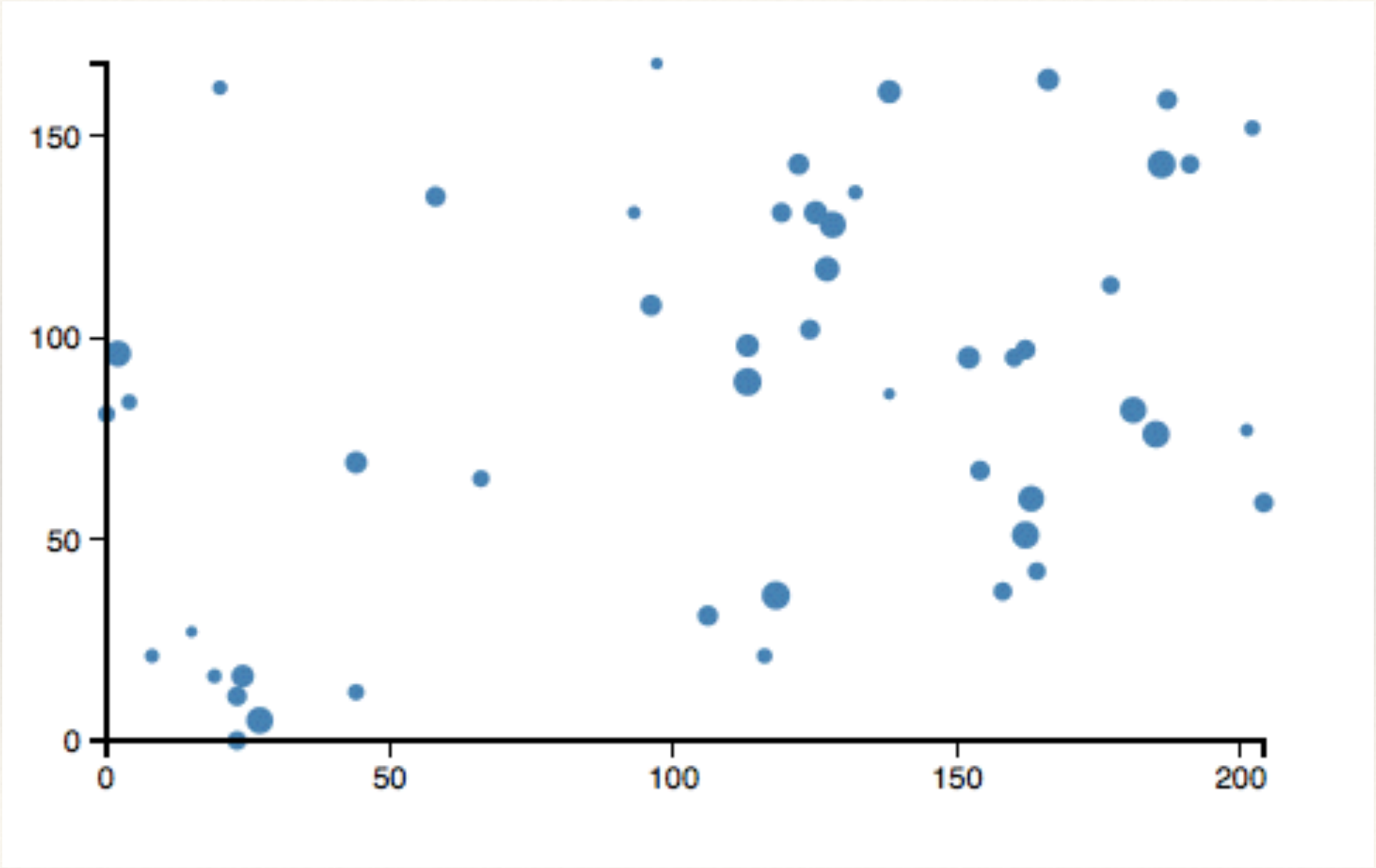
DataScience for Development and Social Change, 2015

D3

How to get started without getting scared…

D3 ("Data Driven Documents")



Where you're going: a D3 File

```
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 “ New paragraph! ” 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="d3/d3.js"></script>

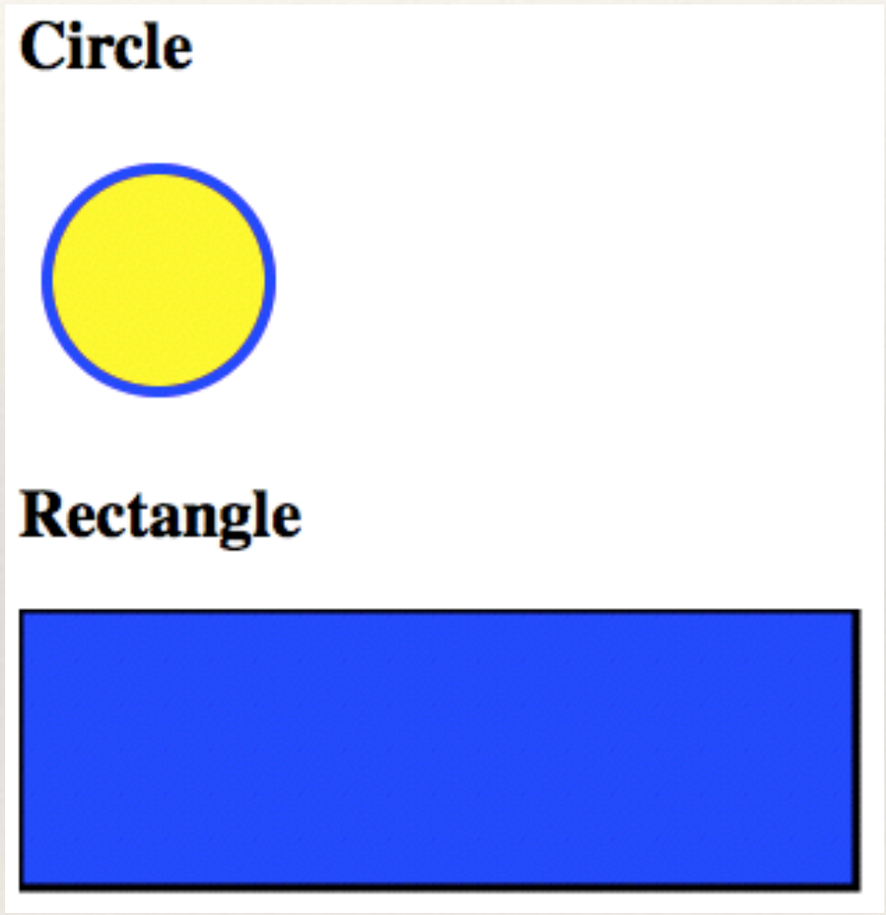
- If you have no Internet:
  - Download the D3 library from http://d3js.org/
  - use d3/d3.js
  - <script type="text/javascript" src="http://d3js.org/d3.v3.min.js"></script>

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>
```

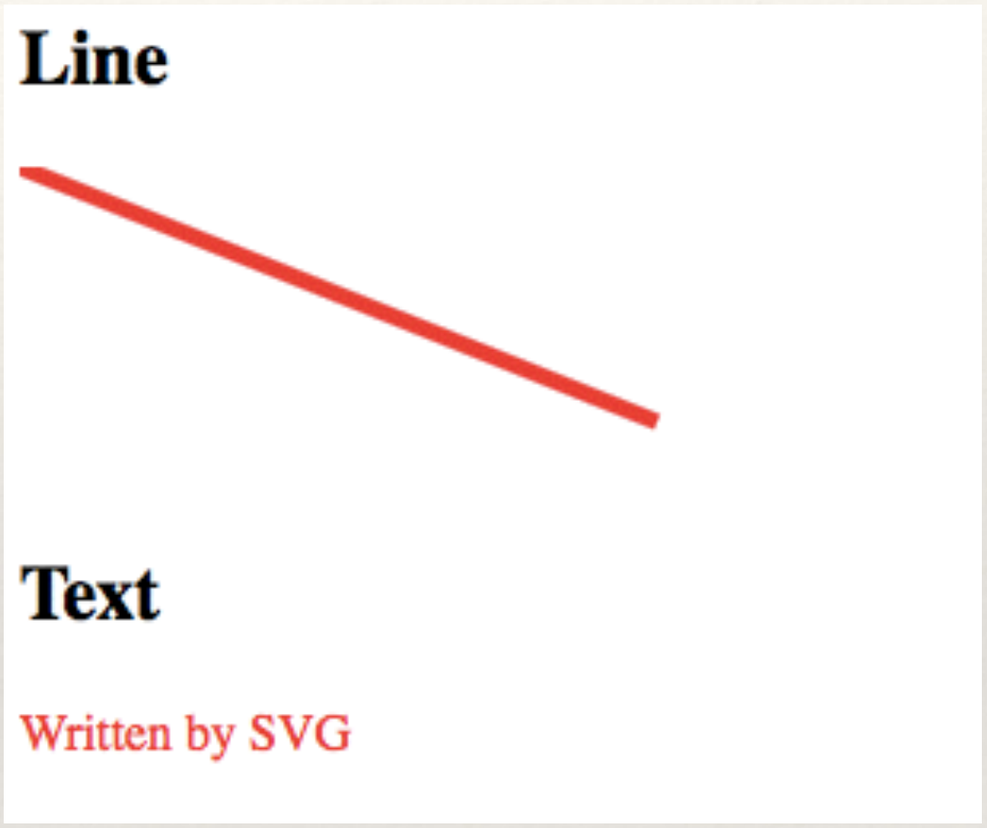


http://www.w3schools.com/svg/

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>
```



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

```
<!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

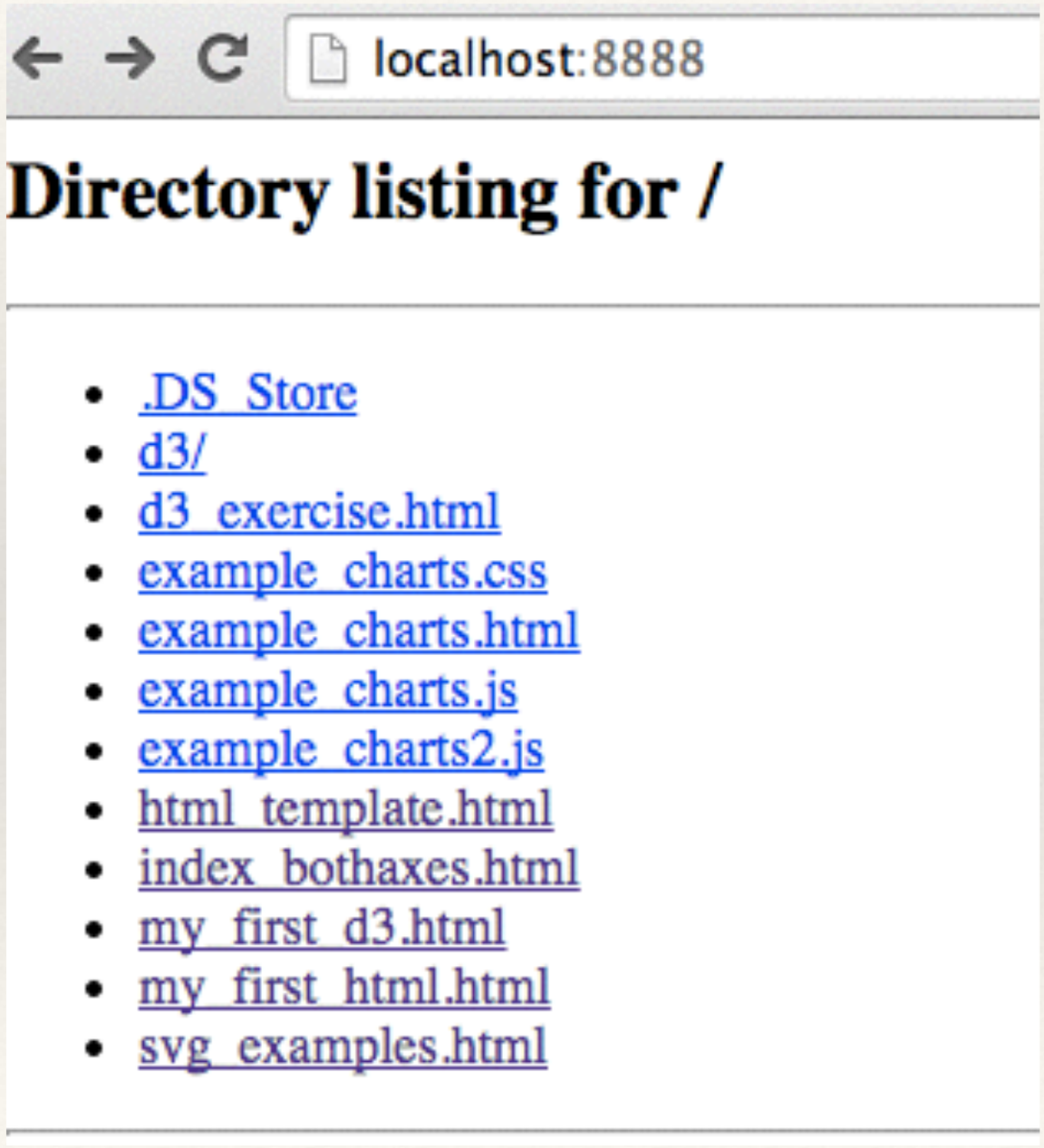
- In the directory your code is in, type:

python -m SimpleHTTPServer 8888

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

- (to exit, type control-c)

You should see something like this



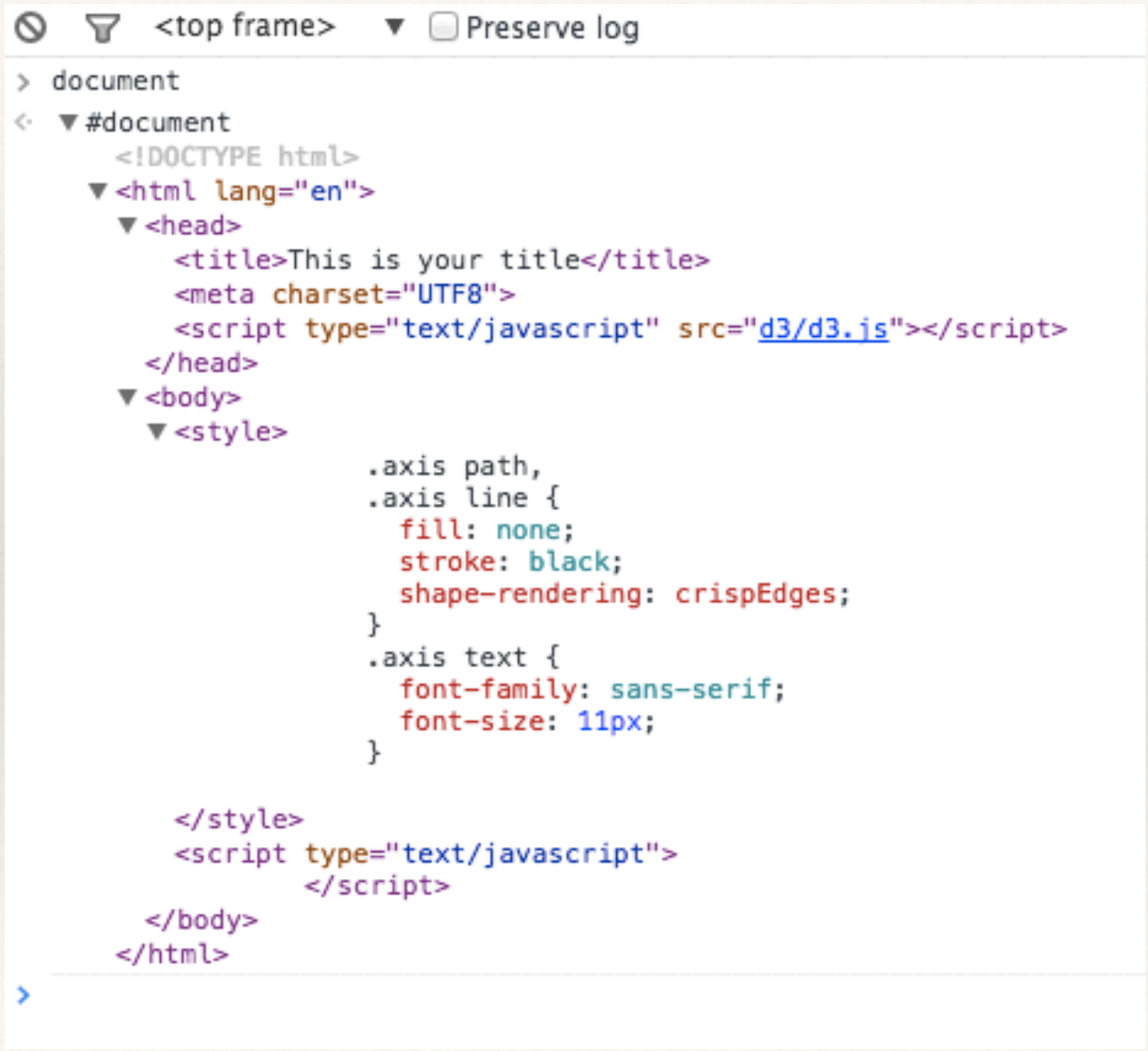
Add Style

```
<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…

```
<!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



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

```
<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

```
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] i          , ▶ 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] ]
>
```

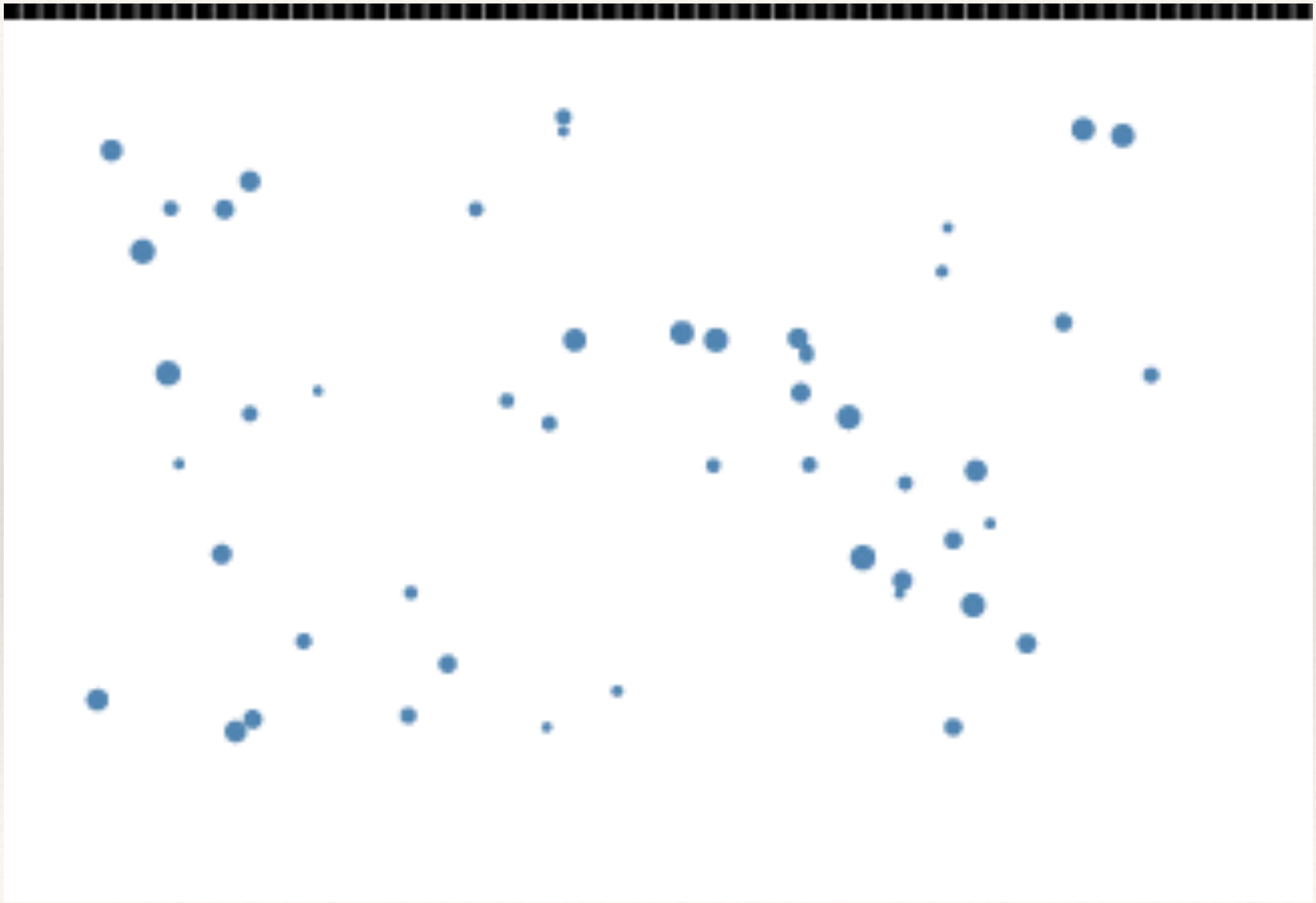
Add x, y and radius Scales

```
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

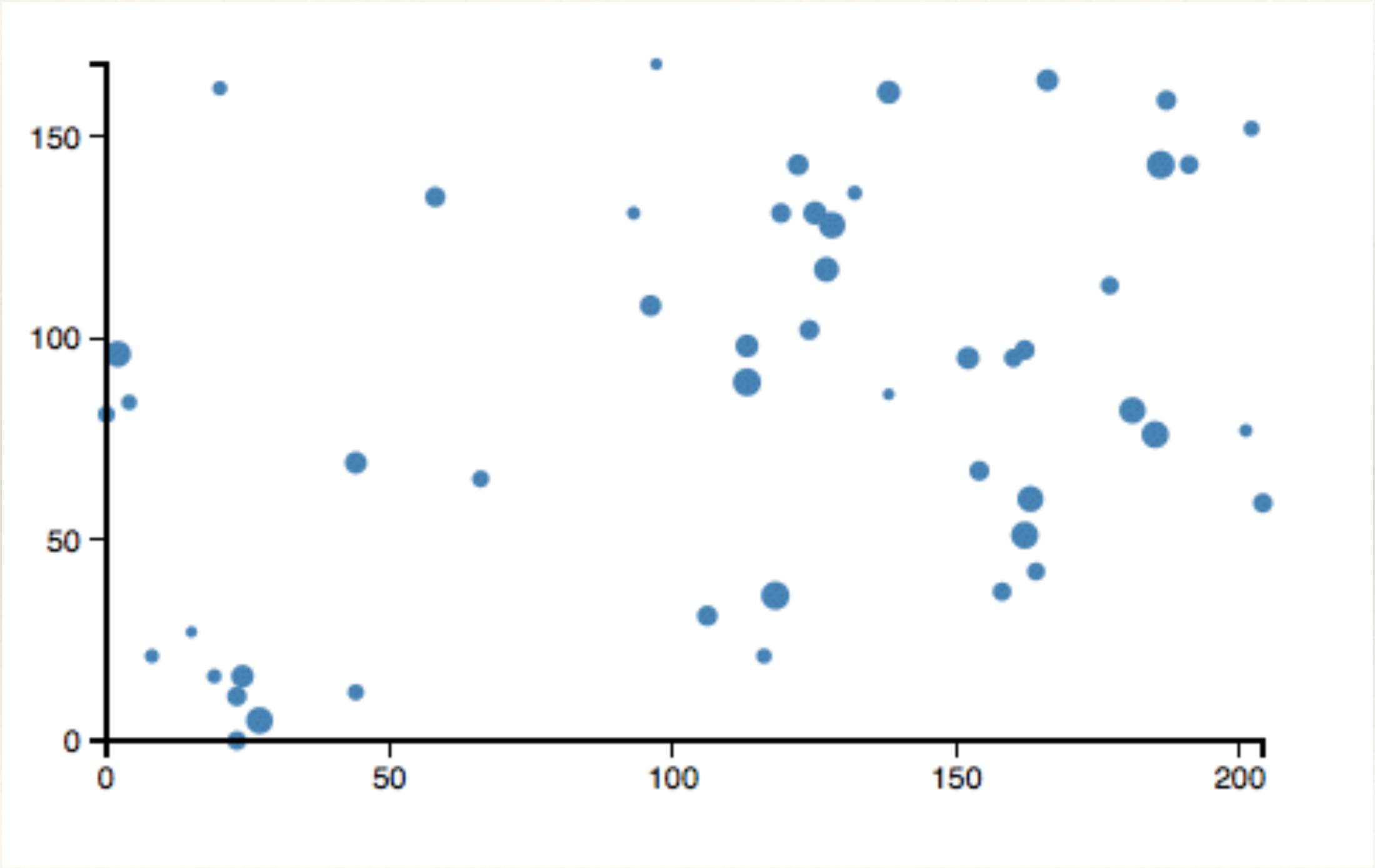
Add x and y Axes

```
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:

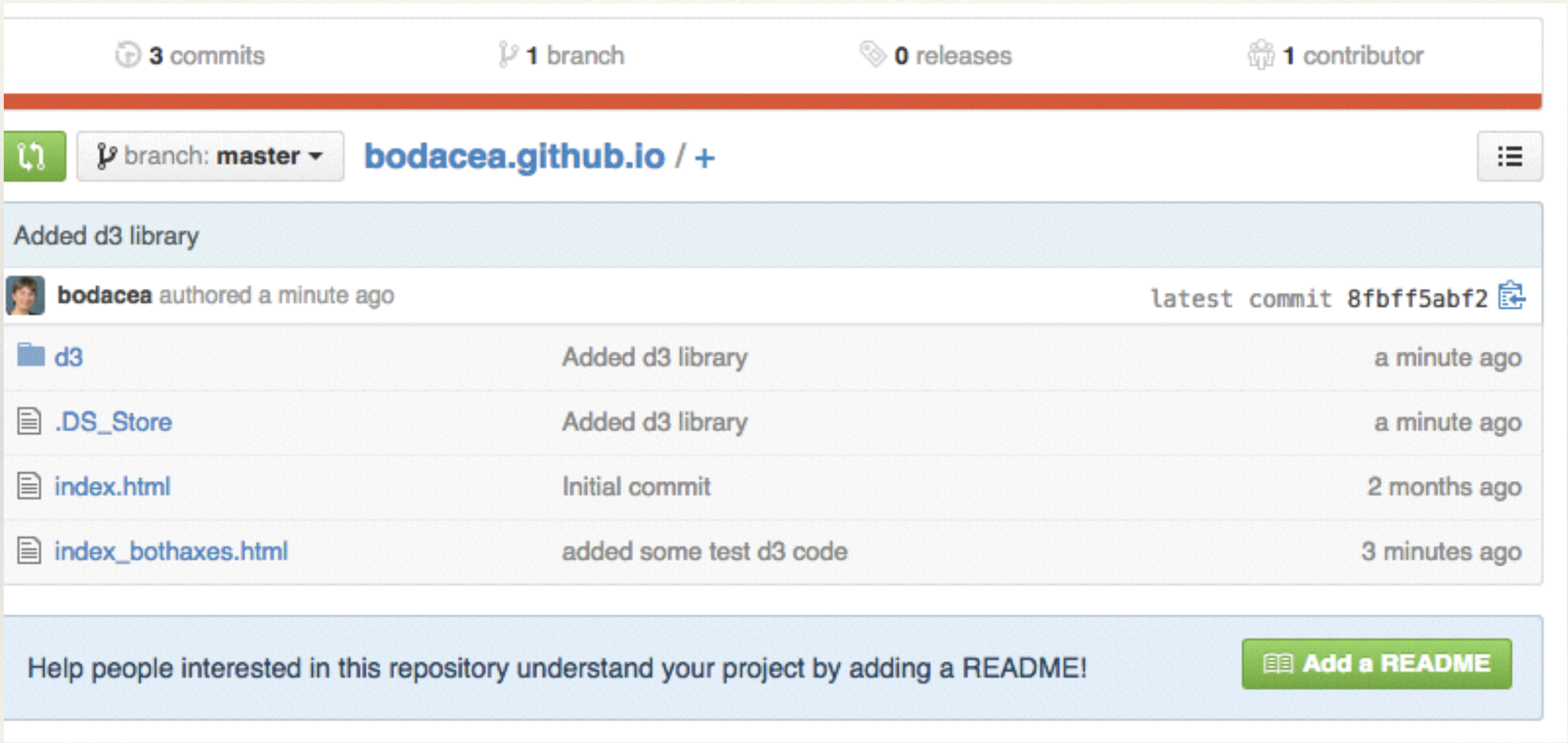


Putting your D3 code online

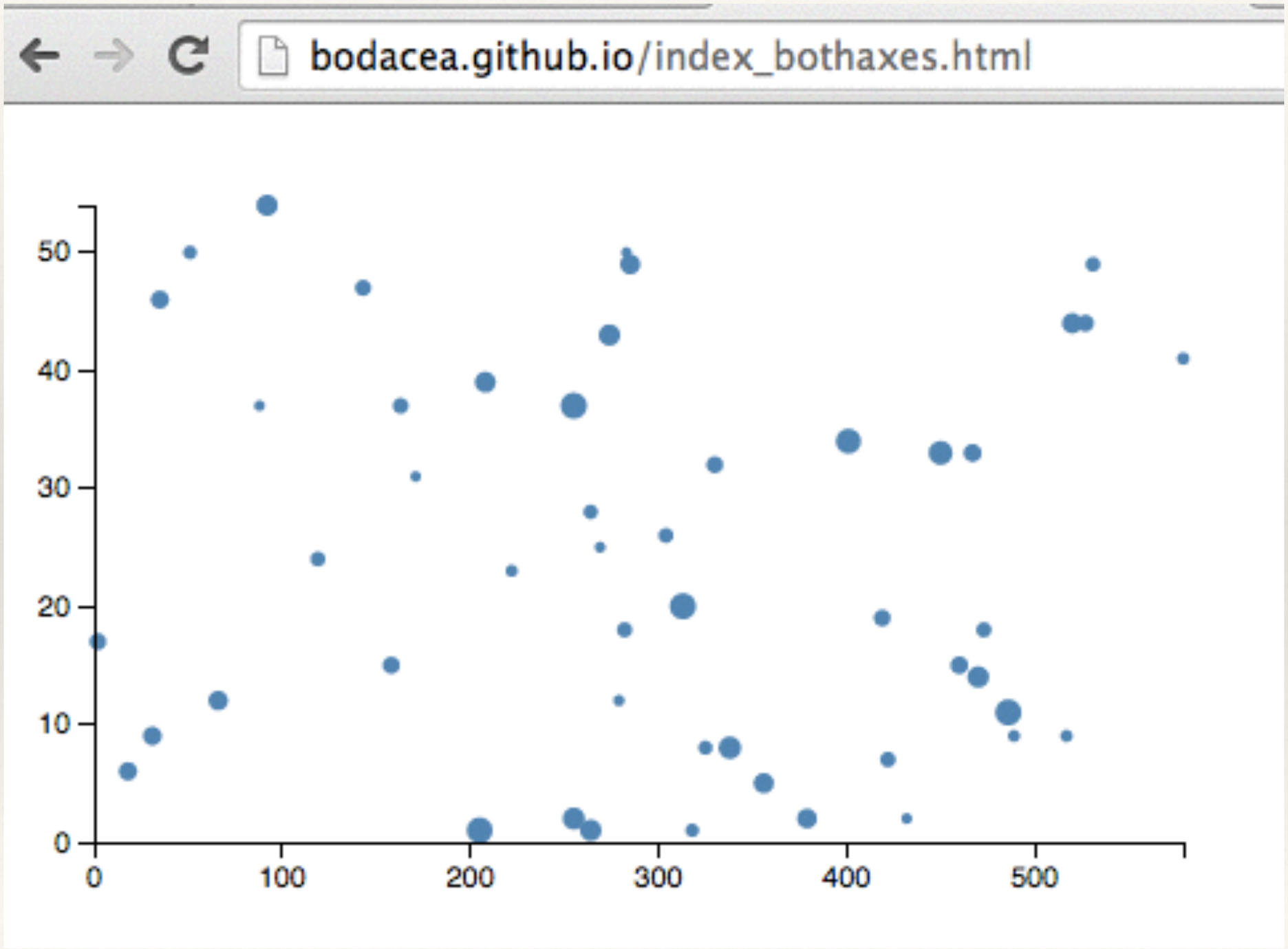
- Put your D3 code onto github pages
  - https://pages.github.com/

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

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



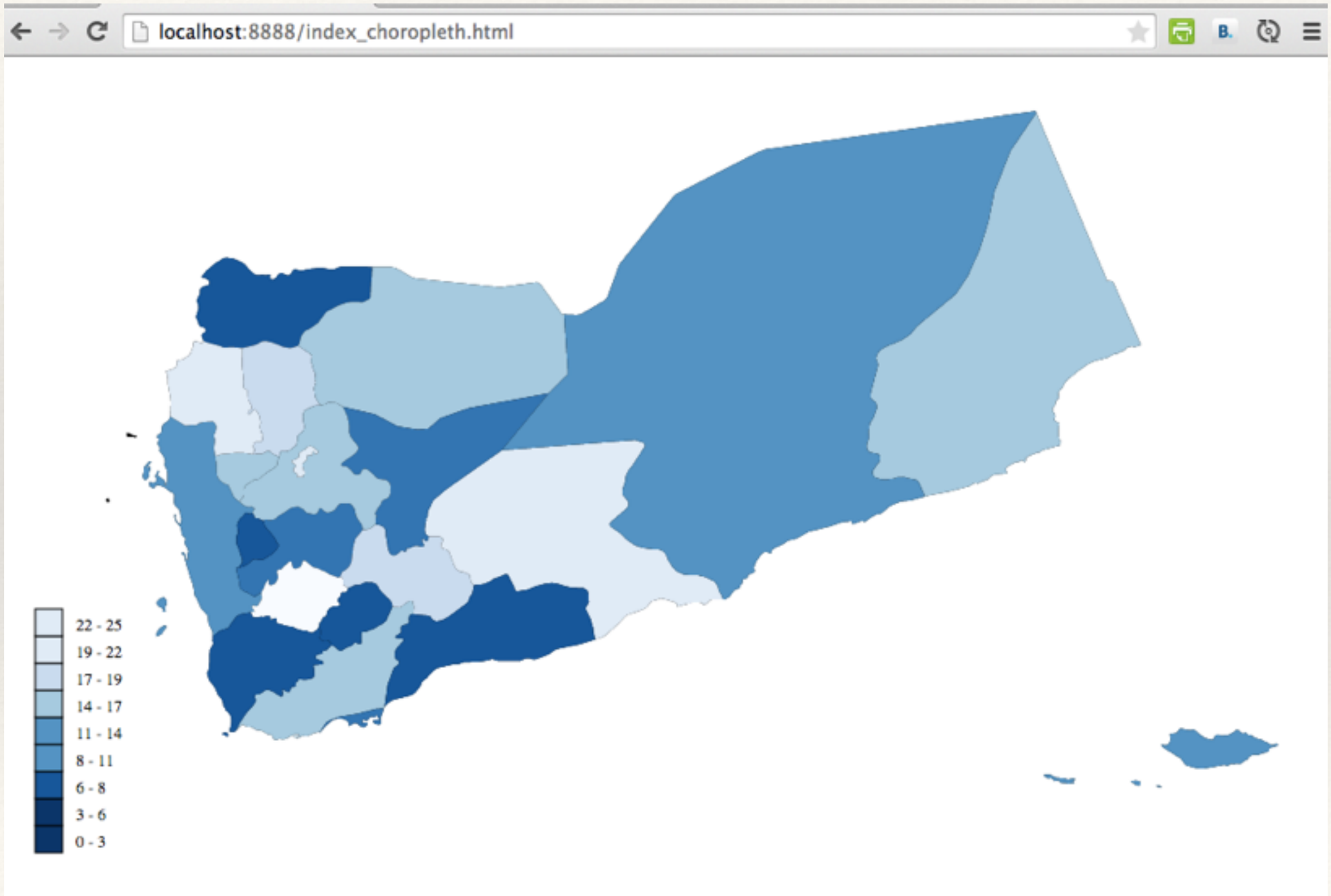
bodacea.github.io/index_bothaxes.html



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