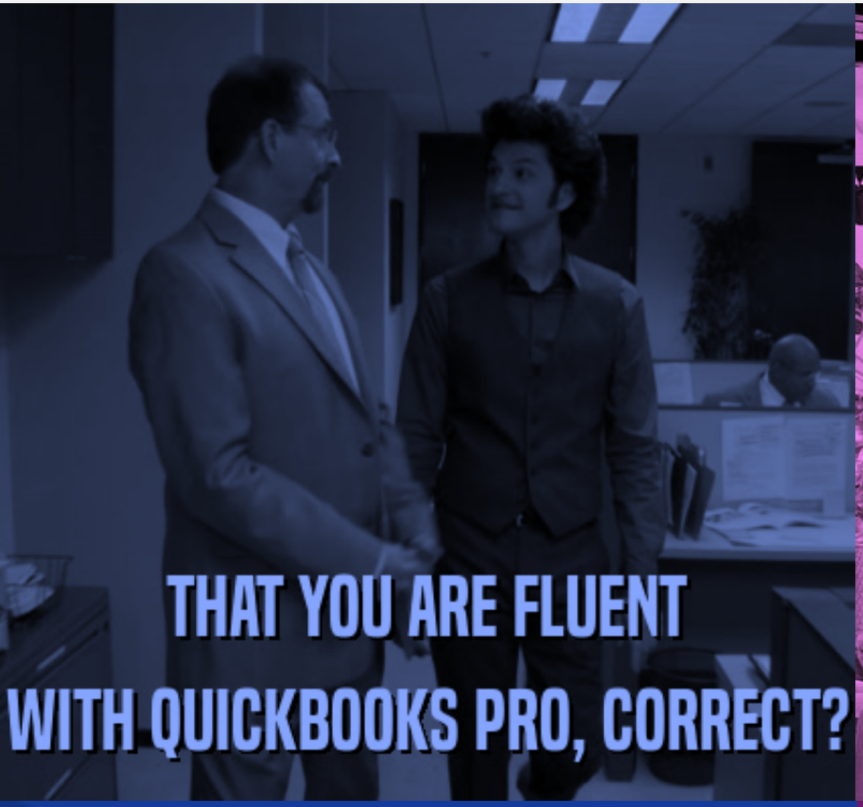
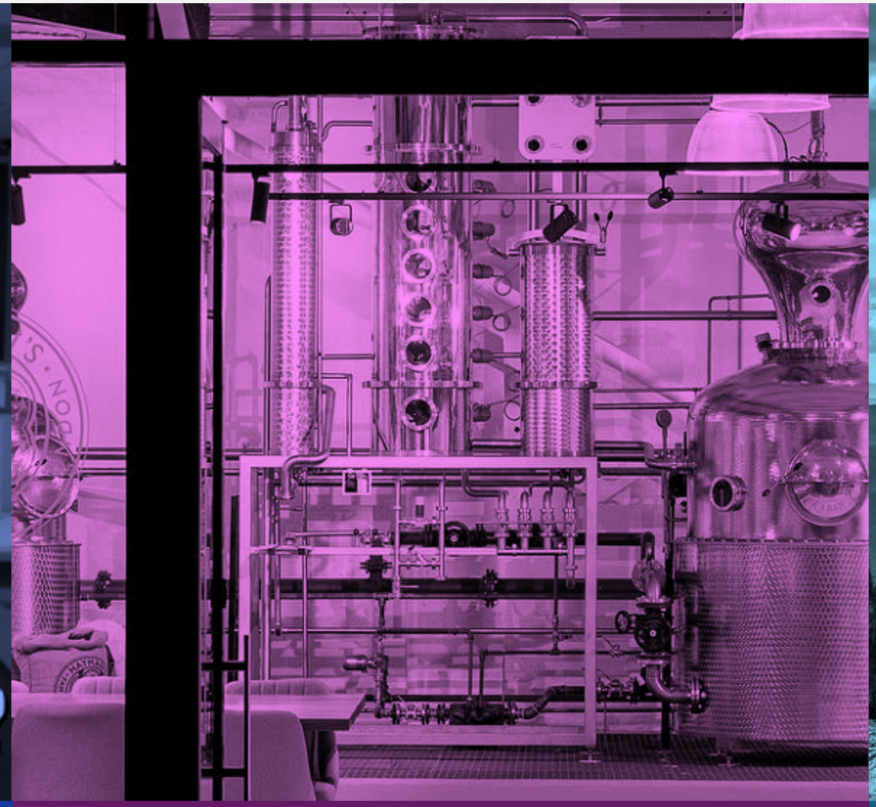
Presentation Options



Accounting Software

😐 too dull



Gin Making

🤷‍♂️🍷 need to share gin

Mountain Sports

🚫⛰️ no mountains in London

An Intro to D3.js

by someone who doesn't really know D3 or JS

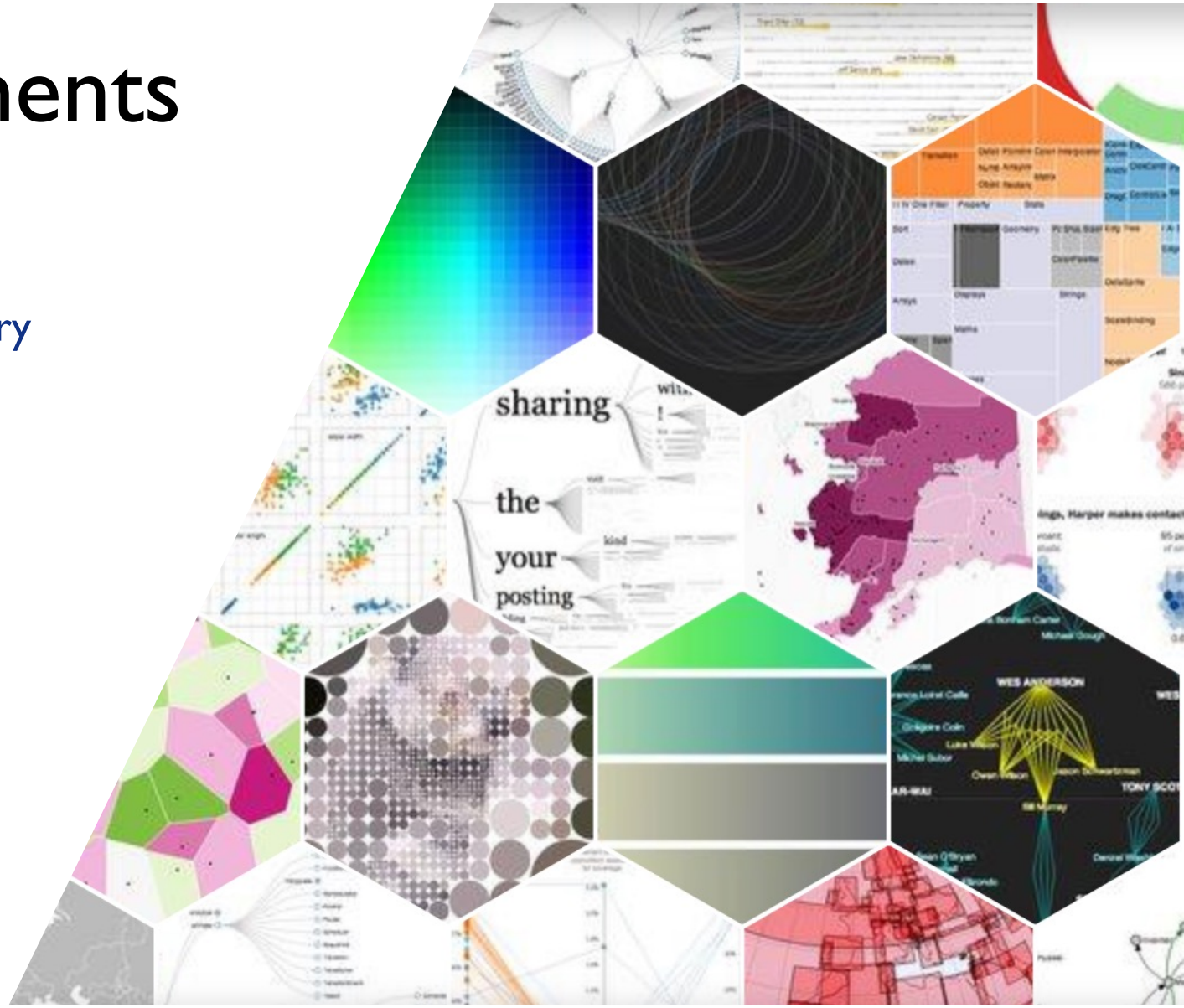
Fullstack d3, Amelia Wattenberger

Data Driven Documents

What
- Advanced, interactive data viz
- Low level; not a simple charting library

How
- **Bind** data to DOM elements
- **Transform** elements based on data
- Setup **transitions** and animations

Who
- Mike Bostock , NYT (2011)
- Industry Standard (191M downloads)



D3 Modules

D3 contains ~30 modules, all written in a functional style, just install the packages you need:

Prepare Data

d3-fetch

d3-array

d3-time-formats

d3-time-intervals

DOM Manipulation

d3-selection

Draw SVG shapes

d3-shapes

d3-path

d3-axes

Convert data to pixels

d3-scales

d3-colors

d3-hsv

Animate & add interactions

d3-transitions

d3-easings

d3-brushes

d3-dragging

d3-zooming

d3-timers

Specific Visualizations

d3-geo-projection

d3-geographies

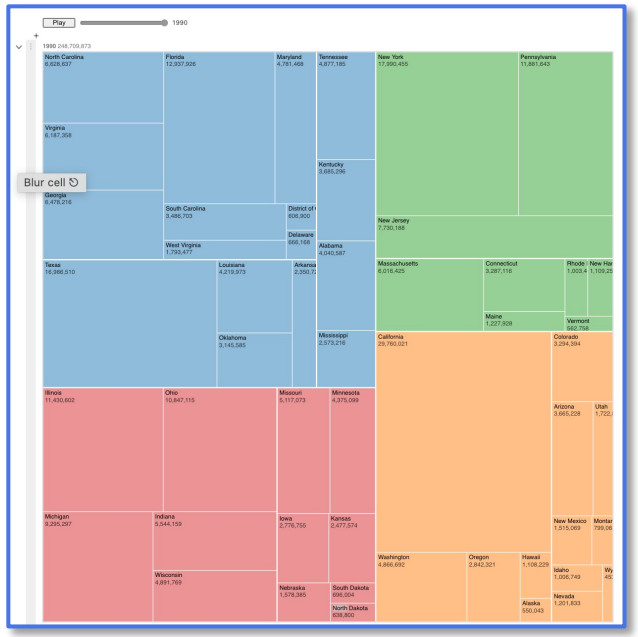
d3-sankey

d3-chords

d3-vonoroi

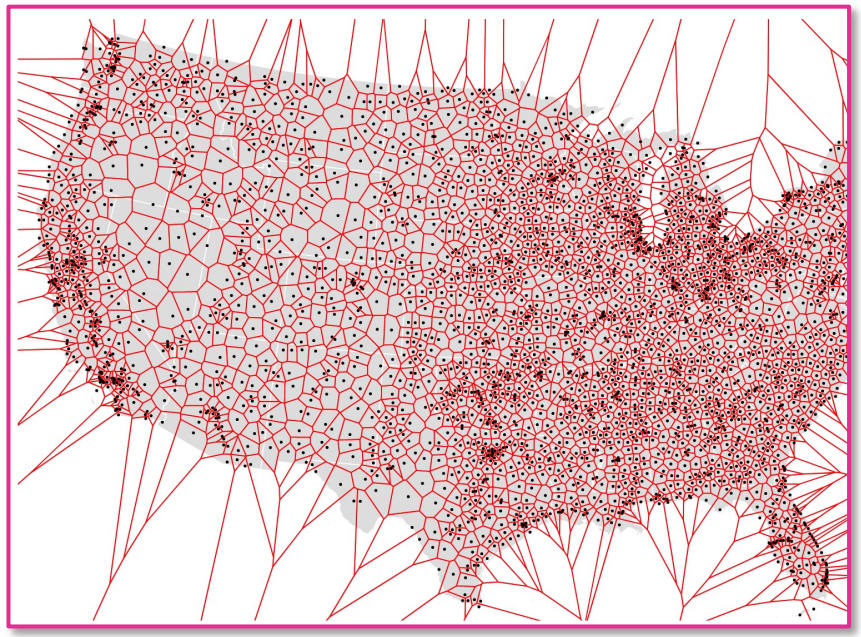
Examples

https://observablehq.com/@d3/gallery



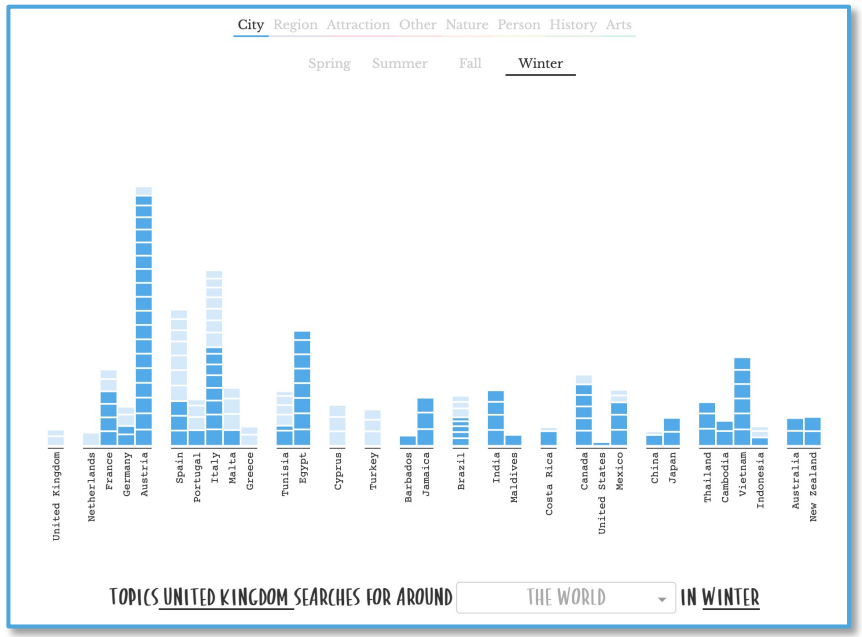
Population by state over time

Mike Bostock



Nearest airport by US city

Mike Bostock



Exploratory analysis of travel searches

Shirley Wu

D3 Basics

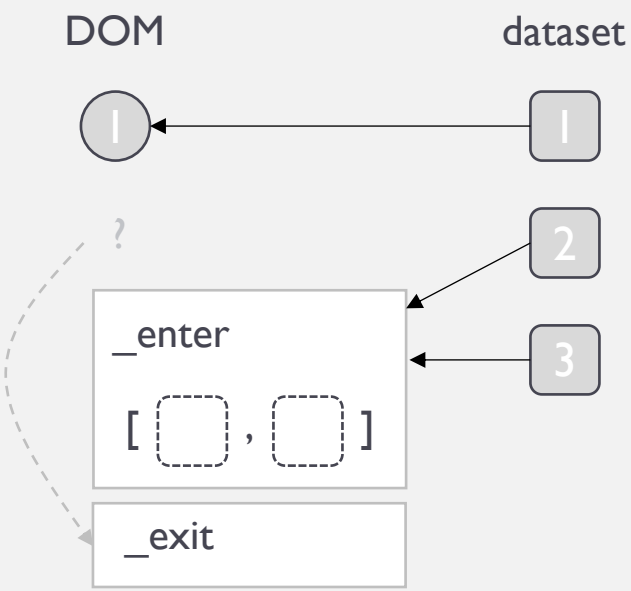
1.	**Fetch** data	dataset = d3.json('example.json');
2.	**Select** /create DOM elements	plot = d3.select('#plotDiv').append('svg');
* 3.	**Bind** data to document elements	dataMap= plot.selectAll('.elements').**data(dataset);**
4.	**Create/remove** elements as required	dataMap.**enter()**.append('circle')
5.	**Transform** elements based on data	.attr('cx', d => **scale**(d))
6.	**Transition** (animate) between states	.transition().duration(1000)

* Will review data, enter and scales in more depth

d3.data(), enter(), exit()

data()

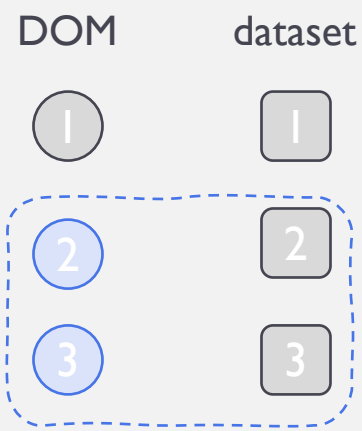
Maps array of data to DOM elements



points =
d3.selectAll('circle').**data**(dataset)

enter()

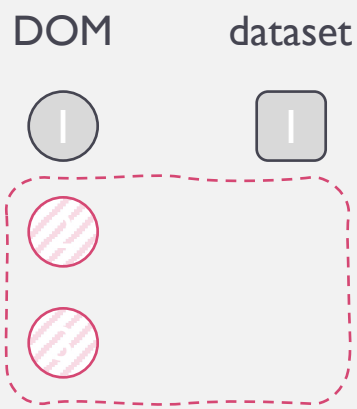
Select data missing elements



points.**enter()**
.append('circle')
.attr('fill', 'blue')

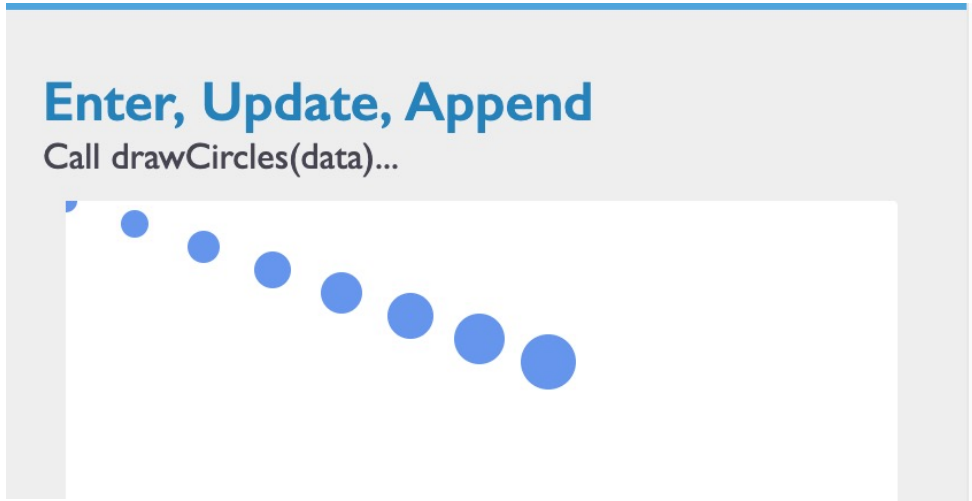
exit()

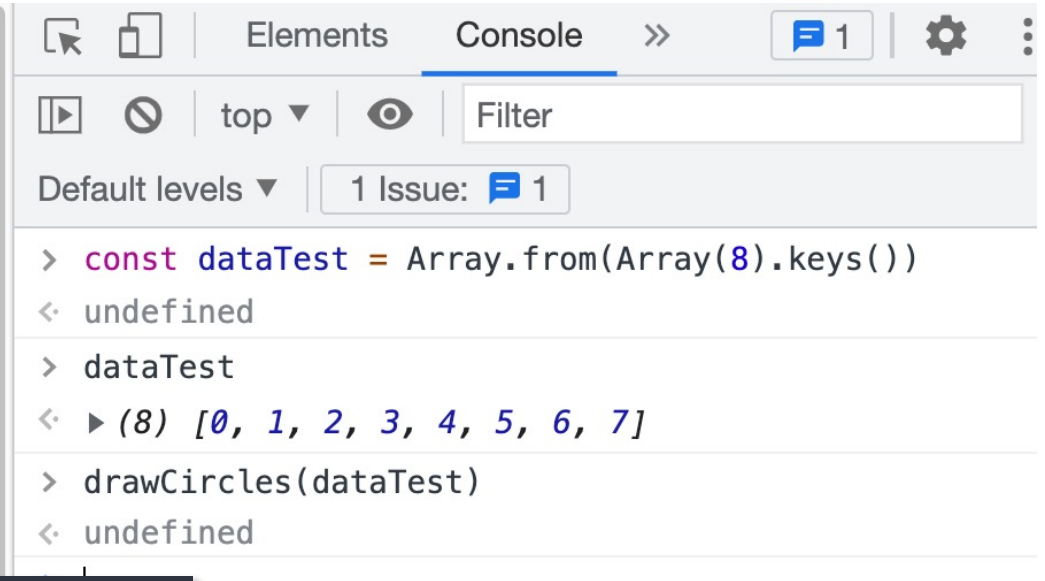
Select elements missing data



points.**exit()**
.attr('fill','red')
.remove()

> drawCircles(dataTest)



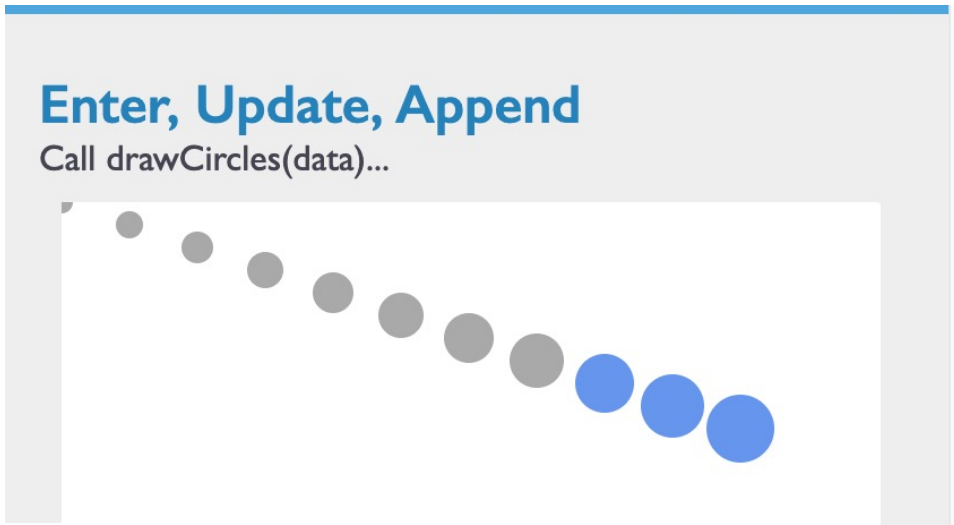


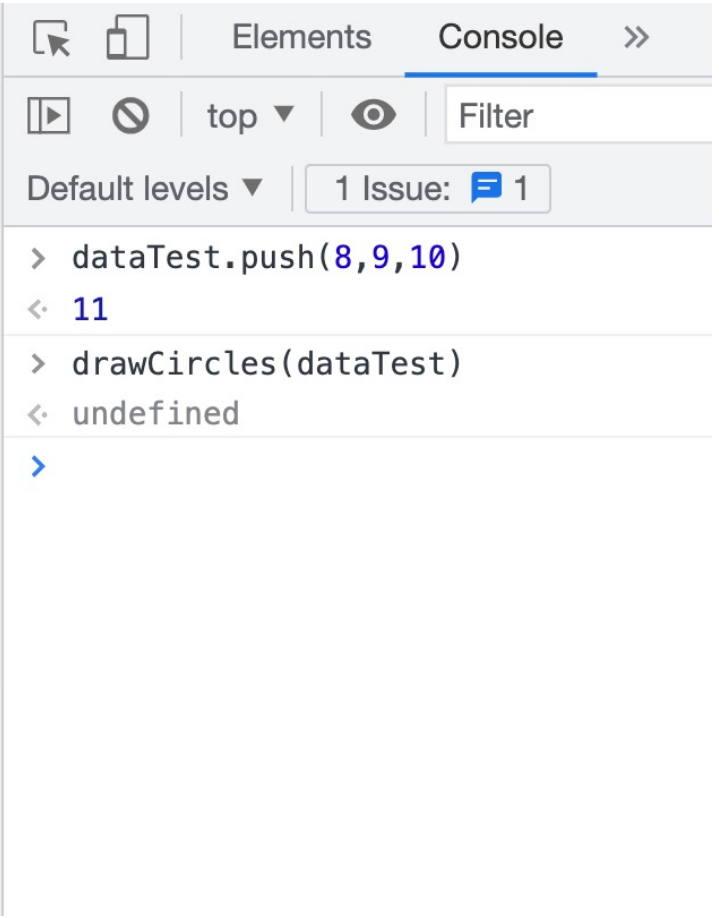
function drawCircles (data) { …

```
// Bind data elements to any existing SVG circles
const circles = plot.selectAll('circle').data(data);

// Create new circles for unmapped data
circles.enter().append('circle')
    .attr('cx', d => d*30)
    .attr('cy', d => d*10)
```

> drawCircles([…dataTest, …[8,9,10])



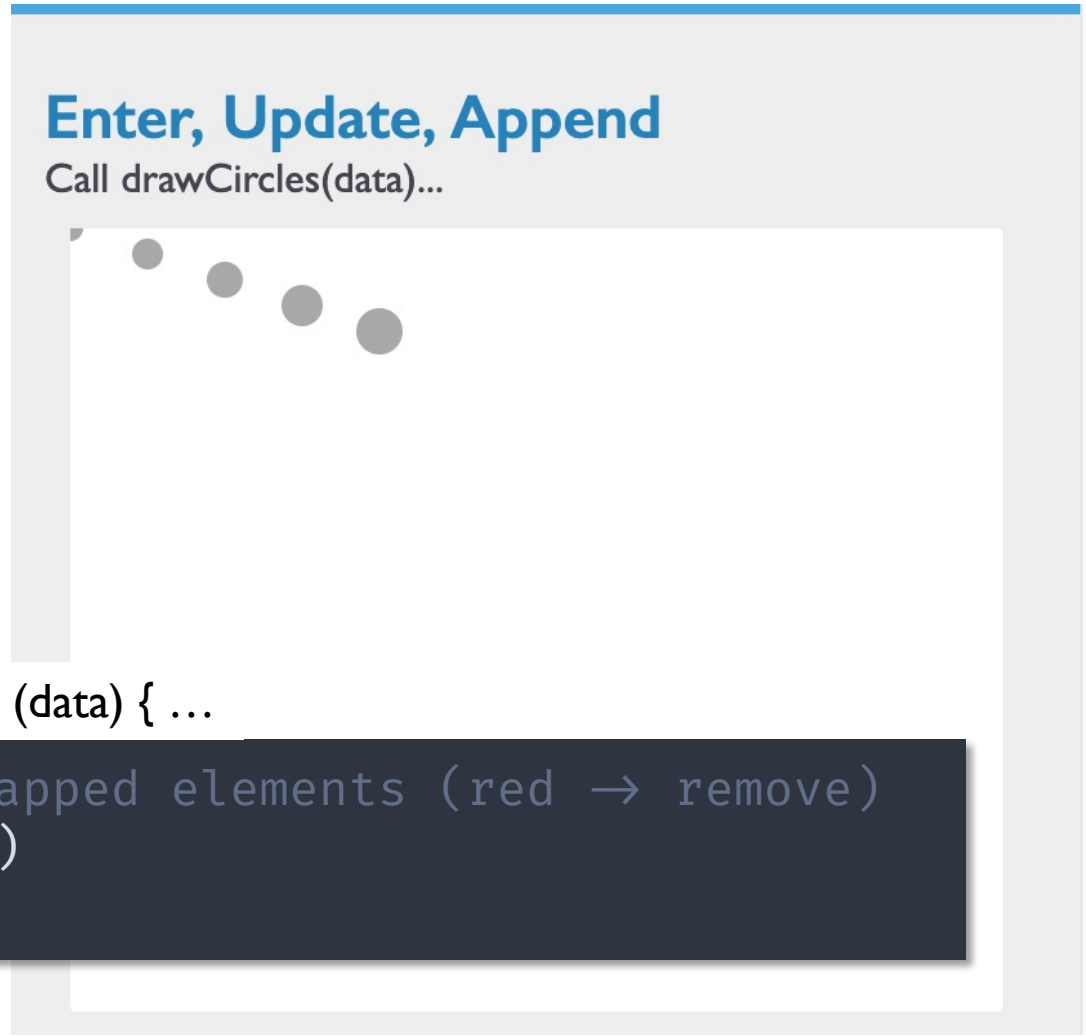


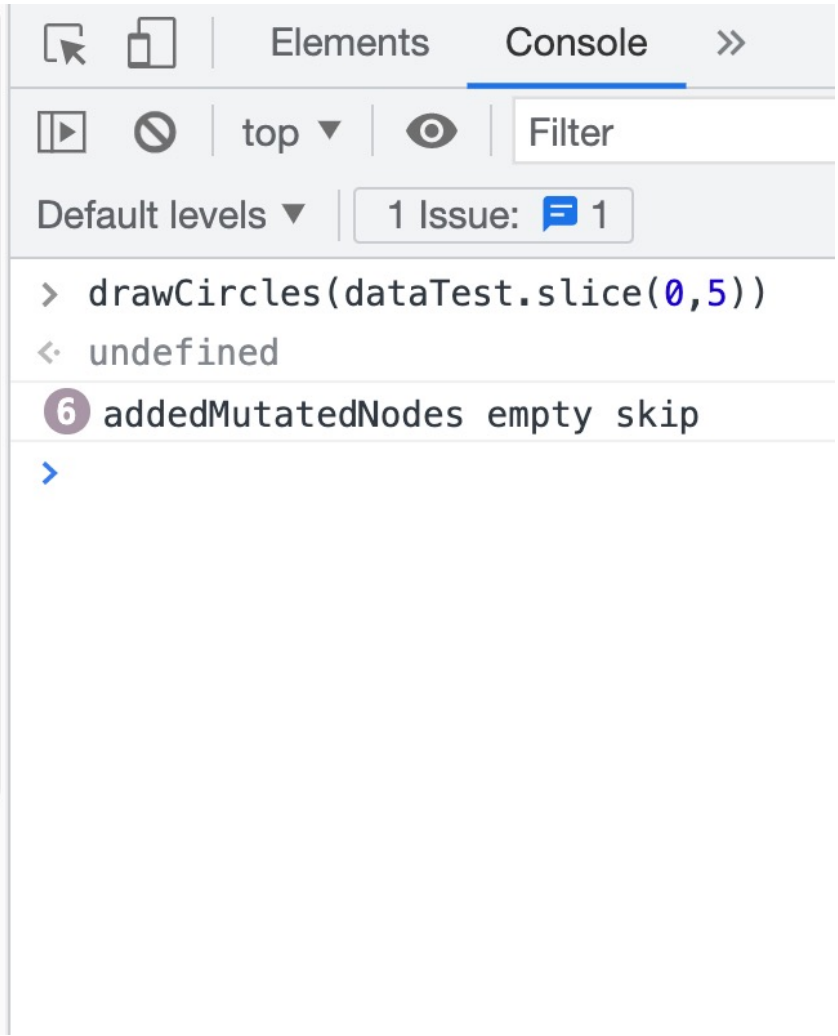
function drawCircles (data) { …

```
// Update existing circles: color grey
circles.attr('fill', ‘darkgrey’);

// Create new circles for unmapped data (blue)
circles.enter().append('circle’)
    .attr(‘color', ‘cornflowerblue')
```

> drawCircles(dataTest.slice(0, 5))





function drawCircles (data) { …

```
// Remove unmapped elements (red → remove)
circles.exit()
    .remove();
```

d3.scale

Scales are functions that map data to physical ranges

1. Choose function type
2. Input data domain
3. Output range

```
xScale = d3.scaleLinear()
        .domain([-10.54, 34.56])
        .range([0, 800])
```

Scale Types

- Continuous (Linear, Power, Log, Time, Radial)
- Sequential
- Diverging
- Quantize
- Quantile
- Threshold
- Ordinal (Band, Point)

Dataset domain example …

[-7.56, -3.45, -2.04, -4.39, -9.24, -10.54, -7.64, -1.24, 6.15, 4.13, 9.84, ..]

Domain: d3.extent(dataset) → [-10.54, 34.56]

Physical range examples …

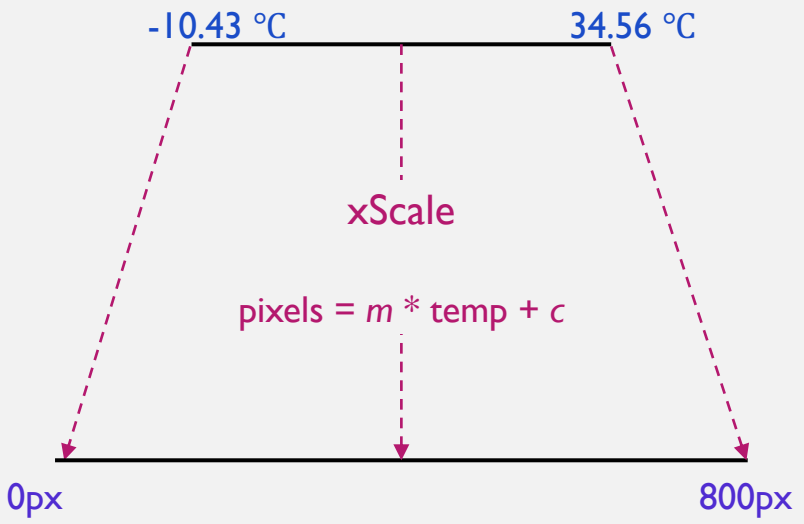
SVG area:

0px 800px

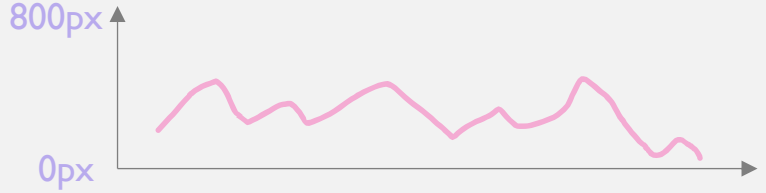
Colours:

#4775E7 #D54773

scaleLinear



Use scale to help position elements on the DOM



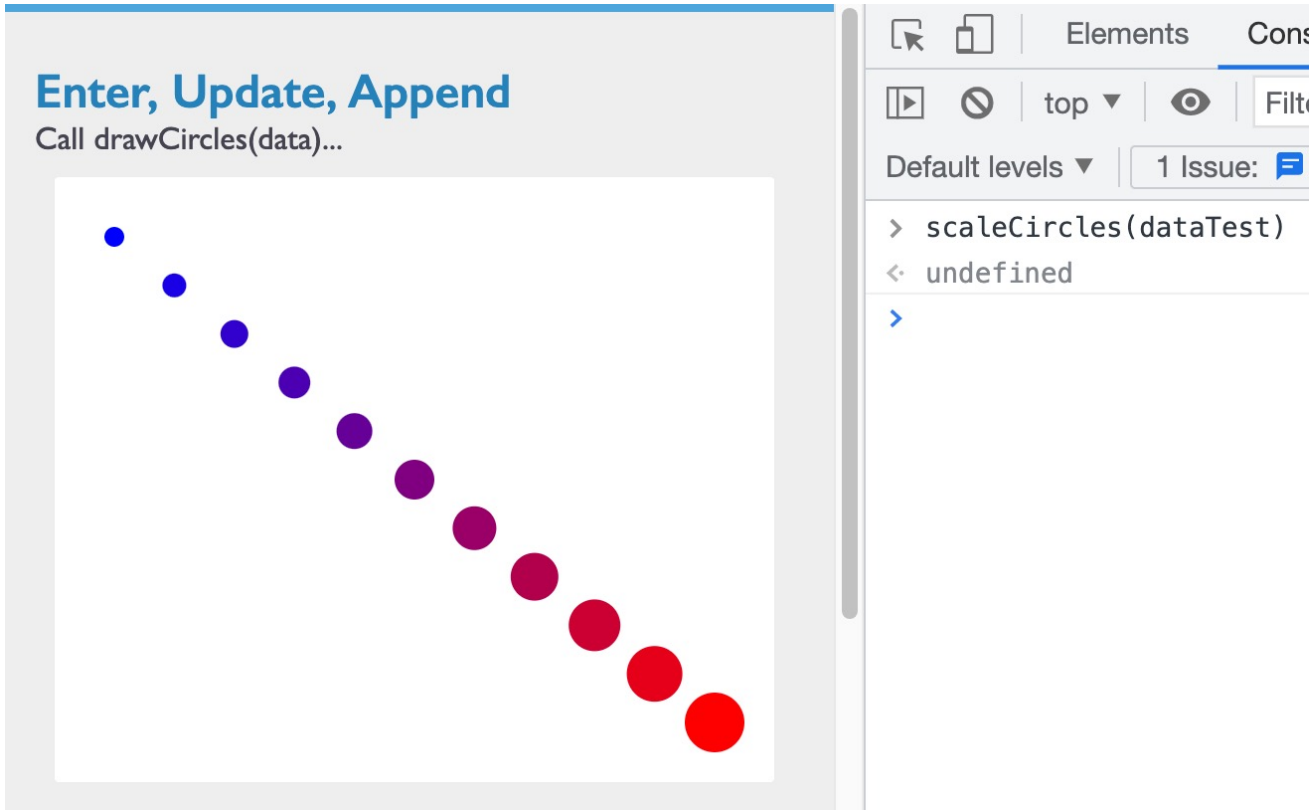
> scaleCircles(dataTest)

function scaleCircles (data) {

```
const xScale = d3.scaleLinear()
    .domain(d3.extent(data))
    .range([30, width-30]);

const colourScale = d3.scaleLinear()
    .domain(d3.extent(data))
    .range(['blue', 'red']);


circles.attr('fill', 'darkrgrey’)
    .attr('cx', d => xScale(d))
    .attr('cy', d => yScale(d))
    .attr('fill', d=>colourScale(d))
```



Workflow For Charts

Access Data	Import dataset, optionally declare ‘accessor’ functions for key fields
Chart Dimensions	Declare chart size in pixels, helps to define scale outputs
Draw Canvas	Render the chart area
Create Scales	Create scales for every data-pixel mapping required in the chart e.g. y-pos, colour
Draw Data	Render SVG or other DOM elements for the data
Draw Peripherals	Render axis, labels, legends
Setup Interactions	Initialize event listeners and create interaction behaviour

Demo

Access Data

```
async function drawScatter () {

  let dataset = await d3.json('./data/my_weather_data.json');

  const xAccessor = d ⇒ d.dewPoint;
  const yAccessor = d ⇒ d.humidity;
}
```

- D3.json parses json file and returns an array with the datapoints in the file
- xAcessor and yAccessor are functions to make accessing the relevant fields in the dataset easier.

Demo

Chart Dimensions

```
const width = d3.min([window.innerHeight * 0.9, window.innerWidth * 0.9]);

let dimensions = {
width,
height: width,
margin: {top: 10, right: 10, bottom: 10, left: 10}
};

dimensions.plotWidth = dimensions.width - dimensions.margin.right –
dimensions.margin.left;
dimensions.plotHeight = dimensions.height - dimensions.margin.top –
dimensions.margin.bottom;
```

- Save dimensions of chart in an object: setting height = width = 90% window
- Calculate dimensions of inner plot area by subtracting the margins

Demo



Draw Canvas

```
const wrapper = d3.select('#wrapper-scatter')
    .append('svg')
    .attr('width', dimensions.width)
    .attr('height', dimensions.height);

const plot = wrapper.append('g')
    .style('transform', `translate(${dimensions.margin.left}px,
    ${dimensions.margin.top}px)`);
```

- Similar approach to jQuery: select div by id, append svg and set attributes
- Plot is a svg group element and will maintain a margin between the plot elements and the outer svg

Demo

Create Scales

```
const xScale = d3.scaleLinear()
    .domain(d3.extent(dataset, xAccessor))
    .range([0, dimensions.plotWidth])
    .nice();

const yScale = d3.scaleLinear()
    .domain(d3.extent(dataset, yAccessor))
    .range([dimensions.plotHeight, 0])
    .nice();
```

- Create scale functions that map datapoints to physical positions
- The scale functions are provided the domain of the data and the physical (pixel) range
- Nice is a helper method that makes ranges ‘nicer’ e.g. [-0.7823, 0.197] -> [-0.8, 0.2]

Demo

Draw Data

```
const points = plot.selectAll('circle').data(data);

points.join('circle') //shortcut for .enter().append('circle').merge(dataset)
    .attr('cx', d ⇒ xScale(xAccessor(d)))
    .attr('cy', d ⇒ yScale(yAccessor(d)))
    .attr('r', 5)
    .attr('fill', d ⇒ colourScale(colourAccessor(d)));
```

- Select all circle SVG elements on the plot and bind them to the datapoints
- Add new circles for each datapoint that cannot be bound to an existing circle
- Update the attributes (x and y position based on applying the scale function to each relevant datapoint)
- Set colour based on colour scale (not shown on earlier slides)

Demo

Draw Peripherals

```
const xAxisGenerator = d3.axisBottom(xScale);
const xAxis = plot.append('g').call(xAxisGenerator)
.style('transform', `translateY(${dimensions.plotHeight}px)`);

const yAxisGenerator = d3.axisLeft(yScale);
const yAxis = plot.append('g').call(yAxisGenerator);
```

- Create an axis generator based on the scale functions
- Append a new g element to the plot, apply the axis generator
- Change the position of the elements as required

D3 and React

Both **React** and **D3** want control of the DOM but there are approaches to make them work together:

Option 1 **React** takes control of DOM, **D3** as a utility library

Option 2 **D3** takes control of DOM

Option 3 **D3** and **React** share control of DOM

---

https://www.youtube.com/watch?v=zXBdNDnqV2Q

https://www.youtube.com/watch?v=I-PZ7rQWs04

Further Resources

Category	Name	Link	Description
Data Visualization	Stephen Few	http://www.stephen-few.com/blog/	Focused on business information & dashboards
Data Visualization	Edward Tufte	https://www.edwardtufte.com/tufte/	Professor emeritus statistics Yale
Data Visualization	Alberto Cairo	http://albertocairo.com/	Chair visual journalism University of Miami
D3.js	Shirley Wu	https://shirleywu.studio/	Freelance data artist & tutor
D3.js	Amelia Wattenberger	https://wattenberger.com/	Engineer at Github
D3.js	Mike Bostock	https://observablehq.com/@mbostock	D3 creator

Appendix

SVG Elements Cheatsheet

svg

The Grand Poobah.

Use this to surround all other SVG elements or to create a new coordinate system.

defs

The definitions element.

Use this to store elements to be used elsewhere. For example:

clipPath

Store in defs. reference: url(#id)

Used to clip other elements outside of its children elements' shape.

linearGradient, radialGradient

Store in defs. reference: url(#id)

Used to define a gradient, using:

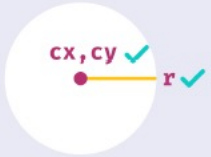
stop

- offset
- ✓stop-color
- ✓stop-opacity

rect

line

circle



g

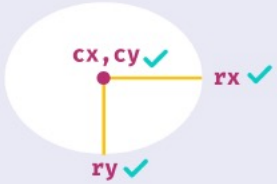
A container to group other SVG elements.

Similar to an HTML .

polygon

path

ellipse



text

The only way to create text within SVG.

- x,y
- dx
- dy
- rotate
- textLength
- lengthAdjust