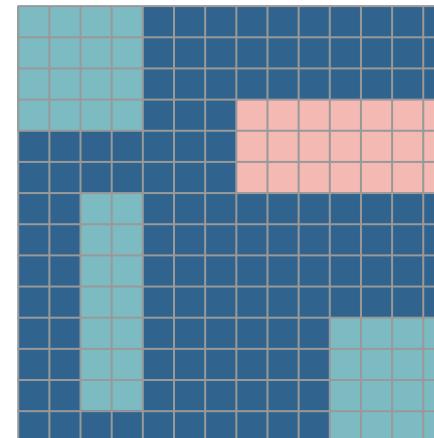
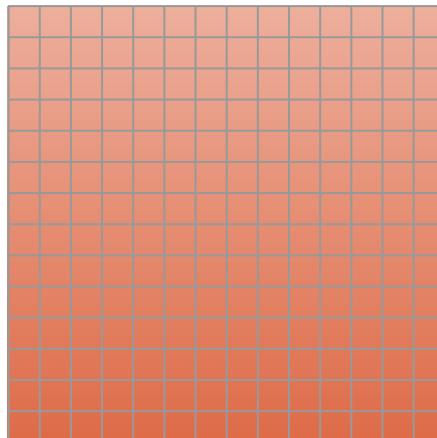


Map algebra

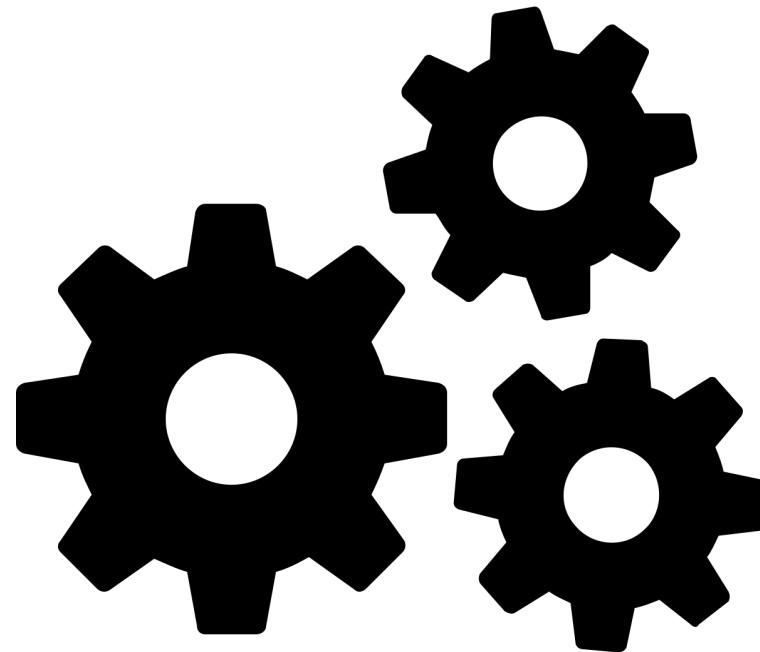
- **Zonal**

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

“zones”



Switching gears...



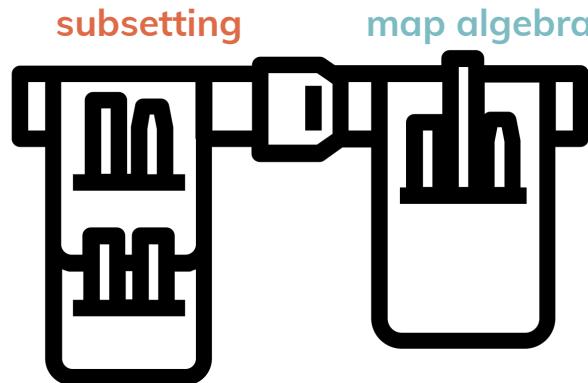
Map algebra

- Local
- Focal
- Zonal
- Global



Scale or number of cells

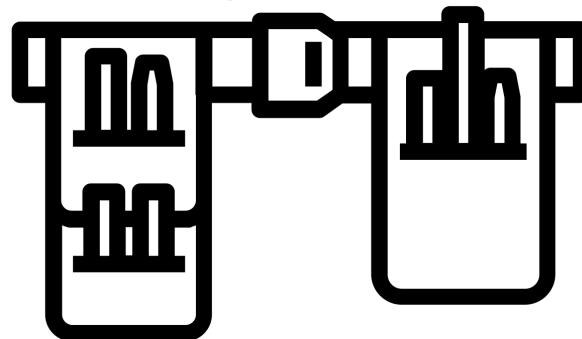
Toolbelt for solving spatial problems



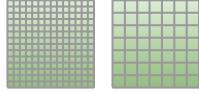
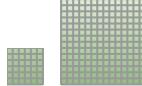
Toolbelt for solving spatial problems

subsetting

map algebra:
summarizing
filtering
mutating



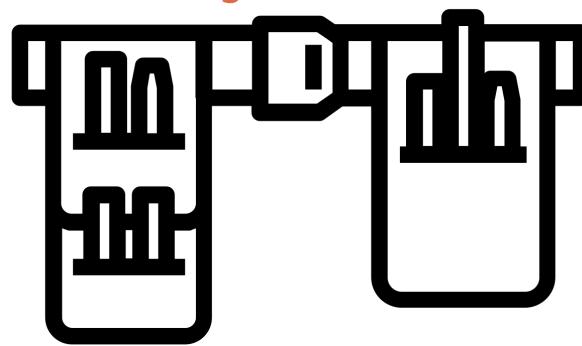
Raster data model

- **Resolution** 
- **Extent** 
- **Position** 

Toolbelt for solving spatial problems

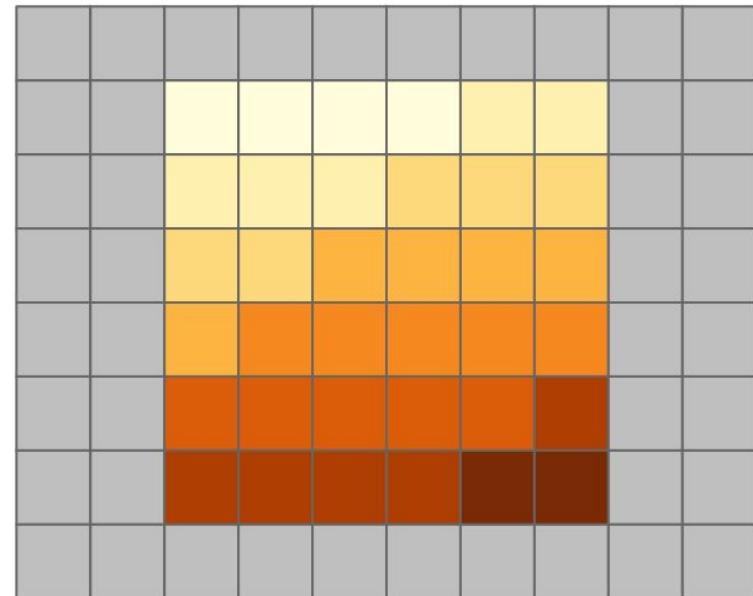
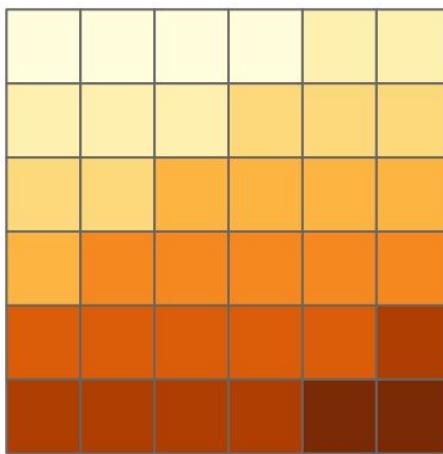
map algebra:
summarizing
filtering
mutating

subsetting

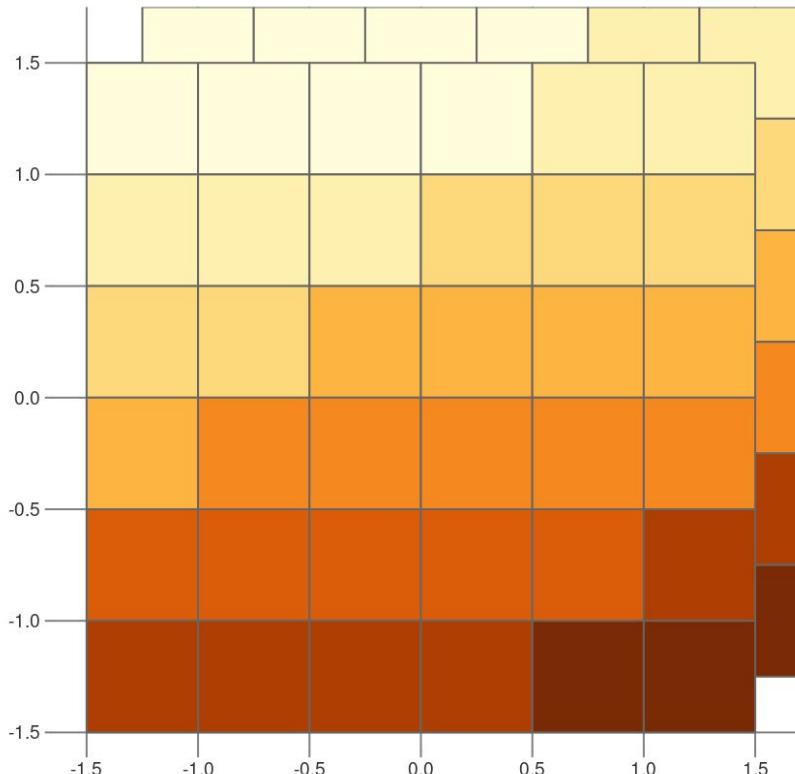


geometry
operations

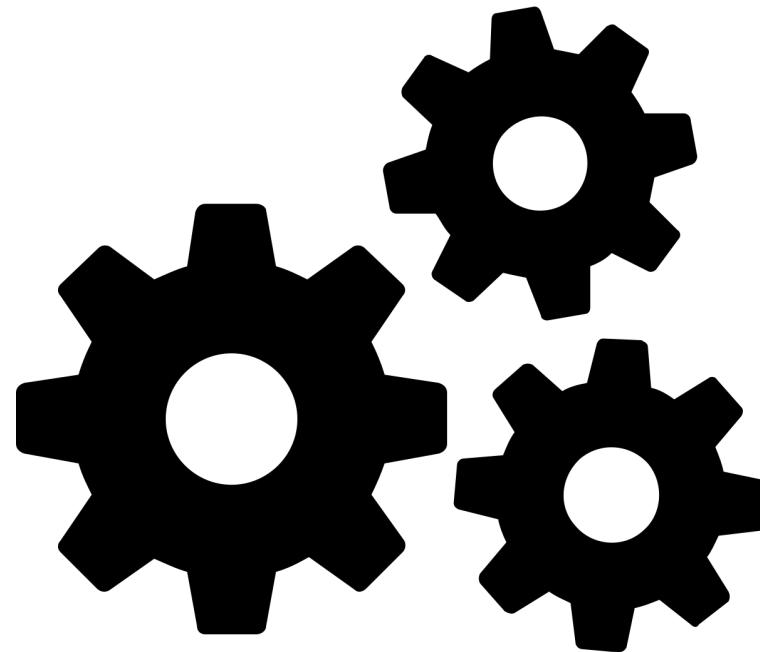
Changing extent and origin



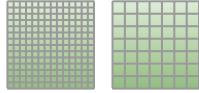
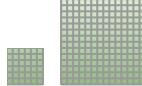
Changing extent and origin



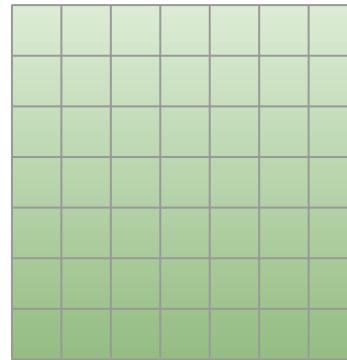
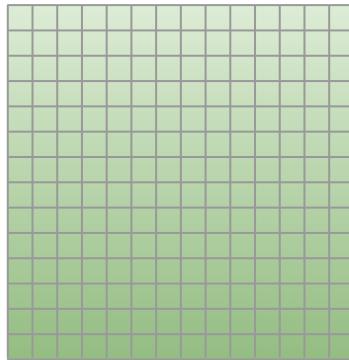
Switching gears...



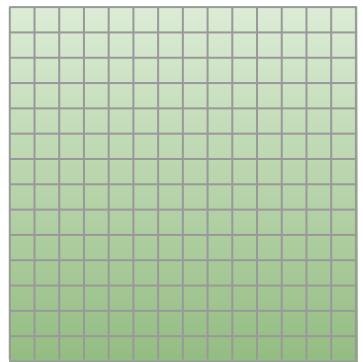
Raster data model

- **Resolution** 
- **Extent** 
- **Position** 

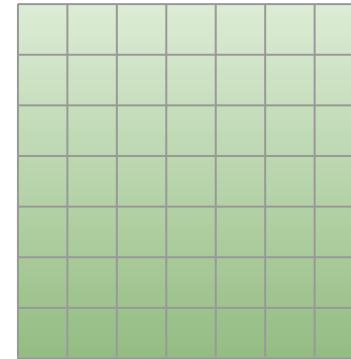
Changing resolution



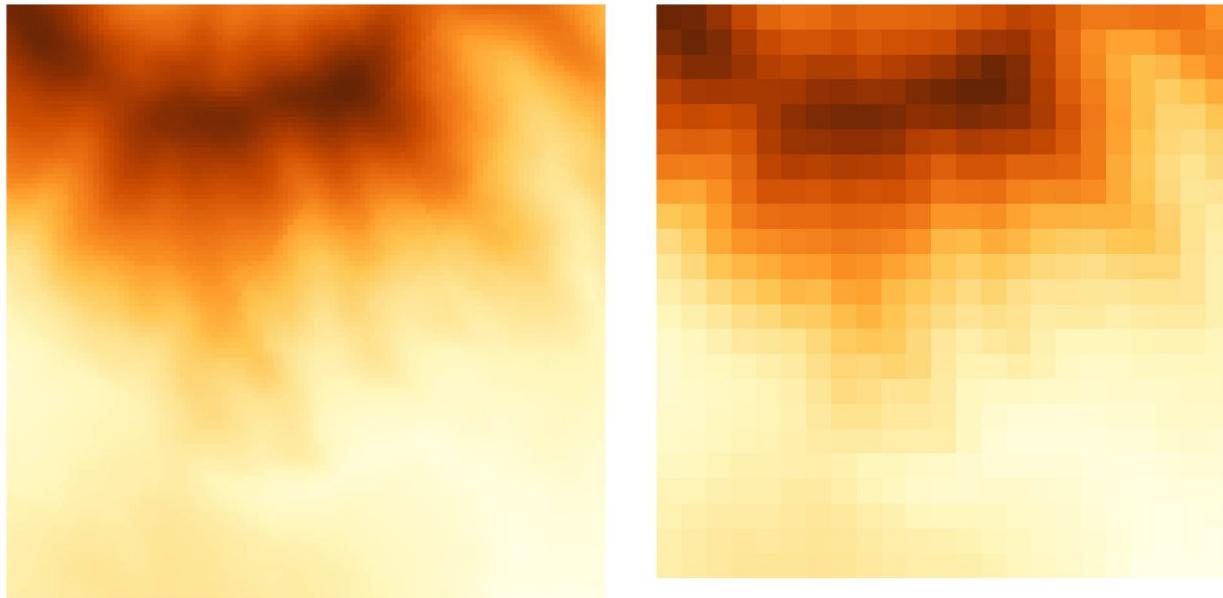
Changing resolution



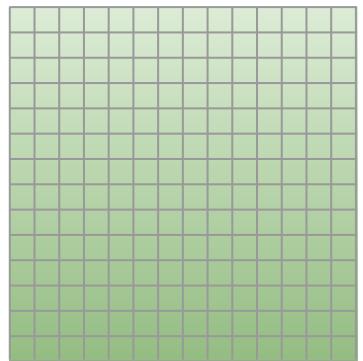
aggregating



Changing resolution



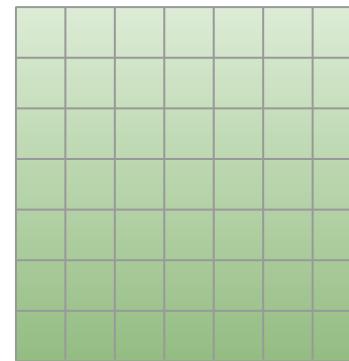
Changing resolution



aggregating



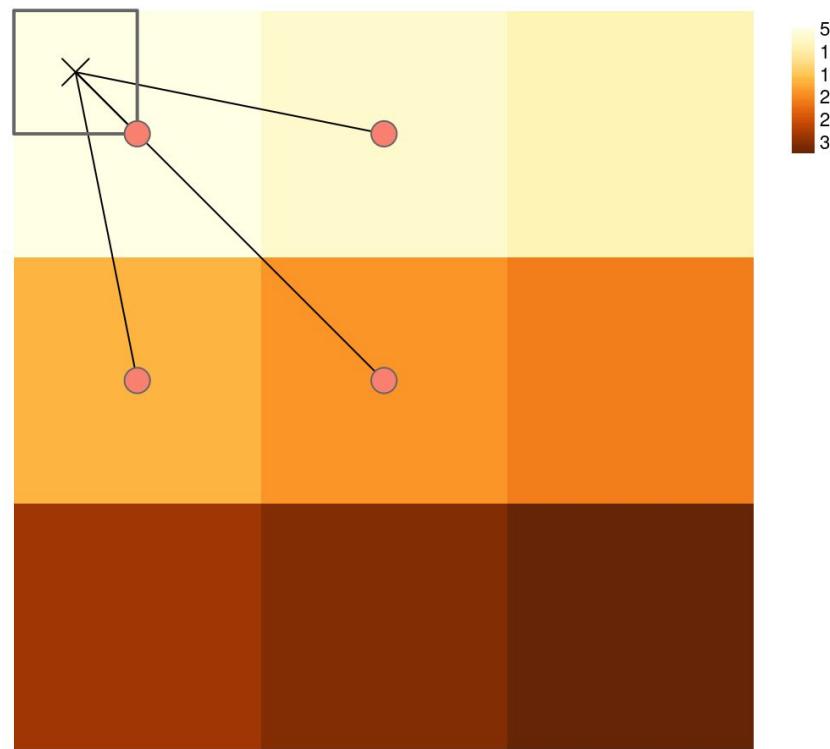
disaggregating



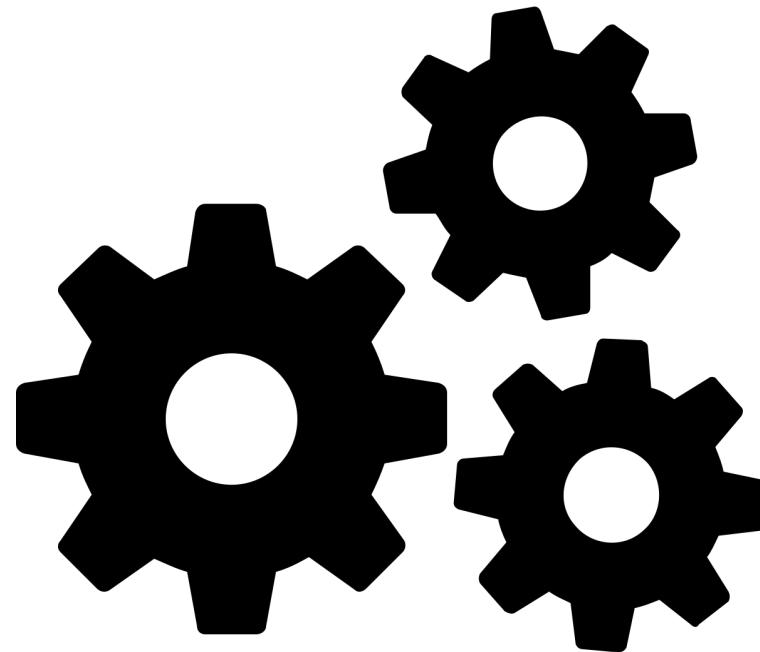
Changing resolution

Nearest neighbor

Bilinear interpolation

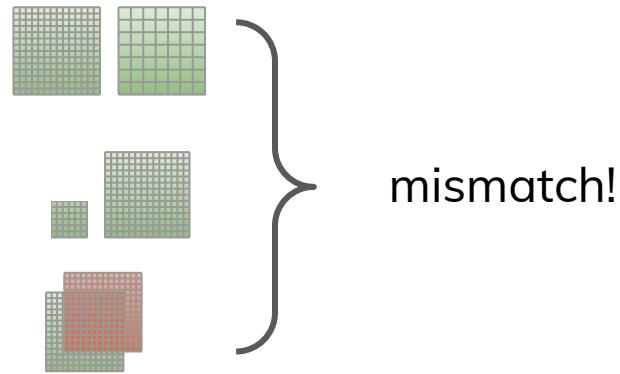


Switching gears...

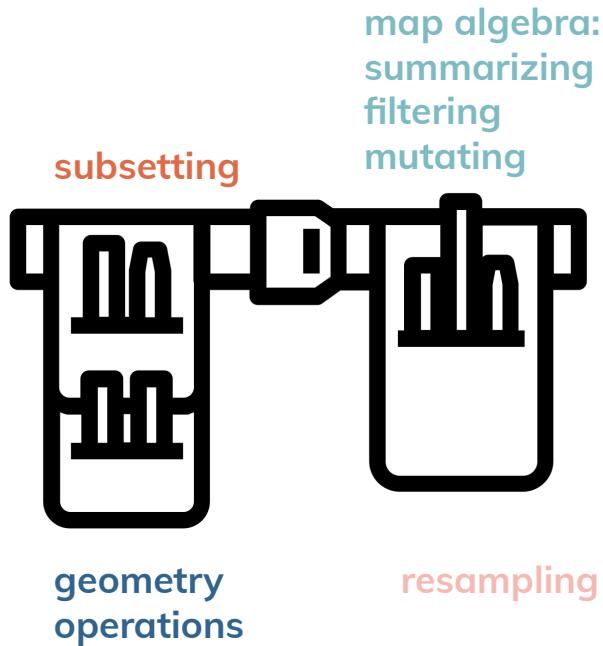


Raster data model

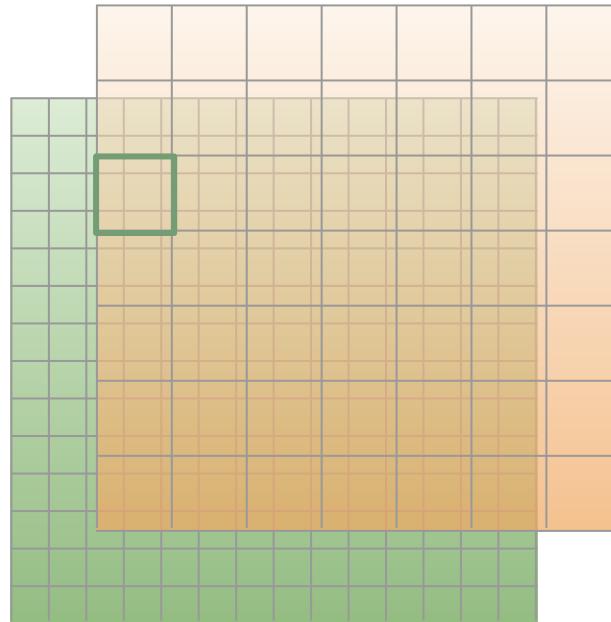
- **Resolution**
- **Extent**
- **Position**



Toolbelt for solving spatial problems



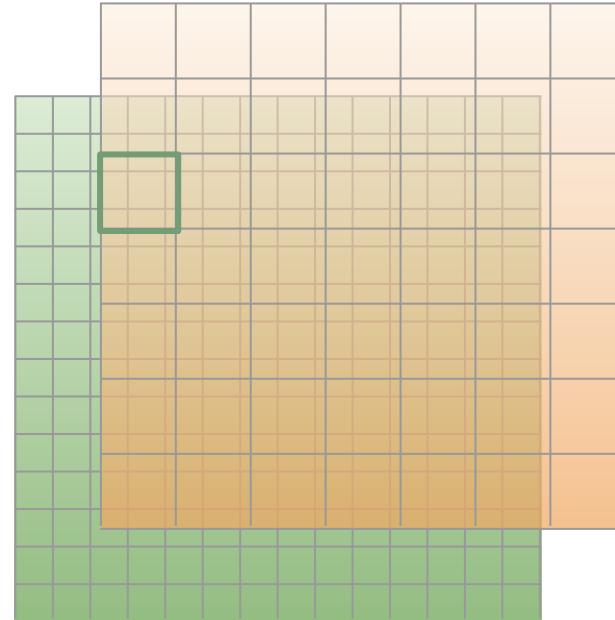
Resampling



Resampling

Nearest neighbor

Bilinear interpolation



Switching gears...

