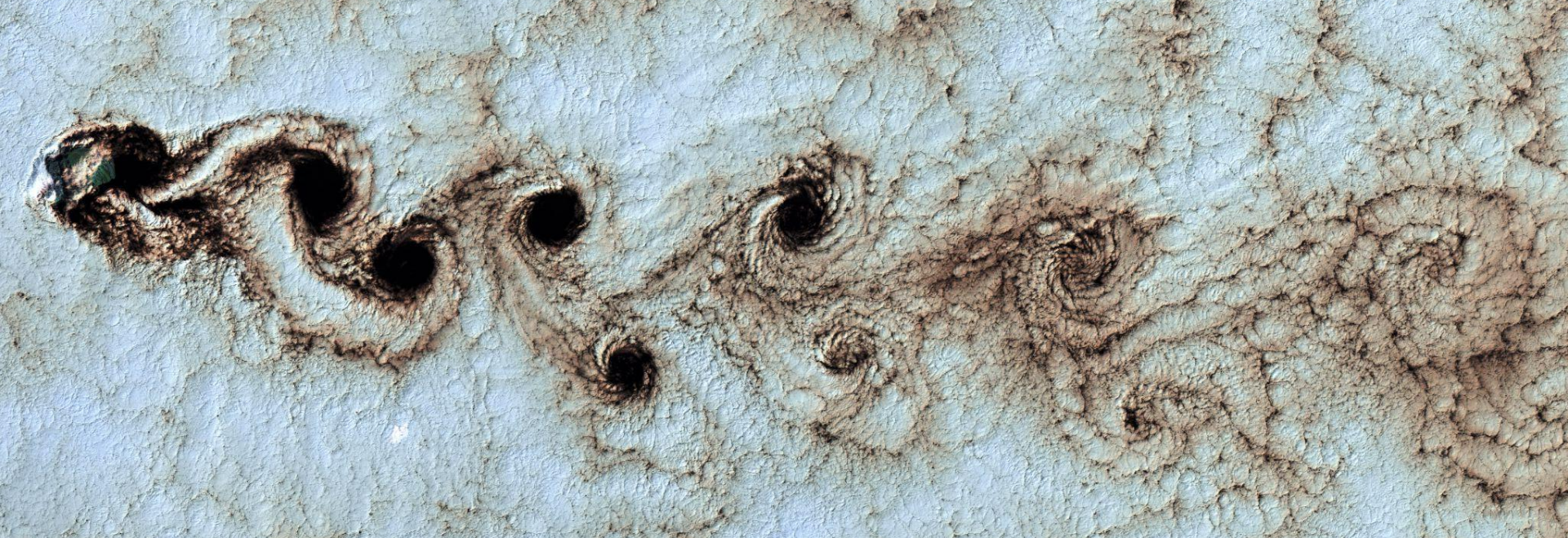


EDS 223: Geospatial Analysis & Remote Sensing

Week 4



Welcome!

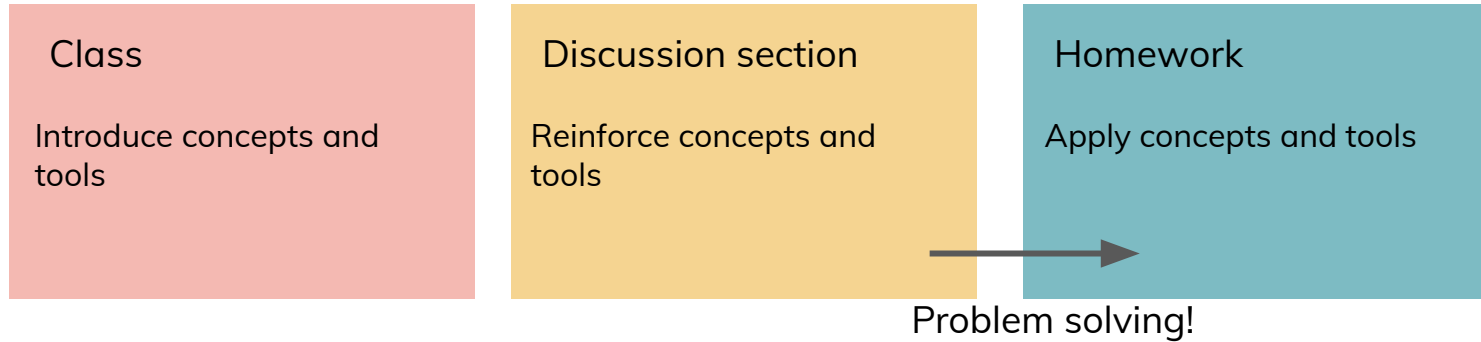
- **Course logistics**
 - Course expectations
 - Upcoming and past events
 - Plans for next week
- **Building a spatial analysis workflow**

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


[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

Samantha Csik 

AFFILIATION

Master of Environmental Data Science Program @
The Bren School (UCSB) & The National Center for
Ecological Analysis and Synthesis

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October 24, 2022

MODIFIED

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](#)

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

Due tonight by midnight!

Questions Responses Settings

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

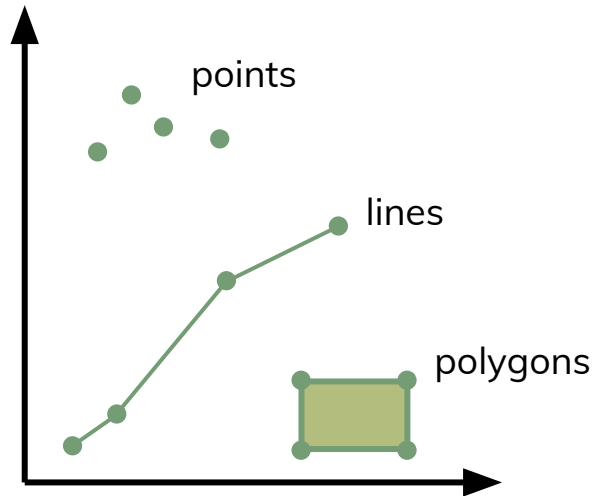
Describe the difference between vector and raster data models. *

Long answer text



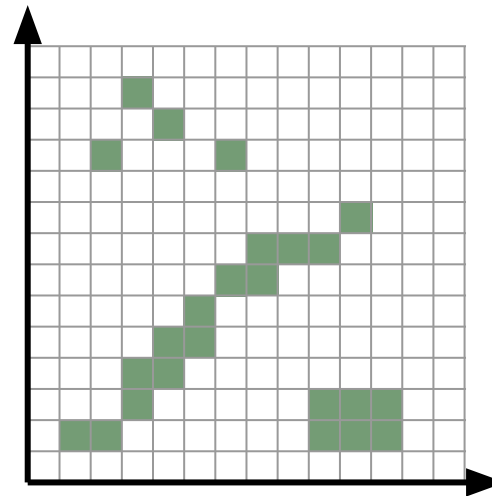
Spatial data models

vector



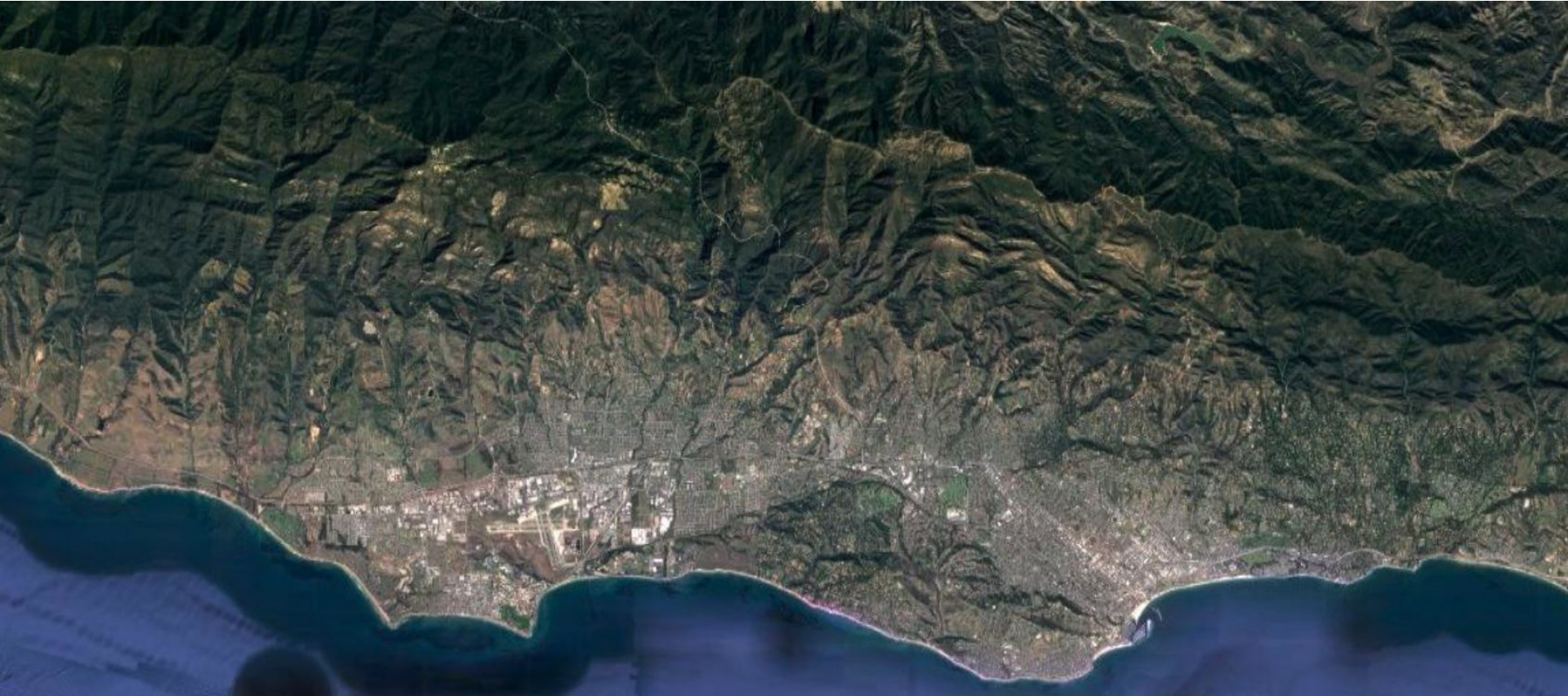
•• discrete

raster

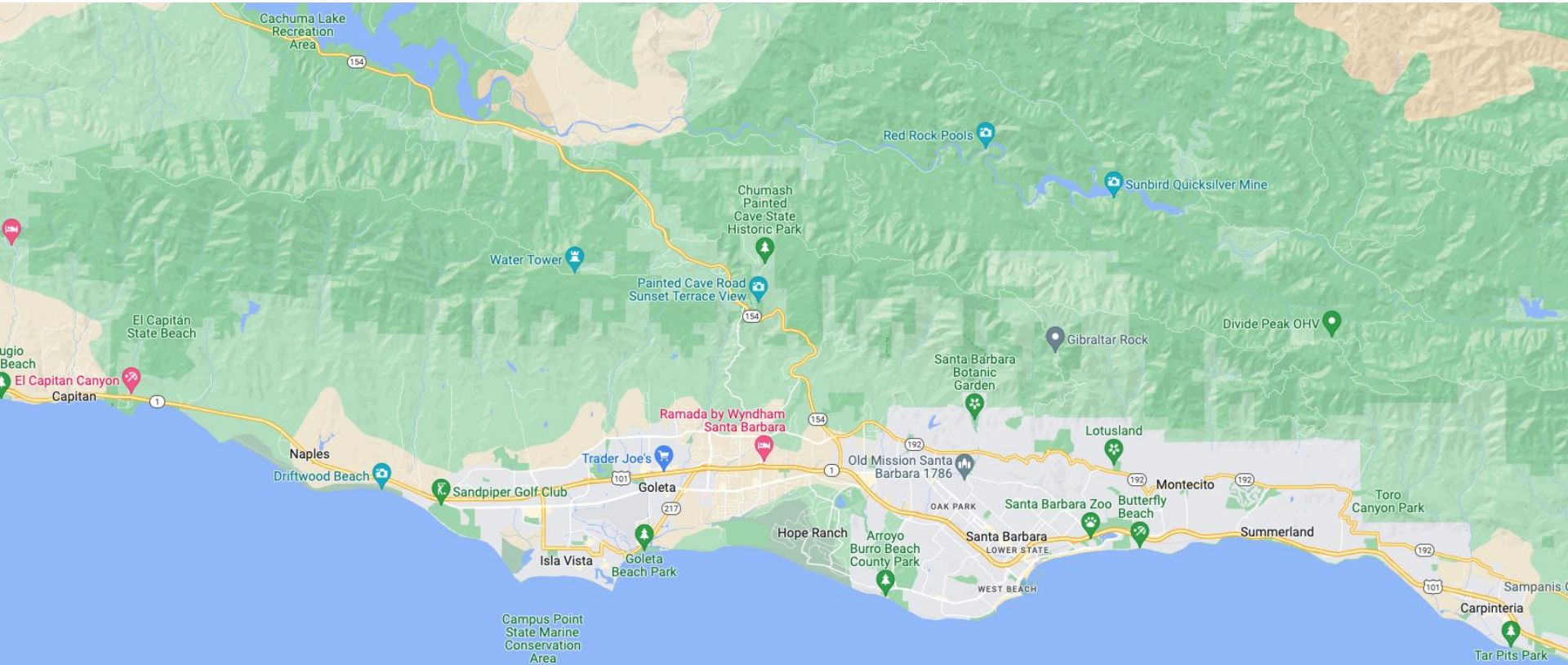


▴ continuous

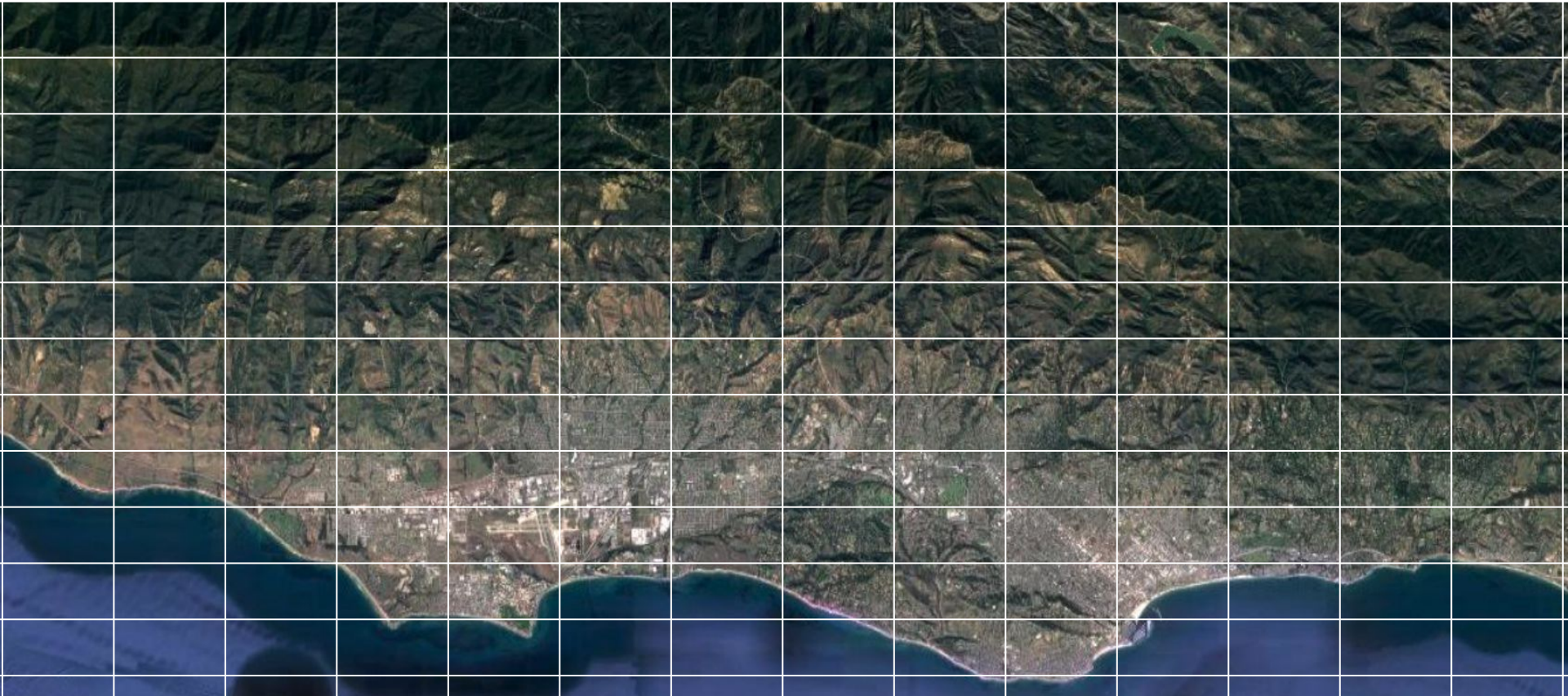
Spatial data models



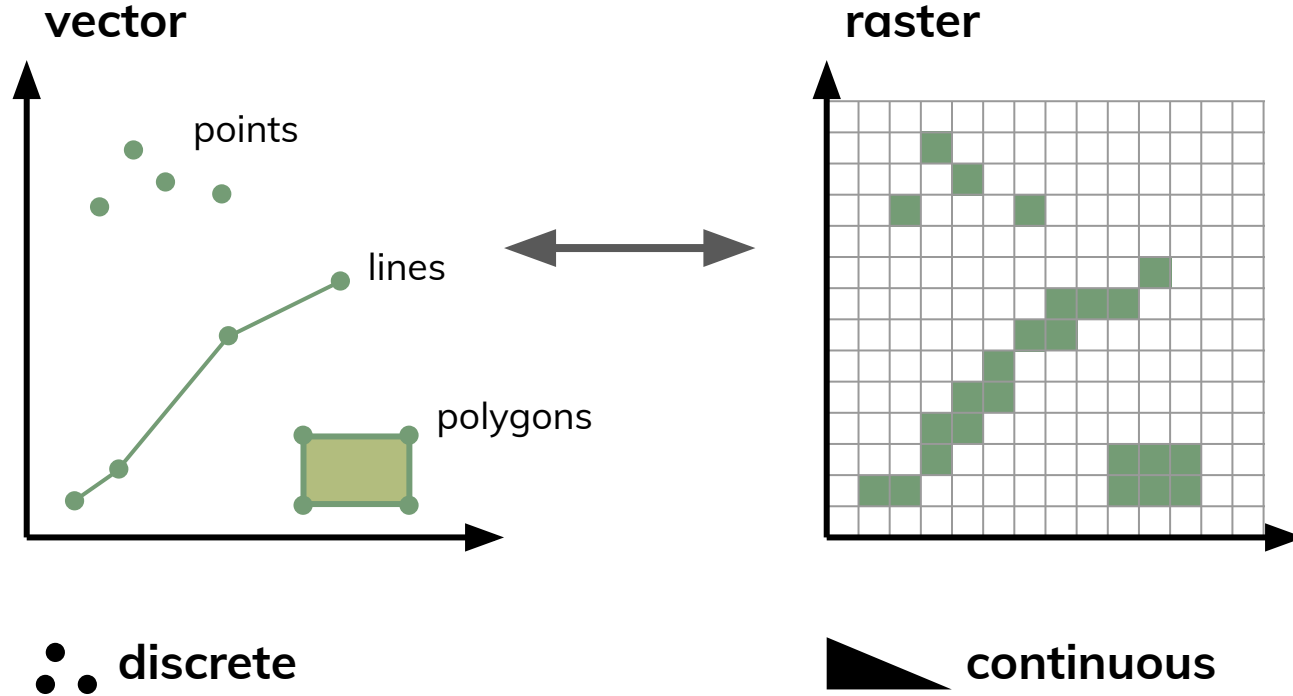
Spatial data models



Spatial data models

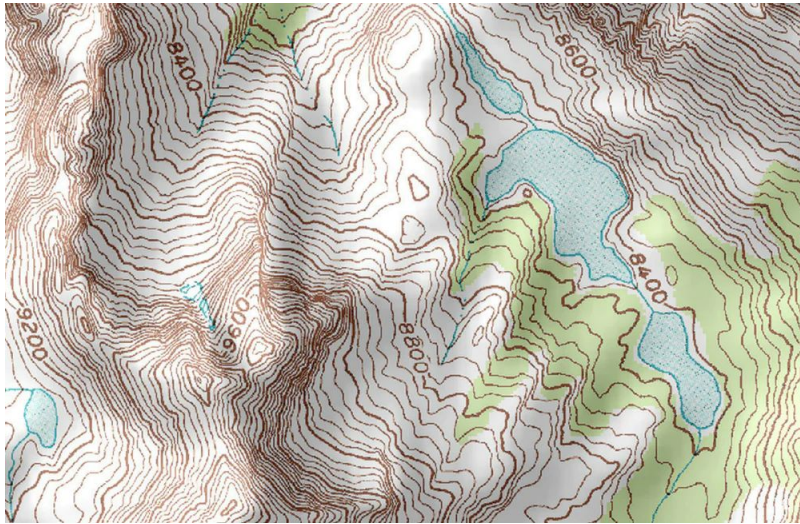


Spatial data models

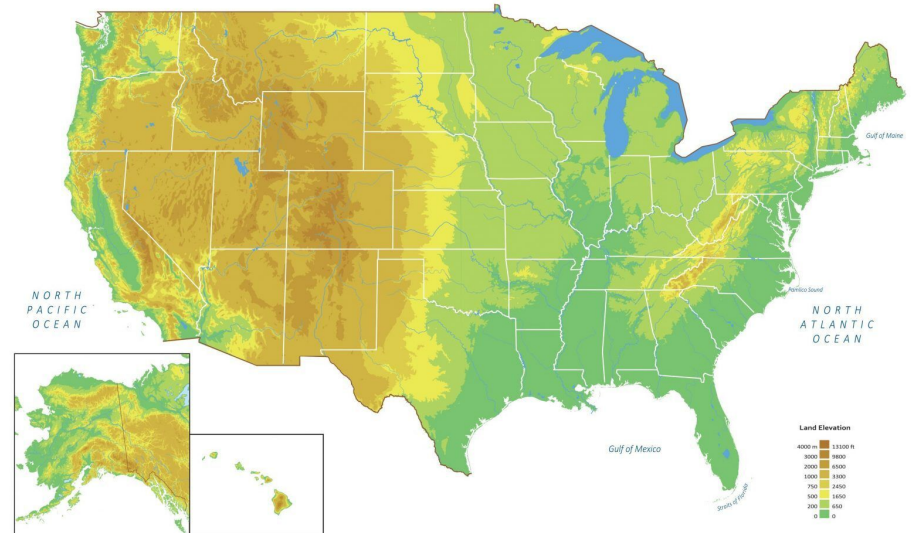


Spatial data models

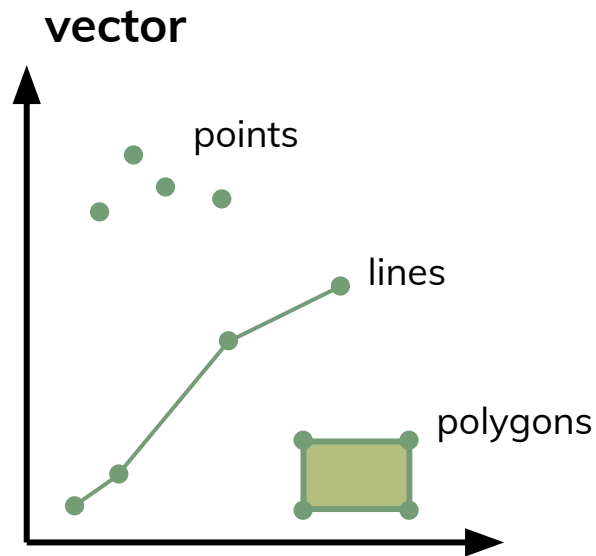
vector



raster



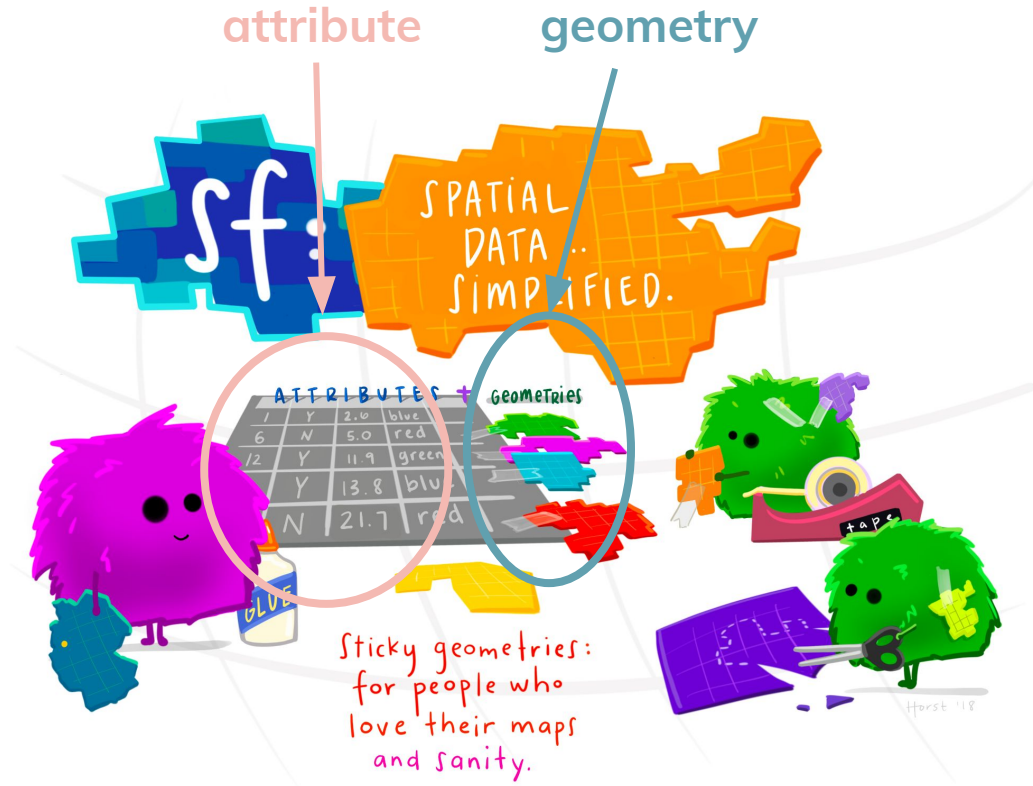
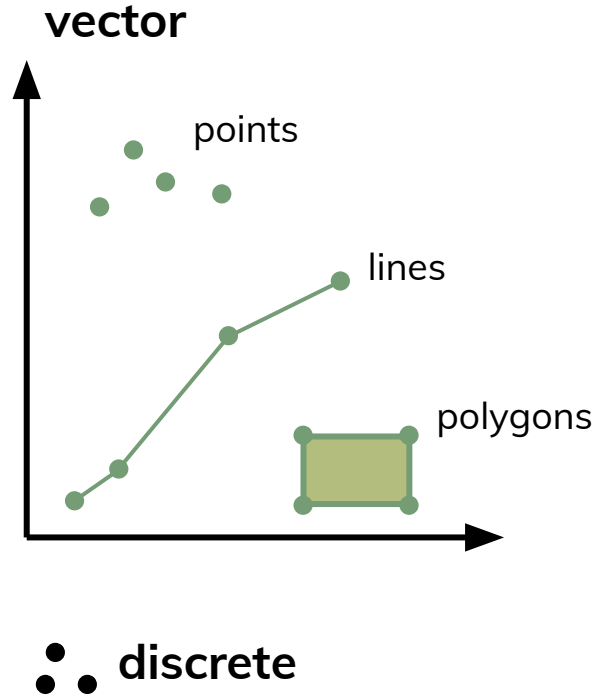
Vector data models



•• discrete

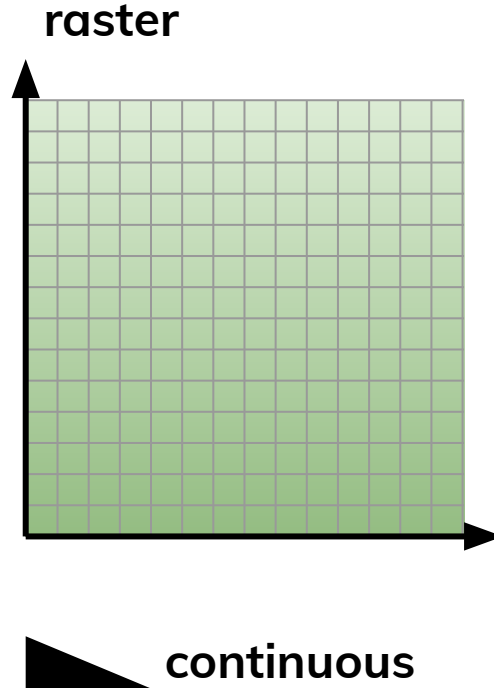


Vector data models



Raster data models

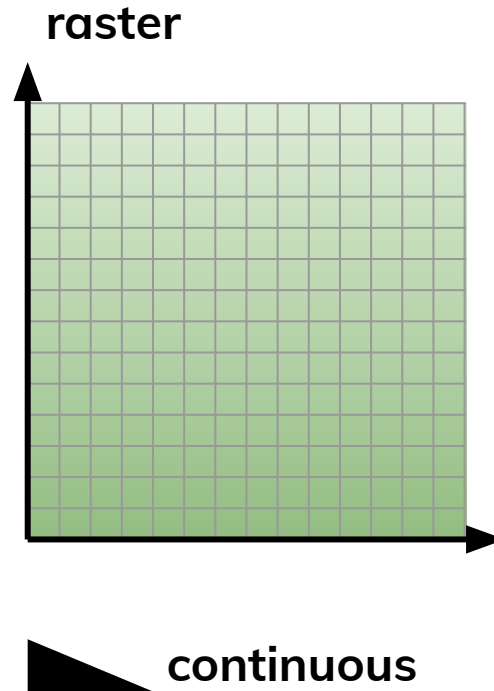
ID	Species	Age
1	Poplar	11
2	Oak	2
3	Beech	12
4	Cedar	15



Raster data models

geometry

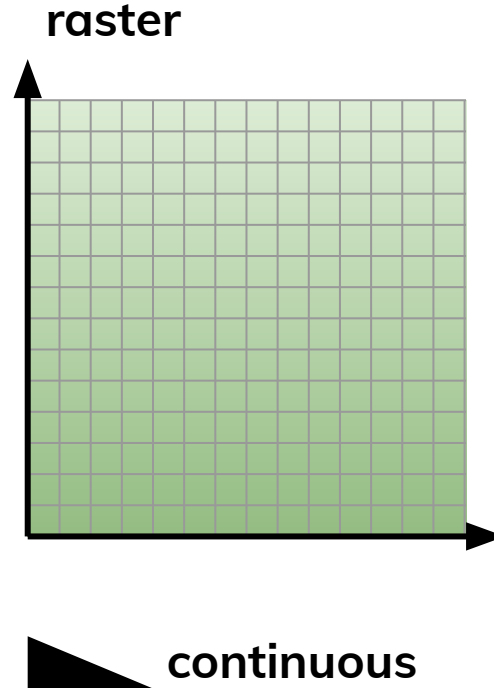
- ?



Raster data models

geometry

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



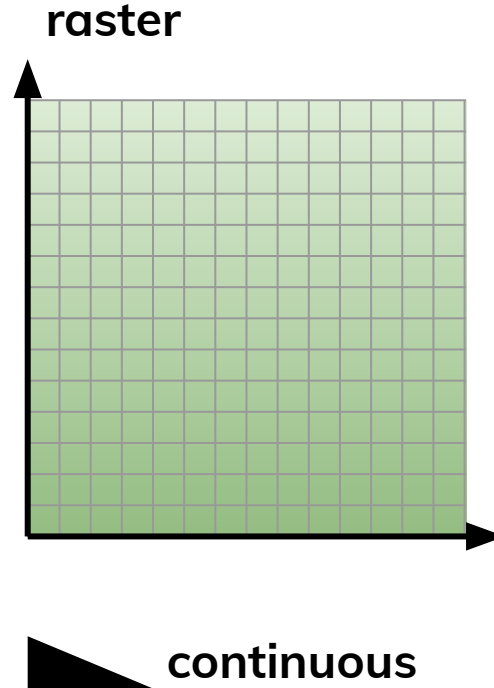
Raster data models

geometry

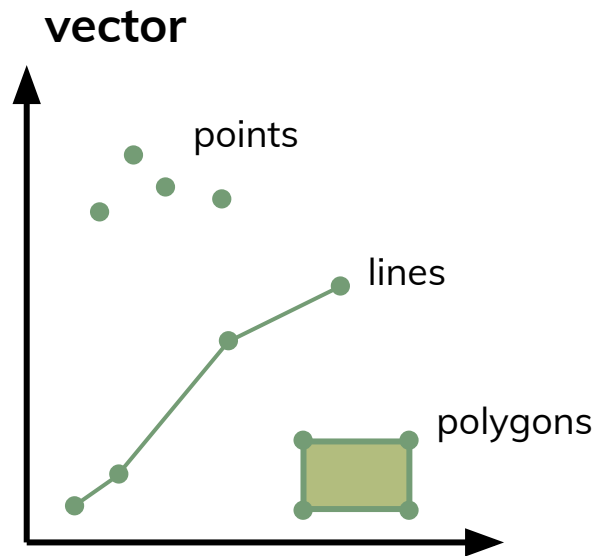
- Cell size
- Number of rows/columns
- Cell origin
- CRS

attribute

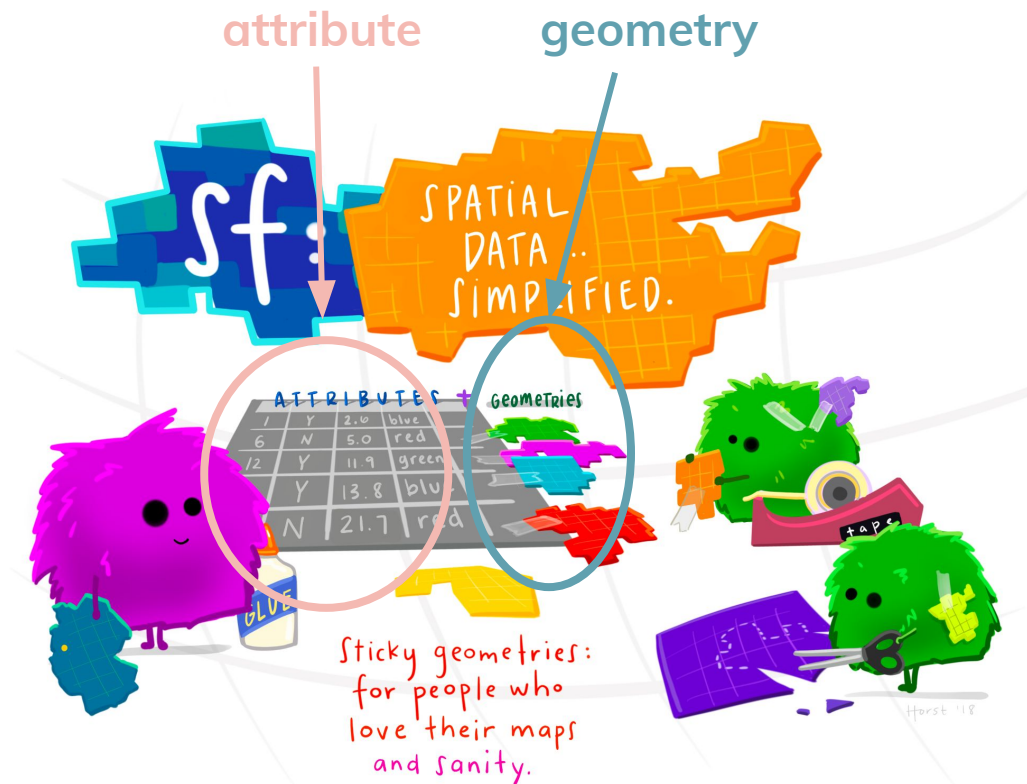
- One value per cell
- Categorical, numerical, logical



Vector data models



•• discrete



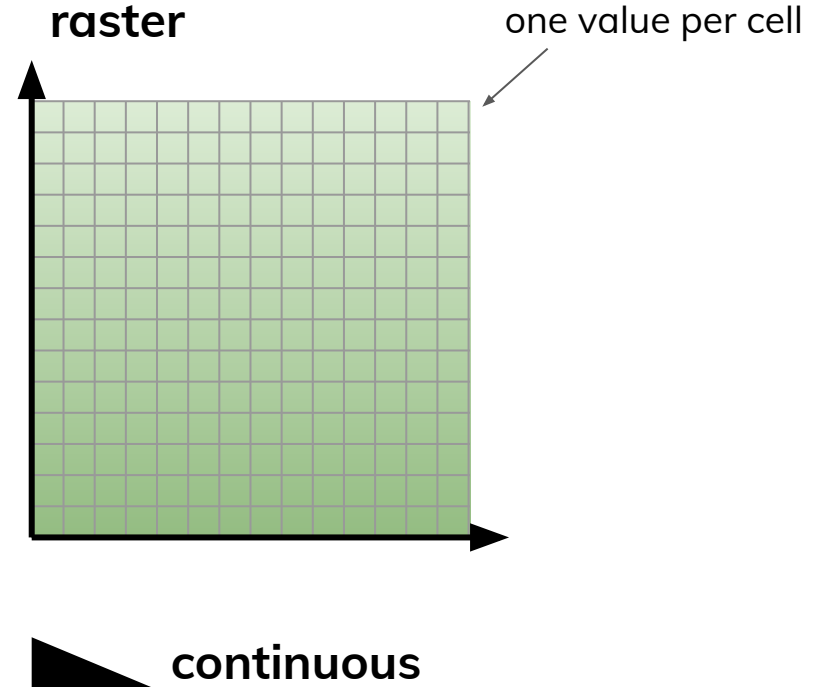
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



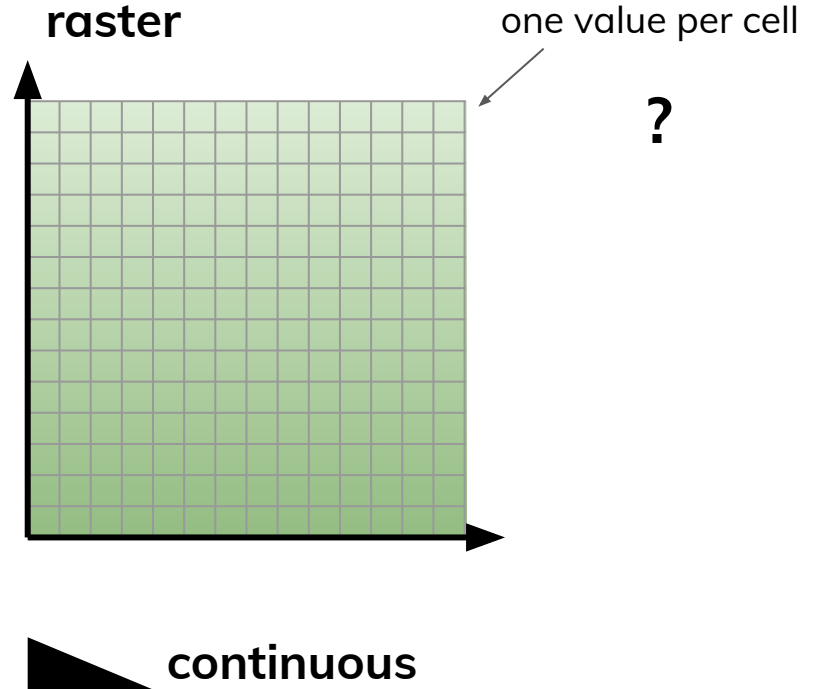
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



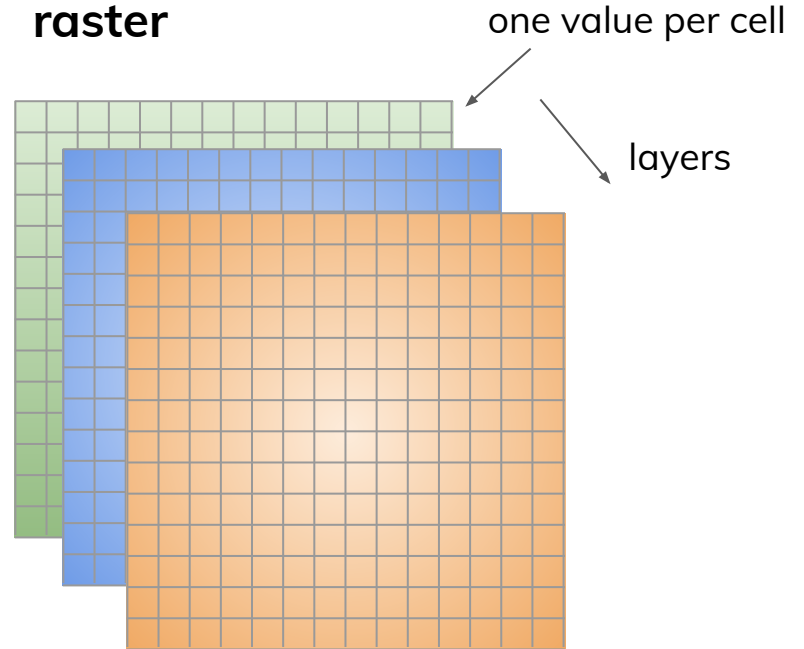
Raster data models

geometry

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

attribute

- One value per cell
- Categorical, numerical, logical



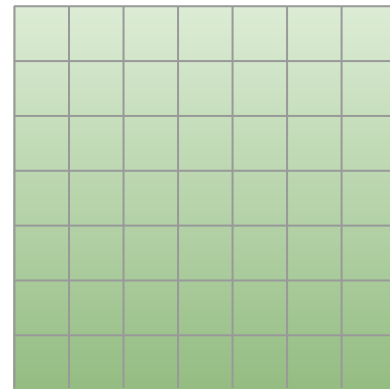
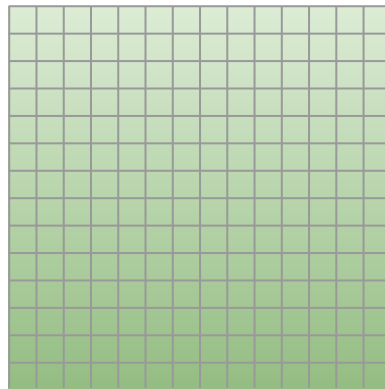
Raster data model

geometry

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



resolution



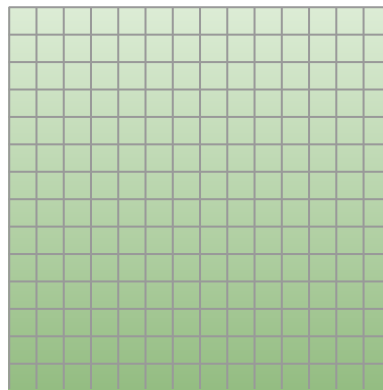
Raster data model

geometry

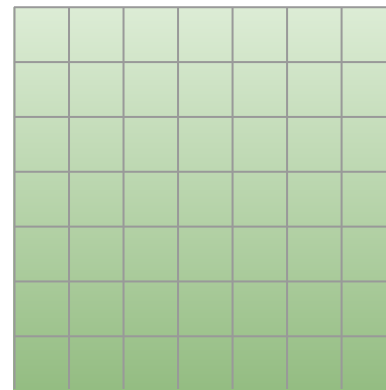
- Cell size
- Number of rows/columns
- Cell origin
- CRS



resolution



- “finer”
- “higher”



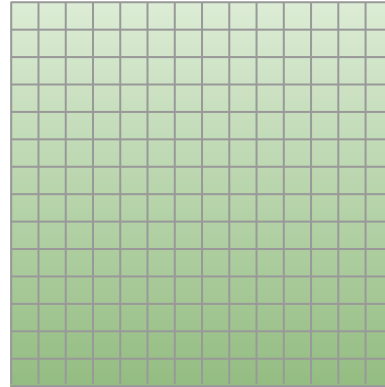
- “coarser”
- “lower”

Raster data model

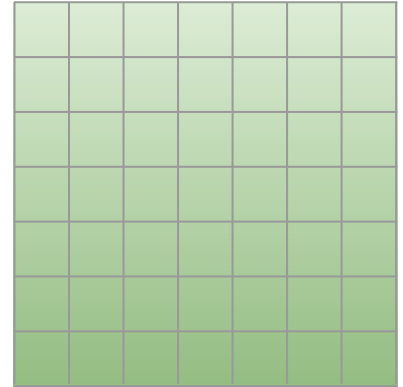
geometry

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

—————→ resolution

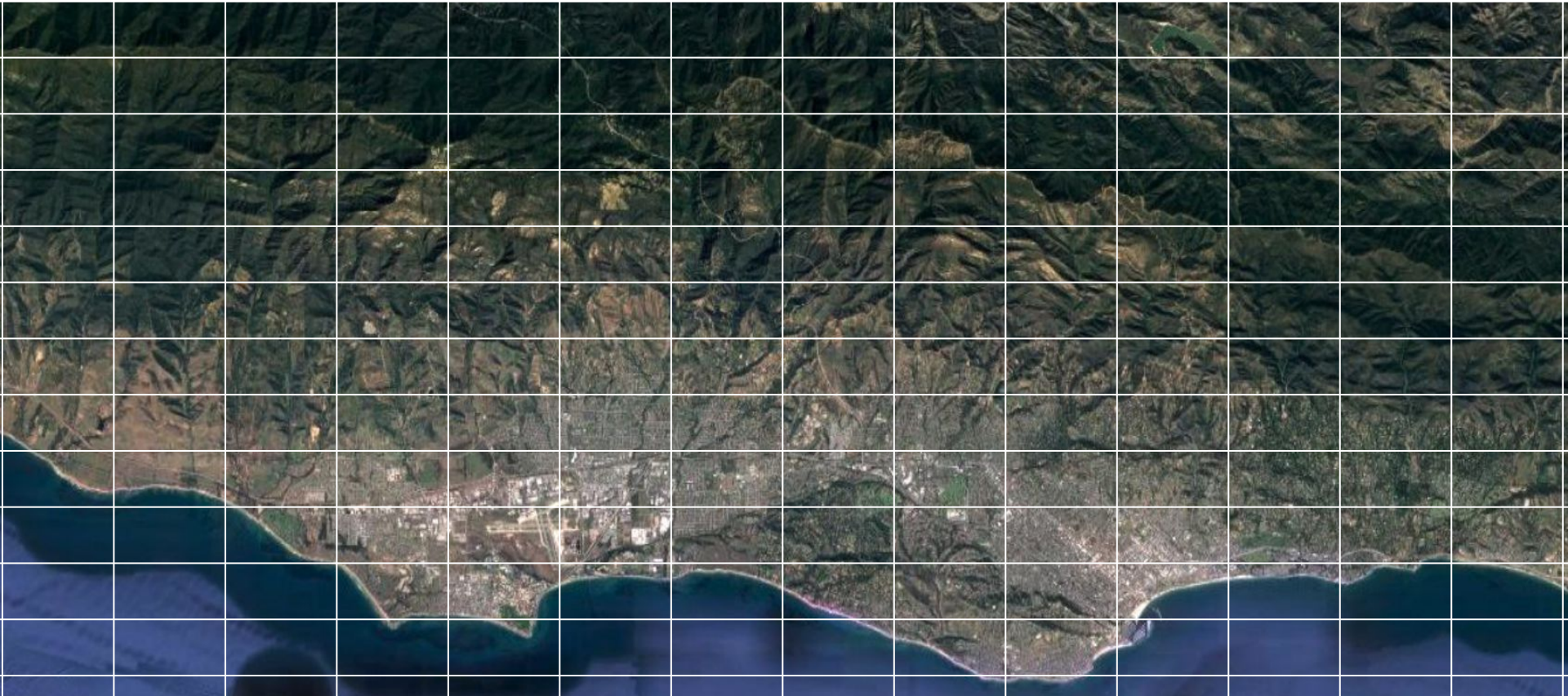


- “finer”
- “higher”
- 1 km

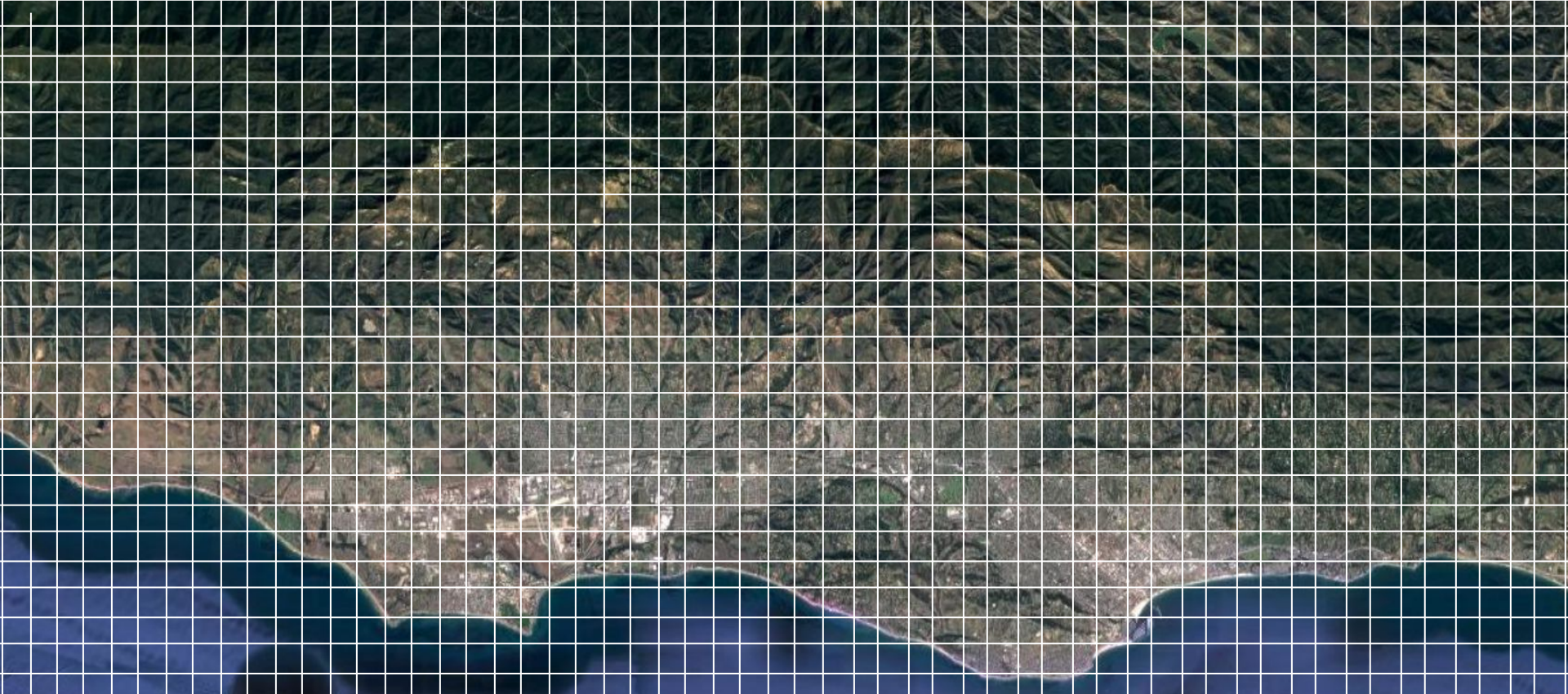


- “coarser”
- “lower”
- 5 km

Spatial data models



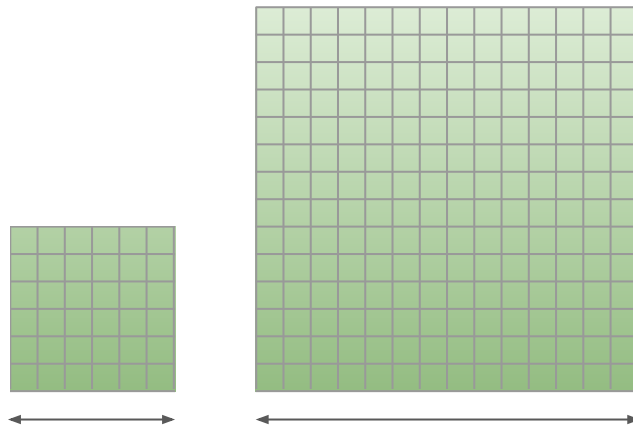
Spatial data models



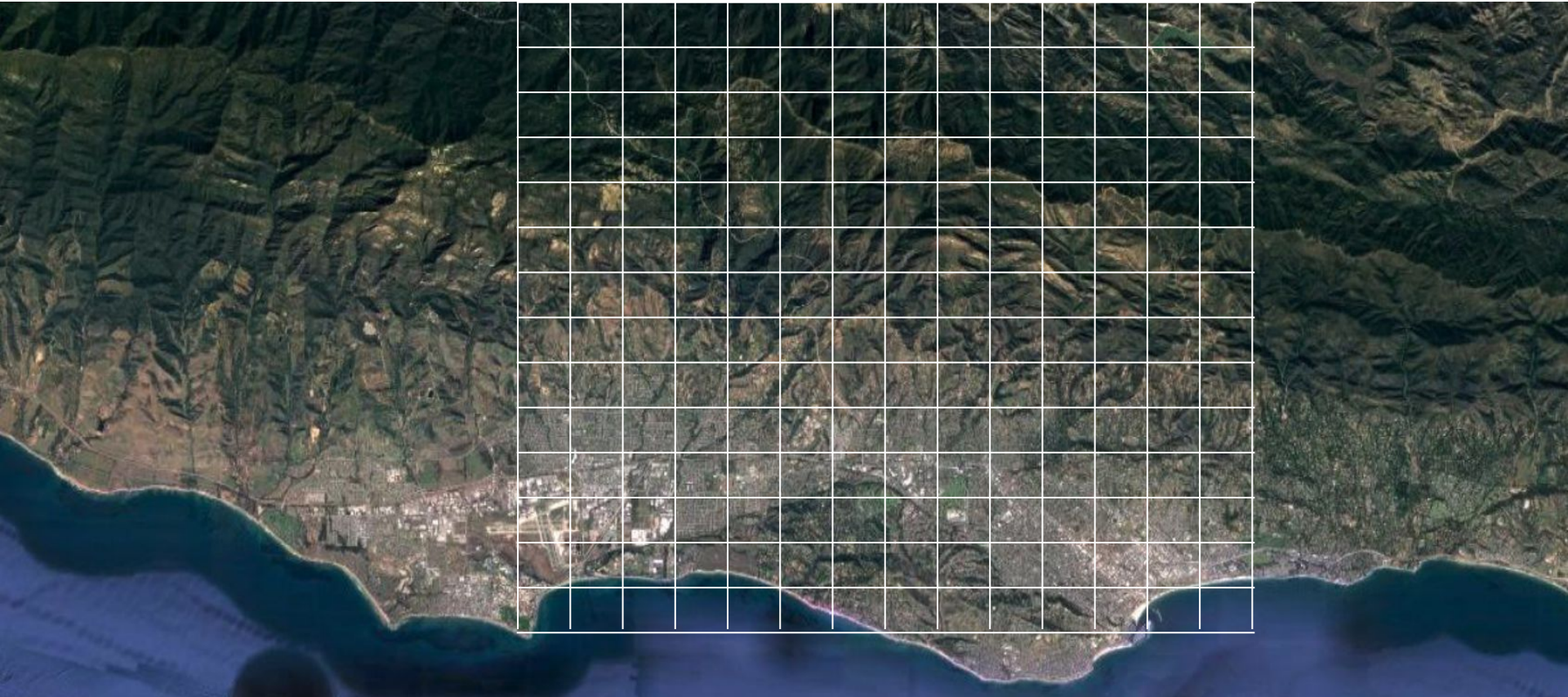
Raster data model

geometry

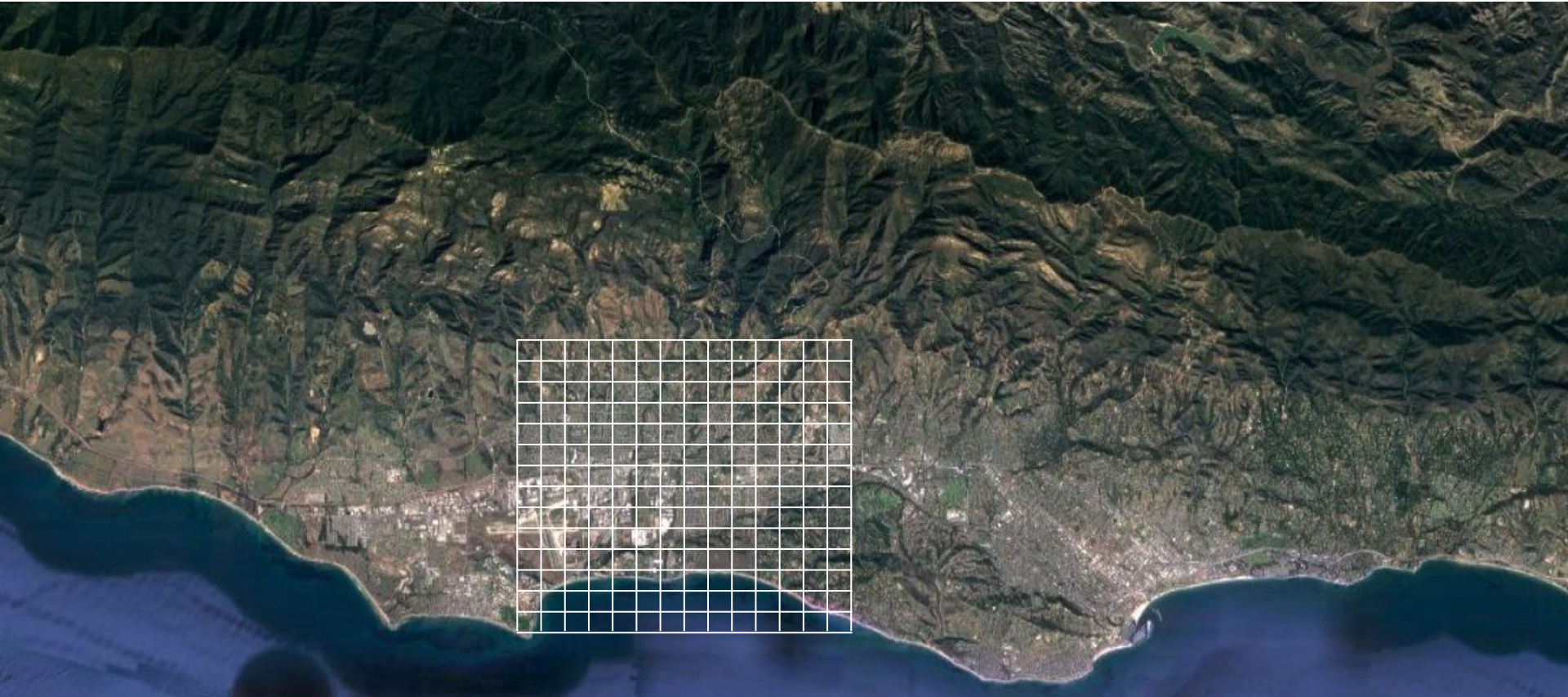
- Cell size
- Number of rows/columns → extent
- Cell origin
- CRS



Spatial data models



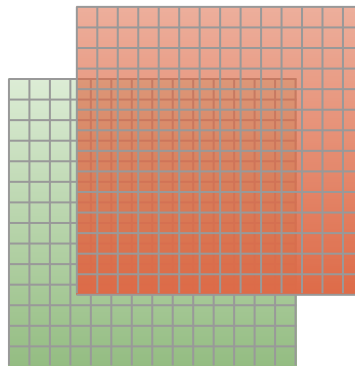
Spatial data models



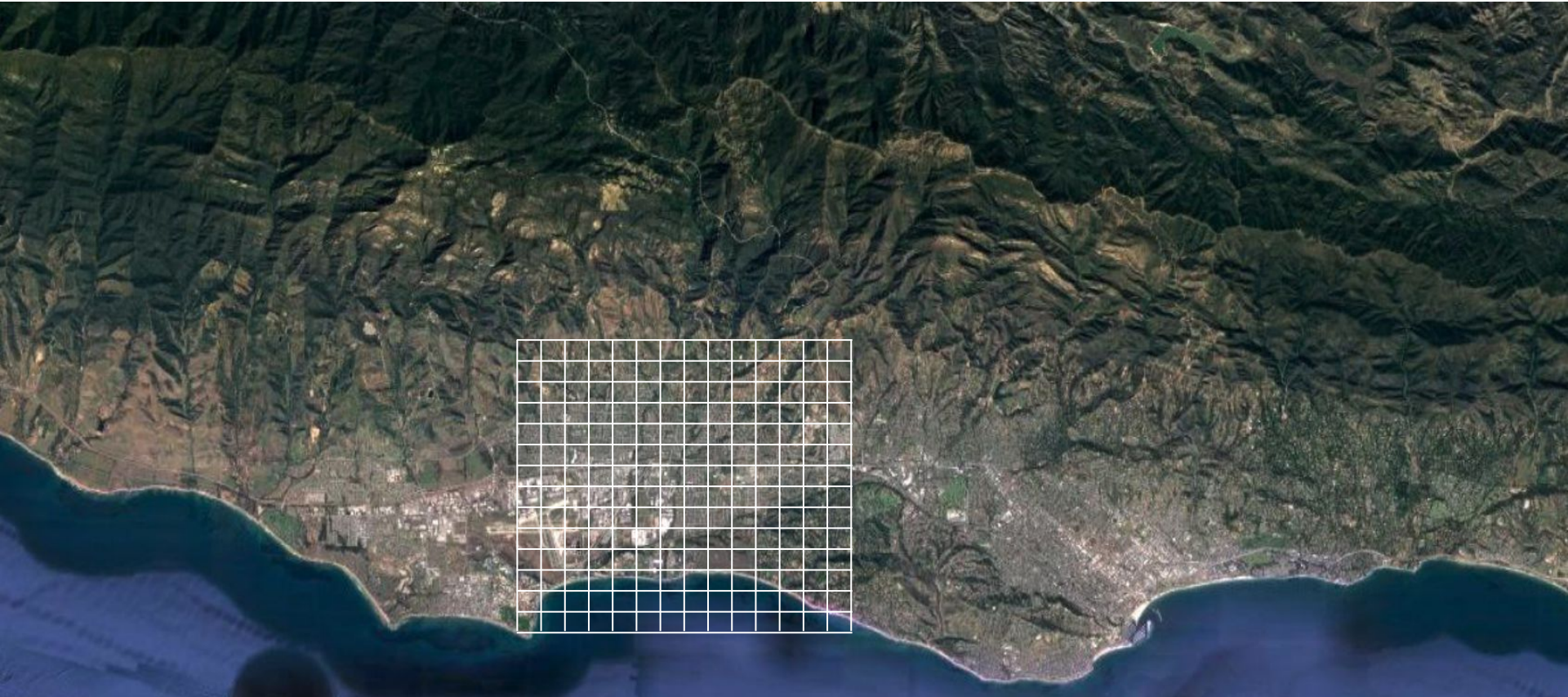
Raster data model

geometry

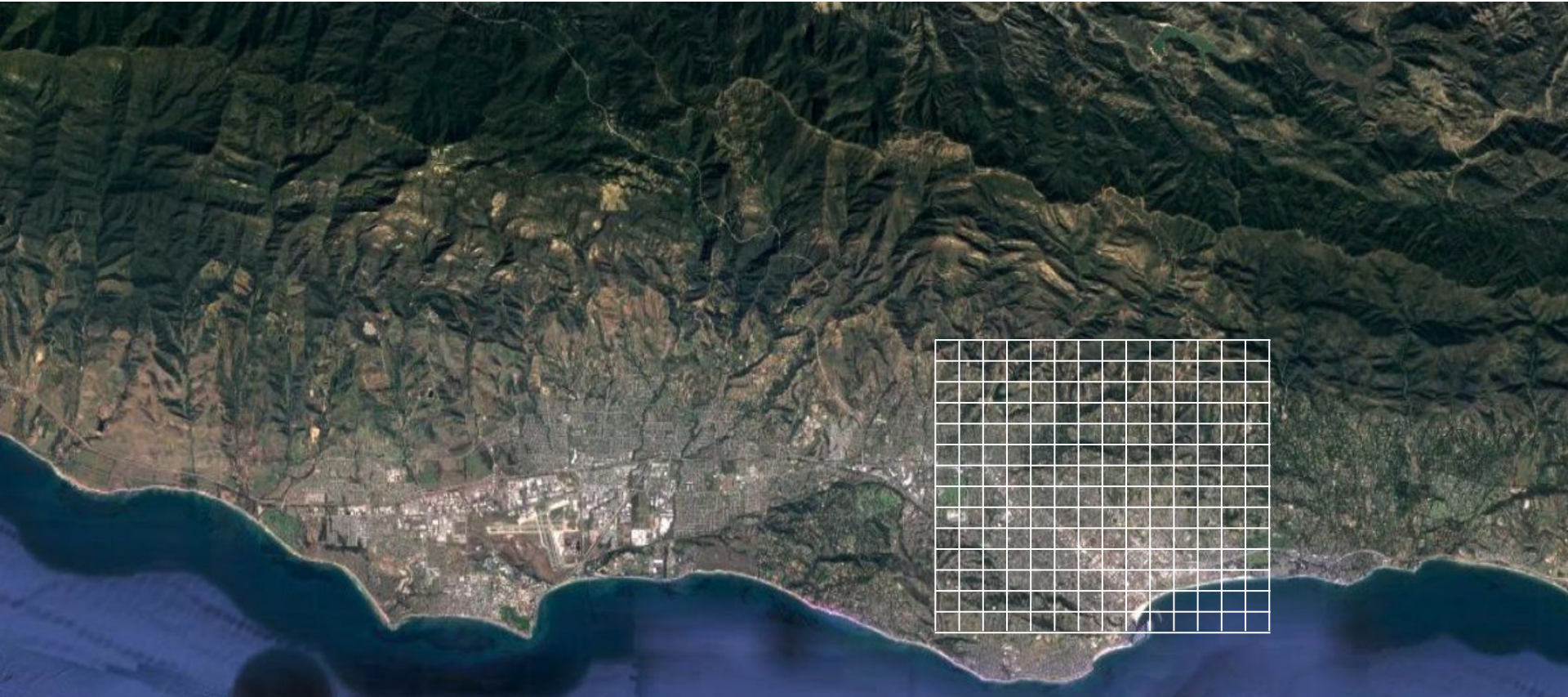
- Cell size
- Number of rows/columns
- Cell origin → position
- CRS



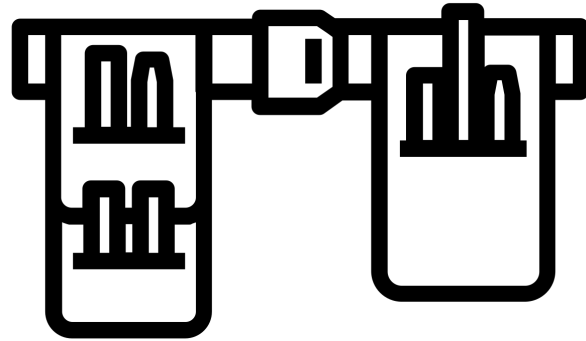
Spatial data models



Spatial data models



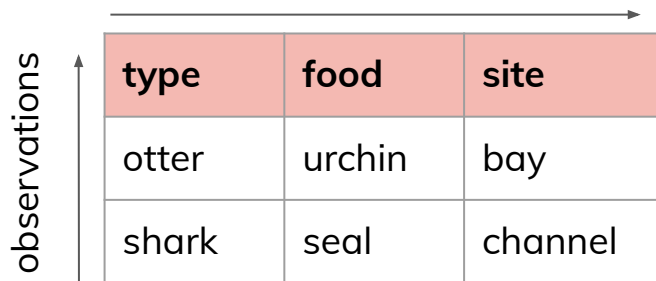
Toolbelt for solving spatial problems



New tools for a new data type

data frame

attributes



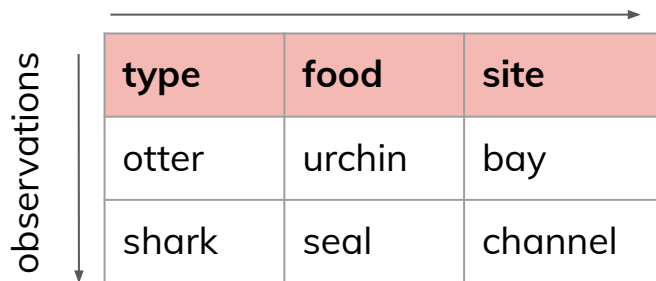
The diagram illustrates a data frame structure. It features a vertical axis on the left labeled 'observations' with an upward-pointing arrow, and a horizontal axis at the top labeled 'attributes' with a rightward-pointing arrow. Below these axes is a table with three columns and three rows. The first row is the header, with cells containing 'type', 'food', and 'site', all in bold black text. The second row contains 'otter', 'urchin', and 'bay'. The third row contains 'shark', 'seal', and 'channel'. The header row has a light red background, while the data rows have a white background.

type	food	site
otter	urchin	bay
shark	seal	channel

New tools for a new data type

data frame

attributes



A diagram of a data frame table. The y-axis is labeled 'observations' with a downward arrow. The x-axis is labeled 'attributes' with a rightward arrow. The table has three columns: 'type', 'food', and 'site'. The first row is highlighted in light red. The data is as follows:

type	food	site
otter	urchin	bay
shark	seal	channel

matrix

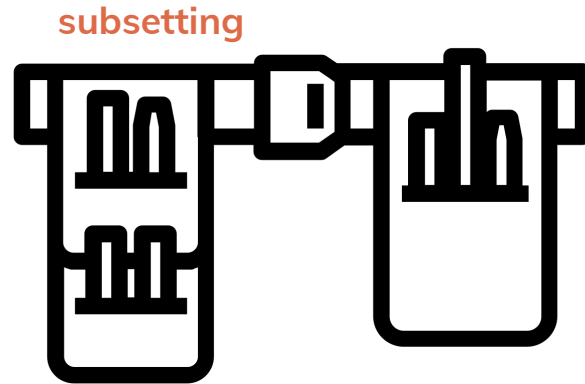
columns



A diagram of a matrix table. The y-axis is labeled 'rows' with a downward arrow. The x-axis is labeled 'columns' with a rightward arrow. The table has three columns and three rows. The data is as follows:

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**

```
filter(df, type == "otter" & site == "bay")
```

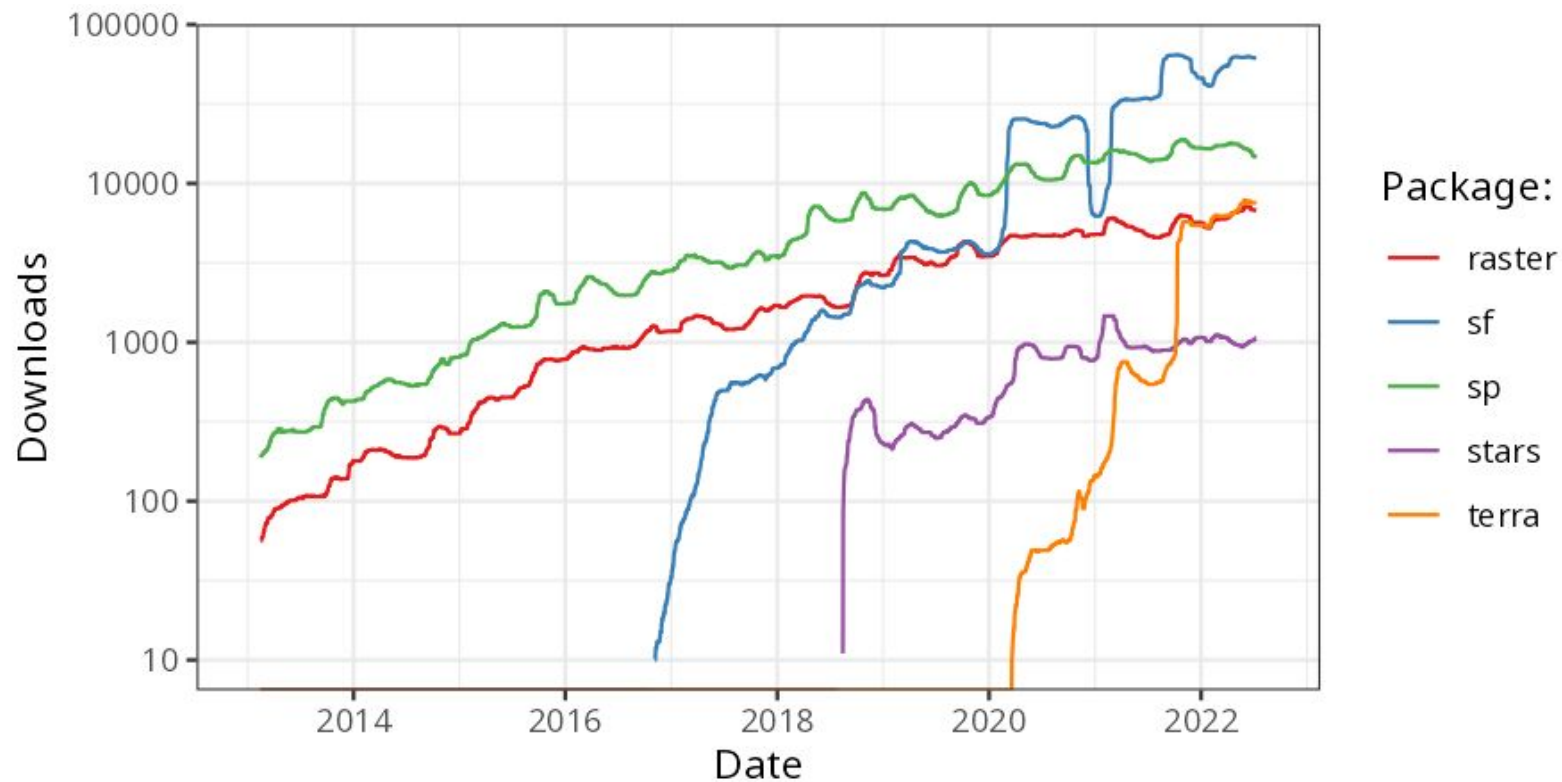
Annotations: "keep rows from..." points to 'df', "this data..." points to 'df', "ONLY IF..." points to 'type == "otter"', "AND" points to '&', "site is 'bay'" points to 'site == "bay"'.

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

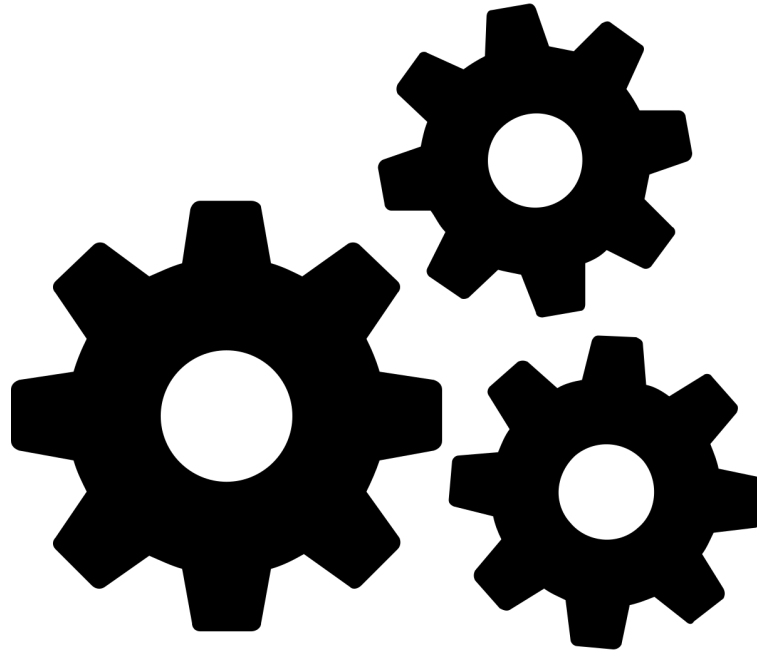
Checkmarks (✓) are next to the first and third rows. Red X marks are next to the second and fourth rows.

@allison_horst

R's spatial ecosystem

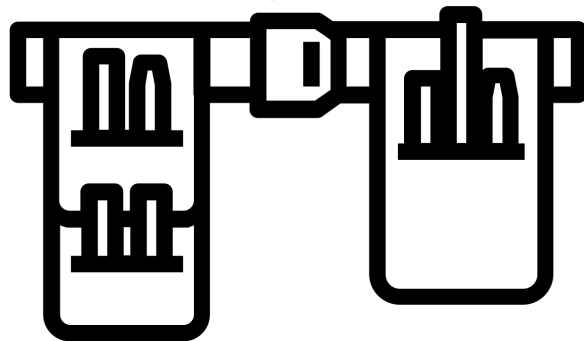


Switching gears...



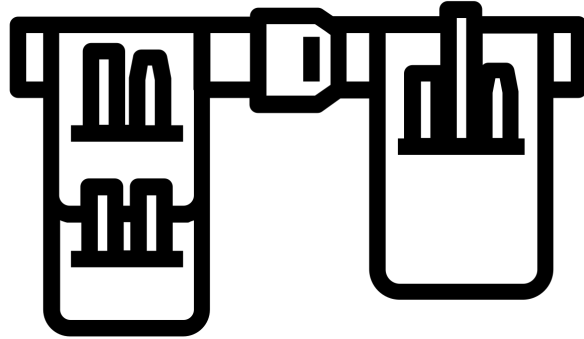
Toolbelt for solving spatial problems

spatial subsetting



Toolbelt for solving spatial problems

spatial subsetting

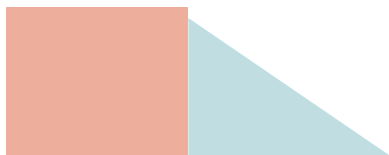


Topological relationships

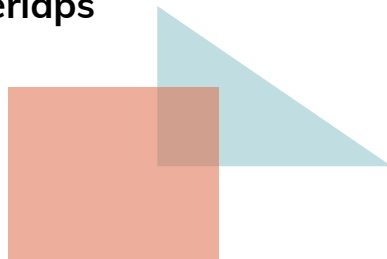
intersects

Yes or No

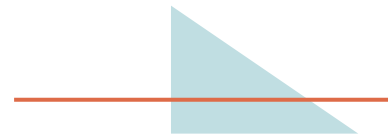
touches



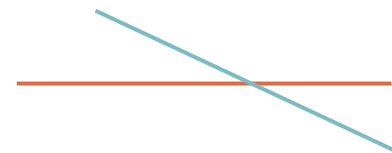
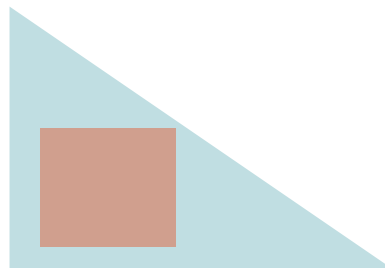
overlaps



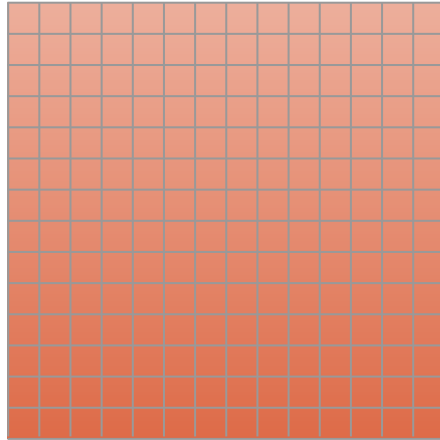
crosses



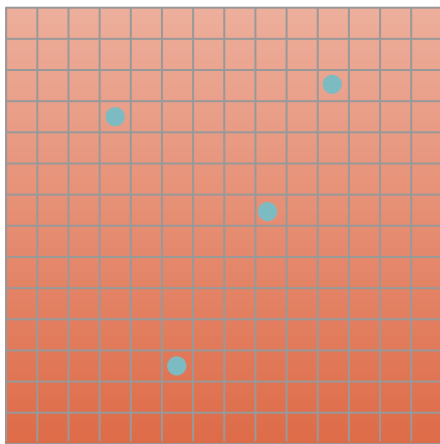
within



Spatial subsetting

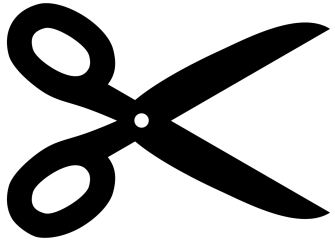
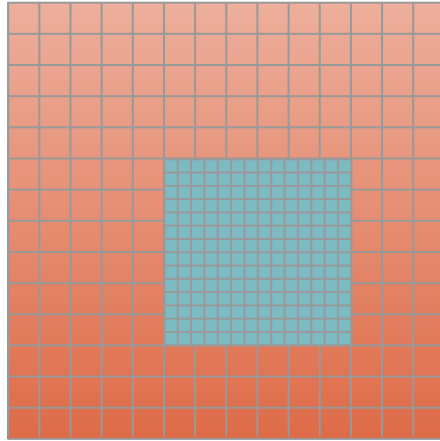


Spatial subsetting

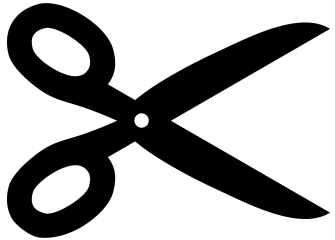
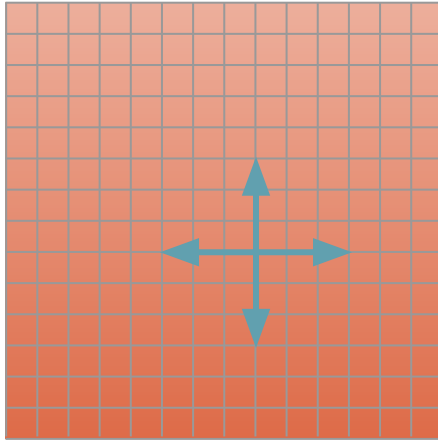


- 1
- 4
- 7
- 15

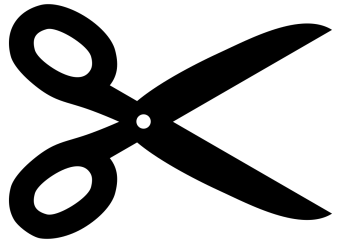
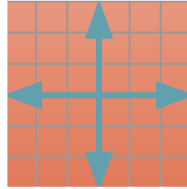
Spatial subsetting: clipping



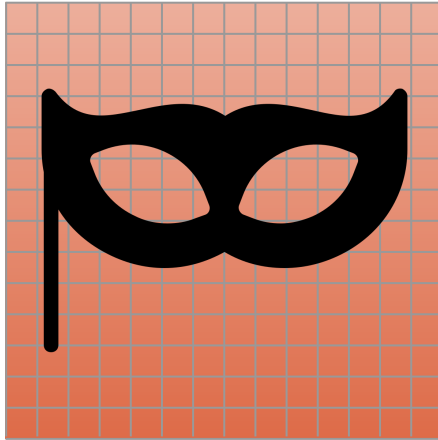
Spatial subsetting: clipping



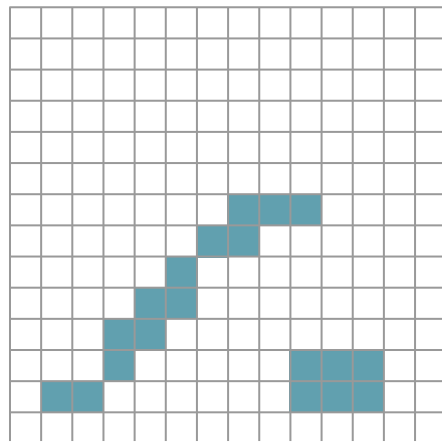
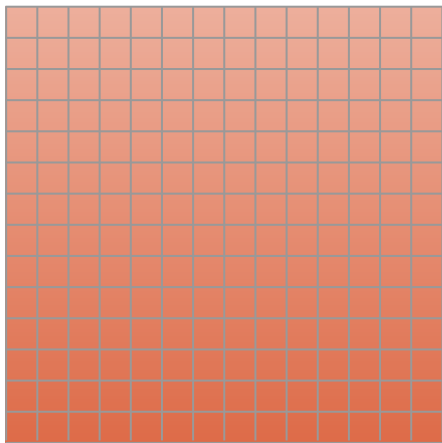
Spatial subsetting: clipping



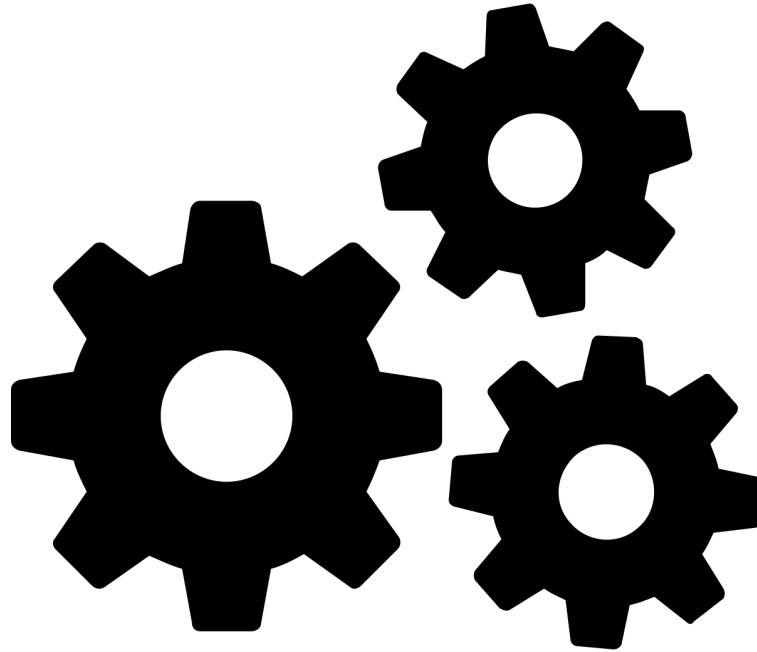
Spatial subsetting: masking



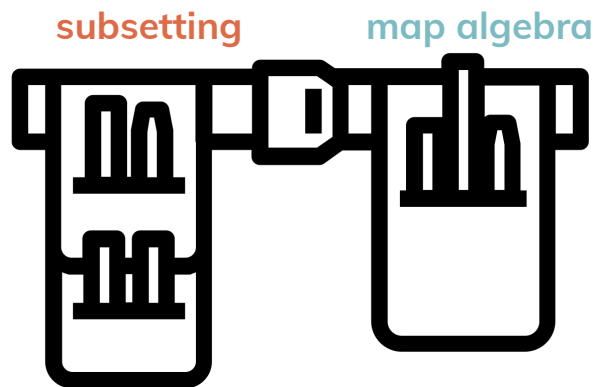
Spatial subsetting: masking



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 →

1	4	8
10	7	3
2	5	1

↑ rows

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 →

1	4	8
10	7	3
2	5	1

↑ rows

geometry

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

Map algebra

- Local
- Focal
- Zonal
- Global

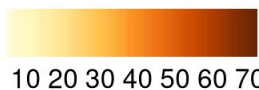
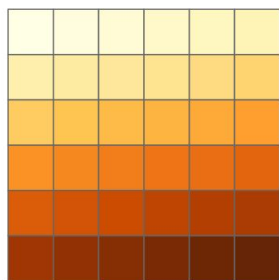


Scale or number of cells

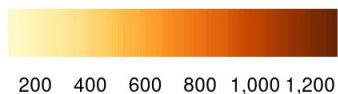
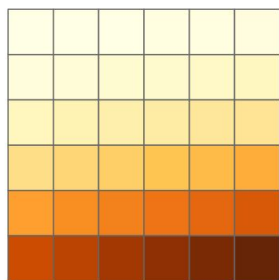
Map algebra

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

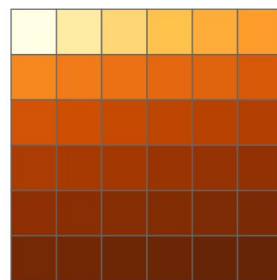
elev + elev



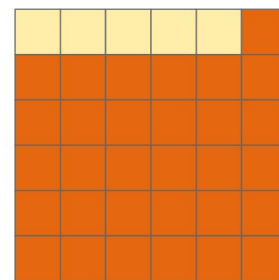
elev²



log(elev)

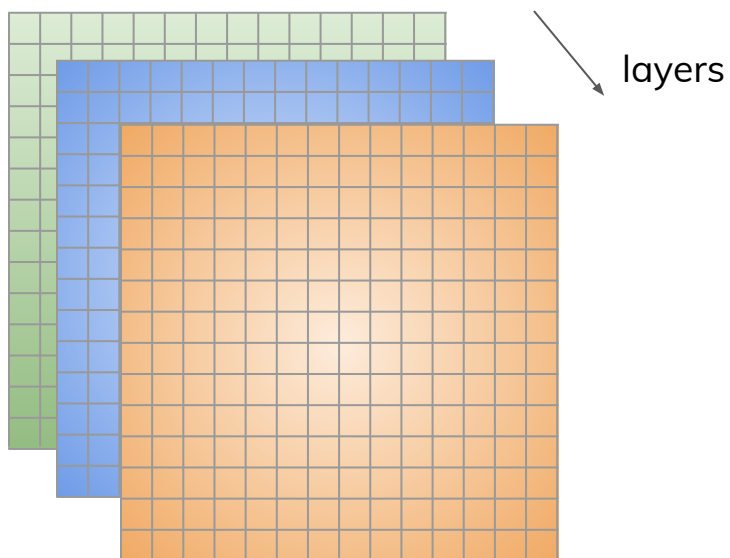


elev > 5



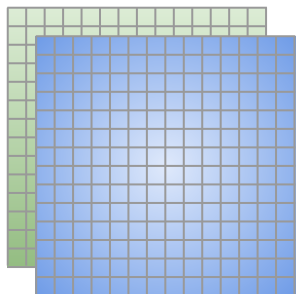
Map algebra

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



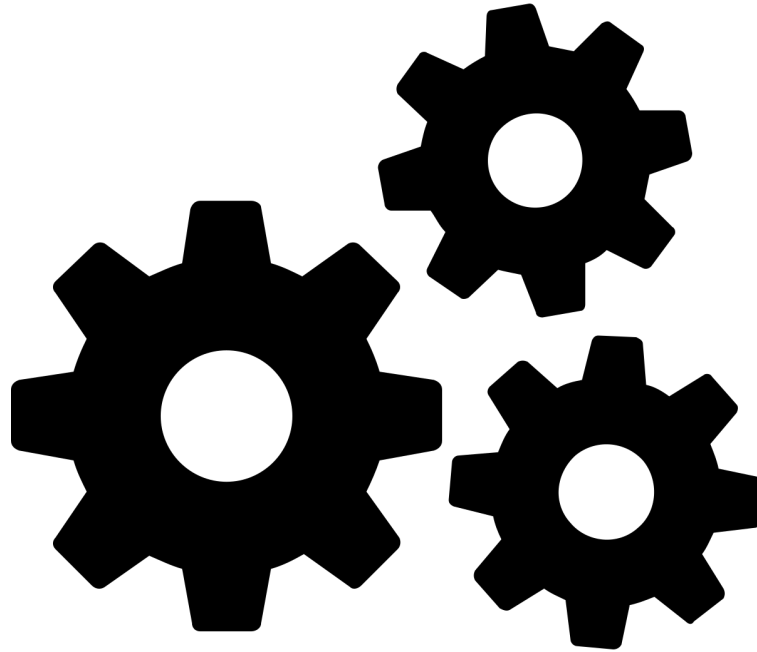
Map algebra

- **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

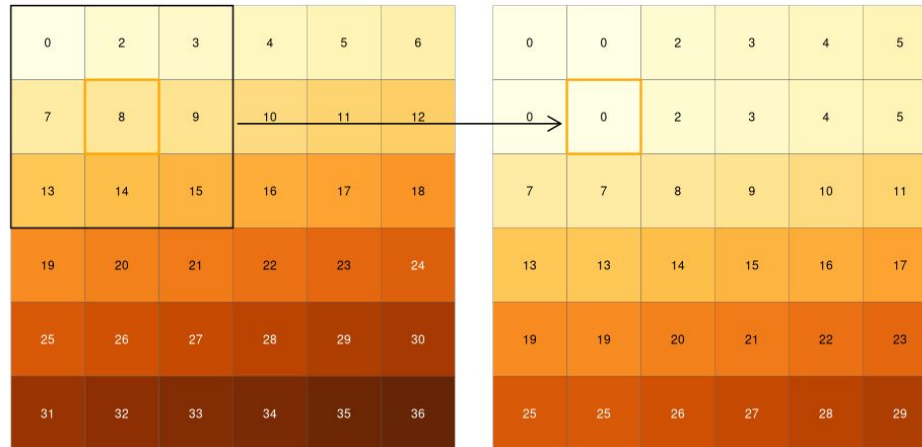
- **Focal**

- 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**

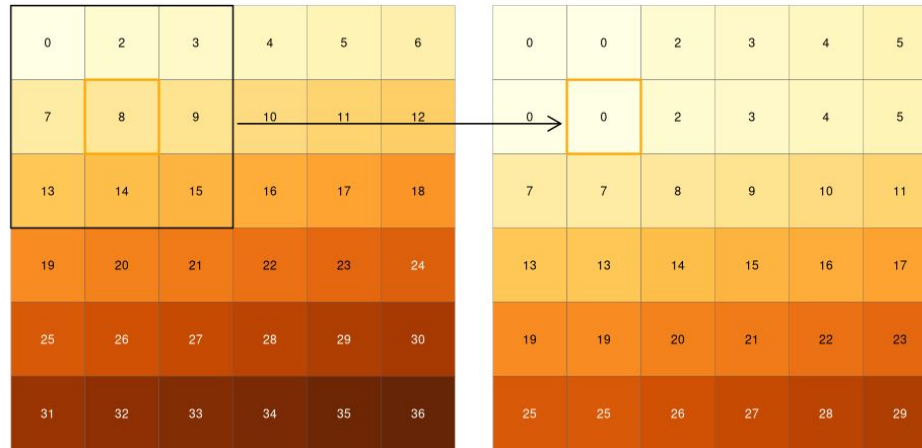
- Applies an aggregation function to all cells within a specified neighborhood, uses the corresponding output as the new value for the central cell, and moves on to the next central cell



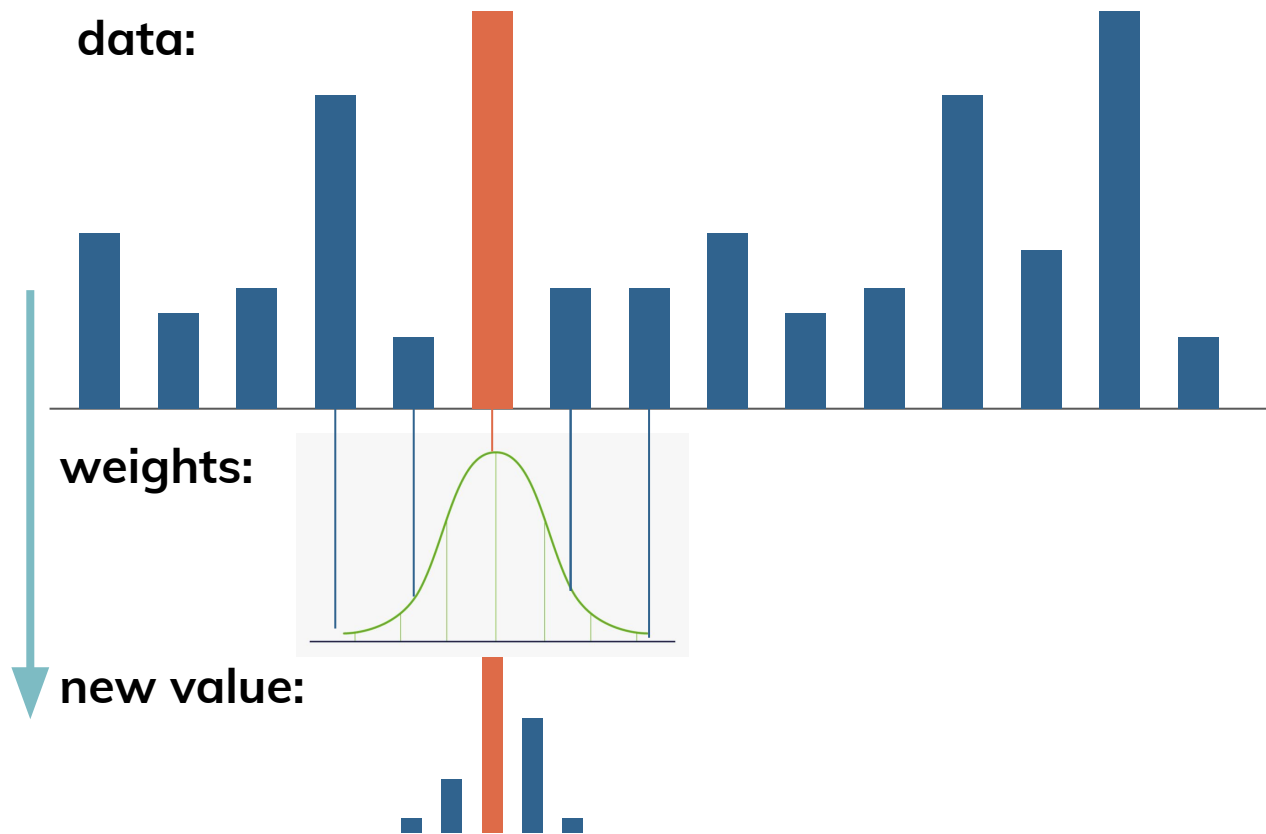
Map algebra

- **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

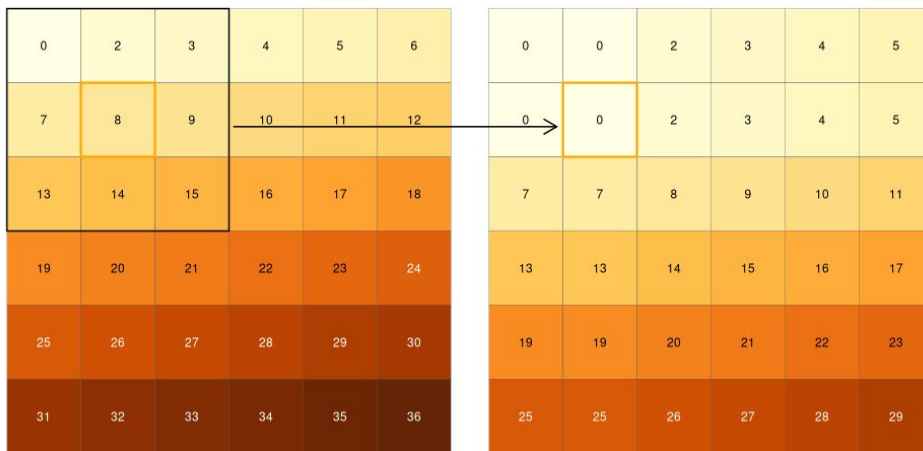


Map algebra

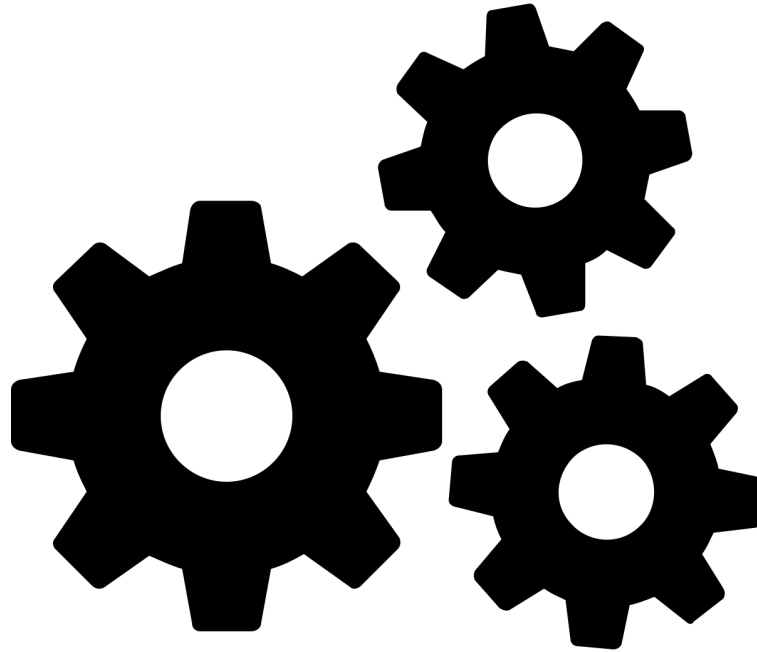
- **Focal**

- 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

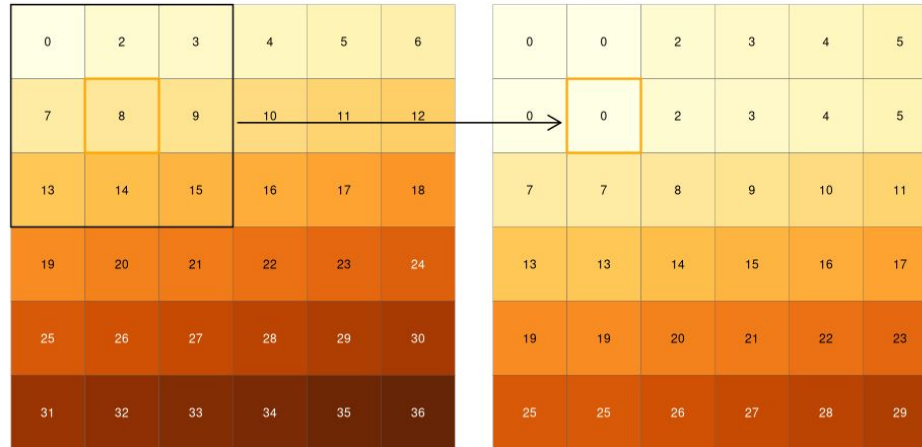
- **Zonal**

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

Map algebra

- **Zonal**

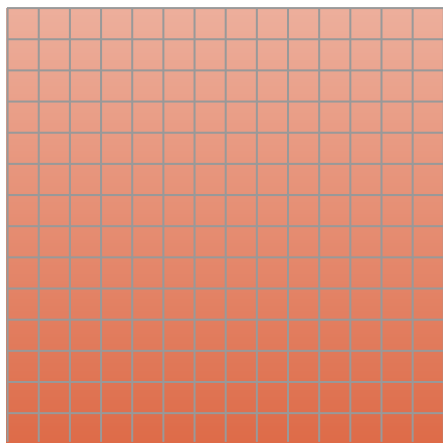
- Applies an aggregation function to multiple cells based on a grouping variable



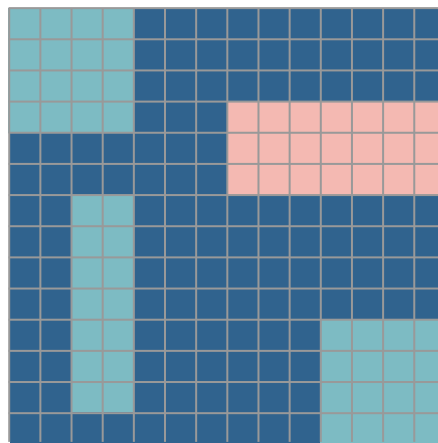
Map algebra

- **Zonal**

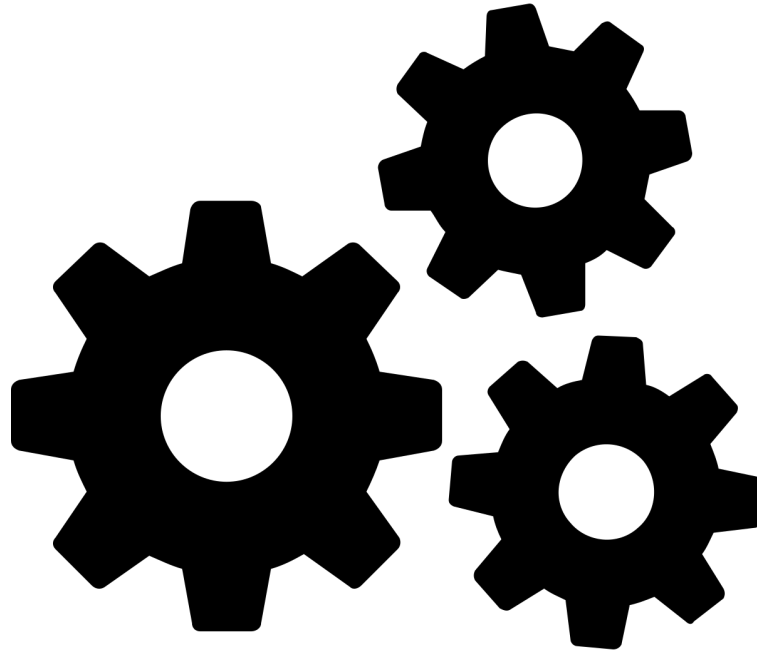
- Applies an aggregation function to multiple cells based on a grouping variable



“zones”



Switching gears...



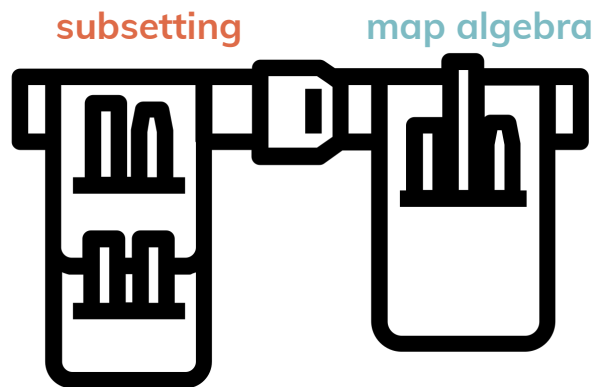
Map algebra

- Local
- Focal
- Zonal
- Global

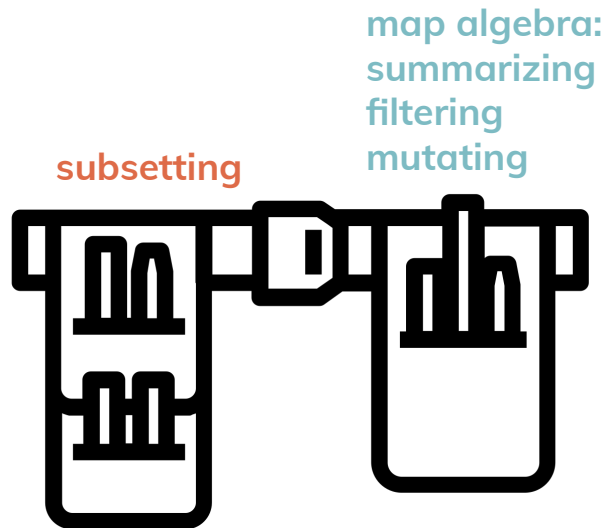


Scale or number of cells

Toolbelt for solving spatial problems



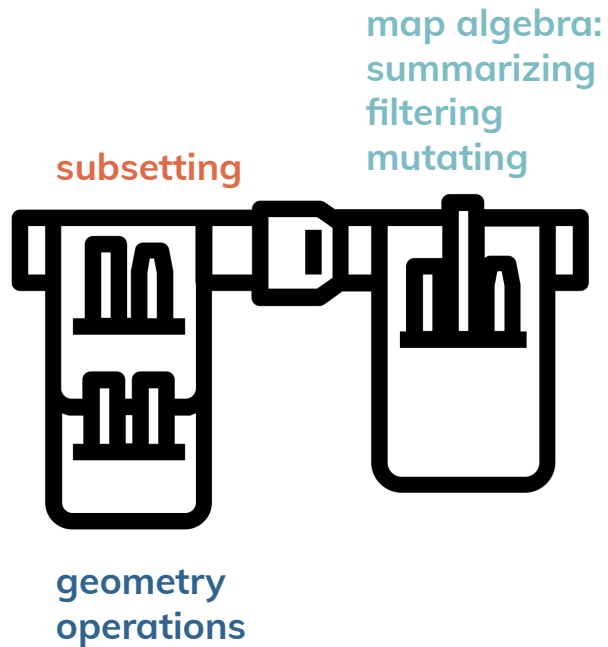
Toolbelt for solving spatial problems



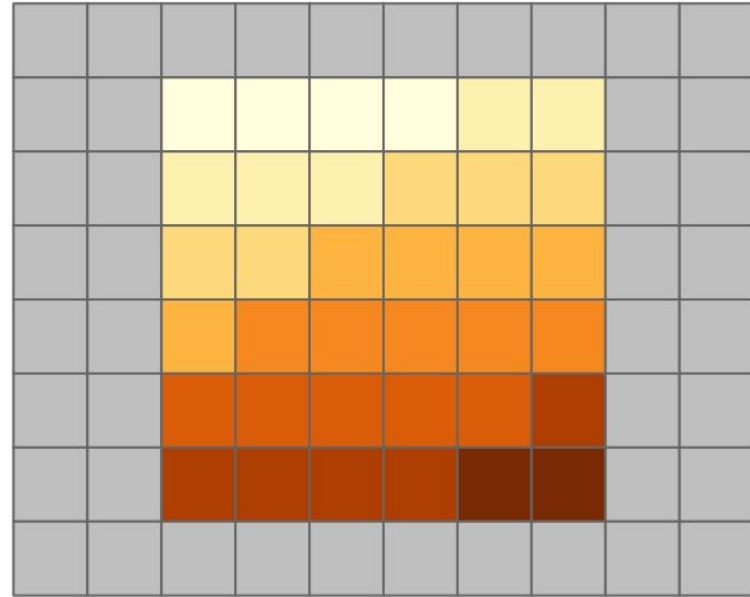
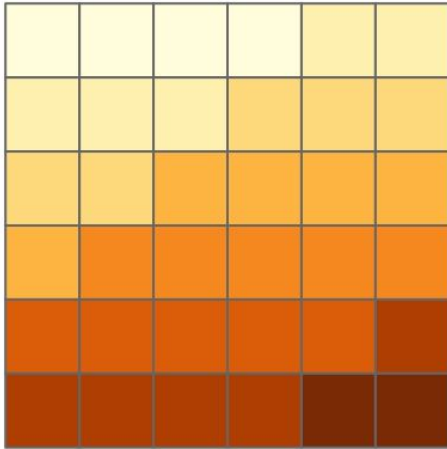
Raster data model

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

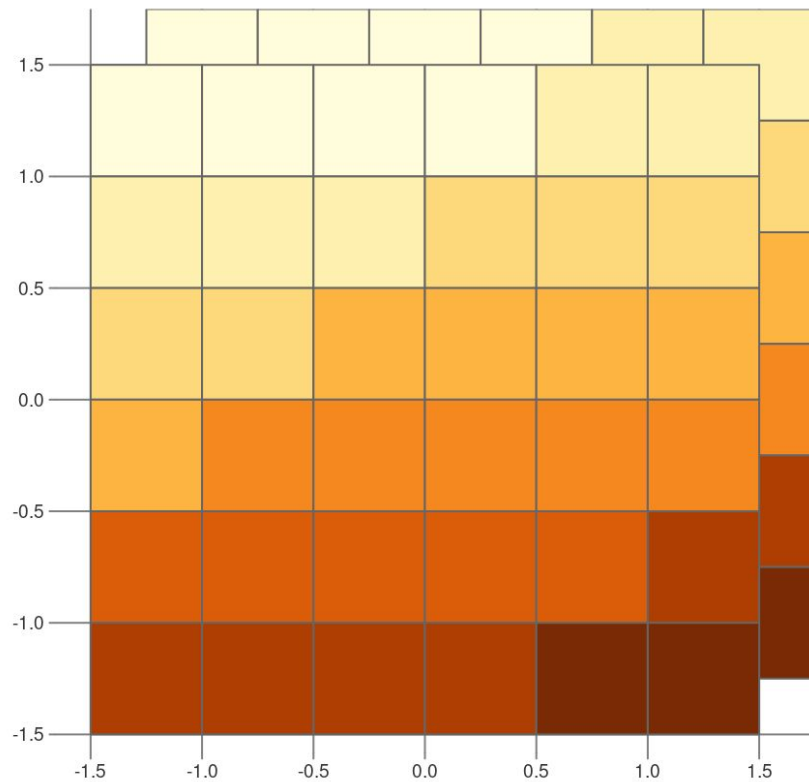
Toolbelt for solving spatial problems



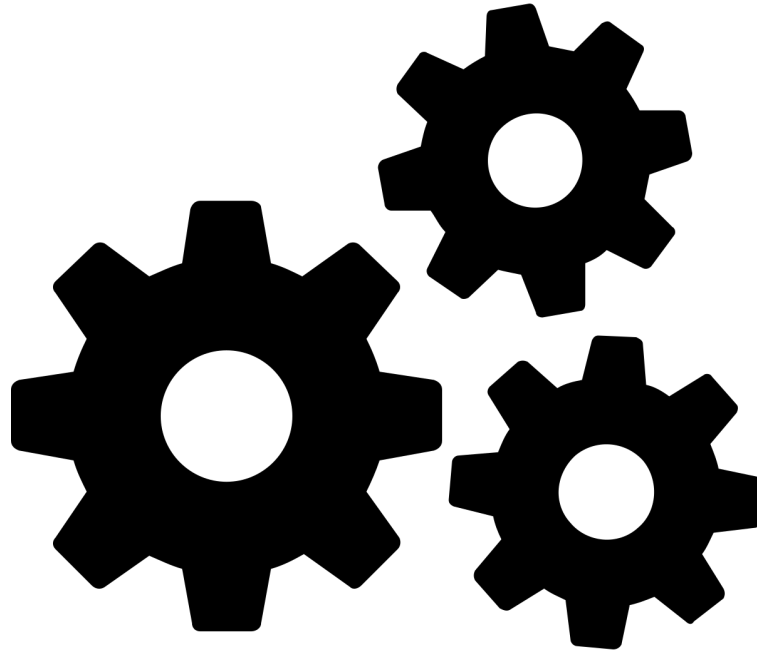
Changing extent and origin



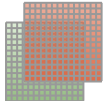
Changing extent and origin



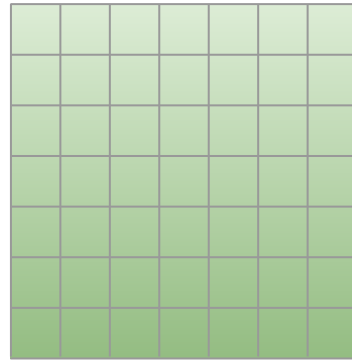
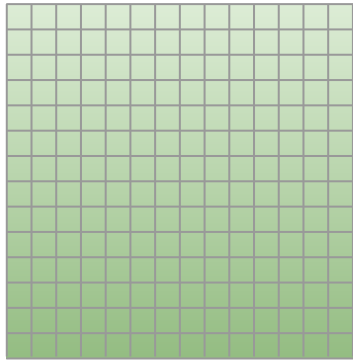
Switching gears...



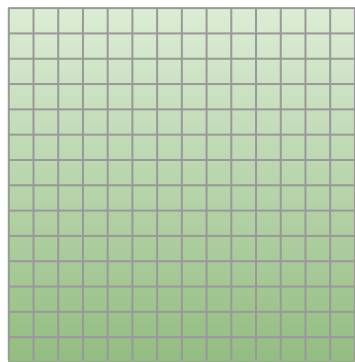
Raster data model

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

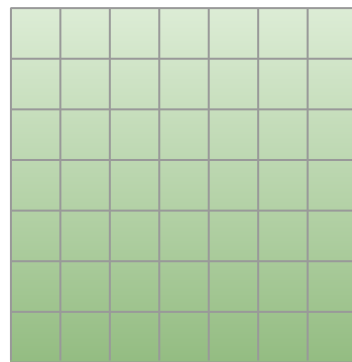
Changing resolution



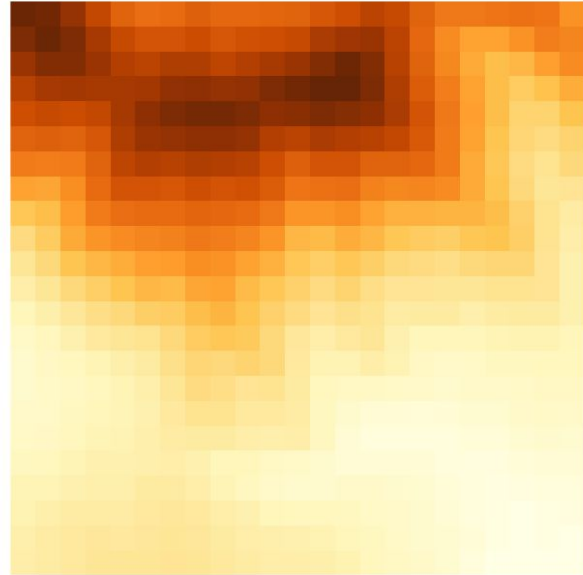
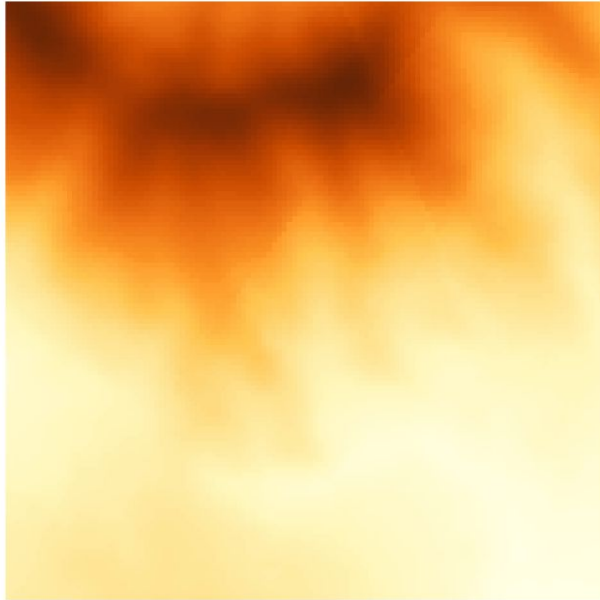
Changing resolution



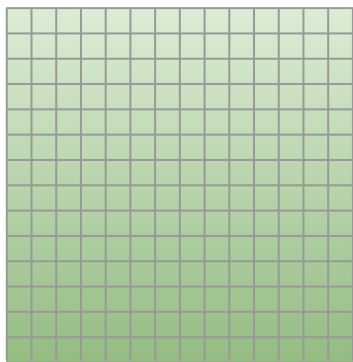
aggregating



Changing resolution



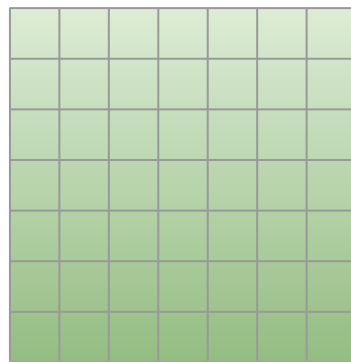
Changing resolution



aggregating



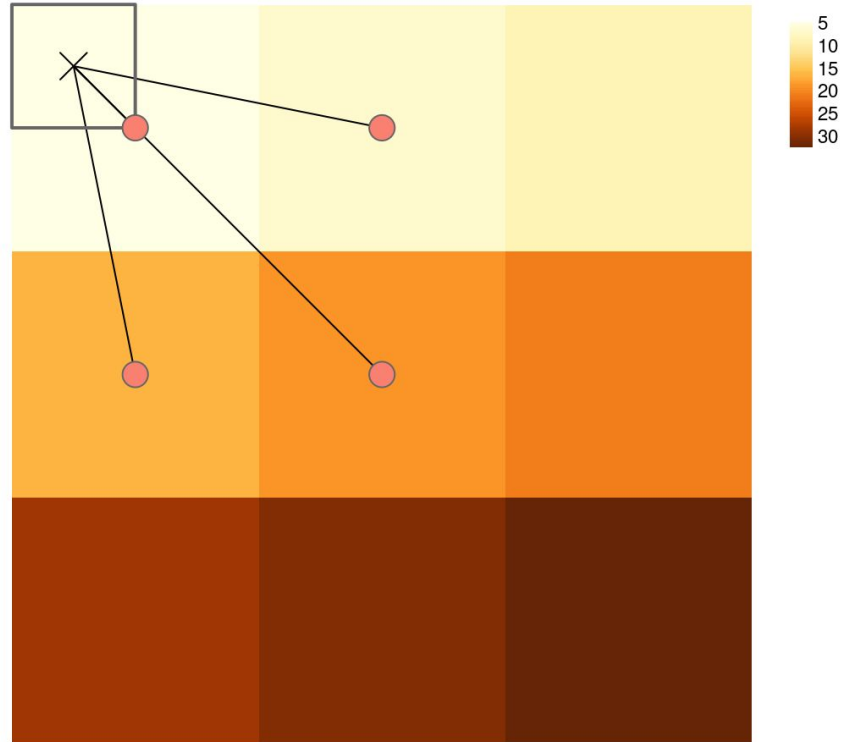
disaggregating



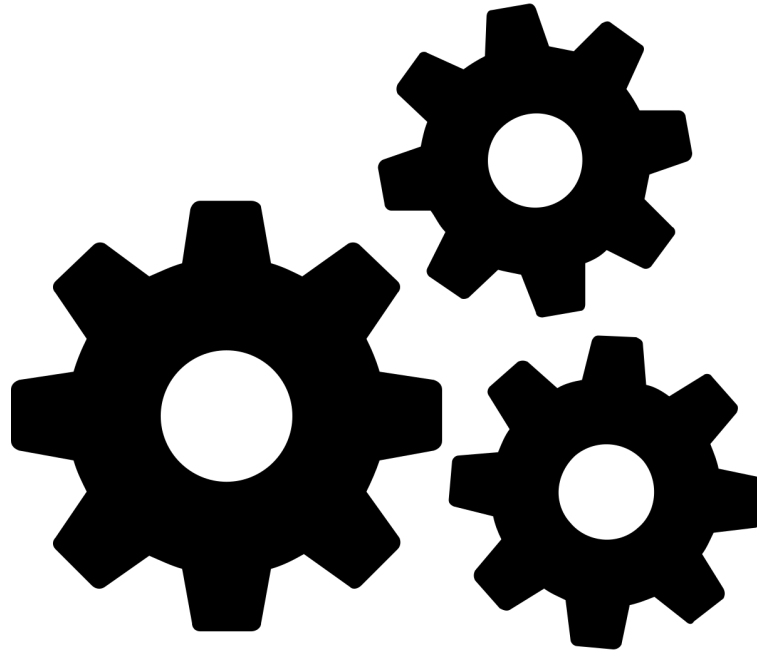
Changing resolution

Nearest neighbor

Bilinear interpolation

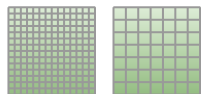


Switching gears...

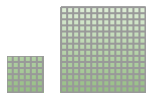


Raster data model

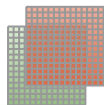
- **Resolution**



- **Extent**

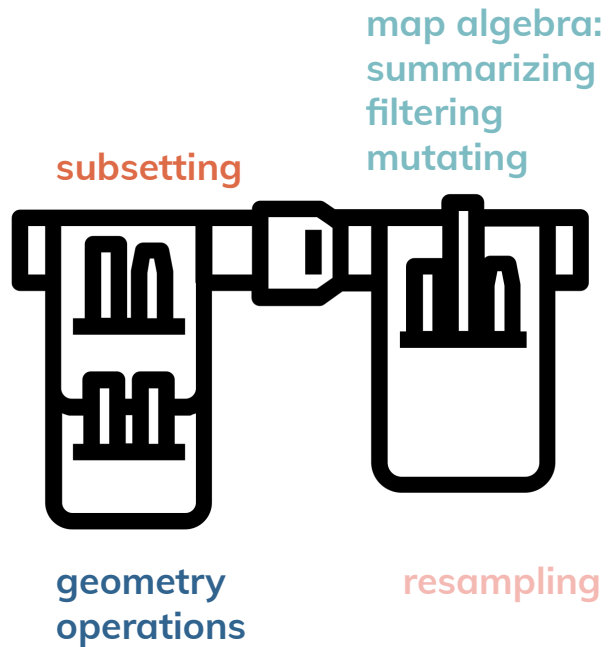


- **Position**

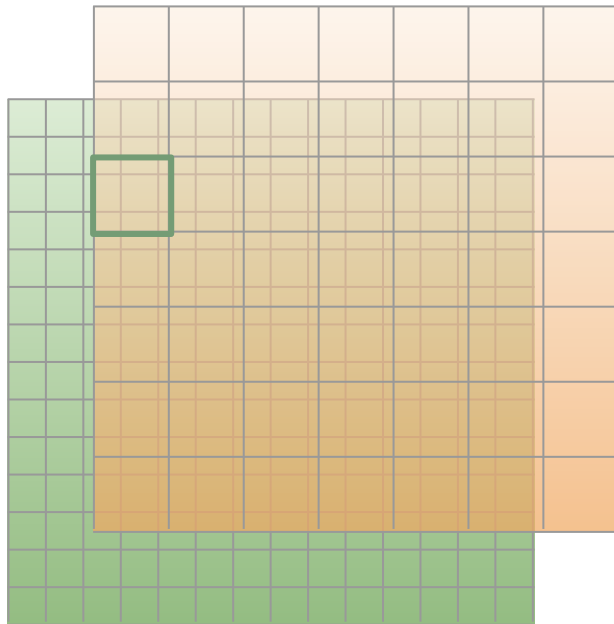


mismatch!

Toolbelt for solving spatial problems



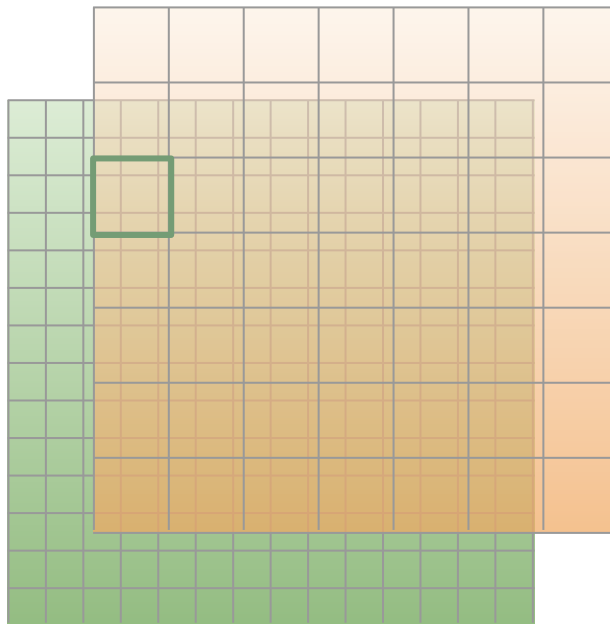
Resampling



Resampling

Nearest neighbor

Bilinear interpolation



Switching gears...

