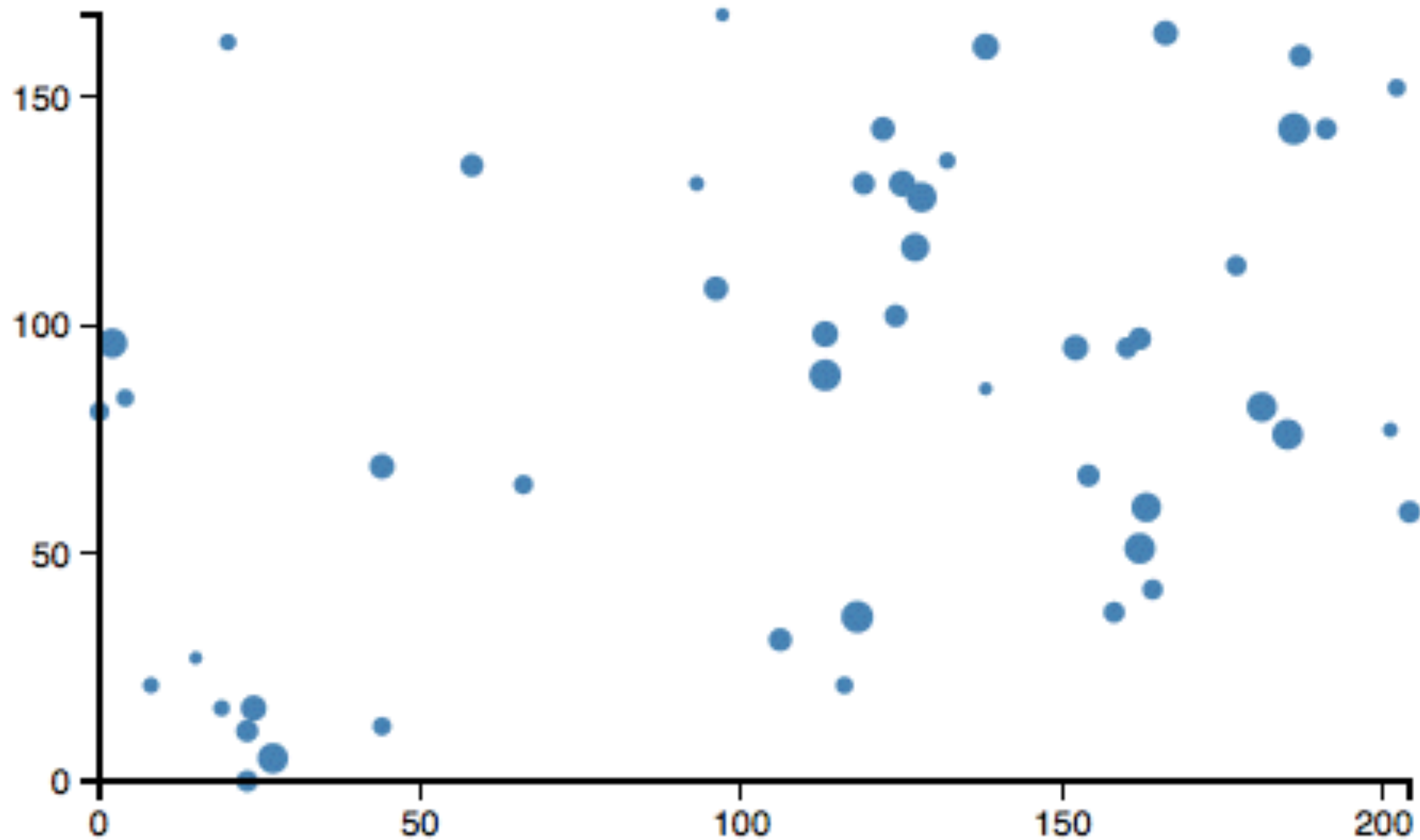*DataScience for Development and Social Change, 2015*

D3

How to get started without getting scared…

D3 ("Data Driven Documents")

Where you're going: a D3 File

```javascript
var xScale = d3.scale.linear()
   .domain([0, d3.max(dataset, function(d) { return d[0]; })])
   .range([padding,w - padding *2]);

var yScale = d3.scale.linear()
   .domain([0, d3.max(dataset, function(d) { return d[1]; })])
   .range([h - padding,padding]);

var rScale = d3.scale.linear()
   .domain([0, d3.max(dataset, function(d) { return d[2];})])
   .range([2,5]);

var svg = d3.select("body")
   .append("svg")
   .attr("width", w)
   .attr("height", h);

svg.selectAll("circle")
   .data(dataset)
   .enter()
   .append("circle")
   .attr("fill", "steelblue")
   .attr("cx", function(d) {
     return xScale(d[0]);
   })
   .attr("cy", function(d) {
     return yScale(d[1]);
   })
   .attr("r", function(d) {
     return rScale(d[2]);
   });
```

We start with HTML

```
<html lang="en">
<head>
    <meta charset="utf-8">
    <title>Hello! This is my title</title>
</head>
<body>
    <h1>Hello World!</h1>
</body>
</html>
```

DOM (Document Object Model)

❖ Open your html file in Chrome

❖ Click view->developer->javascript console

❖ type "document" in the new window

```
> document
<· ▼ #document
      ▼ <html lang="en">
          ▼ <head>
                <title>Hello! This is my title</title>
            </head>
          ▼ <body>
                <h1>Hello World!</h1>
            </body>
        </html>
> |
```

Add some D3

```
<html lang="en">
<head>
    <title>this is where you put your title</title>
    <meta charset="utf-8">
    <script type="text/javascript" src="http://d3js.org/d3.v3.min.js"></script>
</head>
<body>
    <script type="text/javascript">
        d3.select("body").append("p").text("This is my new paragraph!");
    </script>
</body>
</html>
```

Type "document" in the javascript console

```
> document
< ▼ #document
    ▼ <html lang="en">
      ▼ <head>
          <title>Hello! This is my title</title>
          <meta charset="utf-8">
          <script type="text/javascript" src="http://d3js.org/d3.v3.min.js"></script>
        </head>
      ▼ <body>
          <h1>Hello World!</h1>
          <script type="text/javascript">
                d3.select('body').append('p').text('This is my new paragraph!');
            </script>
          <p>This is my new paragraph!</p>
        </body>
      </html>
```

Why do we care about the DOM?

❖ The DOM is created when you open a webpage

❖ It contains the html code for that page

❖ And handles things like mouse clicks on the page

❖ D3 works by changing the DOM.

  ❖ Just like the last example, where "<p>New paragraph!</p>" appeared in the DOM.

Adding D3 to your HTML

❖ If you have stable Internet:

  ❖ use http://d3js.org/d3.v3.min.js

  ❖ <script type="text/javascript" src="http://d3js.org/d3.v3.min.js"></script>

❖ If you have no Internet:

  ❖ Download the D3 library from http://d3js.org/

  ❖ use d3/d3.js

  ❖ <script type="text/javascript" src="d3/d3.js"></script>

Drawing Shapes in HTML

SVG graphics language: draws things like circles and rectangles...
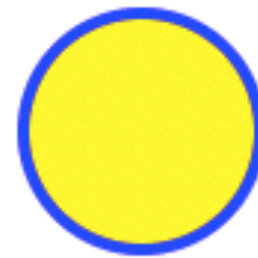
<svg width="100" height="100">

  <circle cx="50" cy="50" r="40" stroke="blue" stroke-width="4" fill="yellow" />

</svg>

<svg width="400" height="110">

  <rect width="300" height="100" style="fill:rgb(0,0,255); stroke-width:3; stroke:rgb(0,0,0)">

</svg>

Circle

Rectangle

http://www.w3schools.com/svg/

Drawing Lines and Text with SVG

And lines and text

```
<svg height="100" width="500">

  <line x1="0" y1="0" x2="200" y2="80"
style="stroke:rgb(255,0,0);stroke-width:5" />

</svg>
```

```
<svg height="30" width="200">

  <text x="0" y="15" fill="red">Written by SVG</text>

</svg>
```

Line

Text

Written by SVG

CSS (Cascading StyleSheets) makes HTML pretty

❖ HTML classes and ids:

<p class="orange">This is an orange paragraph</p>

< p id="mylabel">This paragraph is labelled</p>

❖ CSS:

p {

  color: blue; /* Turn every paragraph blue */

}

#mylabel {

  font-style: bold; /* Make the mylabel paragraph text bold */

}

D3 is a Javascript library

❖ Javascript = "front-end" language, used in webpages

❖ Javascript console:

 ❖ You can type javascript directly into the console

Javascript variables and functions

❖ Javascript variables:

var my_number = 500;

var my_array = [1,2,3];

❖ Javascript functions:

function mySum(a, b) {

    return a * b;

}

mySum(2,4)

A basic D3 visualization

❖ We need:

  ❖ Styles (line colors, text fonts etc) - we have this

  ❖ A drawing area

  ❖ A dataset (x, y values)

  ❖ x and y scales (e.g. a coordinate system)

  ❖ Shapes

  ❖ x and y axes

Start with a blank HTML page

```html
<!DOCTYPE html>
<html lang="en">
    <head>
        <title>This is your title</title>
        <meta charset="UTF8">
        <script type="text/javascript" src="d3/d3.js"></script>
    </head>
    <body>

        <script type="text/javascript">
        </script>

    </body>
</html>
```
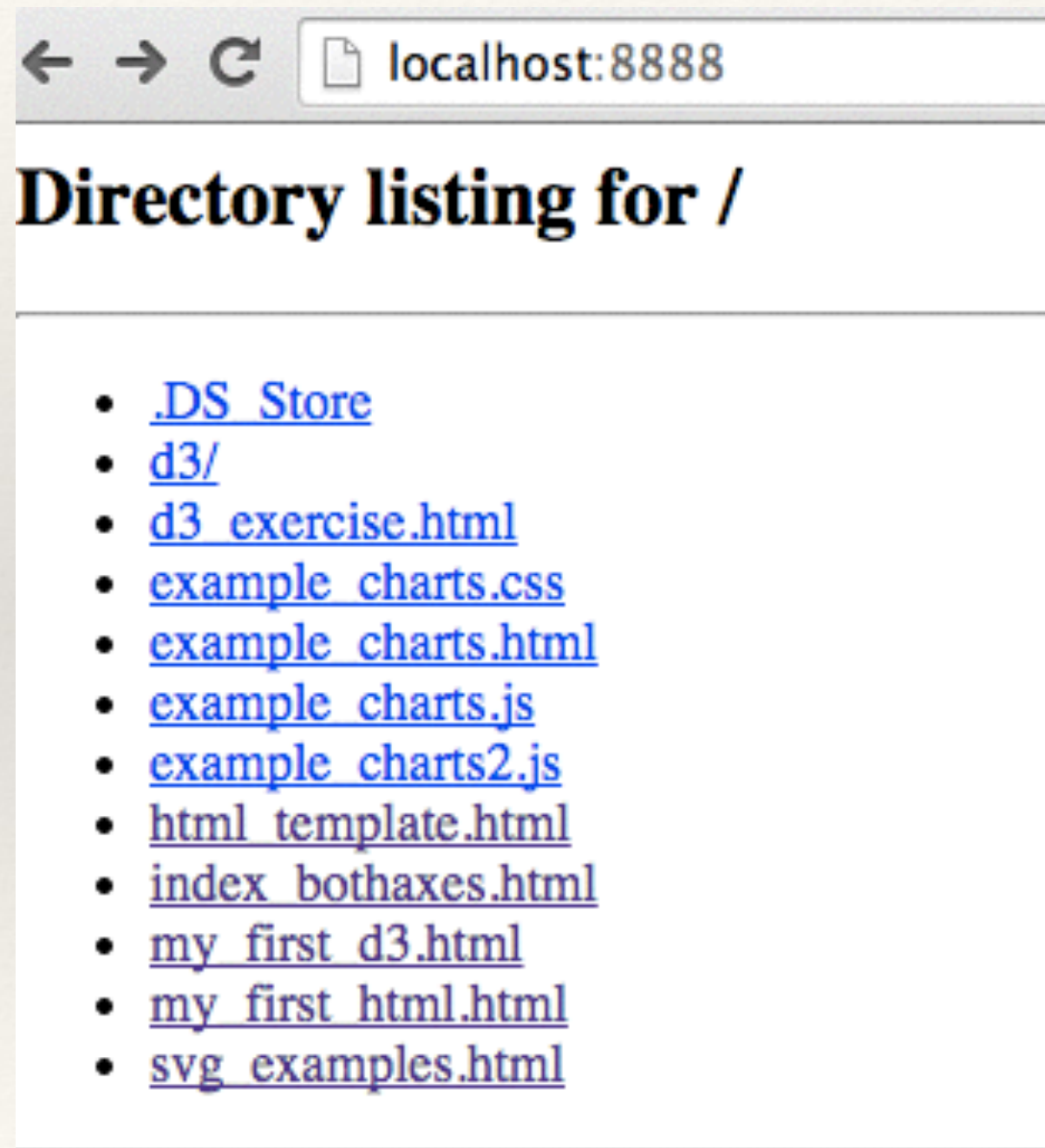
Viewing your D3 visualization

❖ In the directory your code is in, type:

python -m SimpleHTTPServer 8888

❖ Then go to http://localhost:8888/ in your browser

❖ (to exit, type control-c)

You should see something like this

Add Style

```
<style>
  .axis path,
  .axis line {
    fill: none;
    stroke: black;
    shape-rendering: crispEdges;
  }

  .axis text {
    font-family: sans-serif;
    font-size: 11px;
  }
}
</style>
```

You should be here...

```html
<!DOCTYPE html>
<html lang="en">
    <head>
        <title>This is your title</title>
        <meta charset="UTF8">
        <script type="text/javascript" src="d3/d3.js"></script>
    </head>
    <body>

        <style>
          .axis path,
          .axis line {
            fill: none;
            stroke: black;
            shape-rendering: crispEdges;
          }
          .axis text {
            font-family: sans-serif;
            font-size: 11px;
          }
        </style>

        <script type="text/javascript">
        </script>

    </body>
</html>
```
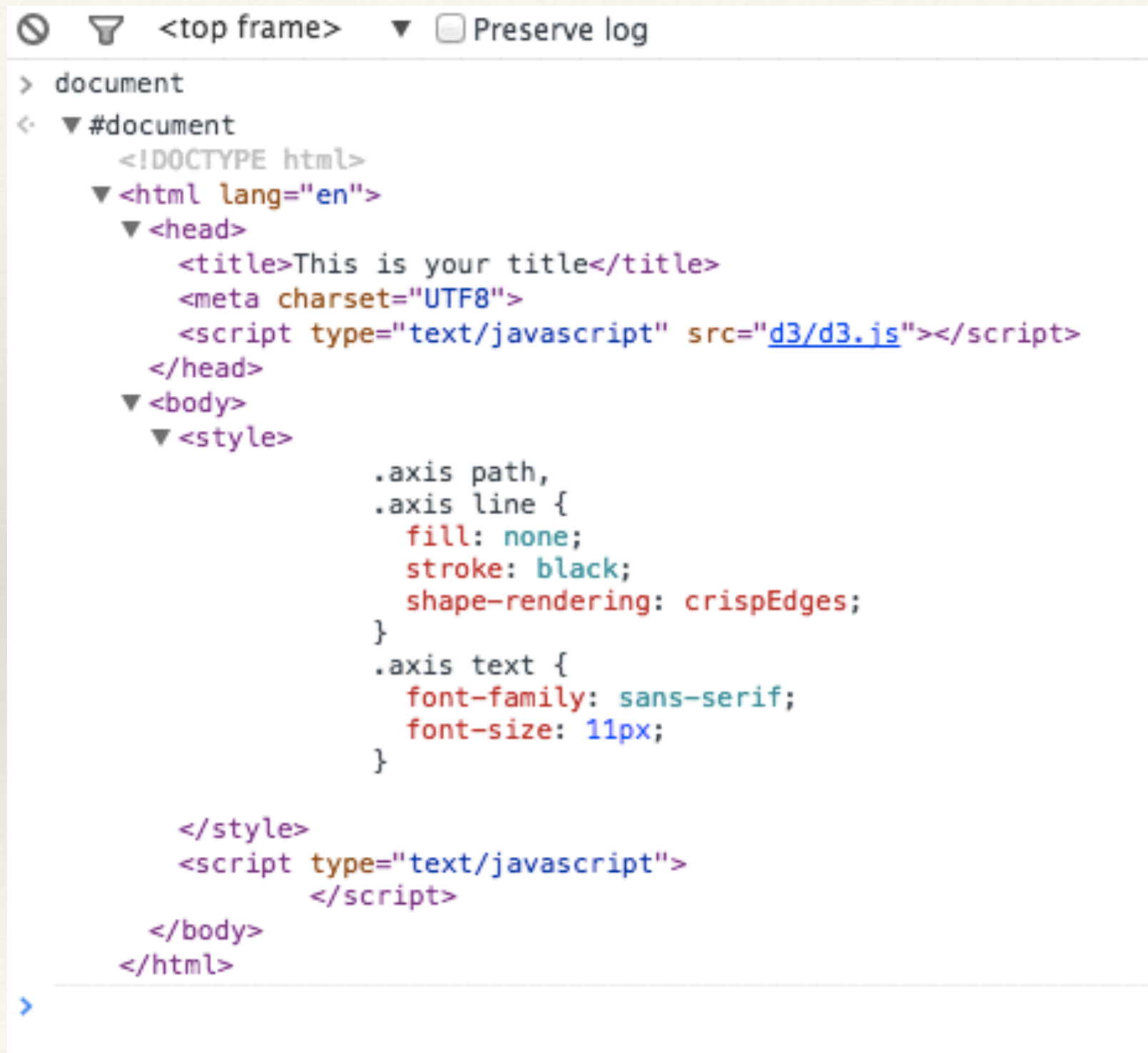
Check the Javascript console


```
◯  ▽  <top frame>   ▼  ☐ Preserve log

> document
◁  ▼ #document
        <!DOCTYPE html>
      ▼ <html lang="en">
        ▼ <head>
            <title>This is your title</title>
            <meta charset="UTF8">
            <script type="text/javascript" src="d3/d3.js"></script>
          </head>
        ▼ <body>
          ▼ <style>
                        .axis path,
                        .axis line {
                          fill: none;
                          stroke: black;
                          shape-rendering: crispEdges;
                        }
                        .axis text {
                          font-family: sans-serif;
                          font-size: 11px;
                        }

            </style>
            <script type="text/javascript">
                    </script>
          </body>
        </html>
>
```

Create a drawing area

```
var vizwidth=500;
var vizheight=300;
var padding=30;

var svg = d3.select("body")
   .append("svg")
   .attr("width", vizwidth)
   .attr("height", vizheight);
```

Your <body> should look like this

```html
<body>

    <style>
      .axis path,
      .axis line {
        fill: none;
        stroke: black;
        shape-rendering: crispEdges;
      }
      .axis text {
        font-family: sans-serif;
        font-size: 11px;
      }
    </style>

    <script type="text/javascript">
      var vizwidth=500;
      var vizheight=300;
      var padding=30;

      var svg = d3.select("body")
        .append("svg")
        .attr("width", vizwidth)
        .attr("height", vizheight);
    </script>

</body>
```

Your javascript console will look like this

```
> document
<·  ▼ #document
      <!DOCTYPE html>
    ▼ <html lang="en">
      ▶ <head>…</head>
      ▼ <body>
        ▶ <style>…</style>
        ▼ <script type="text/javascript">
                        var vizwidth=500;
                        var vizheight=300;
                        var padding=30;

                        var svg = d3.select("body")
                            .append("svg")
                            .attr("width", vizwidth)
                            .attr("height", vizheight);

          </script>
          <svg width="500" height="300"></svg>
          </body>
      </html>
>  |
```

Add some data

```javascript
var dataset = [];
var numDataPoints = 50;
var xRange = Math.random() * 1000;
var yRange = Math.random() * 1000;
var rRange = Math.random() * 1000;
for (var i =0;i<numDataPoints;i++) {
  var newNumber1 = Math.floor(Math.random() * xRange);
  var newNumber2 = Math.floor(Math.random() * yRange);
  var newNumber3 = Math.floor(Math.random() * rRange);
  dataset.push([newNumber1, newNumber2, newNumber3]);
}
```

You can check that in the Console too

```
> dataset
< [▼ Array[3] ⓘ                , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
      0: 208
      1: 210
      2: 229
      length: 3
    ▶ __proto__: Array[0]
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ,
  ▶ Array[3] , ▶ Array[3] , ▶ Array[3] ]
>
```

Add x, y and radius Scales

```
var xScale = d3.scale.linear()
  .domain([0, d3.max(dataset, function(d) { return d[0]; })])
  .range([padding,vizwidth - padding *2]);

var yScale = d3.scale.linear()
  .domain([0, d3.max(dataset, function(d) { return d[1]; })])
  .range([vizheight - padding,padding]);

var rScale = d3.scale.linear()
  .domain([0, d3.max(dataset, function(d) { return d[2];})])
  .range([2,5]);
```
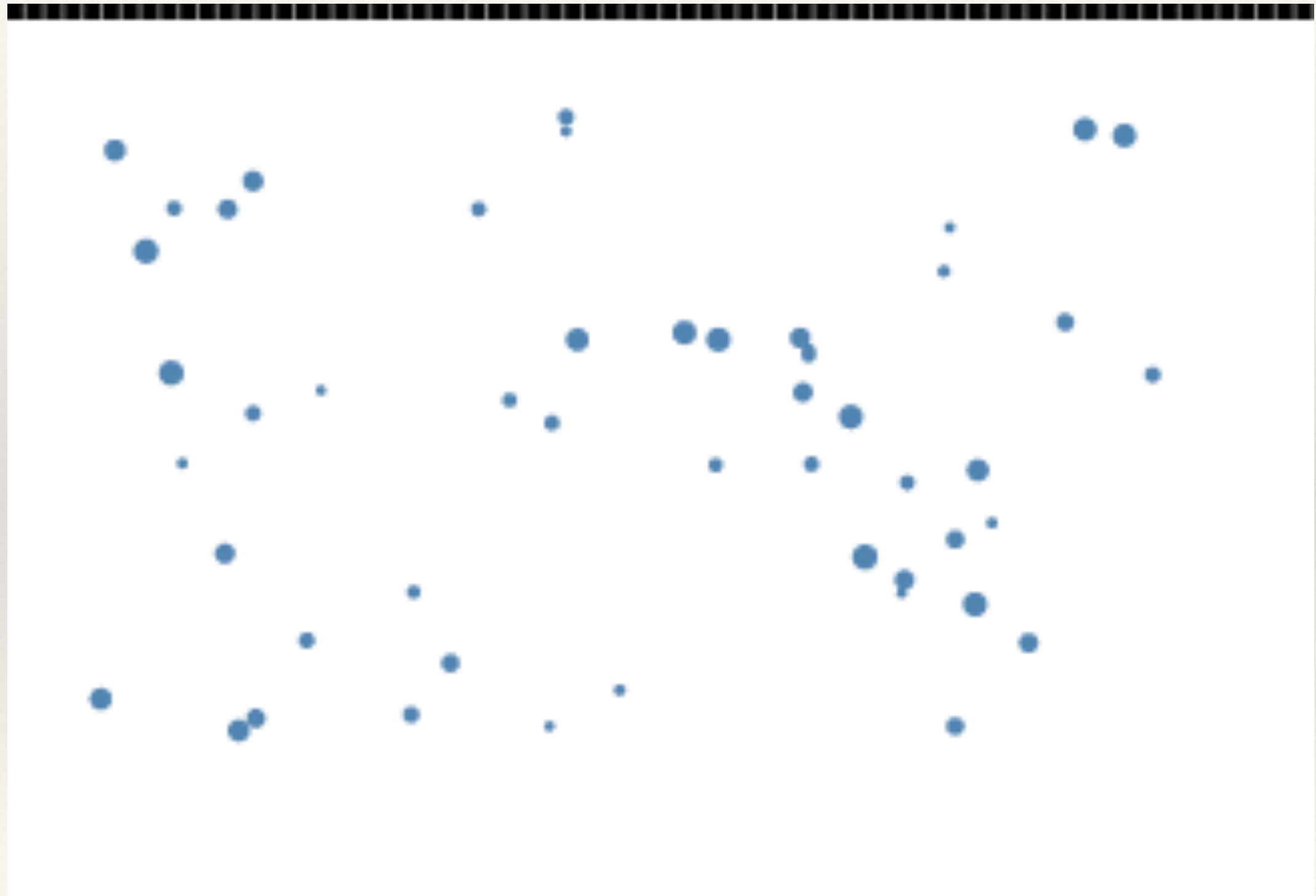
Add Shapes

```
svg.selectAll("circle")
  .data(dataset)
  .enter()
  .append("circle")
  .attr("fill", "steelblue")
  .attr("cx", function(d) {
    return xScale(d[0]);
  })
  .attr("cy", function(d) {
    return yScale(d[1]);
  })
  .attr("r", function(d) {
    return rScale(d[2]);
  });
```

Aha! in the browser

Aha! in the Console

```
►<style<...</style>
►<script type="text/javascript">…</script>
▼<svg width="500" height="300">
    <circle fill="steelblue" cx="47.58713136729223" cy="82.3076923076923" r=
    "4.900277008310249"></circle>
    <circle fill="steelblue" cx="344.3699731903485" cy="172.56410256410257" r=
    "3.0055401662049865"></circle>
    <circle fill="steelblue" cx="30" cy="257.008547008547" r=
    "4.360110803324099"></circle>
    <circle fill="steelblue" cx="371.84986595174263" cy="167.77777777777" r=
    "4.38504155512465375"></circle>
    <circle fill="steelblue" cx="61.87667560321715" cy="165.04273504273505" r=
    "2.2243767313019394"></circle>
    <circle fill="steelblue" cx="232.25201072386056" cy="253.5897435897436" r=
    "2.299168975069252"></circle>
    <circle fill="steelblue" cx="150.91152815013402" cy="263.1623931623932" r=
    "3.263157894736842"></circle>
    <circle fill="steelblue" cx="257.5335120643432" cy="114.1025641025641" r=
    "4.717451523545706"></circle>
    <circle fill="steelblue" cx="83.86058981233245" cy="269.3162393162393" r=
    "4.38504155512465375"></circle>
    <circle fill="steelblue" cx="322.38605898123325" cy="146.92307692307693" r=
    "4.78393351800554"></circle>
    <circle fill="steelblue" cx="270.7238605898123" cy="116.83760683760684" r=
    "4.7756232686980615"></circle>
    <circle fill="steelblue" cx="215.76407506702412" cy="116.83760683760684" r=
    "4.542936288088643"></circle>
    <circle fill="steelblue" cx="429.0080428954424" cy="37.17948717948718" r=
```
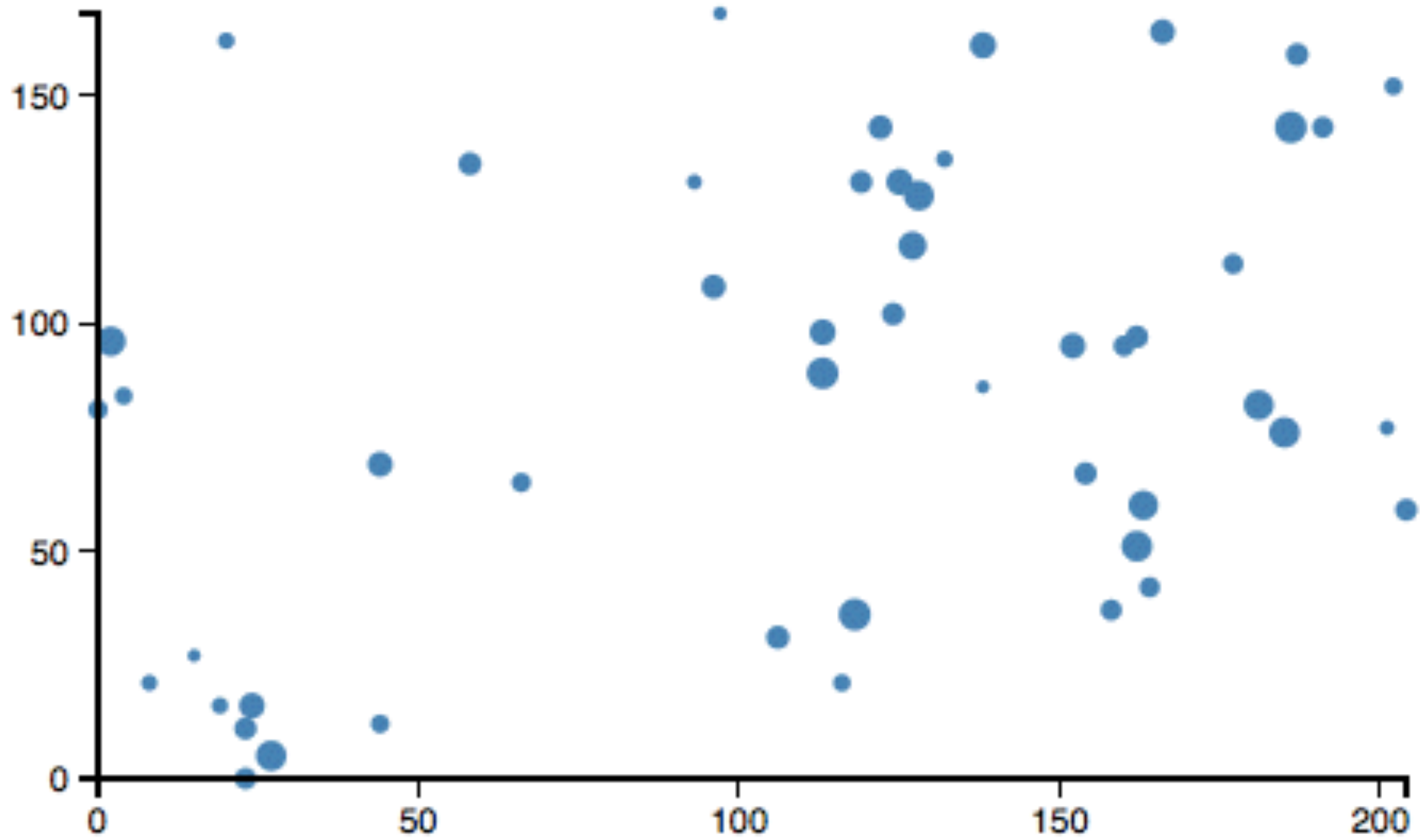
Add x and y Axes

```javascript
var xAxis = d3.svg.axis()
    .scale(xScale)
    .orient("bottom")
    .ticks(5);

svg.append("g")
    .attr("class", "axis")
    .attr("transform", "translate(0,"+(vizheight-padding)+")")
    .call(xAxis);

var yAxis = d3.svg.axis()
    .scale(yScale)
    .orient("left")
    .ticks(5);

svg.append("g")
    .attr("class", "axis")
    .attr("transform", "translate("+padding+",0)")
    .call(yAxis);
```

In the console:

```
▼<g class="axis" transform="translate(0,270)">
  ▶<g class="tick" transform="translate(30,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(116.3157894736842,0)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(202.6315789473684,0)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(288.9473684210526,0)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(375.2631578947368,0)" style="opacity: 1;">
  …</g>
    <path class="domain" d="M30,6V0H440V6"></path>
  </g>
▼<g class="axis" transform="translate(30,0)">
  ▶<g class="tick" transform="translate(0,270)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(0,232.61682242990653)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(0,195.2336448598131)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(0,157.85046728971963)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(0,120.46728971962618)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(0,83.08411214953271)" style="opacity: 1;">
  …</g>
  ▶<g class="tick" transform="translate(0,45.70093457943925)" style="opacity: 1;">
  …</g>
    <path class="domain" d="M-6,30H0V270H-6"></path>
  </g>
</svg>
```

The end product:

Putting your D3 code online

- ❖ Put your D3 code onto github pages

  - ❖ https://pages.github.com/

- ❖ Add your D3 code to http://bl.ocks.org/

https://github.com/bodacea/bodacea.github.io

3 commits	1 branch	0 releases	1 contributor

branch: **master** ▾   **bodacea.github.io** / +

Added d3 library

bodacea authored a minute ago   latest commit 8fbff5abf2

📁 d3	Added d3 library	a minute ago
📄 .DS_Store	Added d3 library	a minute ago
📄 index.html	Initial commit	2 months ago
📄 index_bothaxes.html	added some test d3 code	3 minutes ago

Help people interested in this repository understand your project by adding a README!   **Add a README**
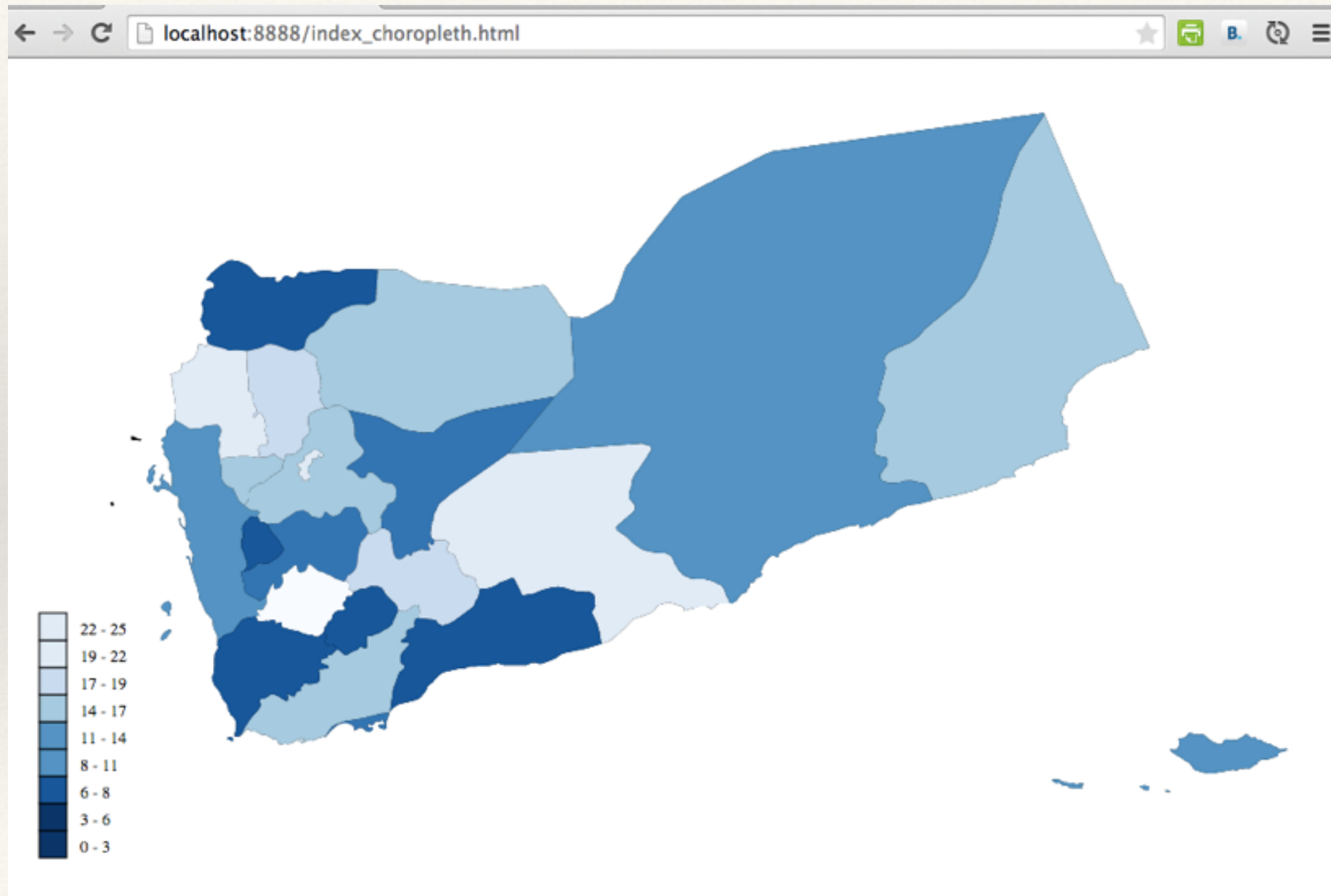
bodacea.github.io/index_bothaxes.html
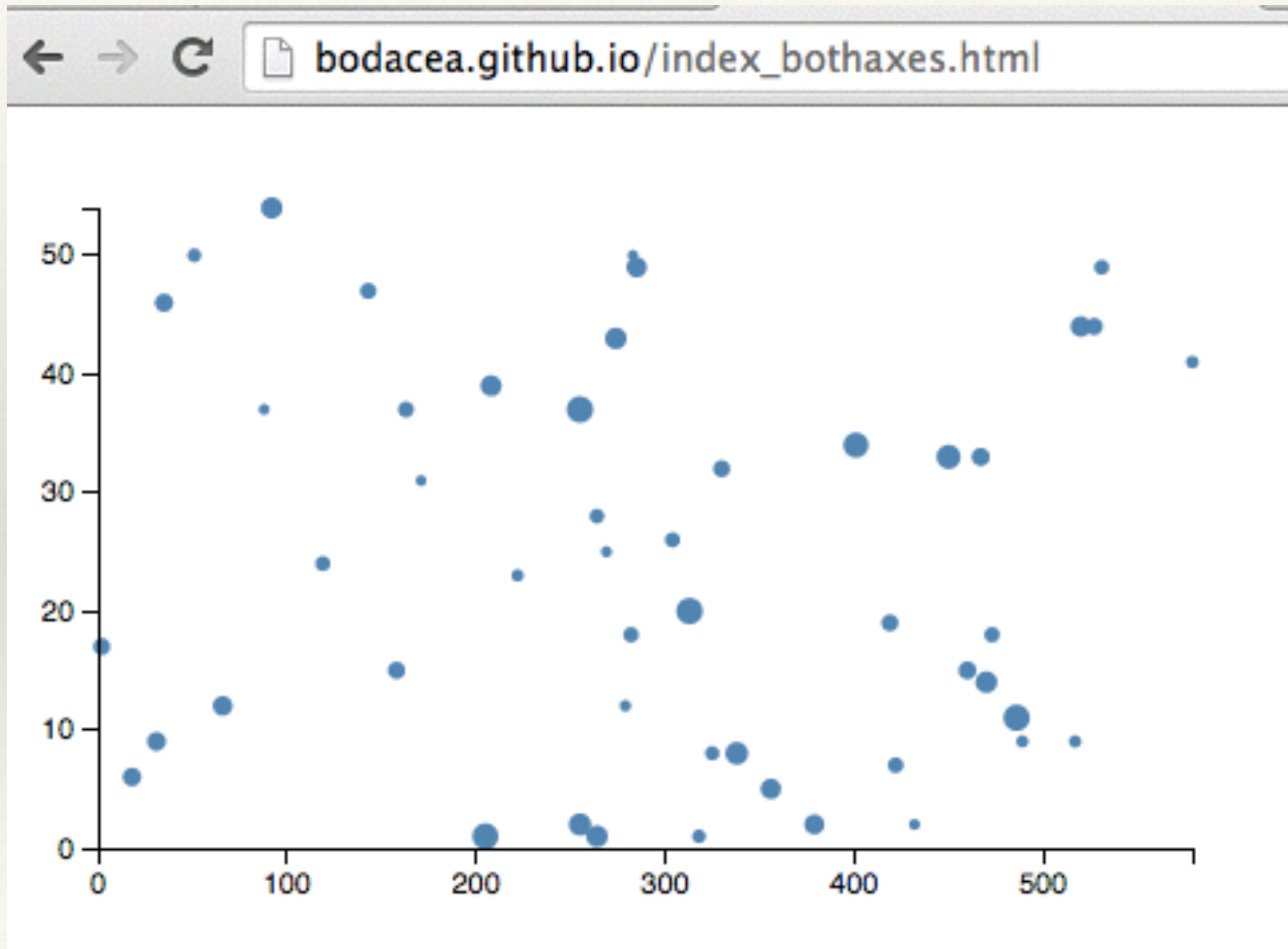
A D3 Choropleth

- ❖ We need:

  - ❖ Styles (line colors, text fonts etc)

  - ❖ A set of map shapes (e.g. admin boundaries)

  - ❖ A dataset (shapename, value)

  - ❖ A color palette (value, color)

  - ❖ A legend

  - ❖ Tooltips

index_choropleth.html

Connecting D3 and Python

❖ Use the Flask python library to create a simple python-based website. Add your D3 code to its html pages

❖ The Django python library is slightly more complex, but a popular Python web framework

Making D3 Easier

- D3 helpers:
  - NVD3
  - xCharts
  - dimple
  - Vega

- D3 libraries:
  - rCharts
  - d3py

http://schoolofdata.org/2013/08/12/climbing-the-d3-js-visualisation-stack/

Easier Alternative: Highcharts

❖ Highcharts: charts

❖ Highstock: timelines

❖ Highmaps: maps

http://www.highcharts.com

Highcharts is also a Javascript Library

❖ <script src="http://code.highcharts.com/adapters/ standalone-framework.js"></script>

http://www.highcharts.com/docs/getting-started/installation

Continuing your D3 journey

❖ https://square.github.io/intro-to-d3/parts-of-a-graph/

❖ Scott Murray's book: http://chimera.labs.oreilly.com/books/1230000000345