Scott Murray

code artist

Assistant Professor, Design
University of San Francisco

UNIVERSITY OF
SAN FRANCISCO

CHANGE THE WORLD FROM HERE


Strawberry
Tiburon
Golden Gate National Recreation Area
Sausalito
San Pablo Avenue
Berkeley
Emeryville
Broadway
Piedmont
Broadway
Oakland
Presidio
Golden Gate National Recreation Area
Golden Gate Park
San Francisco
Great Highway
Sunset Boulevard
3rd Street

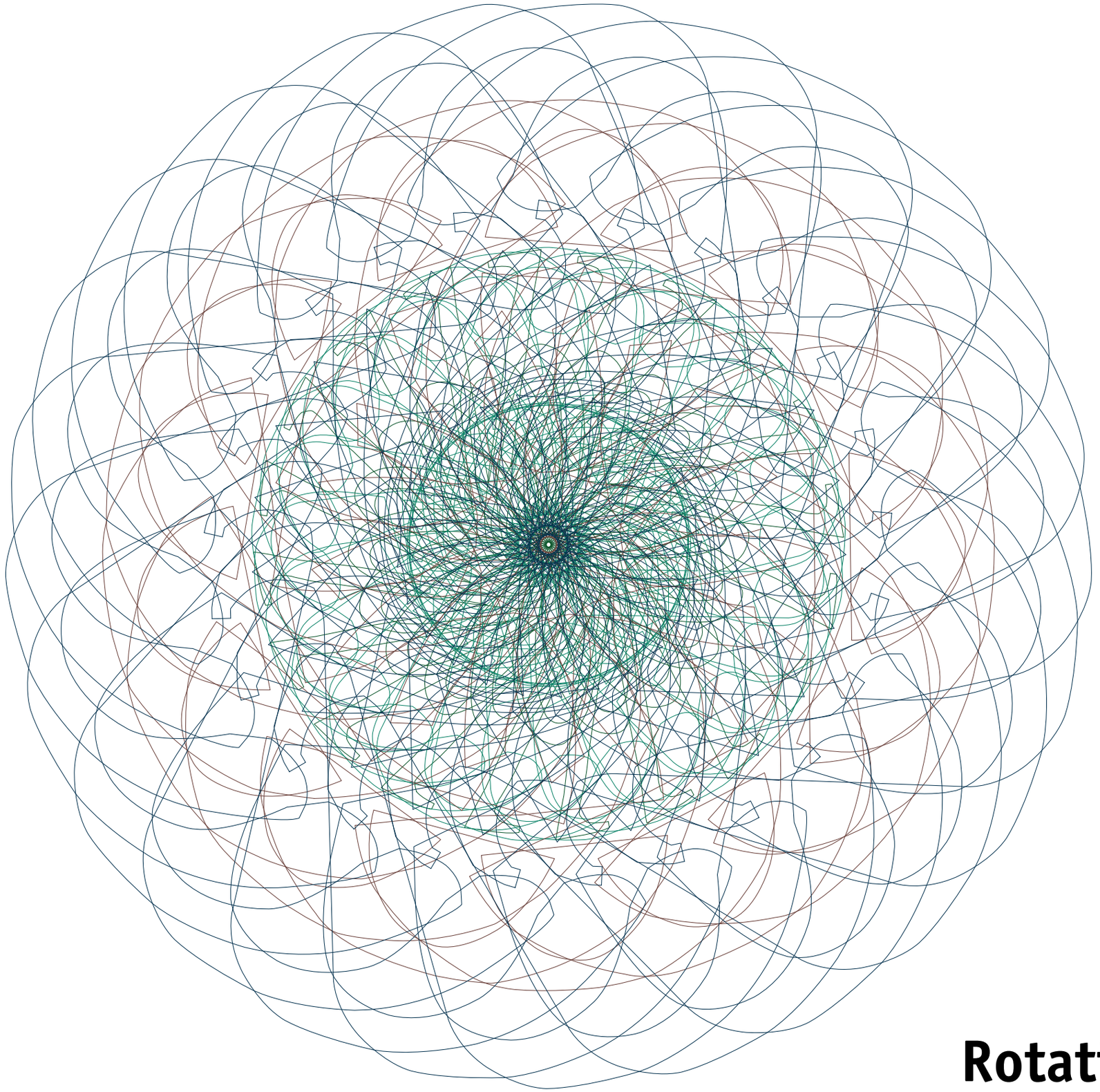
Rue de Paris, temps de pluie

Paris Street, Rainy Day

Gustave Caillebotte, 1877

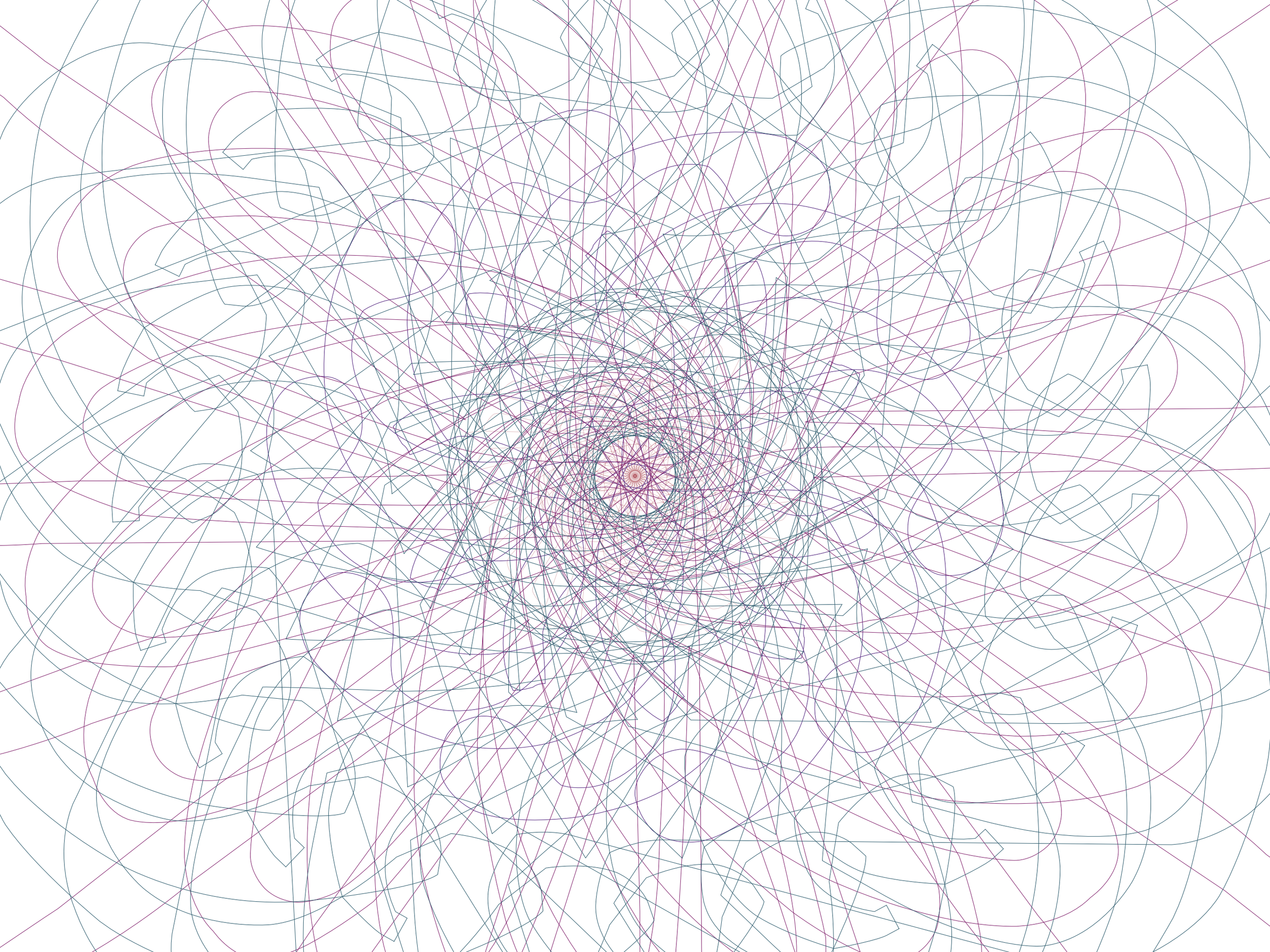
```
void setup() {
  size(1920, 1080);
  frameRate(30);
  smooth();
}
```

```
void draw() {
  translate(width/2, height/2);
  for (int i = 0; i < 100; i++) {
    ellipse(0, 0, i * 5, i * 5);
  }
}
```



Rotating Type

with Jan Kubasiewicz, 2011

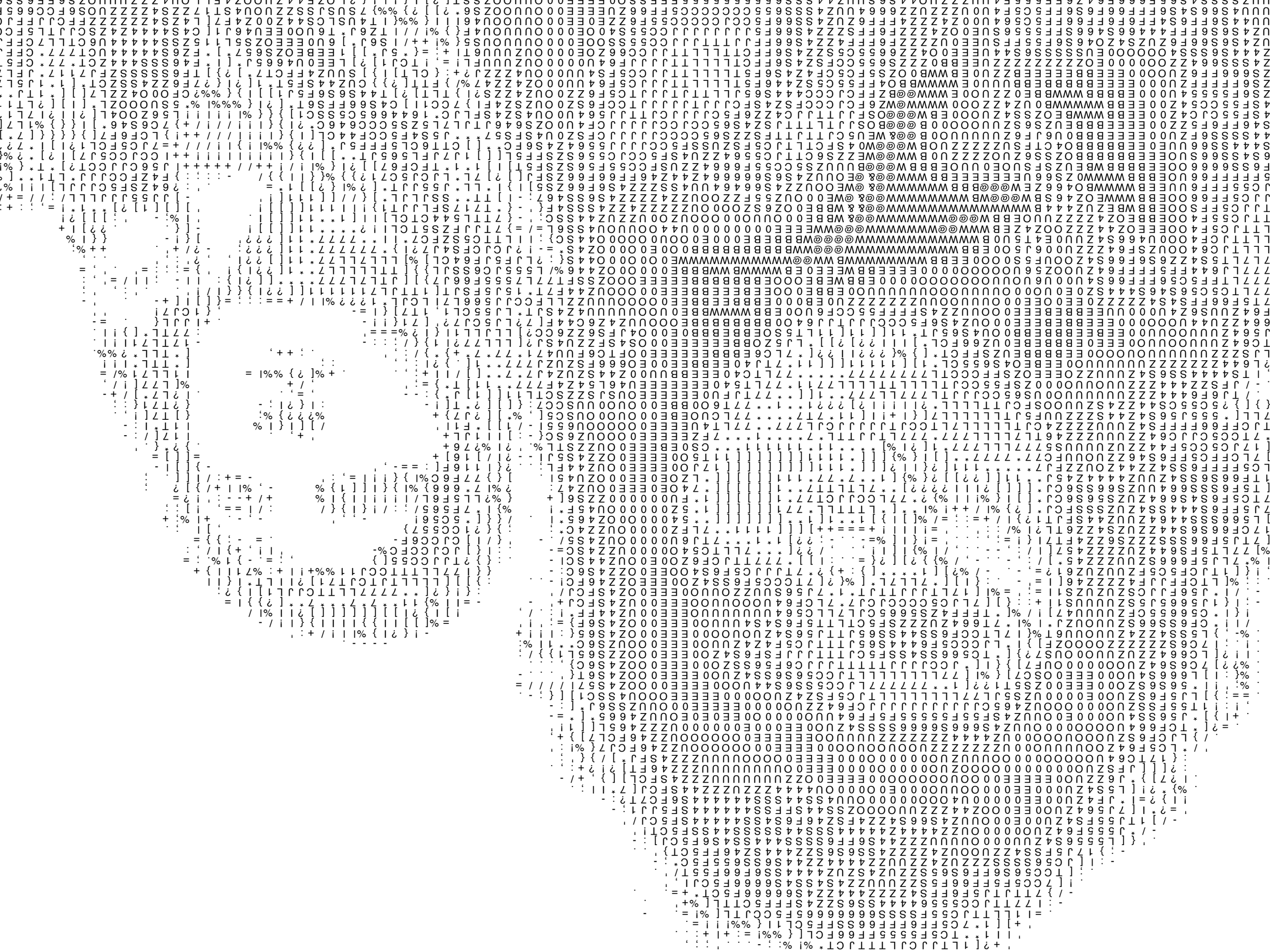


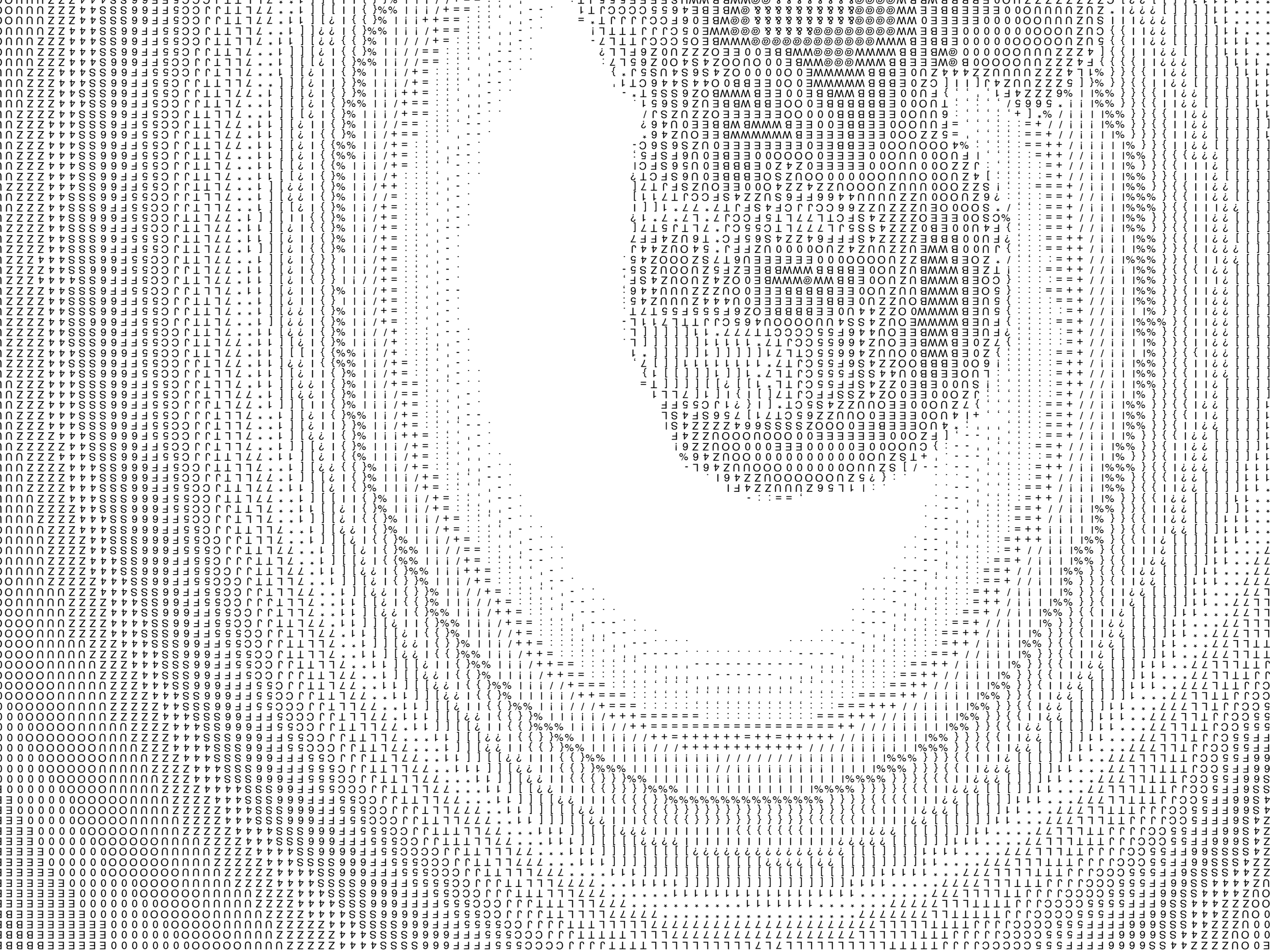
Gesture Project

2008

ASCII Photo Booth

2008





sed a surgically
profile pic,
t's an organ,
n the wrong?

BY BRENDAN I. KOERNER

LET ME GUESS: You were a color-inside-the-lines kind of kid. And that's why you're so discombobulated, because you don't see where Facebook's rules explicitly forbid images of uteruses. Granted, Facebook's community standards make no specific mention of organ shots. But the guidelines are written broadly enough to give the service latitude to exclude anything it deems icky. The section on violent imagery, for example, states that Facebook has the right to remove "any inappropriately graphic content." And what is the definition here of inappropriately graphic? That's entirely up to Facebook, which wields Judge ▶

ILLUSTRATION BY Christoph Niemann

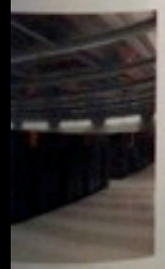
IBM Smarter Planet

with Mirada, 2011

nion

r opinion—and
o ours. The new
rings together
nedia, and cul-
ames Dyson and
ppe Starck and
r contributors
writer and entre-
org; Susan Craw-
olar and professor
aw; and James
ional skeptic of
l and paranormal.
t change your
you think.

u/opinion



ng in the cloud:
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APD to scale
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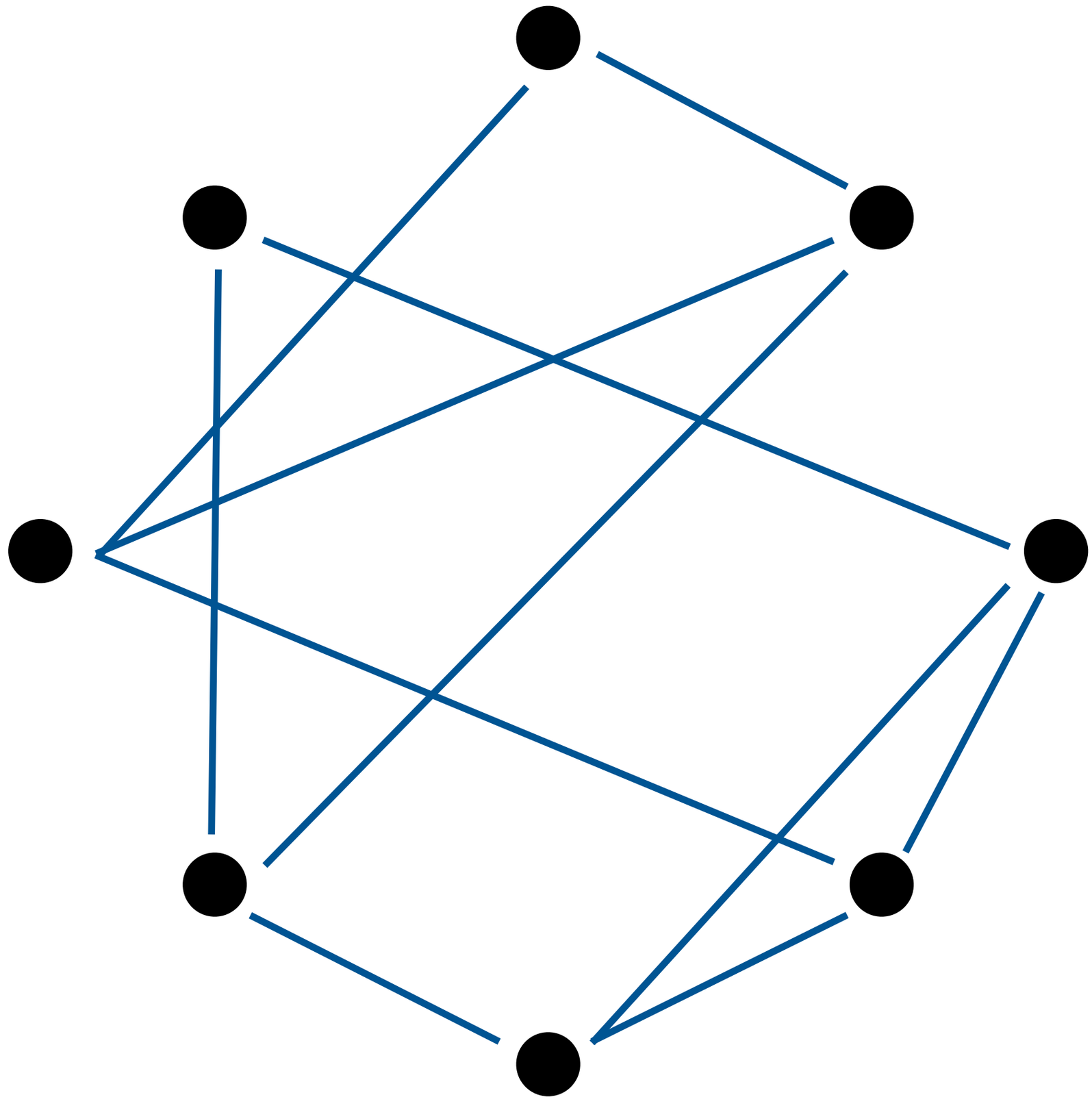
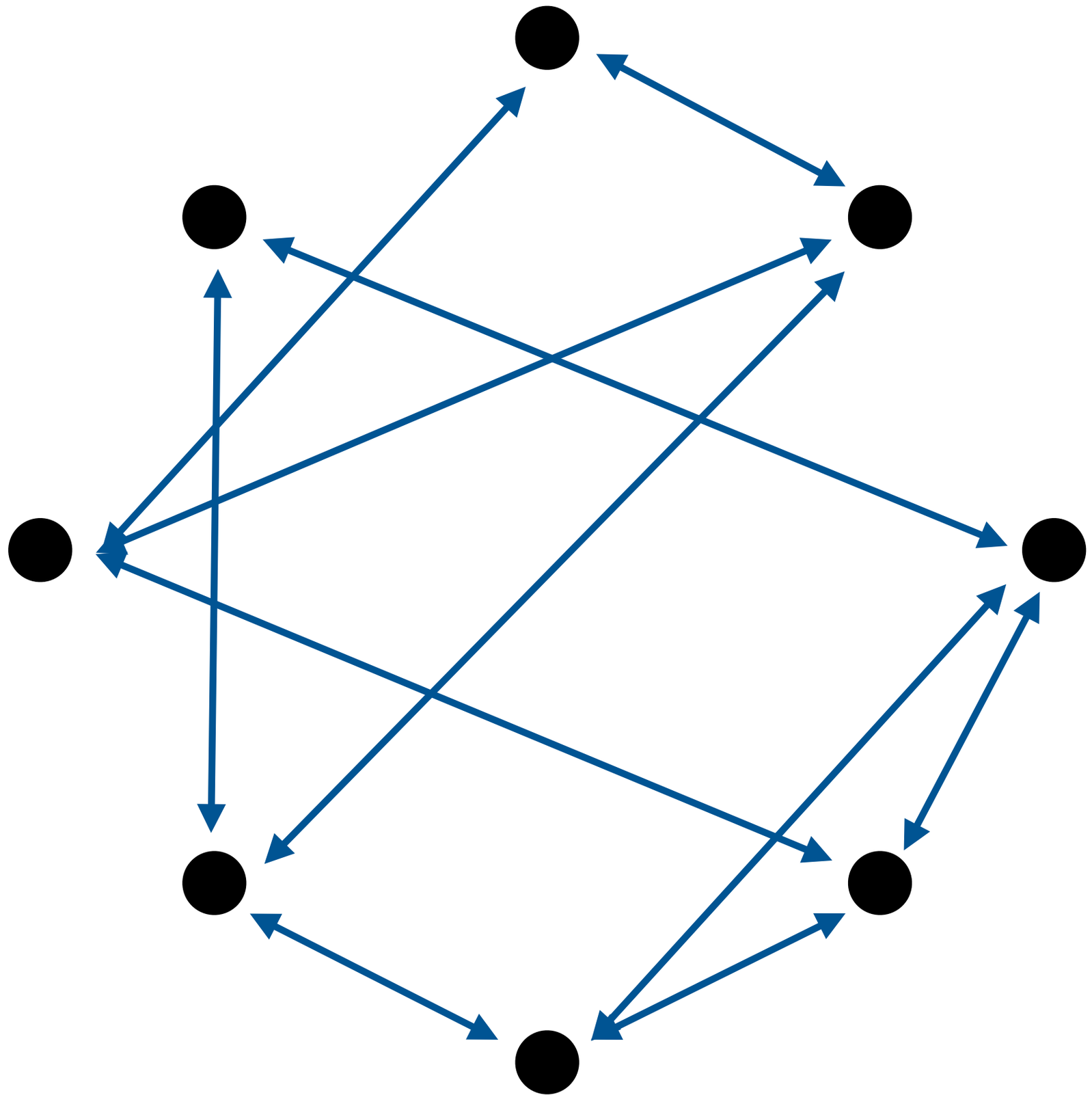
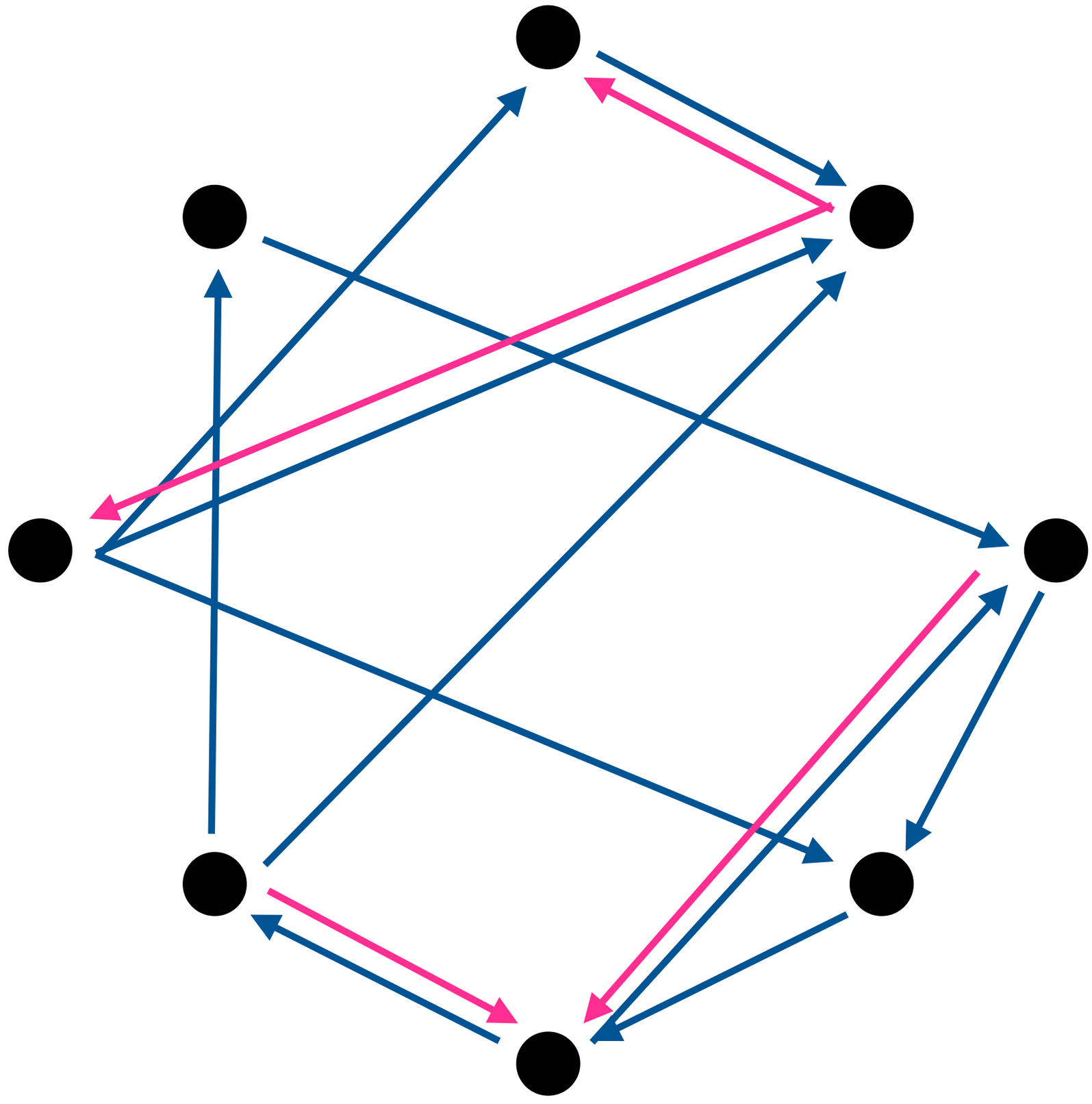
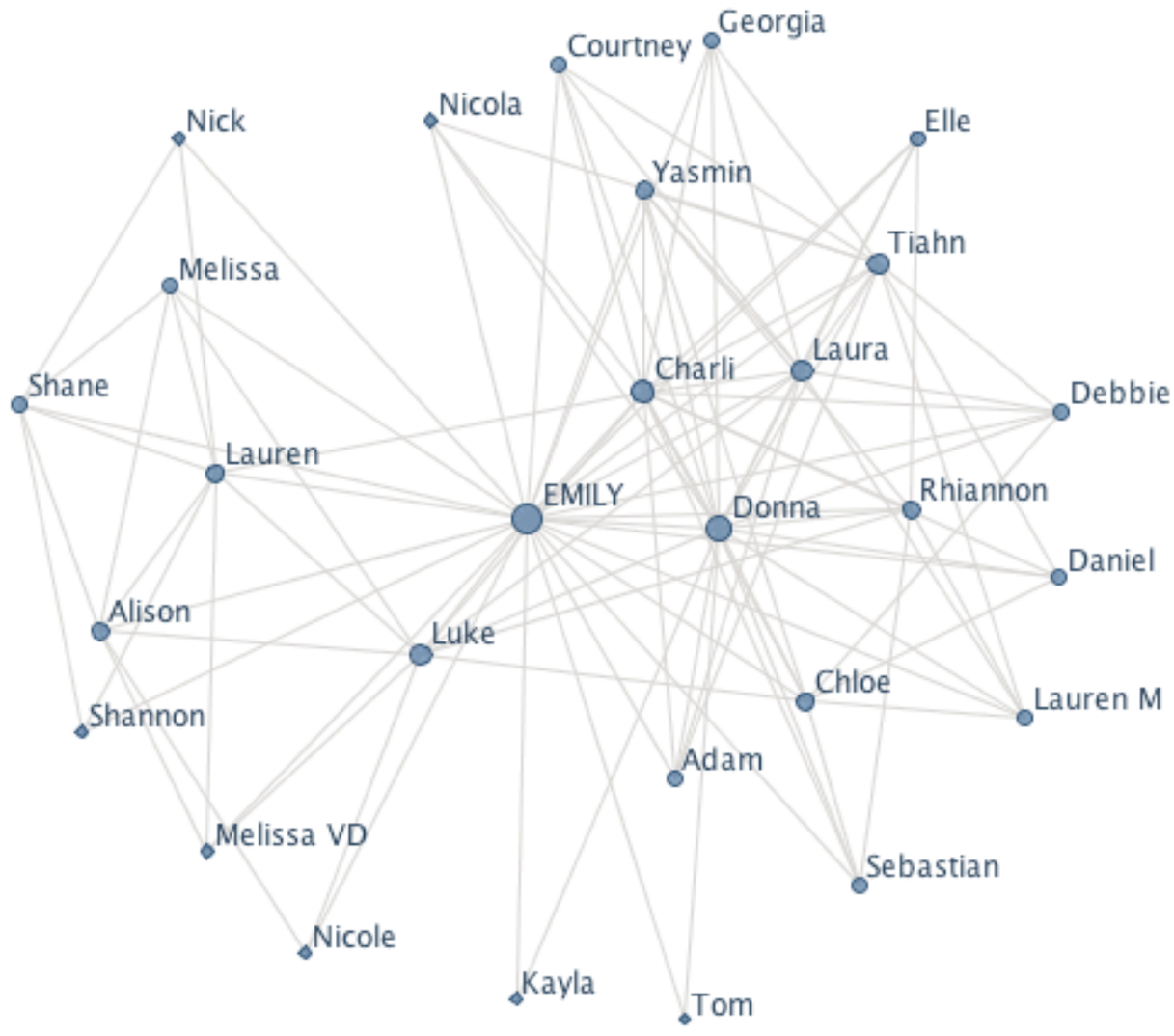
e. In April
om IBM distin-
Snitzer.

Routine

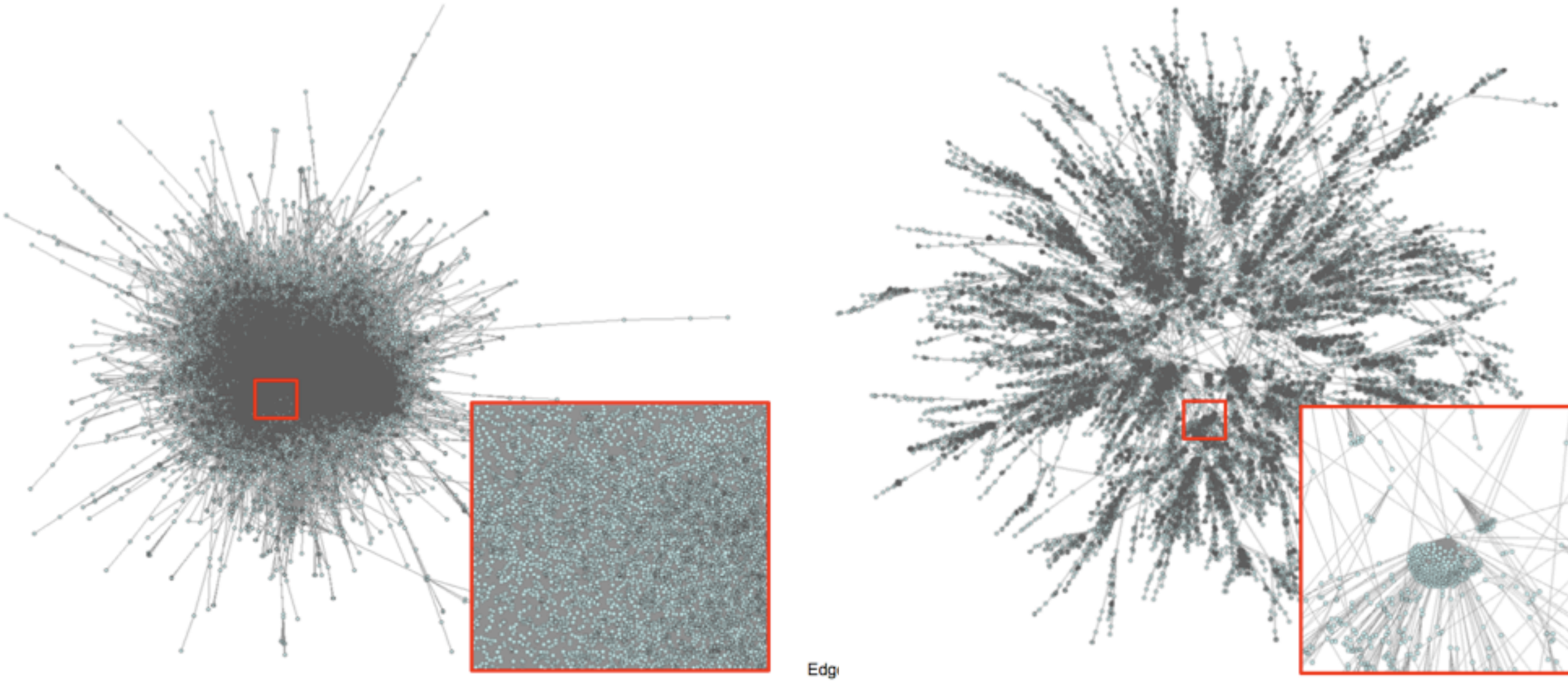




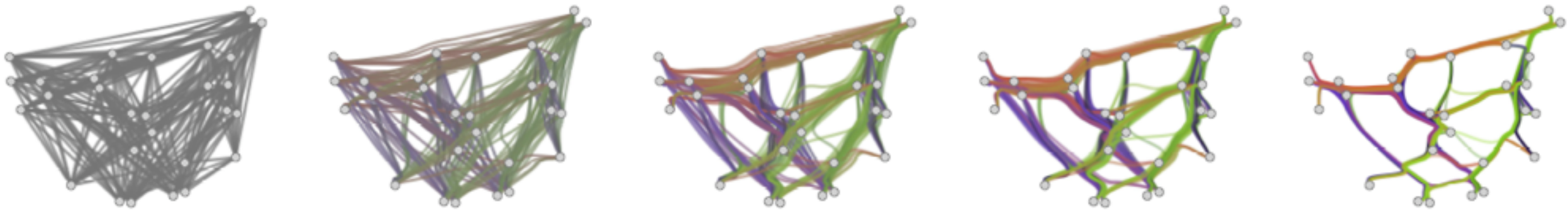




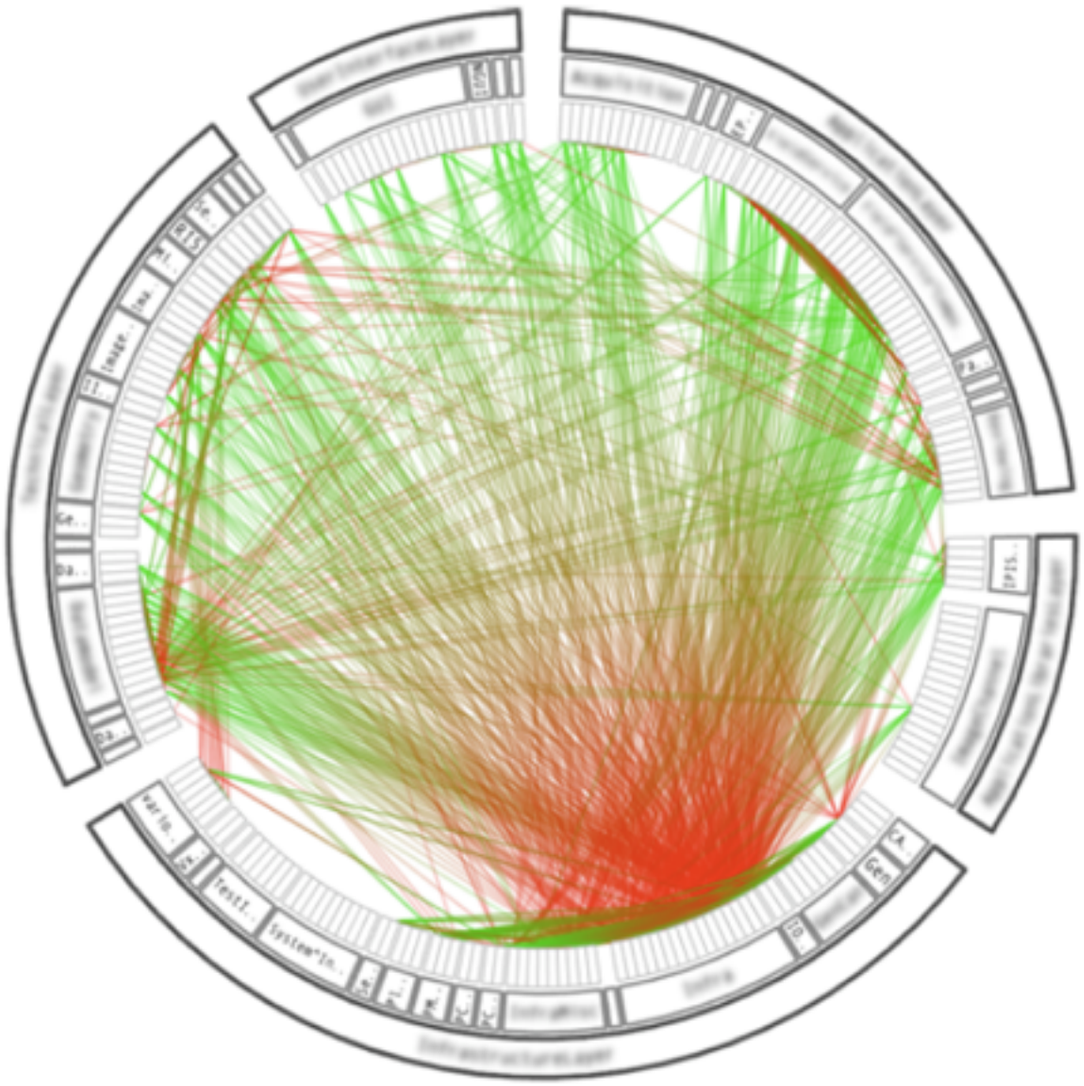
Viégas, Wattenberg, van Ham, Kriss, and McKeon, "*Many Eyes*: A Site for Visualization at Internet Scale"

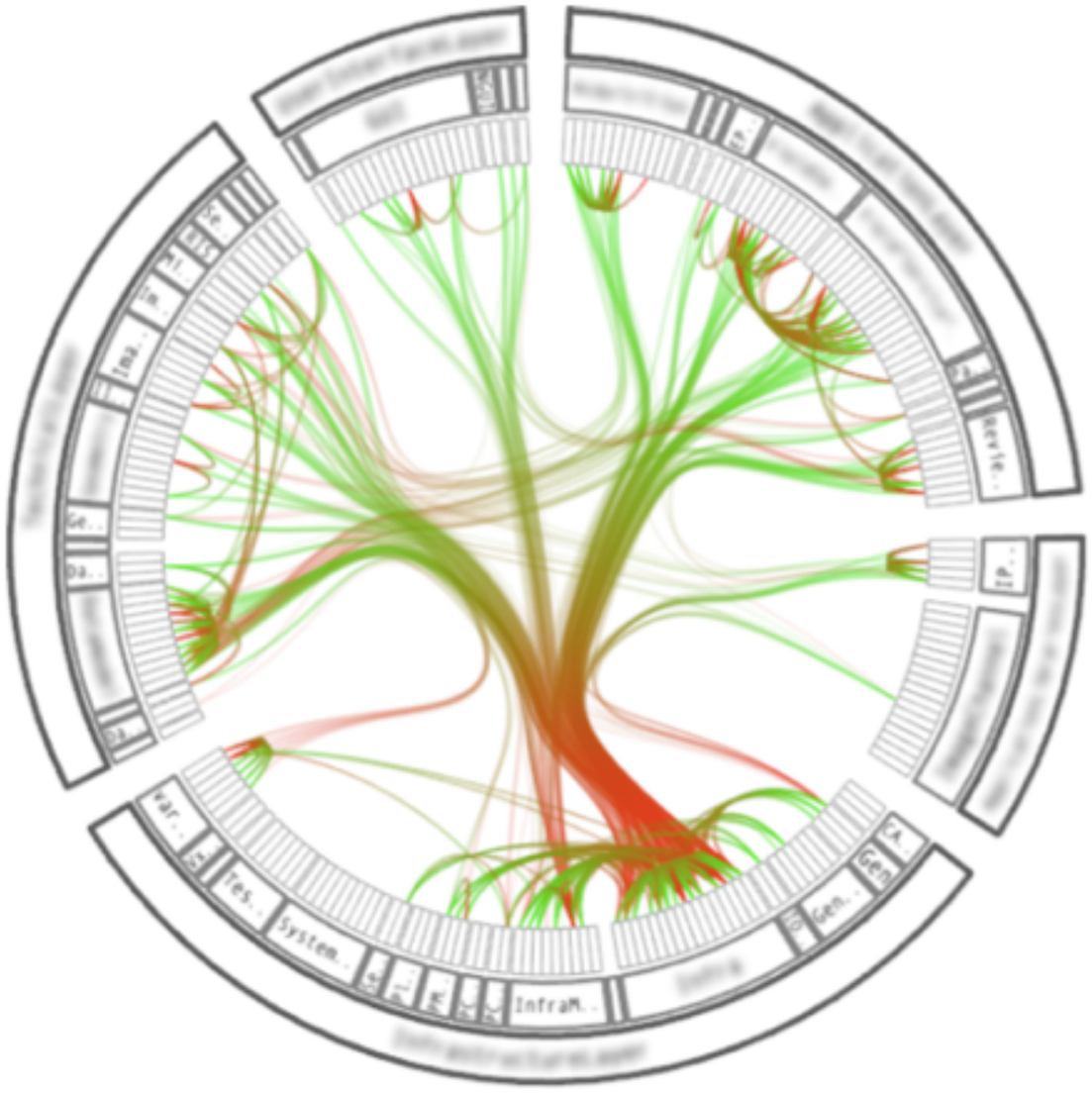


Jia, Hoberock, Garland, and Hart, “On the Visualization of Social and other Scale-Free Networks”

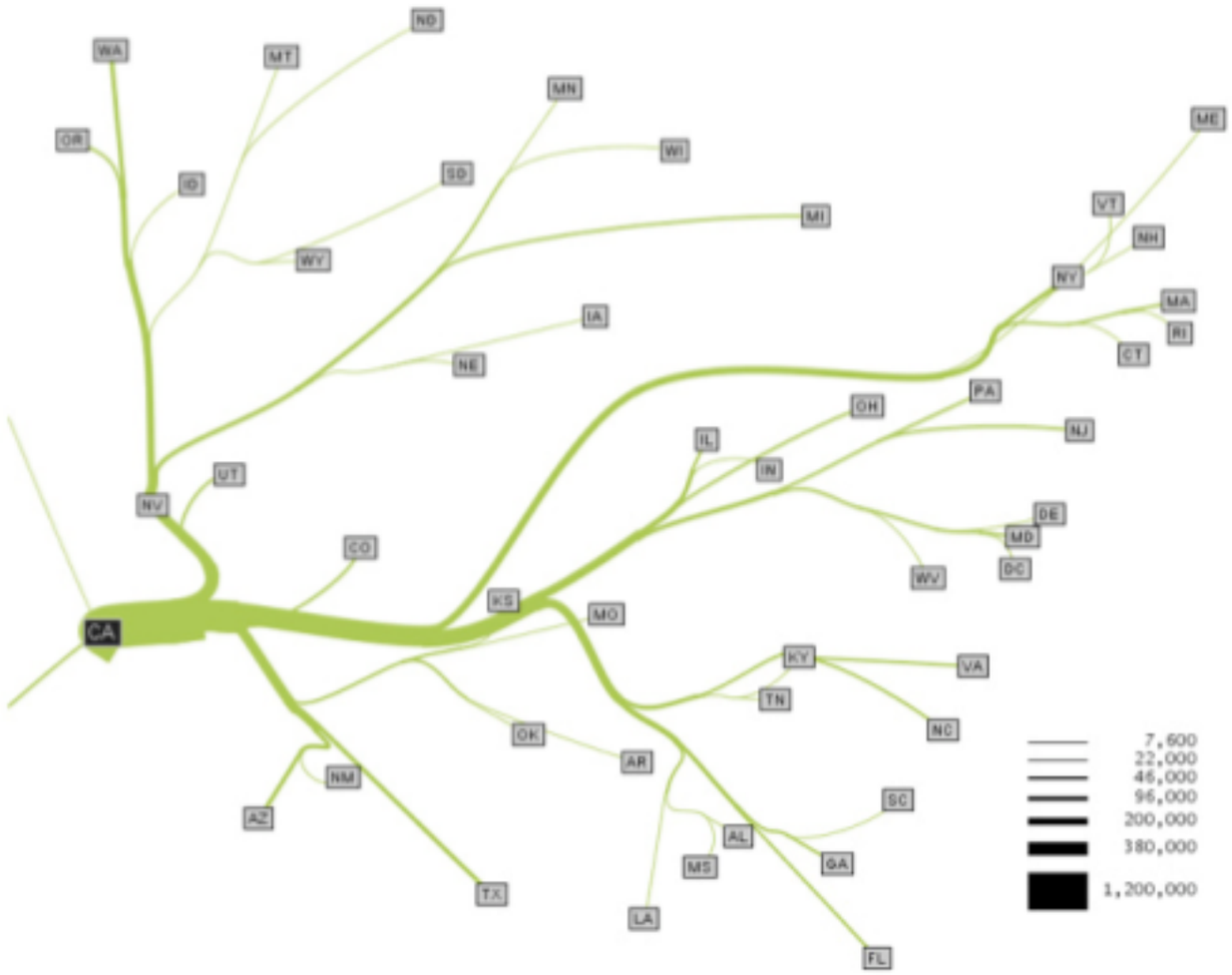


Cui, Zhou, Qu, Wong, and Li, “Geometry-Based Edge Clustering for Graph Visualization”





Holten, “Hierarchical Edge Bundles: Visualization of Adjacency Relations in Hierarchical Data”



Phan, Xiao, Yeh, Hanrahan, and Winograd, “Flow Map Layout”

608-264-xxxx

608-283-xxxx

Relationship Visualizer

2008

January 2012

About these tutorials

Last updated 2012 December 30

These tutorials aim to be

- *Brief*
- *Focused*, each addressing a single topic
- *Modular*, so you can reference only the topics relevant to your goals
- *Complete*, with sample code illustrating each topic
- *Dynamic*, updated and expanded as needed
- *Free*, licensed so you can use the code however you wish

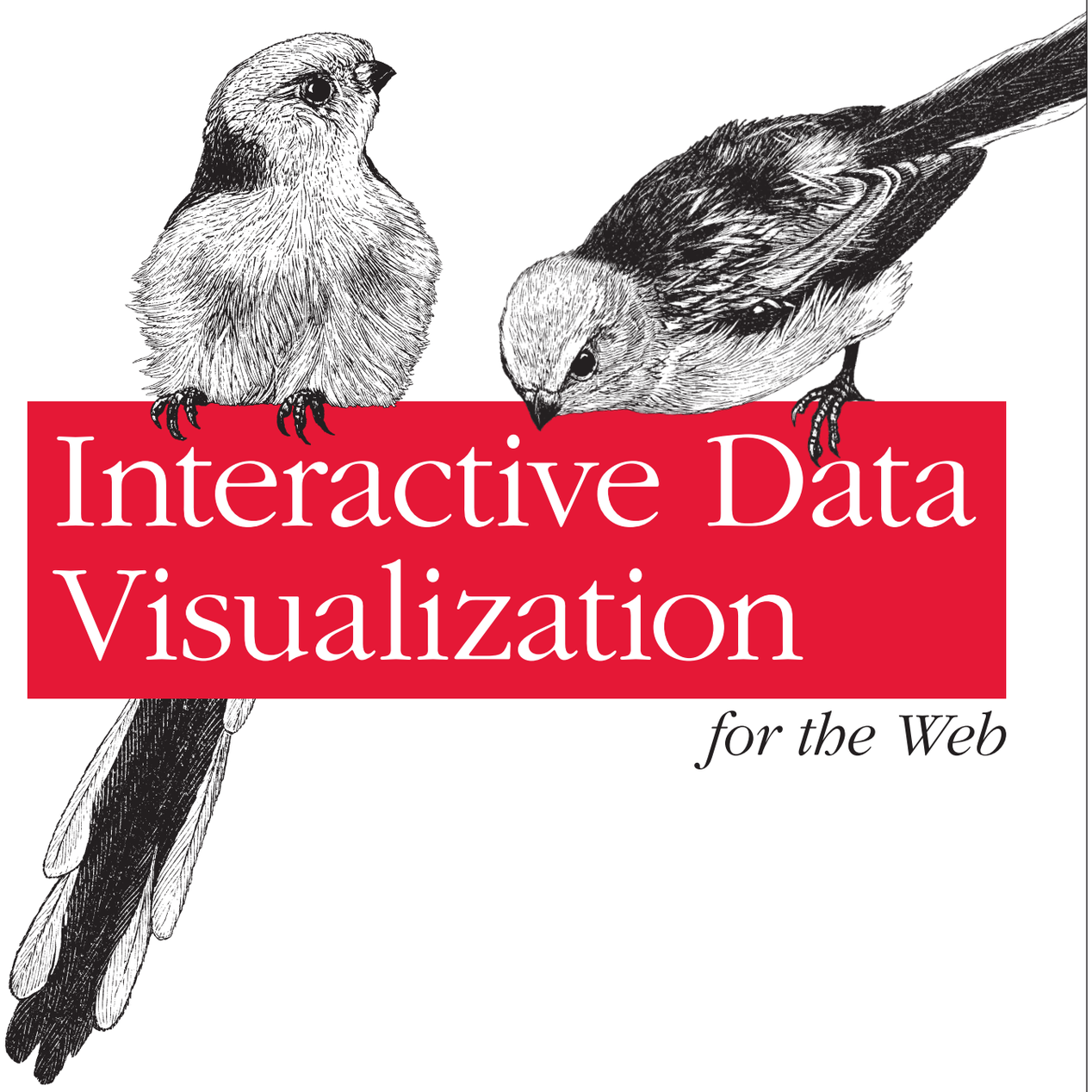
Philosophy

These tutorials evolved out of my own process of learning how to use D3. You already know that D3 is an extraordinary tool for mapping data within web pages, written by Mike Bostock. Many people, including myself, come to D3 with backgrounds in design, mapping, and data visualization, but not programming and computer science.

Yet D3 employs advanced JavaScript techniques, so learning to use D3 often means learning a lot about JavaScript. For many datavis folks, D3 *is* their introduction to JavaScript. It's hard enough to learn a new programming language, let alone a new tool built on that language. D3 is amazing and

March 2013

An Introduction to Designing With D3

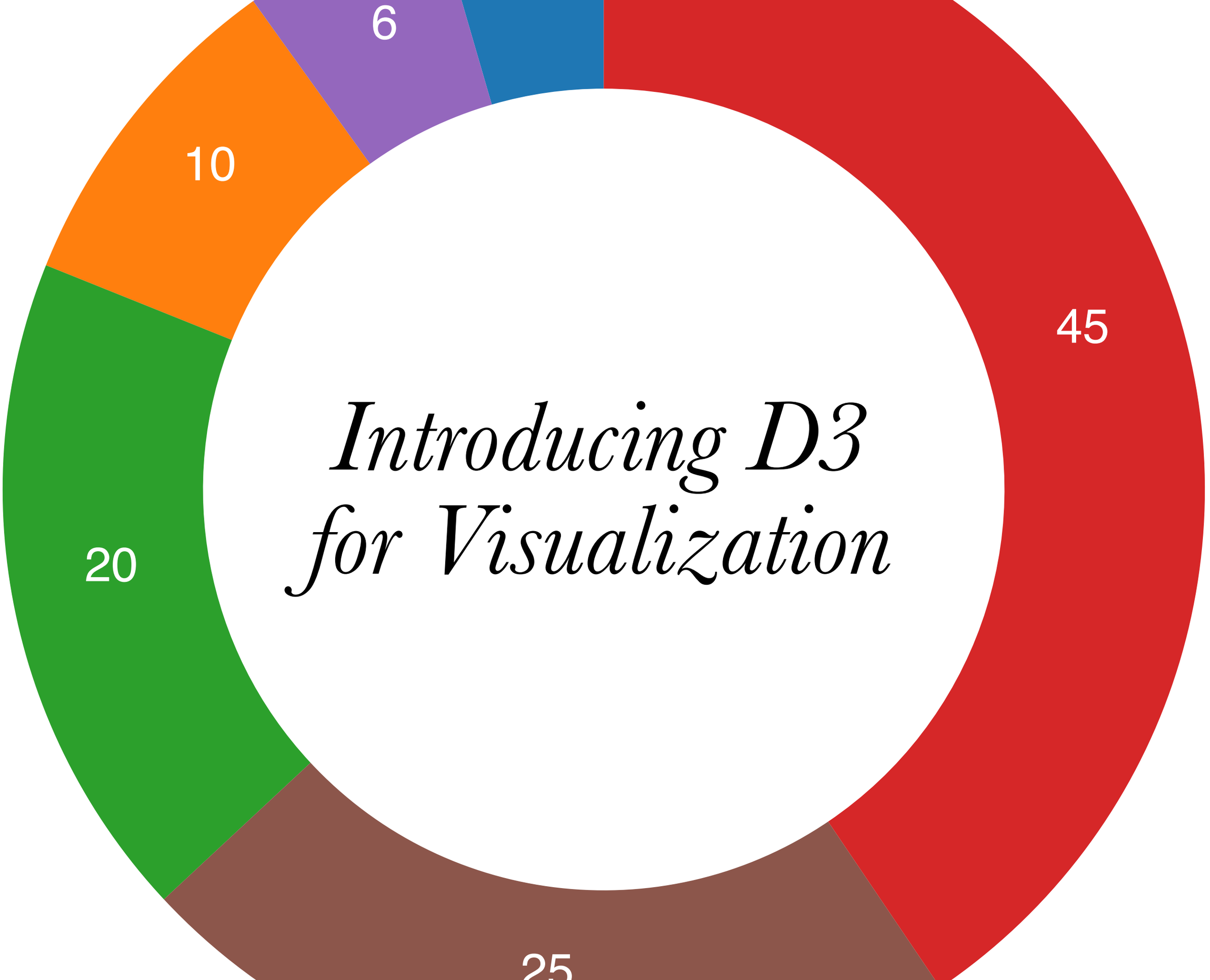


Interactive Data Visualization

for the Web

O'REILLY®

Scott Murray



Introducing D3 for Visualization

Assumptions

— You are somewhat familiar with HTML & CSS

— You have a little programming experience

To follow along, get sample code files from:

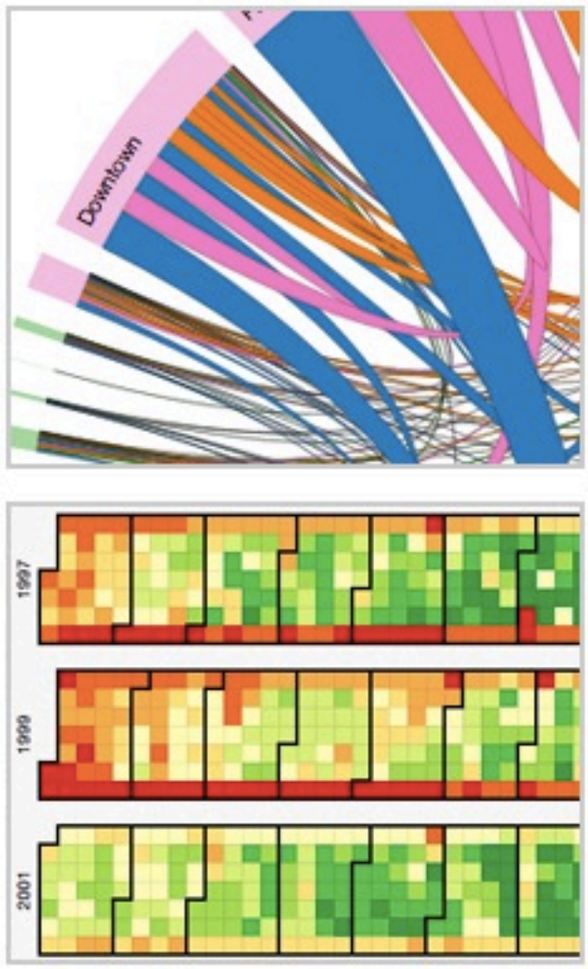
https://github.com/alignedleft/crazy-data-circles

What is d3.js?

d3js.org

Overview Examples Documentation Source

Data-Driven Documents



D3.js is a JavaScript library for manipulating documents based on data. **D3** helps you bring data to life using HTML, SVG and CSS. D3's emphasis on web standards gives you the full capabilities of modern browsers without tying yourself to a proprietary framework, combining powerful visualization components and a data-driven approach to DOM manipulation.

See more examples.

```
<!DOCTYPE html>
<html lang="en">
<head>
   <meta charset="utf-8">
   <title>D3 Page Template</title>
   <script type="text/javascript"
           src="d3.v3.js"></script>
</head>
<body>
   <script type="text/javascript">
      // Your beautiful D3 code
      // can go here
   </script>
</body>
</html>
```

```
d3 = function() {
  var π = Math.PI, ε = 1e-6, d3 = {
    version: "3.0.6"
  }, d3_radians = π / 180, d3_degrees = 180 / π, d3_document = document, d3_window = window;
  function d3_target(d) {
    return d.target;
  }
  function d3_source(d) {
    return d.source;
  }
  var d3_format_decimalPoint = ".", d3_format_thousandsSeparator = ",", d3_format_grouping = [ 3, 3 ];
  if (!Date.now) Date.now = function() {
    return +new Date();
  };
  try {
    d3_document.createElement("div").style.setProperty("opacity", 0, "");
  } catch (error) {
    var d3_style_prototype = d3_window.CSSStyleDeclaration.prototype, d3_style_setProperty = d3_style_prototype.setProperty;
    d3_style_prototype.setProperty = function(name, value, priority) {
      d3_style_setProperty.call(this, name, value + "", priority);
    };
  }
  function d3_class(ctor, properties) {
    try {
      for (var key in properties) {
        Object.defineProperty(ctor.prototype, key, {
          value: properties[key],
          enumerable: false
        });
      }
    } catch (e) {
      ctor.prototype = properties;
    }
  }
  var d3_array = d3_arraySlice;
  function d3_arrayCopy(pseudoarray) {
    var i = -1, n = pseudoarray.length, array = [];
    while (++i < n) array.push(pseudoarray[i]);
    return array;
  }
  function d3_arraySlice(pseudoarray) {
    return Array.prototype.slice.call(pseudoarray);
  }
  try {
    d3_array(d3_document.documentElement.childNodes)[0].nodeType;
  } catch (e) {
    d3_array = d3_arrayCopy;
  }
```

```
d3=function(){function t(t){return t.target}function n(t){return t.source}function e(t,n){try{for(var e in
n)Object.defineProperty(t.prototype,e,{value:n[e],enumerable:!1})}catch(r){t.prototype=n}}function r(t){for(var
n=-1,e=t.length,r=[];e>++n;)r.push(t[n]);return r}function u(t){return Array.prototype.slice.call(t)}function
i(){}function a(t){return t}function o(){return!0}function c(t){return"function"==typeof t?t:function(){return
t}}function l(t,n,e){return function(){var r=e.apply(n,arguments);return arguments.length?t:r}}function f(t)
{return null!=t&&!isNaN(t)}function s(t){return t.length}function h(t){return t.trim().replace(/\s+/g," ")}
function g(t){for(var n=1;t*n%1;)n*=10;return n}function p(t){return 1===t.length?function(n,e){t(null==n?
e:null)}:t}function d(t){return t.responseText}function m(t){return JSON.parse(t.responseText)}function v(t){var
n=Di.createRange();return n.selectNode(Di.body),n.createContextualFragment(t.responseText)}function y(t){return
t.responseXML}function M(){}function b(t){function n(){for(var n,r=e,u=-1,i=r.length;i>++u;)
(n=r[u].on)&&n.apply(this,arguments);return t}var e=[],r=new i;return n.on=function(n,u){var i,a=r.get(n);return
2>arguments.length?a&&a.on:(a&&(a.on=null,e=e.slice(0,i=e.indexOf(a)).concat(e.slice(i
+1)),r.remove(n)),u&&e.push(r.set(n,{on:u})),t)},n}function x(t,n){return n-(t?Math.ceil(Math.log(t)/Math.LN10):
1)}function _(t){return t+""}function w(t,n){var e=Math.pow(10,3*Math.abs(8-n));return{scale:n>8?function(t)
{return t/e}:function(t){return t*e},symbol:t}}function S(t){return function(n){return 0>=n?0:n>=1?1:t(n)}}
function k(t){return function(n){return 1-t(1-n)}}function E(t){return function(n){return.5*(.5>n?t(2*n):2-
t(2-2*n))}}function A(t){return t*t}function N(t){return t*t*t}function T(t){if(0>=t)return 0;if(t>=1)return
1;var n=t*t,e=n*t;return 4*(.5>t?e:3*(t-n)+e-.75)}function q(t){return function(n){return Math.pow(n,t)}}
function C(t){return 1-Math.cos(t*Ni/2)}function z(t){return Math.pow(2,10*(t-1))}function D(t){return 1-
Math.sqrt(1-t*t)}function L(t,n){var e;return 2>arguments.length&&(n=.45),arguments.length?e=n/
(2*Ni)*Math.asin(1/t):(t=1,e=n/4),function(r){return 1+t*Math.pow(2,10*-r)*Math.sin(2*(r-e)*Ni/n)}}function F(t)
{return t||(t=1.70158),function(n){return n*n*((t+1)*n-t)}}function H(t){return 1/2.75>t?7.5625*t*t:2/2.75>t?
7.5625*(t-=1.5/2.75)*t+.75:2.5/2.75>t?7.5625*(t-=2.25/2.75)*t+.9375:7.5625*(t-=2.625/2.75)*t+.984375}function
j(){qi.event.stopPropagation(),qi.event.preventDefault()}function P(){for(var
t,n=qi.event;t=n.sourceEvent;)n=t;return n}function R(t){for(var n=new M,e=0,r=arguments.length;r>+
+e;)n[arguments[e]]=b(n);return n.of=function(e,r){return function(u){try{var
i=u.sourceEvent=qi.event;u.target=t,qi.event=u,n[u.type].apply(e,r)}finally{qi.event=i}}},n}function O(t){var
n=[t.a,t.b],e=[t.c,t.d],r=U(n),u=Y(n,e),i=U(I(e,n,-u))||
0;n[0]*e[1]<e[0]*n[1]&&(n[0]*=-1,n[1]*=-1,r*=-1,u*=-1),this.rotate=(r?Math.atan2(n[1],n[0]):Math.atan2(-
e[0],e[1]))*zi,this.translate=[t.e,t.f],this.scale=[r,i],this.skew=i?Math.atan2(u,i)*zi:0}function Y(t,n){return
t[0]*n[0]+t[1]*n[1]}function U(t){var n=Math.sqrt(Y(t,t));return n&&(t[0]/=n,t[1]/=n),n}function I(t,n,e){return
t[0]+=e*n[0],t[1]+=e*n[1],t}function V(t){return"transform"==t?qi.interpolateTransform:qi.interpolate}function
X(t,n){return n=n-(t=+t)?1/(n-t):0,function(e){return(e-t)*n}}function Z(t,n){return n=n-(t=+t)?1/(n-t):
0,function(e){return Math.max(0,Math.min(1,(e-t)*n))}}function B(){}function $(t,n,e){return new J(t,n,e)}
function J(t,n,e){this.r=t,this.g=n,this.b=e}function G(t){return
16>t?"0"+Math.max(0,t).toString(16):Math.min(255,t).toString(16)}function K(t,n,e){var r,u,i,a=0,o=0,c=0;if(r=/
([a-z]+)\((.*)\)/i.exec(t))switch(u=r[2].split(","),r[1]){case"hsl":return e(parseFloat(u[0]),parseFloat(u[1])/
100,parseFloat(u[2])/100);case"rgb":return n(nn(u[0]),nn(u[1]),nn(u[2]))}return(i=aa.get(t))?n(i.r,i.g,i.b):
(null!=t&&"#"===t.charAt(0)&&(4===t.length?(a=t.charAt(1),a+=a,o=t.charAt(2),o+=o,c=t.charAt(3),c+=c):
7===t.length&&(a=t.substring(1,3),o=t.substring(3,5),c=t.substring(5,7)),a=parseInt(a,16),o=parseInt(o,
16),c=parseInt(c,16)),n(a,o,c))}function W(t,n,e){var r,u,i=Math.min(t/=255,n/=255,e/
=255),a=Math.max(t,n,e),o=a-i,c=(a+i)/2;return o?(u=.5>c?o/(a+i):o/(2-a-i),r=t==a?(n-e)/o+(e>n?6:0):n==a?(e-t)/o
+2:(t-n)/o+4,r*=60):u=r=0,en(r,u,c)}function Q(t,n,e){t=tn(t),n=tn(n),e=tn(e);var r=pn((.4124564*t+.3575761*n+.
1804375*e)/fa),u=pn((.2126729*t+.7151522*n+.072175*e)/sa),i=pn((.0193339*t+.119192*n+.9503041*e)/ha);return
ln(116*u-16,500*(r-u),200*(u-i))}function tn(t){return.04045>=(t/=255)?t/12.92:Math.pow((t+.055)/1.055,2.4)}
function nn(t){var n=parseFloat(t);return"%"===t.charAt(t.length-1)?Math.round(2.55*n):n}function en(t,n,e)
```

HTML Hypertext Markup Language

CSS Cascading Style Sheets

JS JavaScript

SVG Scalable Vector Graphics

DOM The Document Object Model

all of the above == web standards

HTML	Hypertext Markup Language
CSS	Cascading Style Sheets
JS	JavaScript
SVG	Scalable Vector Graphics
DOM	The Document Object Model

Learning D3 is a process of "learning the web"

Selecting & generating elements

SVG

Binding data / data joins

```
// JavaScript arrays!
```

```
var dataset = [ 5, 10, 20, 15, 18 ];
```

```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
   .append(“circle”);
```

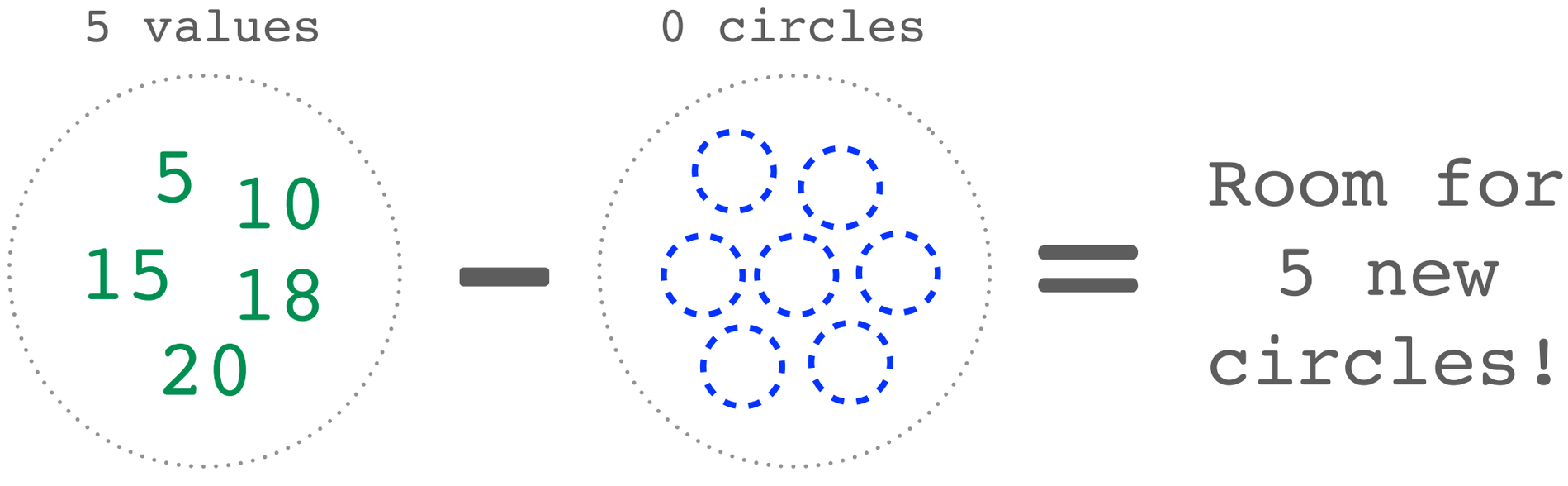
```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
   .append(“circle”);
```

```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
   .append(“circle”);
```

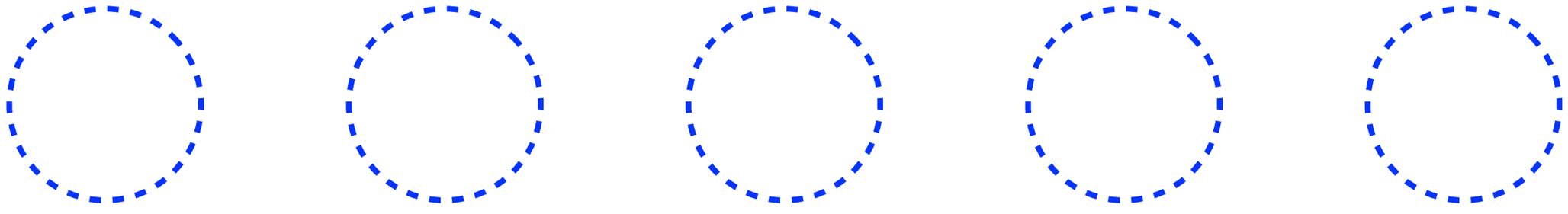
?

(empty selection)

```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
.append(“circle”);
```



```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
   .append(“circle”);
```



```
// Data joins!

var dataset = [ 5, 10, 20, 15, 18 ];

d3.select(“svg”).selectAll(“circle”)
   .data(dataset)
   .enter()
   .append(“circle”);
```


5
10
20
15
18

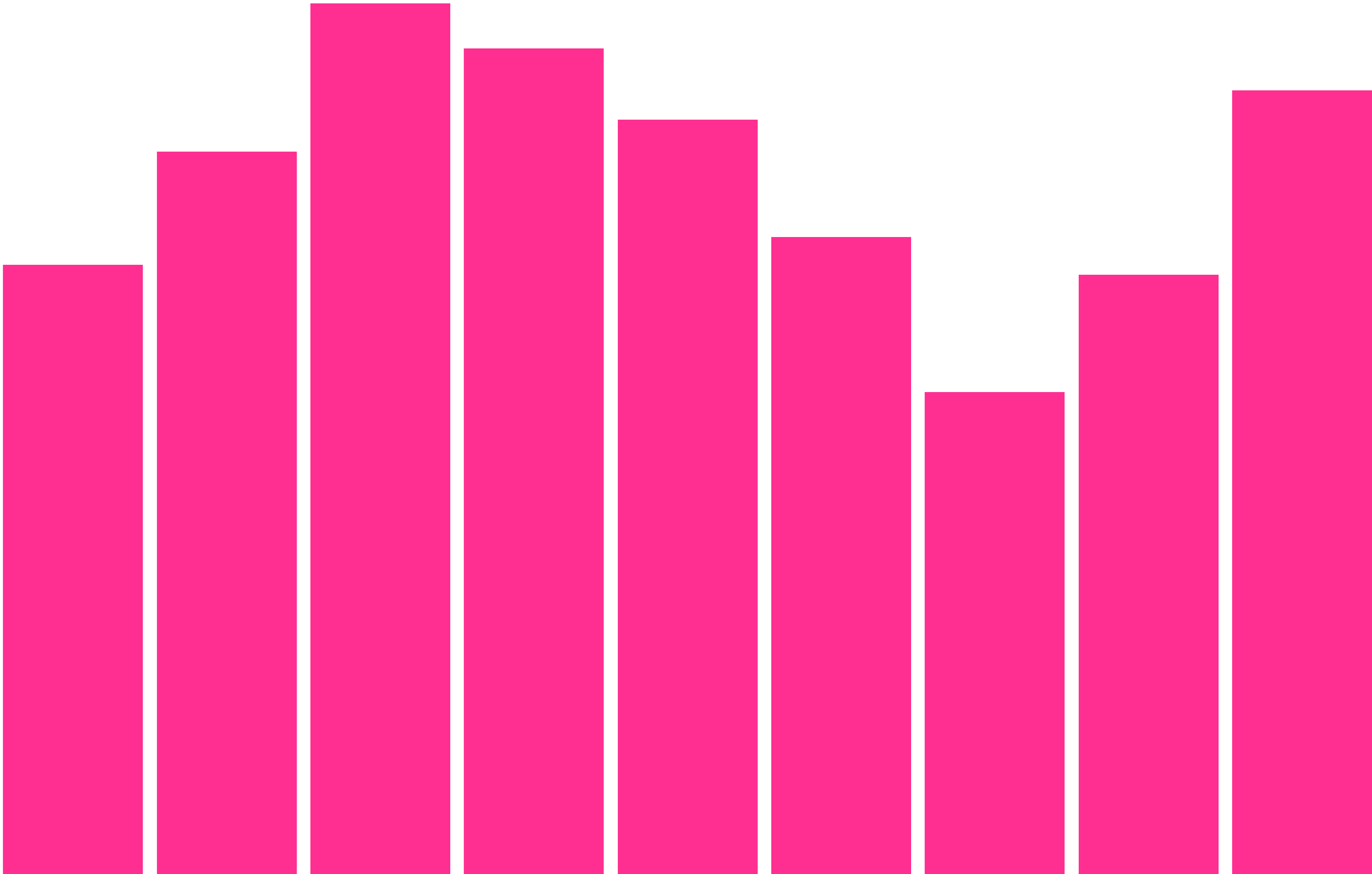
```
// Setting attributes from data!
```

```
d3.selectAll(“circle”)
   .attr(“r”, function(d) {
      return d;
   });
```

```
// Binding data to elements

// 1. Lets you reference values later
// 2. Prevents need to “redraw” elements
```

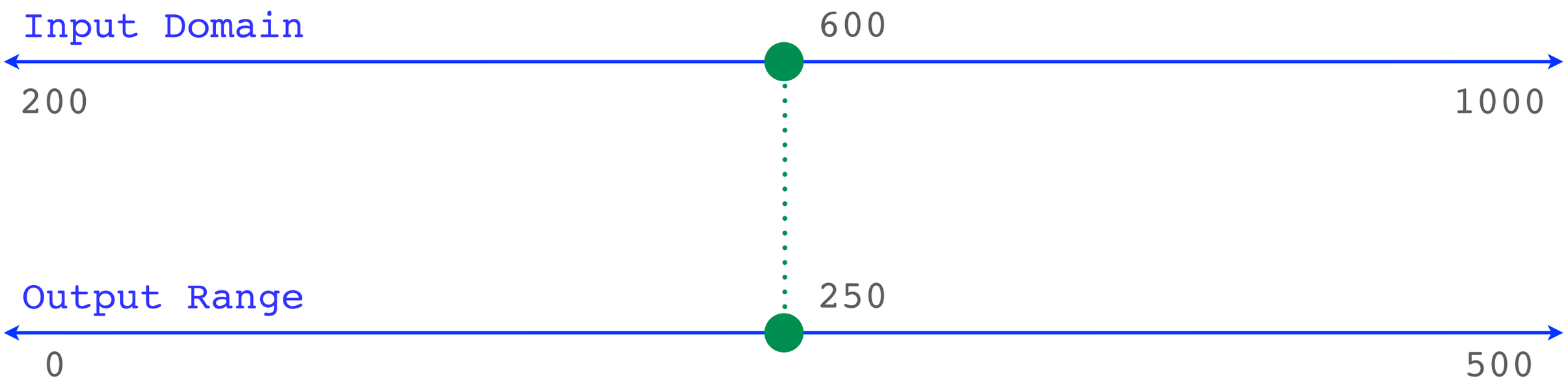
Transitions

// Transitions and motion



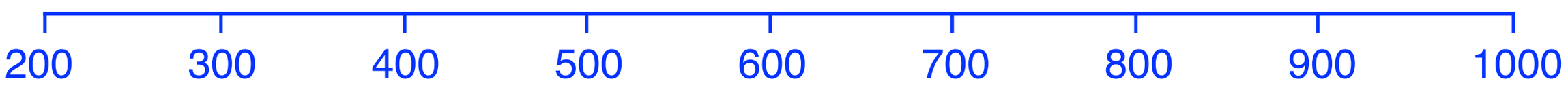
Scales

```
// Scale values

var scale = d3.scale.linear()
                    .domain([200, 1000])
                    .range([0, 500]);

scale(600);  // Returns 250
```



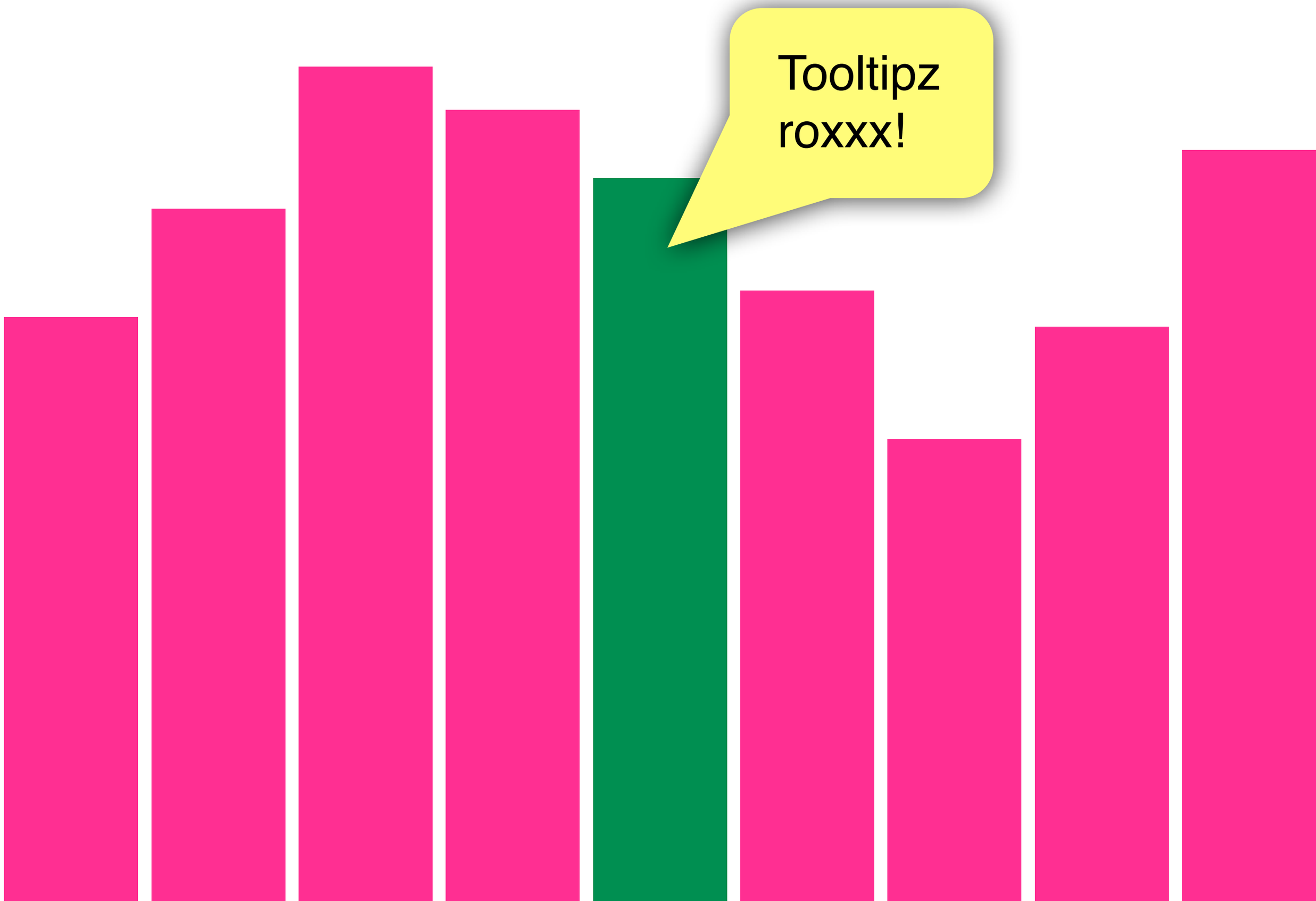
Axes

```
// Generate axes

var axis = d3.svg.axis()
                 .scale(scale);

svg.append("g")
   .call(axis);
```

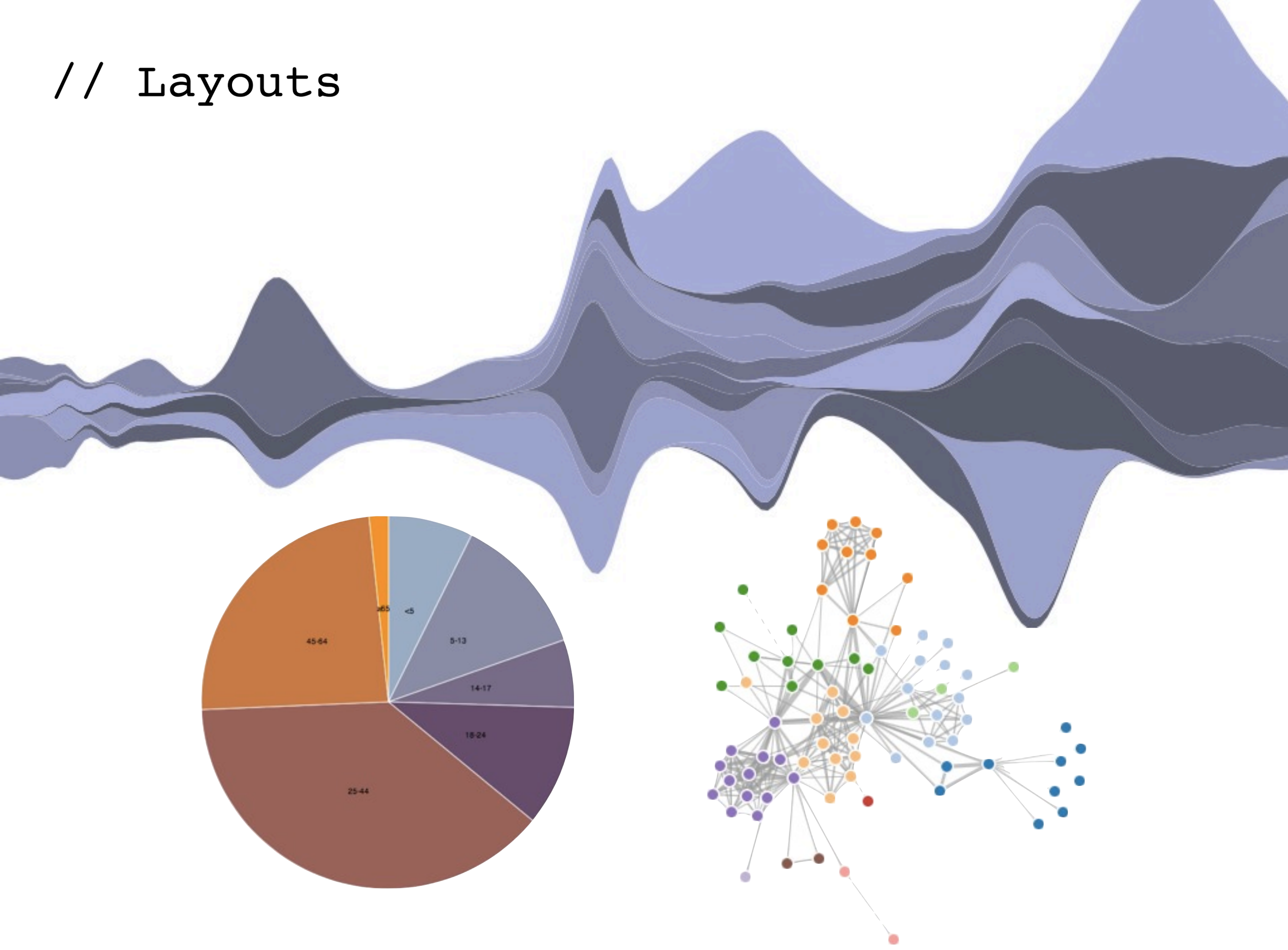


What else can D3 do for me?

// Interactivity



// Layouts

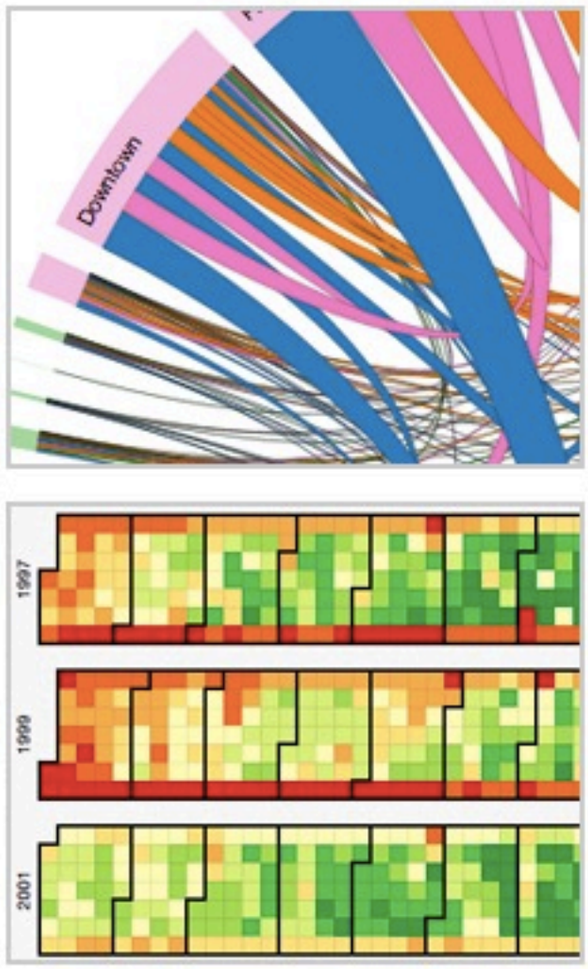


// More mapping and projections

d3js.org

Overview Examples Documentation Source

Data-Driven Documents



D3.js is a JavaScript library for manipulating documents based on data. **D3** helps you bring data to life using HTML, SVG and CSS. D3's emphasis on web standards gives you the full capabilities of modern browsers without tying yourself to a proprietary framework, combining powerful visualization components and a data-driven approach to DOM manipulation.

See more examples.

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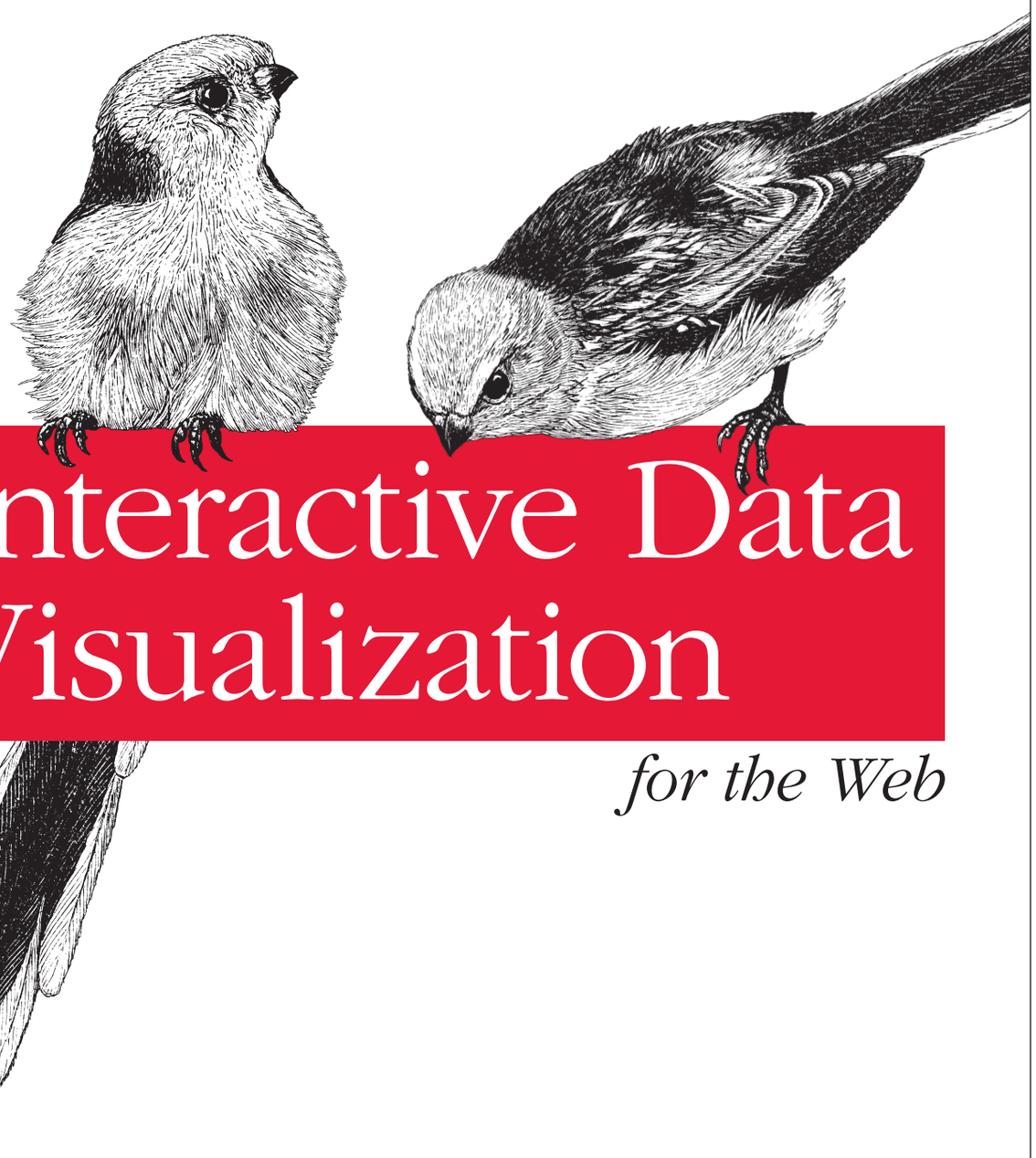
An Introduction to Designing With D3



Interactive Data Visualization

for the Web

O'REILLY®

Scott Murray

Thanks!