

# Lecture 4

# Interactivity - *Manipulate*

DSCI 532, Data Visualization II

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# Interactivity

*What is it?*

Selecting

Hovering

Zooming

Filtering

Recomputing

Sorting

Change  
layout

Panning

Aggregating

Clustering

Animate

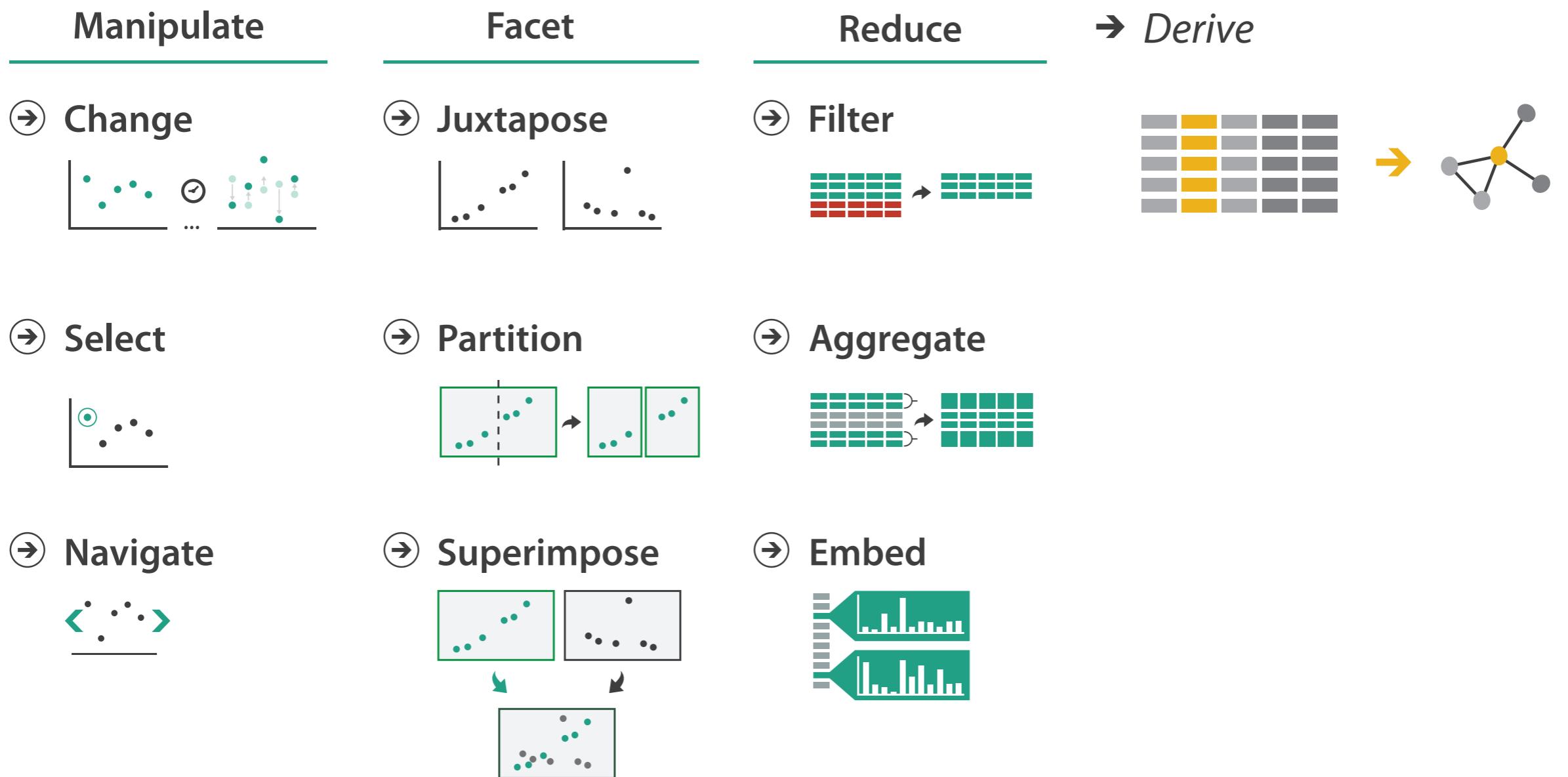
# Interactivity

*What is good for?*

# Interactivity | What is it good for?

- Provides a way to deal with complexity and data volume
- Enables a single view to address many analytical tasks
- Is an invitation to your audience to *change the view* and *explore the data* from different angles

# Dealing with complexity

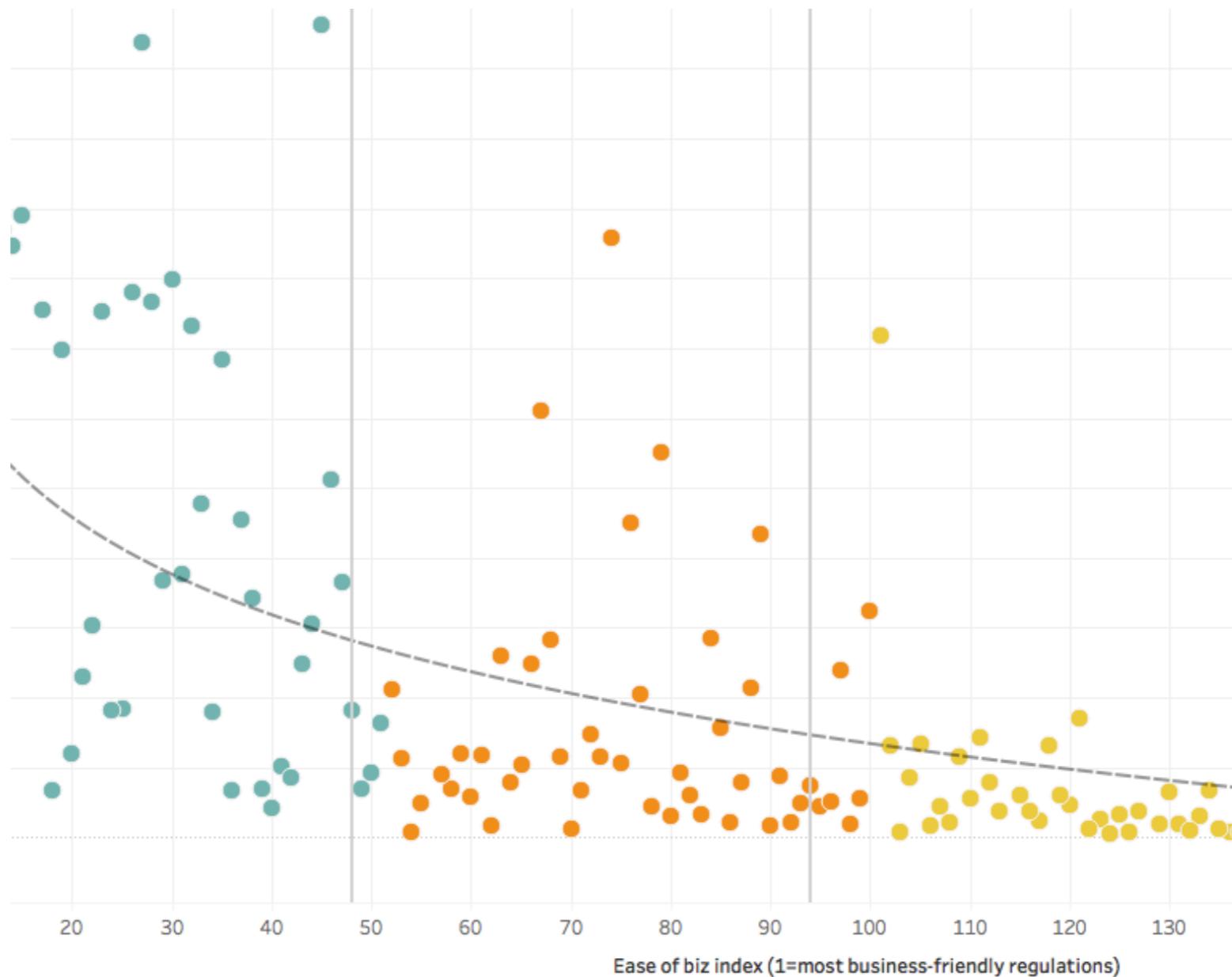


# Manipulate

We will focus on interacting with a single plot for now

# Selection + Highlighting

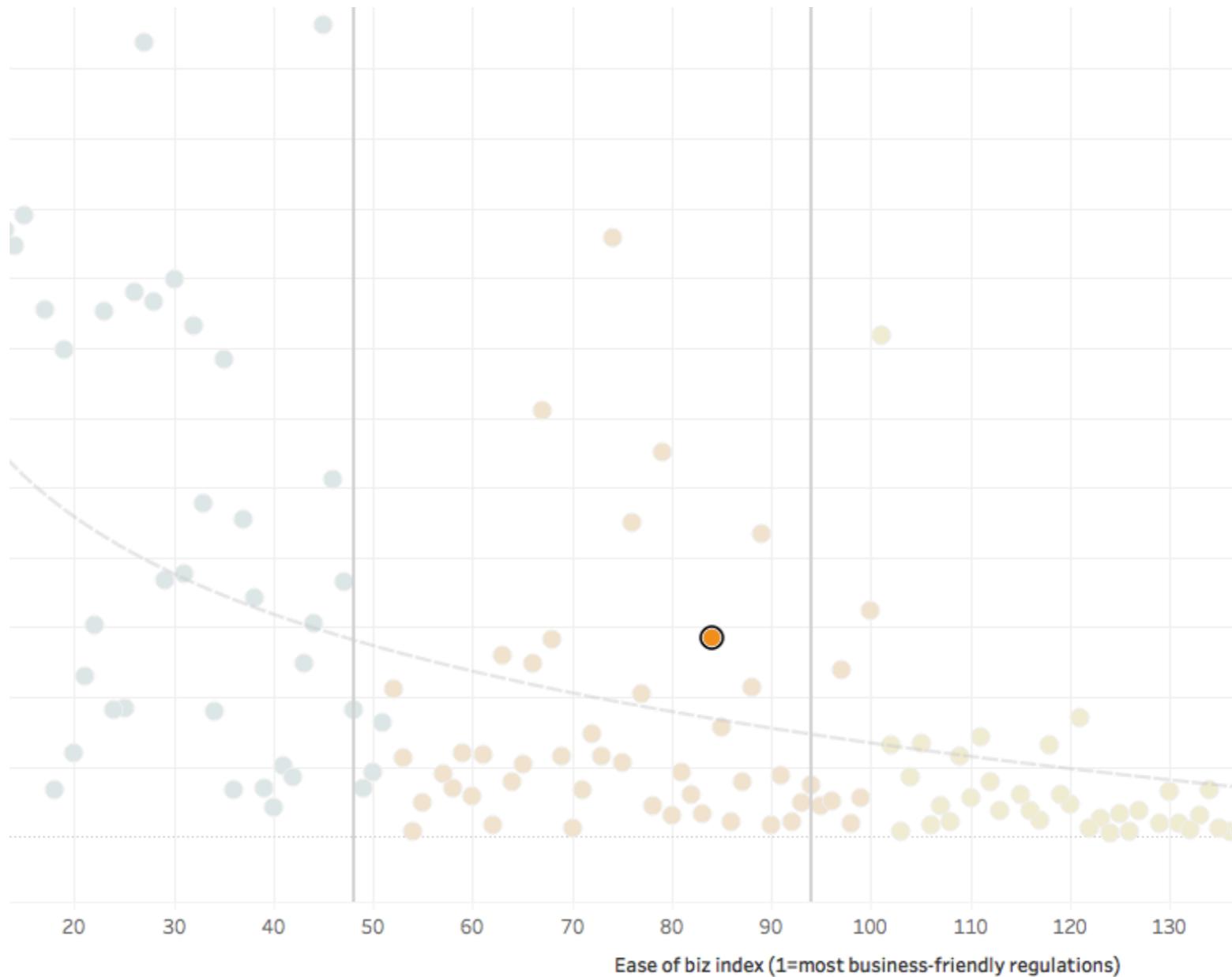
# Selection



**Tableau**  
World Indicators Sample Workbook

# Selection | on click

**Selection** almost always leads to **Highlighting** (restyling marks)

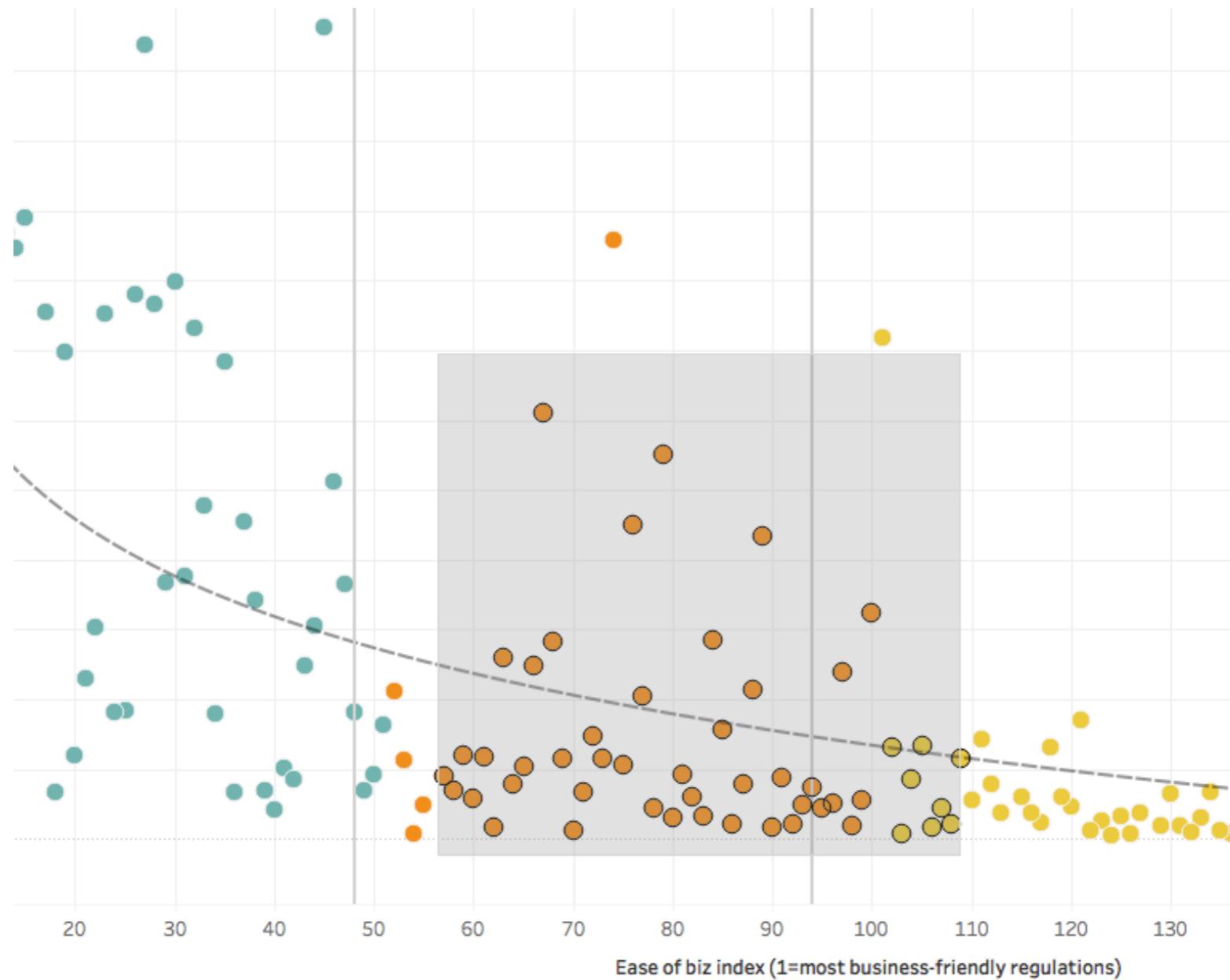


Tableau

World Indicators Sample Workbook

# Brush selection | on drag

Click and drag across the view to select items

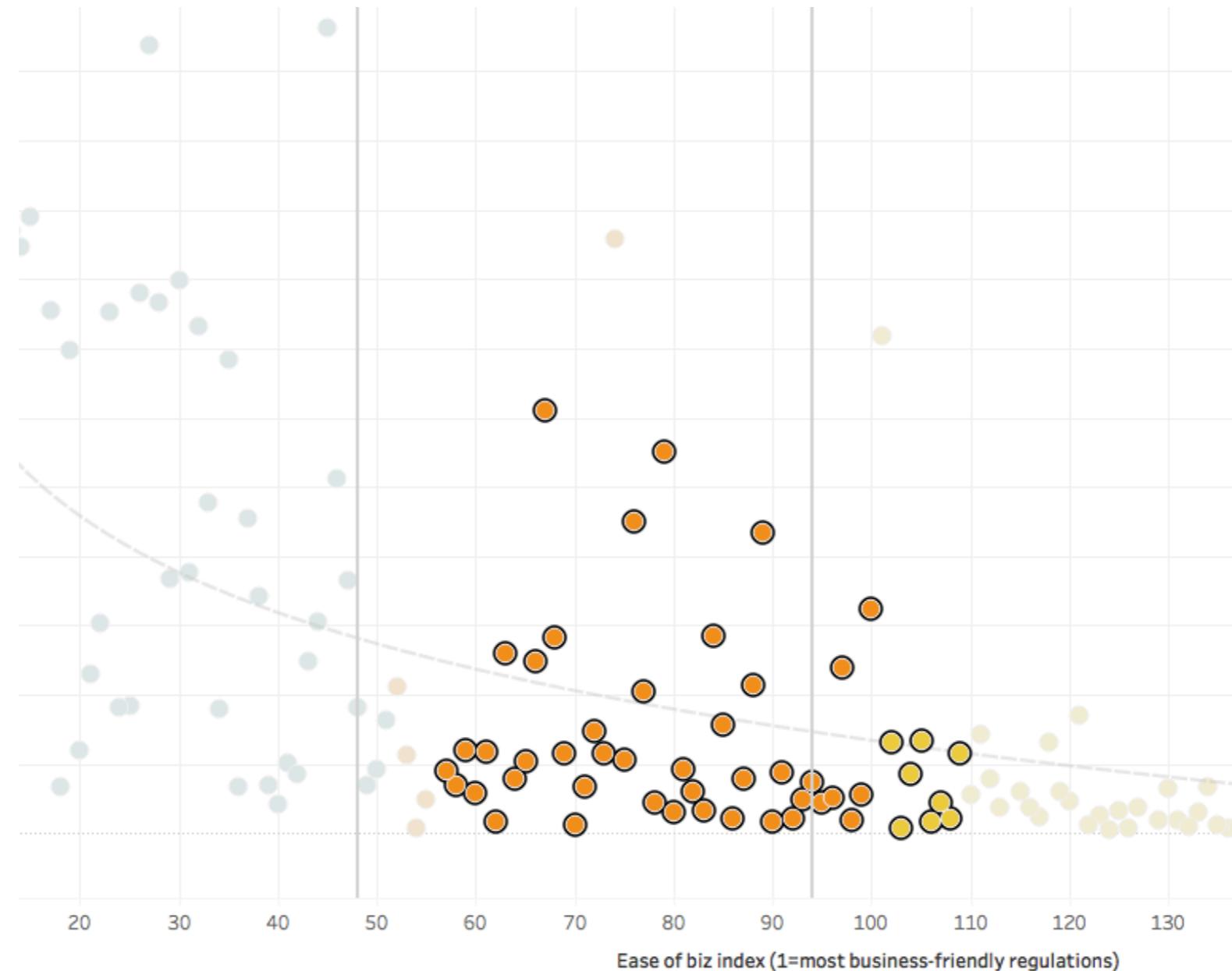


**Tableau**

World Indicators Sample Workbook

# Brush selection | on drag

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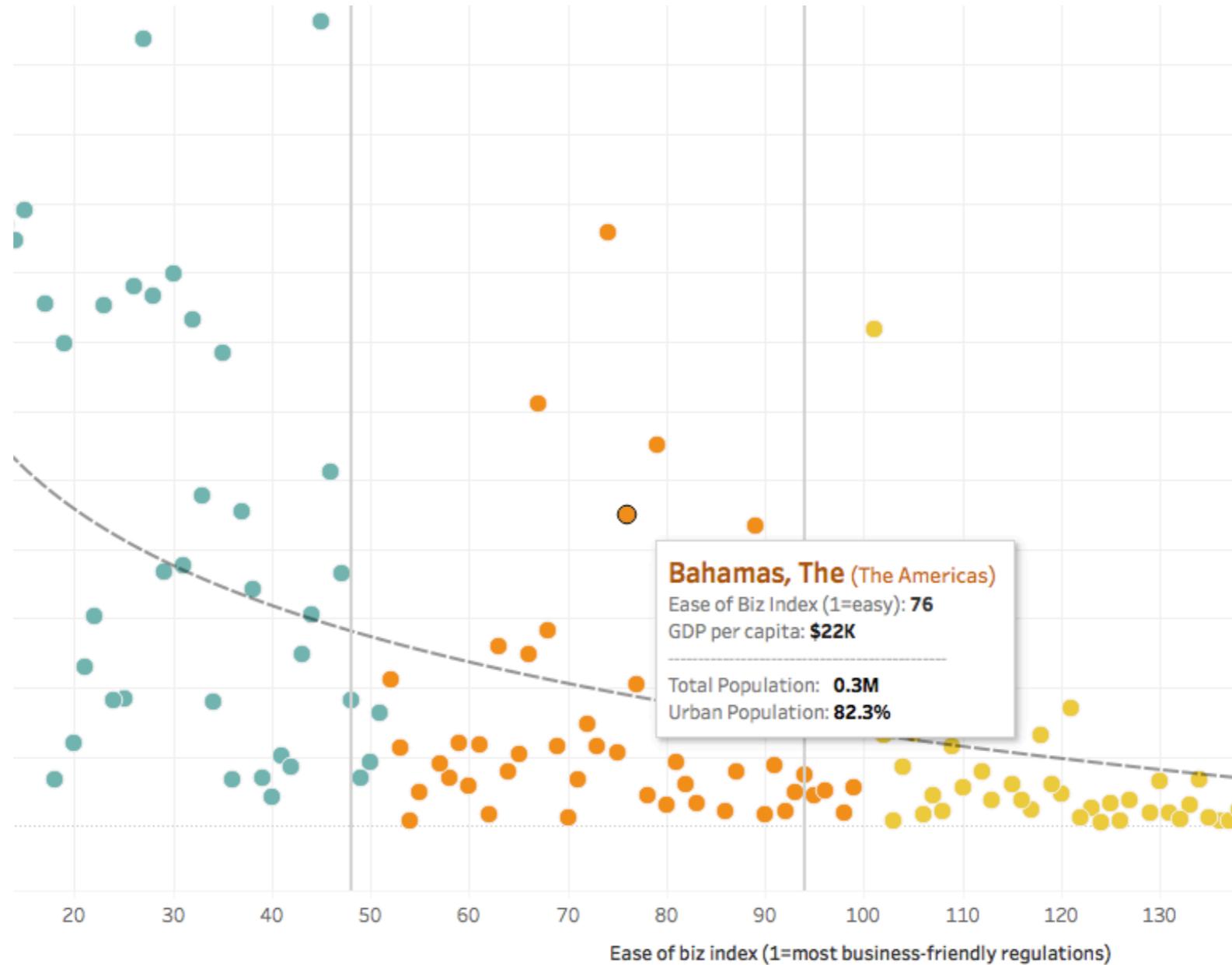


**Tableau**

World Indicators Sample Workbook

# Hover

Cursor passes over the object



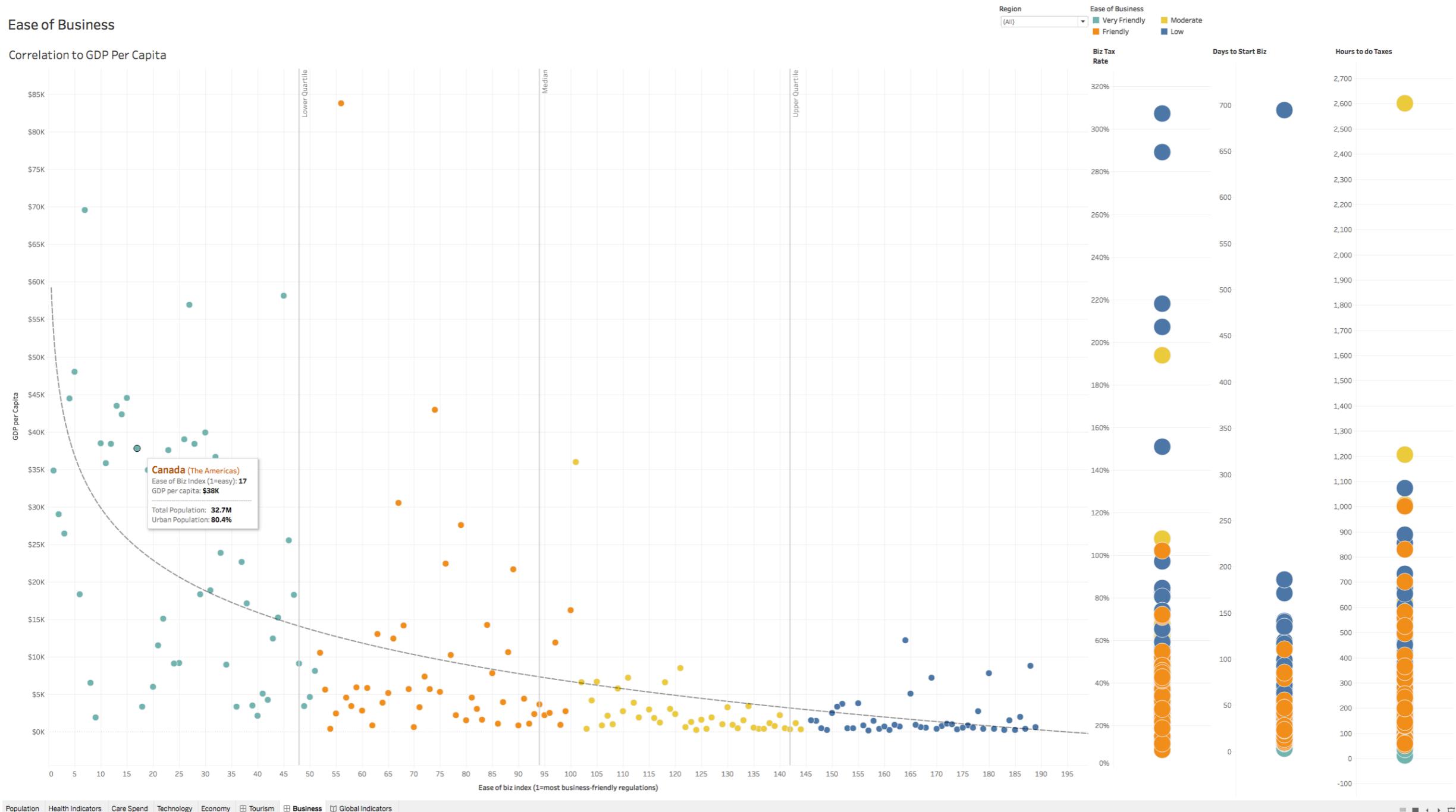
Tableau

World Indicators Sample Workbook

# Selection | What is it good for?

- **To pick data points (and do something with them)**
  - Use to highlight or filter data in other plots | **Linked Views**

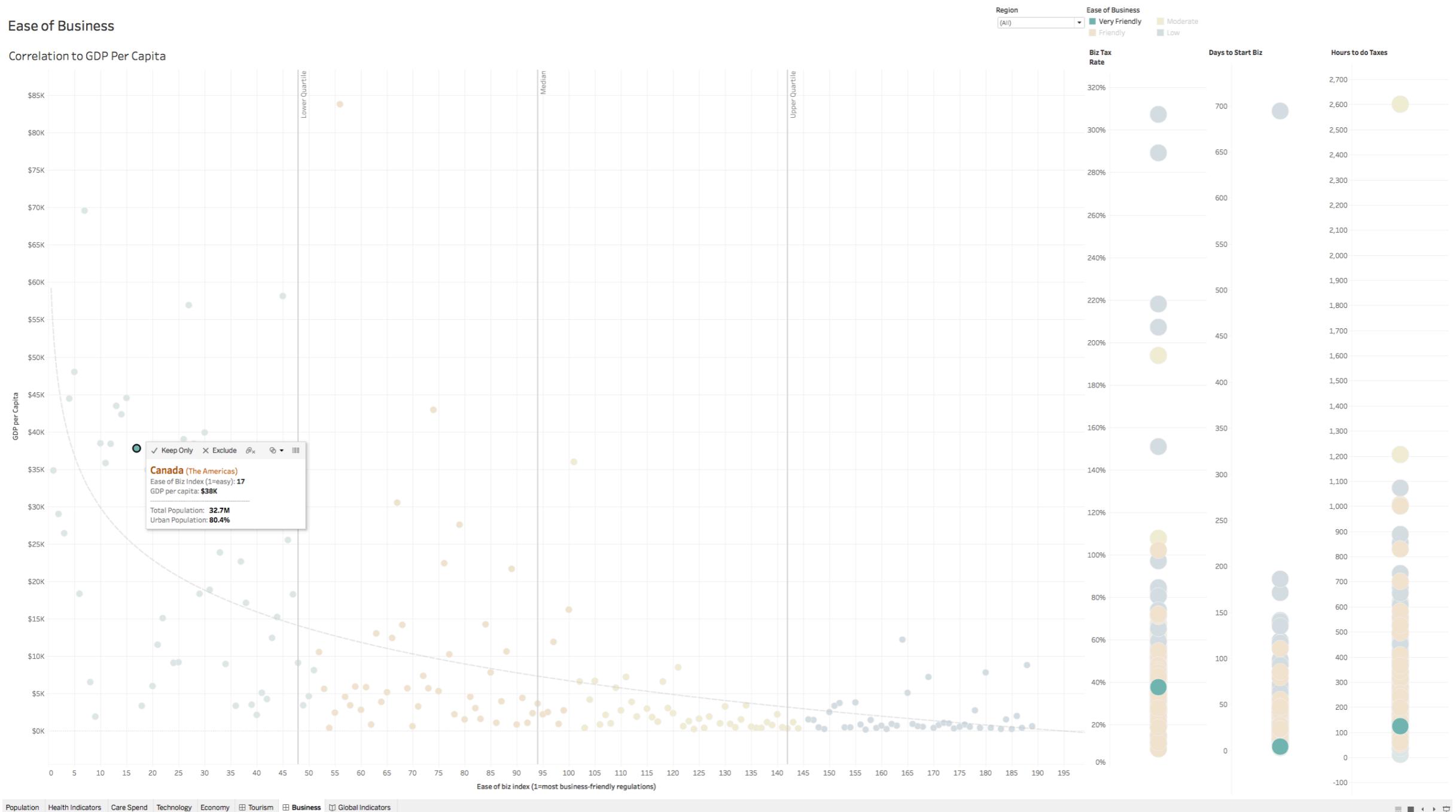
# Linked views



Tableau

World Indicators Sample Workbook

# Linked views



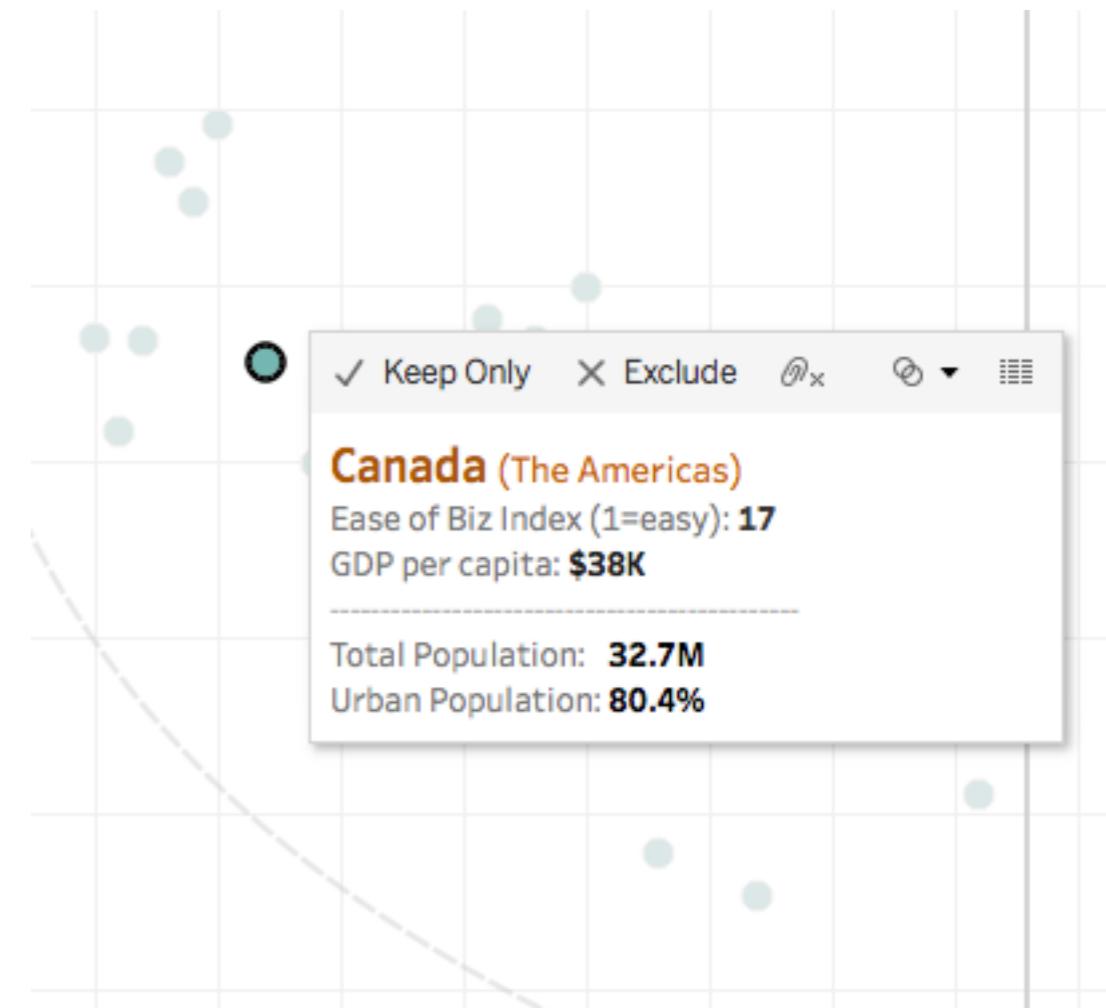
Tableau

World Indicators Sample Workbook

# Selection | What is it good for?

- **To pick data points (and do something with them)**

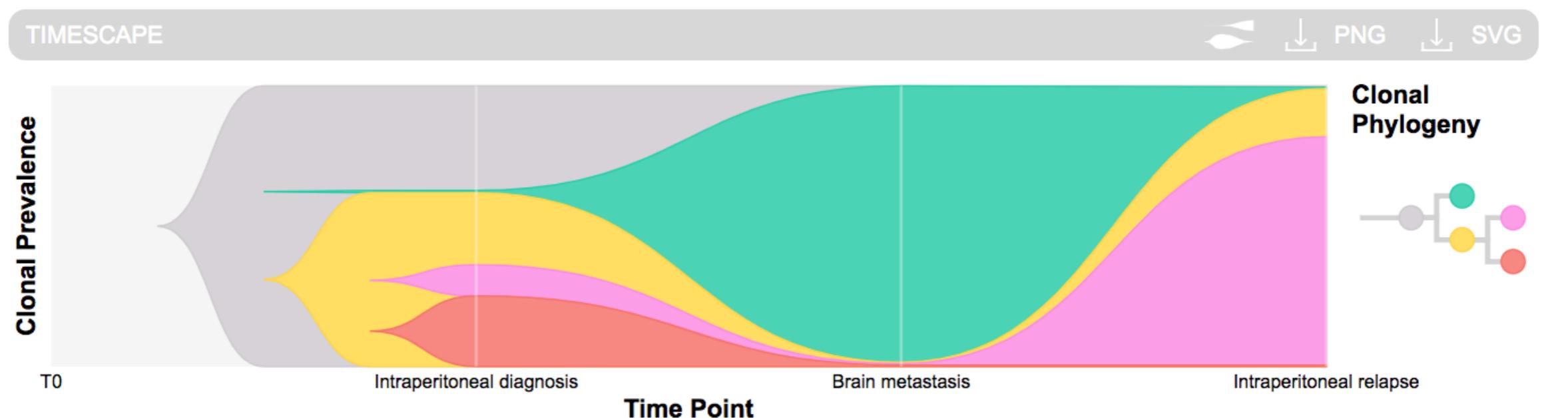
- Use to filter data in other plots (linked views)
- Take action based on those points
  - Remove all other data
  - Exclude selected data
  - Make a group
  - Use as input for a computation



# Selection | What is it good for?

- **To pick data points (and do something with them)**
  - Use to filter data in other plots (linked views)
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    - Remove all other data
    - Exclude selected data
    - Make a group
    - Use as input for a computation
- **Focus your attention on a subset**
  - Highlighting emphasizes the selected set while preserving overall context of the plot

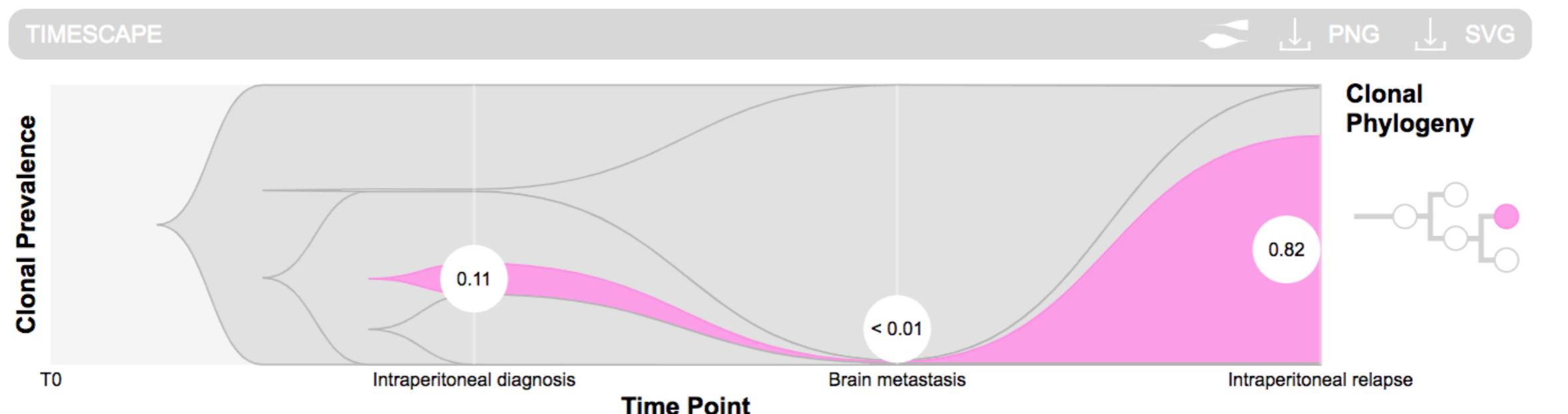
# Highlighting | Emphasize subset while keeping context



TimeScape

[https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape_vignette.html)

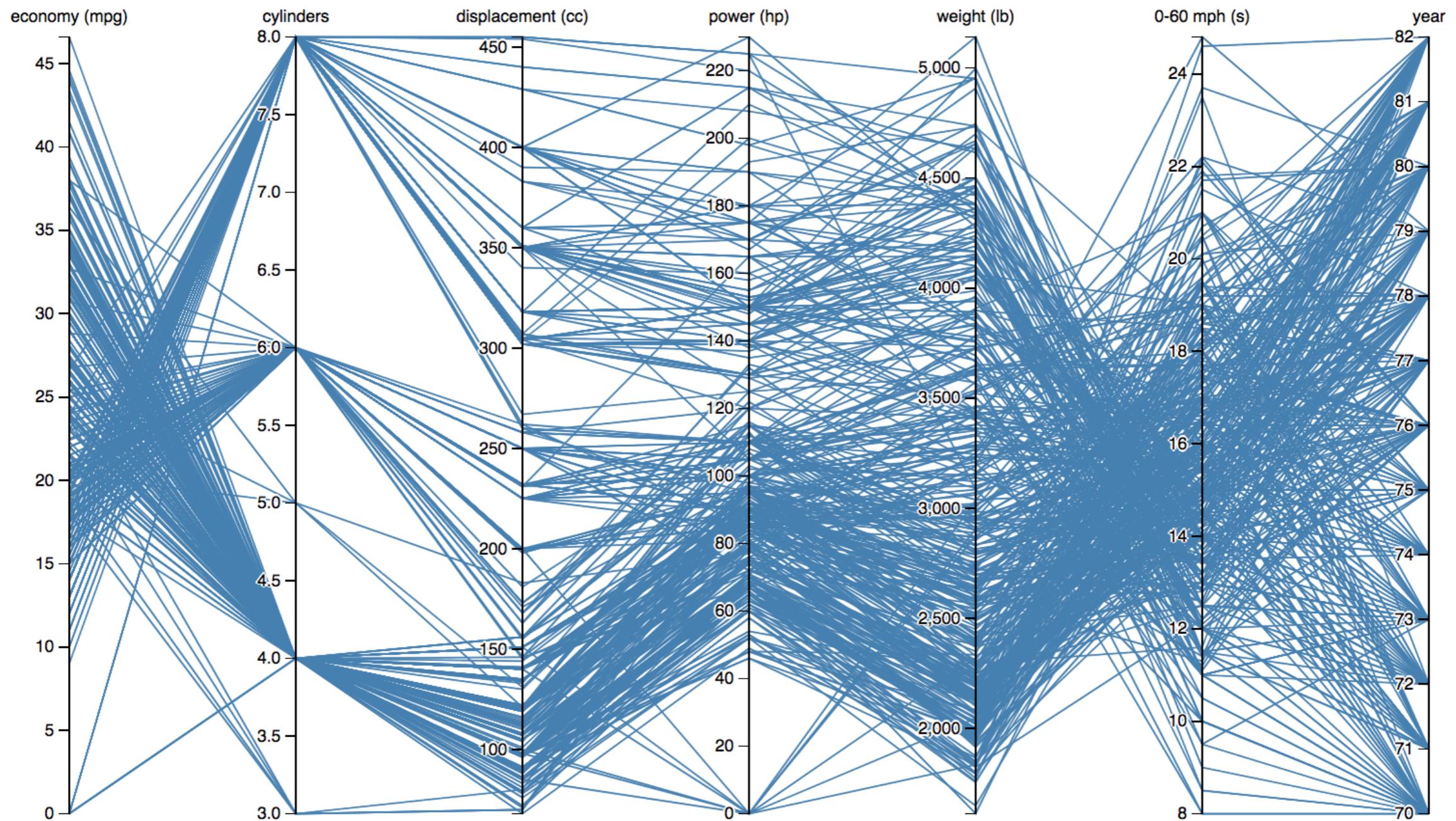
# Highlighting | Emphasize subset while keeping context



TimeScape

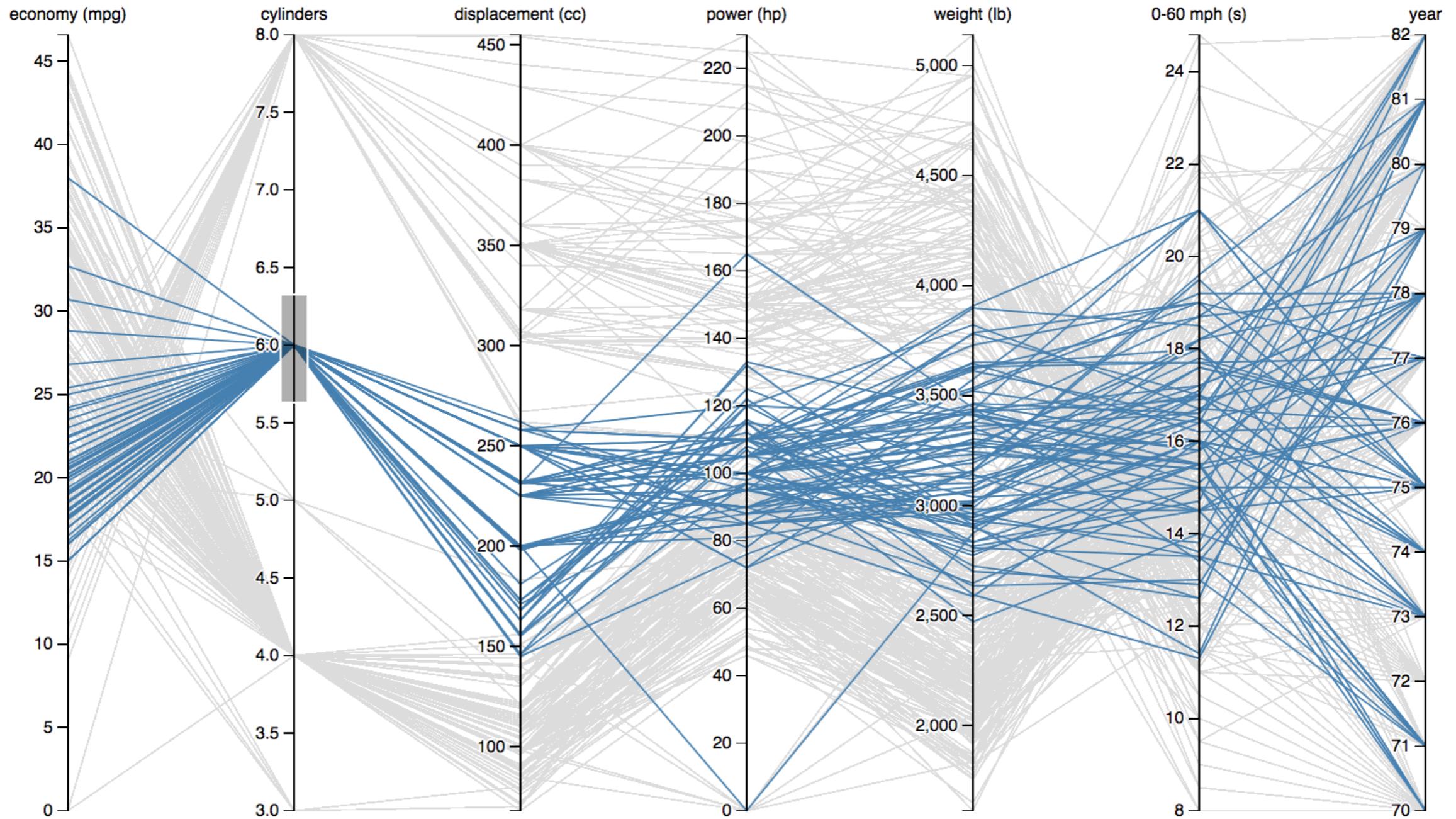
[https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape_vignette.html)

# Highlighting | Emphasize subset while keeping context



<https://bl.ocks.org/mbostock/1341021>

# Highlighting | Emphasize subset while keeping context

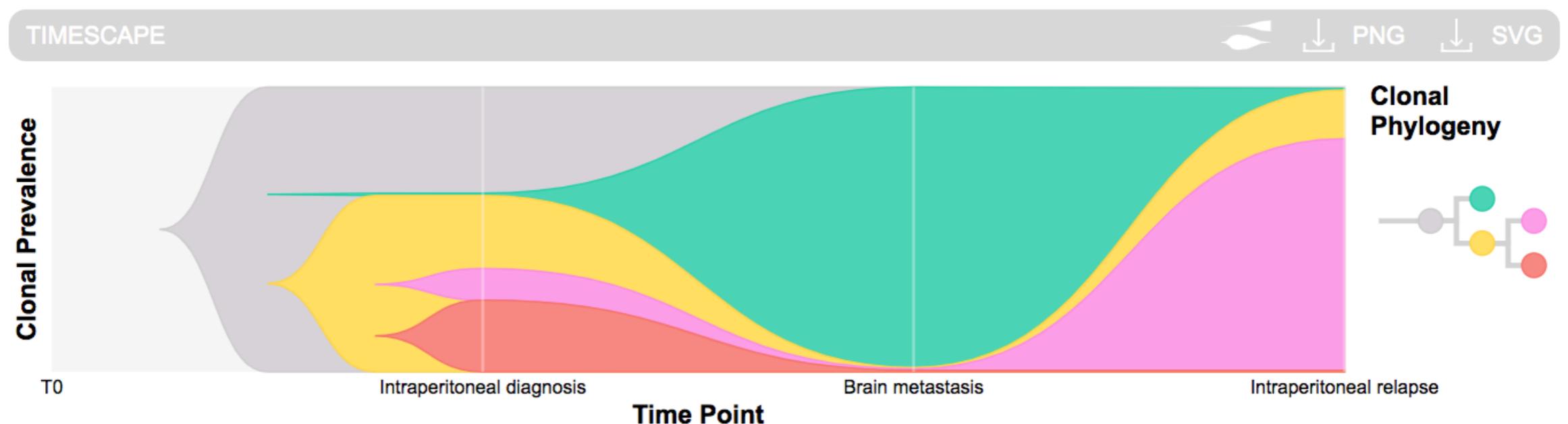


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# Selection | What is it good for?

- **To pick data points (and do something with them)**
  - Use to filter data in other plots (linked views)
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    - Use as input for a computation
- **Focus your attention on a subset**
  - Highlighting emphasizes the selected set while preserving overall context of the plot
- **Hover is great way to show details on demand**

# Hover | Details on demand

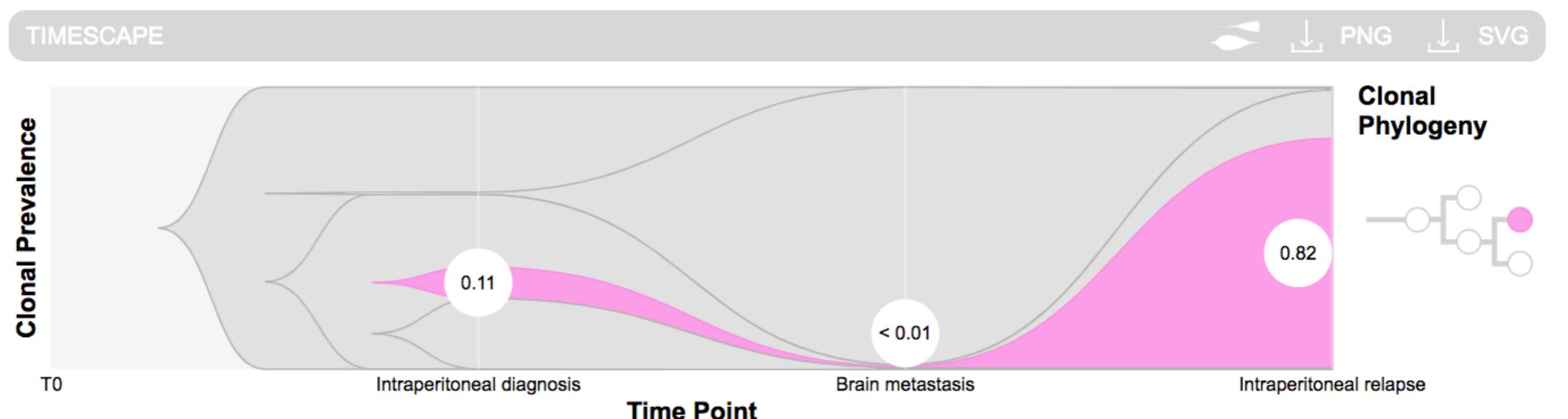


TimeScape

[https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape_vignette.html)

# Hover | Details on demand

Get exact quantitative values on hover



**TimeScape**

[https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape_vignette.html)

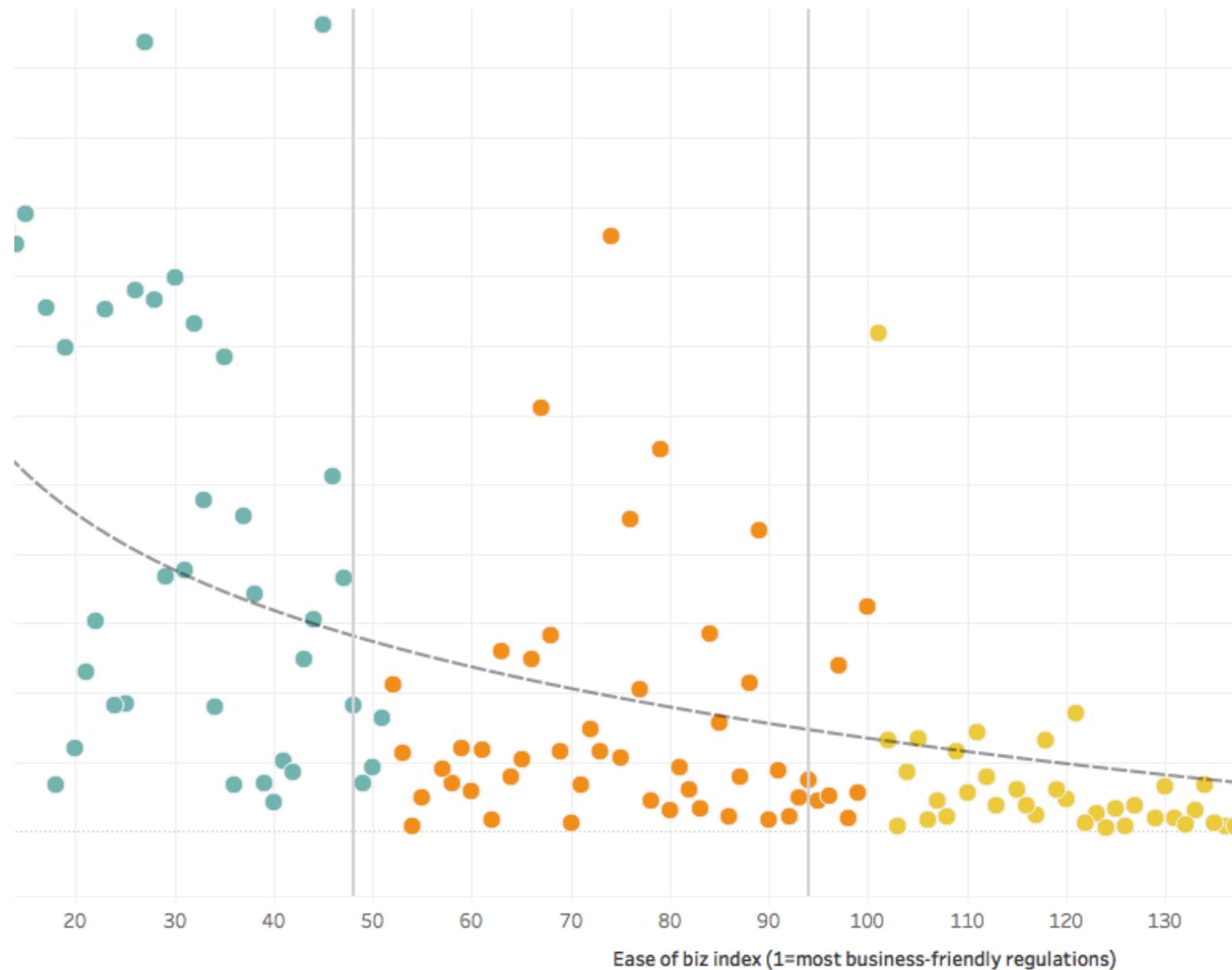
**“If you make a rollover or tooltip,  
assume nobody will see it.  
If it's important, make it explicit.”**

- Gregor Aisch, NYTimes

# Choosing colours | highlighting + hover

- **When starting to design a new visualization, you can draw inspiration from what already exists**
  - Look to established tools for robust conventions (take advantage of their user testing!)
  - Be inspired by existing plots you enjoy using or find effective

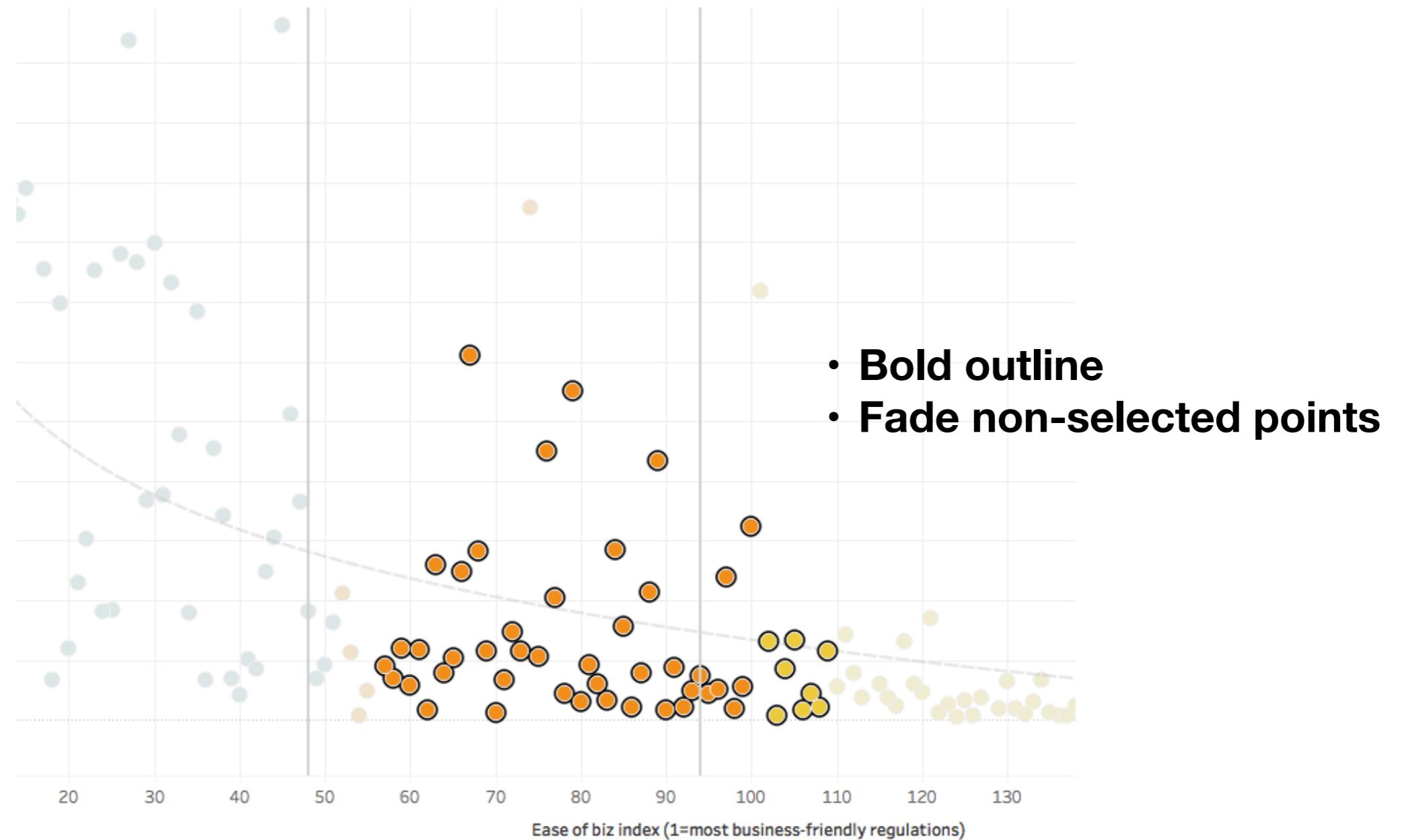
# Choosing colours | highlighting + hover



**Tableau**

World Indicators Sample Workbook

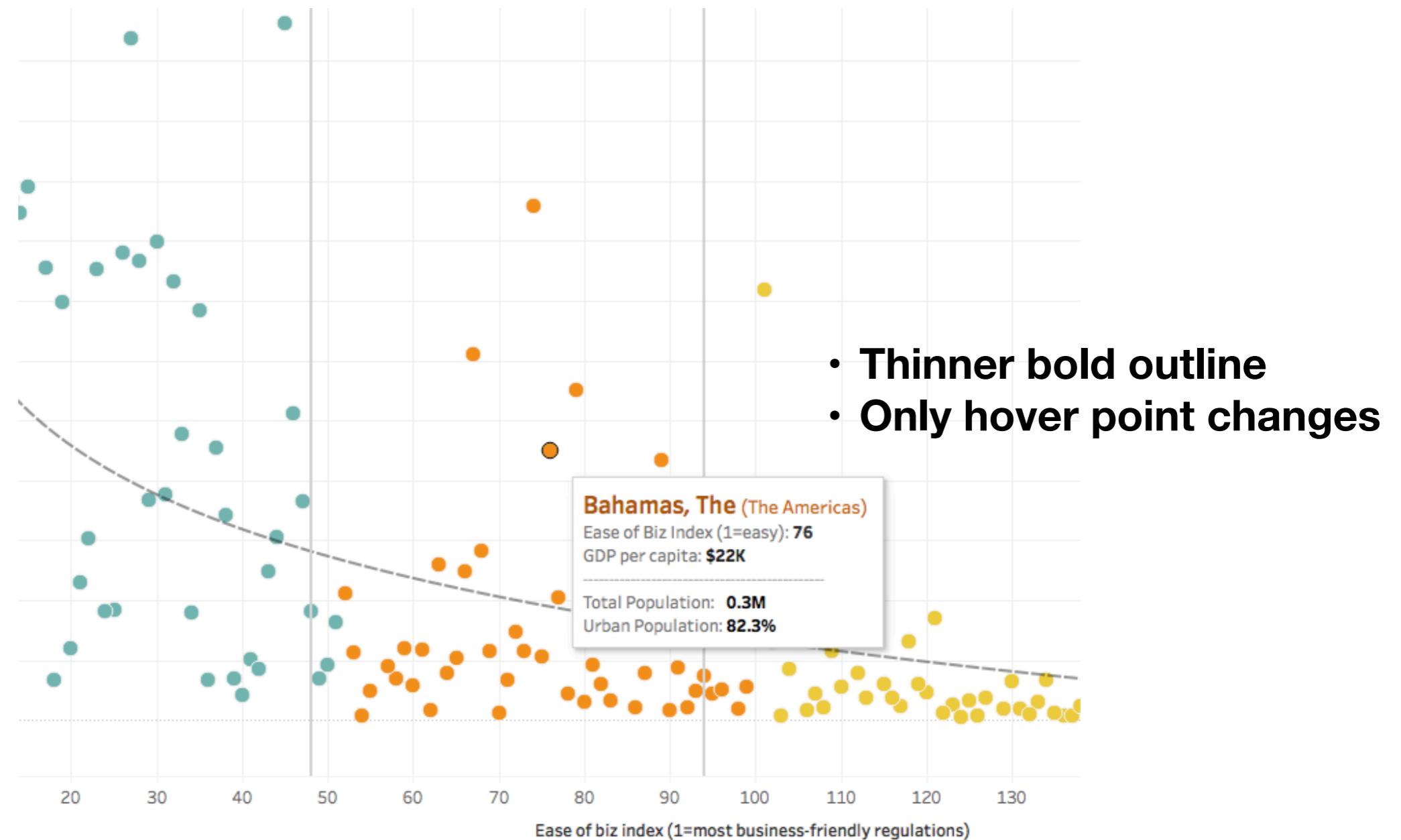
# Choosing colours | highlighting + hover



**Tableau**

World Indicators Sample Workbook

# Choosing colours | highlighting + hover



Tableau

World Indicators Sample Workbook

# Common selection conventions

- **Creating a selection**

- Direct click on the item to select
- One point selected at a time by default
- Click and drag a rectangular selection anywhere on the plot to select points

- **Adding points to the selection**

- Shift or Ctrl (Command on Mac) and click/drag to add points

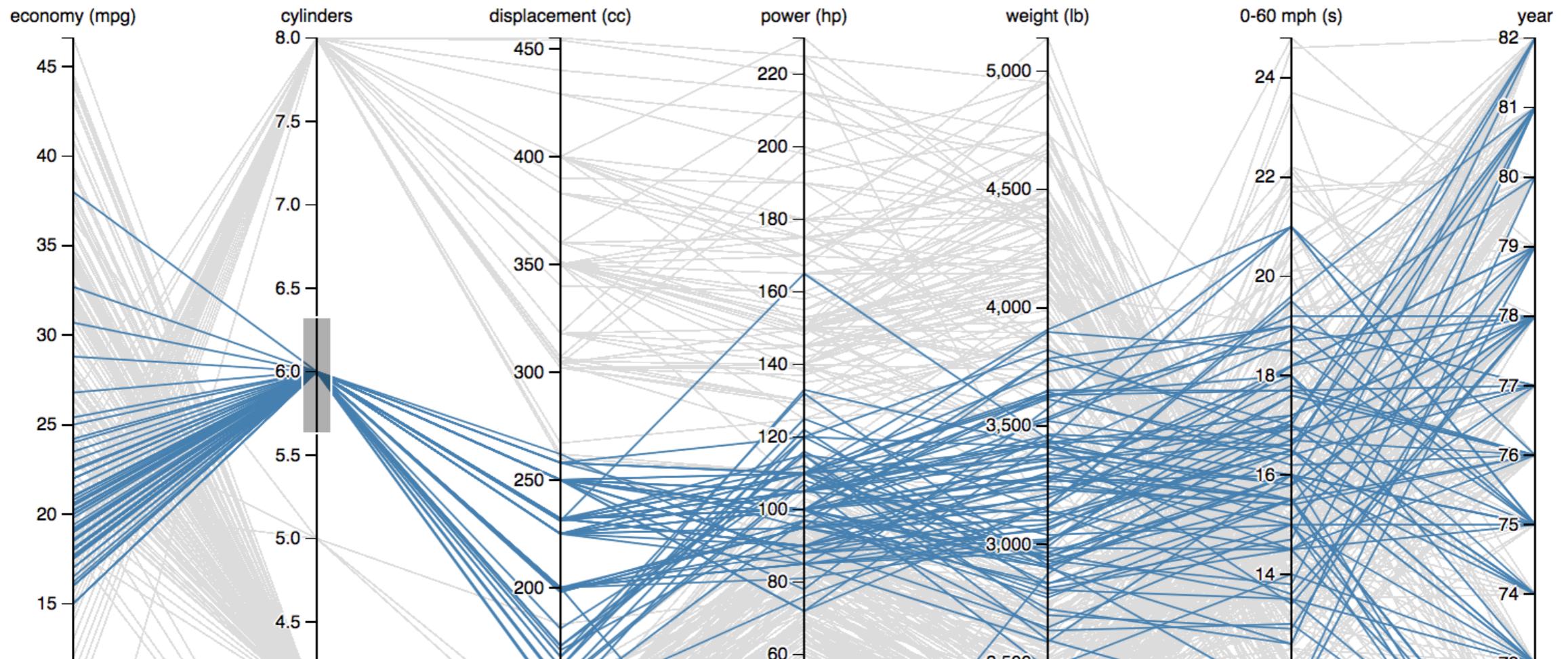
- **Removing points from the selection**

- Click (or in some cases Ctrl-click) on the selected item to de-select it

- **Clearing the whole selection at once**

- Click on the background of the plot

# Selection example



## Does not follow common conventions

- Must be very close to an axis to create a selection
- De-selection requires clicking on the axis (very small hit target)
- Why do you think the author chose these interactions?

<https://bl.ocks.org/mbostock/1341021>

# Sorting + Alignment + Layout

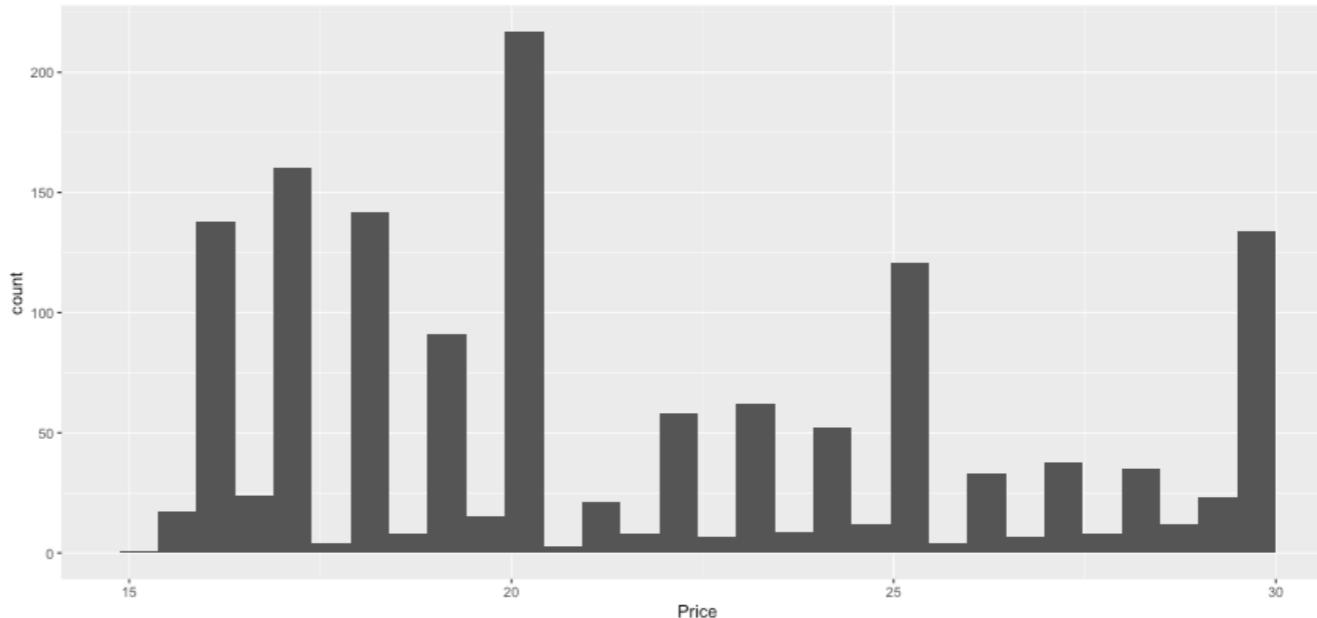
# Tables

## BC Liquor price app

Select your desired price range.

Select your alcoholic beverage type.

- BEER
- REFRESHMENT
- SPIRITS
- WINE



Type	Subtype	Country	Name	Alcohol_Content	Price	Sweetness
WINE	TABLE WINE RED	CANADA	SOMMET ROUGE	12.00	29.99	0
WINE	TABLE WINE WHITE	ITALY	PINOT GRIGIO DELLE VENEZIE - RUFFINO LUMINA	12.50	15.99	0
WINE	MONTILLA	SPAIN	ALVEAR - MEDIUM DRY	17.00	17.99	3
WINE	TABLE WINE RED	UNITED STATES OF AMERICA	CALIFORNIA RED - APOTHIC WINEMAKERS BLEND	13.10	16.99	0
WINE	TABLE WINE WHITE	FRANCE	VOUVRAY SEC - VINCENT RAIMBAULT BEL AIR 10/11	12.50	23.99	1
WINE	TABLE WINE WHITE	ISRAEL	VIognier - GALIL MOUNTAIN KOSHER	14.00	18.99	0
WINE	TABLE WINE WHITE	GERMANY	RIESLING KABINETT - B RESS SCHLOSS REICHARTSHAUSEN	9.50	26.99	1

## Basic table has limited analytical value

- No interactive sorting
- Have to scroll extensively

From Lecture 3

<http://stat545.com/Classroom/notes/cm107.nb.html#getting-started-with-shiny>

# Tables | Sorting + Pagination + Search

Show	10	entries	Search:		
	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
14	4.3	3	1.1	0.1	setosa
9	4.4	2.9	1.4	0.2	setosa
39	4.4	3	1.3	0.2	setosa
43	4.4	3.2	1.3	0.2	setosa
42	4.5	2.3	1.3	0.3	setosa
4	4.6	3.1	1.5	0.2	setosa
7	4.6	3.4	1.4	0.3	setosa
23	4.6	3.6	1	0.2	setosa
48	4.6	3.2	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa

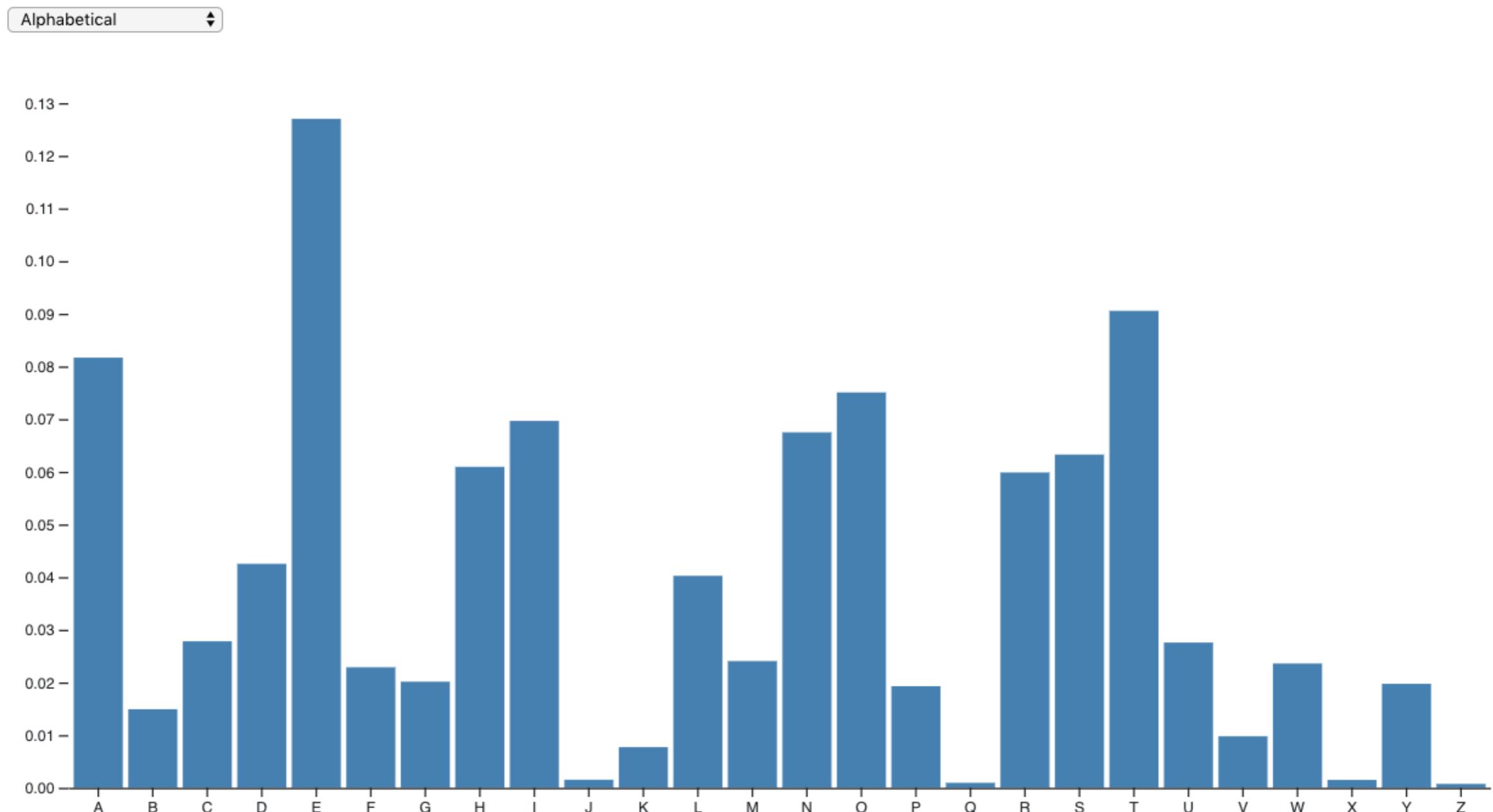
Showing 1 to 10 of 150 entries

Previous 1 2 3 4 5 ... 15 Next

DT: An R interface to the DataTables library

<https://rstudio.github.io/DT/>

# Bar Chart

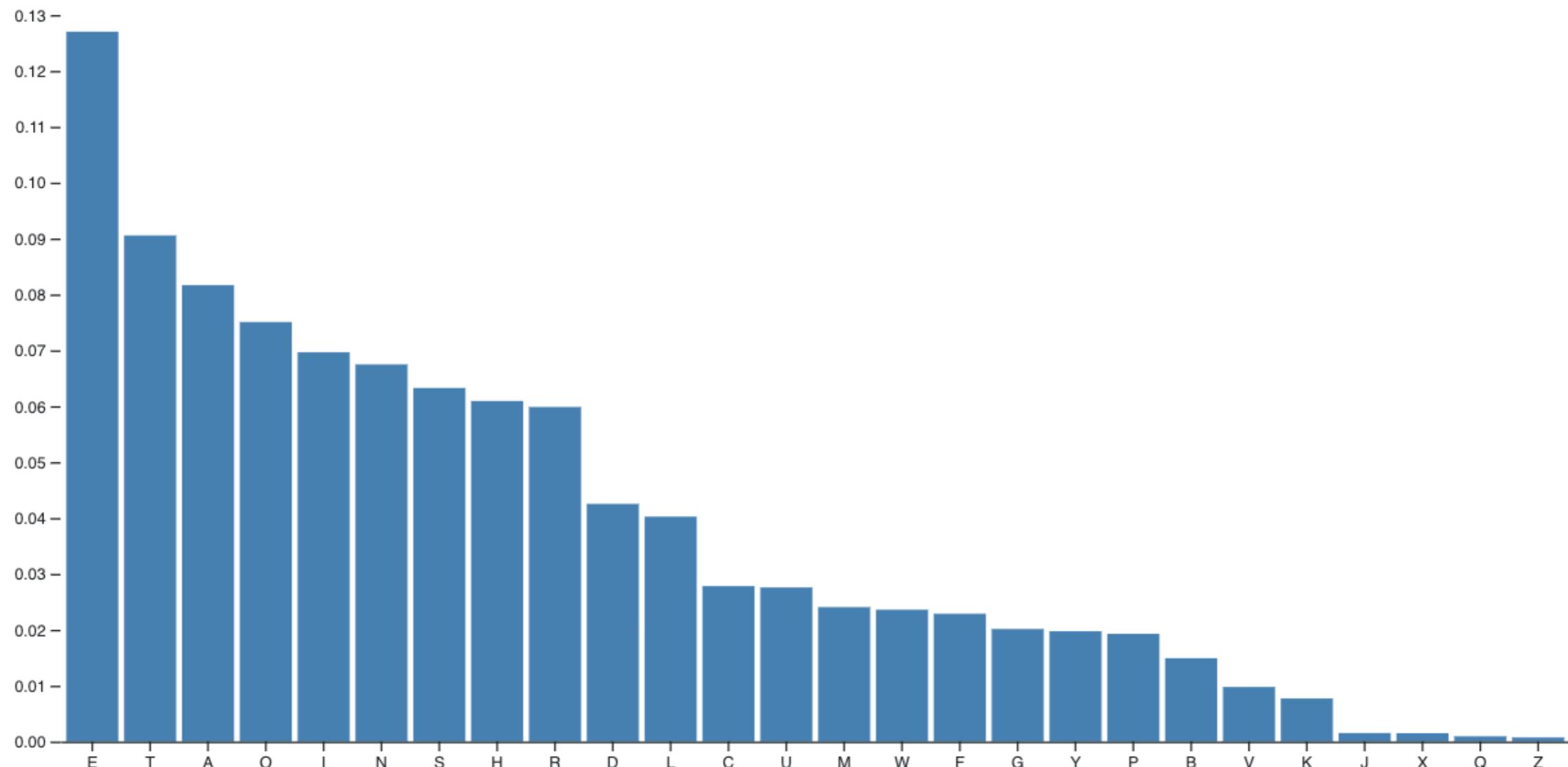


<https://beta.observablehq.com/@mbostock/d3-sortable-bar-chart>

# Bar Chart | Sorting

Frequency, descending ▾

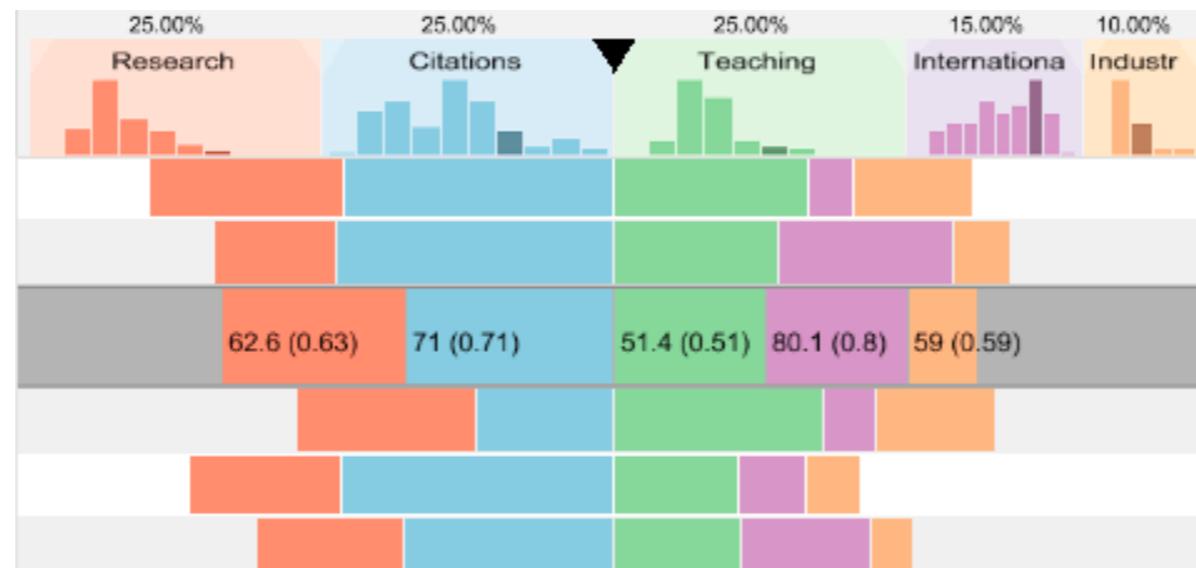
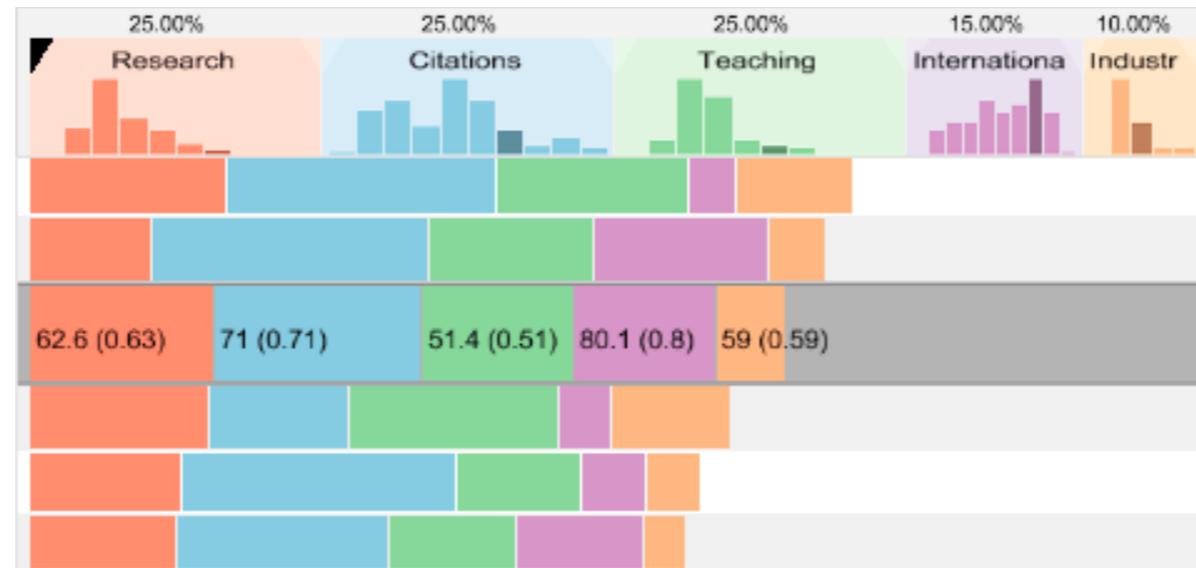
Trends and extremes are easier to detect



<https://beta.observablehq.com/@mbostock/d3-sortable-bar-chart>

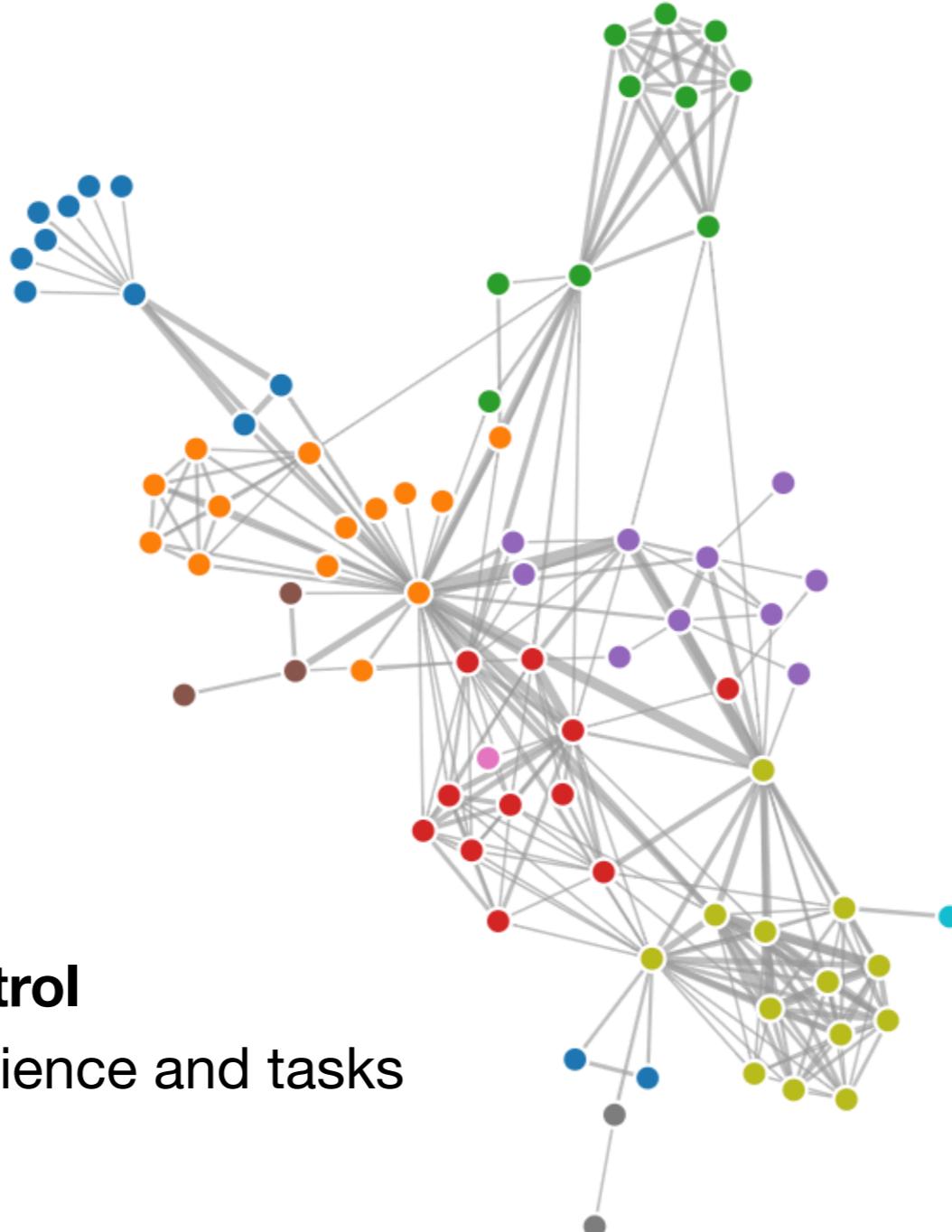
# Stacked bar charts

Ability to align to different segments supports flexible comparison



<https://caleydo.org/tools/lineup/>

# Changing the layout



## Fun but hard to control

- Design for your audience and tasks

<https://beta.observablehq.com/@mbostock/d3-force-directed-graph>

# Changing the layout



[https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape_vignette.html)

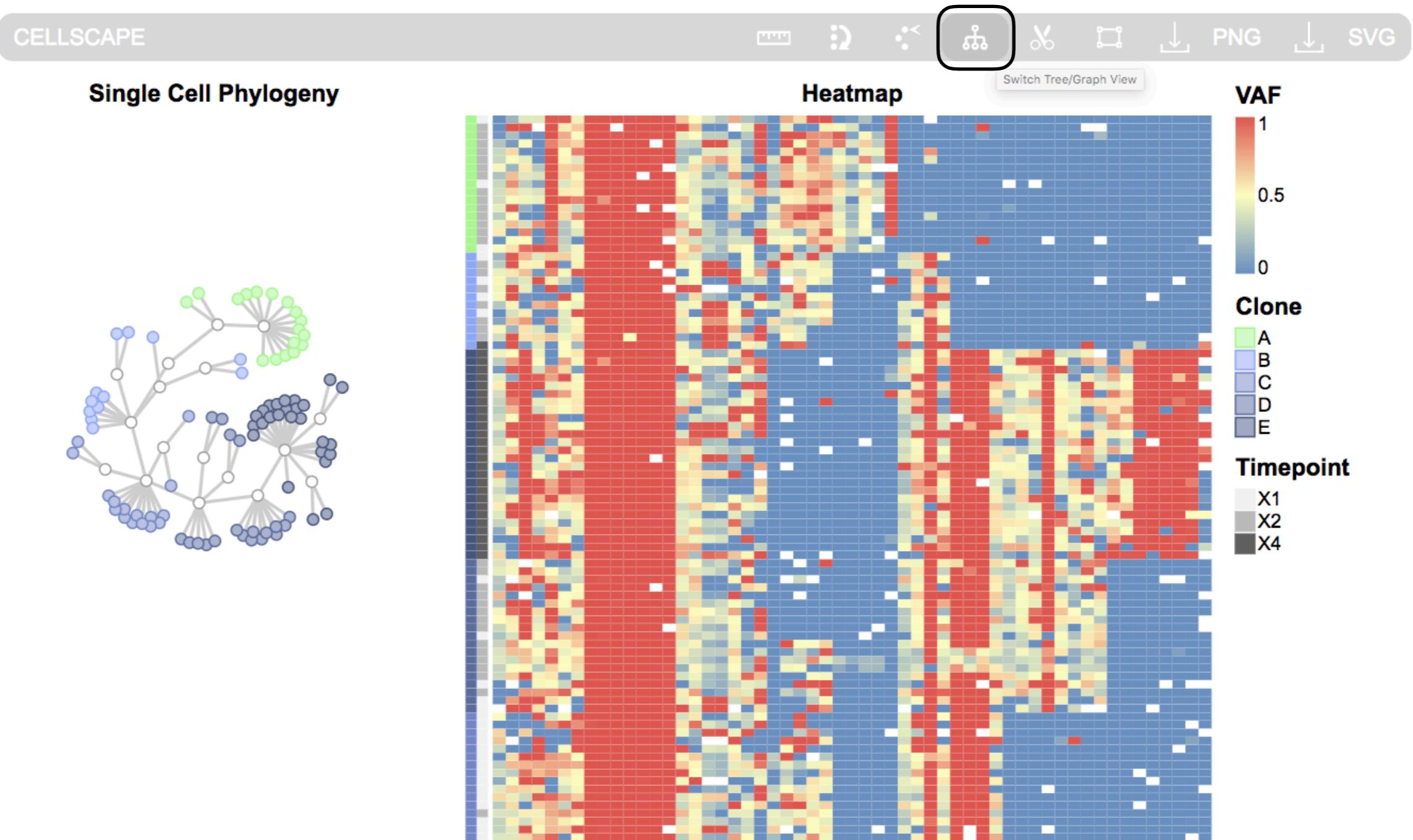
# Changing the layout



[https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape_vignette.html)

# Changing the layout

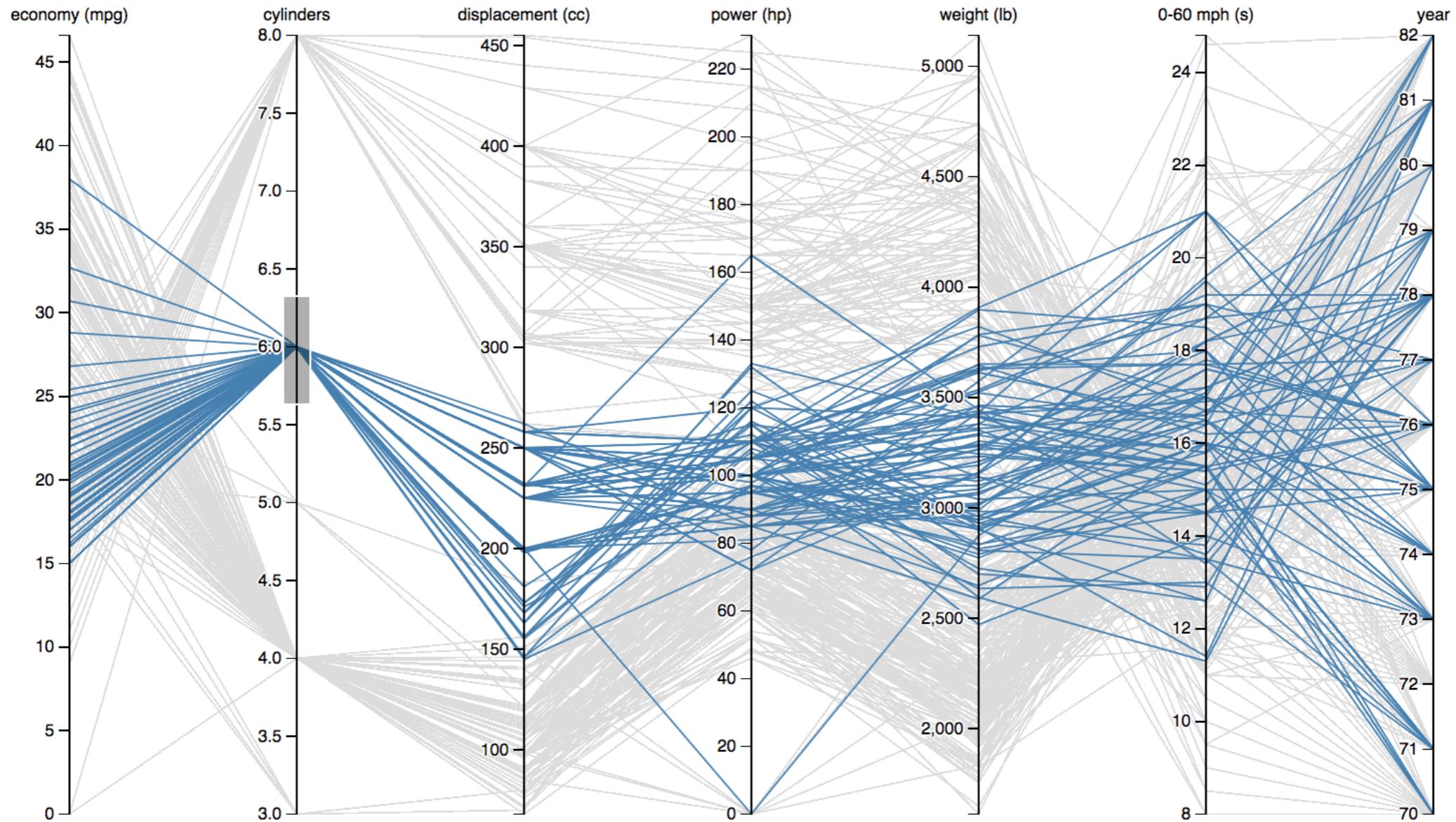
Toggle to alternative layout



[https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape_vignette.html)

# Changing the layout

Changes in axes order may make line patterns easier to interpret

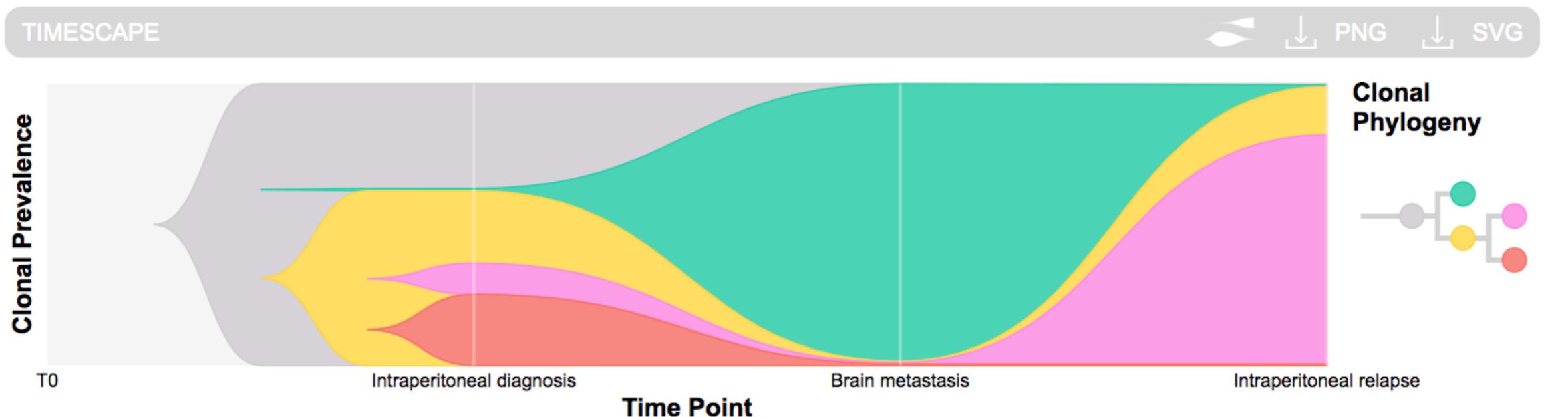


*Note change in cursor when hover over an axis label*

<https://bl.ocks.org/jasondavies/1341281>

# Animated Transitions

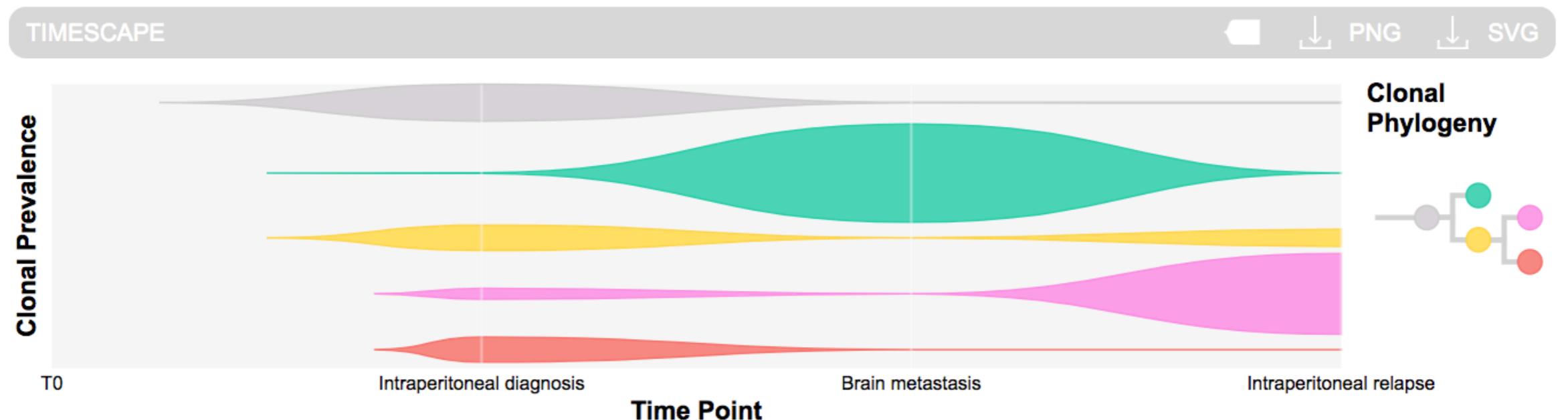
# Animated transitions



TimeScape

[https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/timescape/inst/doc/timescape_vignette.html)

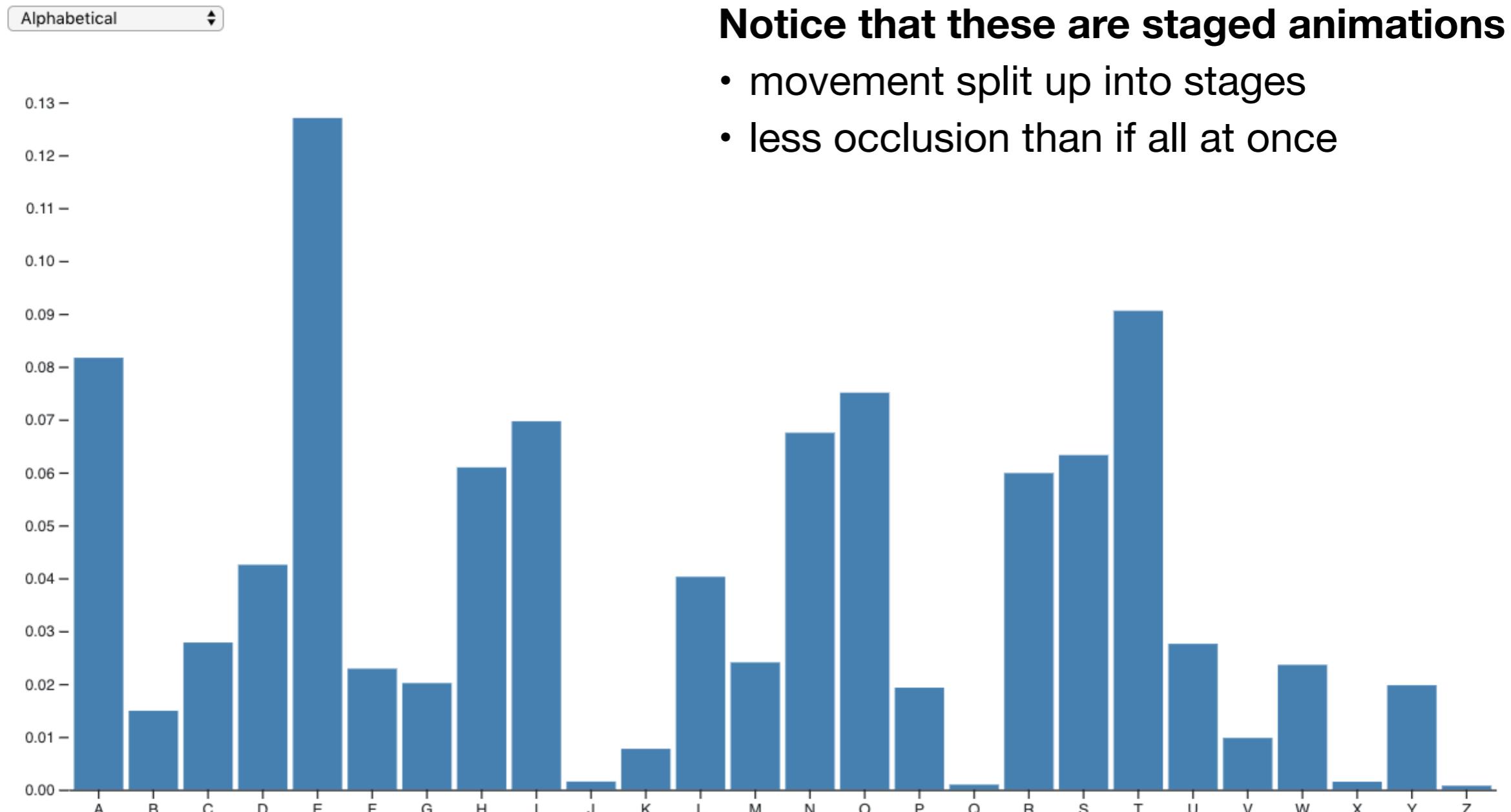
# Animated transitions



TimeScape

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# Bar Chart



<https://beta.observablehq.com/@mbostock/d3-sortable-bar-chart>

# Empirical evidence that transitions help

- **Subjects were asked to follow two objects across a transition and identify the locations of the objects in the final graphic**
  - Animation is significantly better than static across all conditions
  - Staged animation (separated into parts/stages) outperforms animation (all at once)

<https://www.youtube.com/watch?v=vLk7mlAtEXI>

Animated Transitions in Statistical Data Graphics  
Heer and Robertson.

IEEE Trans. on Visualization and Computer Graphics (Proc. InfoVis07) 13:6 (2007), 1240– 1247.

# Navigation

# Navigation

## **Changing the point of view from which things are drawn**

- Metaphor of a virtual camera
- When camera viewpoint is changed, the set of items visible in the camera frame also change

# Terminology | Items and Attributes

**Attributes / Dimensions**

The diagram illustrates a dataset represented as a table. A vertical double-headed arrow on the left is labeled 'Items', indicating the rows of the table. A horizontal double-headed arrow at the top is labeled 'Attributes / Dimensions', indicating the columns. The table has six columns: Sepal.Length, Sepal.Width, Petal.Length, Petal.Width, and Species. The Species column contains categorical values: setosa. The table consists of 10 rows, each representing an item with its corresponding attribute values.

	Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
14	4.3	3	1.1	0.1	setosa
9	4.4	2.9	1.4	0.2	setosa
39	4.4	3	1.3	0.2	setosa
43	4.4	3.2	1.3	0.2	setosa
42	4.5	2.3	1.3	0.3	setosa
4	4.6	3.1	1.5	0.2	setosa
7	4.6	3.4	1.4	0.3	setosa
23	4.6	3.6	1	0.2	setosa
48	4.6	3.2	1.4	0.2	setosa
3	4.7	3.2	1.3	0.2	setosa

# Navigation

## → Navigate

→ Item Reduction

→ Zoom

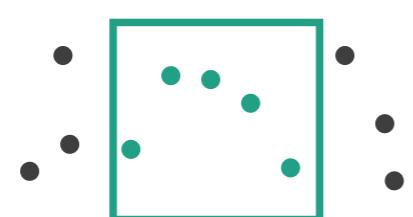
*Geometric* or *Semantic*



→ Pan/Translate



→ Constrained



### Zoom

Moving the camera closer or farther from the plane

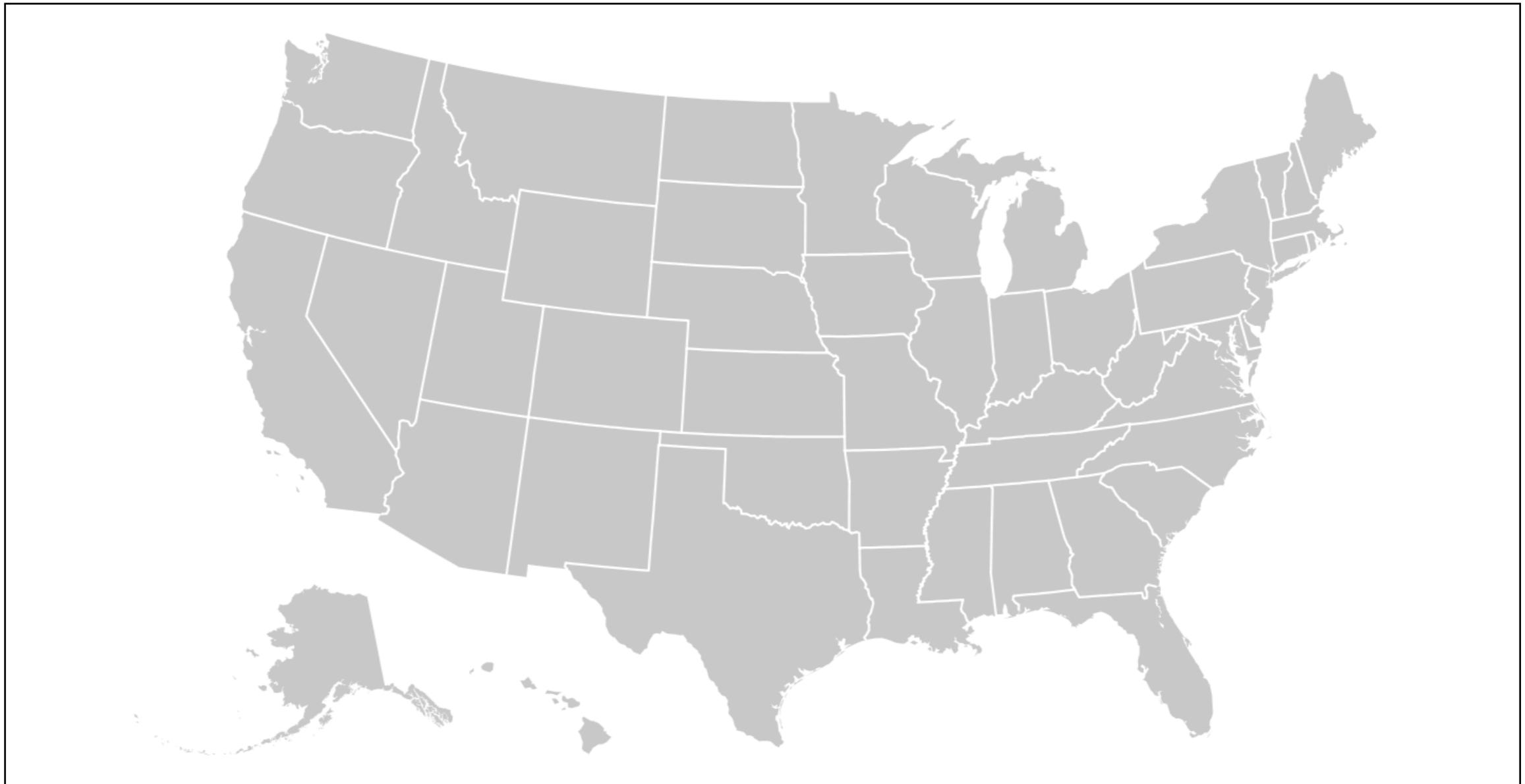
### Pan / Translate

Moving the camera parallel to the plane, either up/down or side to side

### Constrained / Unconstrained

How much control the user has over the camera motion

# Zoom | Examples of geometric zoom

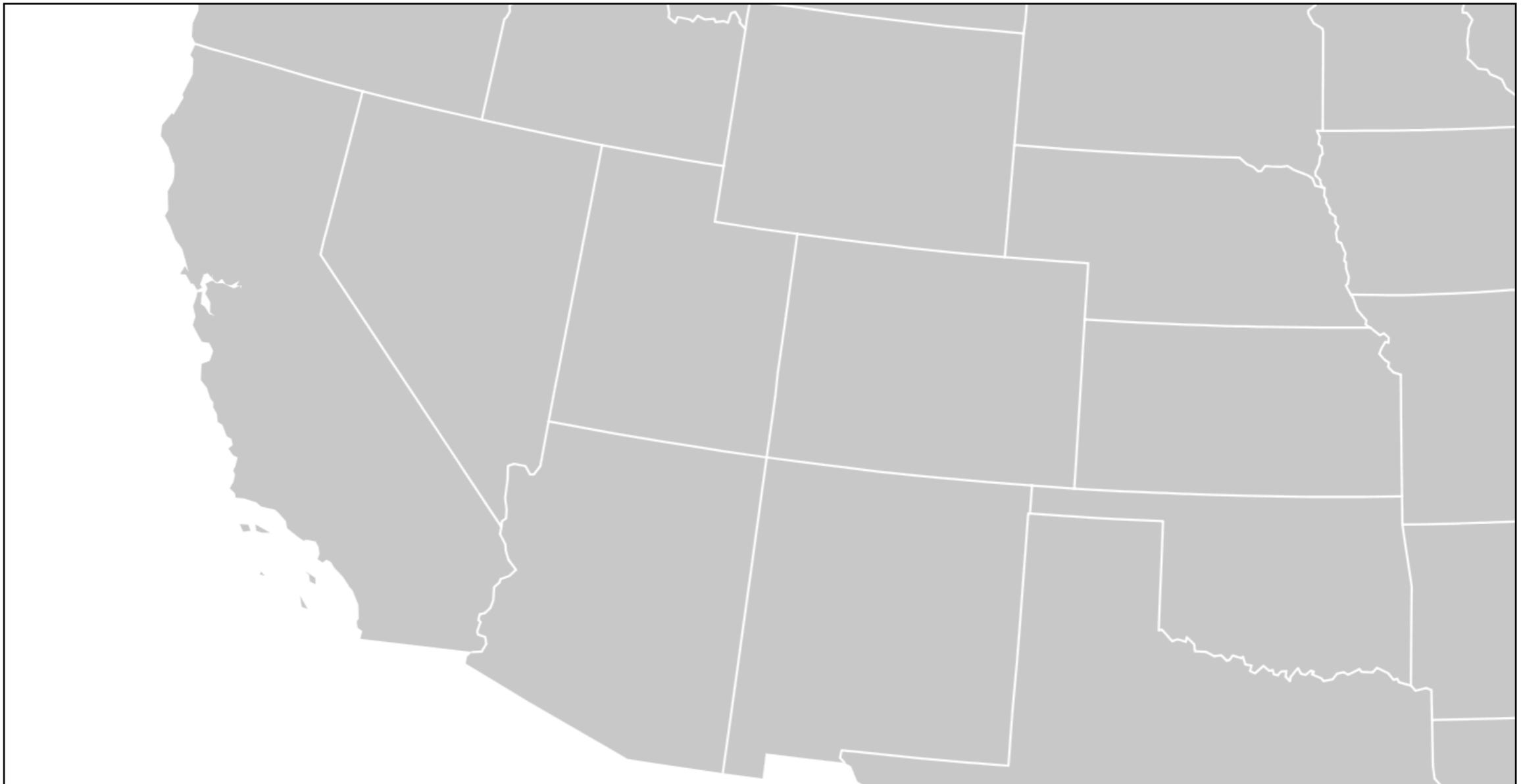


- **Geometric zoom**

- Zooming in | fewer items, which appear larger
- Zooming out | more items, which appear smaller

<https://bl.ocks.org/mbostock/9656675>

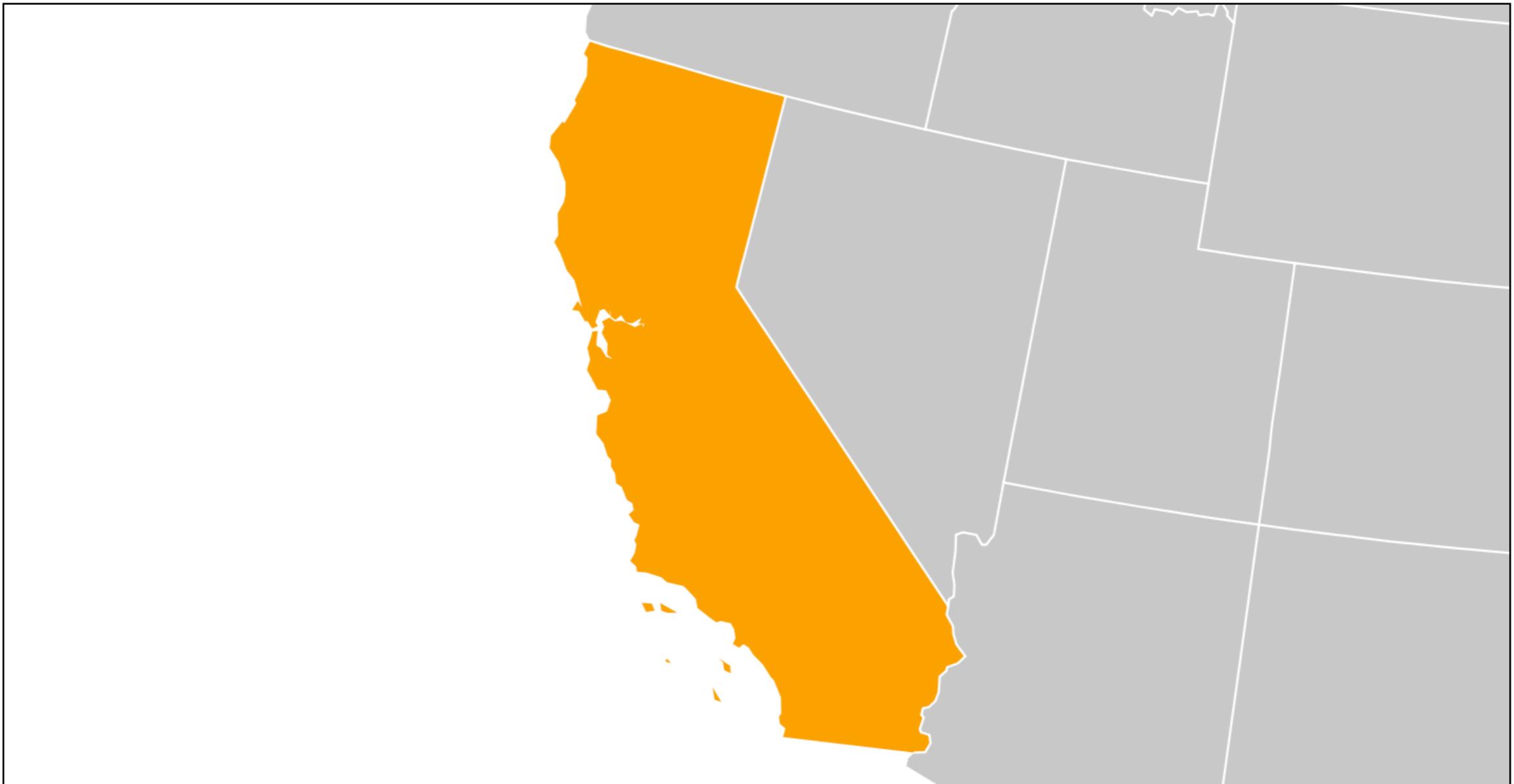
# Zoom | Example 1



- **Unconstrained zoom**
  - As a user, I can freely control the camera motion

<https://bl.ocks.org/mbostock/9656675>

# Zoom | Example 2



- **Constrained zoom**
  - As a user, my ability to control the camera motion is limited

<https://bl.ocks.org/mbostock/4699541>

# Constrained versus unconstrained zoom

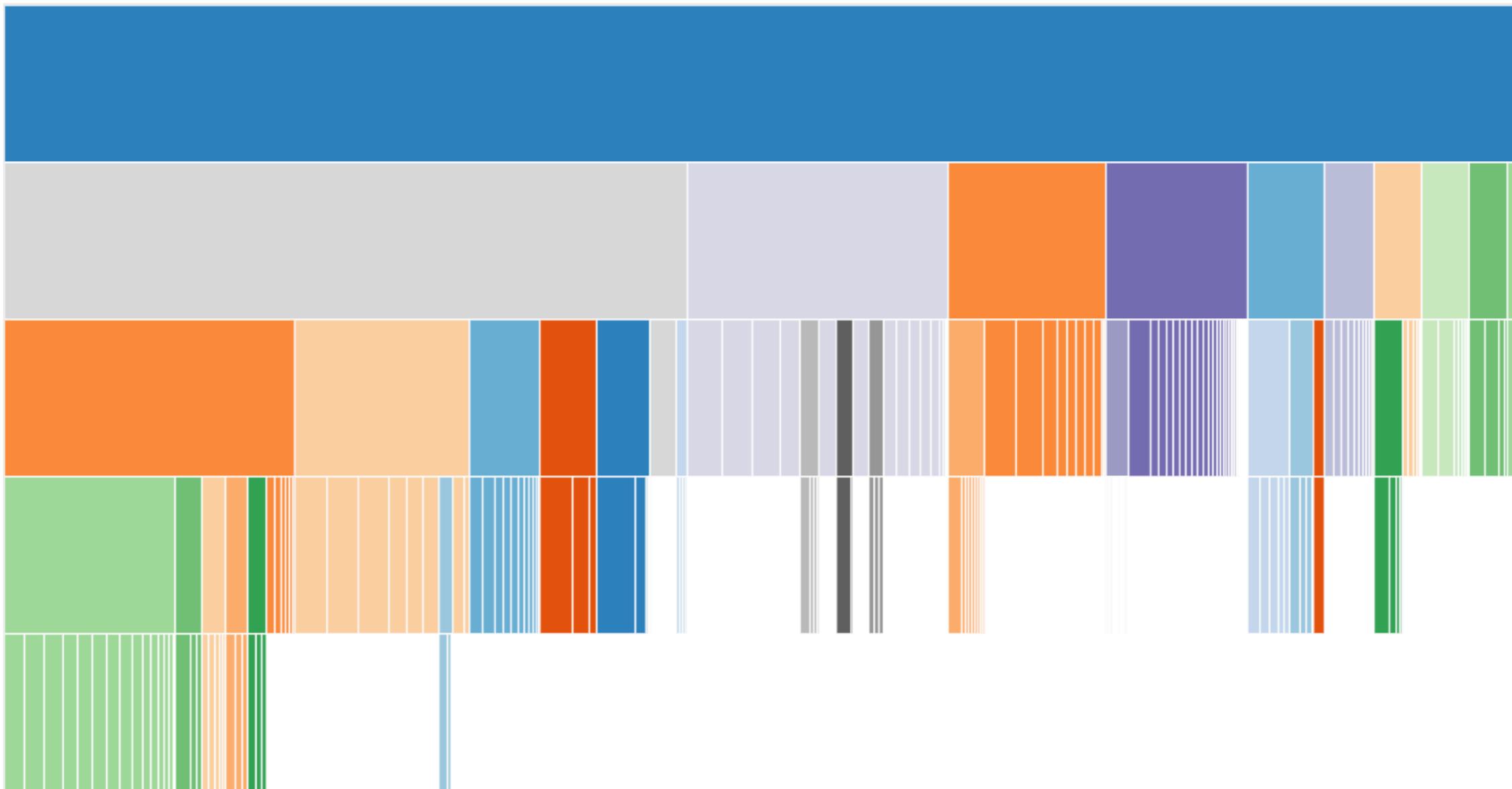
- **Constrained**

- More effort to design + implement
- Easier for the user to manipulate (click on target and view takes care of the rest)
- Restricted navigation may inhibit certain analytical tasks (e.g. only see fixed zoom levels)

- **Unconstrained**

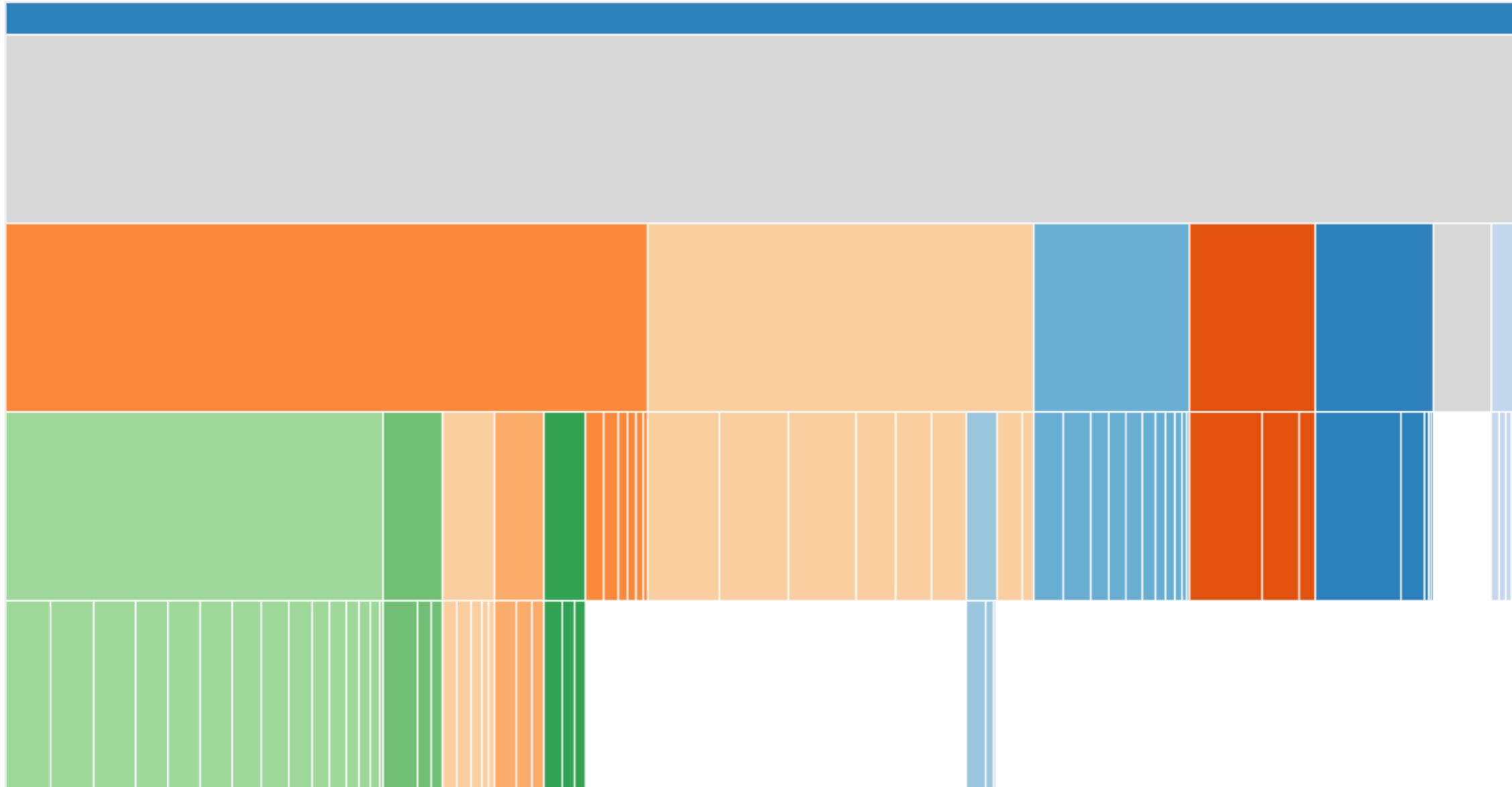
- Less effort to design + implement
- More difficult for the user to manipulate
- Gives user greater control to use zoom level, which may be useful for their task

# Navigating a hierarchy



<https://bl.ocks.org/mbostock/1005873>

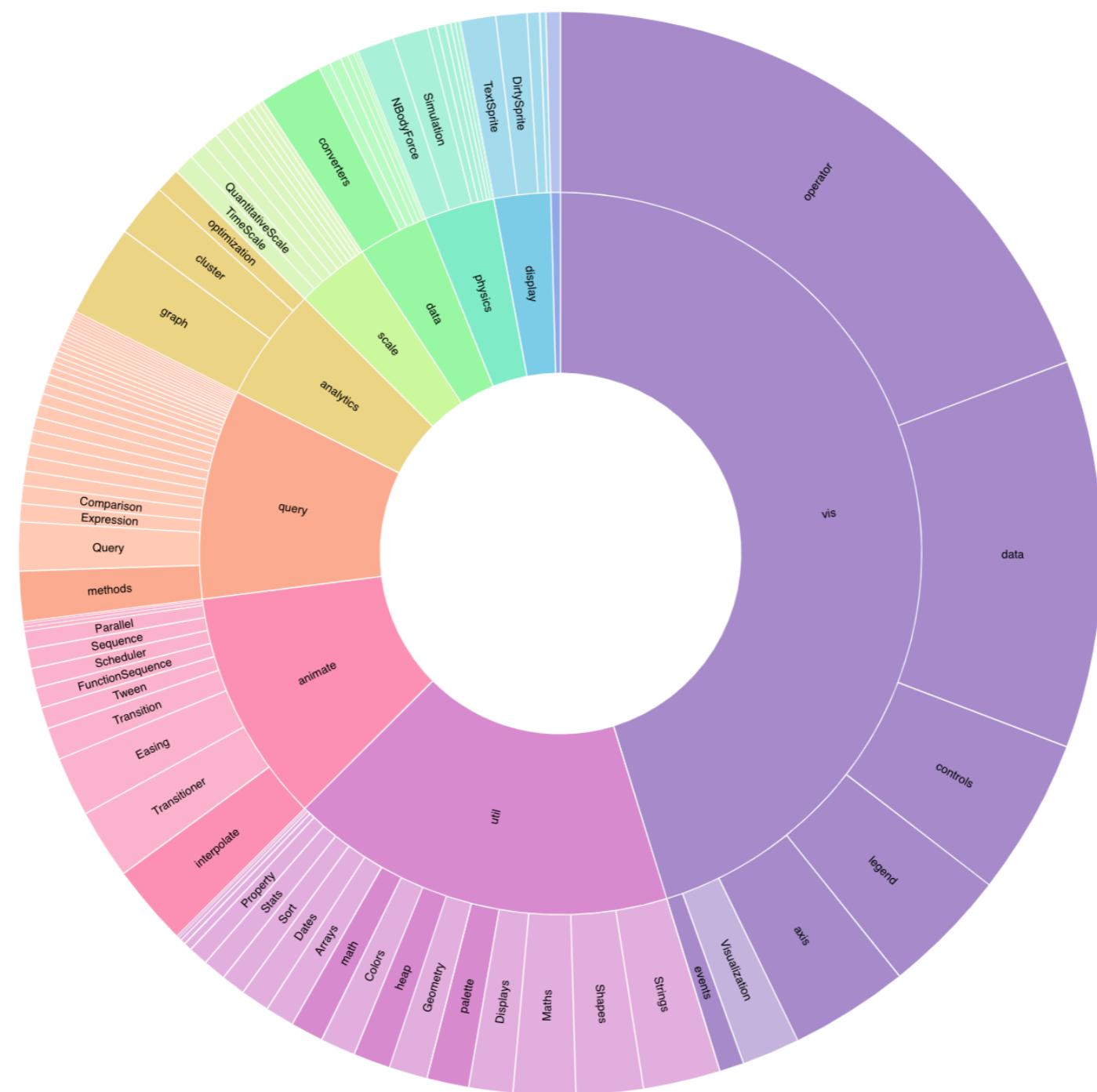
# Navigating a hierarchy



**How do I go back? Notice the top bar hint**

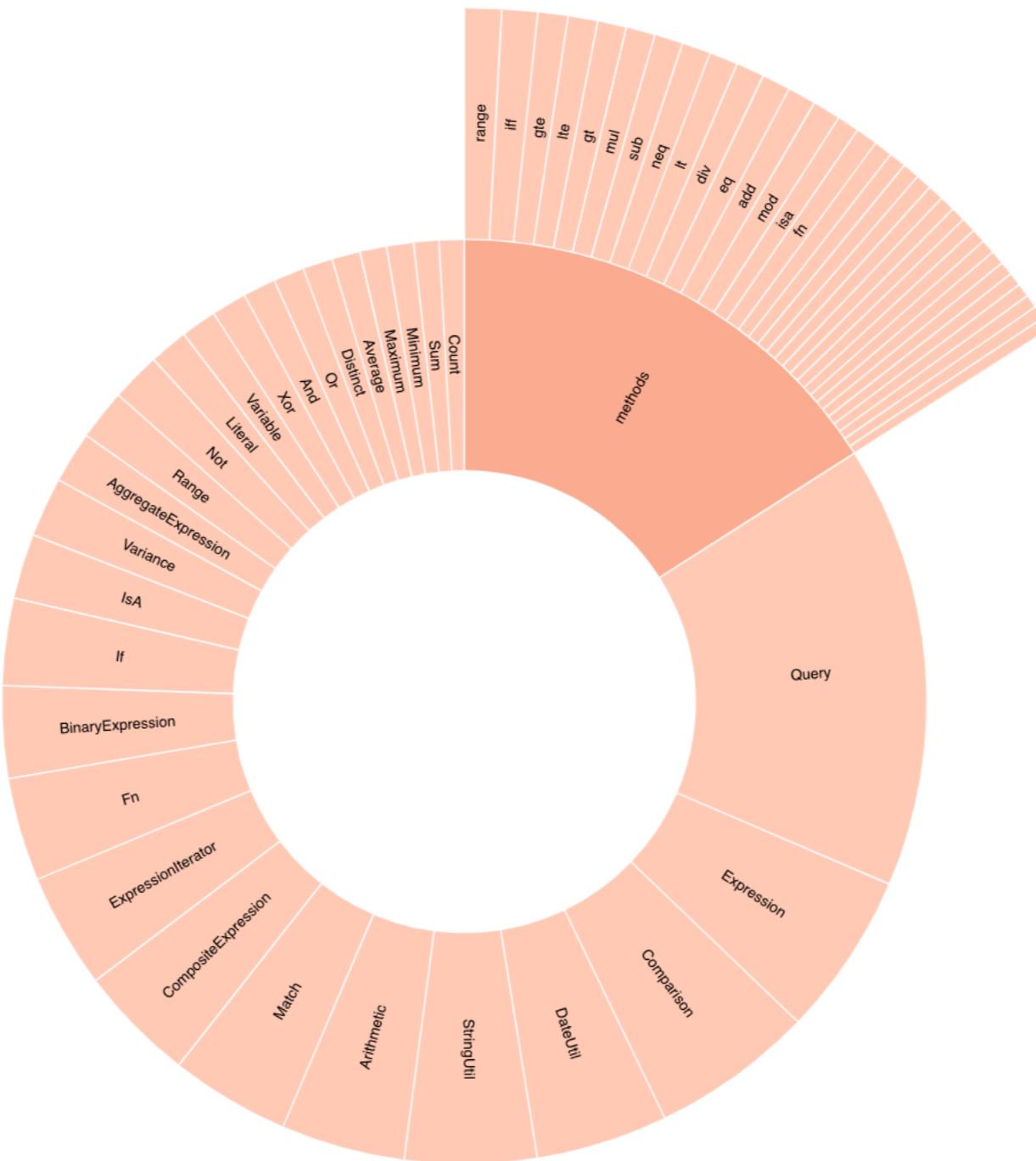
<https://bl.ocks.org/mbostock/1005873>

# Navigating a hierarchy



<https://beta.observablehq.com/@mbostock/d3-zoomable-sunburst>

# Navigating a hierarchy



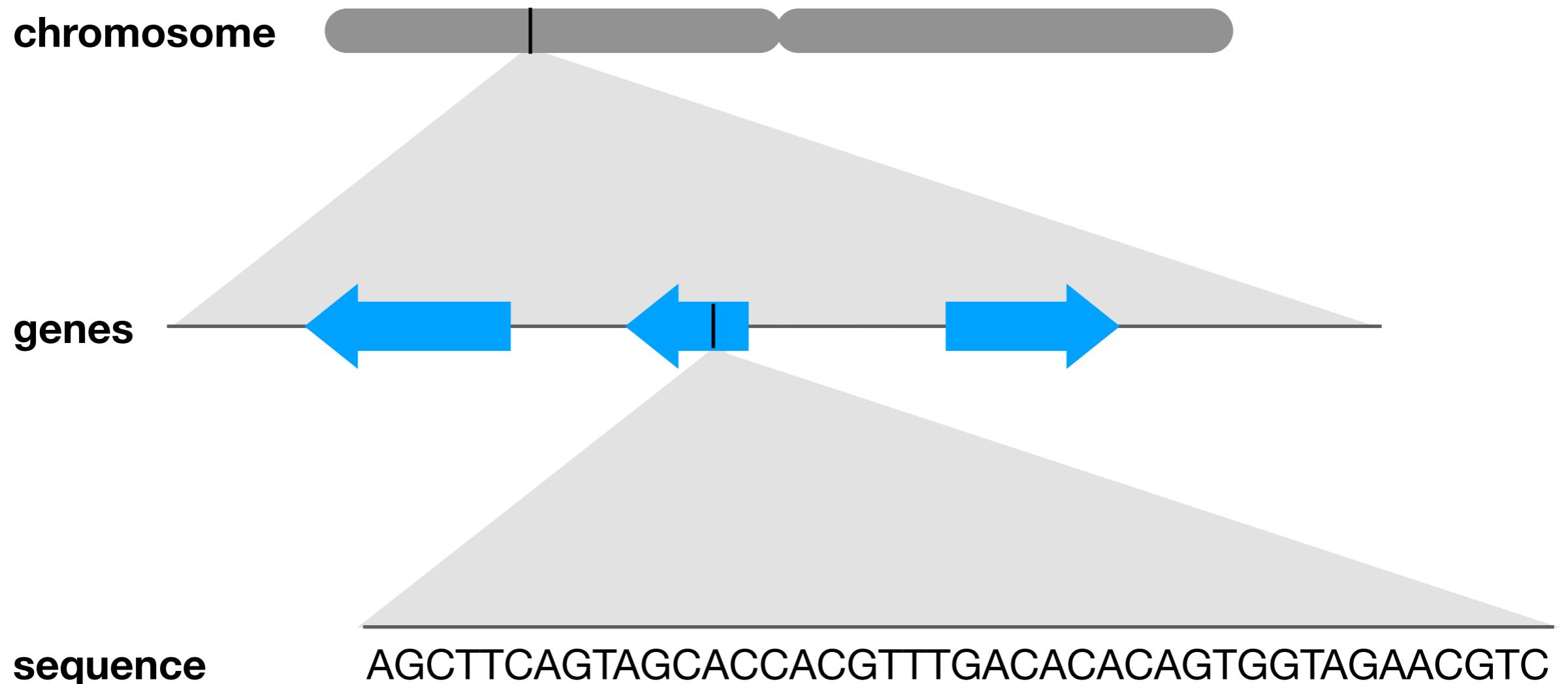
How do I go back?

<https://beta.observablehq.com/@mbostock/d3-zoomable-sunburst>

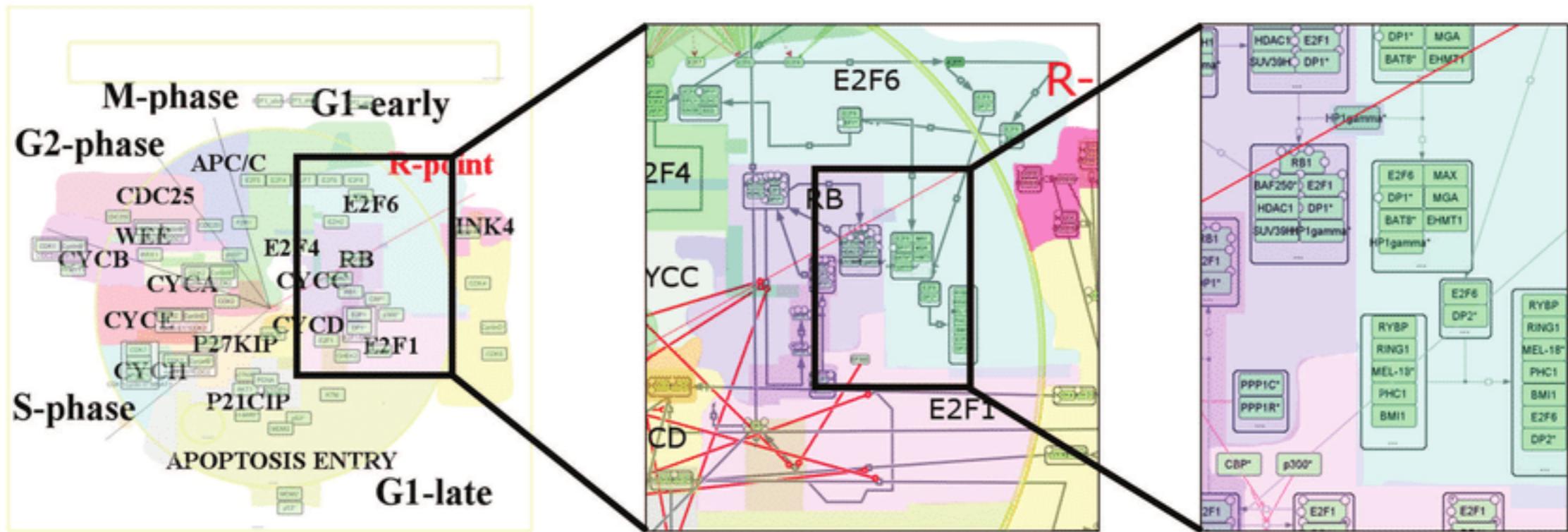
# Semantic zoom

- Instead of items becoming larger/smaller with the zoom level (geometric zoom), different representations are used for different zoom levels
- The representation changes as more space becomes available

# Semantic zoom | genome example



# Semantic zoom | genome example



Boxes expand into more complex structures on zoom

NaviCell

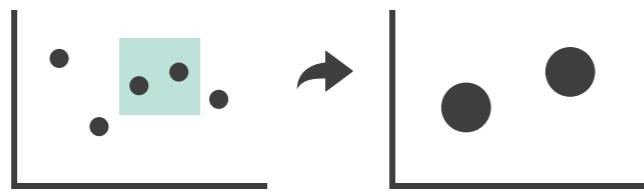
<https://navicell.curie.fr/>

## ➔ Navigate

→ Item Reduction

→ Zoom

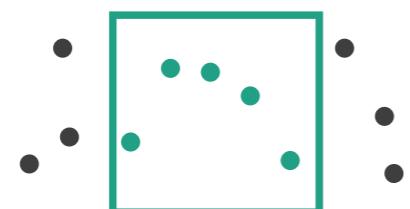
*Geometric* or *Semantic*



→ Pan/Translate

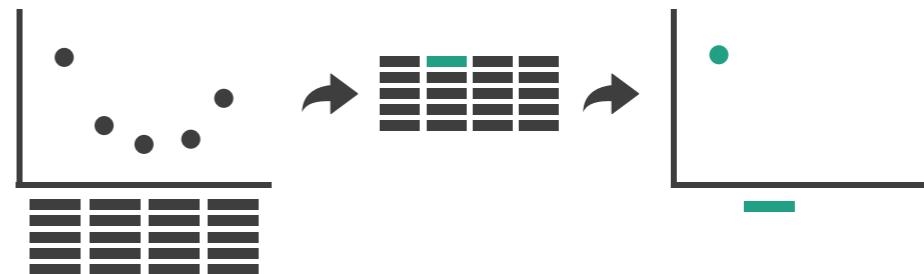


→ Constrained

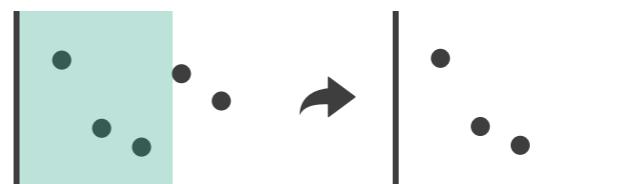


→ Attribute Reduction

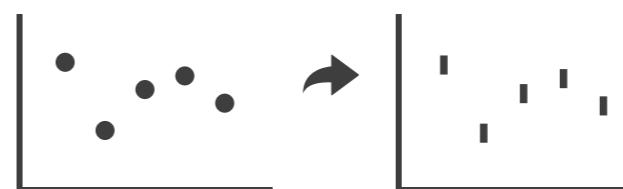
→ Slice



→ Cut

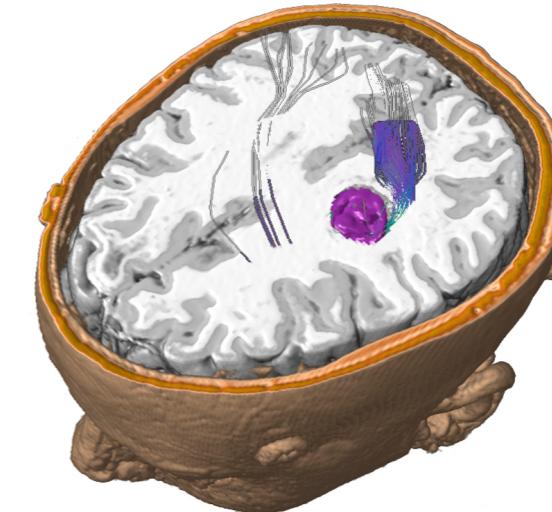
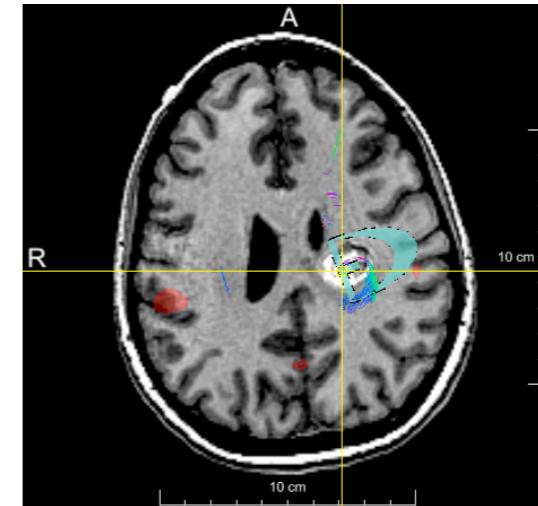


→ Project



# Navigation | Reducing attributes

- **Slice**
  - Show only items matching specific value for given attribute: slicing plane
- **Cut**
  - Show only items on far side of plane from camera
  - Preserves more context than the slice

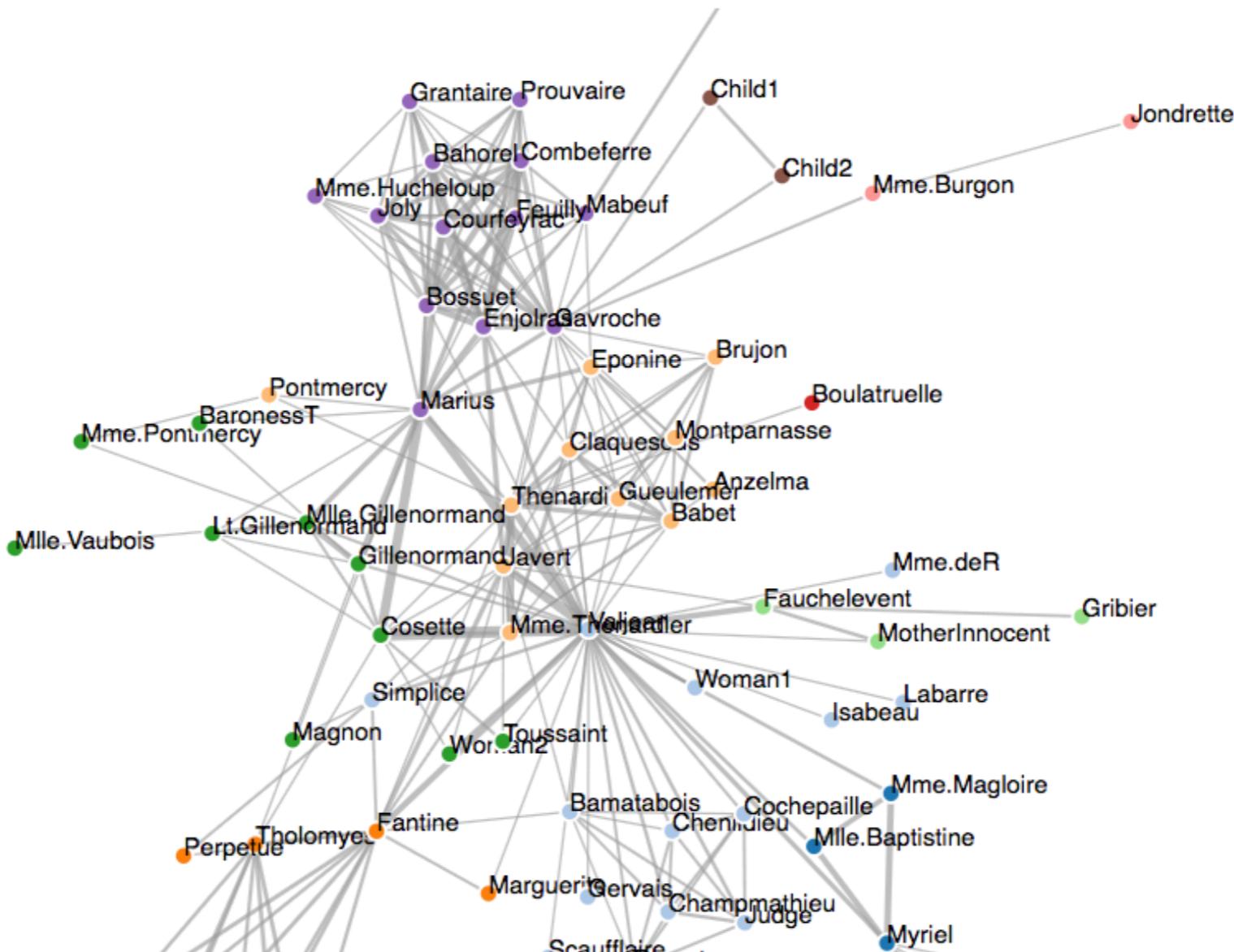


Interactive Visualization of Multimodal Volume Data for Neurosurgical Tumor Treatment.  
Rieder, Ritter, Raspe, and Peitgen.  
Computer Graphics Forum (Proc. EuroVis 2008) 27:3 (2008), 1055–1062.

# Focus + Context

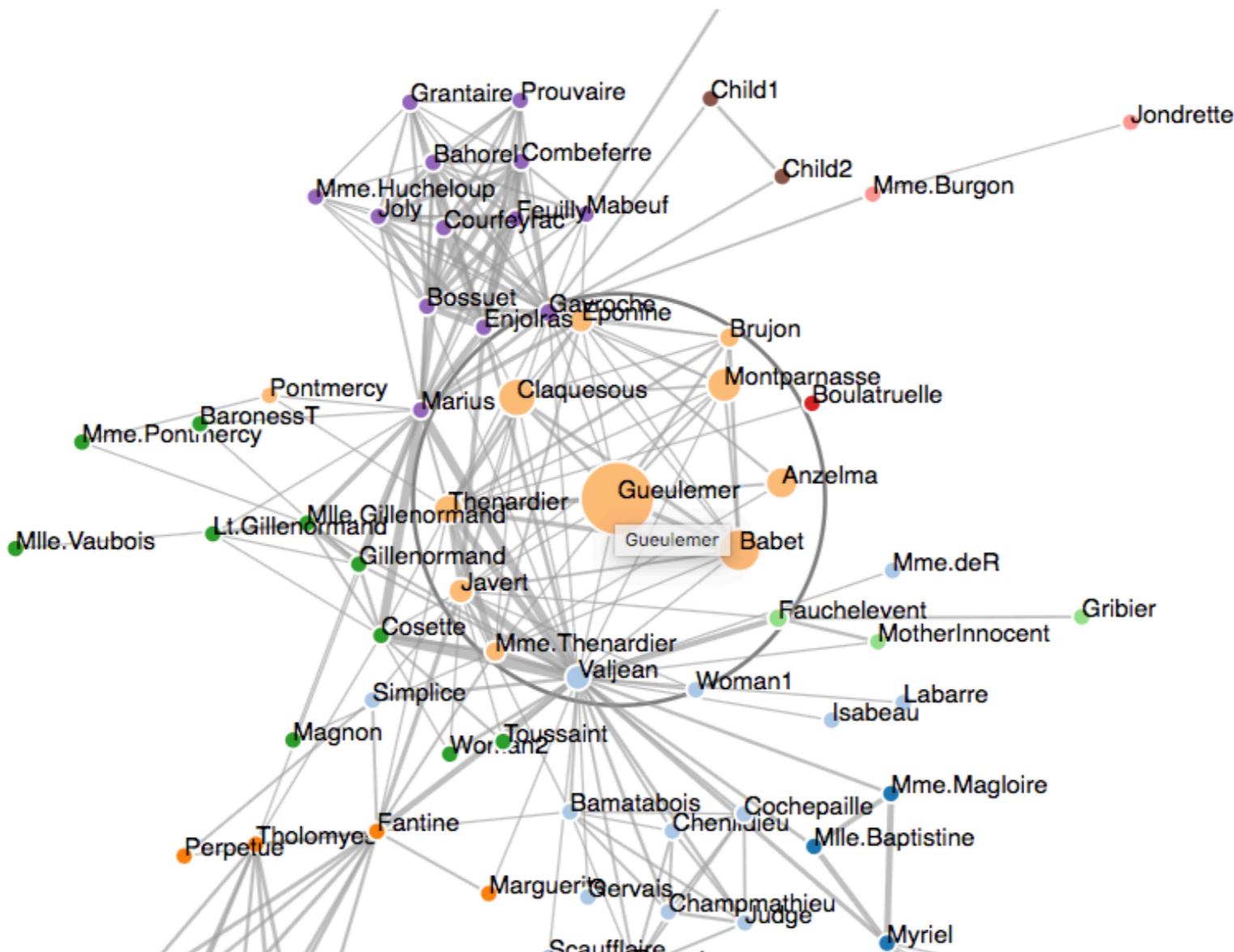
Reveal greater detail in a focus area, but preserve context

# Focus + Context



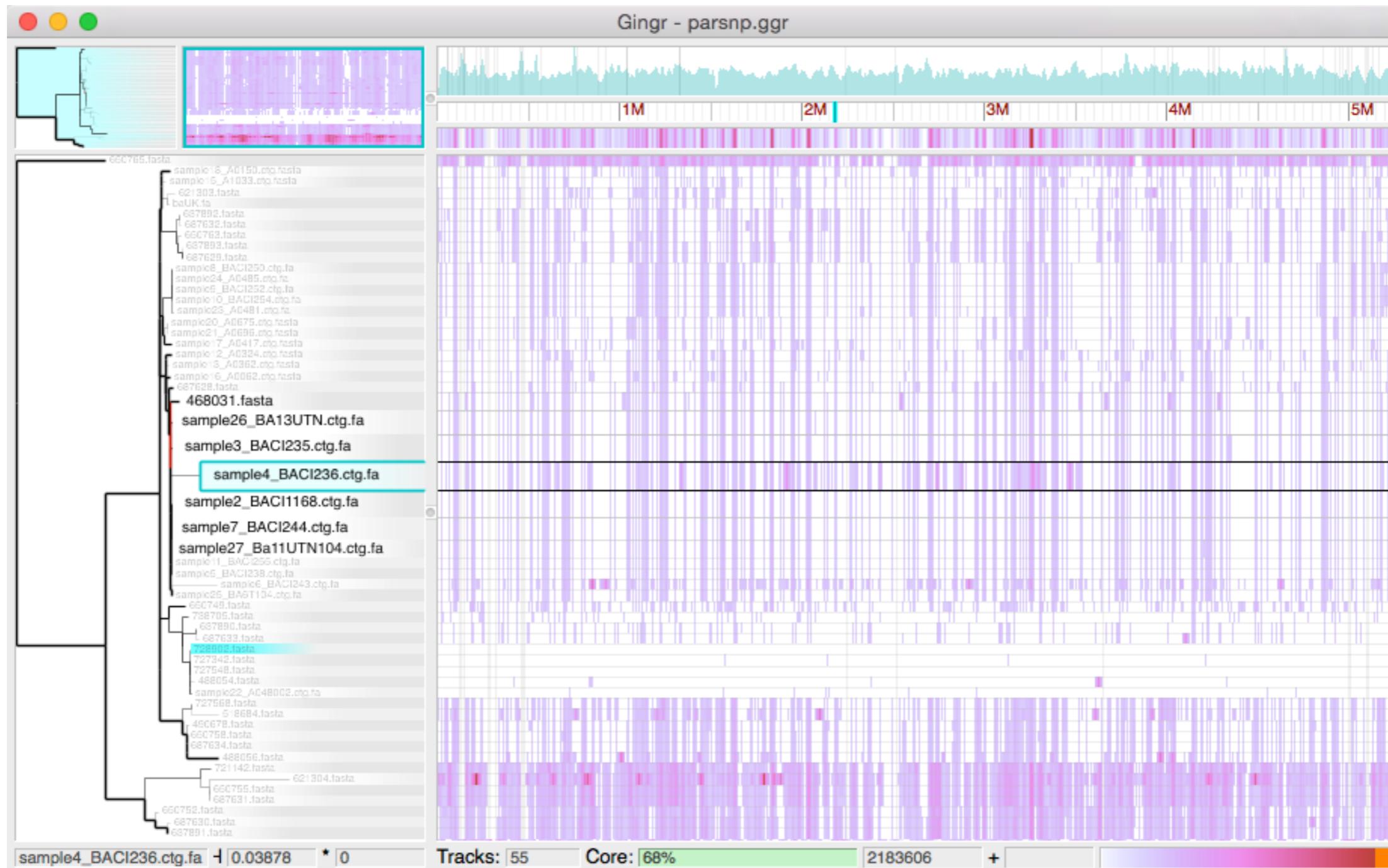
<http://bl.ocks.org/fernofftheandes/8637581>

# Focus + Context



<http://bl.ocks.org/fernofftheandes/8637581>

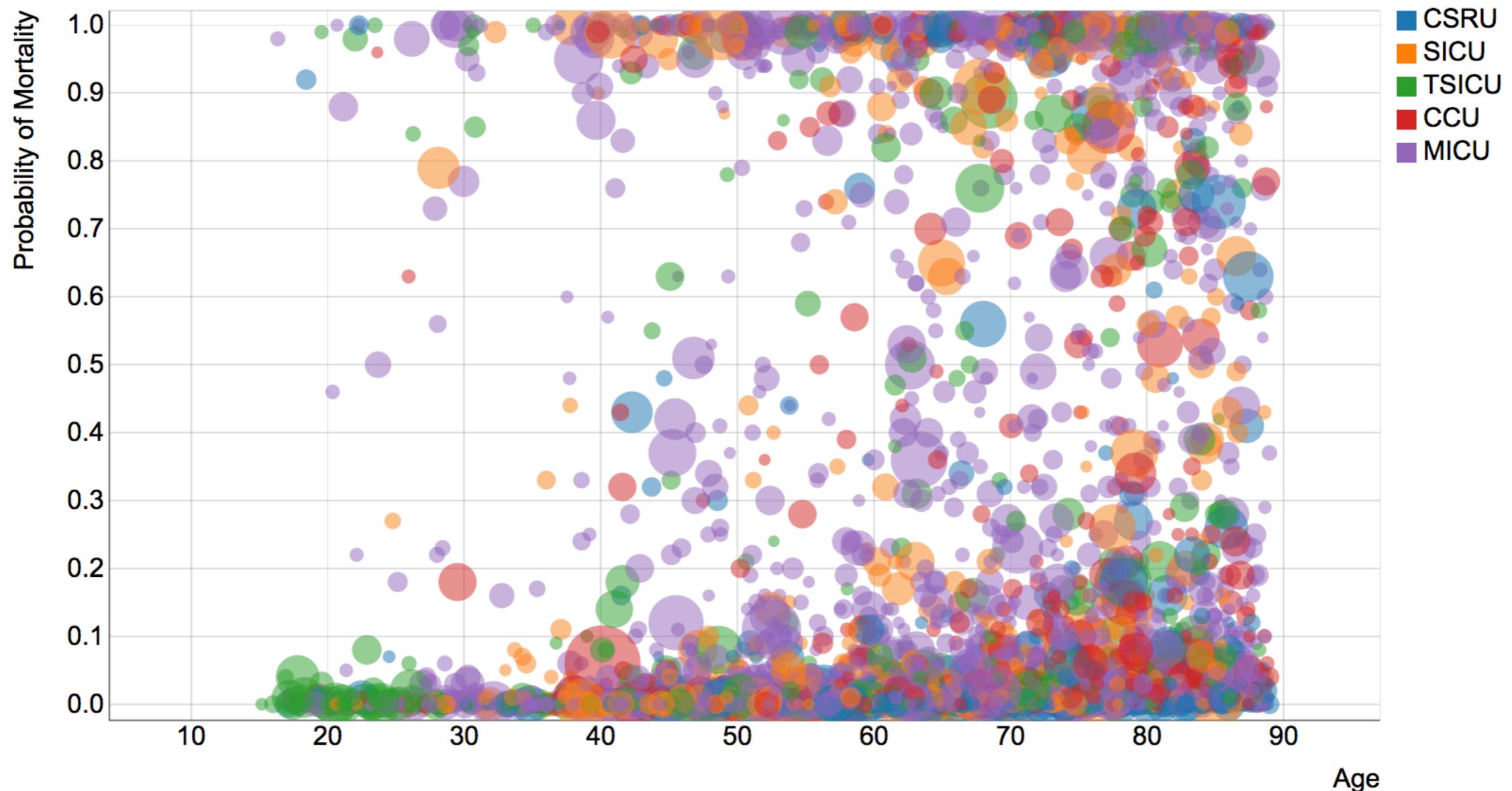
# Focus + Context



<https://harvest.readthedocs.io/en/latest/content/gingr.html>

# Common interaction conflicts

Click and drag | brush selection or panning?

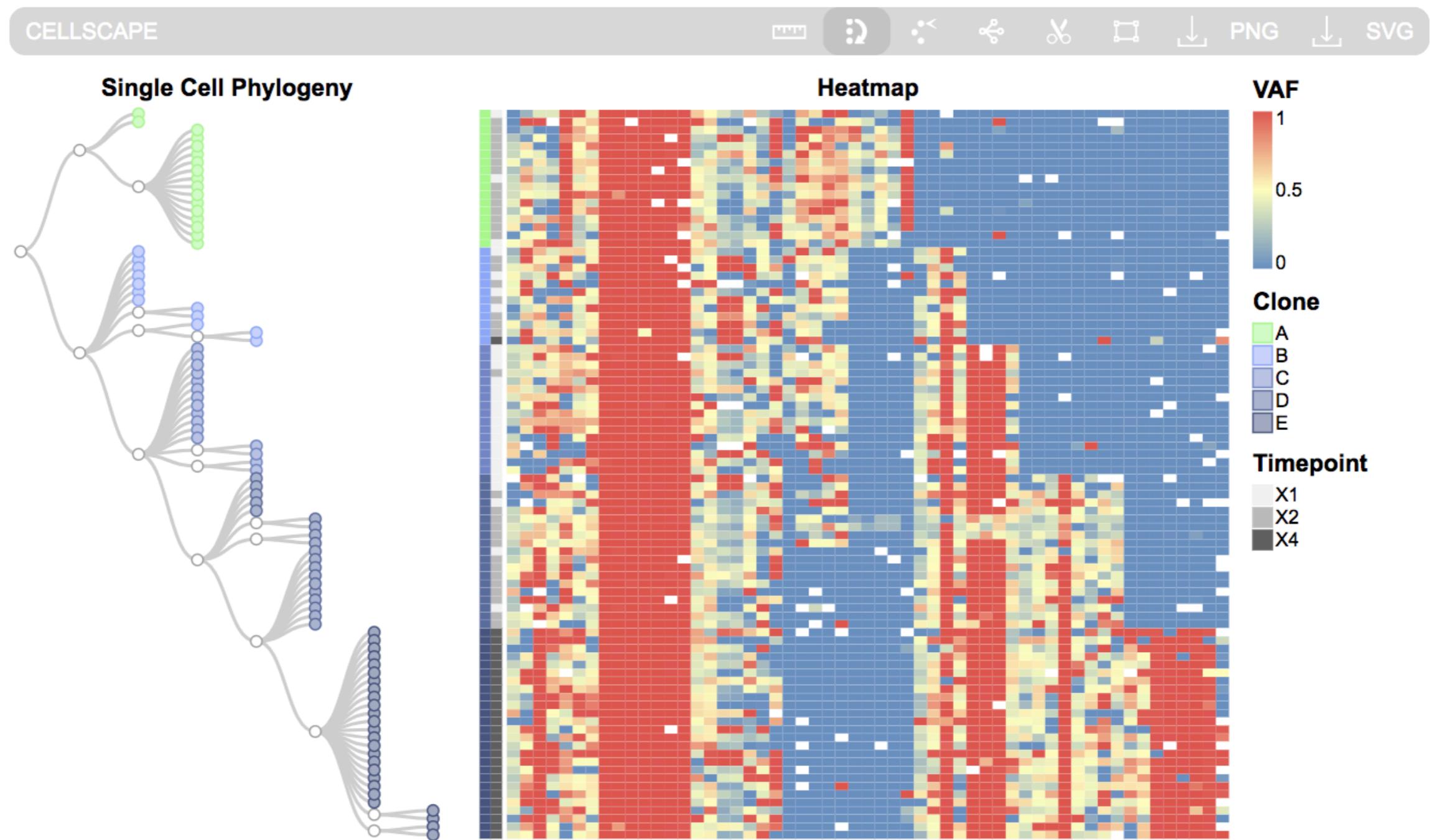


<https://bl.ocks.org/floofydugong/9c94ab01d8c3ed8ea3821d4a7e119b07>

# Help your users know what to do

- **Look to common conventions**
  - e.g. Tableau | click and drag = selection; shift+click and drag = panning
- **Restyle cursor to indicate behaviour**
- **Use toolbars for more complex interactions**
  - Can be disruptive to switch interaction modes, so use with care

# Use toolbar for more complex interactions



[https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape\\_vignette.html](https://bioconductor.org/packages/release/bioc/vignettes/cellscape/inst/doc/cellscape_vignette.html)

# Scrollytelling

# Scrollytelling

Use of scrolling to move through a story

# Scrollytelling

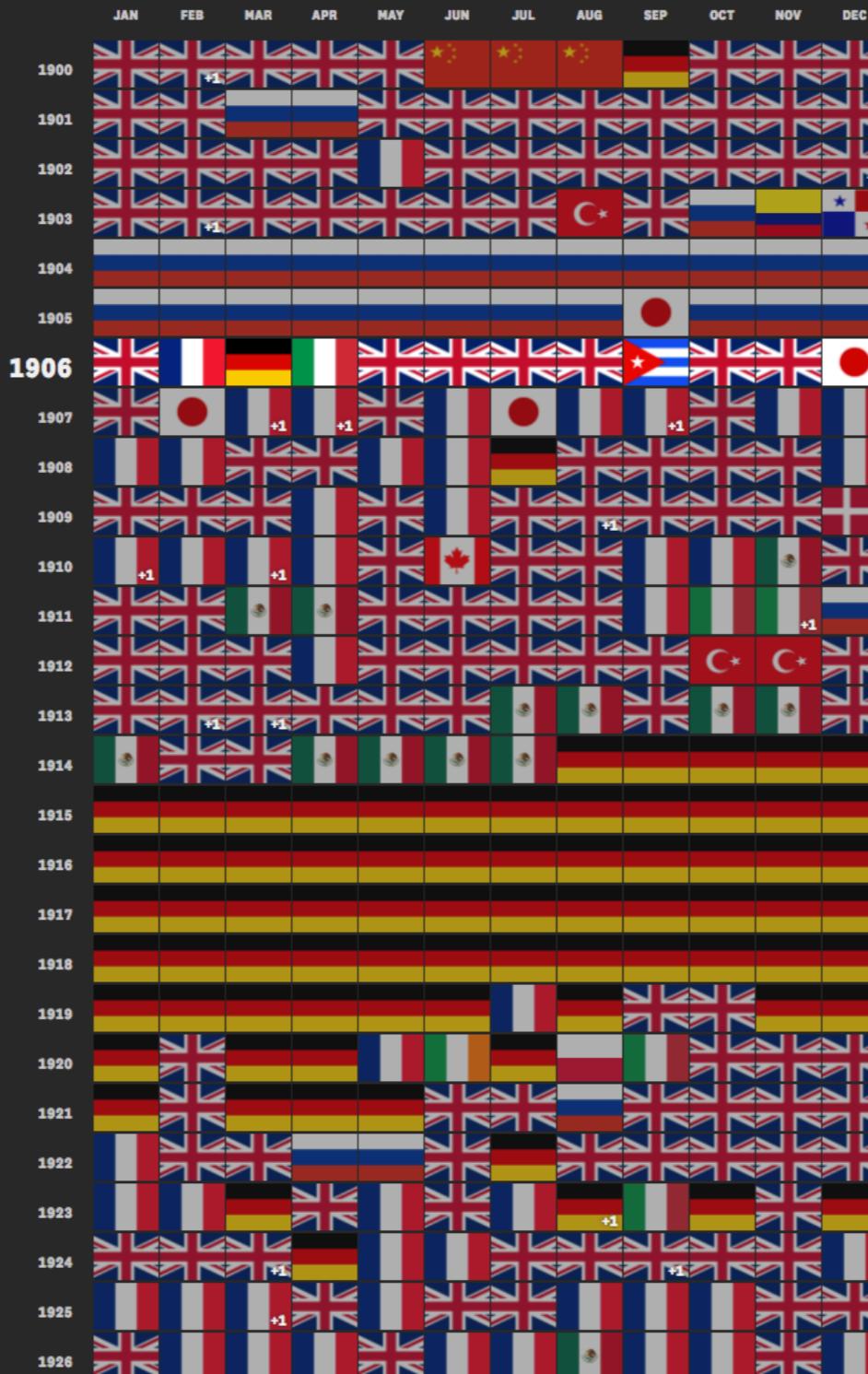
## HEADLINES FROM 1906

A sample of the three months with the most country mentions.

OCT NEW SPELLING IN SCOTLAND; Principal of St. Andrew's University Praises the Reform Movement.

SEP BURN AMERICAN PROPERTY; Cuban Rebels Begin Their Programme -- Two Plantations Attacked.

- Scrolling to navigate a single very long visualization, but also to tell a story over time



### 1904

The Russo-Japanese War began February 8, 1904 and lasted until September 5, 1905. President Theodore Roosevelt mediated the Treaty of Portsmouth, which ended the conflict.

### 1914

Germany declared war on the Russian Empire August 1, 1914. The conflict caused the New York Stock Exchange to close since nearly all the European stock exchanges were already closed. At these early stages in the Great War, the United States declared neutrality.

# Scrollytelling

☰ Menu

Search

Bloomberg Businessweek

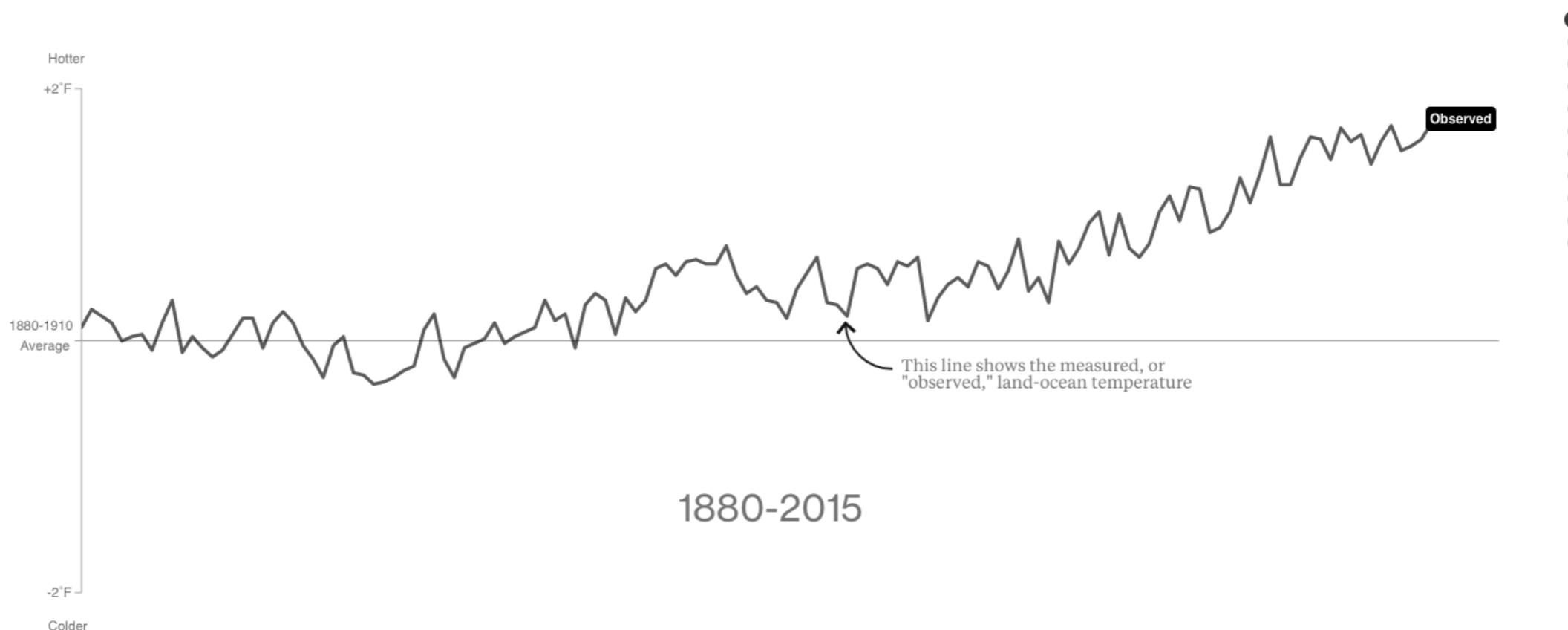
Sign In

Subscribe

## What's Really Warming the World?

By Eric Roston  and Blacki Migliozi  | June 24, 2015

Skeptics of manmade climate change offer various natural causes to explain why the Earth has warmed 1.4 degrees Fahrenheit since 1880. But can these account for the planet's rising temperature? Scroll down to see how much different factors, both natural and industrial, contribute to global warming, based on findings from NASA's Goddard Institute for Space Studies.



# Scrollytelling

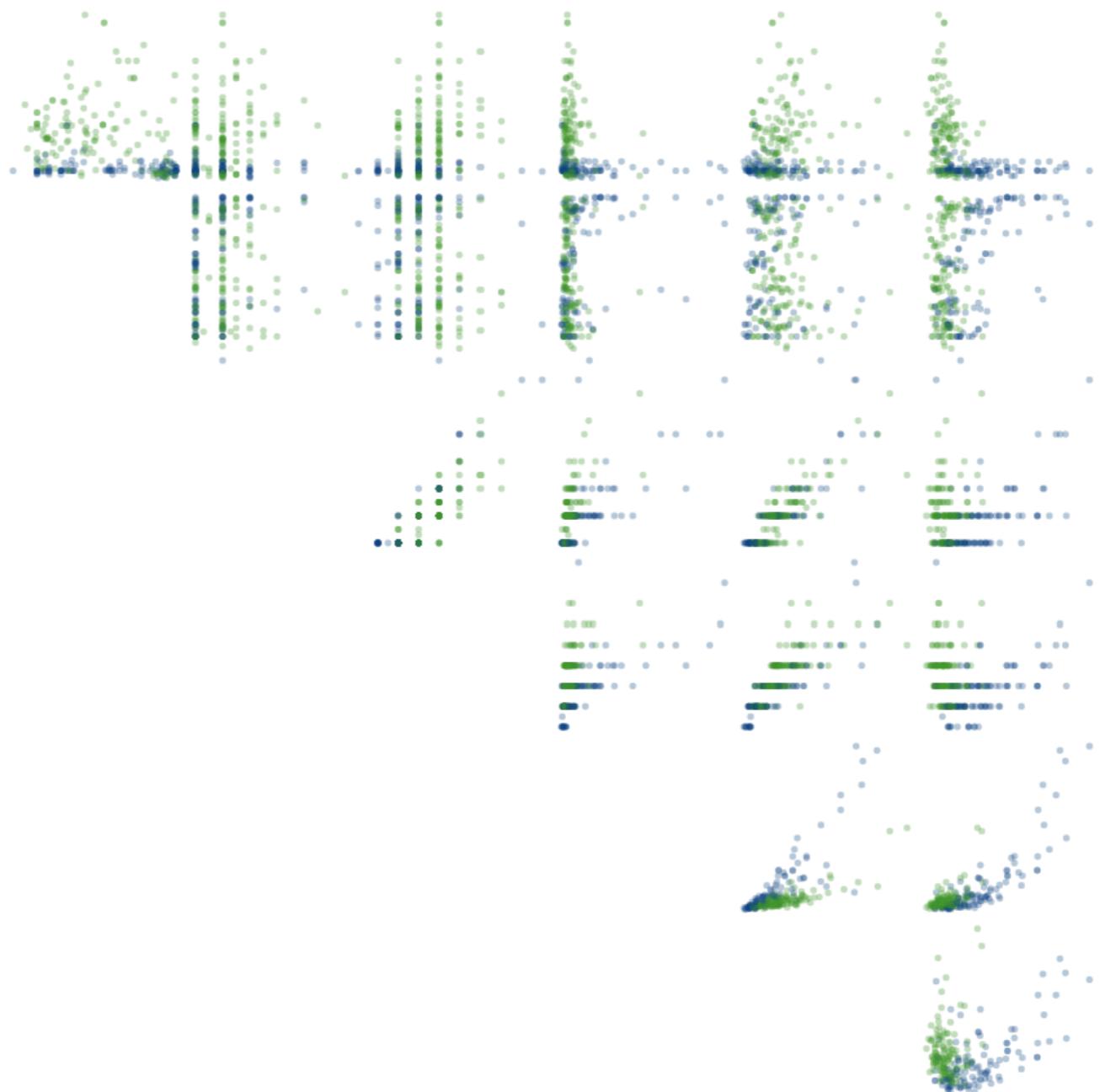
A visual  
introduction to  
machine learning

🌐 English ▾

In machine learning, computers apply **statistical learning** techniques to automatically identify patterns in data. These techniques can be used to make highly accurate predictions.

*Keep scrolling.* Using a data set about homes, we will create a machine learning model to distinguish homes in New York from homes in San Francisco.

SCROLL



# Scrollytelling

- **Pros**

- Engaging and light to use
- Great for casual audiences
- Linear (only up & down) vs possible overload of click-based interfaces

- **Cons**

- Continuous control for discrete steps (stepper may be better)
- Scrolljacking, no direct access
- Difficult to design (can easily produce unexpected behaviour)

- **Further reading**

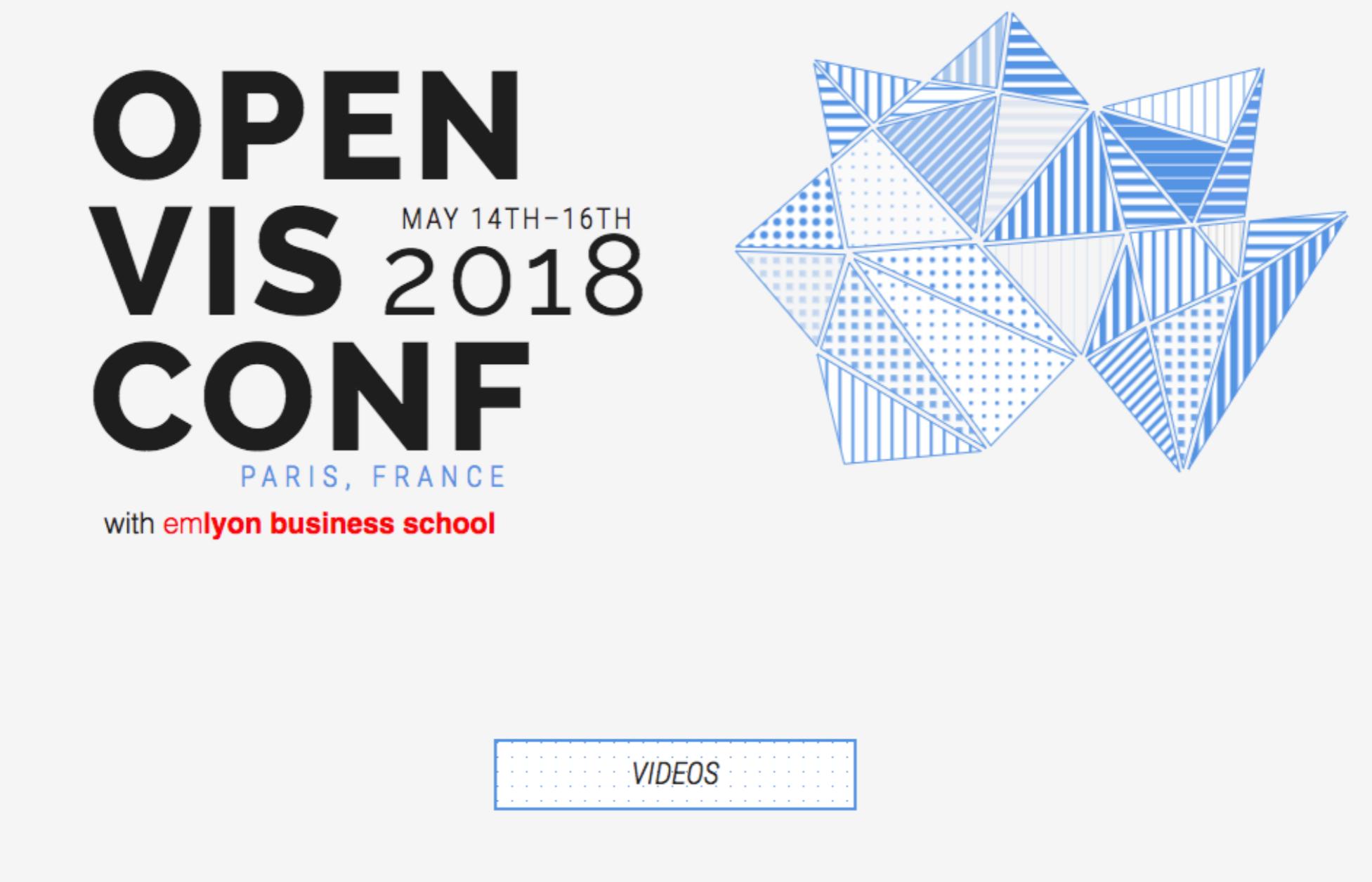
- <https://eagereyes.org/blog/2016/the-scrollytelling-scourge>
- <https://bostocks.org/mike/scroll/>

# Key points

# Key points

- **Think about how users will know what to do**
  - Follow conventions; deviate for a reason
  - Provide affordances (e.g. change in mouse cursor)
- **Design for your audience and their analytical tasks**
- **Don't design in a void**
  - Look to examples you like for inspiration
- **Selection + highlighting**
  - Powerful ways of emphasizing a subset in a complex visual
- **Order matters**
  - Consider including interactive sorting, alignment, or layout

# What I've been watching...



The image features the official logo for the OpenVisConf 2018 conference. The logo is composed of large, bold, black sans-serif letters spelling "OPEN", "VIS", and "CONF" vertically. To the right of "VIS", the text "MAY 14TH-16TH" is stacked above "2018". Below "CONF", the text "PARIS, FRANCE" is written in a smaller blue font. At the bottom, the text "with emlyon business school" is displayed in red. To the right of the text is a complex, abstract graphic composed of numerous blue triangles of varying sizes and orientations, creating a sense of depth and geometric complexity.

VIDEOS

<http://www.openvisconf.com/>