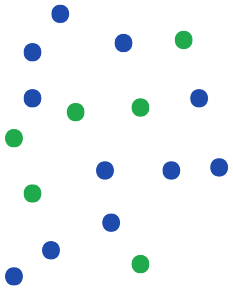
Data Exploration and Linked Views

Steven Braun

Data Analytics and Visualization Specialist

May 9, 2017

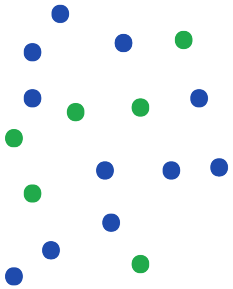


Data Collection

A lot can happen in the space between

A→B

Interpretation



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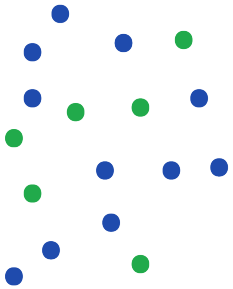

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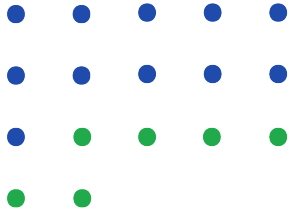
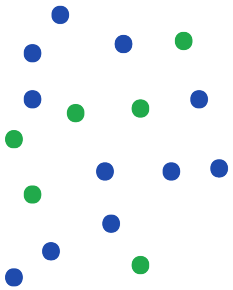
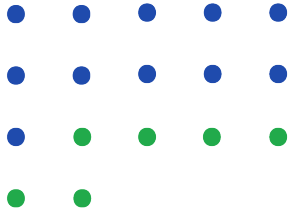


Structuring and Cleanup



Data Collection



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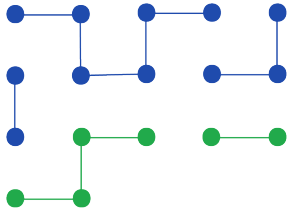
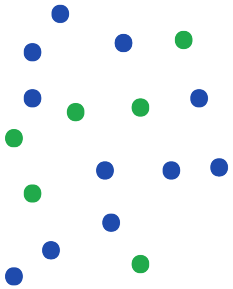


Analysis



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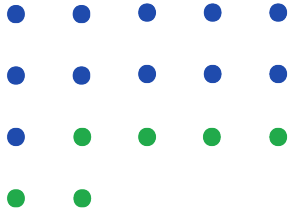

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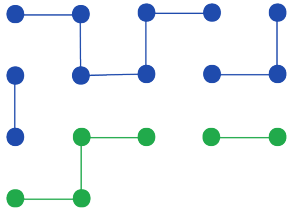

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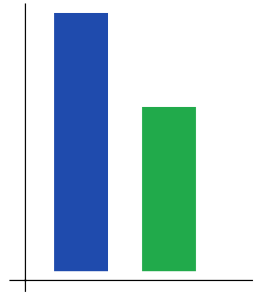
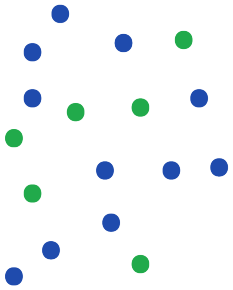
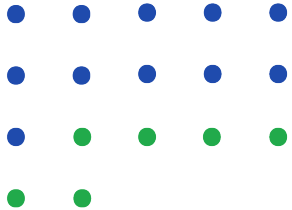


Visualization



Data Collection



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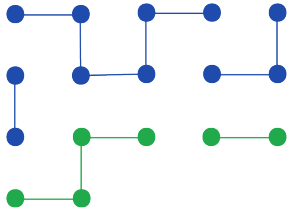

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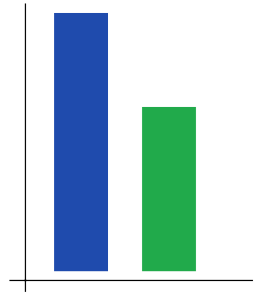

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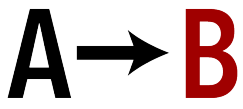
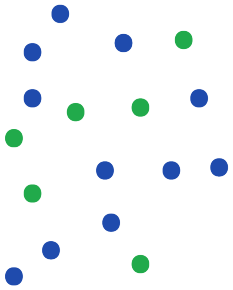


Interpretation



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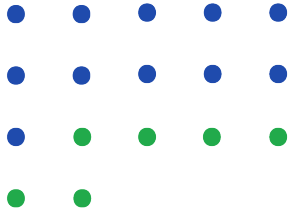

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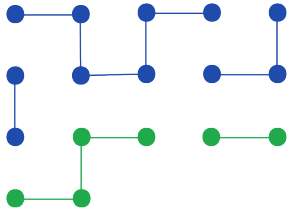
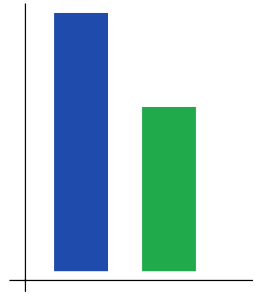
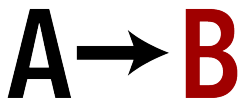


Analysis



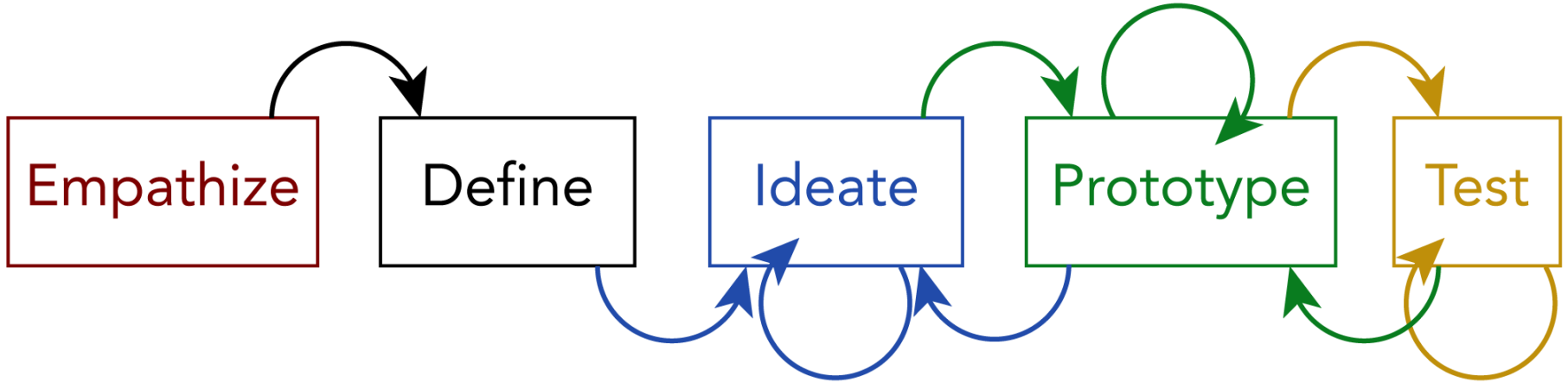
Visualization



Interpretation

well-defined ⟷ ill-defined

DESIGN THINKING PROCESS



Stanford d.school

Why do we use data visualization
to explore our data?

Why do we use data visualization
to explore our data?

Visually displaying data makes it
easier to **find patterns**

Visualization helps make complex data accessible and understandable

How?

By mapping visual and spatial cognition to experiential knowledge

Data that seem statistically identical
may actually be graphically distinct

ANSCOMBE'S QUARTET

I	
x	**y**
10.0	8.04
8.0	6.95
13.0	7.58
9.0	8.81
11.0	8.33
14.0	9.96
6.0	7.24
4.0	4.26
12.0	10.84
7.0	4.82
5.0	5.68

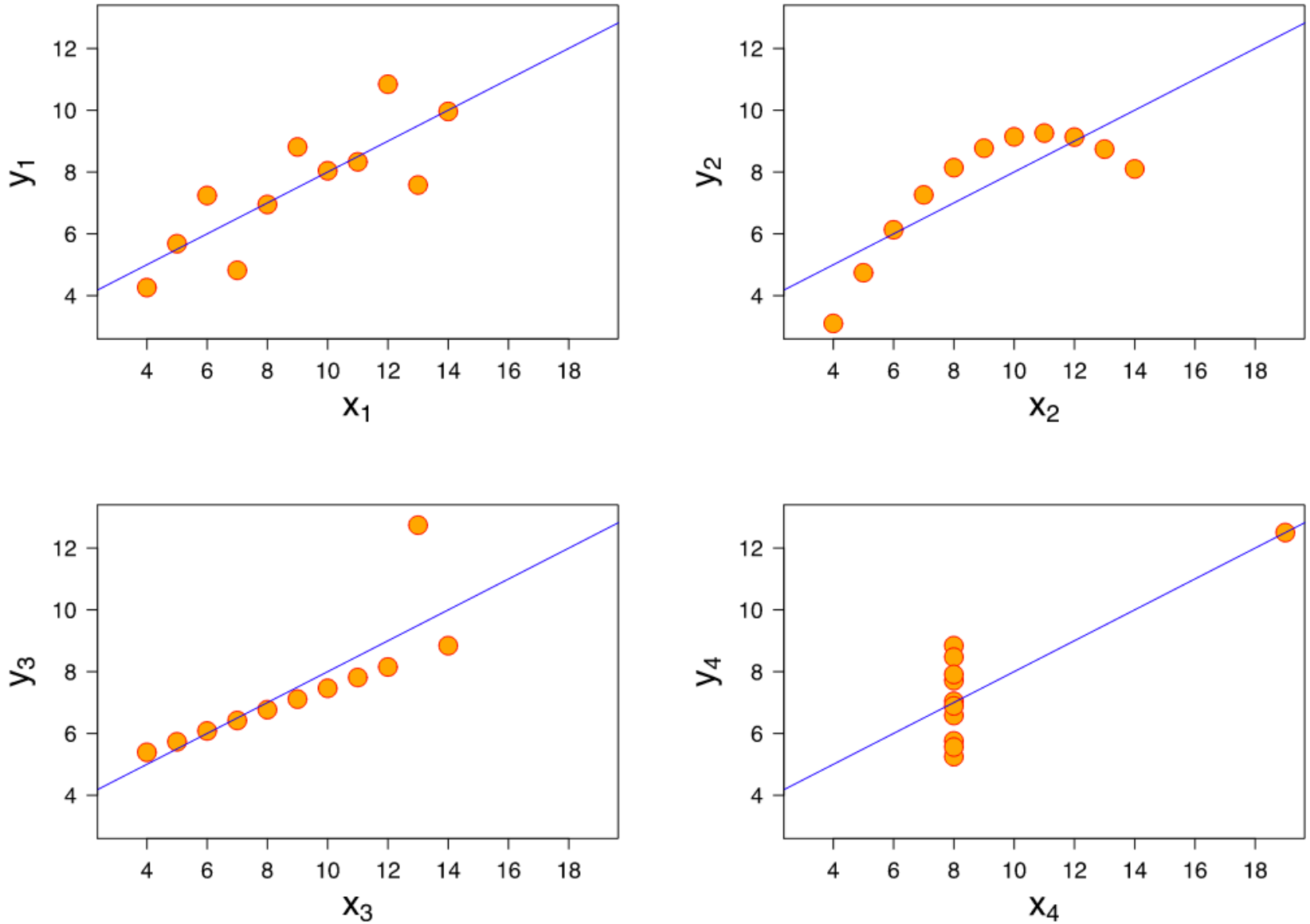
II	
x	**y**
10.0	9.14
8.0	8.14
13.0	8.74
9.0	8.77
11.0	9.26
14.0	8.10
6.0	6.13
4.0	3.10
12.0	9.13
7.0	7.26
5.0	4.74

III	
x	**y**
10.0	7.46
8.0	6.77
13.0	12.74
9.0	7.11
11.0	7.81
14.0	8.84
6.0	6.08
4.0	5.39
12.0	8.15
7.0	6.42
5.0	5.73

IV	
x	**y**
8.0	6.58
8.0	5.76
8.0	7.71
8.0	8.84
8.0	8.47
8.0	7.04
8.0	5.25
19.0	12.50
8.0	5.56
8.0	7.91
8.0	6.89

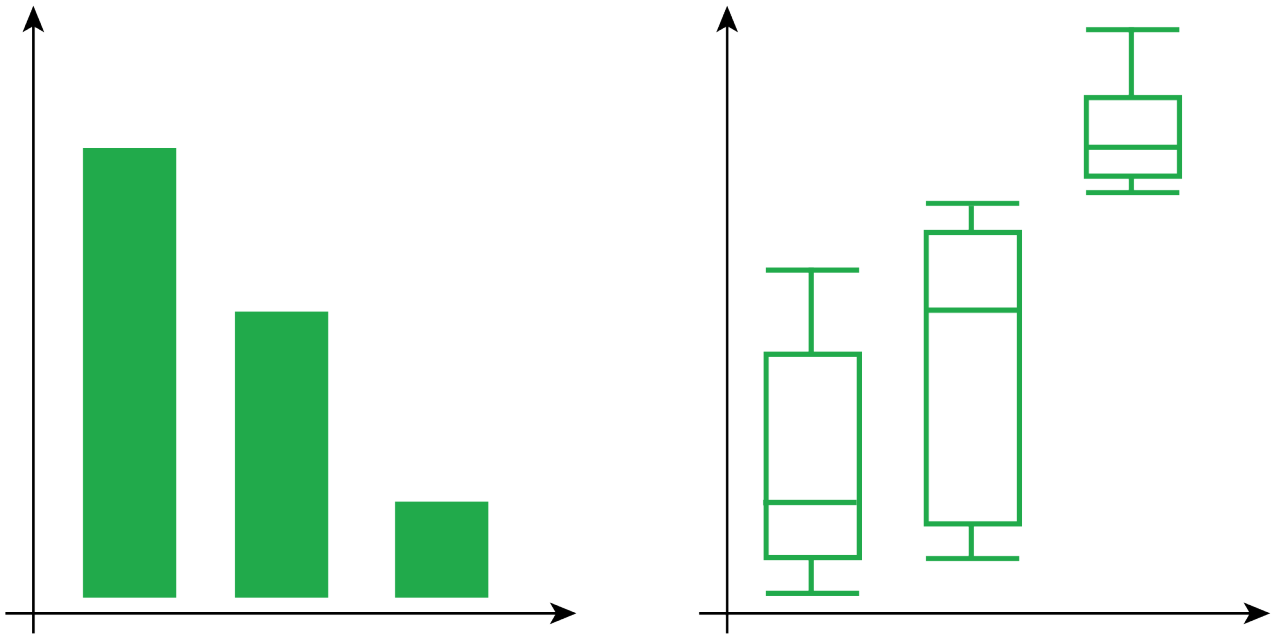
ANSCOMBE'S QUARTET

Mean of x	9
Variance of x	11
Mean of y	7.5
Variance of y	4.125
Correlation between x and y	0.816
Linear regression	$y = 3.00 + 0.500x$


y1
x1
y2
x2
y3
x3
y4
x4
4
6
8
10
12
14
16
18

Lesson Learned

Be cautious of analyses that collapse distributions into summary representations – including charts



One way we can use visualization to explore data is through making charts and graphs **interactive**

DATA EXPLORATION TECHNIQUES

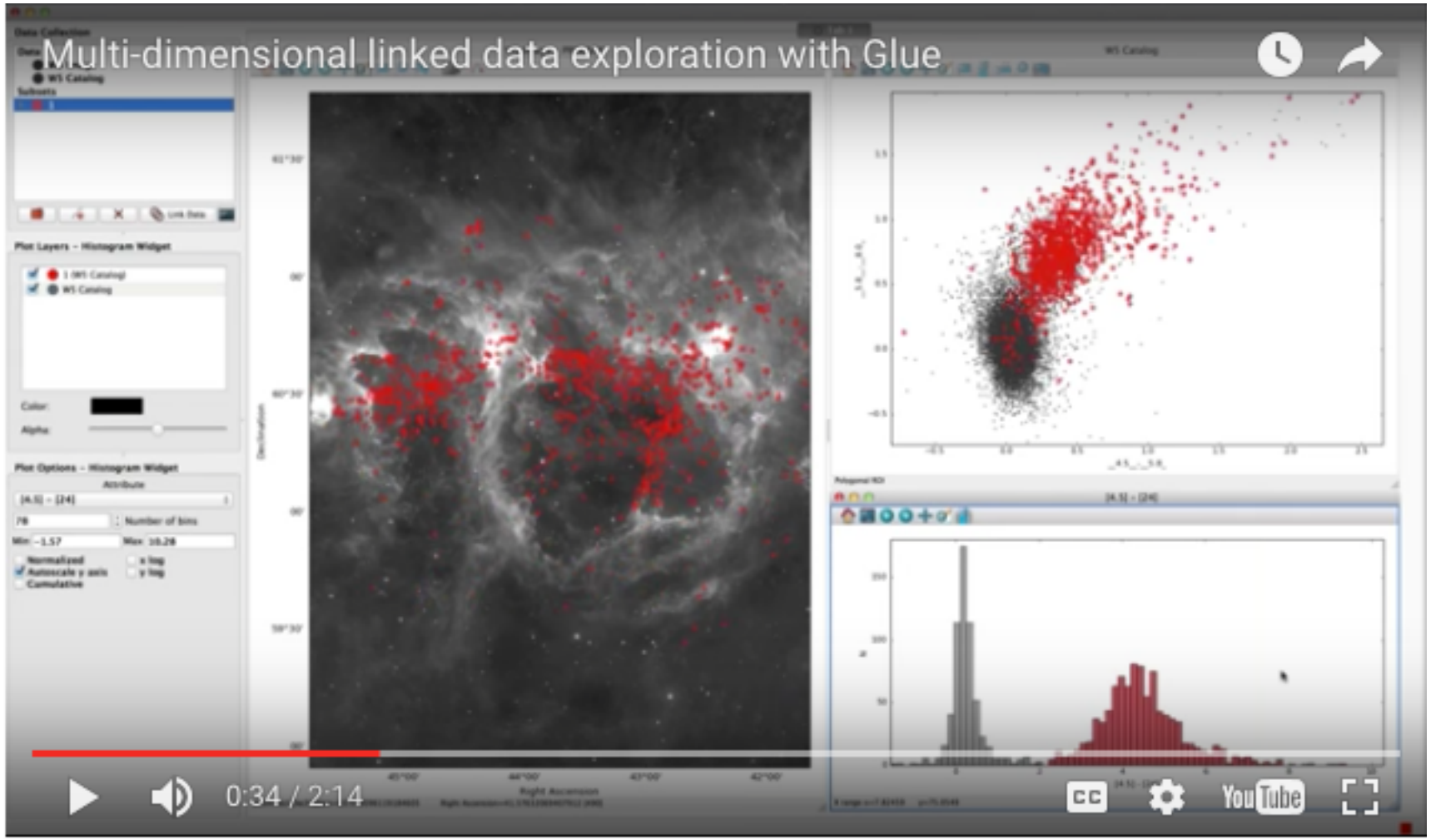
Zooming and panning
Highlighting
Brushing
Filtering (faceting)
Eliding
Details on demand
Animation

DATA EXPLORATION TECHNIQUES

LINKED VIEWS

Interaction with data in one chart (view) is mirrored or translated in another chart

LINKED VIEWS

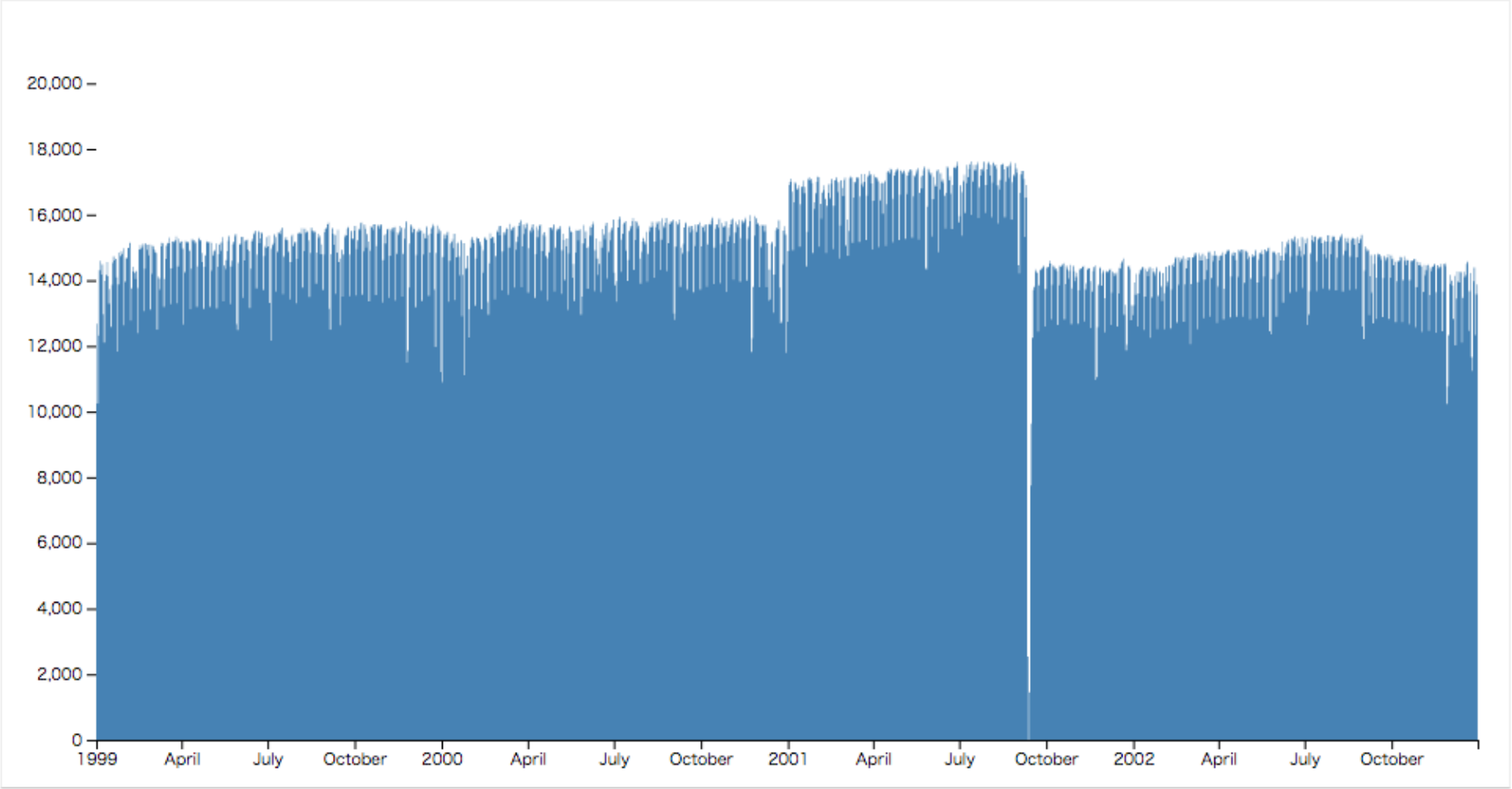


https://www.youtube.com/watch?v=qO3RQiRjWA4

Interactivity enables

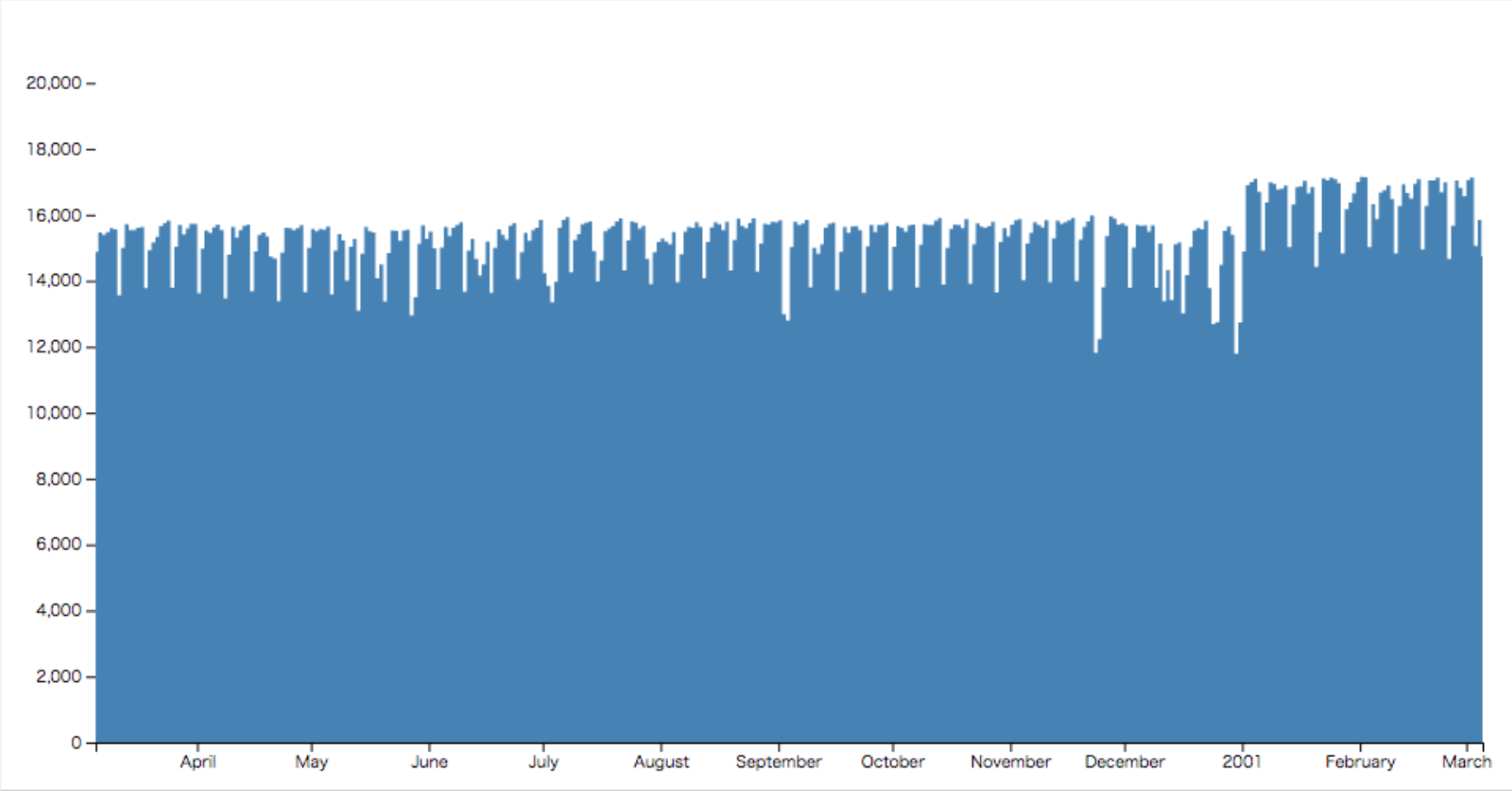
focus + context

ZOOMING AND PANNING



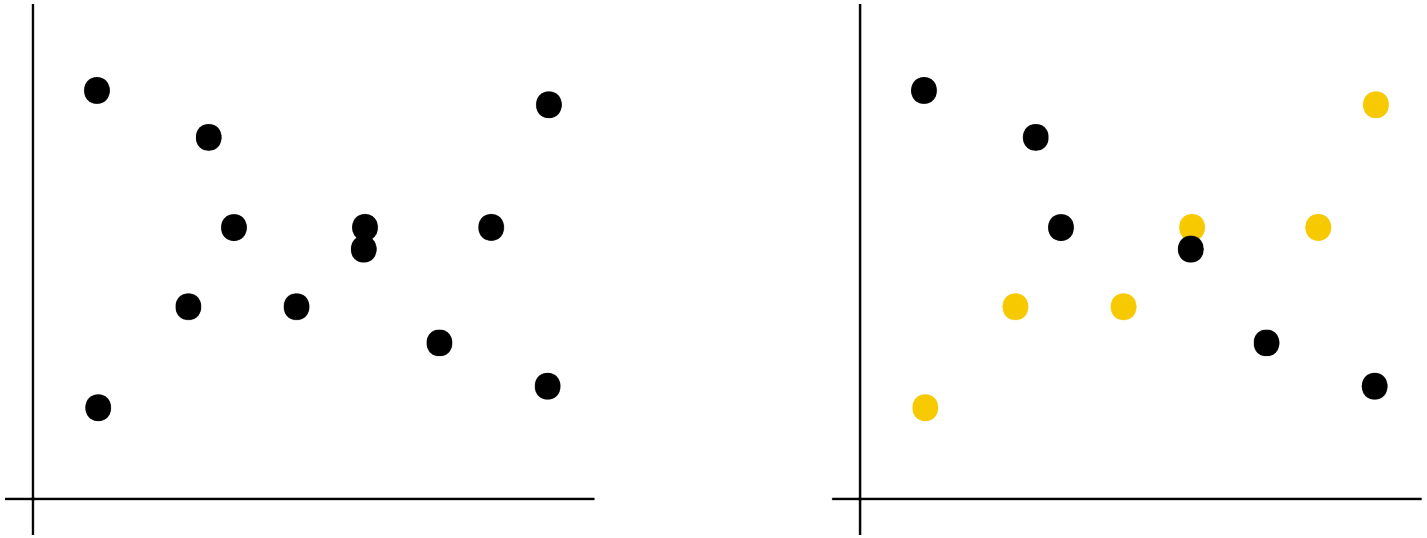
https://bl.ocks.org/mbostock/4015254

ZOOMING AND PANNING

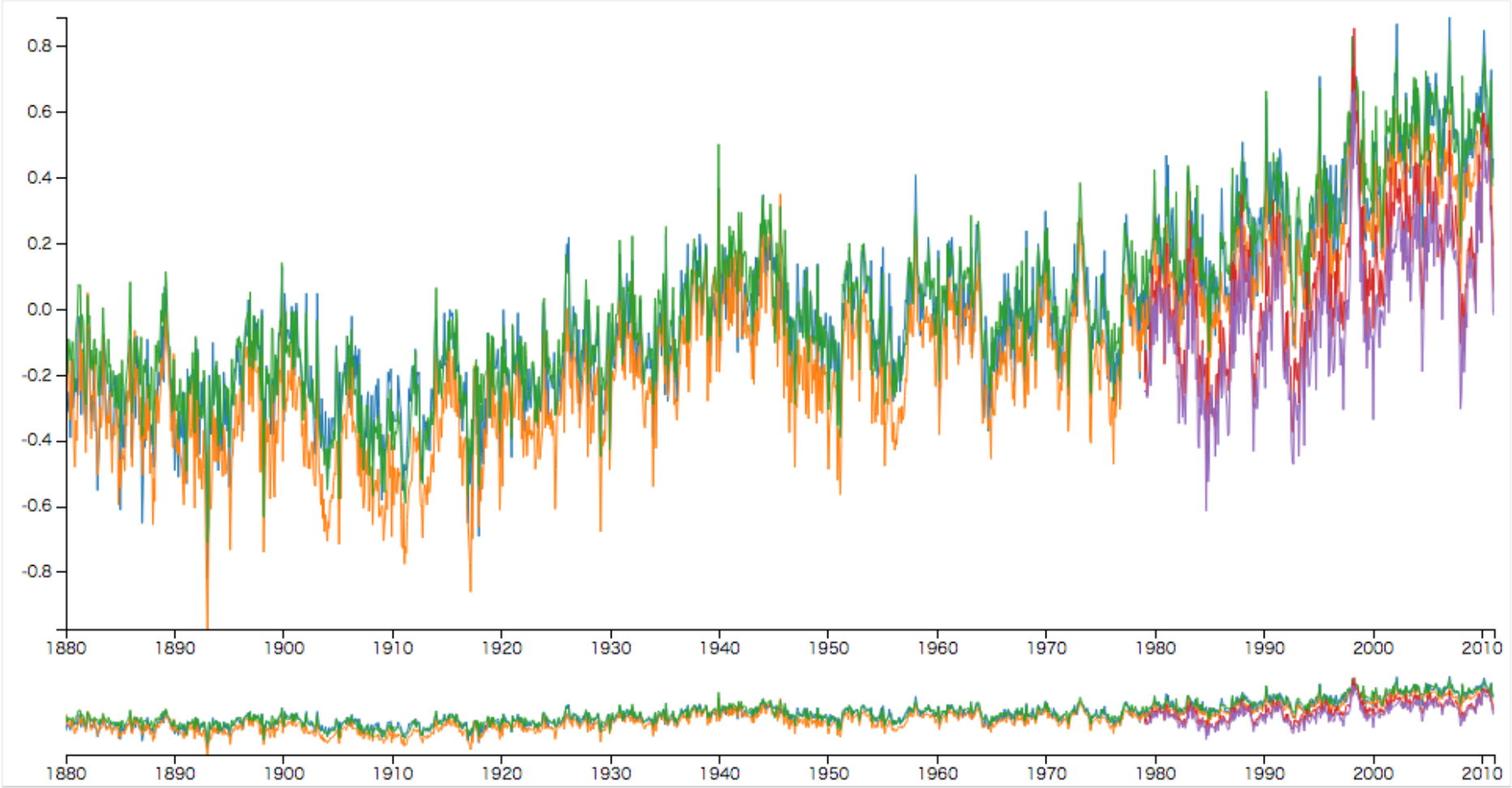


https://bl.ocks.org/mbostock/4015254

HIGHLIGHTING



BRUSHING



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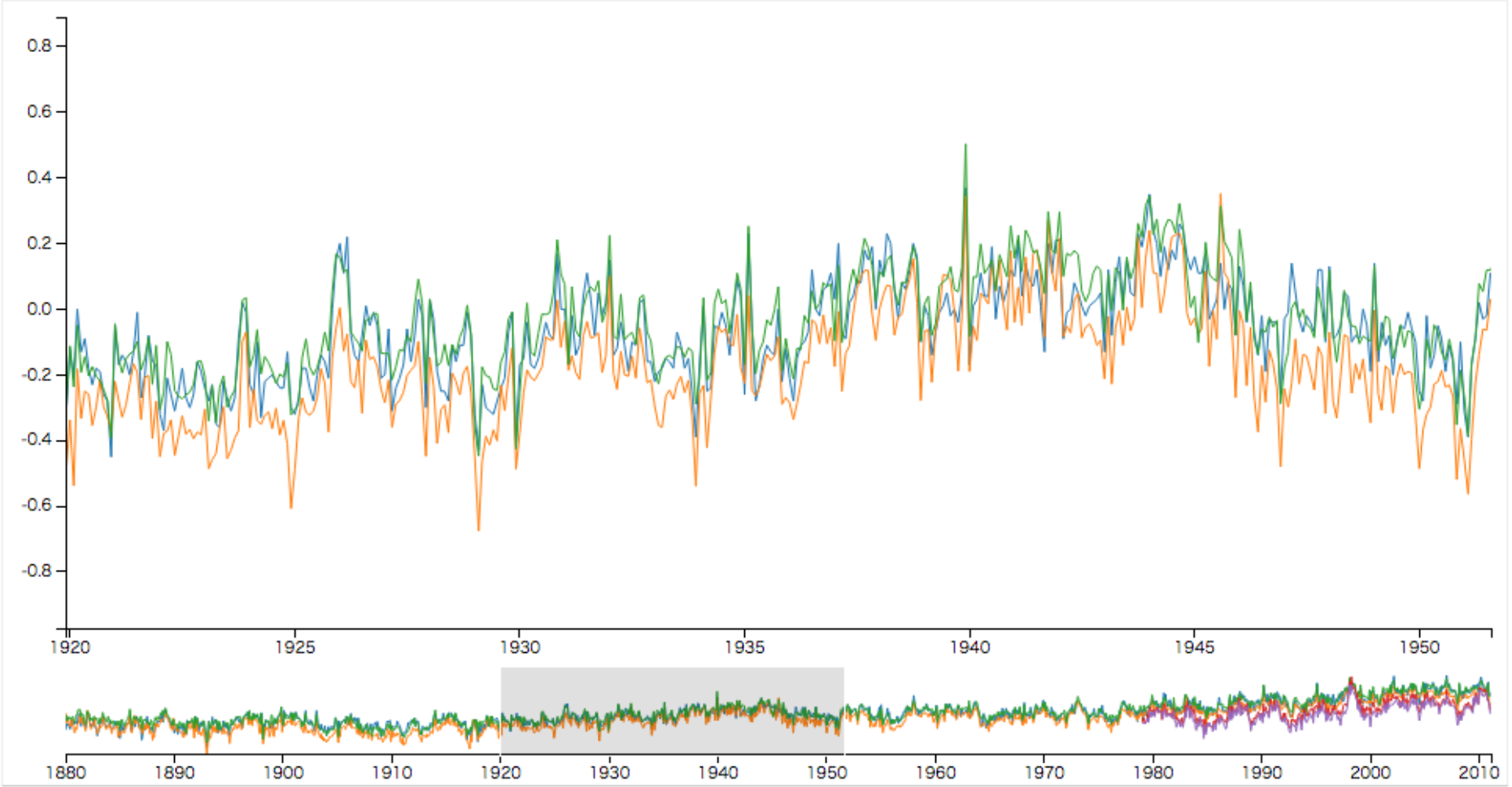
BRUSHING



http://bl.ocks.org/natemiller/7dec148bb6aab897e561

BRUSHING

https://bl.ocks.org/mbostock/4063663

FILTERING AND FACETING

Side-by-side

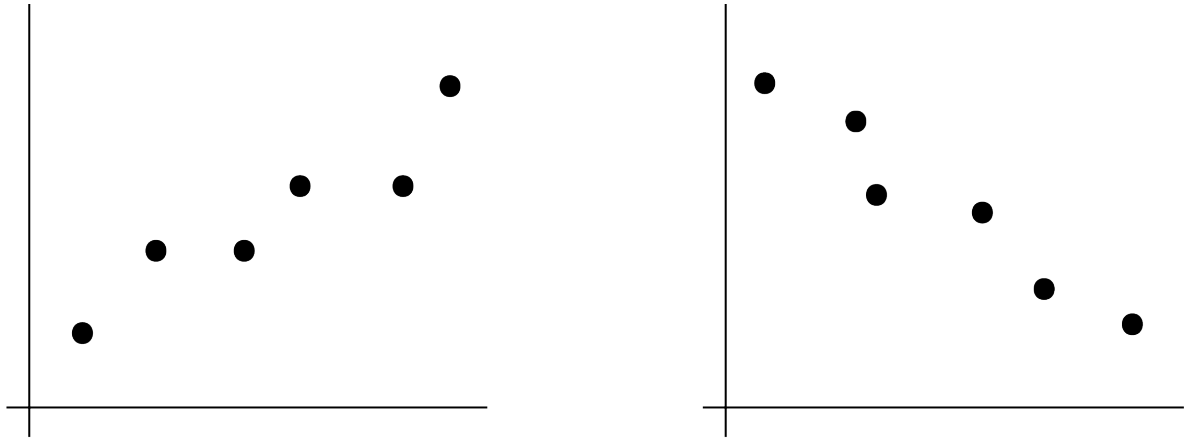
Juxtapose data classes using common axis

Layering

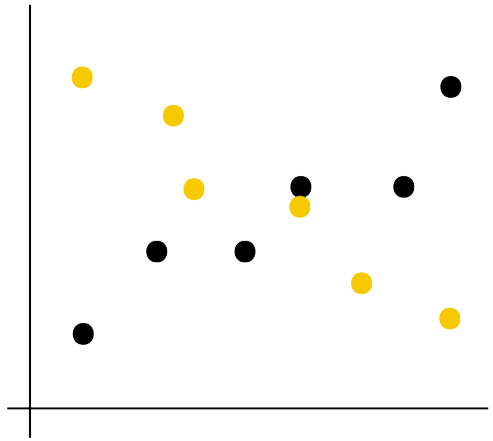
Superimpose data classes with different encodings

FILTERING AND FACETING

Side-by-side



Layered



ELIDING

Focus on selected item to show detail while remaining data are shown in summary

https://bl.ocks.org/mbostock/4339083

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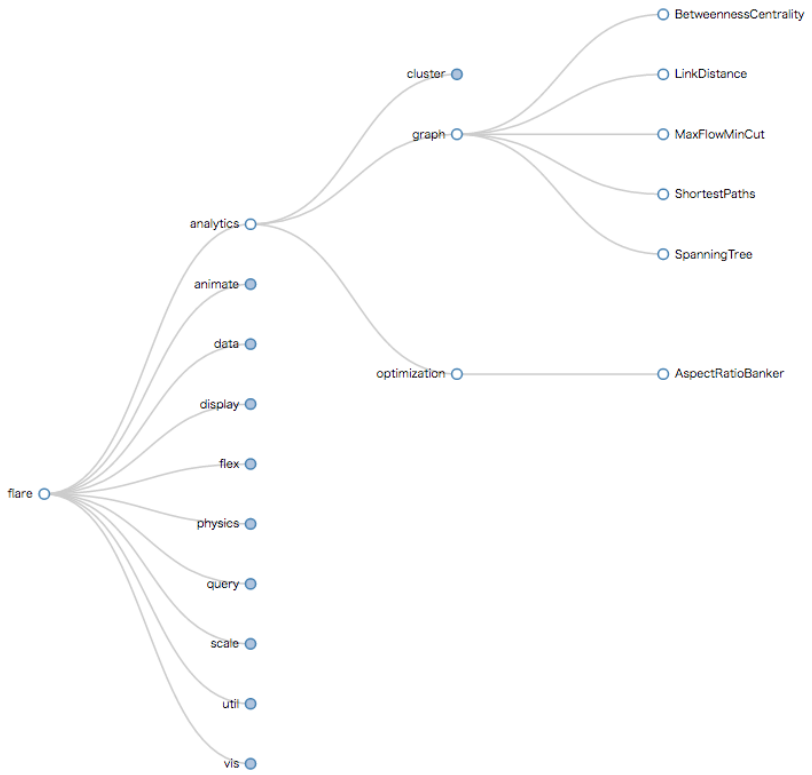
Focus on selected item to show detail while remaining data are shown in summary



https://bl.ocks.org/mbostock/4339083

reductionist reading

vs

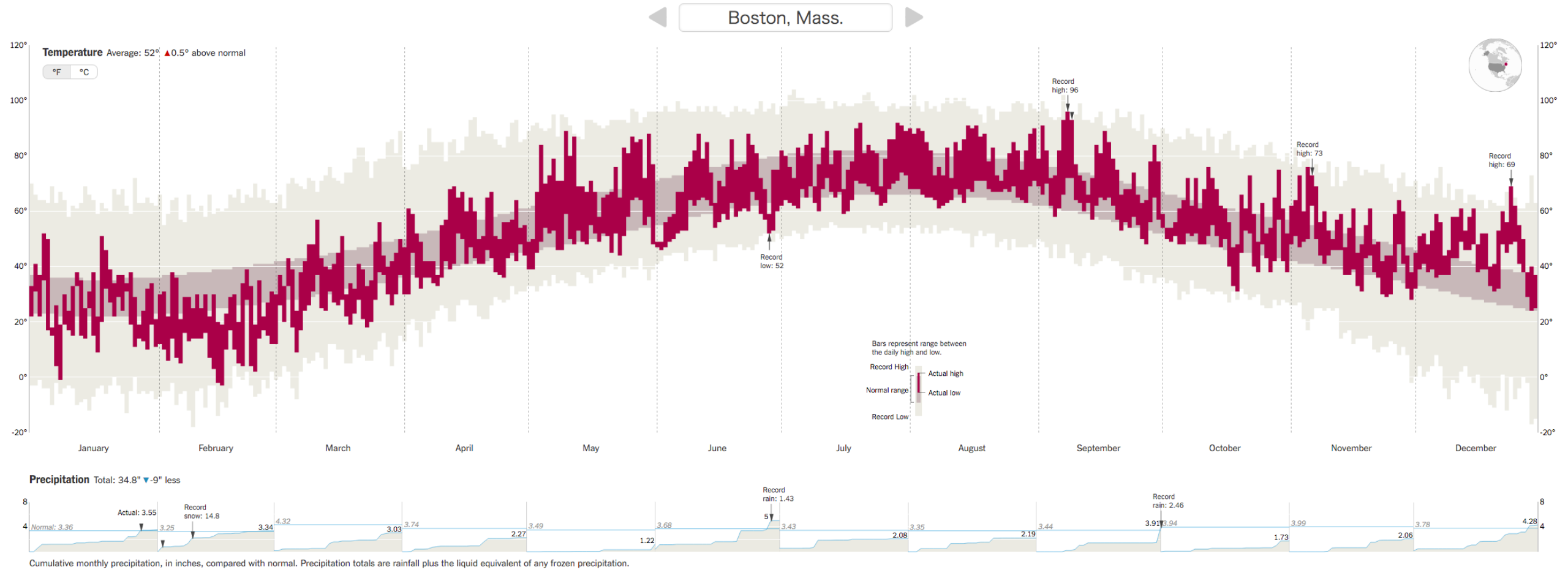
holistic reading

How Much Warmer Was Your City in 2015?

By K.K. REBECCA LAI FEB. 19, 2016

Scientists declared that 2015 was Earth's hottest year on record. In a database of 3,116 cities provided by AccuWeather, about 90 percent of them were warmer than normal. Enter your city in the field below to see how much warmer it was last year.

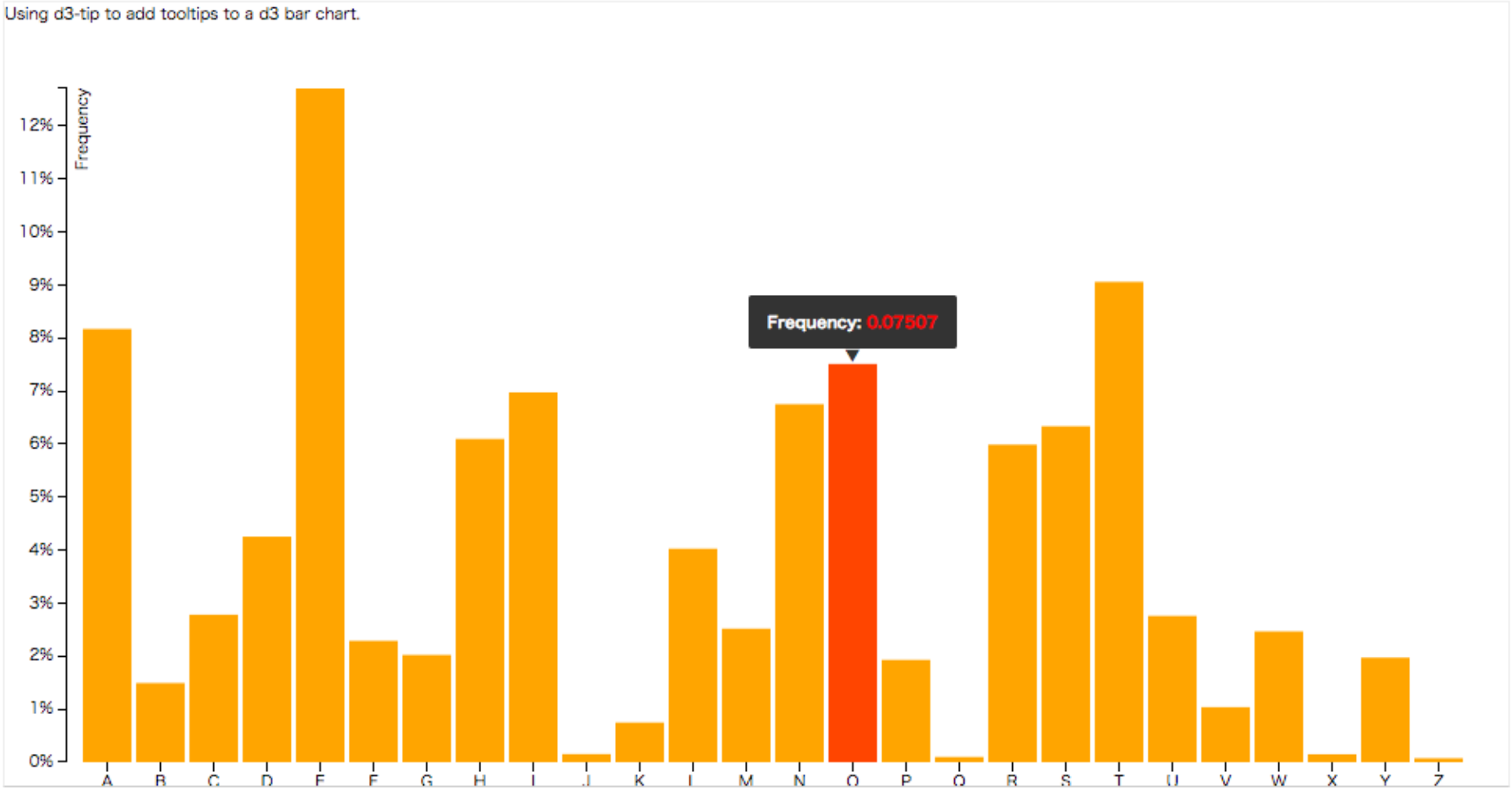
RELATED ARTICLE



Cumulative monthly precipitation, in inches, compared with normal. Precipitation totals are rainfall plus the liquid equivalent of any frozen precipitation.

http://www.nytimes.com/interactive/2016/02/19/us/2015-year-in-weather-temperature-precipitation.html#boston_ma

DETAILS ON DEMAND



http://bl.ocks.org/Caged/6476579

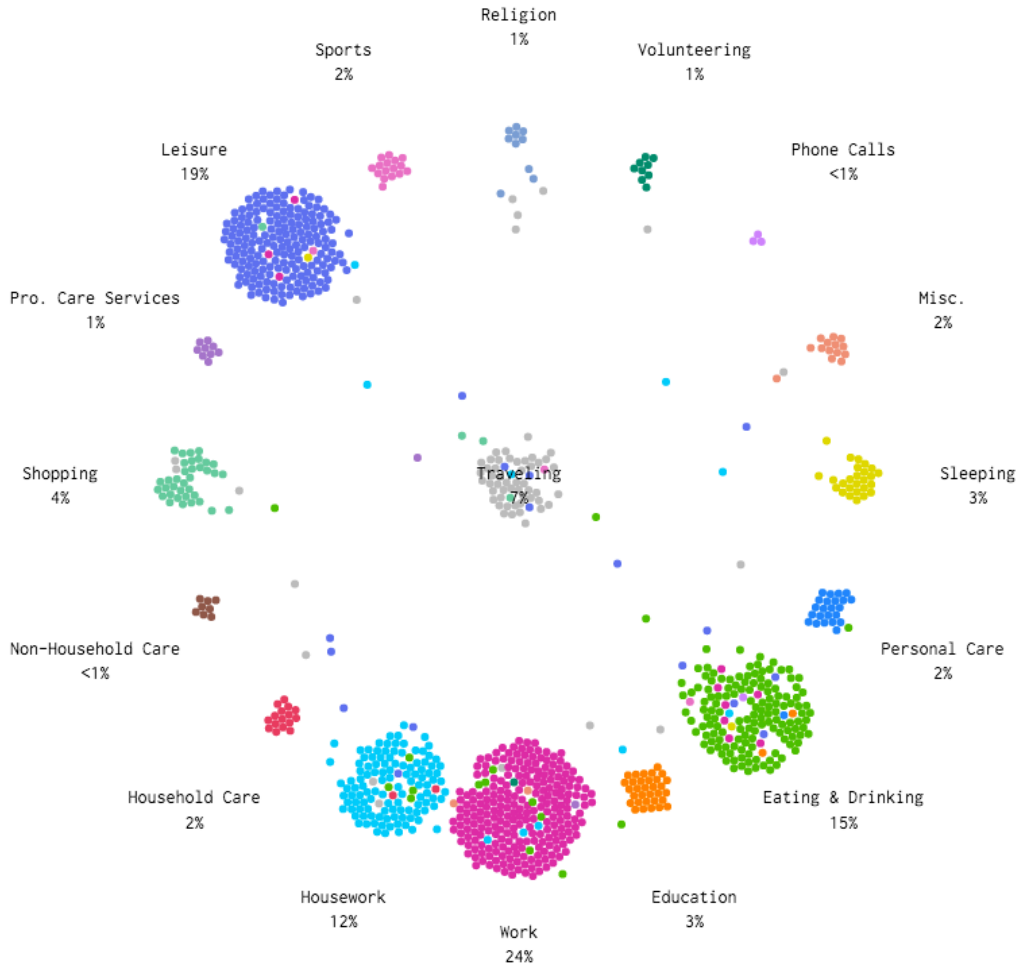
ANIMATION

12:16pm

SLOW | MEDIUM | FAST

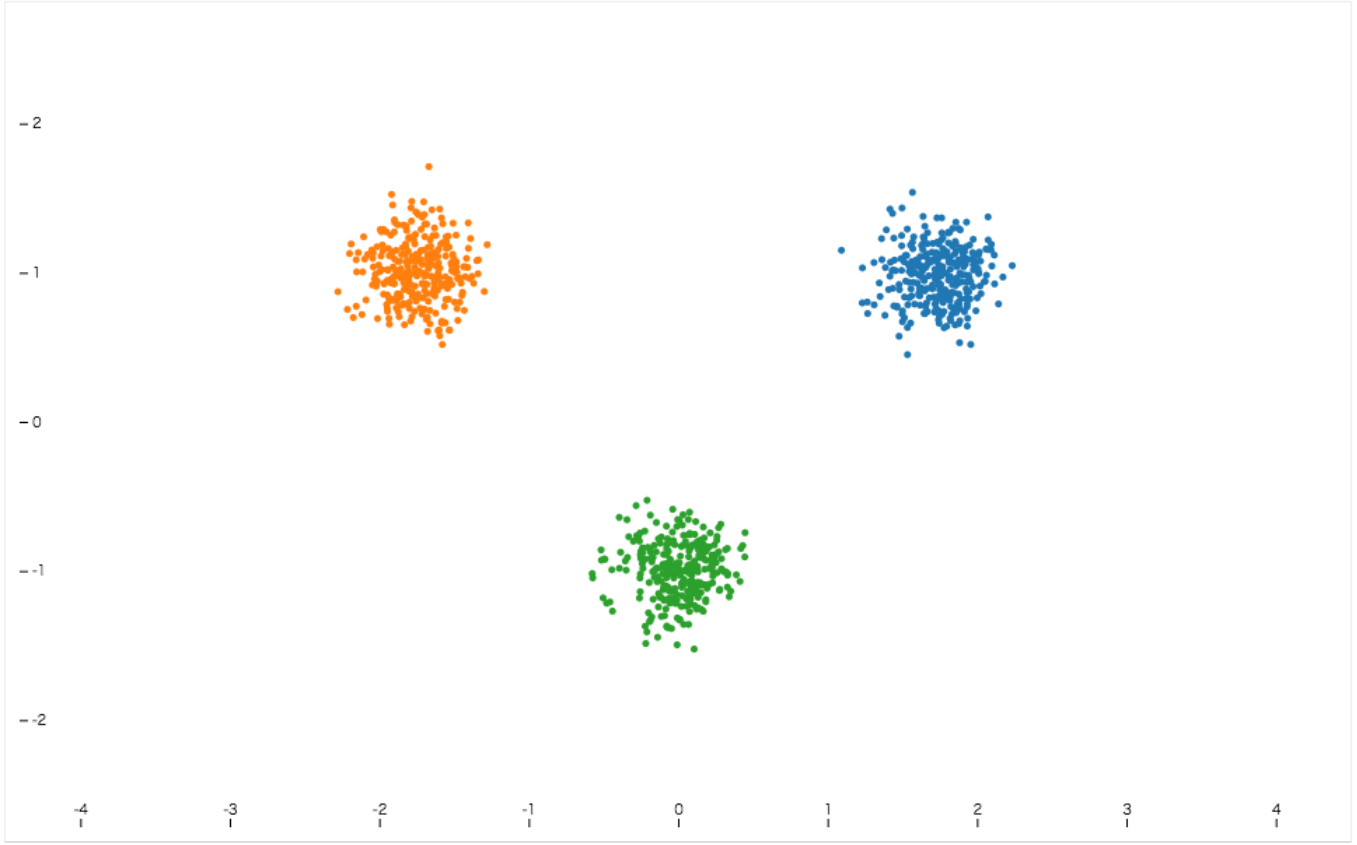
Lunch hour. Many go eat, but there's still activity throughout. You see a small shift at the end of the hour.

This is a simulation of 1,000 people's average day. It's based on 2014 data from the American Time Use Survey, made way more accessible by the ATUS Extract Builder.



http://flowingdata.com/2015/12/15/a-day-in-the-life-of-americans/

COMBINING INTERACTIVITY



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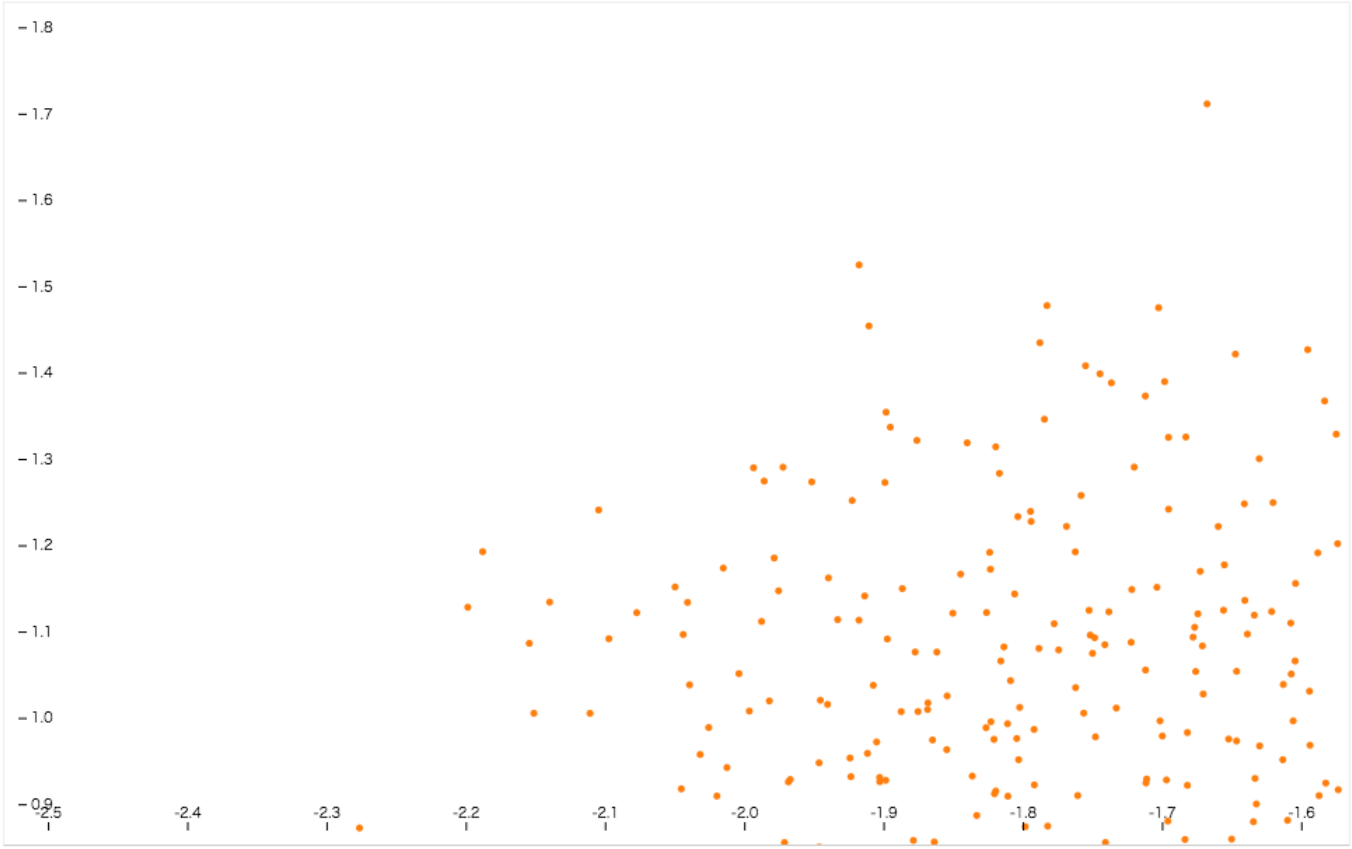
COMBINING INTERACTIVITY



https://bl.ocks.org/mbostock/f48fcdb929a620ed97877e4678ab15e6

How can we embed “interactivity” and exploration into static visualizations?

STRATEGIES FOR STATIC VISUALIZATIONS

Small multiples

Callouts (selection/highlighting)

Filtering and faceting

Multiform encoding

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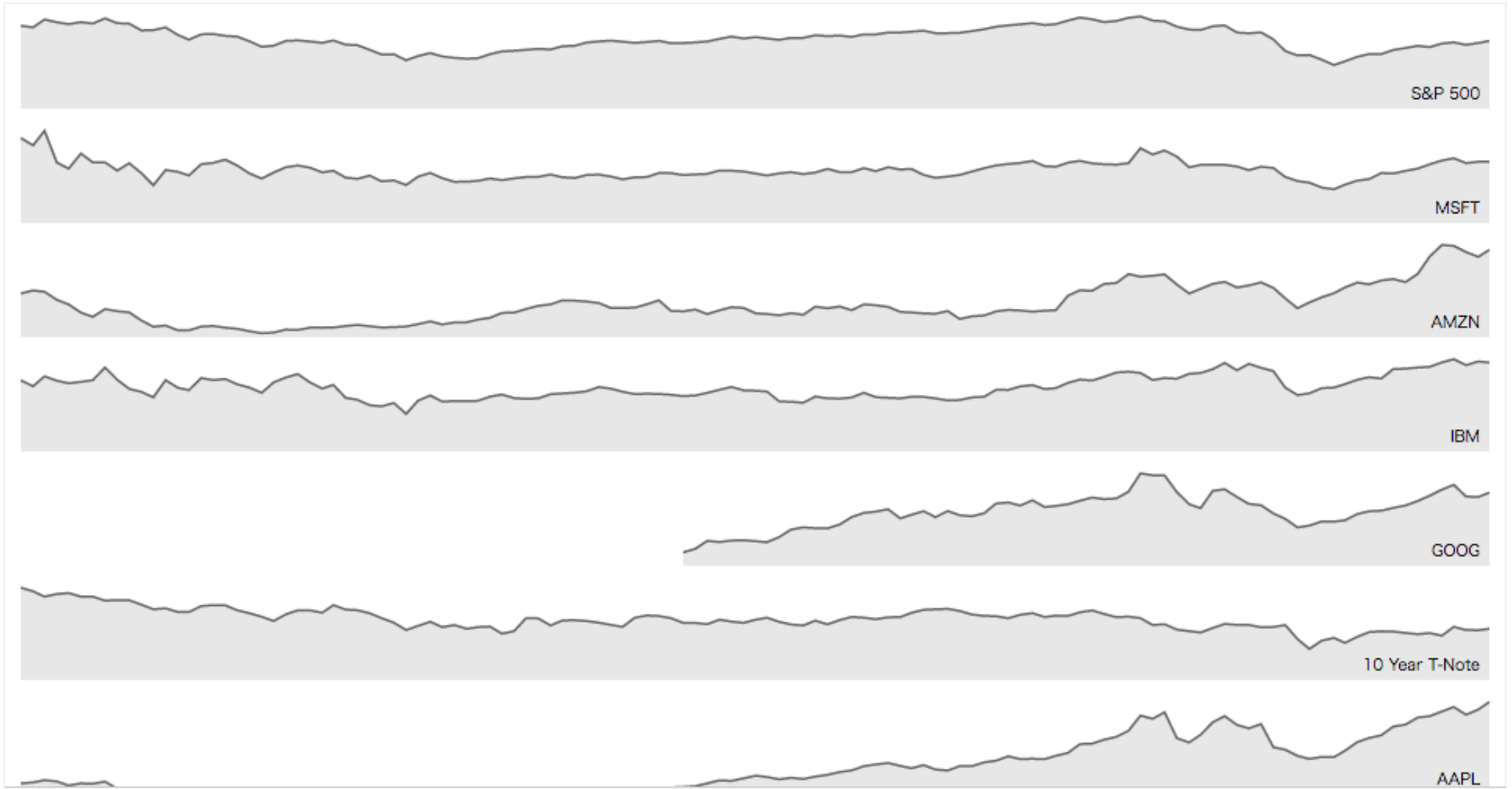

https://bl.ocks.org/mbostock/1157787

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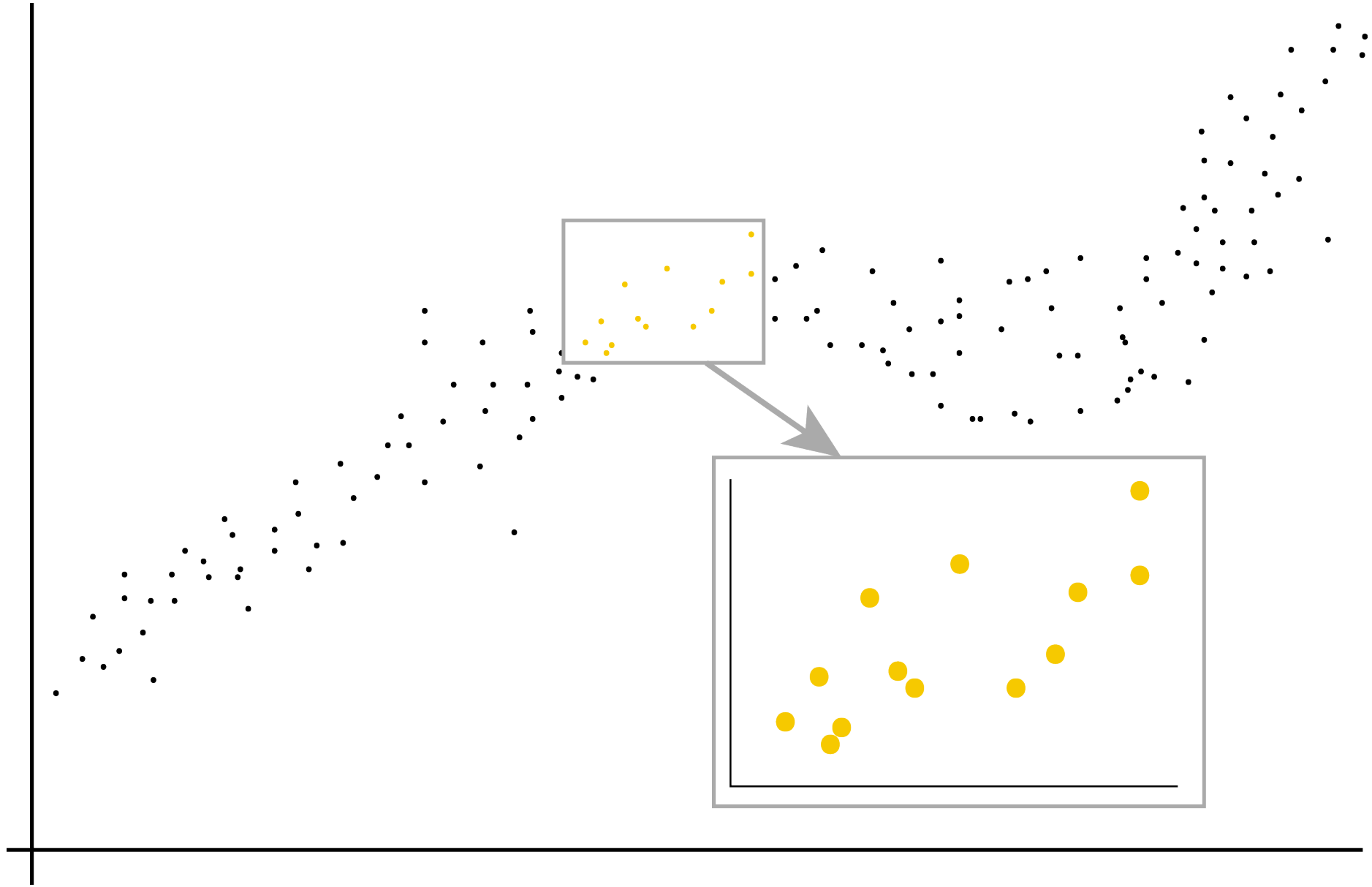

STRATEGIES FOR STATIC VISUALIZATIONS

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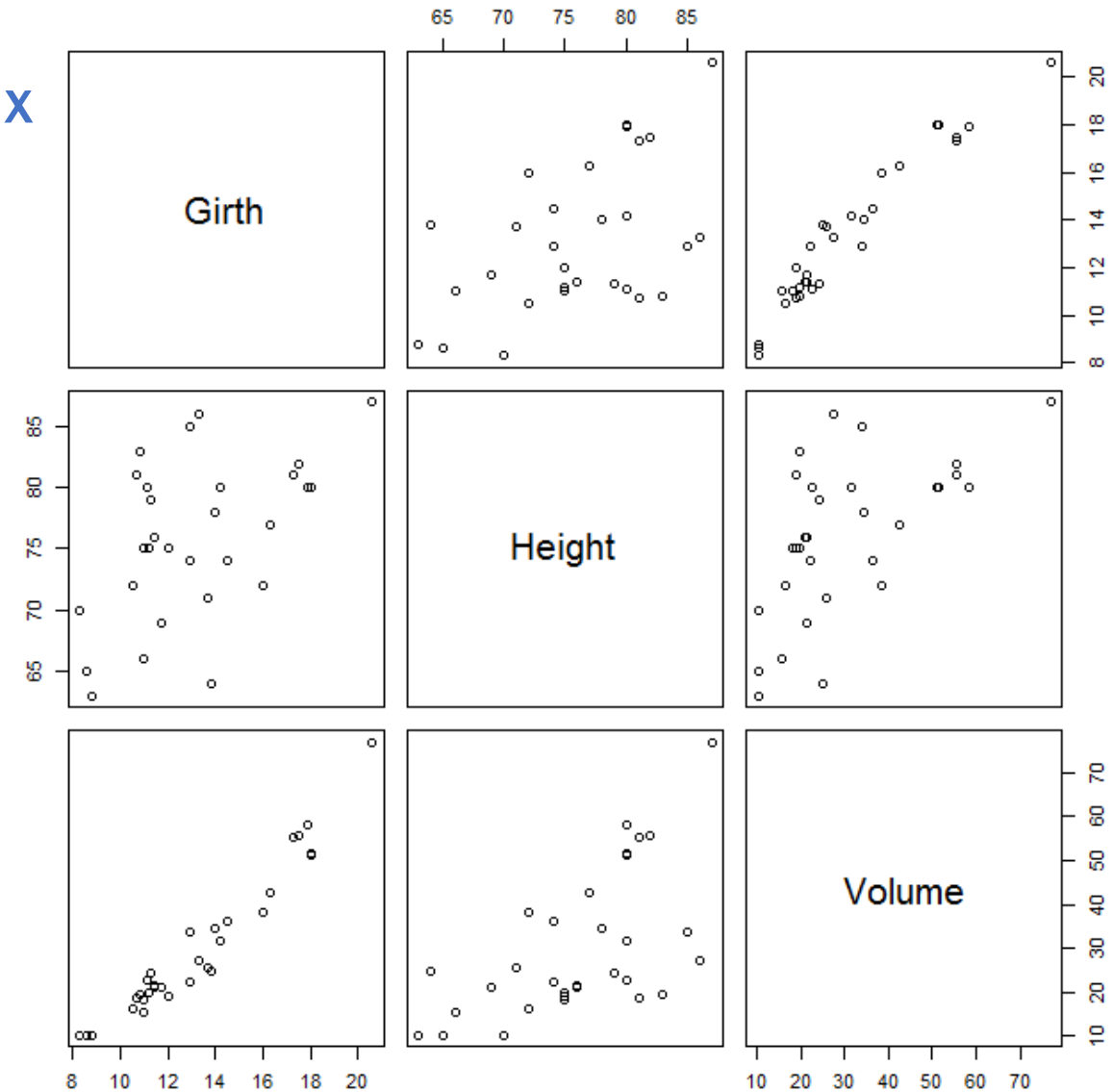
Scatter plot matrix



https://www.r-bloggers.com/scatterplot-matrices/

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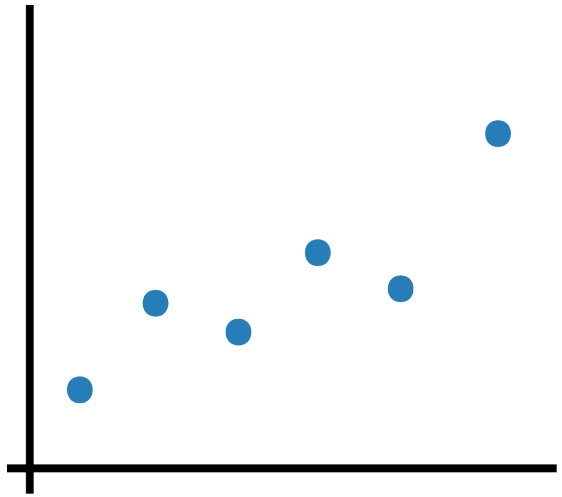
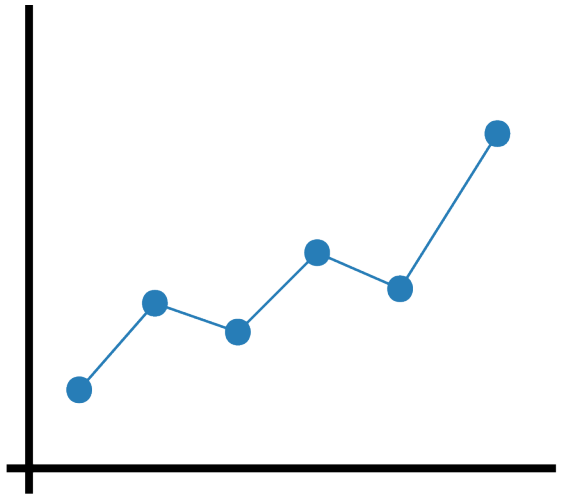
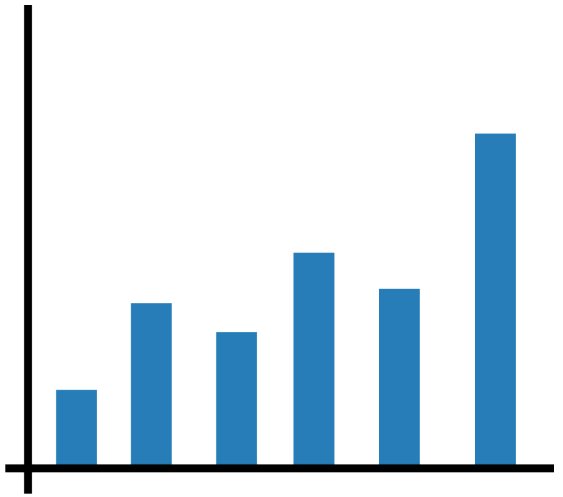
Filtering and faceting

Multiform encoding







Shiny

An R package for creating interactive web-based applications

https://shiny.rstudio.com/

Iris k-means clustering

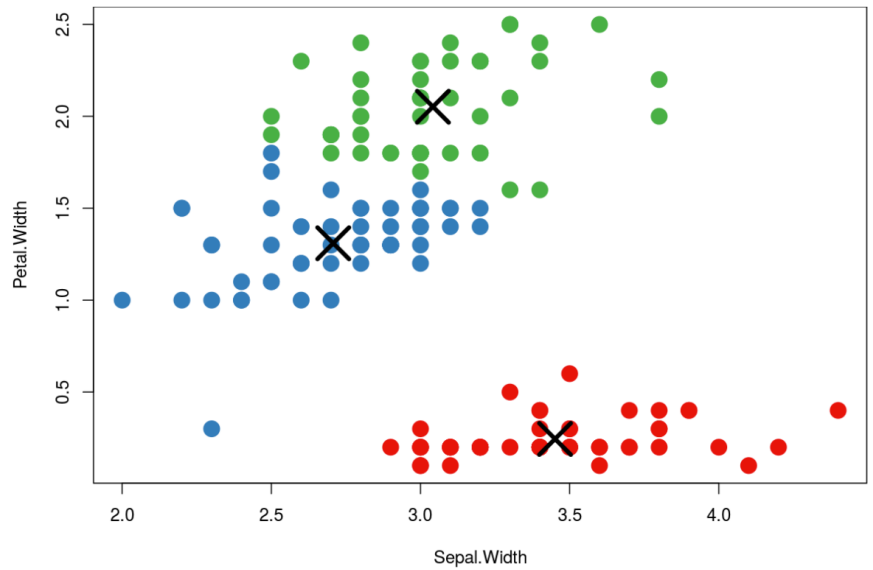
X Variable

Sepal.Width

Y Variable

Petal.Width

- Sepal.Length
- Sepal.Width
- Petal.Length
- Petal.Width
- Species

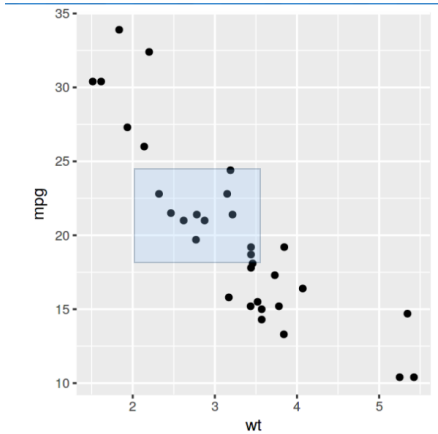


server.R | ui.R

show below

```
function(input, output, session) {

  # Combine the selected variables into a new data frame
  selectedData <- reactive({
    iris[, c(input$xcol, input$ycol)]
  })

  clusters <- reactive({
    kmeans(selectedData(), input$clusters)
  })

  output$plot1 <- renderPlot({
    palette(c("#E41A1C", "#377EB8", "#4DAF4A", "#984EA3",
      "#FF7F00", "#FFFF33", "#A65628", "#F781BF",
"#999999"))

    par(mar = c(5.1, 4.1, 0, 1))
    plot(selectedData(),
         col = clusters()$cluster,
         pch = 20, cex = 3)
    points(clusters()$centers, pch = 4, cex = 4, lwd = 4)
  })

}
```

https://shiny.rstudio.com/gallery/kmeans-example.html



Points near click

```
[1] mpg   cyl   disp  hp    wt    am    gear  dist_
<0 rows> (or 0-length row.names)
```

Brushed points

	mpg	cyl	disp	hp	wt	am	gear
Mazda RX4	21.0	6	160.0	110	2.620	1	4
Mazda RX4 Wag	21.0	6	160.0	110	2.875	1	4
Datsun 710	22.8	4	108.0	93	2.320	1	4
Hornet 4 Drive	21.4	6	258.0	110	3.215	0	3
Hornet Sportabout	18.7	8	360.0	175	3.440	0	3
Merc 240D	24.4	4	146.7	62	3.190	0	4
Merc 230	22.8	4	140.8	95	3.150	0	4
Merc 280	19.2	6	167.6	123	3.440	0	4
Toyota Corona	21.5	4	120.1	97	2.465	0	3
Ferrari Dino	19.7	6	145.0	175	2.770	1	5
Volvo 142E	21.4	4	121.0	109	2.780	1	4

app.R

↴ show below

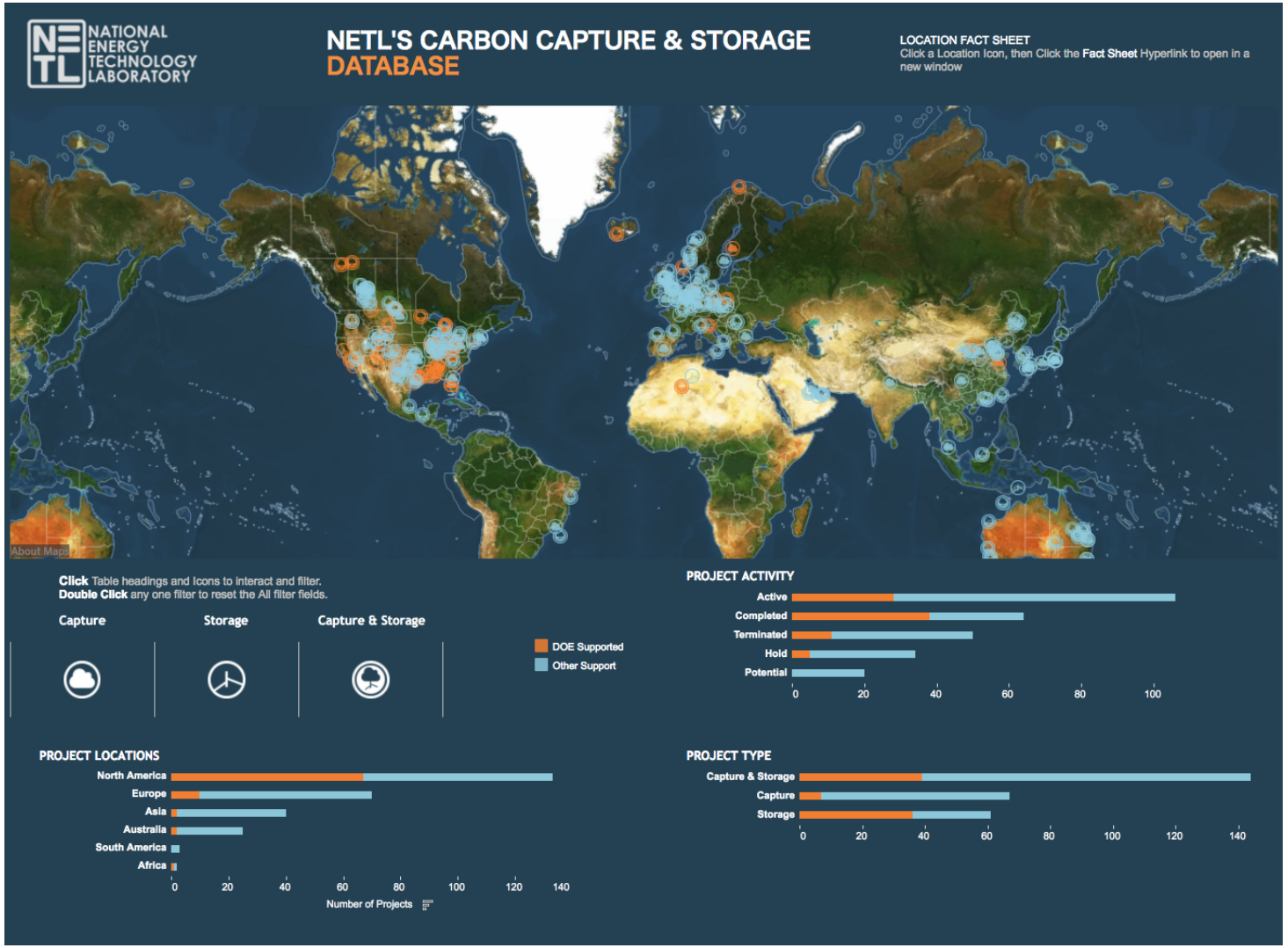
```r
library(ggplot2)
library(Cairo)   # For nicer ggplot2 output when deployed on Linux

# We'll use a subset of the mtcars data set, with fewer columns
# so that it prints nicely
mtcars2 <- mtcars[, c("mpg", "cyl", "disp", "hp", "wt", "am", "gear")]


ui <- fluidPage(
  fluidRow(
    column(width = 4,
      plotOutput("plot1", height = 300,
        # Equivalent to: click = clickOpts(id = "plot_click")
        click = "plot1_click",
        brush = brushOpts(
          id = "plot1_brush"
        )
      )
    )
  ),
  fluidRow(
    column(width = 6,
      h4("Points near click"),
      verbatimTextOutput("click_info")
```

https://shiny.rstudio.com/gallery/plot-interaction-selecting-points.html

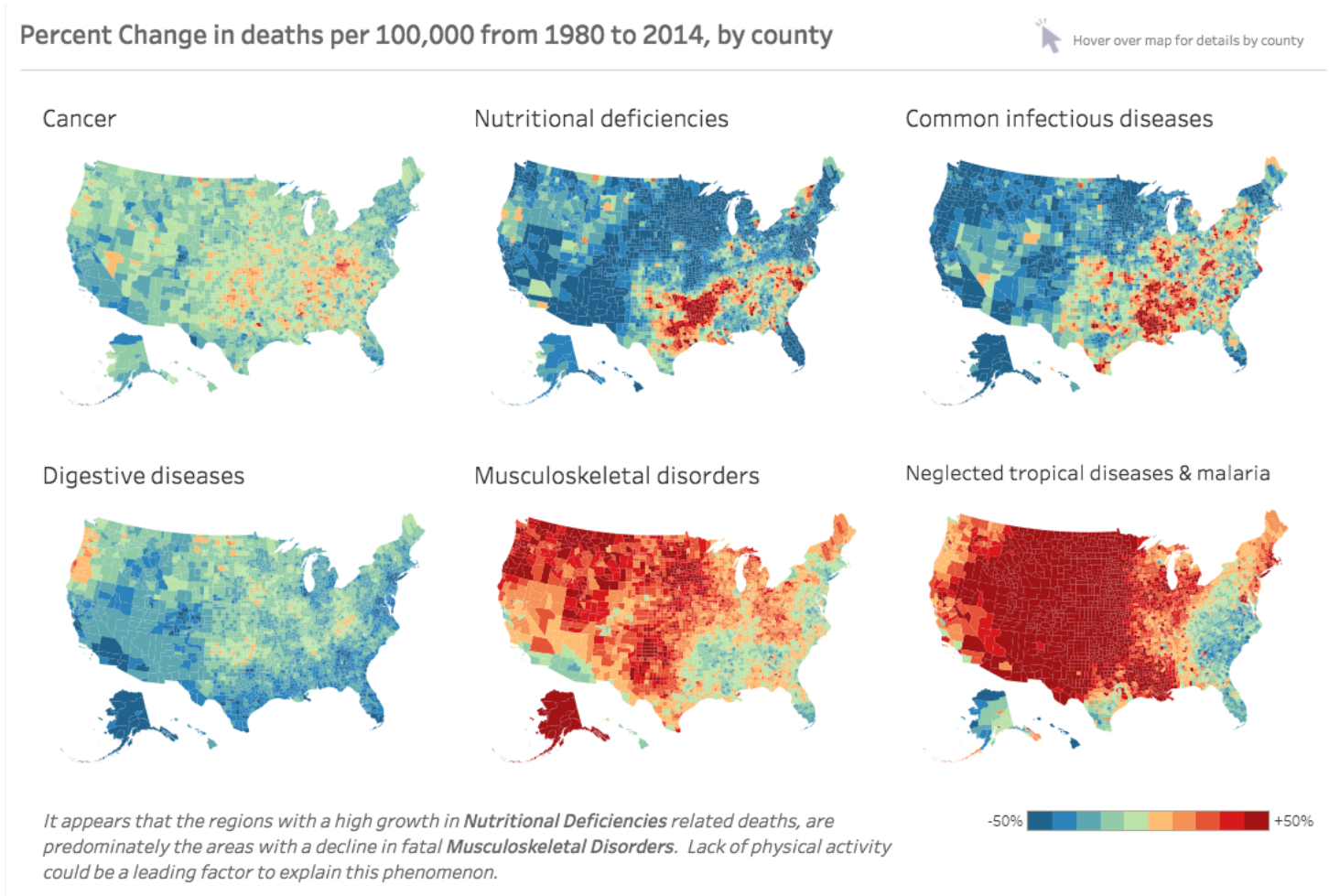
Tableau

Application for creating linked visualizations and dashboards

https://www.tableau.com/



https://public.tableau.com/en-us/s/gallery/carbon-capture-and-storage



https://public.tableau.com/en-us/s/gallery/changing-diseases