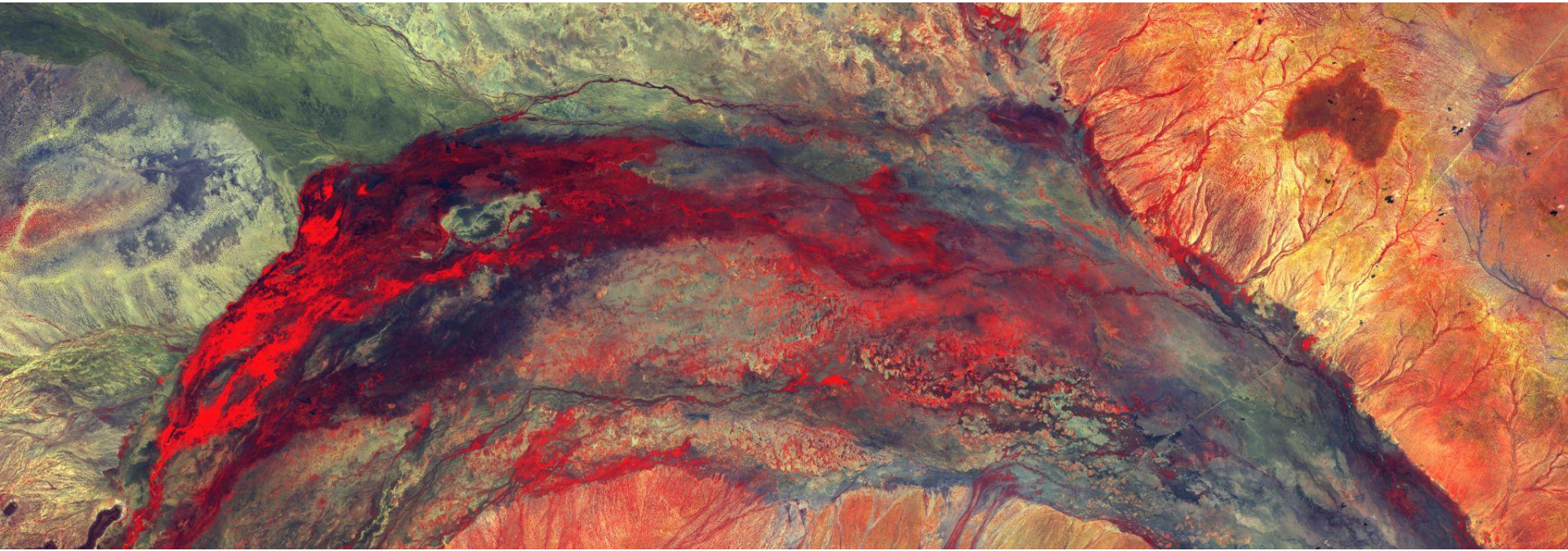
EDS 223: Geospatial Analysis & Remote Sensing
Week 3



USGS via Unsplash

Welcome!

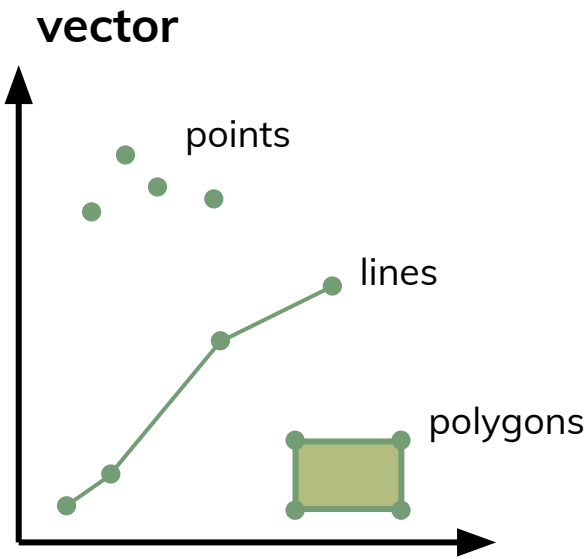
- **Week 2 recap**
- **Building a spatial analysis workflow**
  - Subsetting
  - Aggregating
  - Summarizing
  - Simplifying

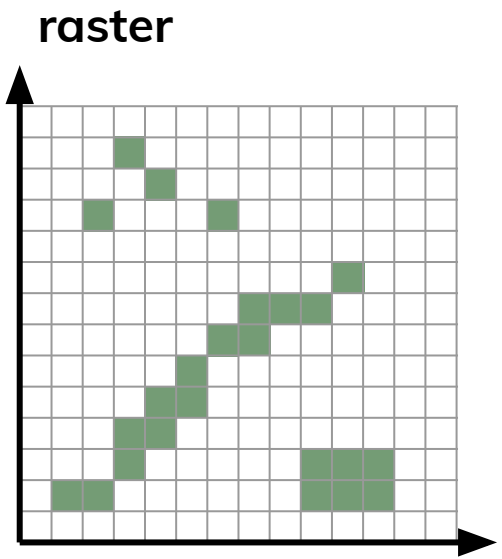
How to get unstuck

Start here

Resource	Steps
Yourself	• Review the lecture/lab/discussion materials • Review the background reading • Google!
Your peers	• Talk to a friend • Ask the #eds-223-geospatial Slack channel
TA	• Ask questions in discussion section • Attend office hours • Send a message over Slack
Instructor	• Attend office hours • Send a message over Slack

Spatial data models





discrete

continuous

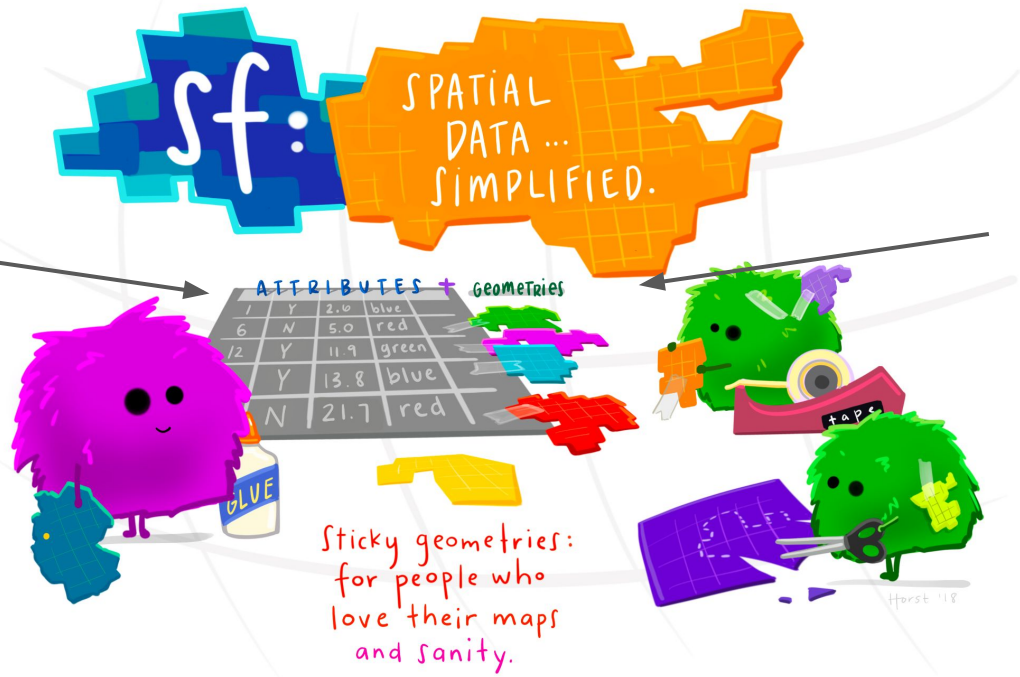
geometries

Modified from: GIS Fundamentals, Paul Bolstad

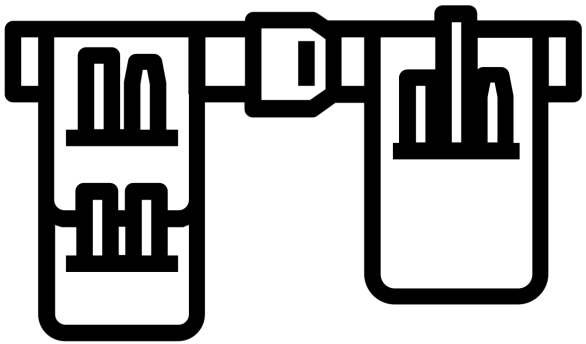
Simple features: **sf**

Data frame

Geometries??

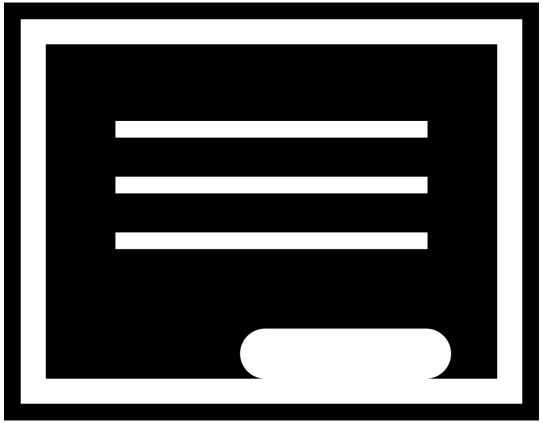


Toolbelt for solving spatial problems



Toolbelt for solving spatial problems

There is a group of 10 people who are ordering pizza. If each person gets 2 slices and each pizza has 4 slices, how many pizzas should they order?



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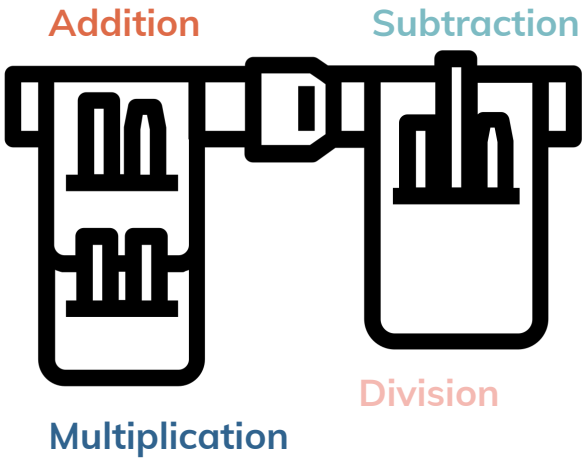
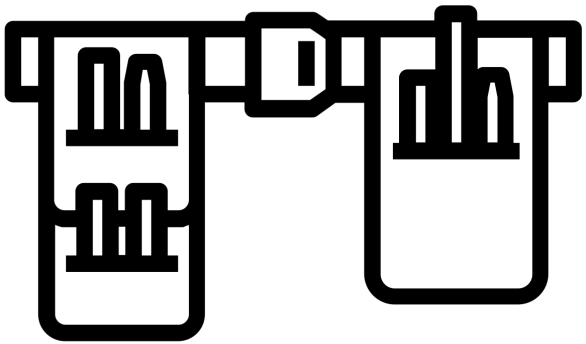


Toolbelt for solving spatial problems

What is the life expectancy of the country in Asia with the highest population density?



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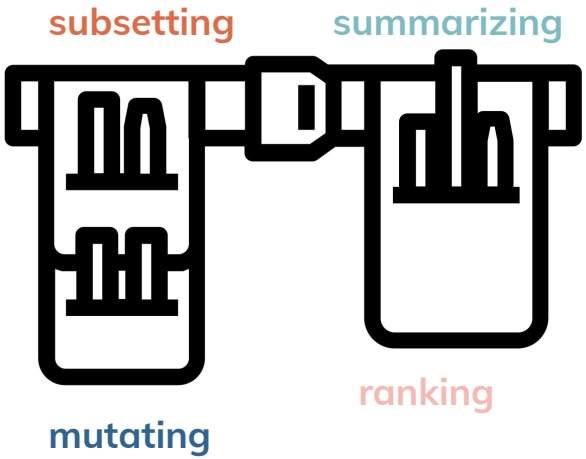

New tools for a new data type

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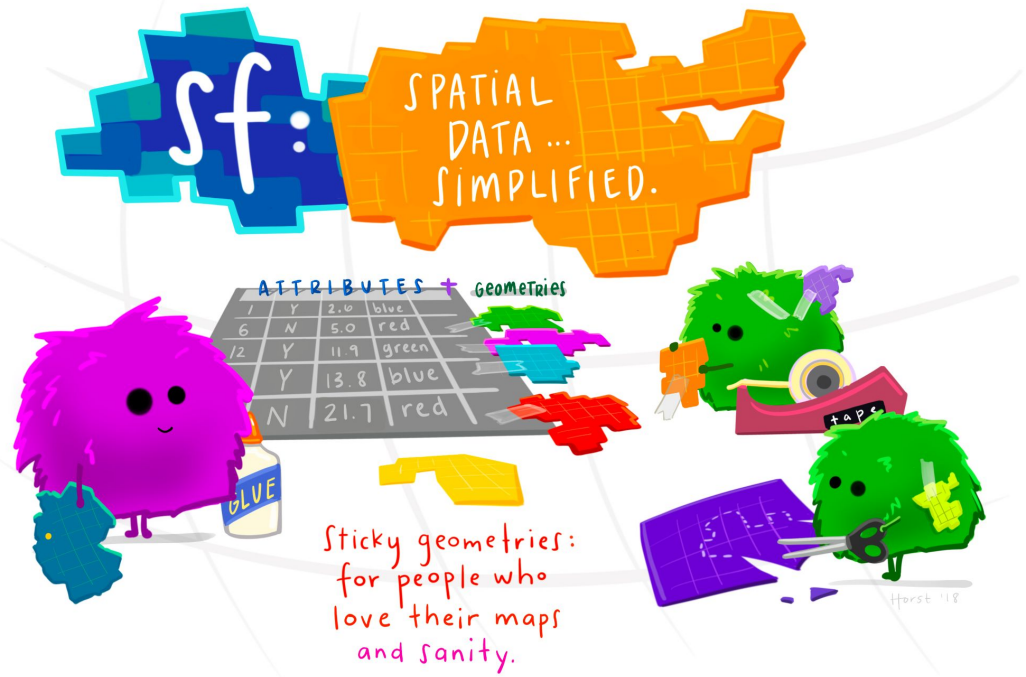

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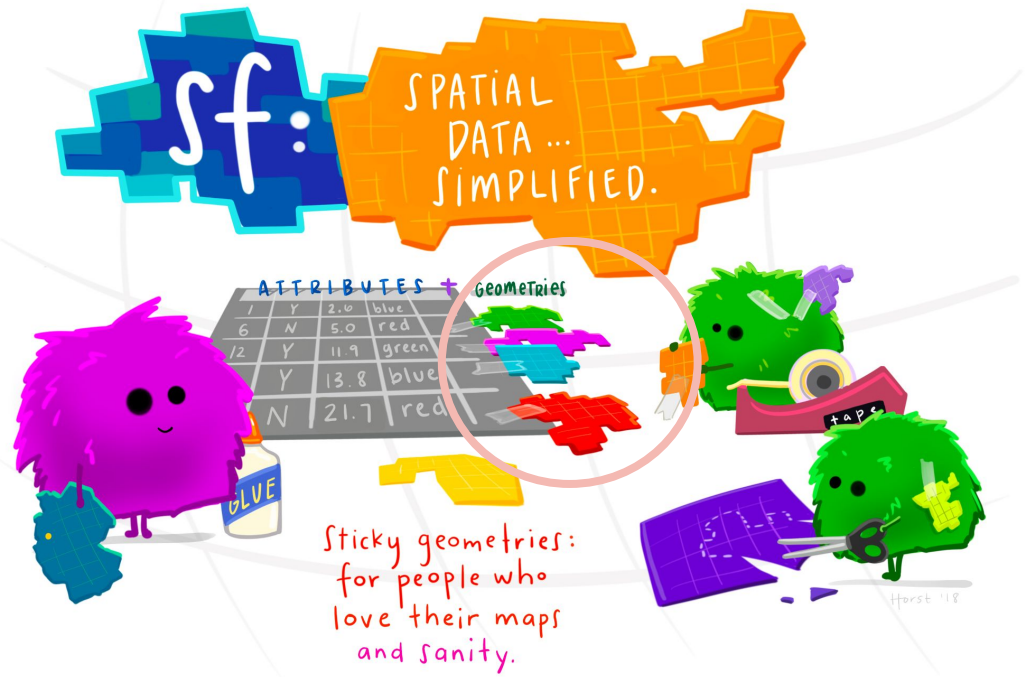

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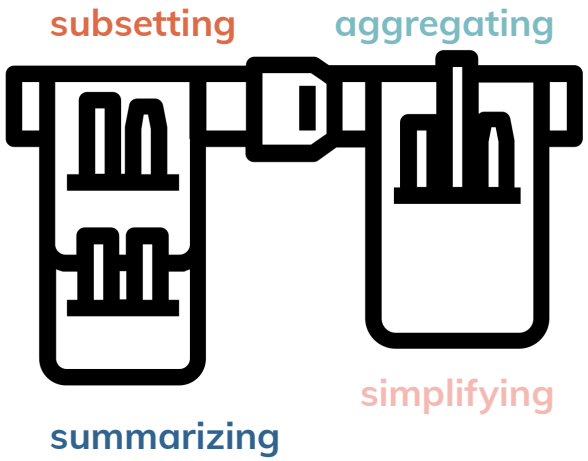
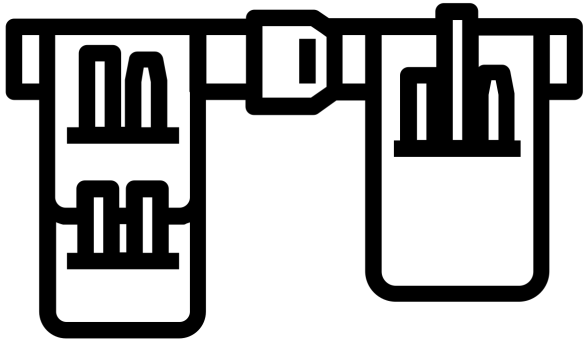


Toolbelt for solving spatial problems

subsetting



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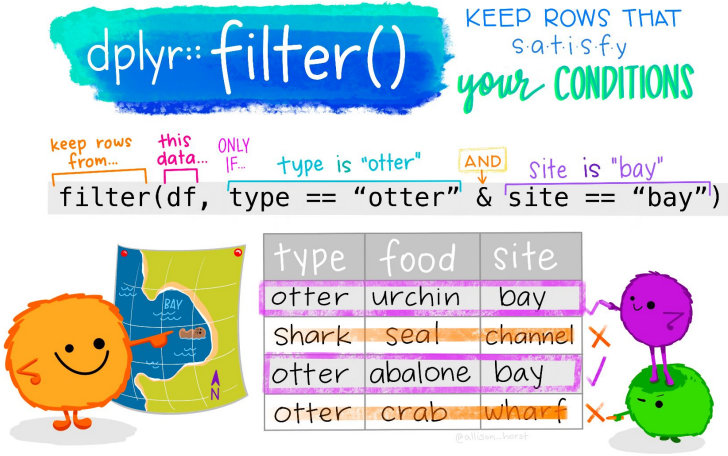

New tools for a new data type

How many mountains over 14K feet are in the United States?

New tools for a new data type

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Name	Country	Latitude, longitude
Machu Picchu	Peru	13.163°S, 72.545°W
...		...

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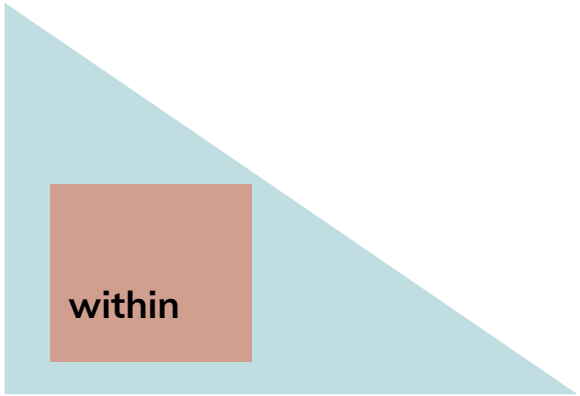
Geometry!

Topological relationships

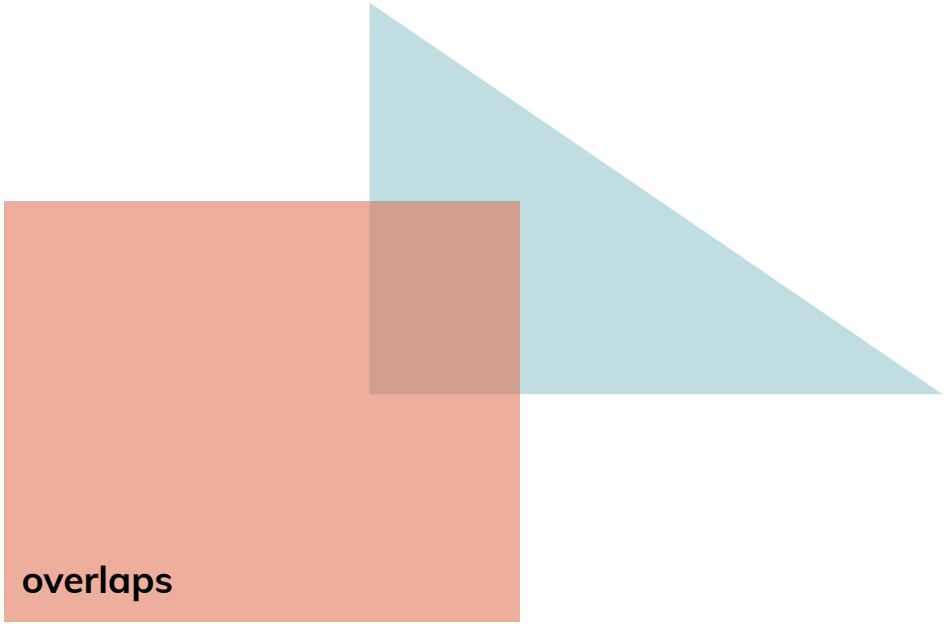
Topological relationships

Topological relationships

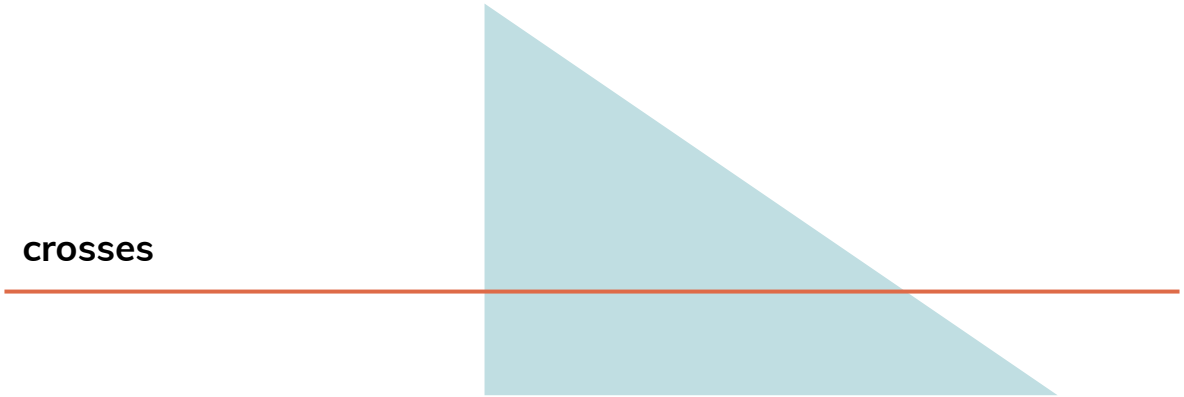
Topological relationships



Topological relationships



Topological relationships



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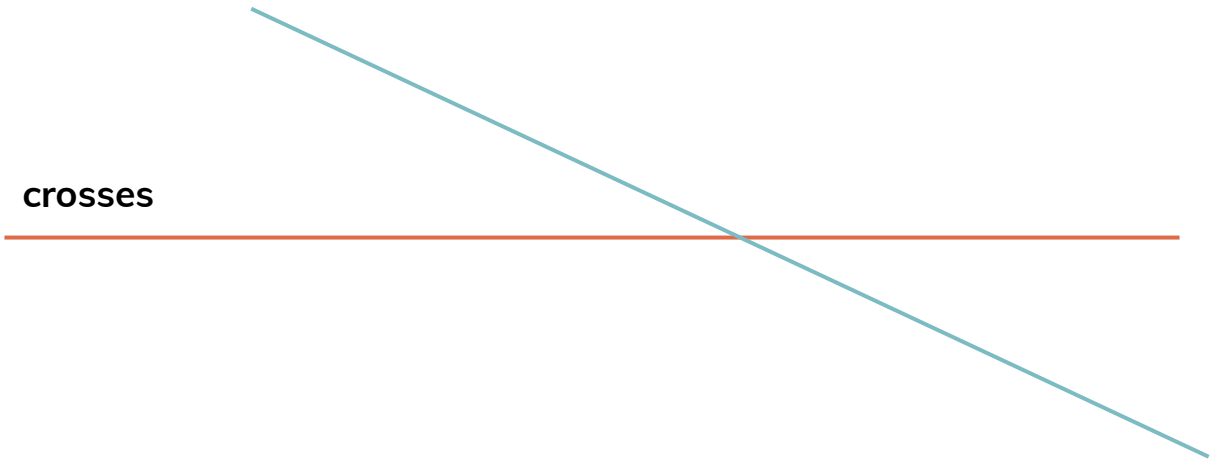
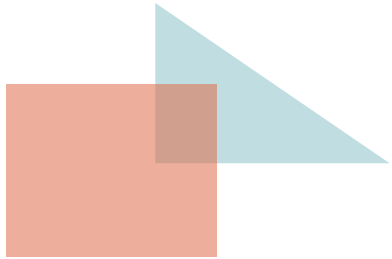


Topological relationships

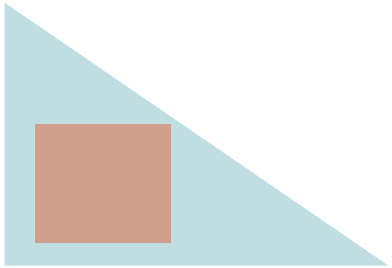
touches

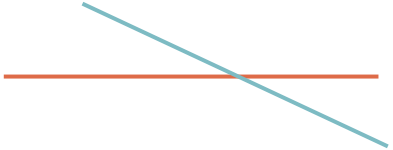
overlaps



crosses

within



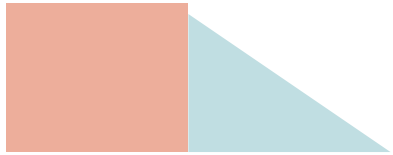


Topological relationships

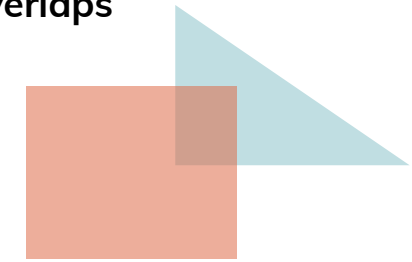
intersects

Yes or No

touches



overlaps



crosses

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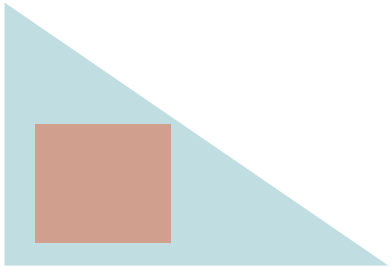
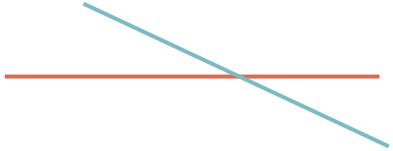




Topological relationships

disjoint

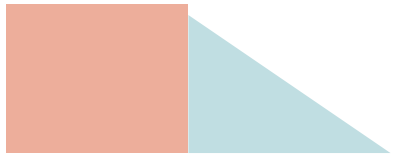
Yes or No

Topological relationships

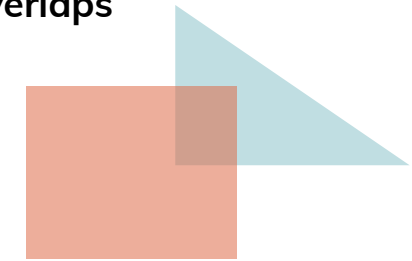
intersects

Yes or No

touches



overlaps



crosses

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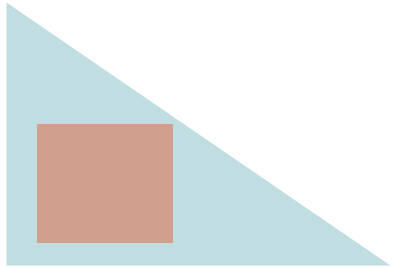
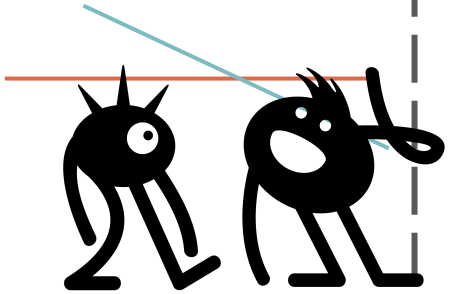
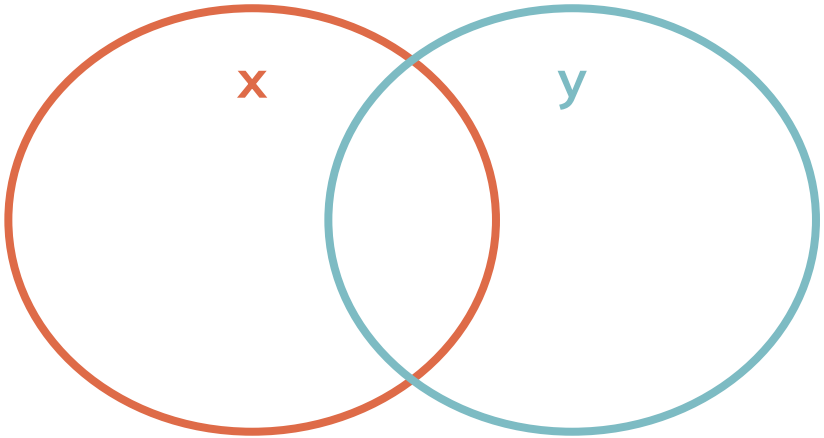




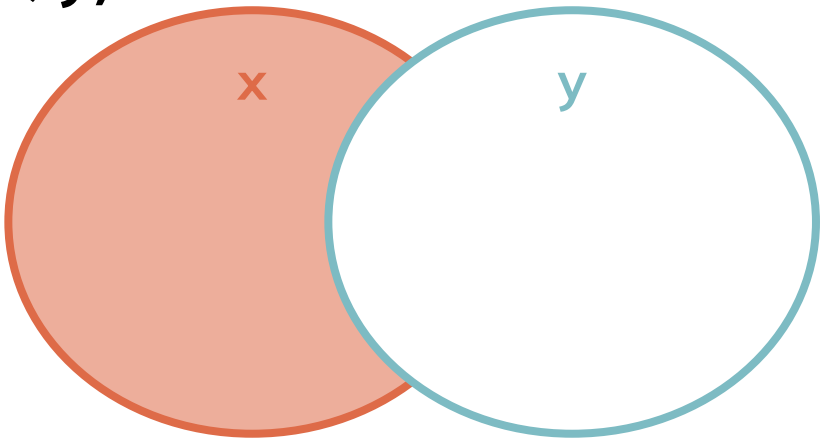
Topological relationships

Topological relationships: clipping



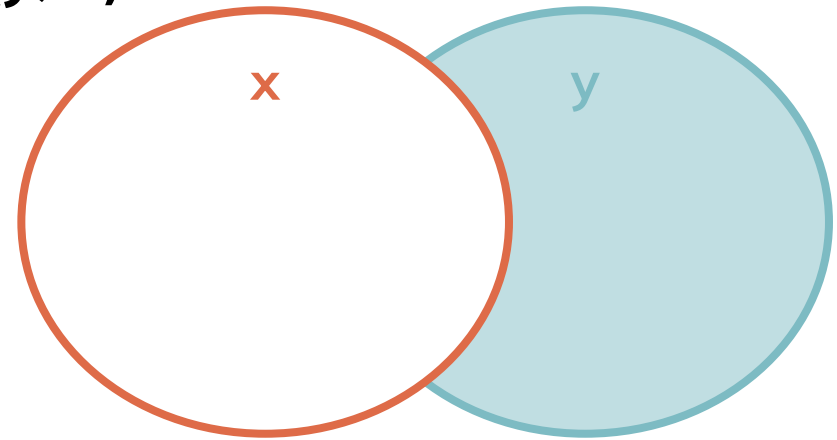
Topological relationships: clipping

difference (x, y)



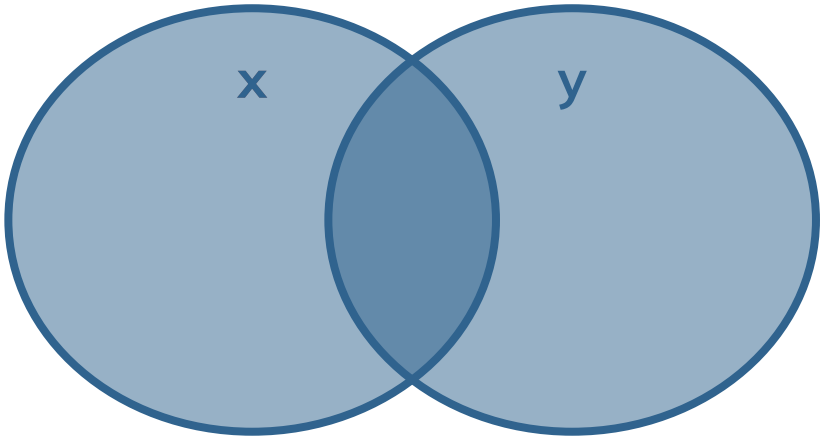
Topological relationships: clipping

difference (y, x)



Topological relationships: clipping

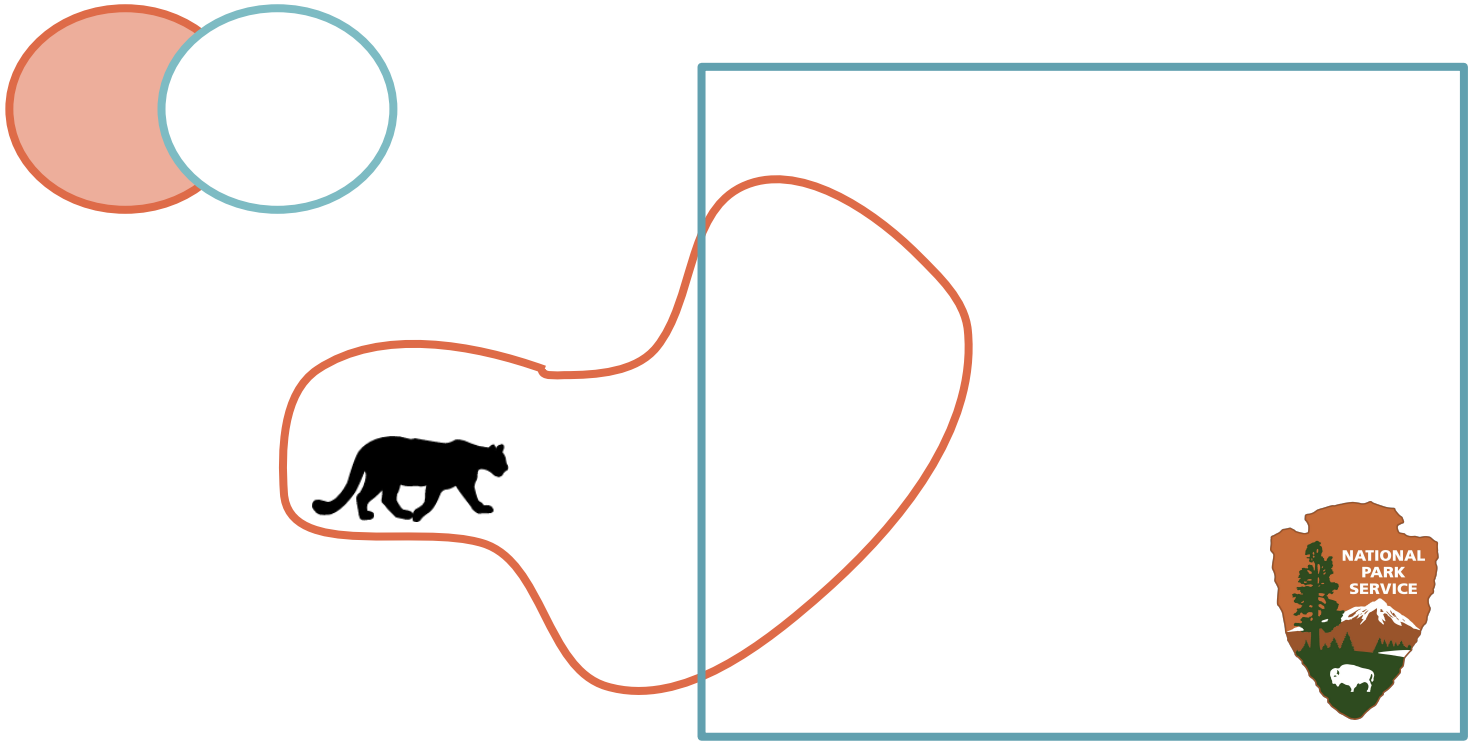
union



Topological relationships

What proportion of a species' range is unprotected?

Topological relationships

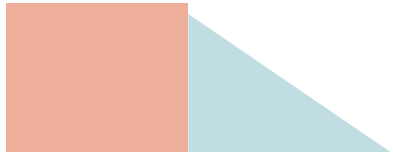


Topological relationships

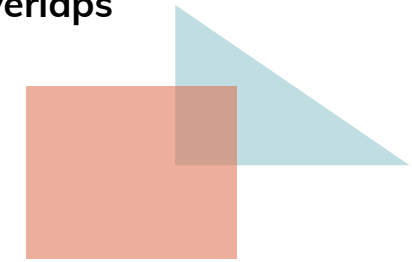
intersects

Yes or No

touches

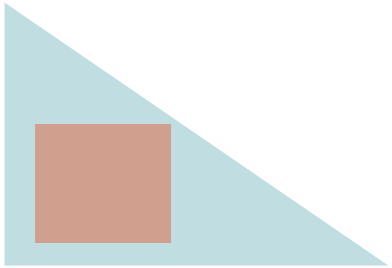


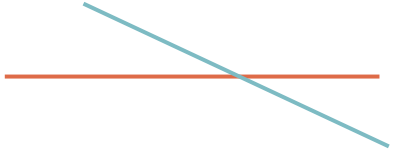
overlaps



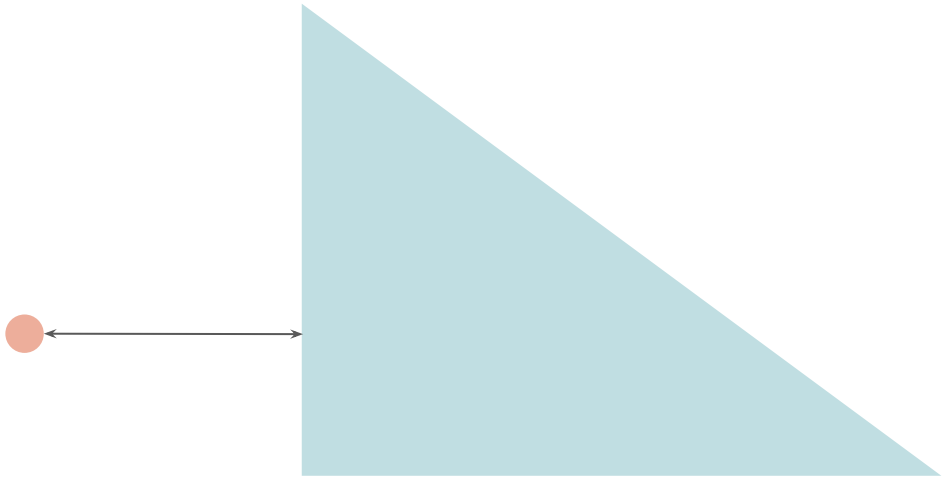
crosses

within

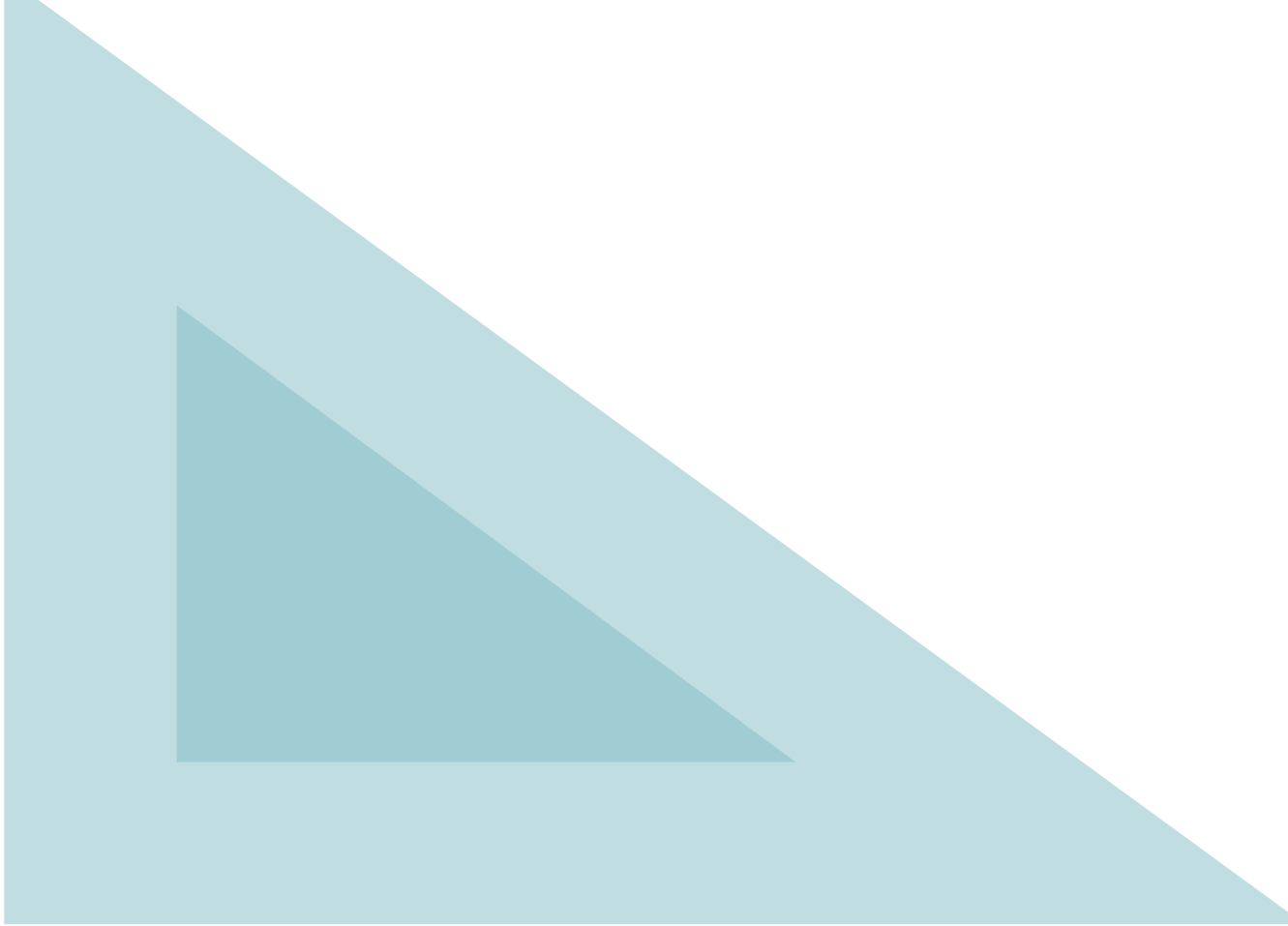




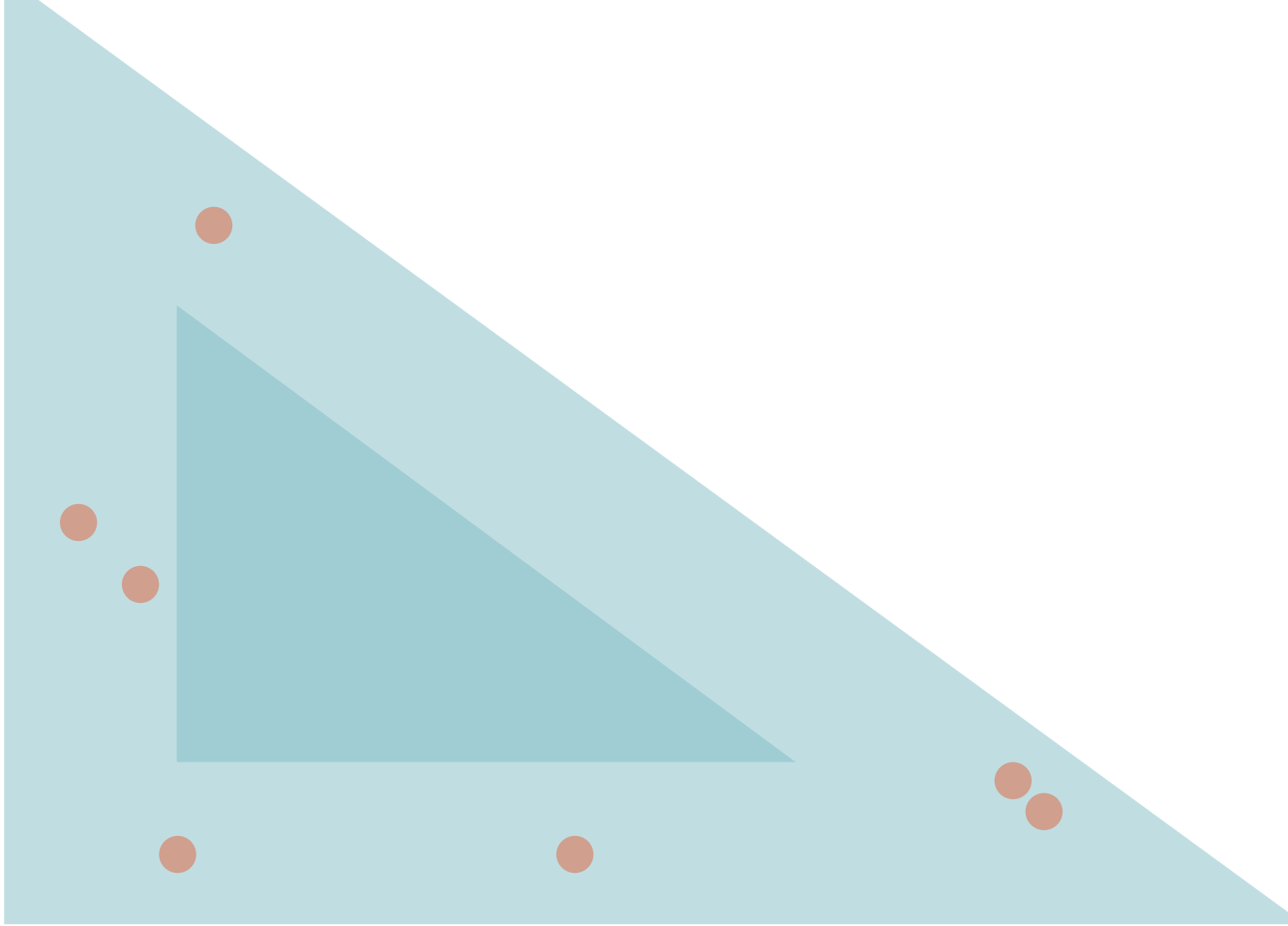
Topological relationships



Buffers



Buffers



Buffers

How many people live within walking distance of a grocery store?

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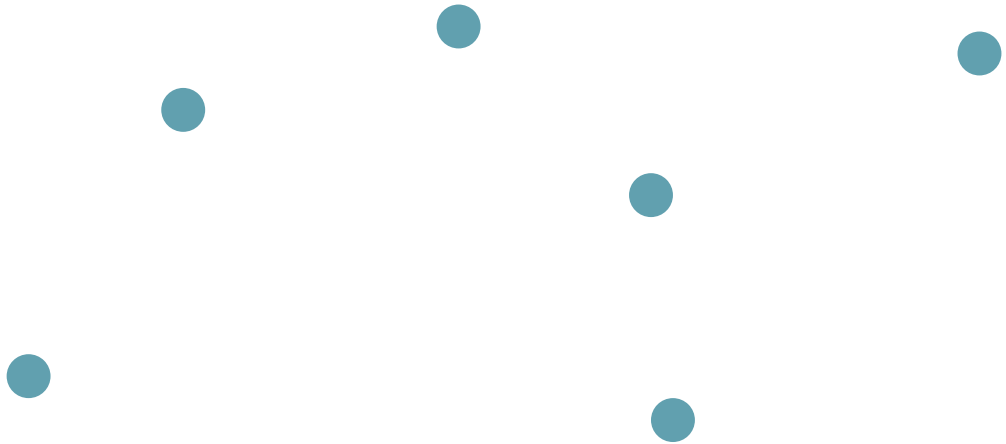

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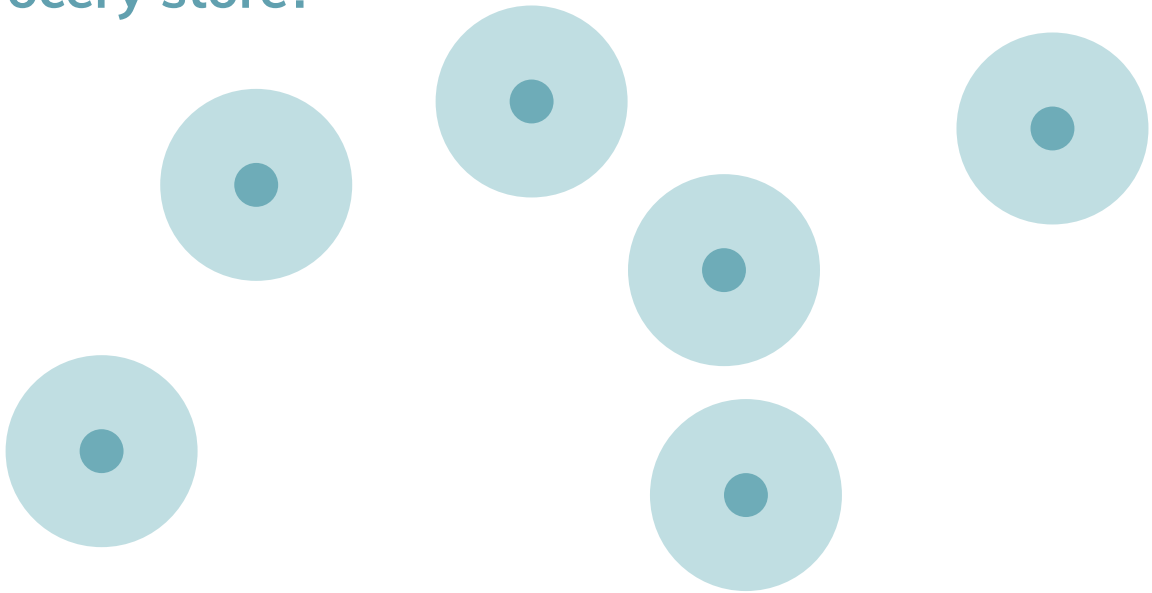

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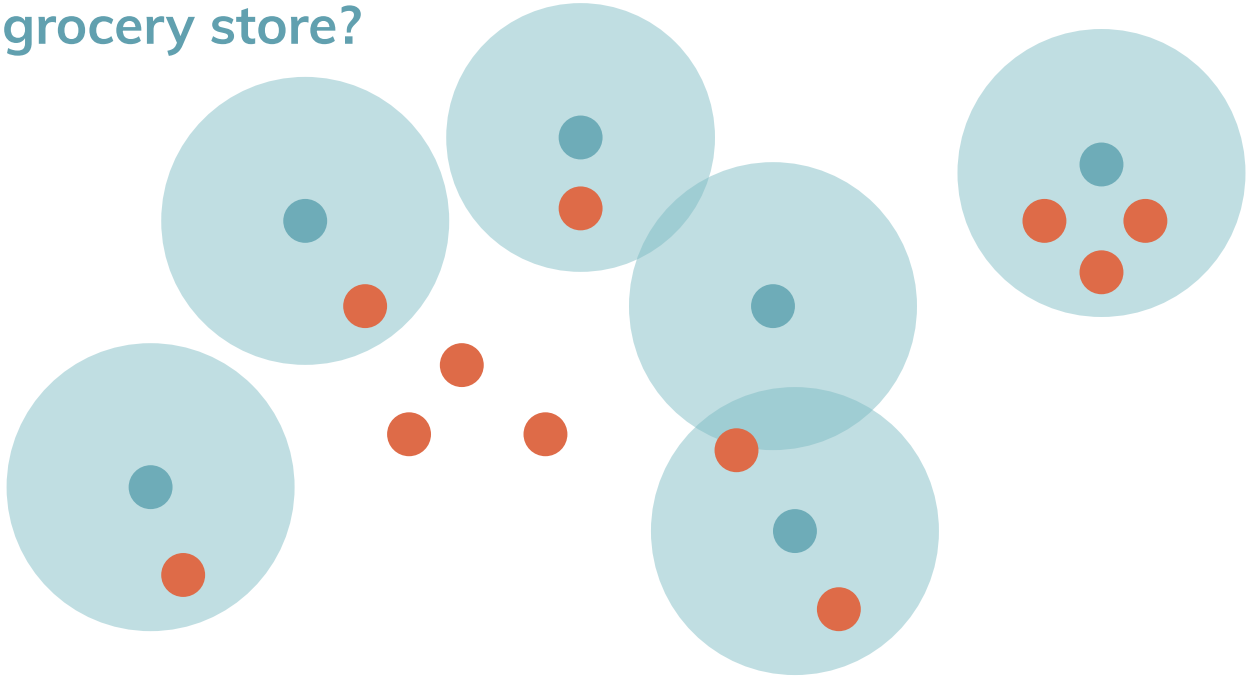

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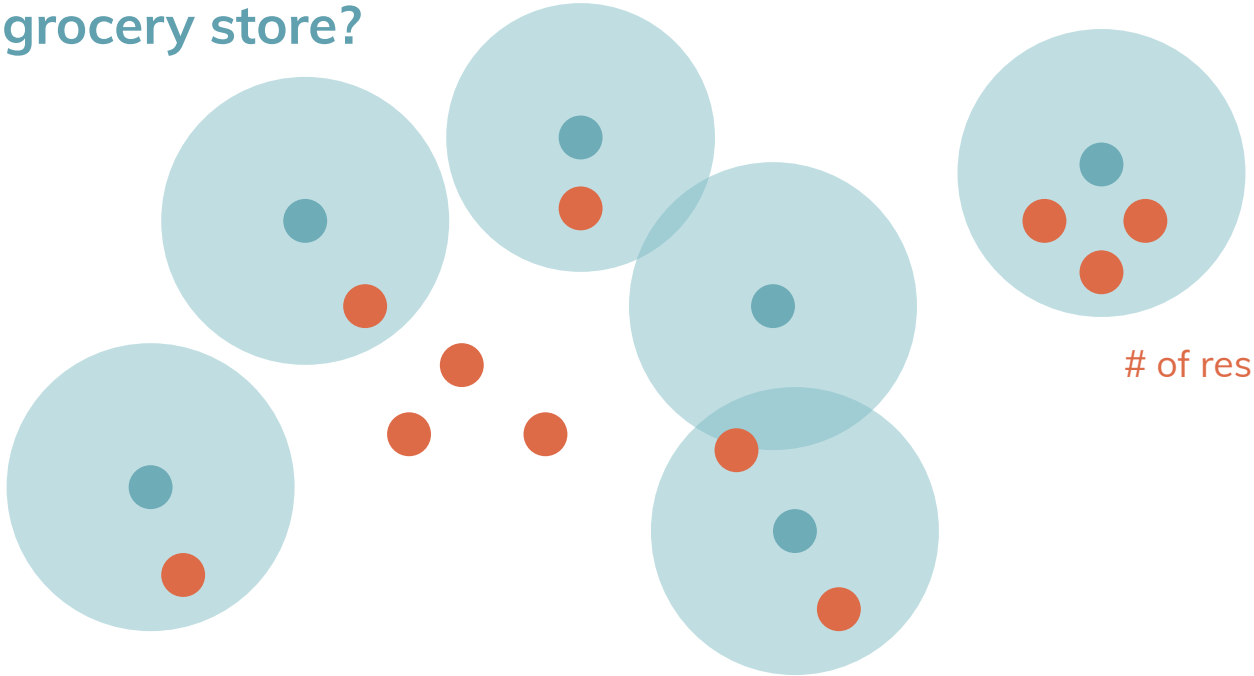
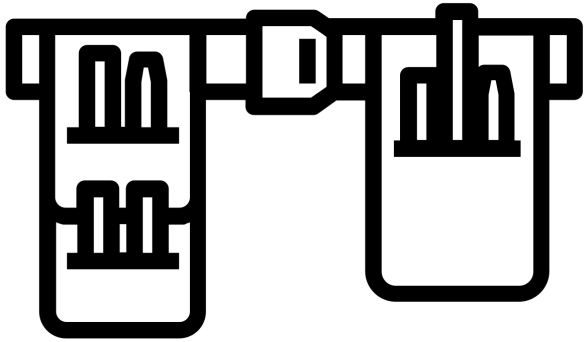


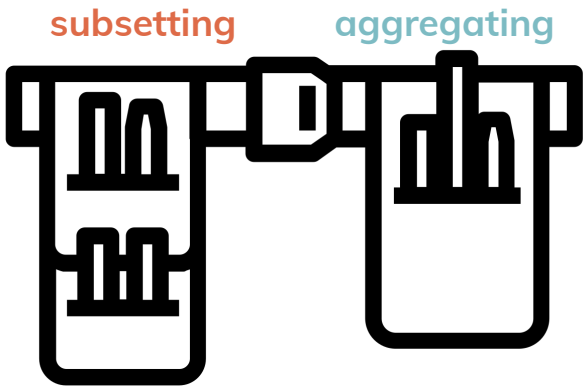
# of residents

Toolbelt for solving spatial problems

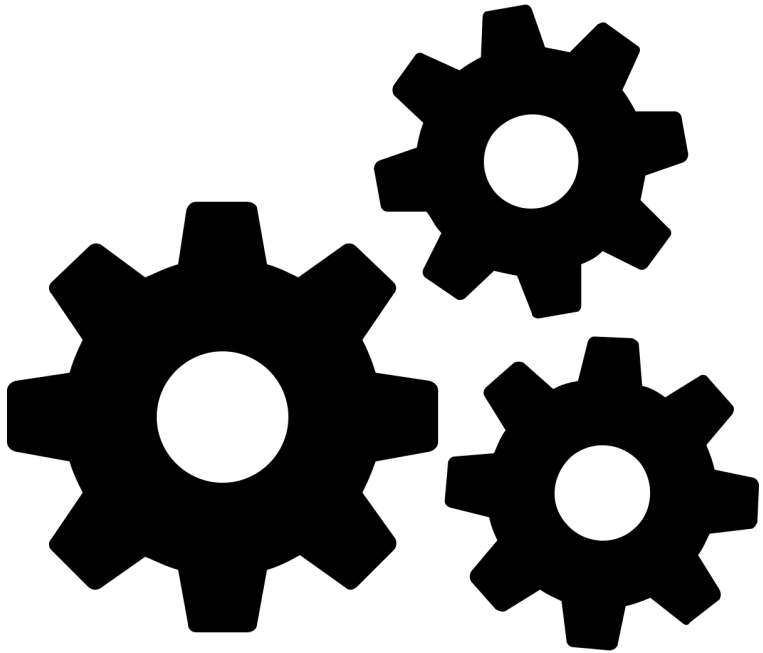
subsetting



Toolbelt for solving spatial problems



Switching gears...



Aggregation

Which continent has the highest population?

Aggregation

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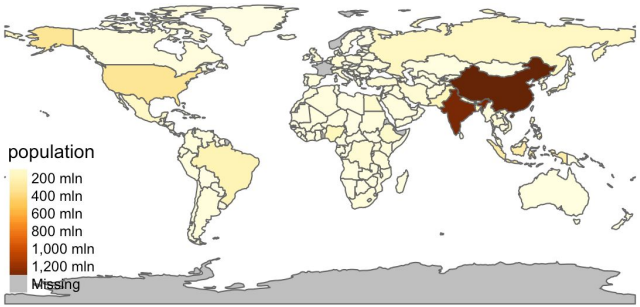
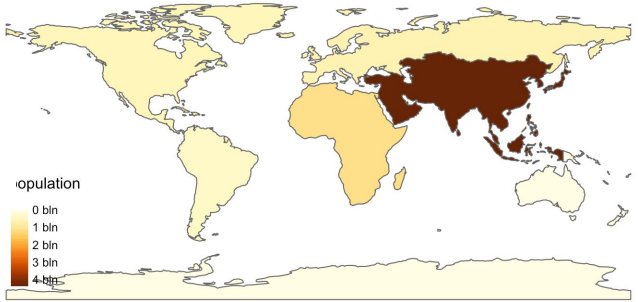


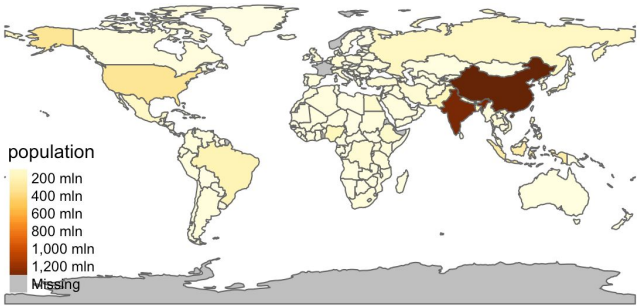

```
continents <- world %>%
  group_by(continent) %>%
  summarise(population = sum(pop, na.rm = TRUE))
```

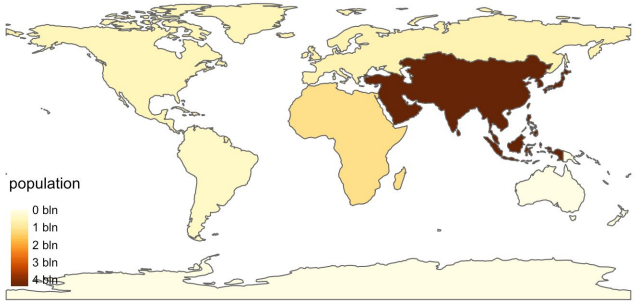


Country	Continent
USA	North America
...	...

Aggregation

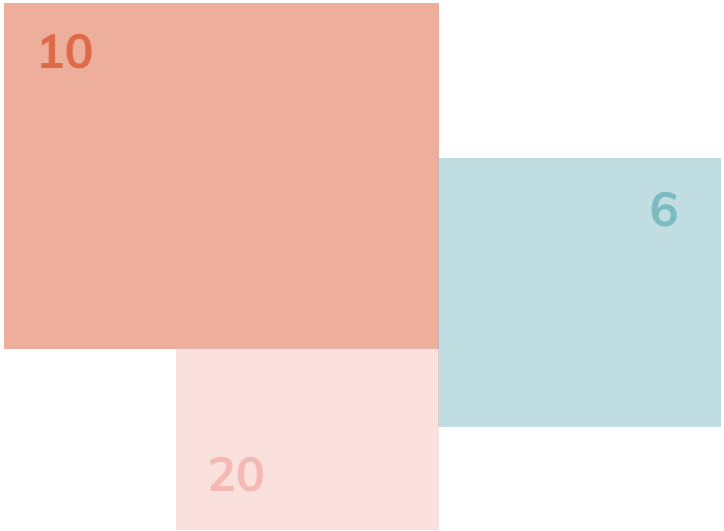
Which continent has the highest population?



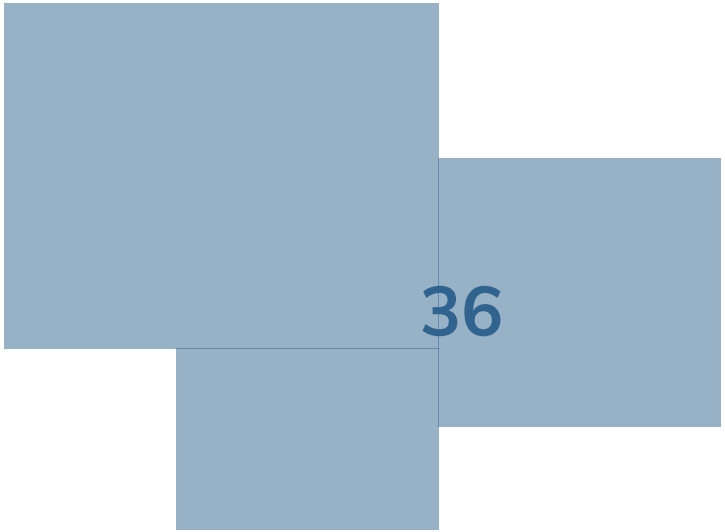


Country	Continent
USA	North America
...	...

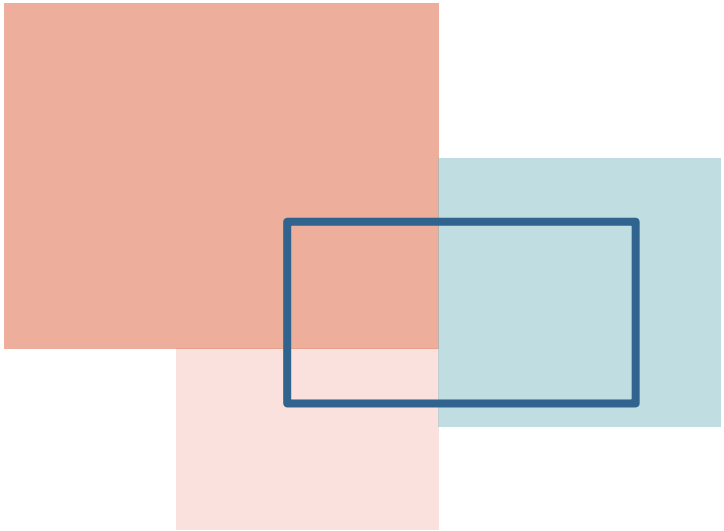
Geometry unions



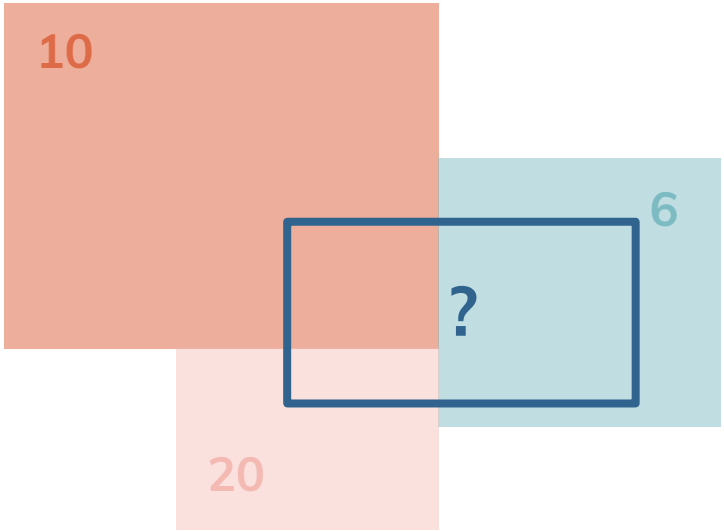
Geometry unions



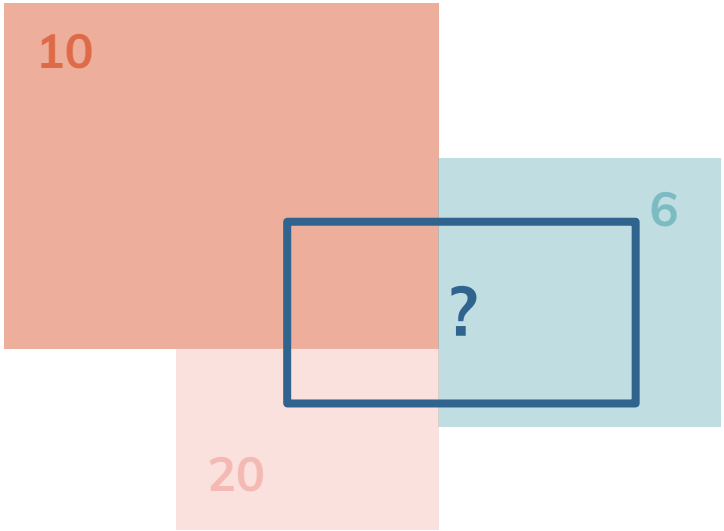
Geometry unions



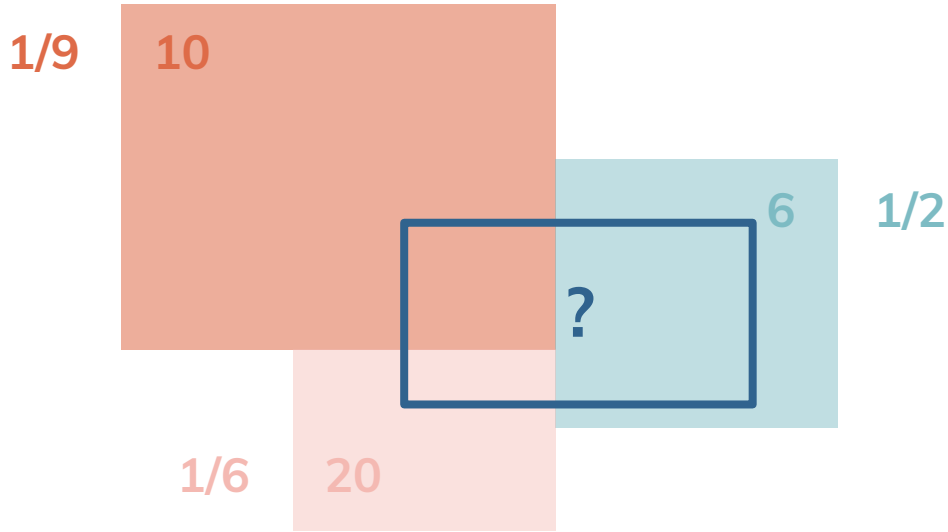
Geometry unions



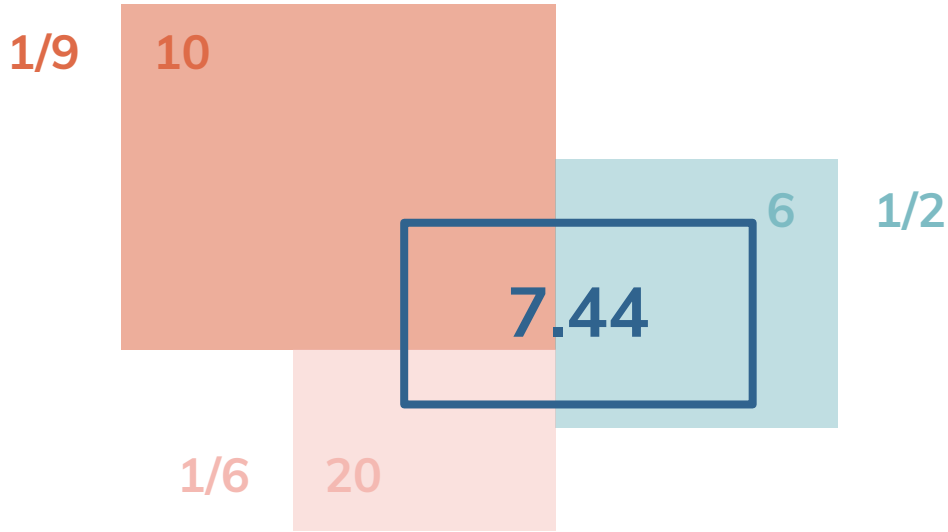
Geometry unions



Geometry unions: area-weighted interpolation

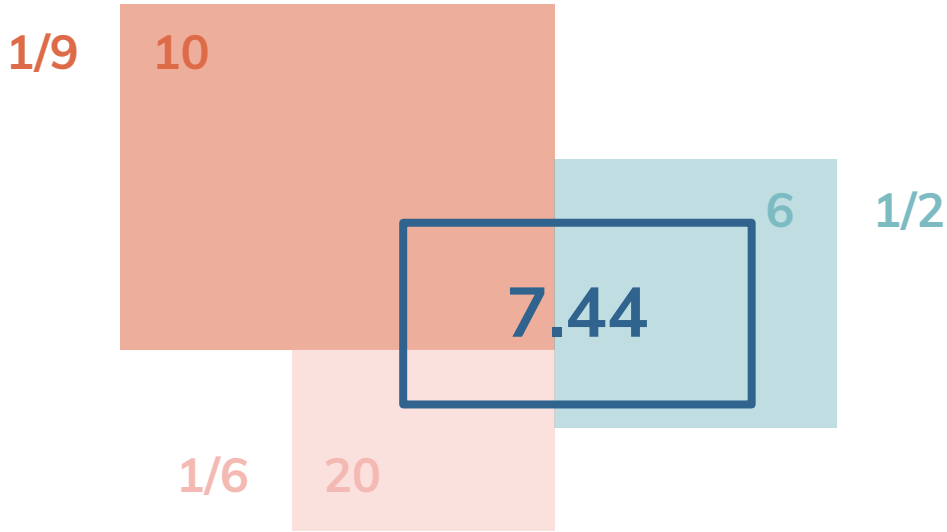


Geometry unions: area-weighted interpolation

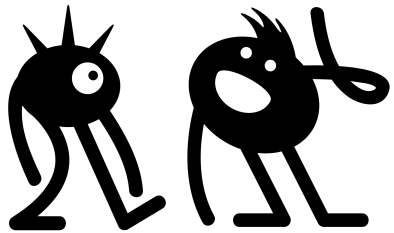


$$1/9(10) + ½(6) + ⅙(20) = 7.44$$

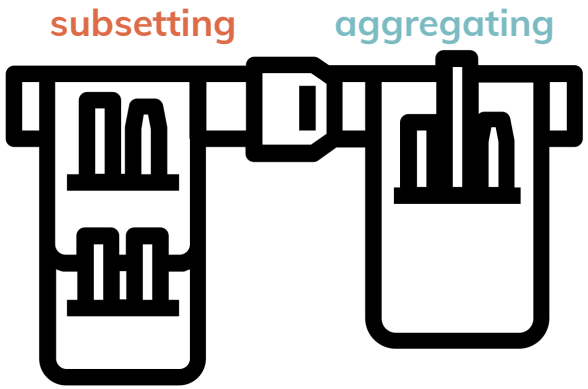
Geometry unions: area-weighted interpolation



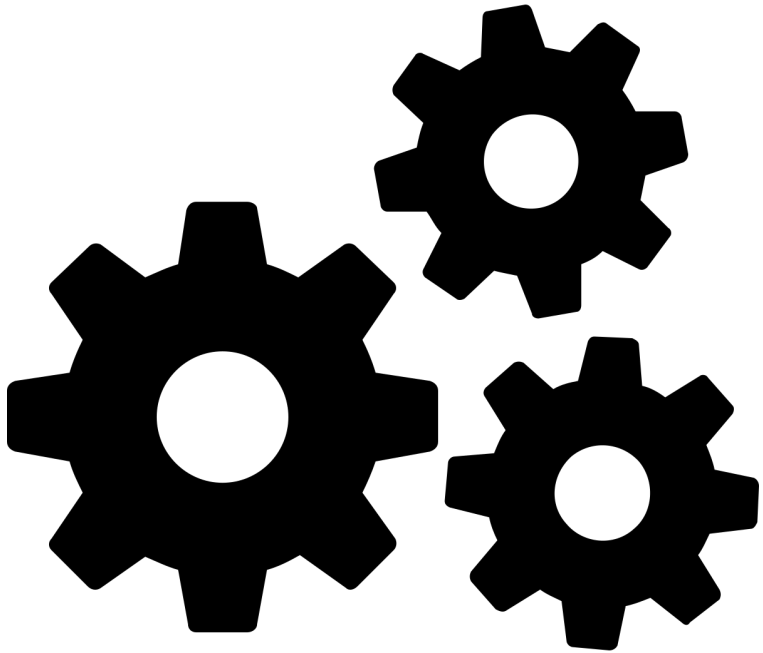
$1/9(10) + ½(6) + ⅙(20) = 7.44$



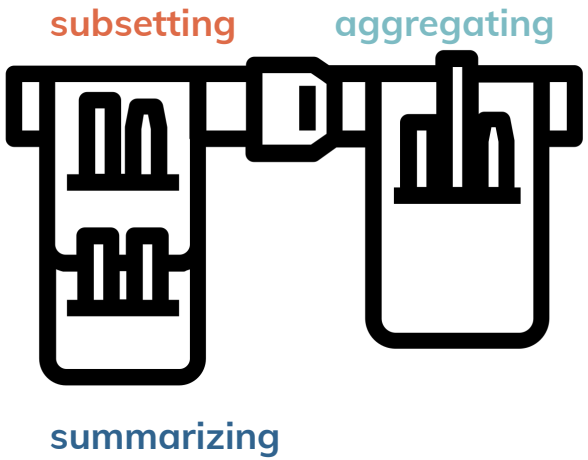
Toolbelt for solving spatial problems



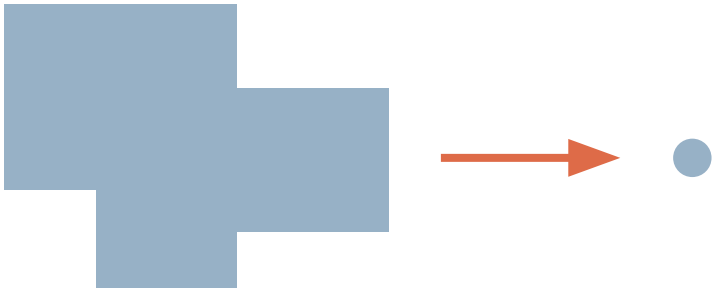
Switching gears...



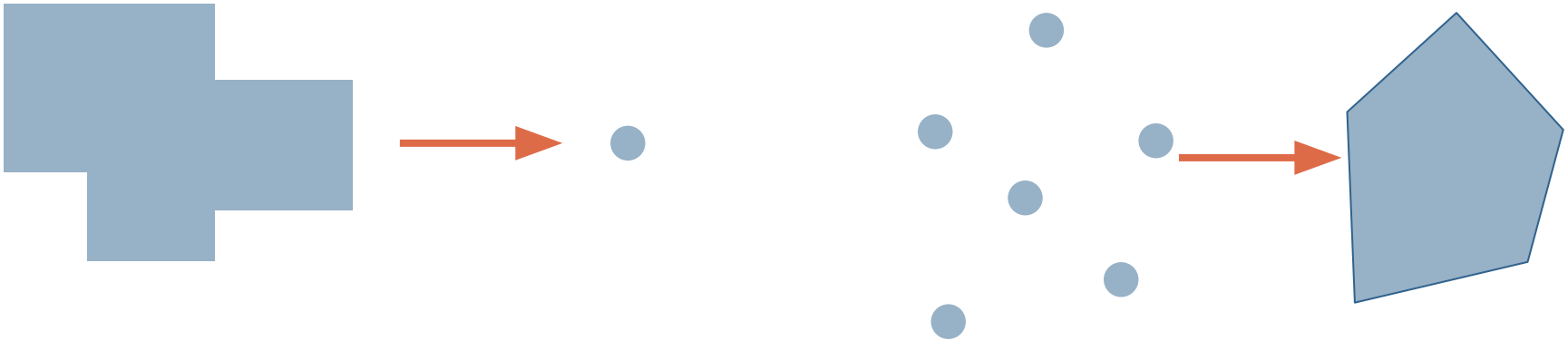
Toolbelt for solving spatial problems



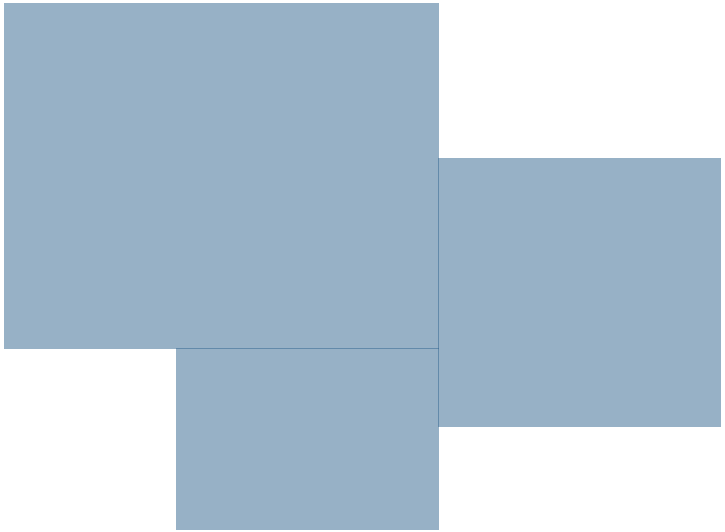
Summarizing



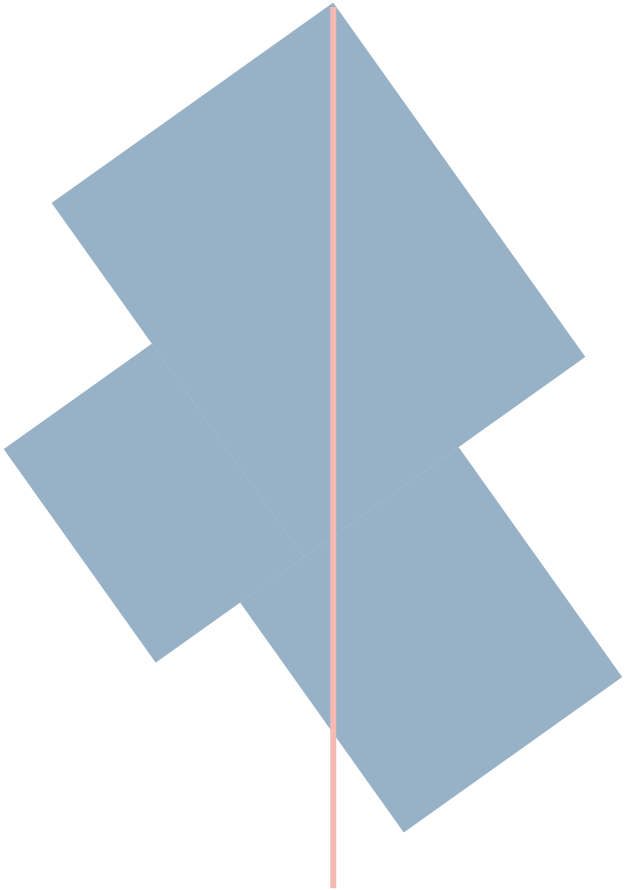
Summarizing



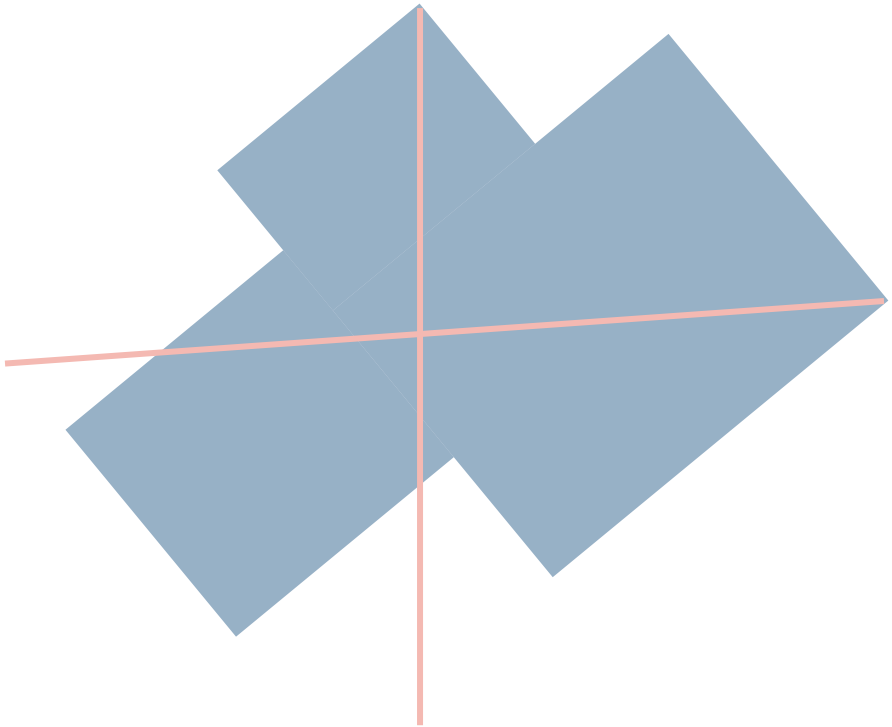
Centroids



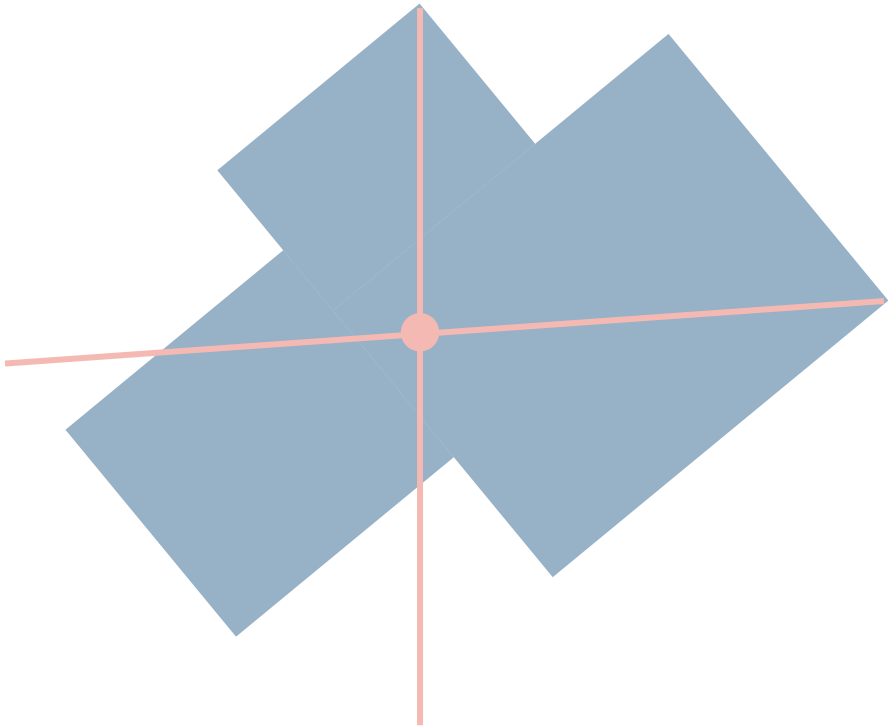
Centroids



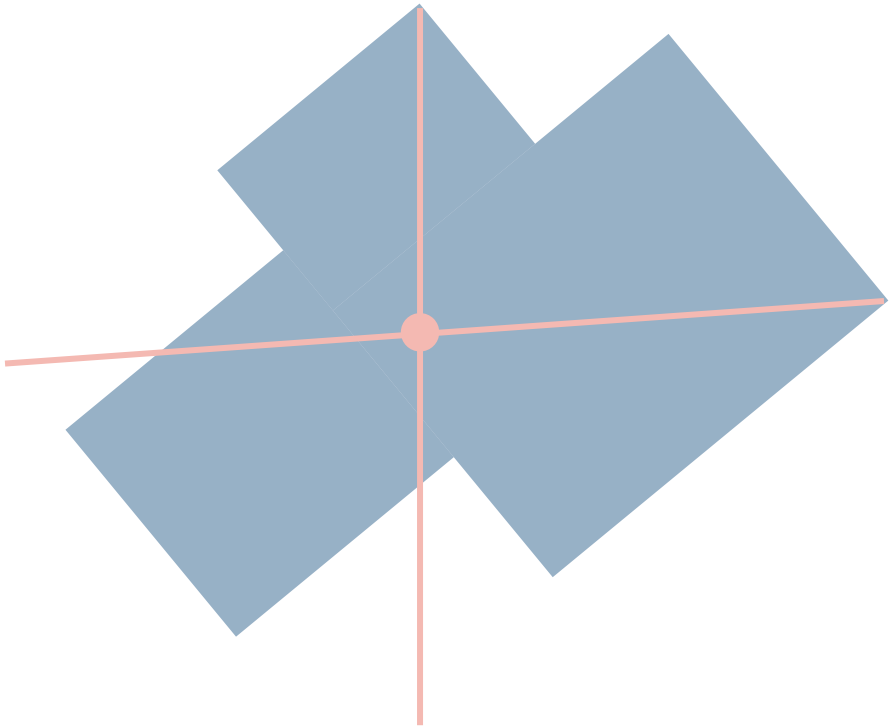
Centroids



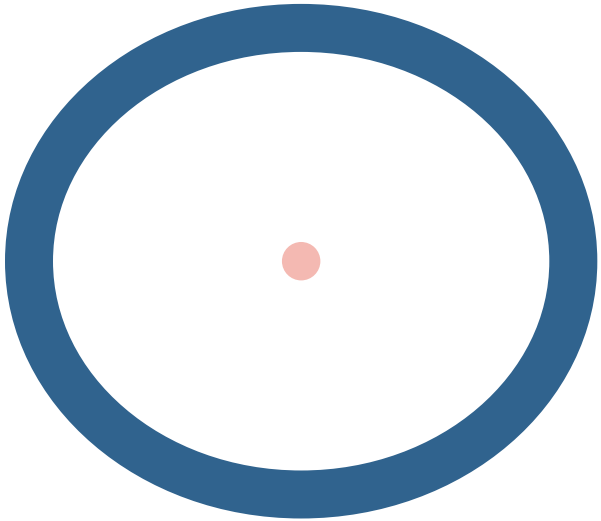
Centroids

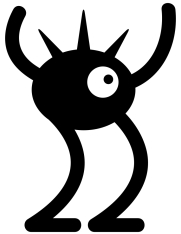


Centroids

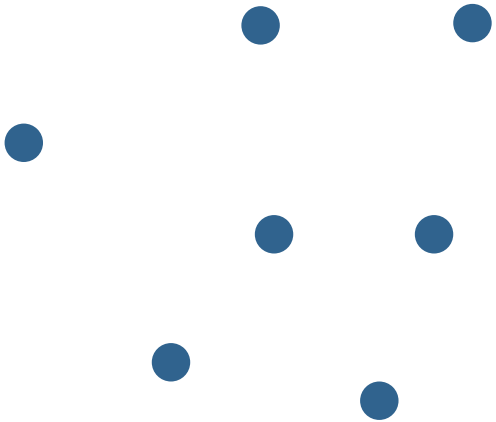


Centroids

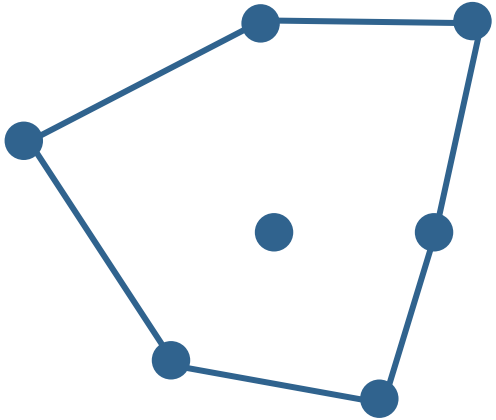




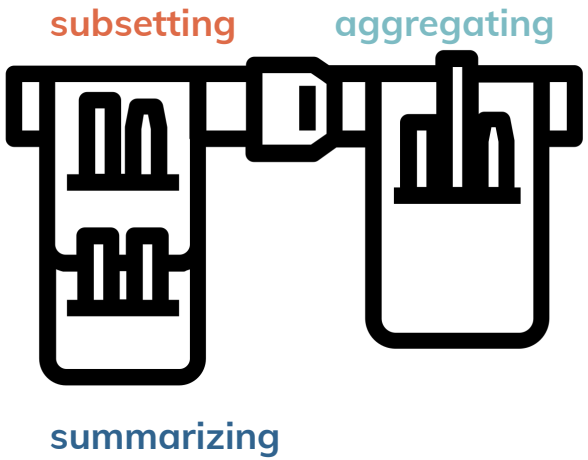
Convex hulls



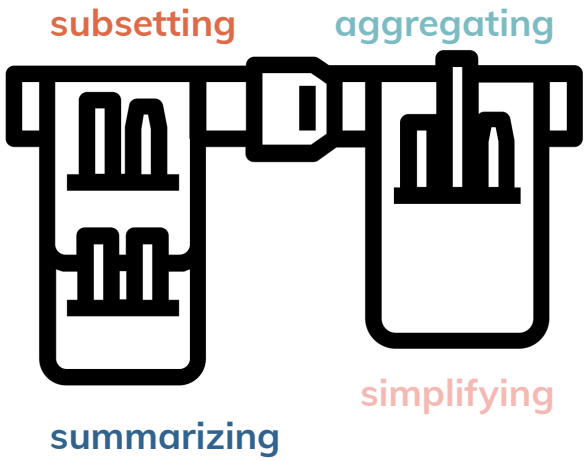
Convex hulls



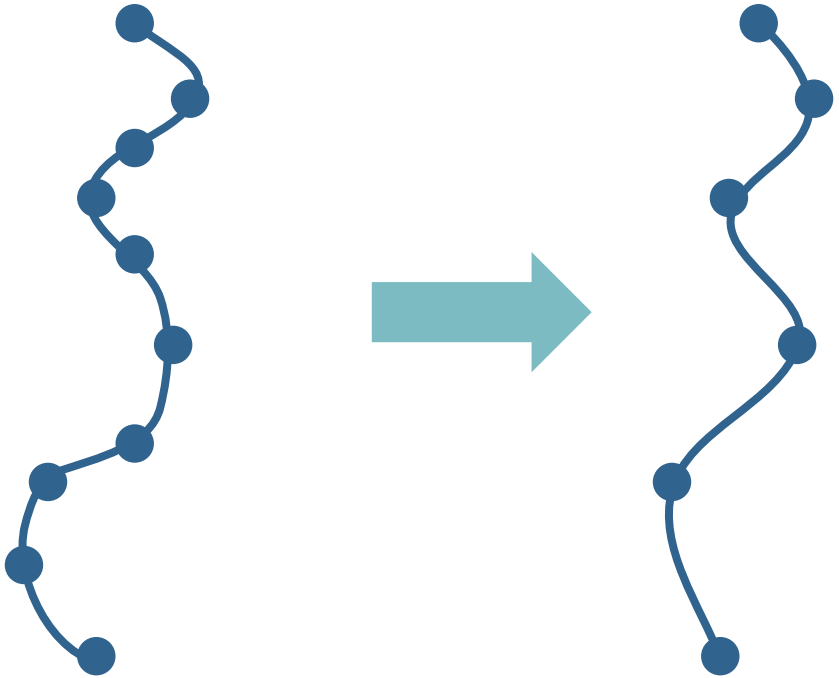
Toolbelt for solving spatial problems



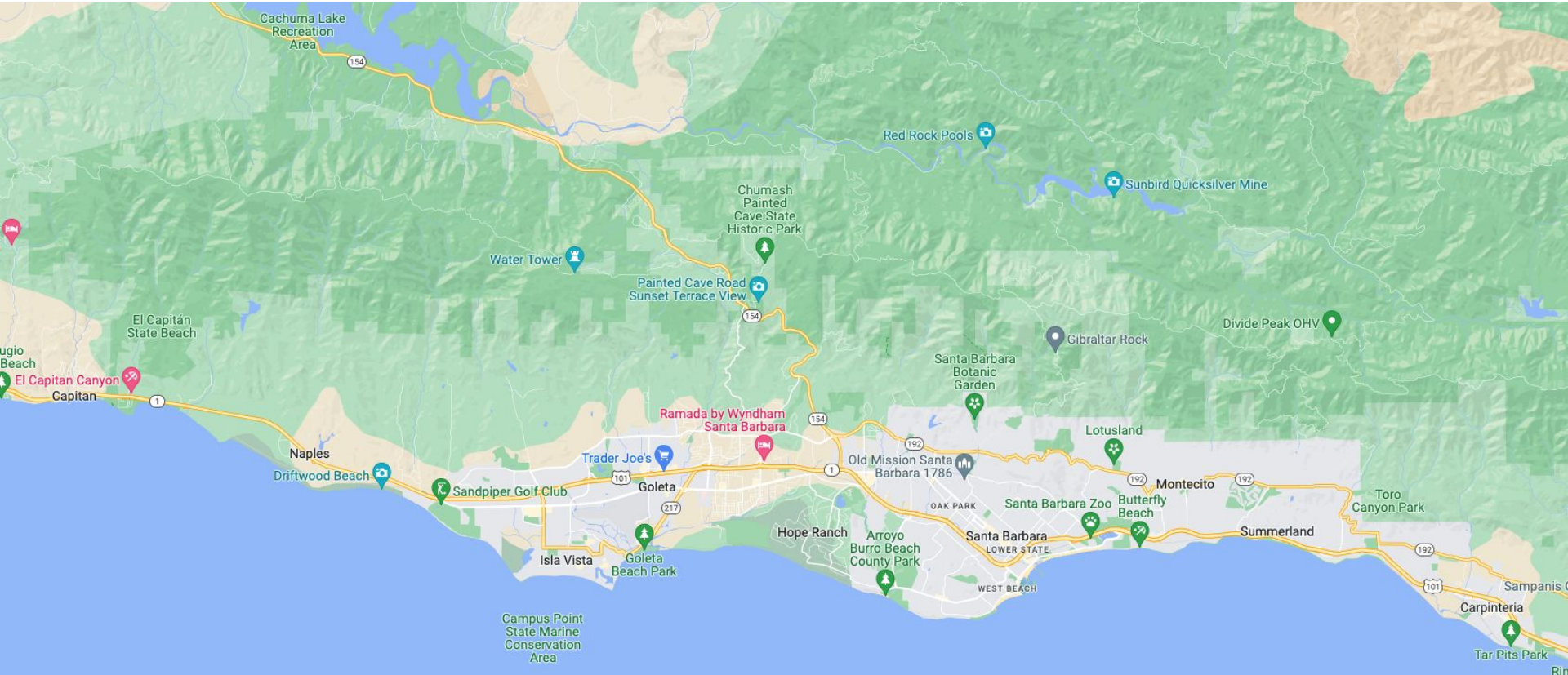
Toolbelt for solving spatial problems



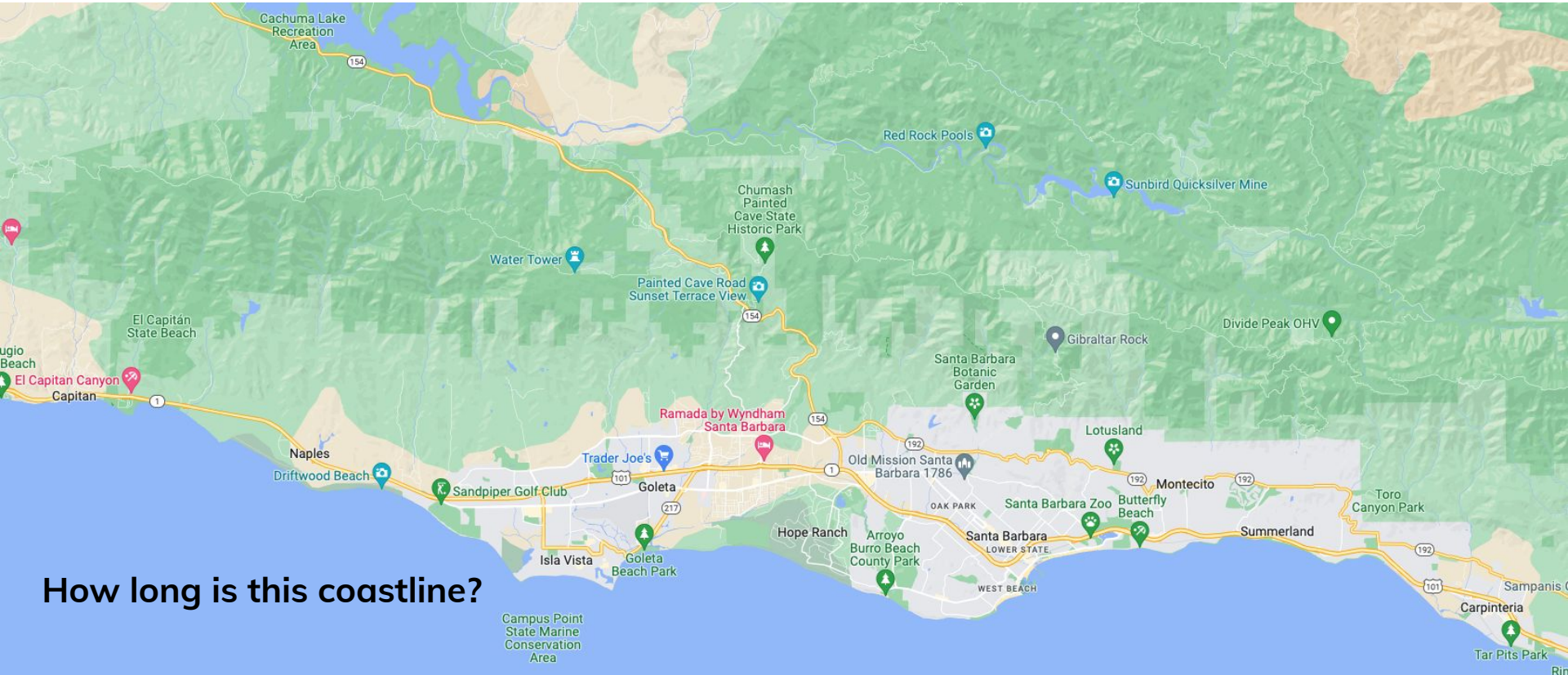
Simplifications



Coastline paradox

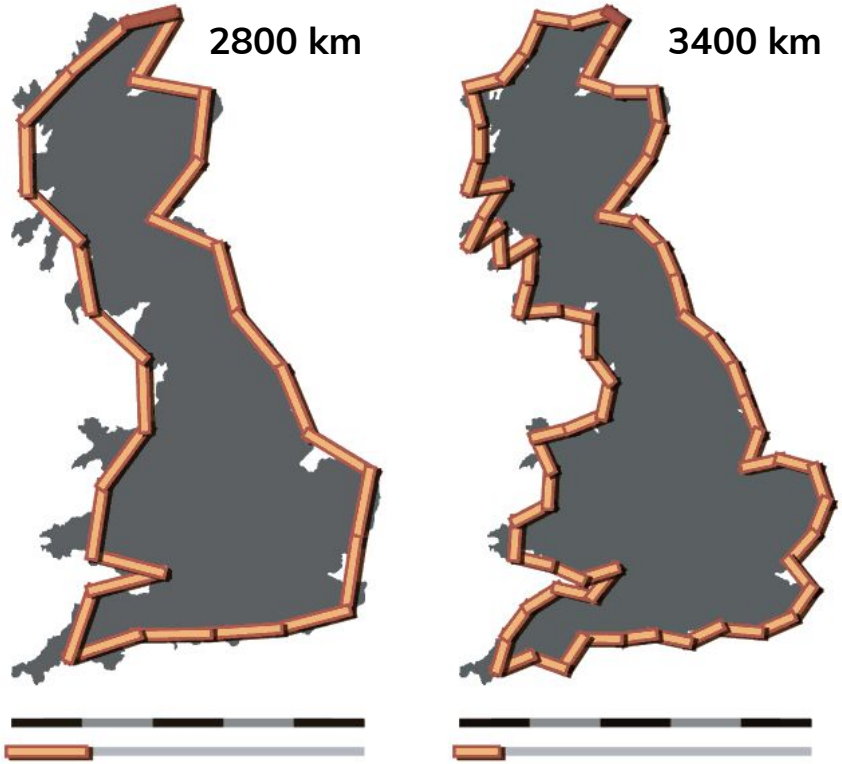


Coastline paradox



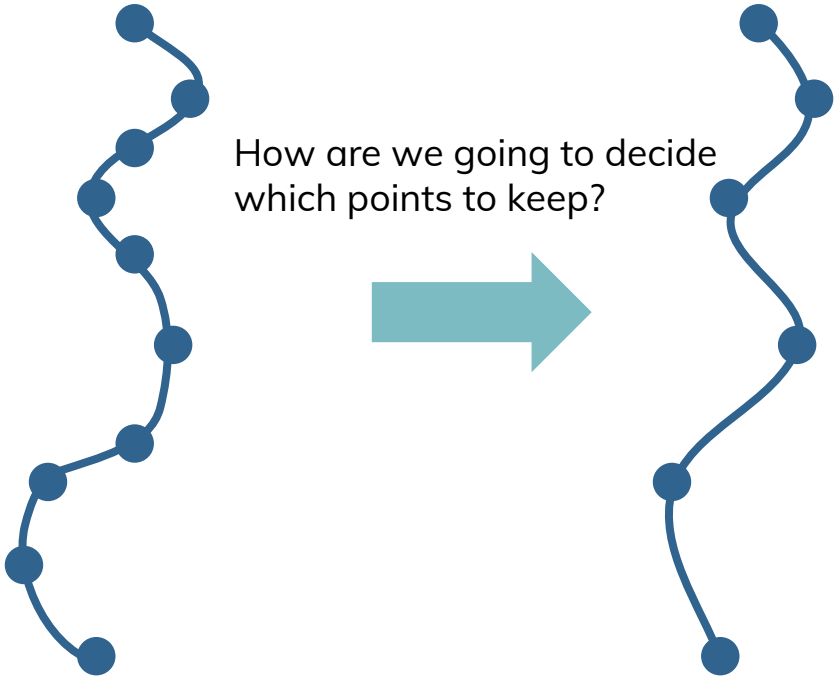
How long is this coastline?

Coastline paradox

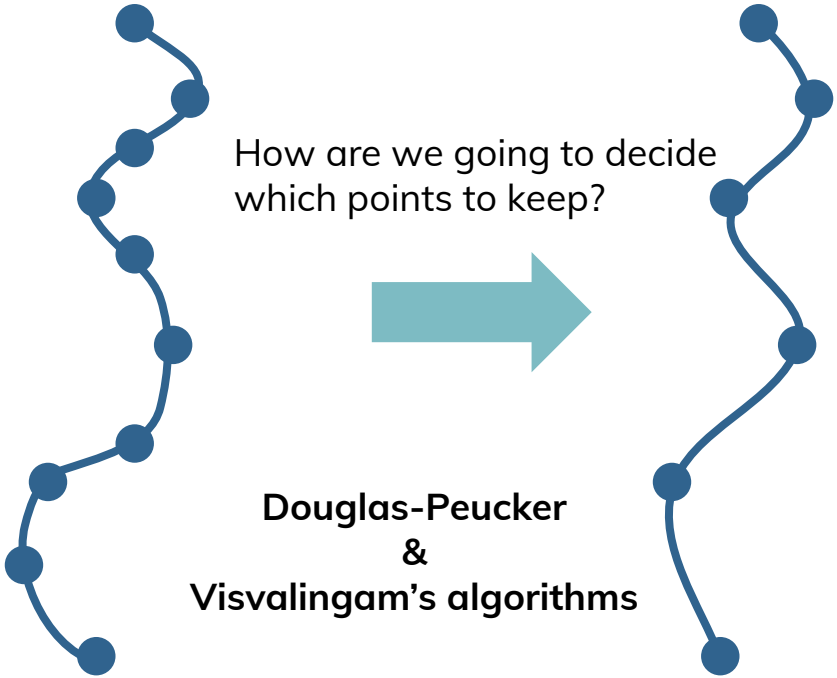


Source: Wikipedia

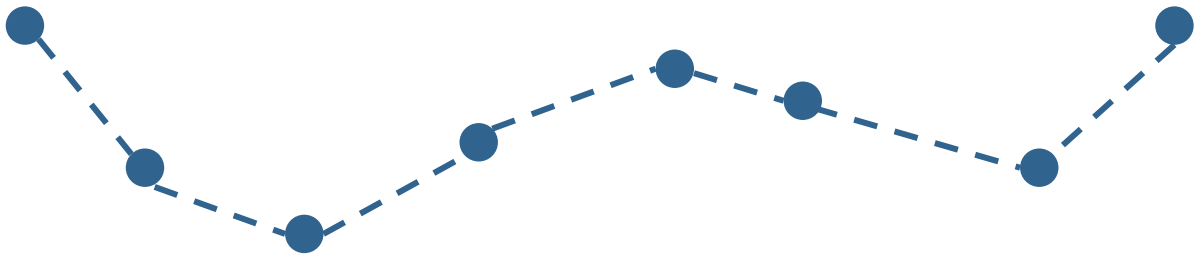
Simplification



Simplification



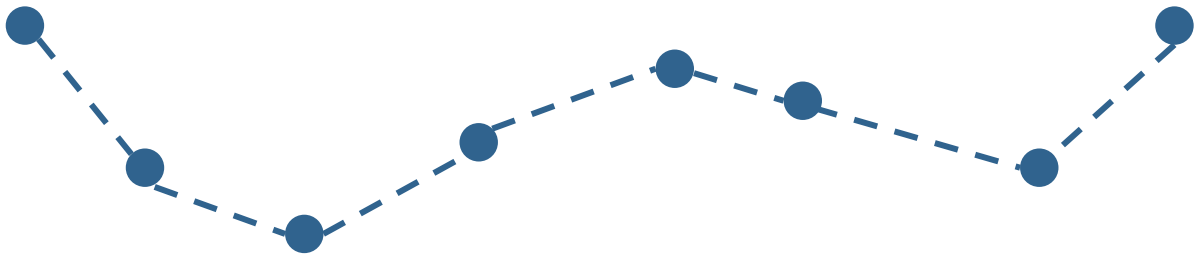
Simplification: Douglas-Peucker algorithm



Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$C = (P_1, P_3, P_3, \ldots, P_n)$

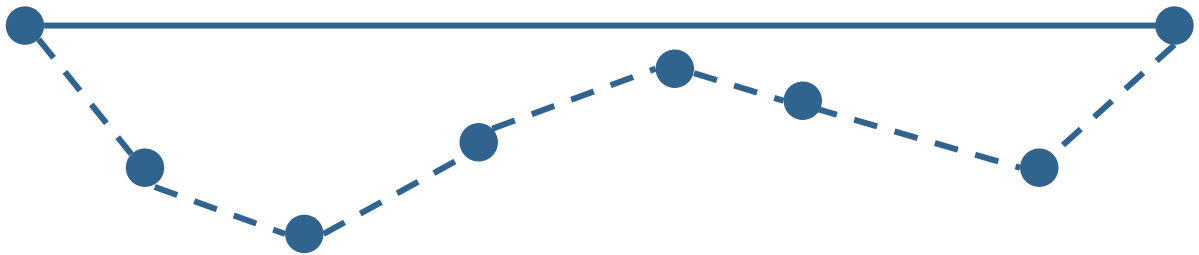


$\varepsilon > 0$ 

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

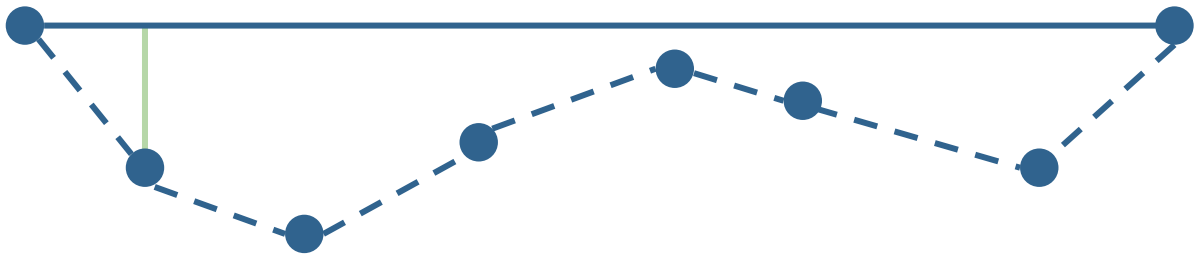
$\overline{P_1 P_n}$



Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$\overline{P_1 P_n}$

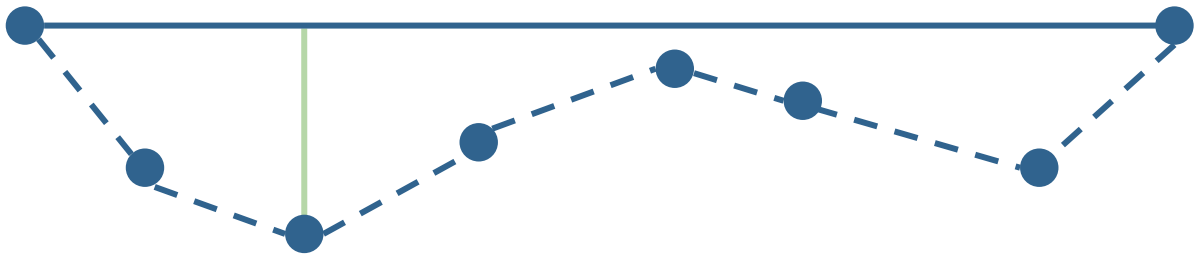


$d(P_i, \overline{P_1 P_n})$

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$\overline{P_1 P_n}$

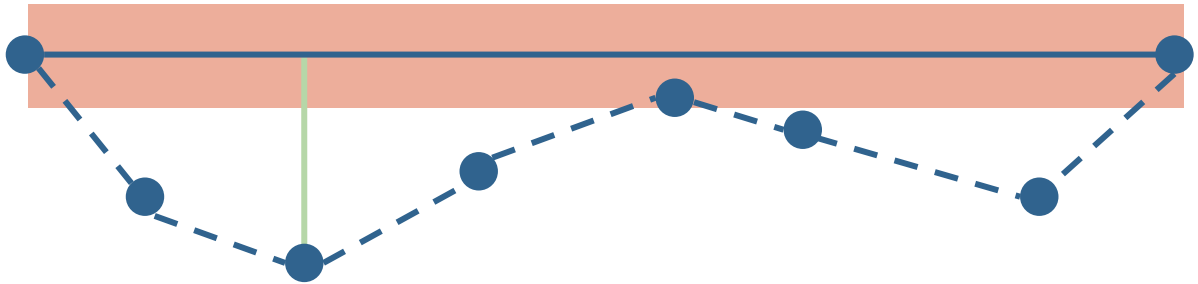


$$d_{max} = \max_{i = 2 \ldots n\text{-}1} d(P_i, \overline{P_1 P_n})$$

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$\overline{P_1 P_n}$

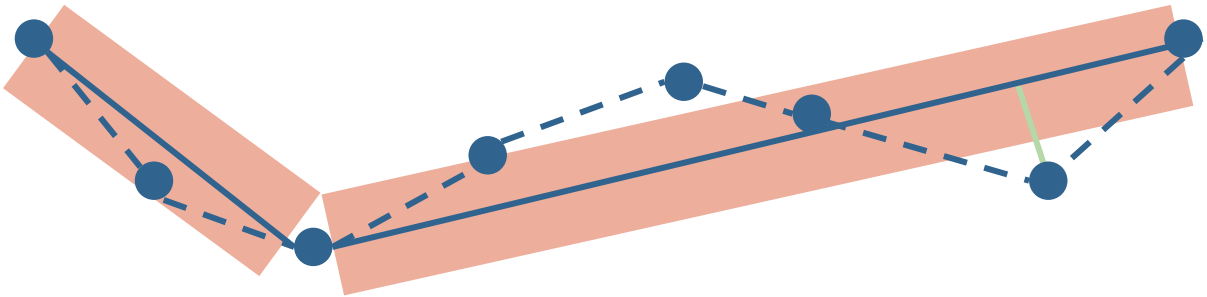


$$d_{max} = \max_{i = 2 \ldots n\text{-}1} d(P_i, \overline{P_1 P_n}) \leq \varepsilon$$

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$\overline{P_1 P_m}$ $\overline{P_m P_n}$

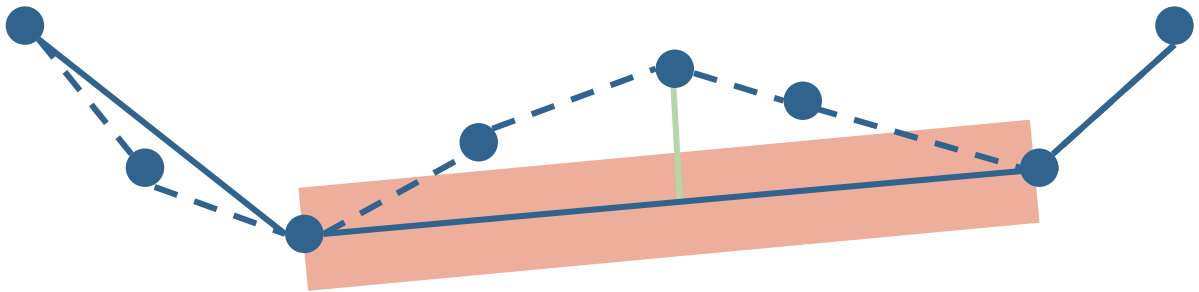


$$d_{max} = \max_{i = 2 \ldots n\text{-}1} d(P_i, \overline{P_1 P_n}) \leq \varepsilon$$

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

$\overline{P_1 P_m}$ $\overline{P_m P_n}$

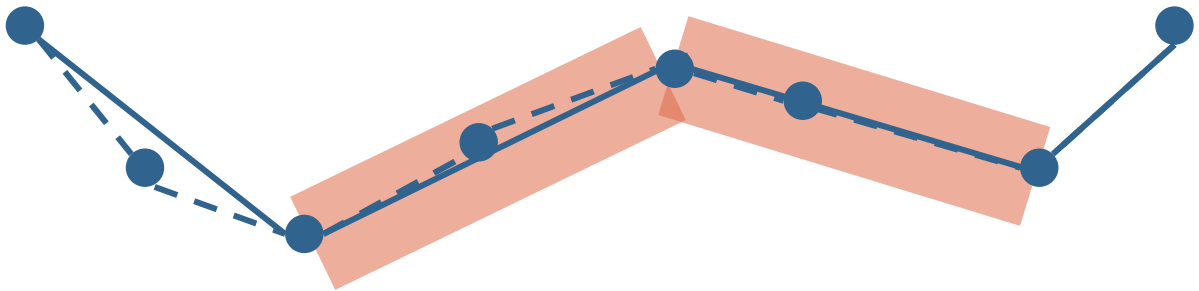


$$d_{max} = \max_{i = 2 \ldots n\text{-}1} d(P_i, \overline{P_1 P_n}) \leq \varepsilon$$

Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

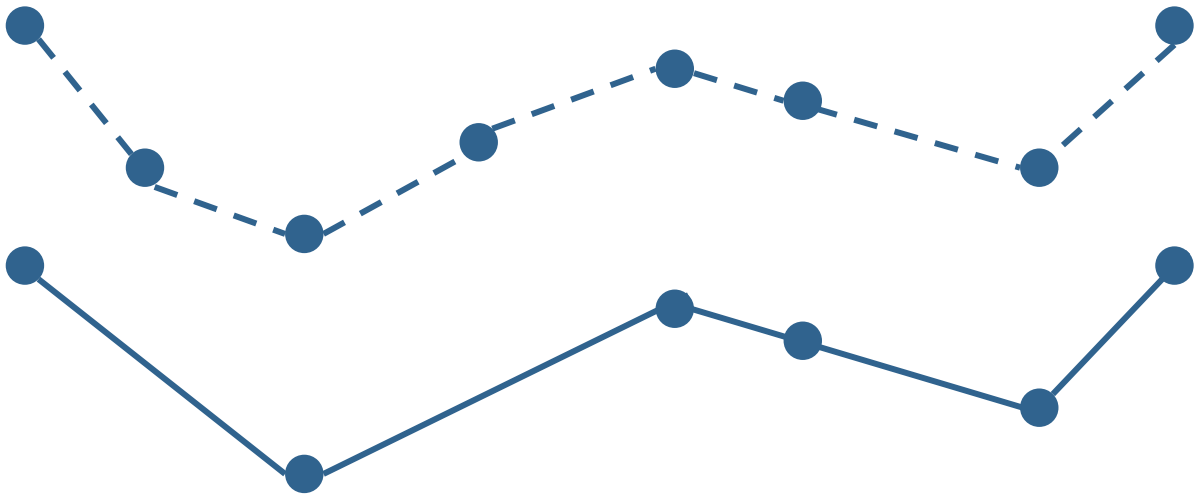
$\overline{P_1 P_m}$ $\overline{P_m P_n}$



$$d_{max} = \max_{i = 2 \ldots n\text{-}1} d(P_i, \overline{P_1 P_n}) \leq \varepsilon$$

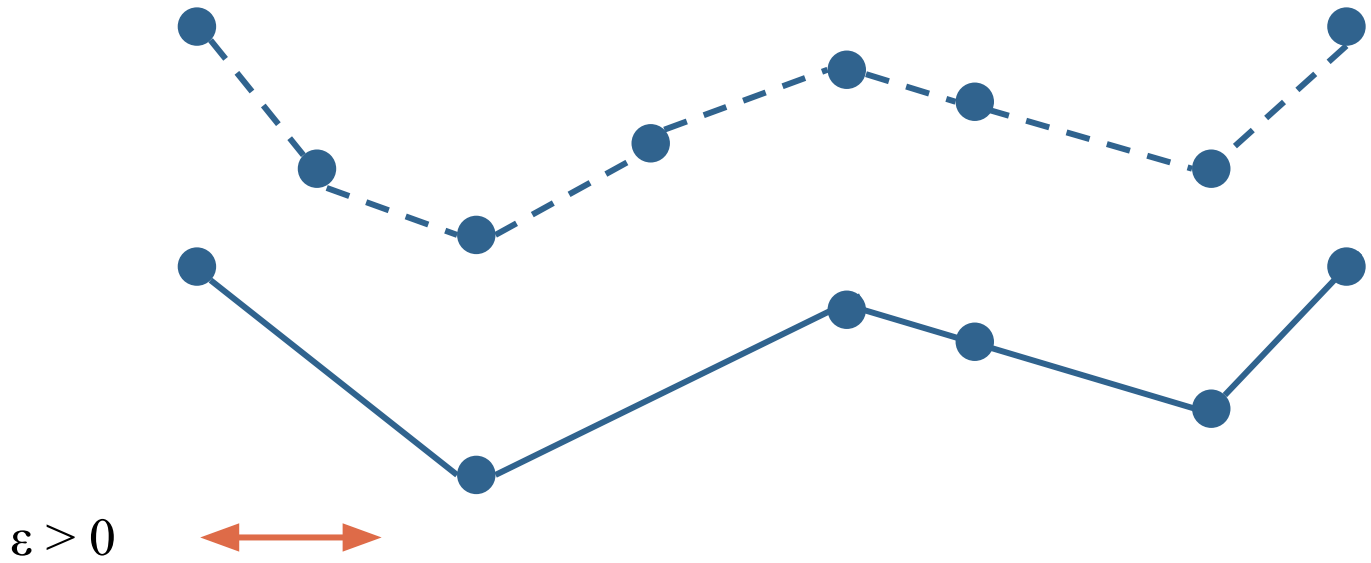
Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm



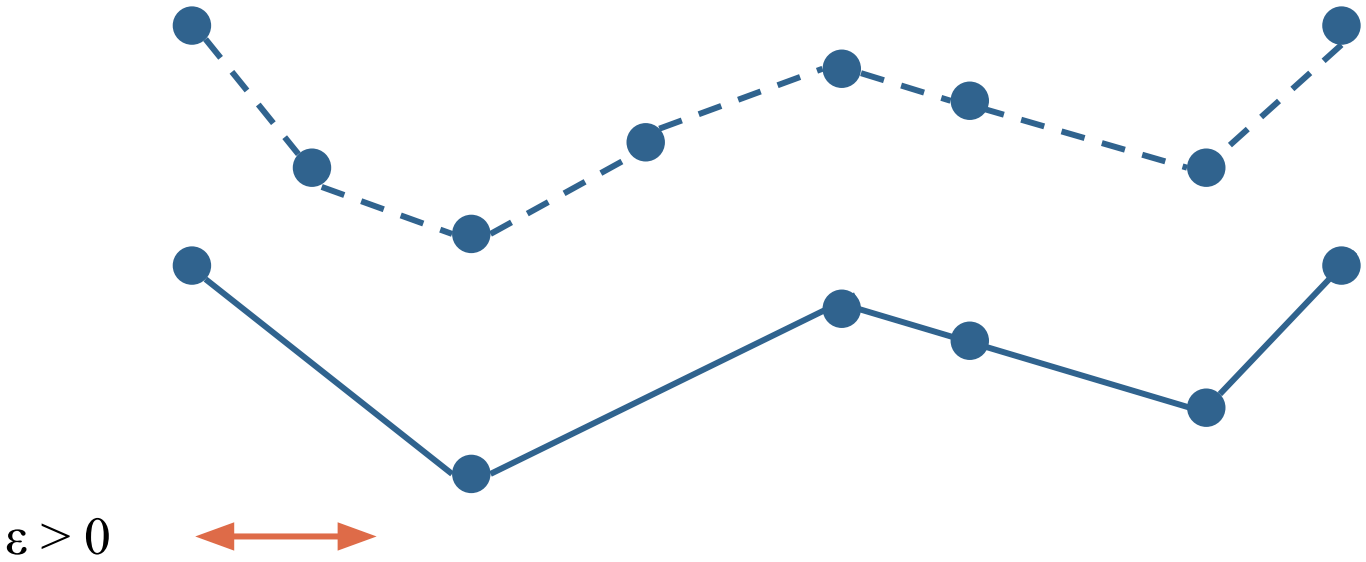
Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm



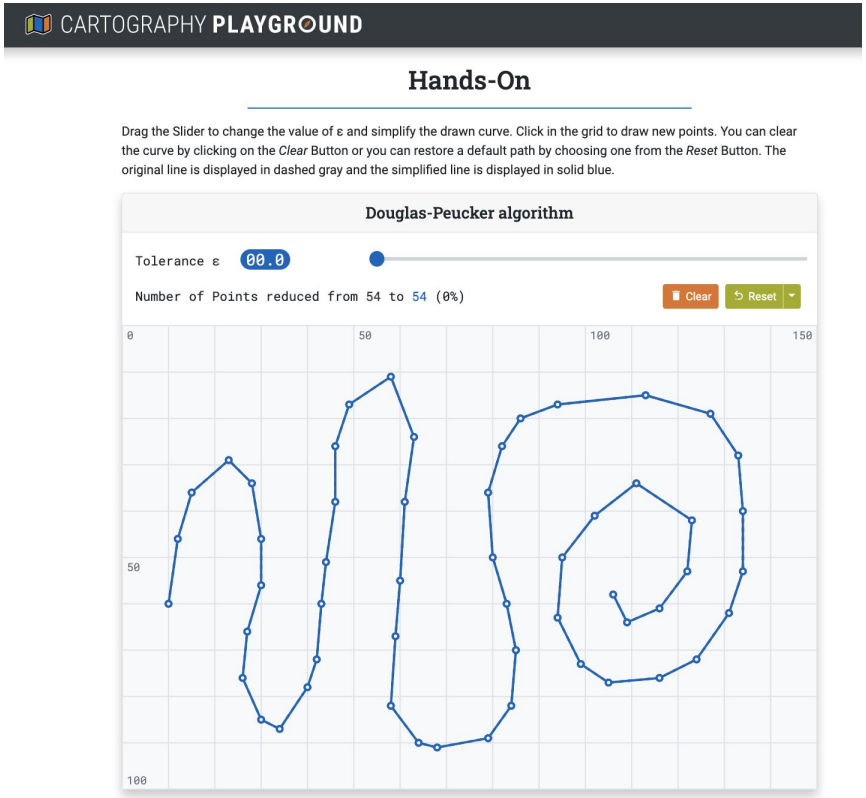
Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

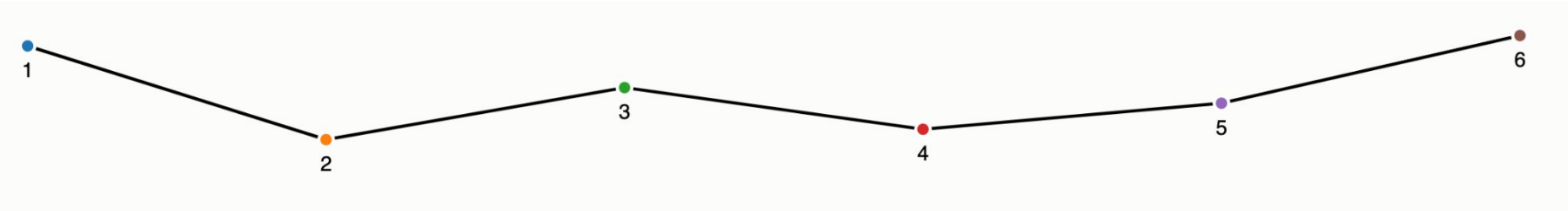


Modified from Cartography Playground

Simplification: Douglas-Peucker algorithm

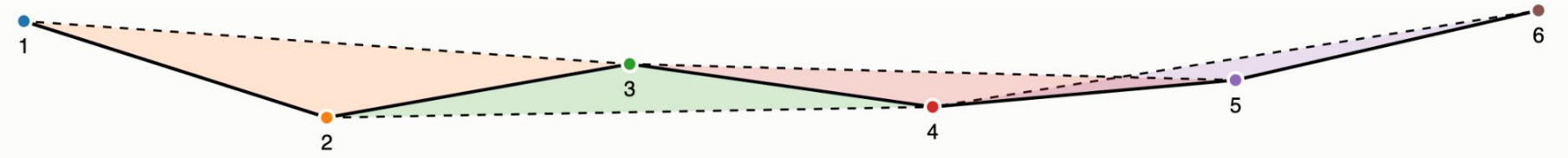


Simplification: Visvalingam's algorithm



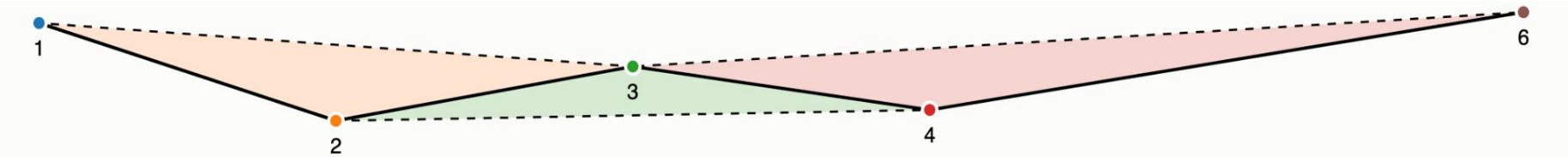
Source: Mike Bostok

Simplification: Visvalingam's algorithm



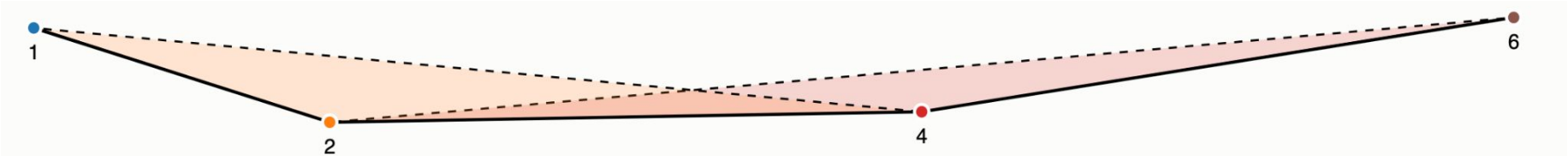
Source: Mike Bostok

Simplification: Visvalingam's algorithm



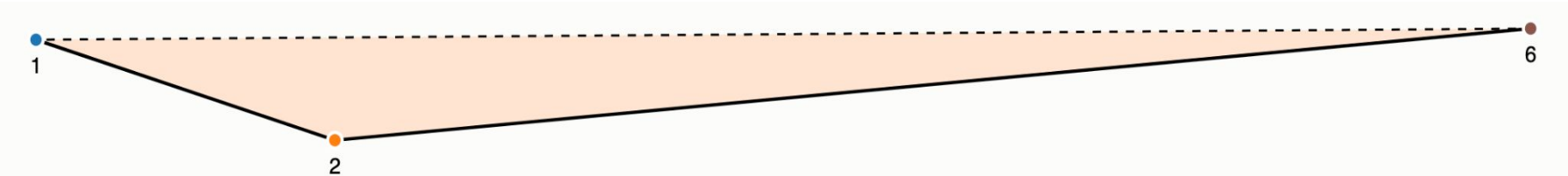
Source: Mike Bostok

Simplification: Visvalingam's algorithm



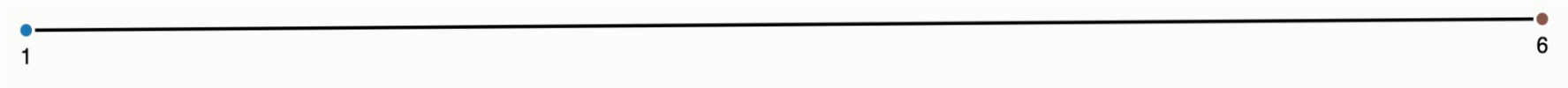
Source: Mike Bostok

Simplification: Visvalingam's algorithm



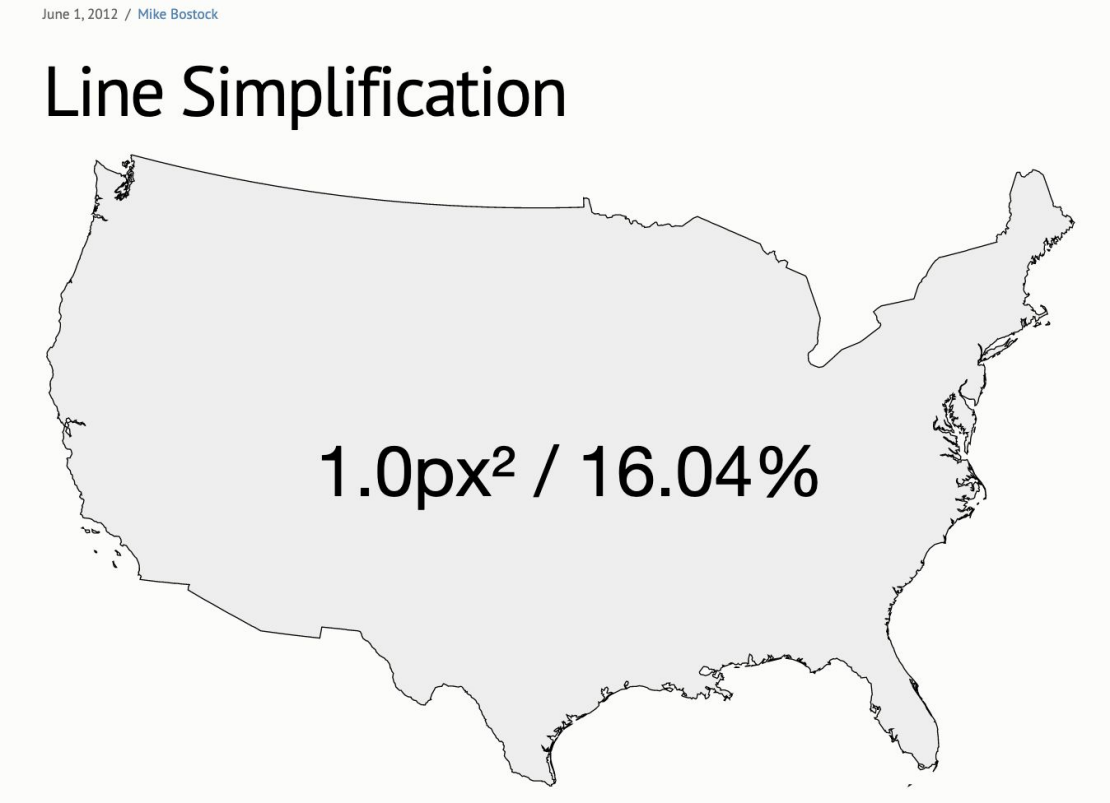
Source: Mike Bostok

Simplification: Visvalingam's algorithm



Source: Mike Bostok

Simplification: Visvalingam's algorithm

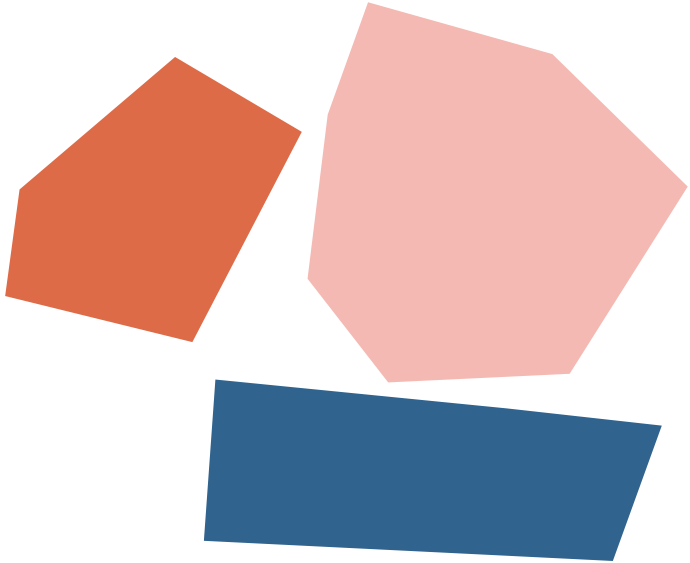


Source: Mike Bostok

Simplification

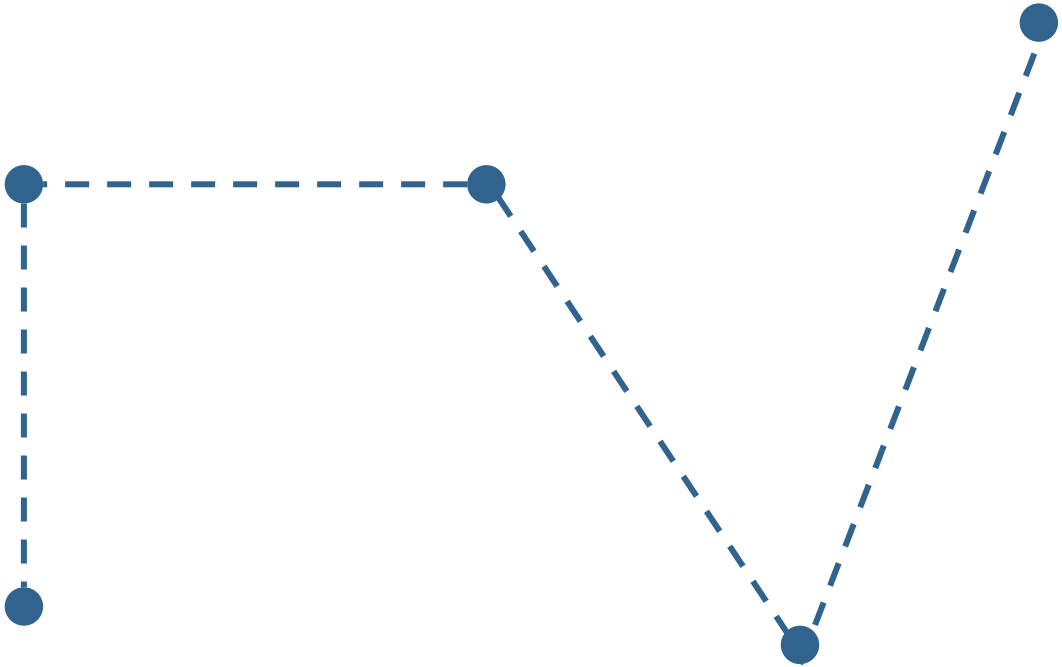
Simplification

Simplification

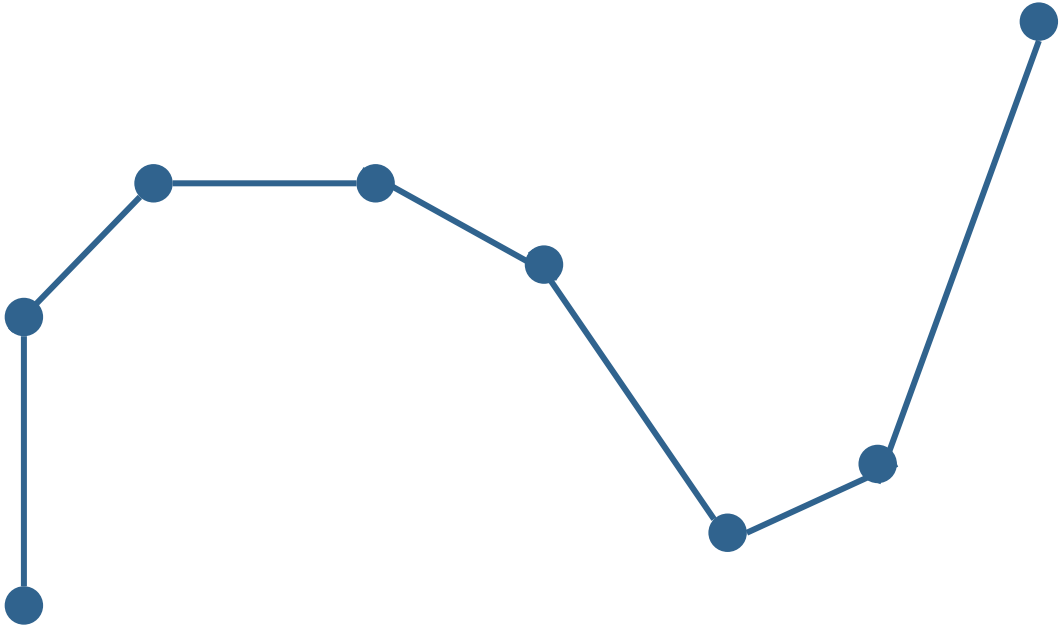


Smoothing

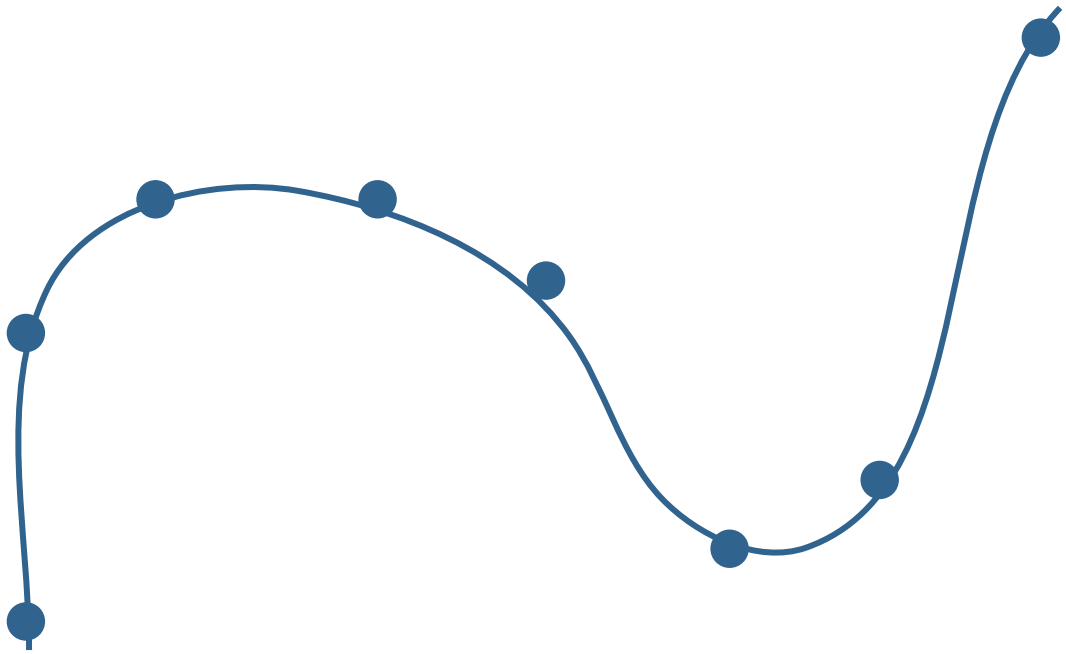
Smoothing: Chaikin’s corner cutting algorithm



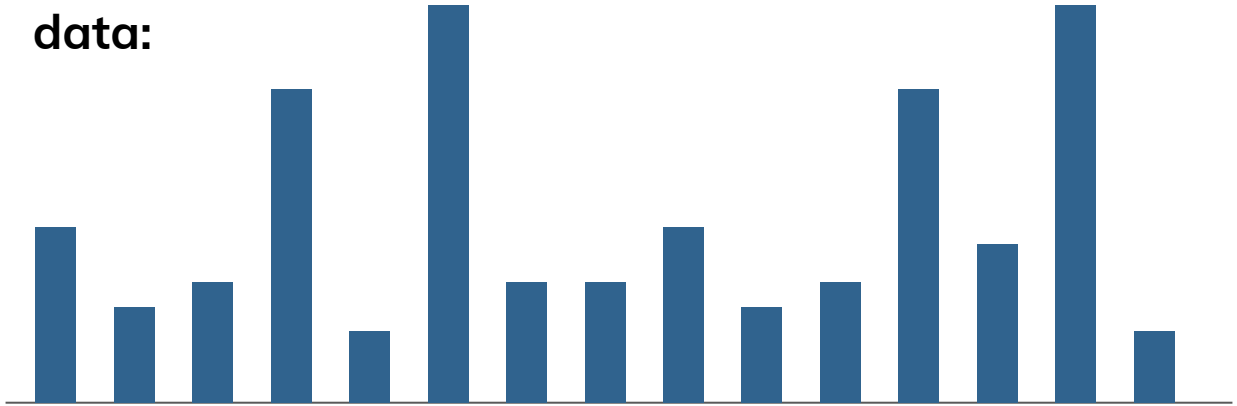
Smoothing: Chaikin’s corner cutting algorithm



Smoothing: Chaikin’s corner cutting algorithm



Smoothing: Gaussian kernel



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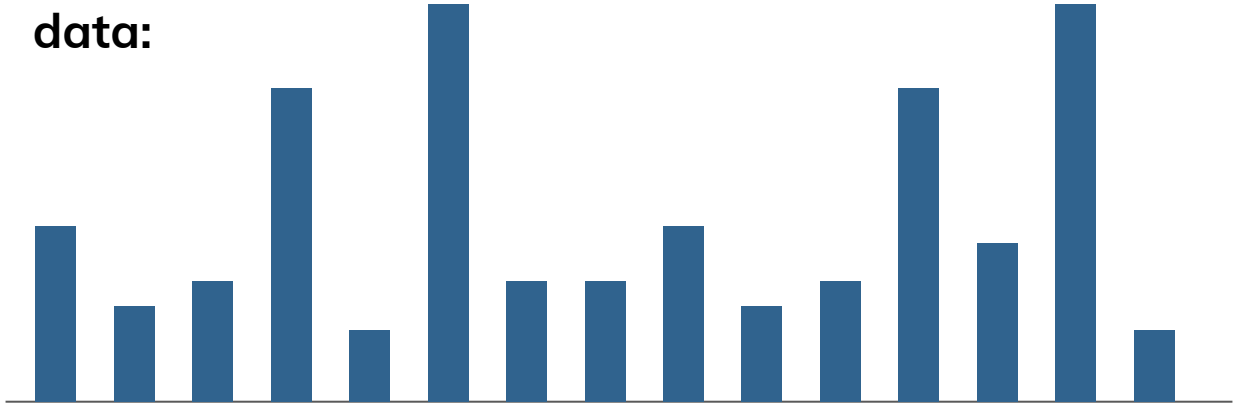
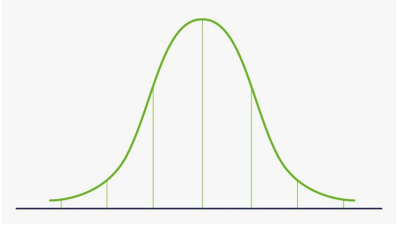
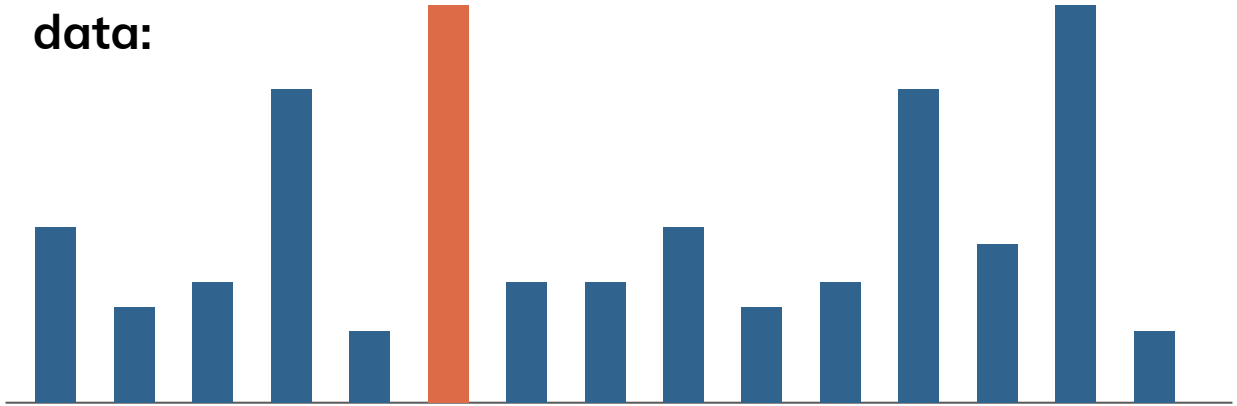


Gaussian distribution:



Smoothing: Gaussian kernel



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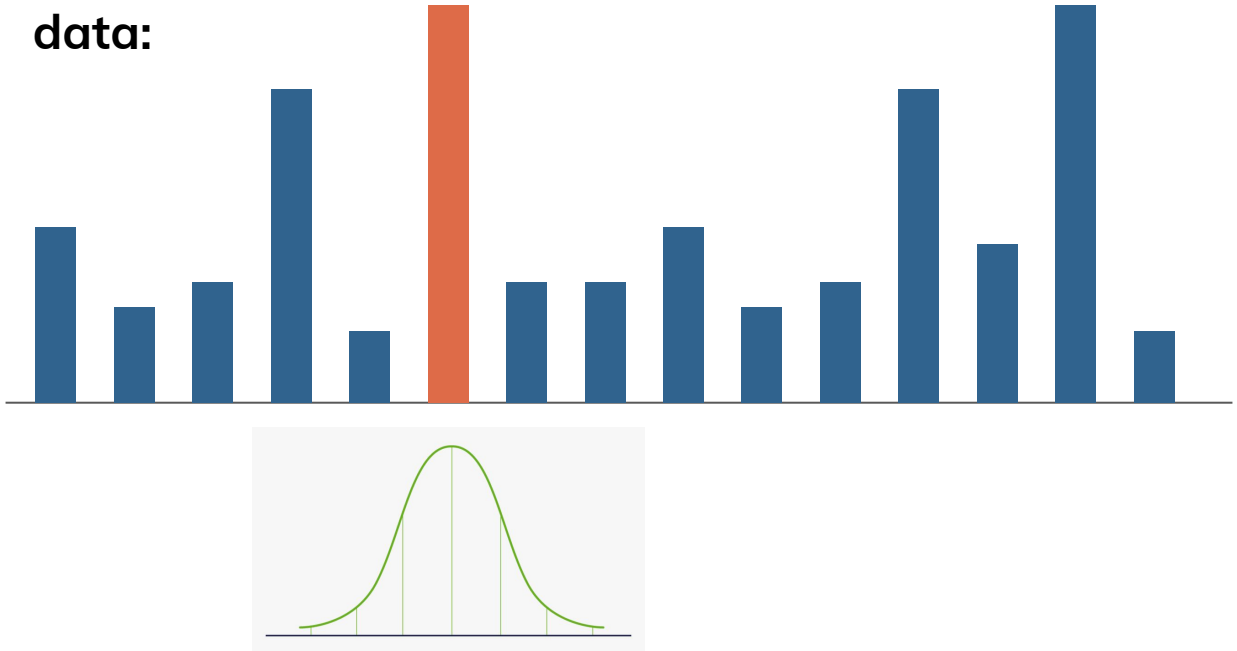

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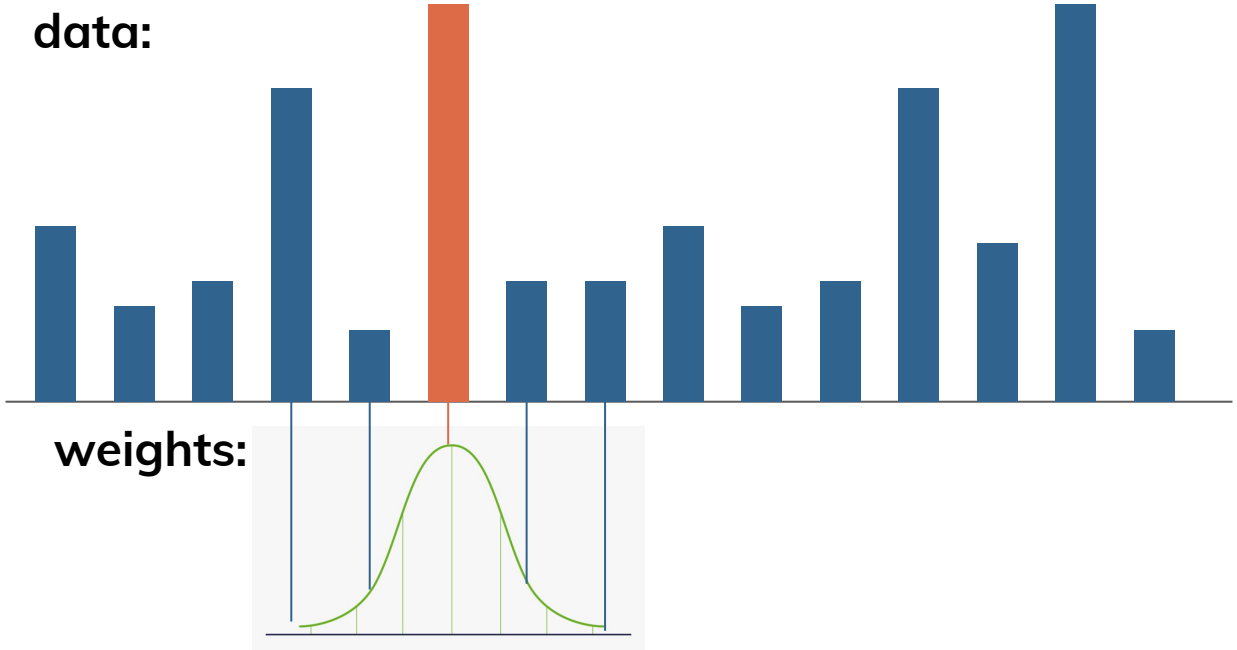

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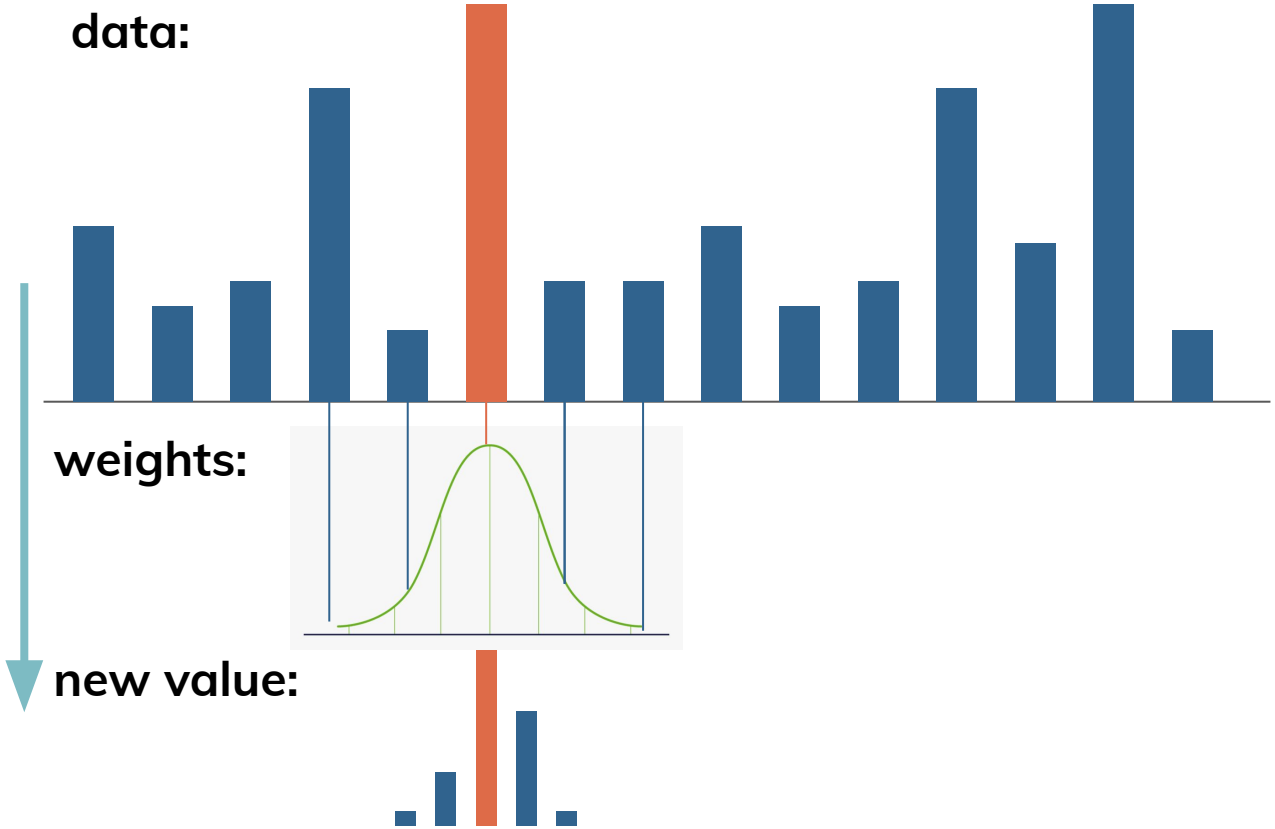

Toolbelt for solving spatial problems