



Scott Murray

code artist

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UNIVERSITY OF
SAN FRANCISCO

CHANGE THE WORLD FROM HERE



Strawberry

Tiburon

Golden Gate National
Recreation Area

Sausalito

Berkeley

San Pablo Avenue

Emeryville

Broadway

Piedmont

Oakland

Presidio

Golden Gate National
Recreation Area

Golden Gate Park

San Francisco

Great Highway

Sunset Boulevard

3rd Street





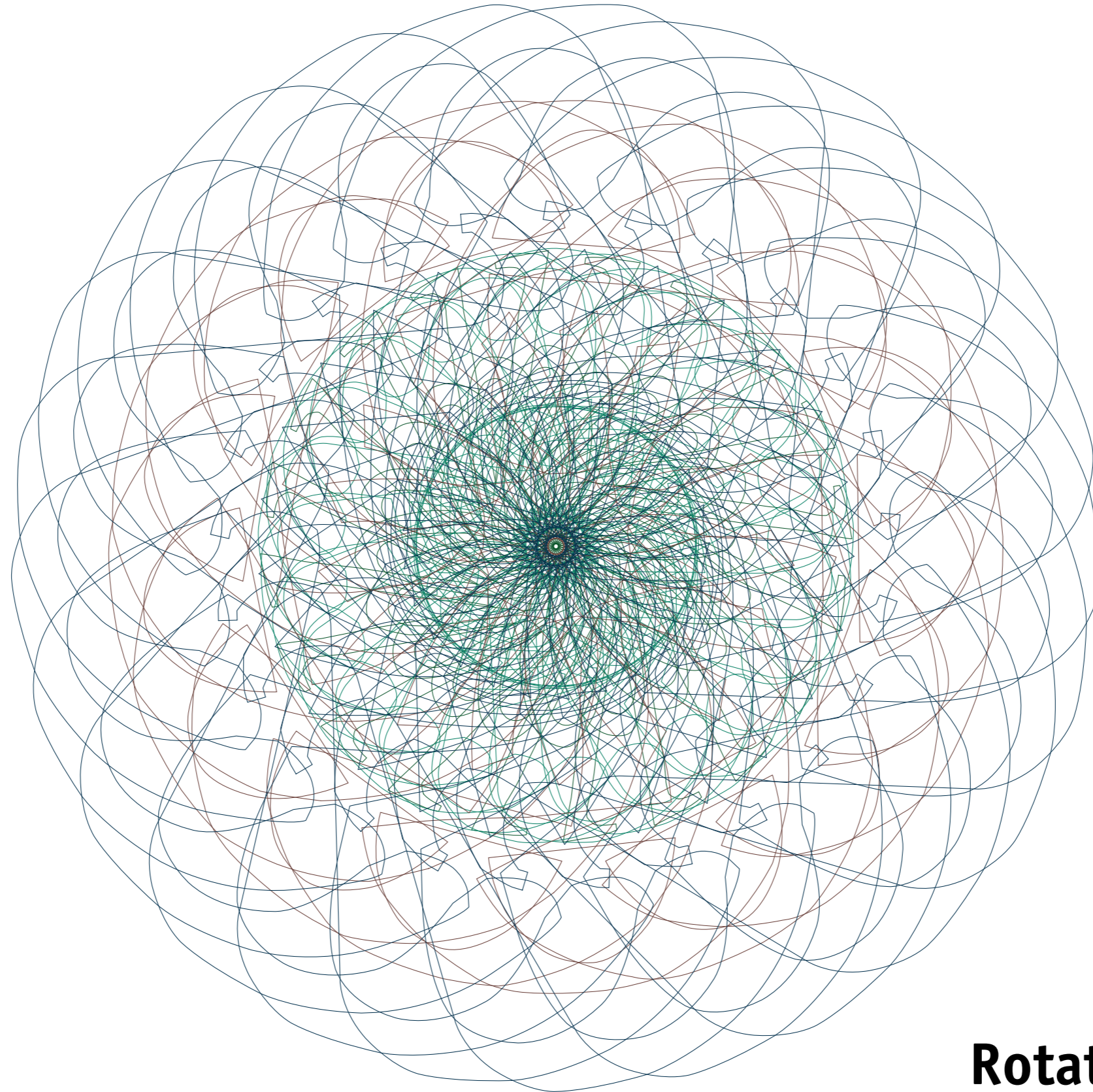
**Rue de Paris,
temps de pluie**

Paris Street, Rainy Day
Gustave Caillebotte, 1877

G. Caillebotte, 1877

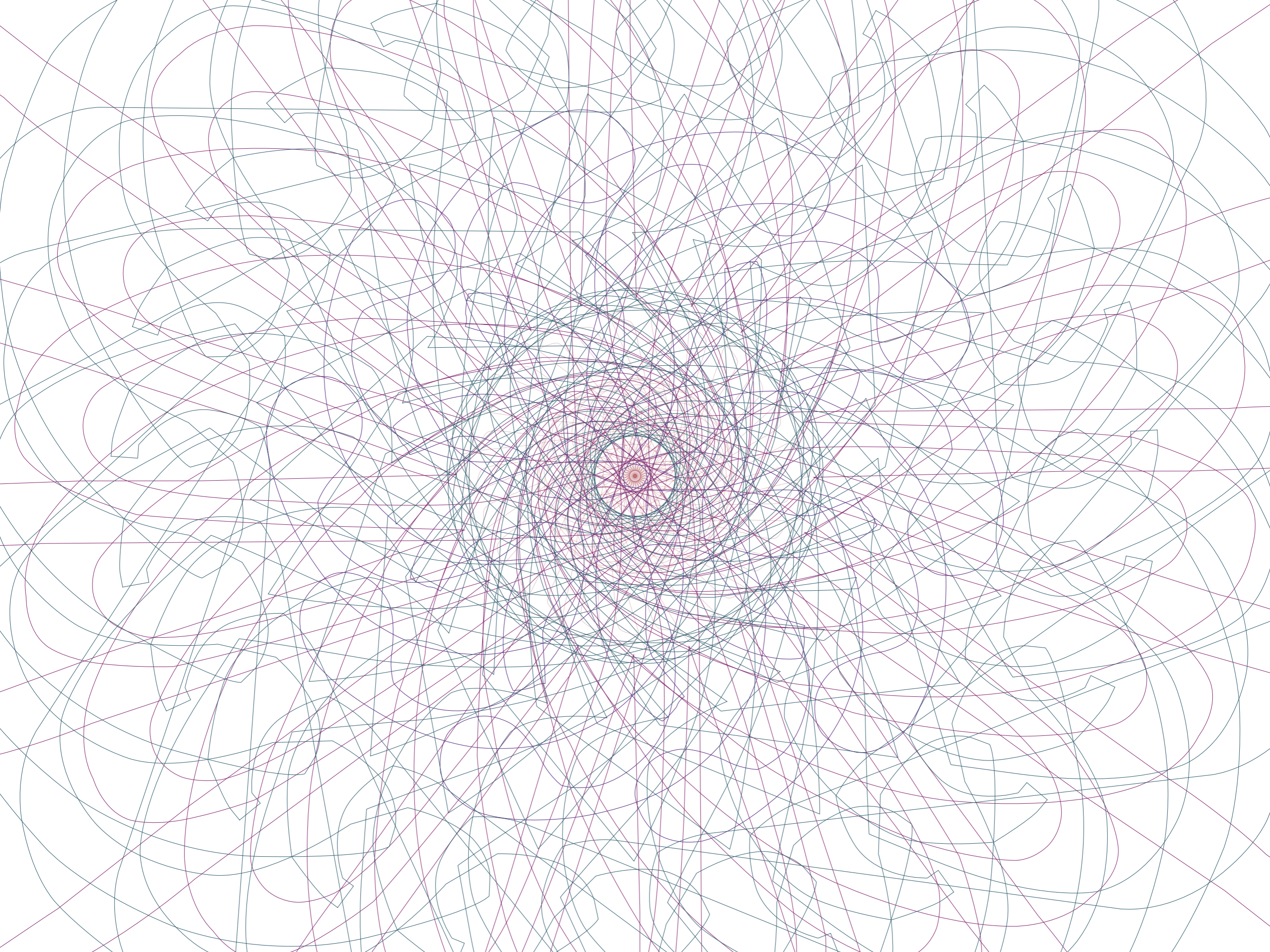
```
void setup() {  
    size(1920, 1080);  
    frameRate(30);  
    smooth();  
}
```

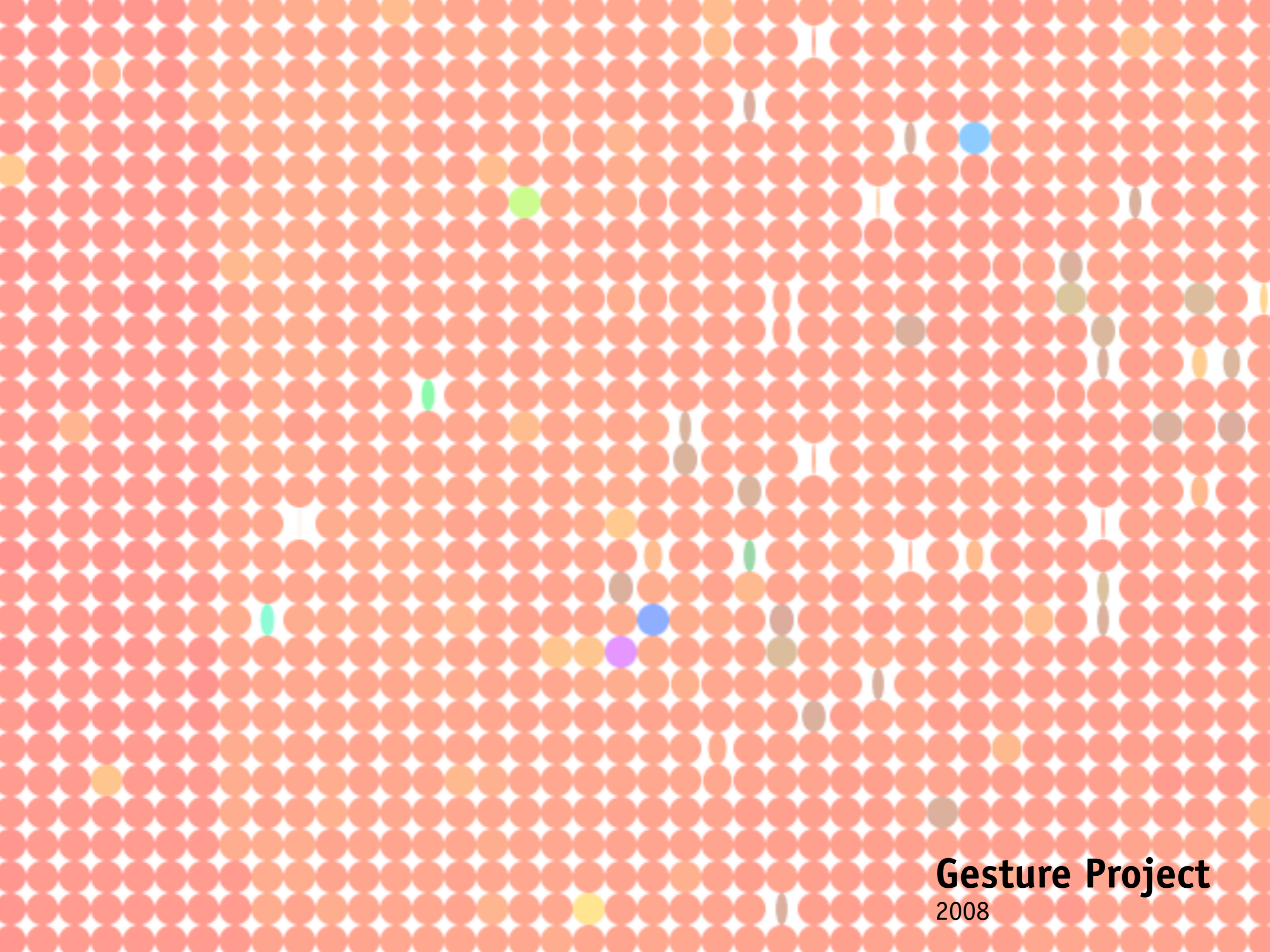
```
void draw() {  
    translate(width/2, height/2);  
    for (int i = 0; i < 100; i++) {  
        ellipse(0, 0, i * 5, i * 5);  
    }  
}
```



Rotating Type

with Jan Kubasiewicz, 2011





Gesture Project

2008



ASCII Photo Booth

2008

Click the mouse,
take your photo.



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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

Smarter business for a Smarter Planet:

Most boats are moved by propellers. This one was moved by intelligence.

There are thousands of different types of boats, but to a boat dealer, there are really just two: boats that have been sold and boats that haven't. MarineMax®, the world's largest boat retailer, is using Cognos® business analytics software to make sure its boats aren't languishing in showrooms, hurting its bottom line. By better aligning inventory decisions with customer demand, MarineMax reduced its planning cycle from 3 months to 3 weeks, cut costs by 48% and ultimately moved more boats. A smarter planet is built on smarter software, systems and services.

Let's build a smarter planet. ibm.com/insights



Data visualization of revenue projections for monthly boat sales.

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IBM Smarter Planet

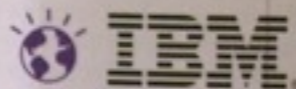
with Mirada, 2011

Smarter business for a Smarter Planet:

How to build a car fueled by software.

When you look at the Chevrolet Volt, are you looking at steel and plastic, or are you looking at software? The Volt, an electric car with gas-powered extended range, contains over 10 million lines of code, more software than you'd find in the avionics and navigation systems of a modern fighter jet. Chevrolet turned to IBM to help them design the control systems and software for the Volt, allowing them to deliver this revolutionary car in far less time than development typically takes. Using the Rational® platform to design the car allowed engineers around the world to collaborate in real time, which helped the Volt become the 2011 *Motor Trend* Car of the Year®. A smarter business is built on smarter software, systems and services.

Let's build a smarter planet. ibm.com/collaborate



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nion

opinion—and
ours. The new
rings together
media, and cul-
James Dyson and
ppe Starck and
contributors
writer and entre-
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olar and professor
aw; and James
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l and paranormal
change your
you think.

Opinion



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Headline

Smarter business for a Smarter Planet:

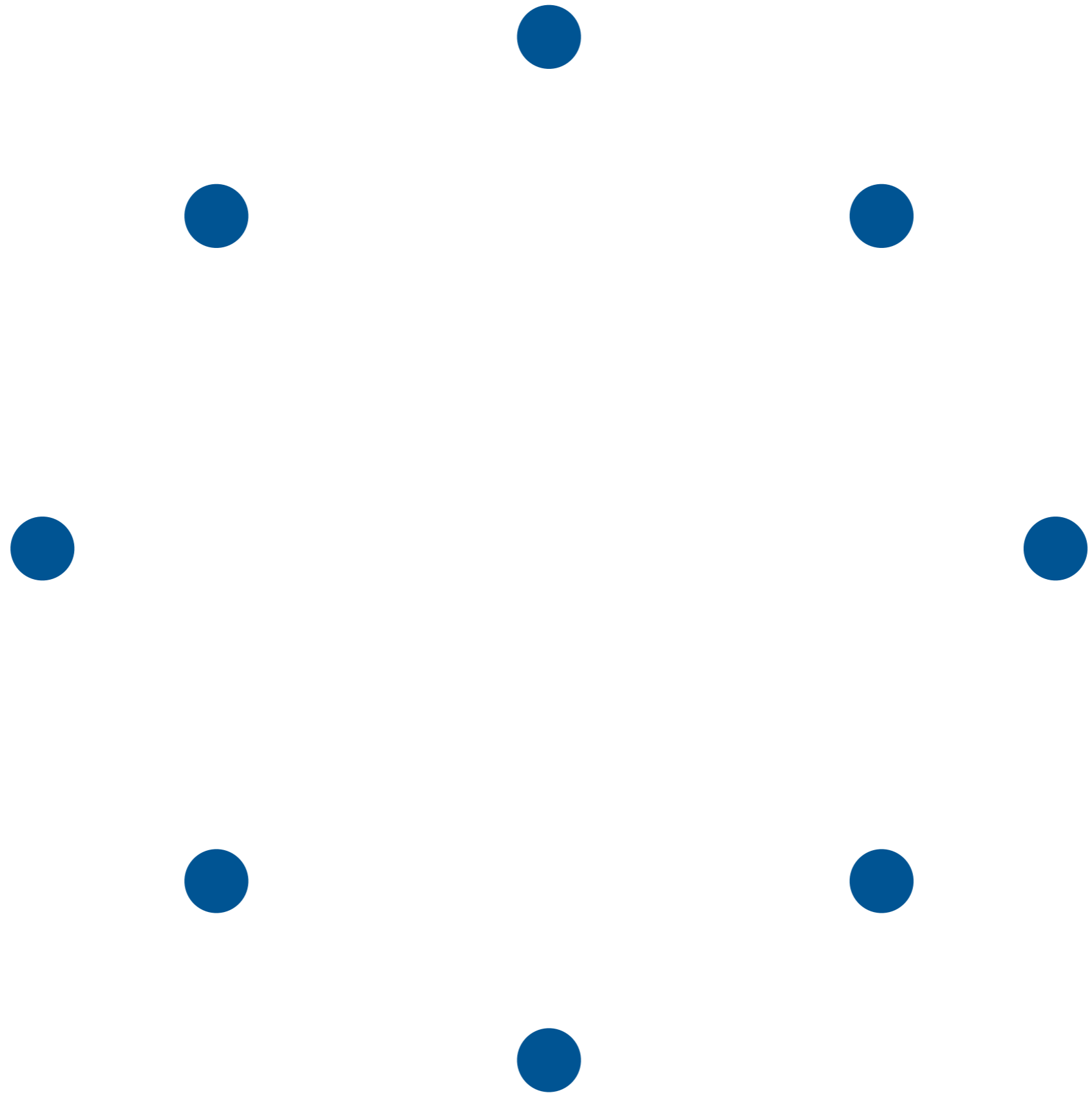
The cloud that's transforming an industry, one fish at a time.

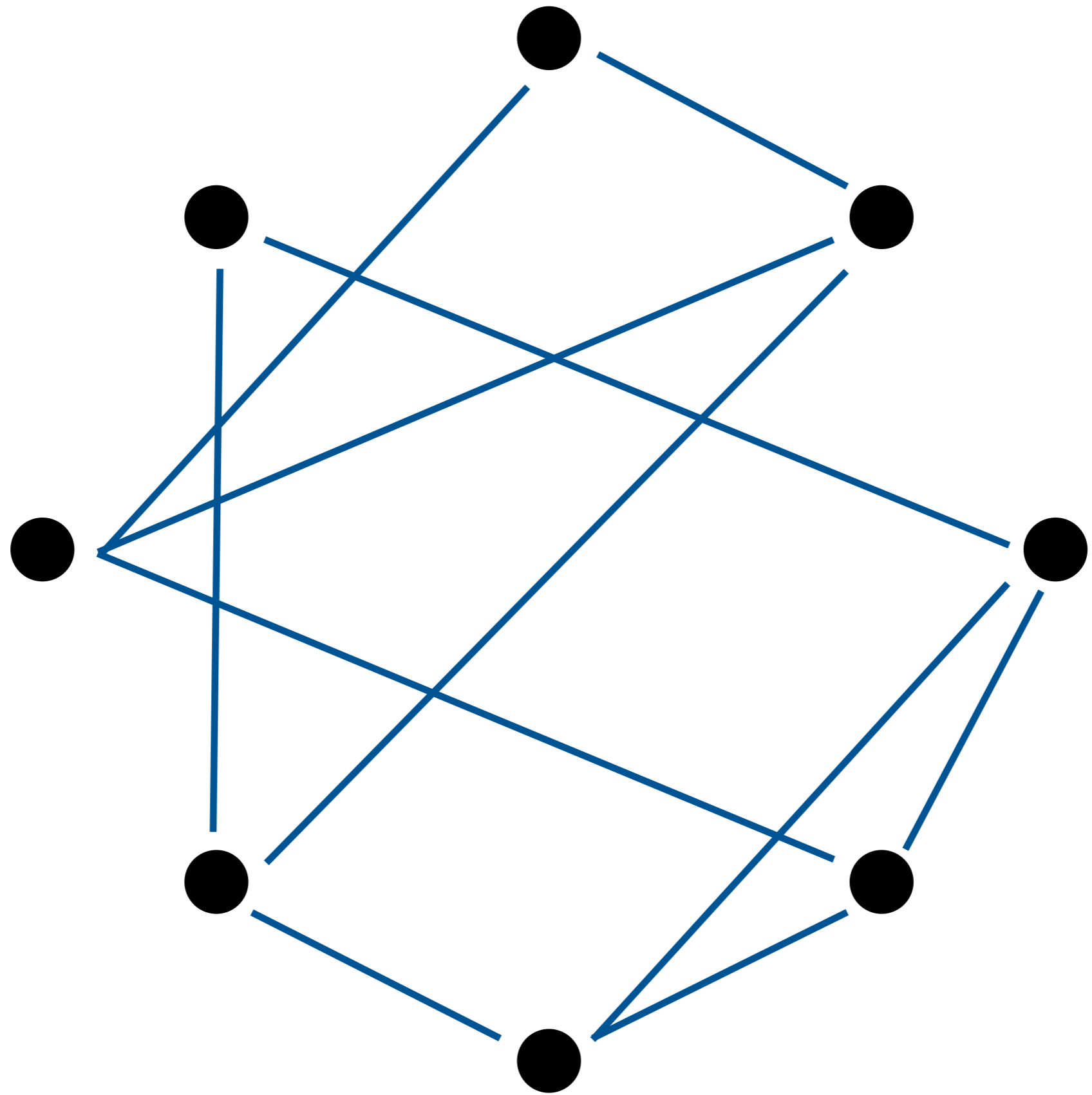
At the University of Bari, a new computing model is creating new business models. Using an IBM SmartCloud™ their team built a solution that allows local fishermen to auction their catch while still at sea. By creating more demand for the fishermen's product, the cloud has increased income by 25% while reducing time to market by 70%. Now the team is scaling the solution to create new business models for the winemaking and transportation industries. What can cloud do for your business? A smarter planet is built on smarter software, systems and services.

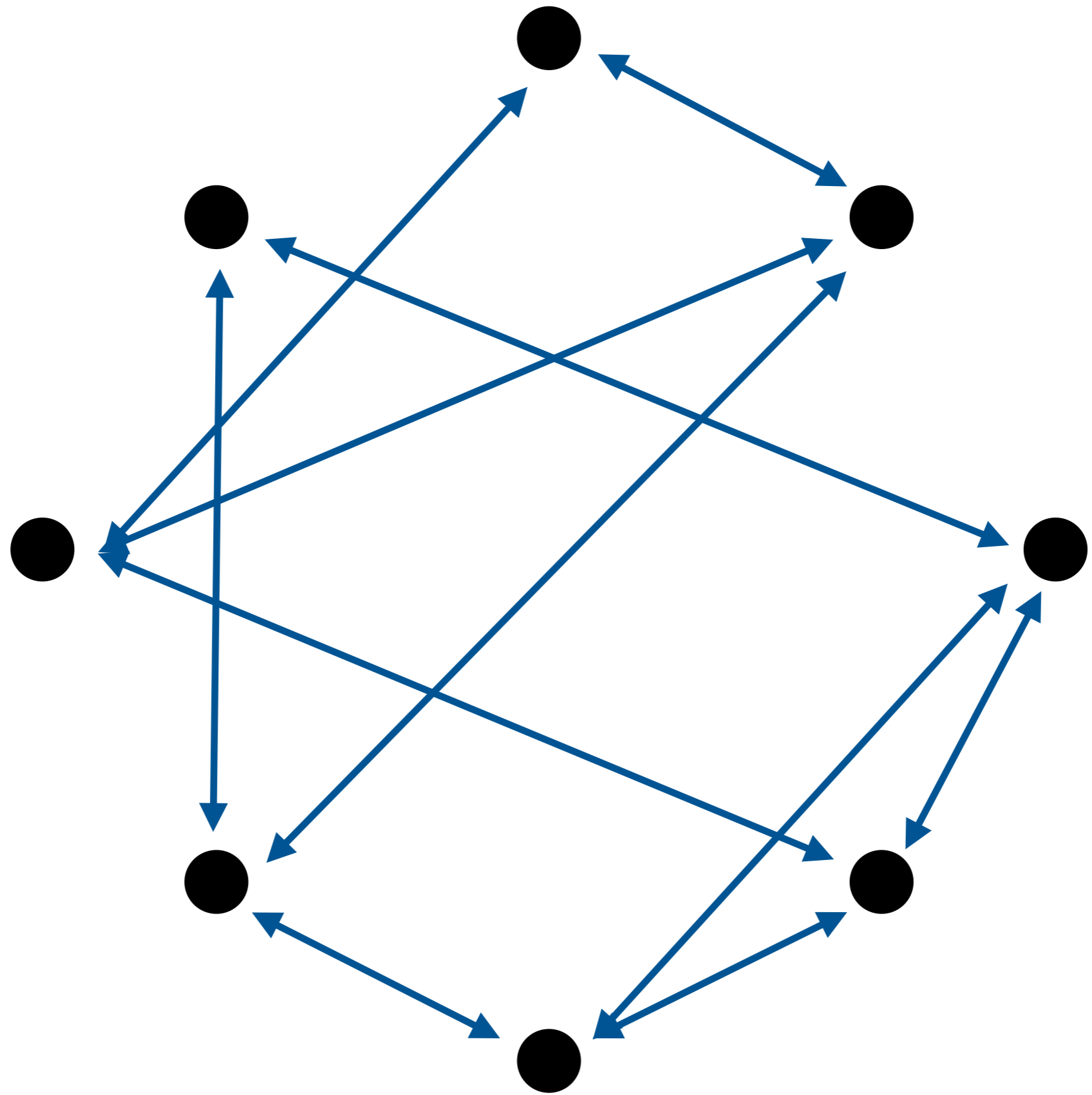
Let's build a smarter planet. ibm.com/cloudsolutions

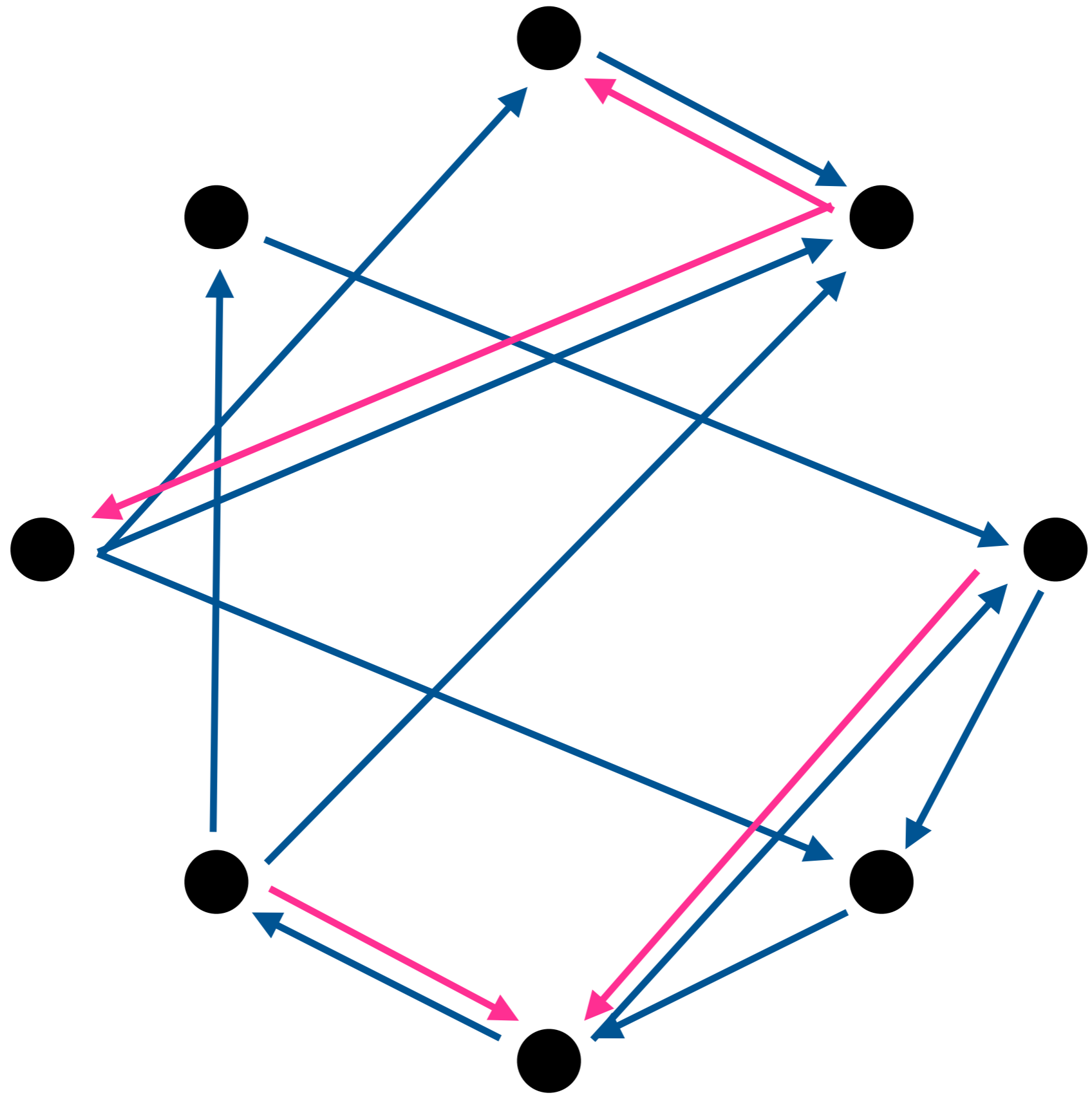


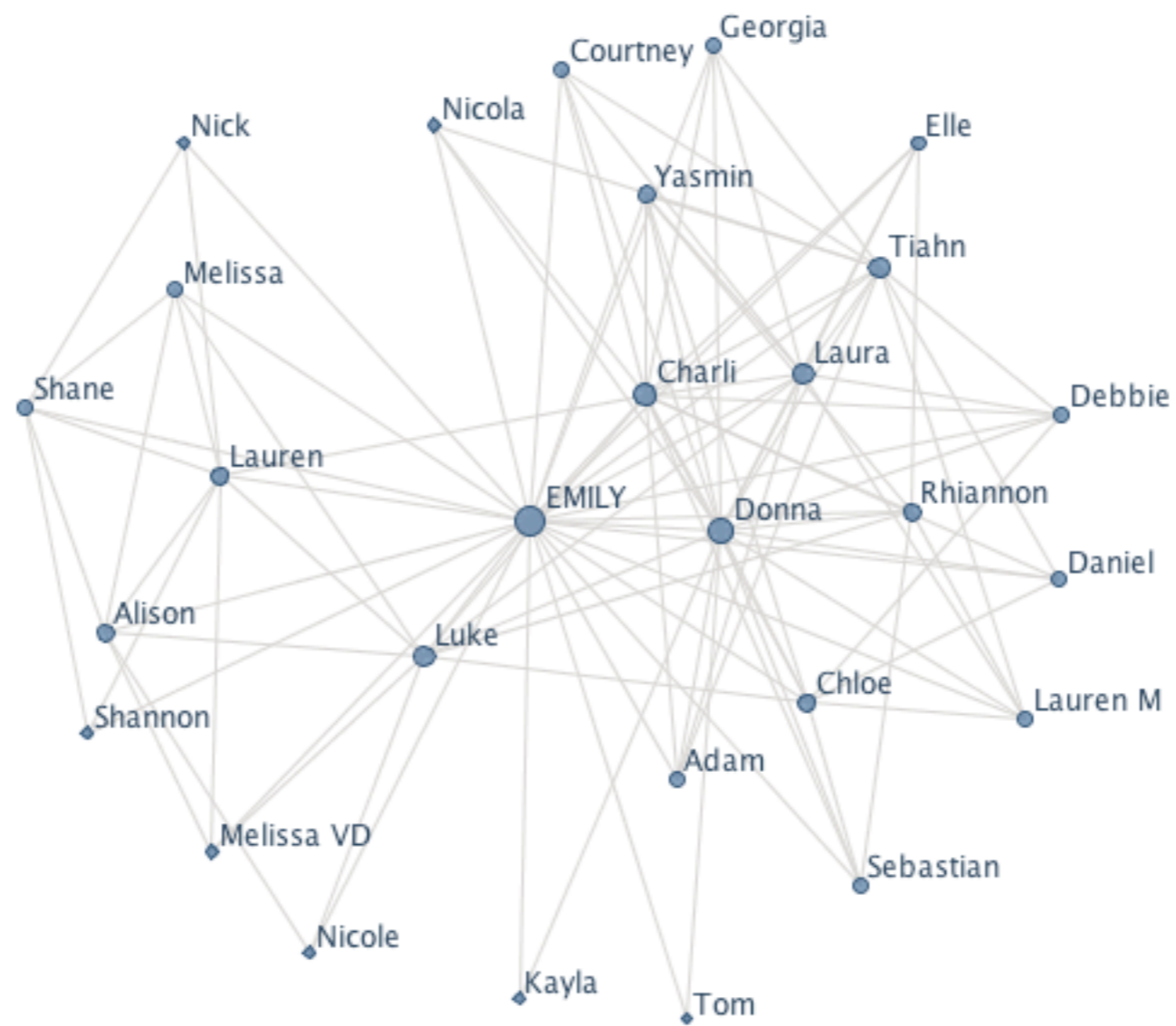
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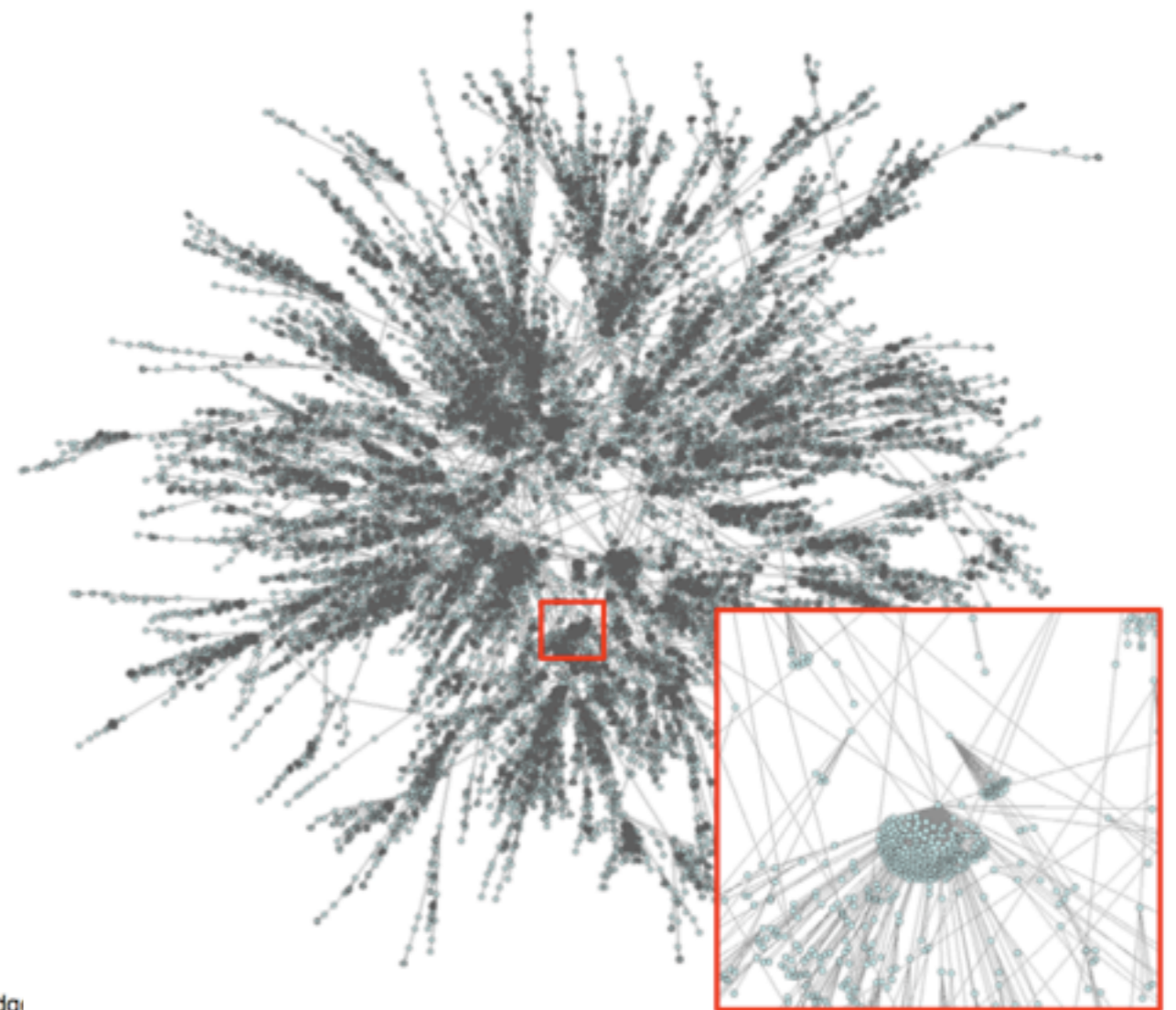
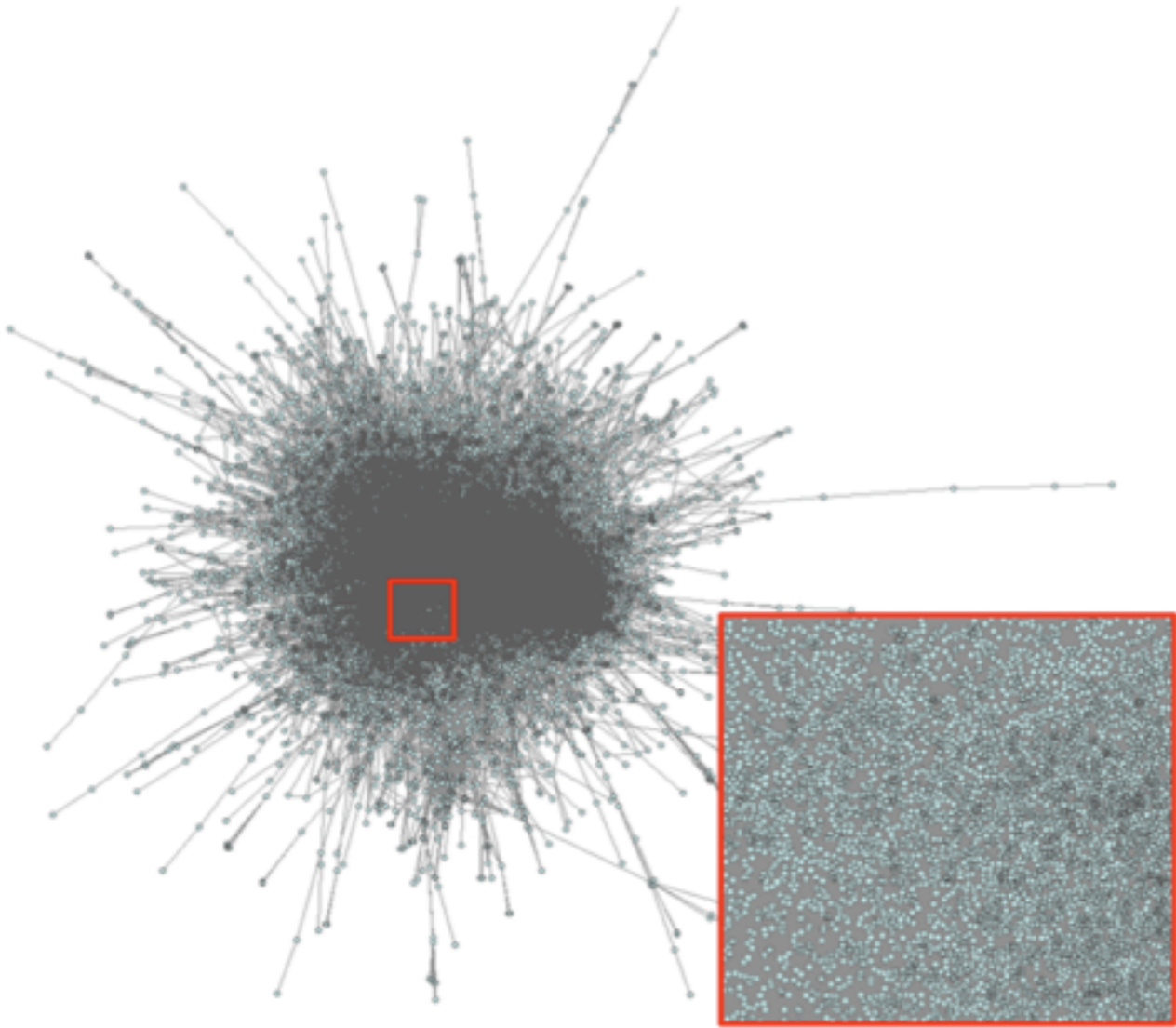




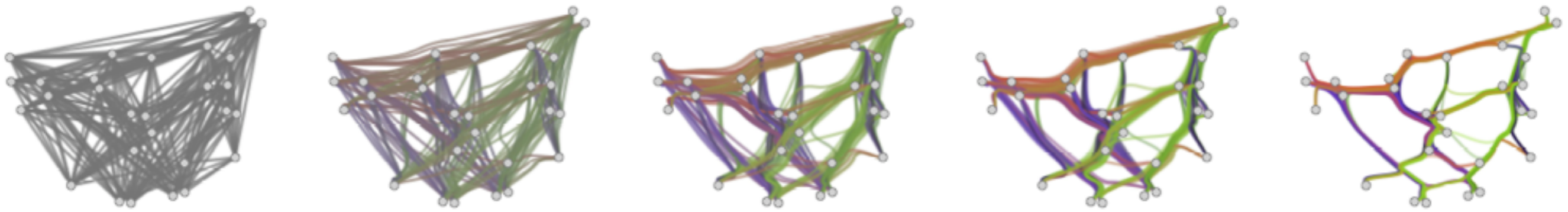


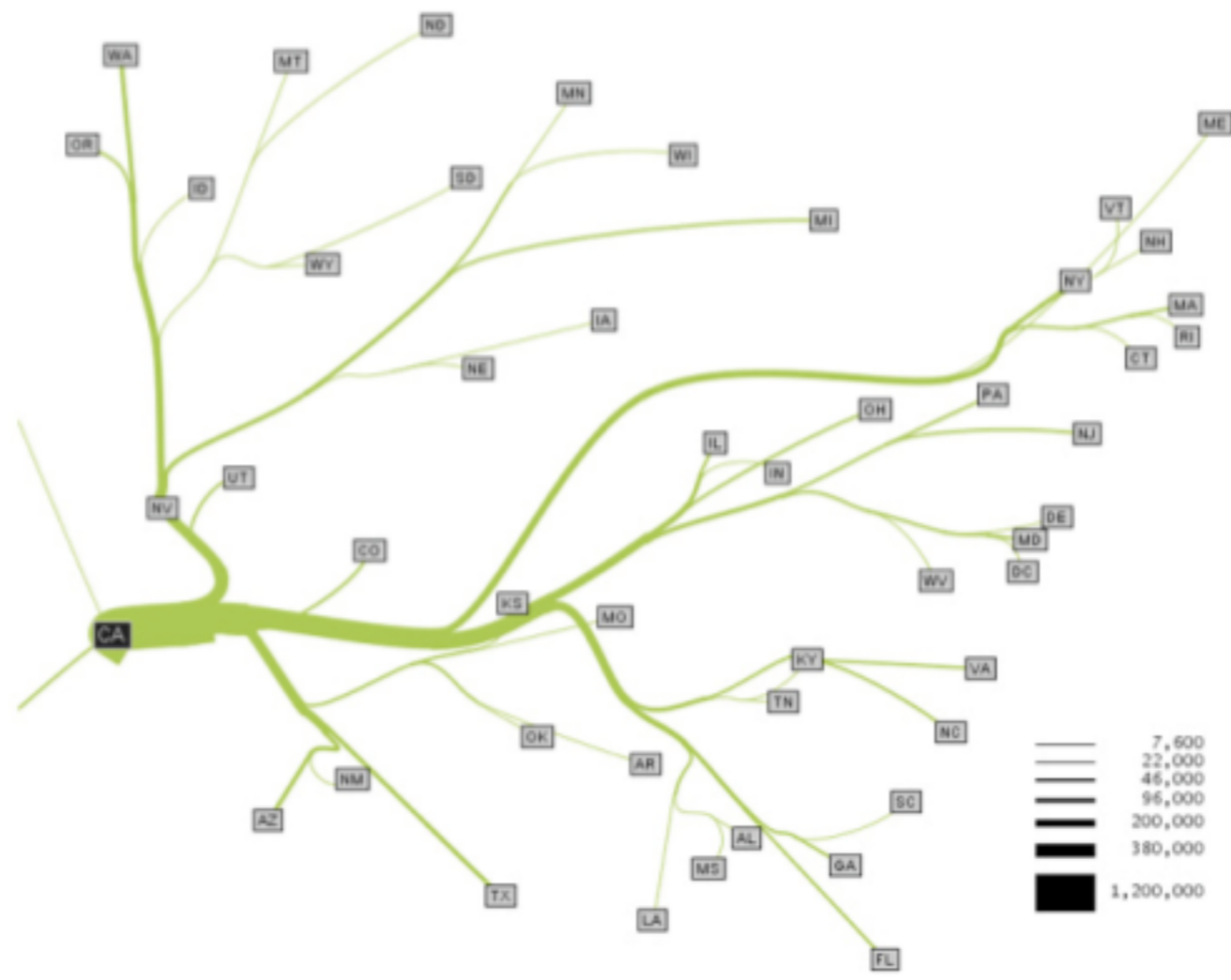


Viégas, Wattenberg, van Ham, Kriss, and McKeon, "Many Eyes: A Site for Visualization at Internet Scale"

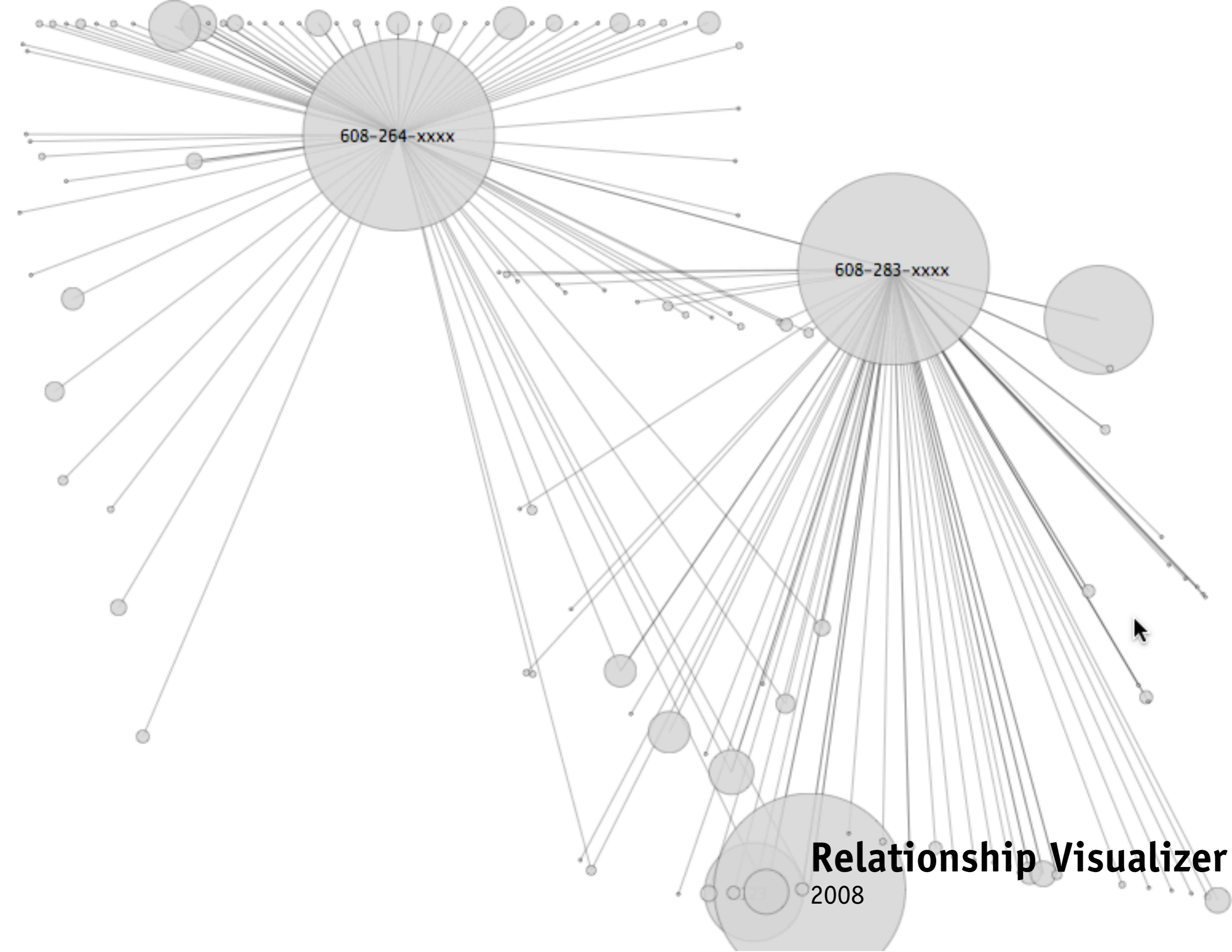


Edge





Phan, Xiao, Yeh, Hanrahan, and Winograd, "Flow Map Layout"



Relationship Visualizer
2008

Scott Murray, code artist

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January 2012

[Tutorials](#) > [D3](#) > About these tutorials

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

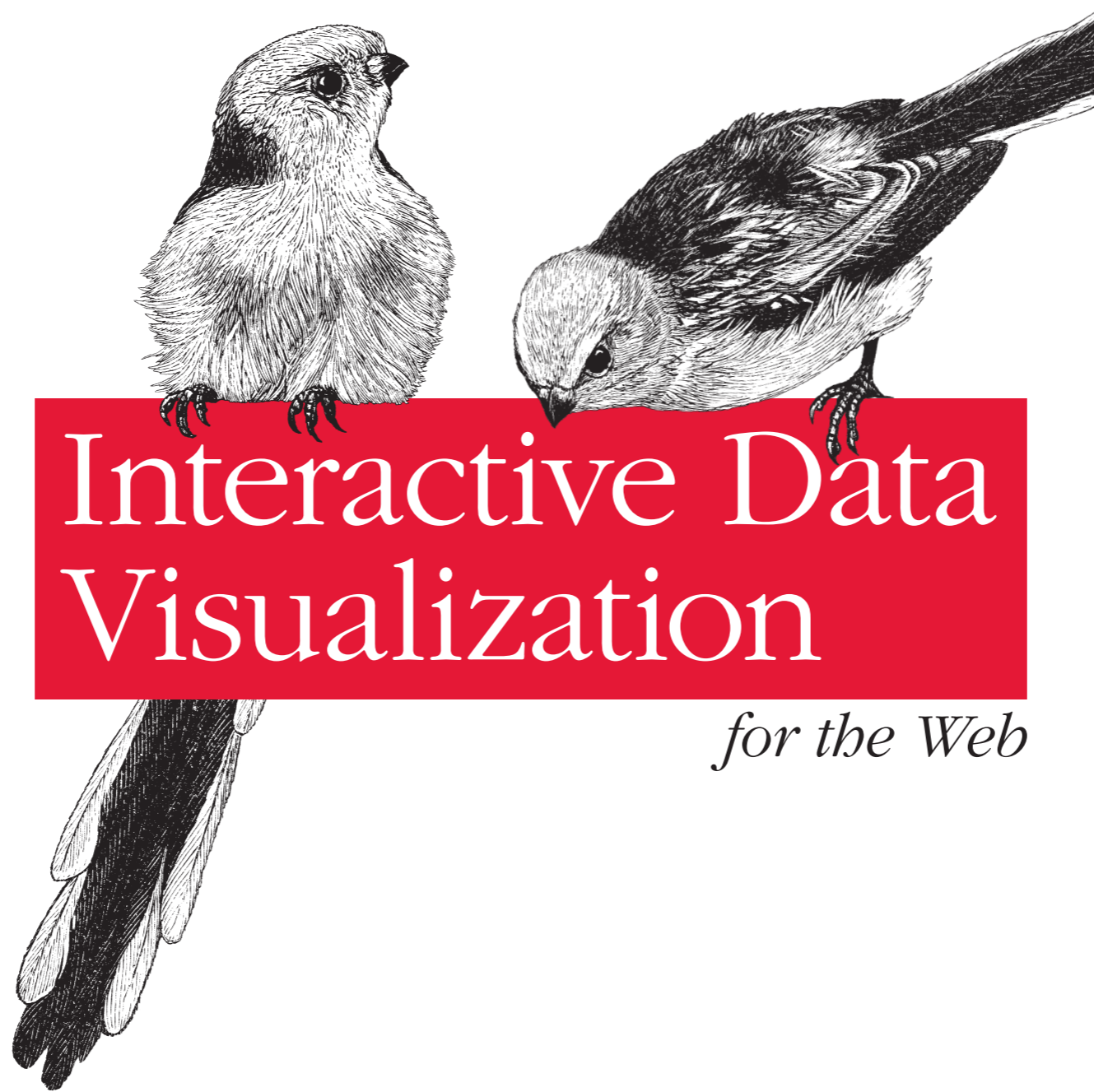
Philosophy

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

An Introduction to Designing With D3

March 2013



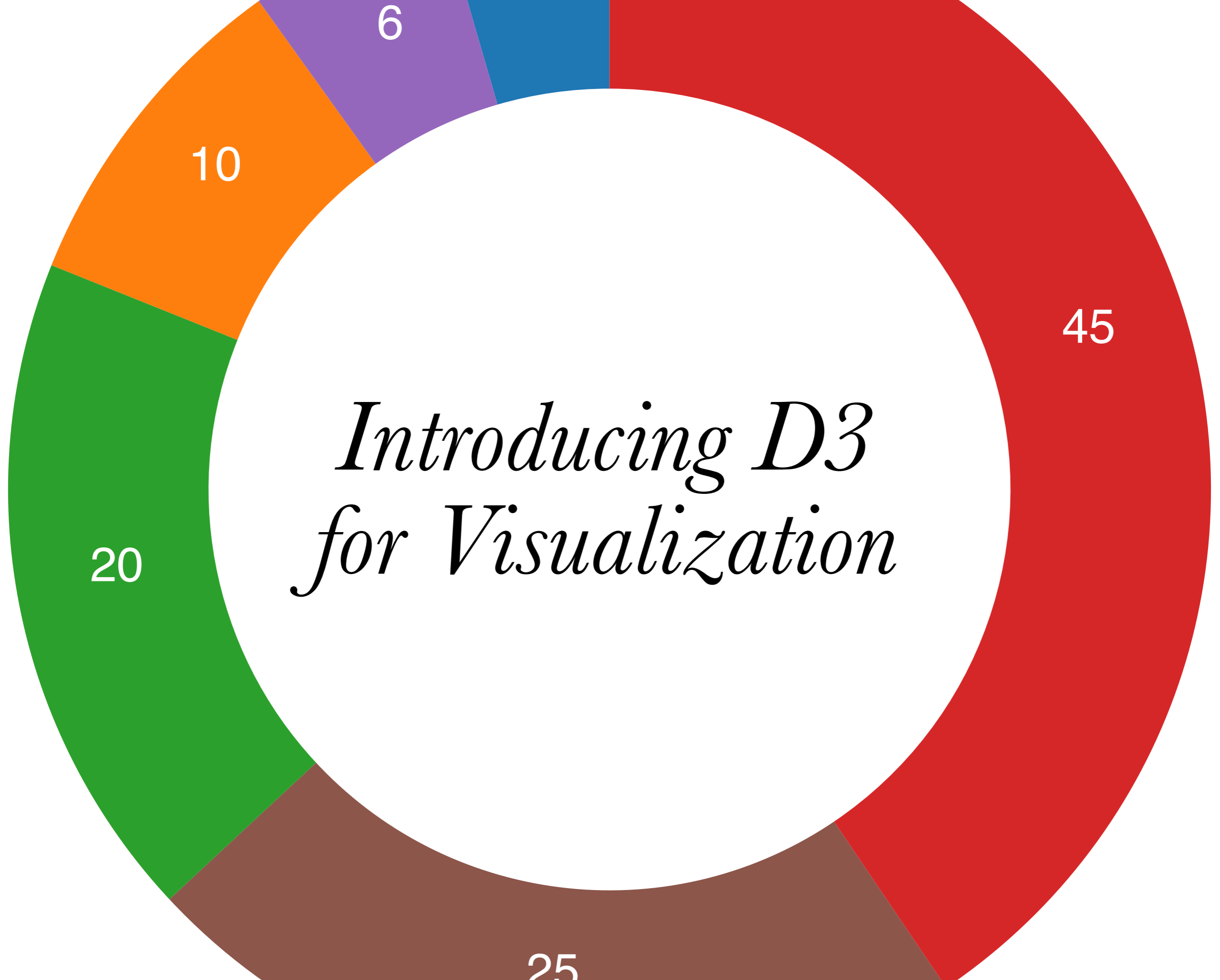
Interactive Data Visualization

for the Web

O'REILLY®

Scott Murray

*Introducing D3
for Visualization*



Assumptions

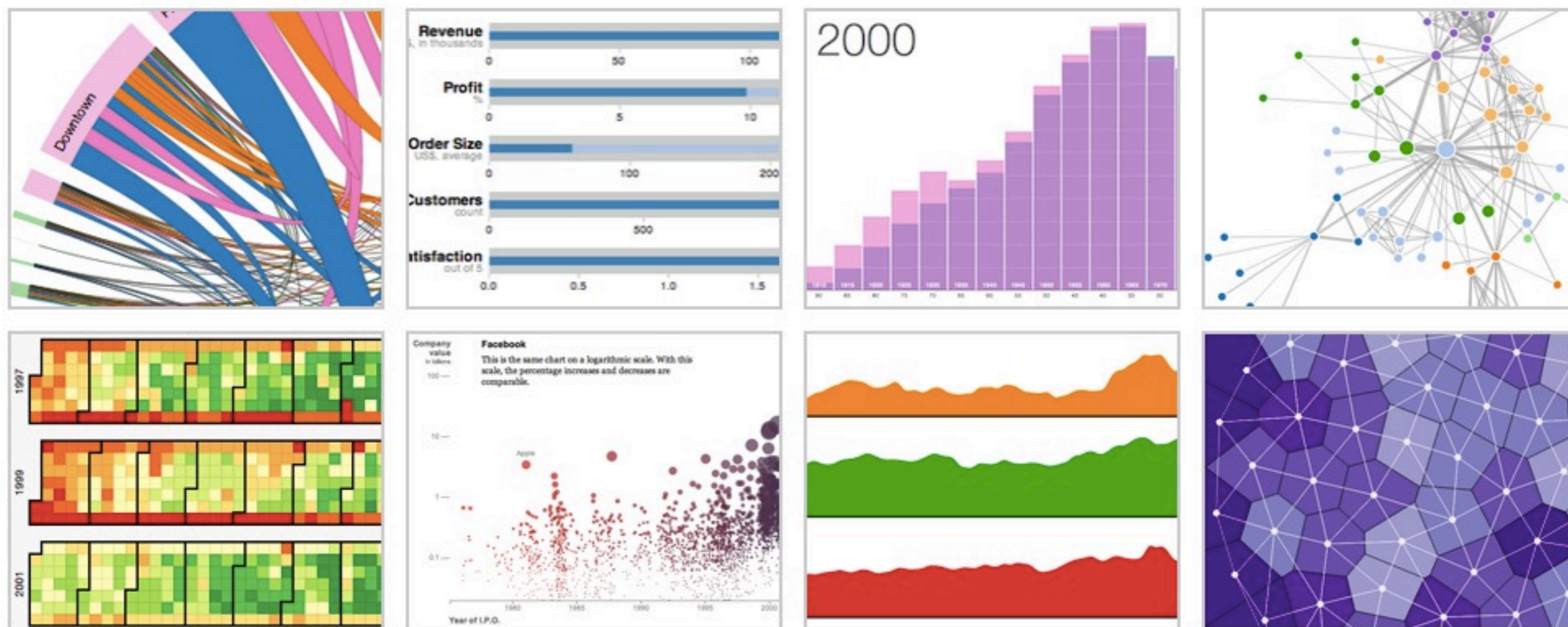
- You are somewhat familiar with HTML & CSS
- You have a little programming experience

To follow along, get sample code files from:

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

What is d3.js?

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  $\pi$  = Math.PI,  $\epsilon$  = 1e-6, d3 = {
    version: "3.0.6"
  }, d3_radians =  $\pi$  / 180, d3_degrees = 180 /  $\pi$ , 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(){return t}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(){return t}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(){return t}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).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!
```

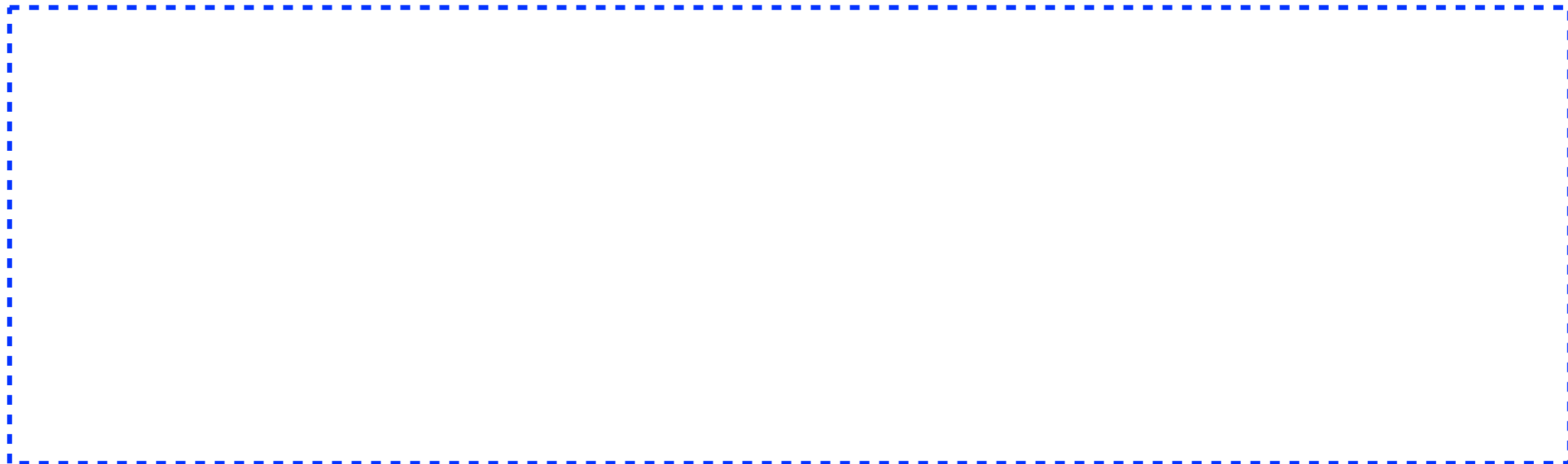
```
var dataset = [ 5, 10, 20, 15, 18 ];
```

```
// 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");
```

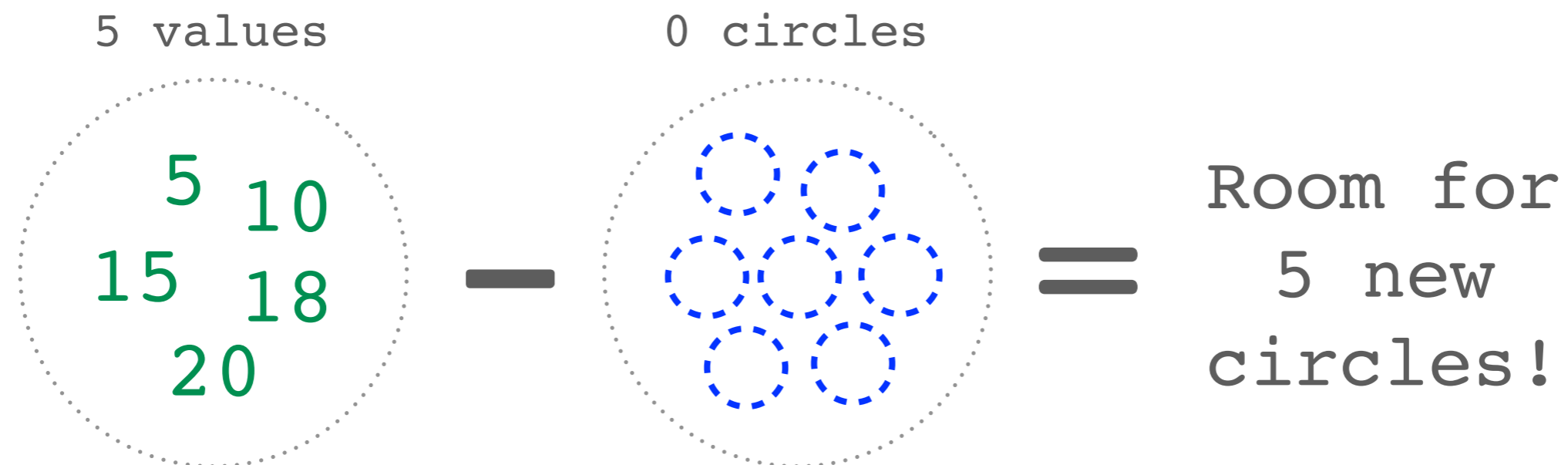
?

(empty selection)

```
// Data joins!
```

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

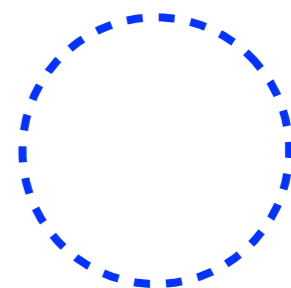
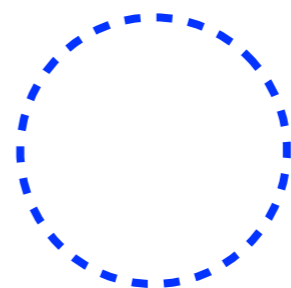
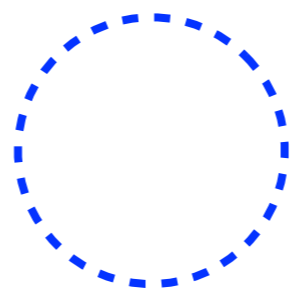
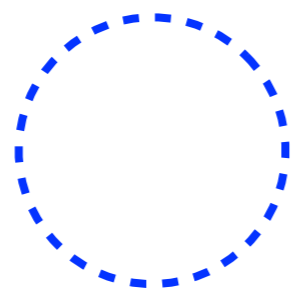
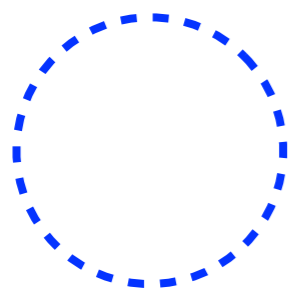
```
d3.select("svg").selectAll("circle")  
  .data(dataset)  
  .enter()  
  .append("circle");
```



```
// Data joins!
```

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

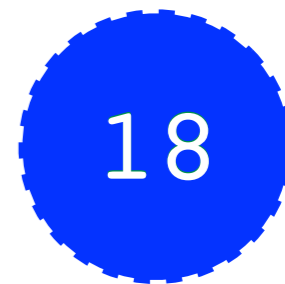
```
d3.select("svg").selectAll("circle")  
  .data(dataset)  
  .enter()  
  .append("circle");
```




```
// 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!
```

5

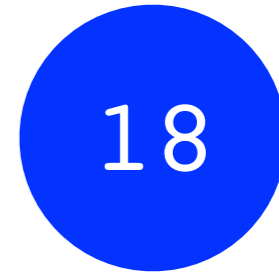
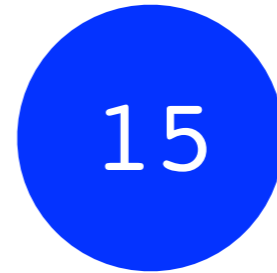
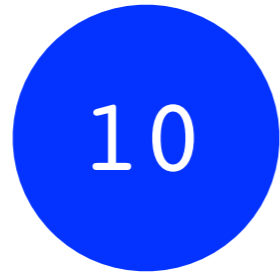
10

20

15

18

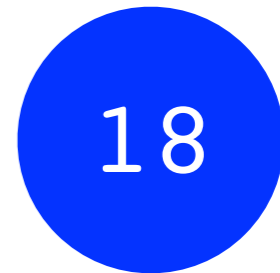
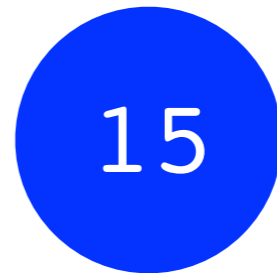
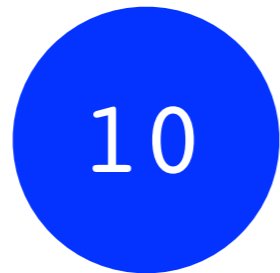
```
d3.selectAll("circle")  
  .attr("r", function(d) {  
    return d;  
  });
```



```
// Binding data to elements
```

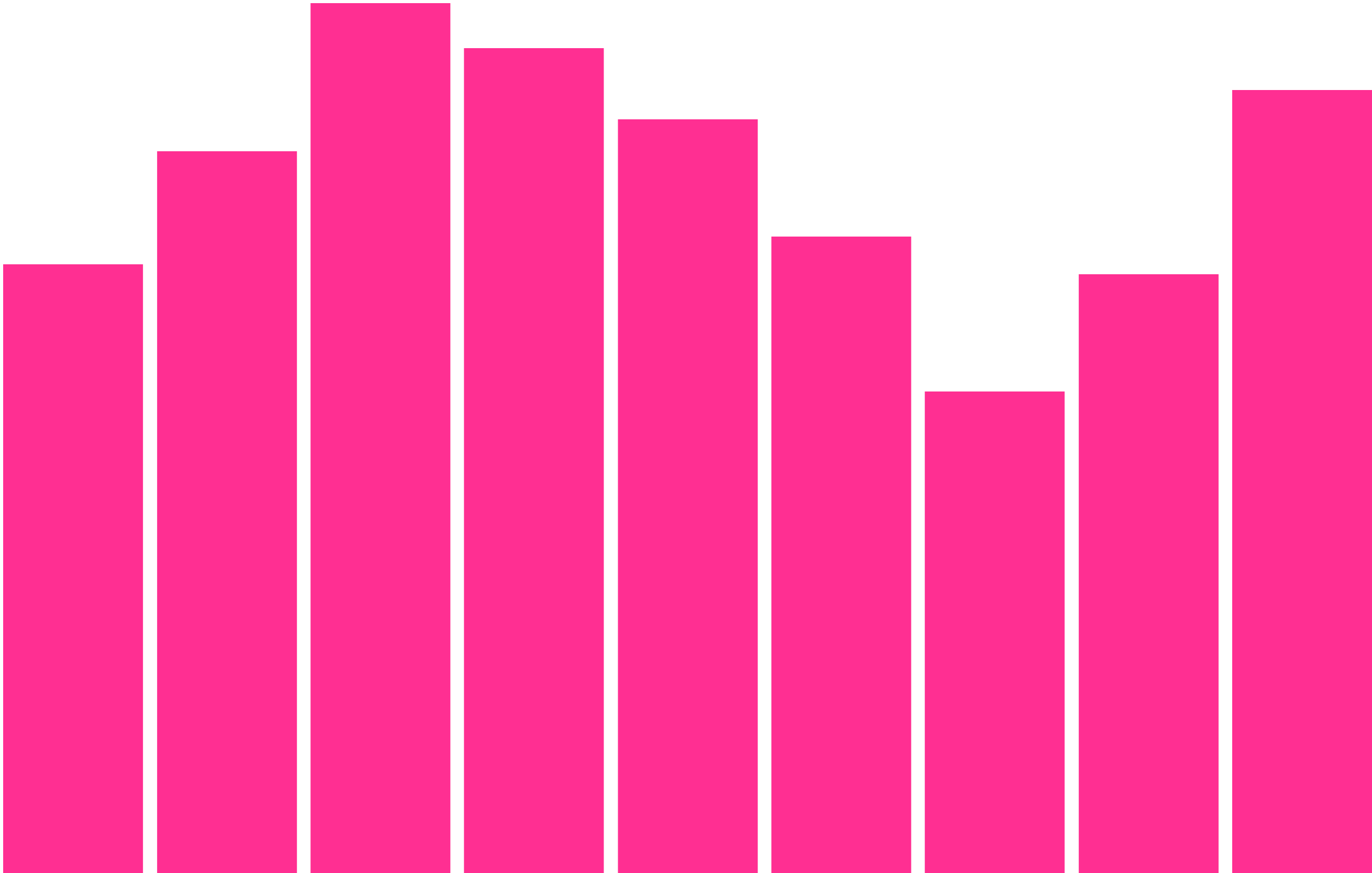
```
// 1. Lets you reference values later
```

```
// 2. Prevents need to "redraw" elements
```



Transitions

// Transitions and motion

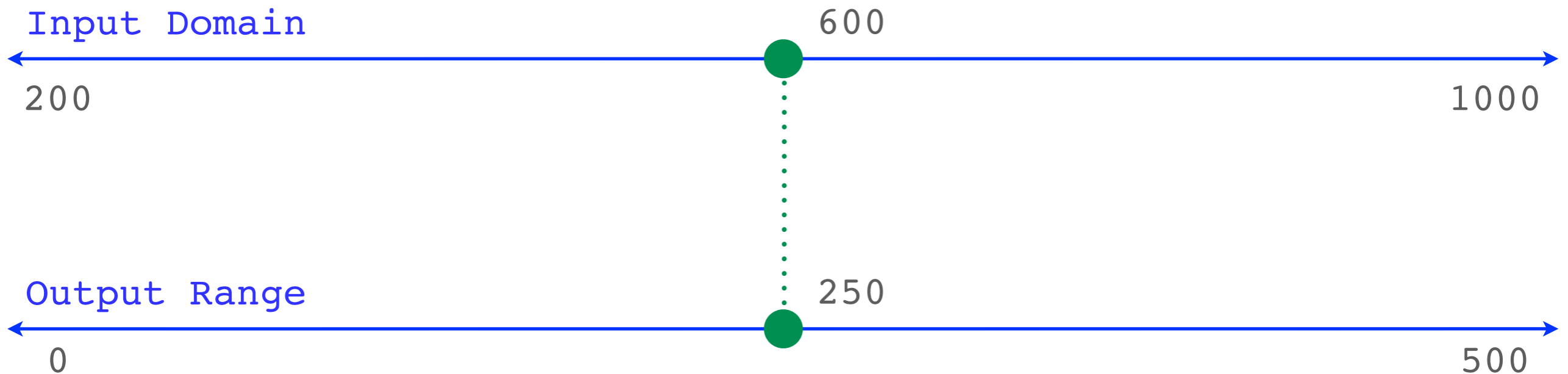


Scales


```
// Scale values
```

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

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



Axes

```
// Generate axes
```

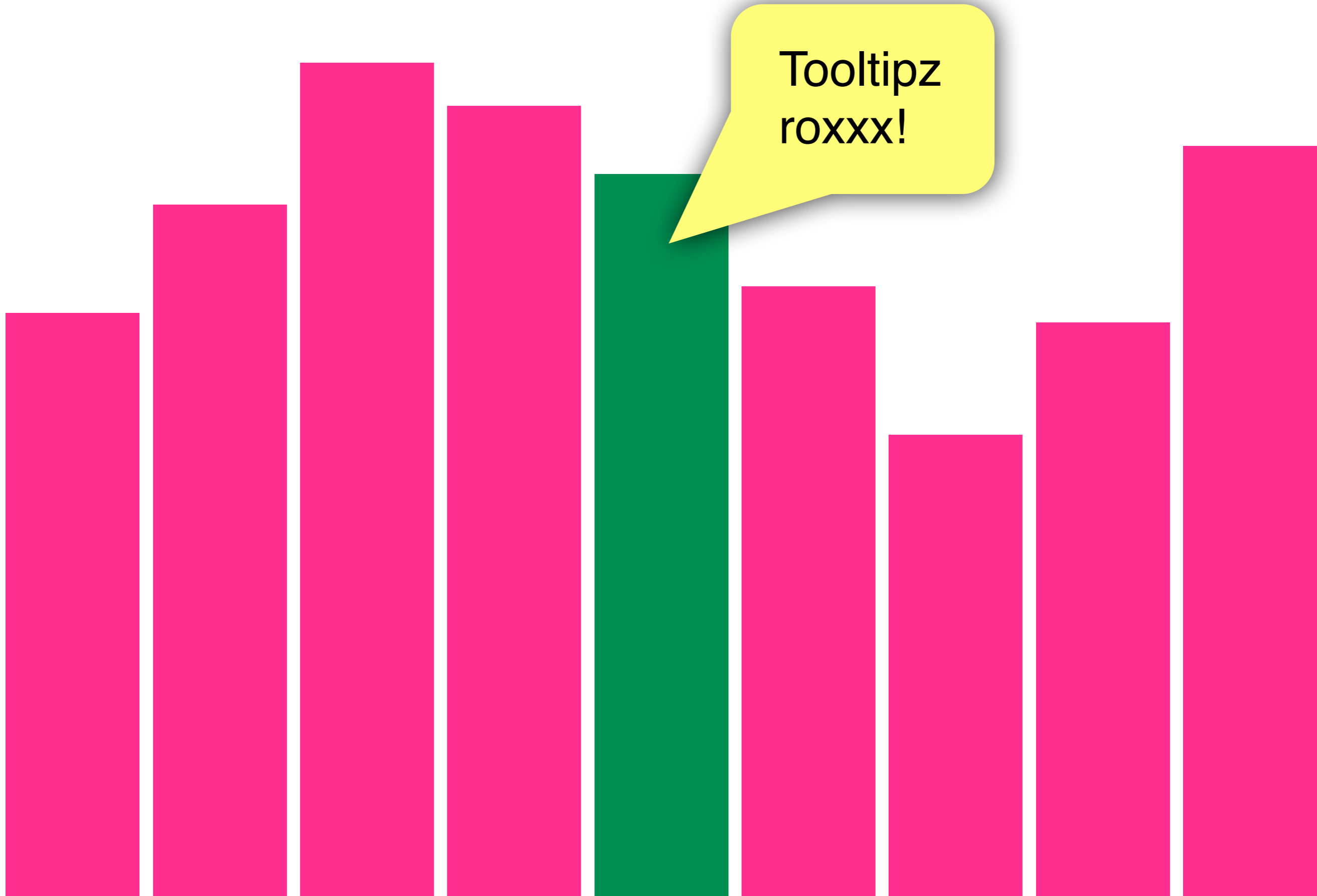
```
var axis = d3.svg.axis()  
            .scale(scale);
```

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

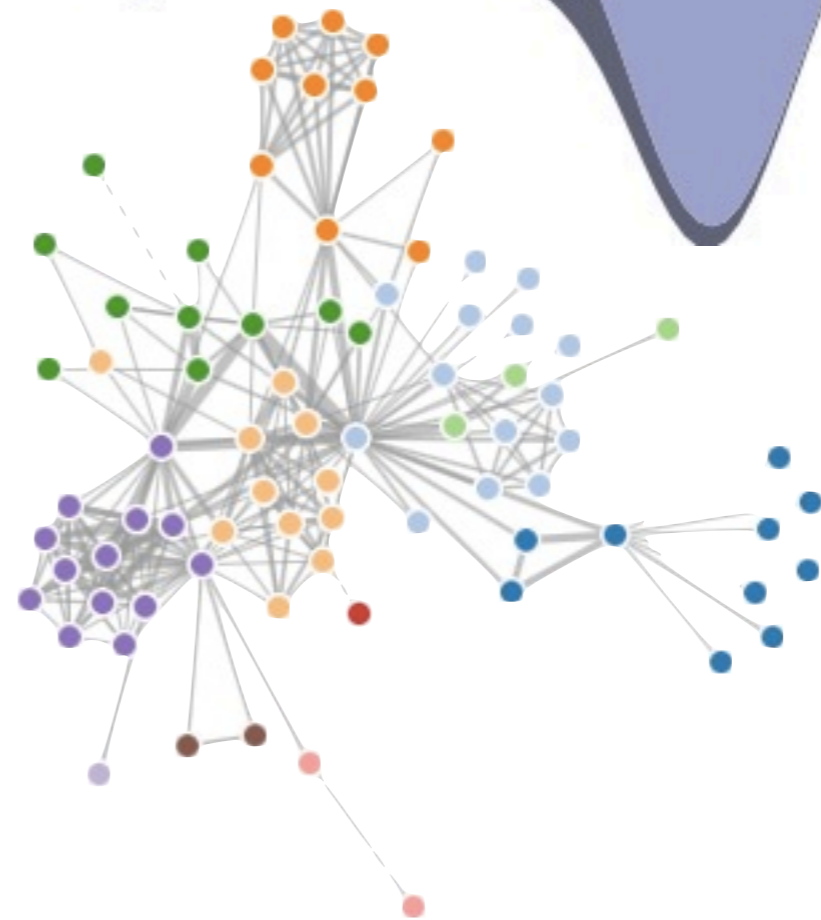
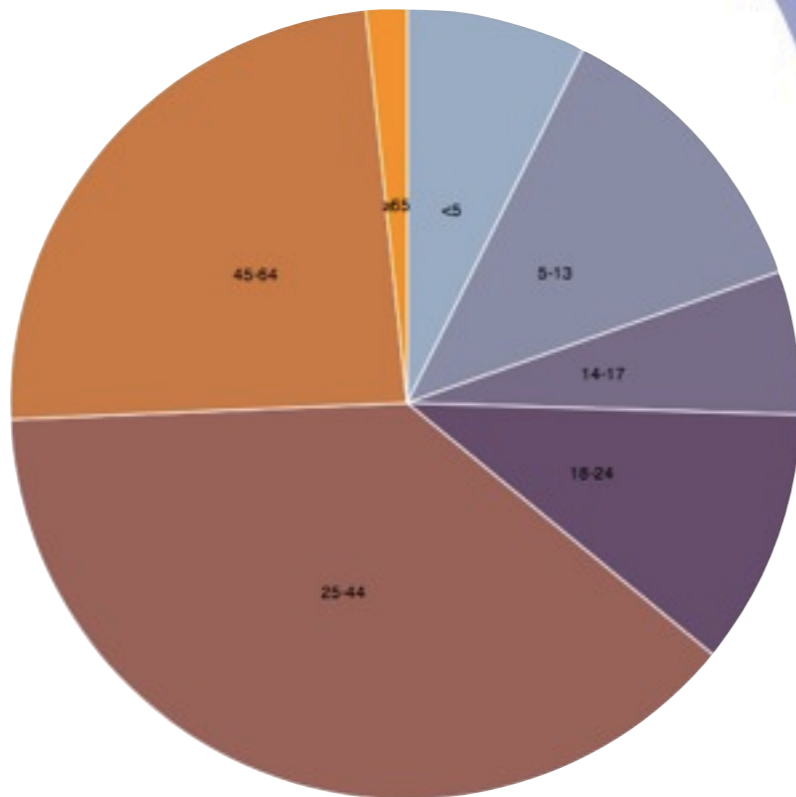
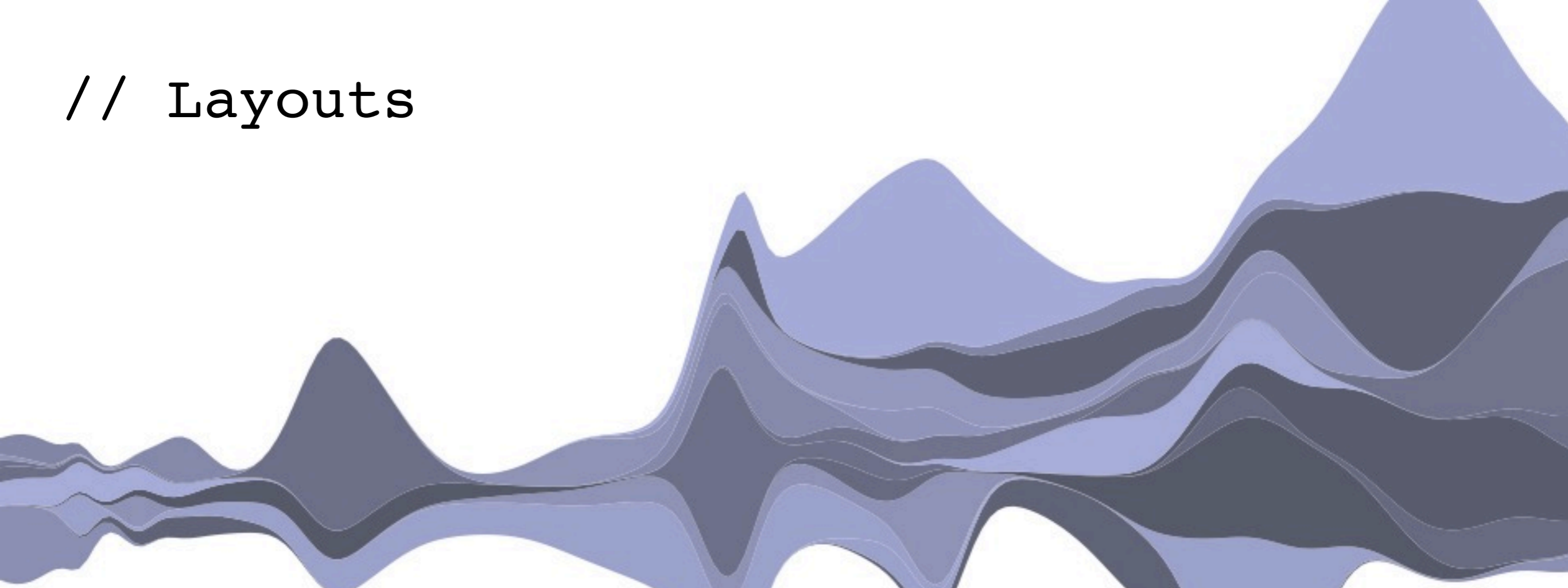


What else can D3 do for me?

// Interactivity



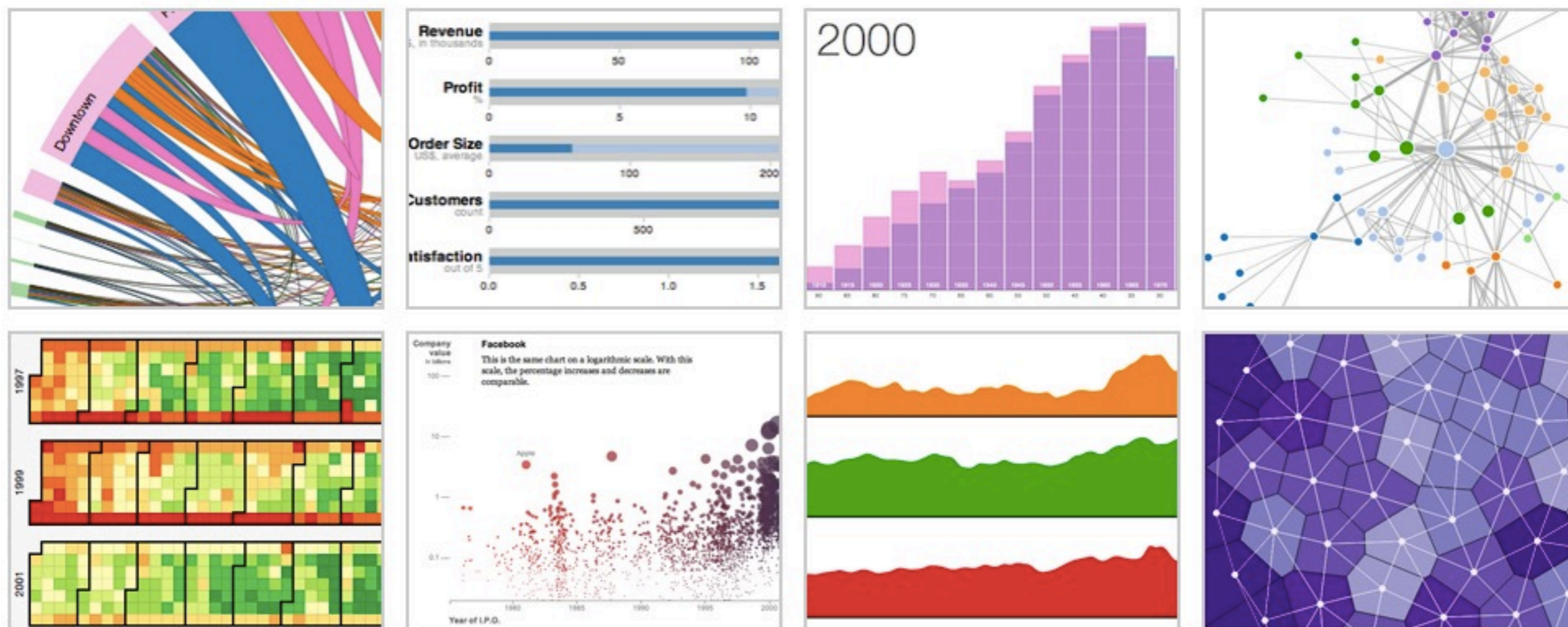
// Layouts



// More mapping and projections



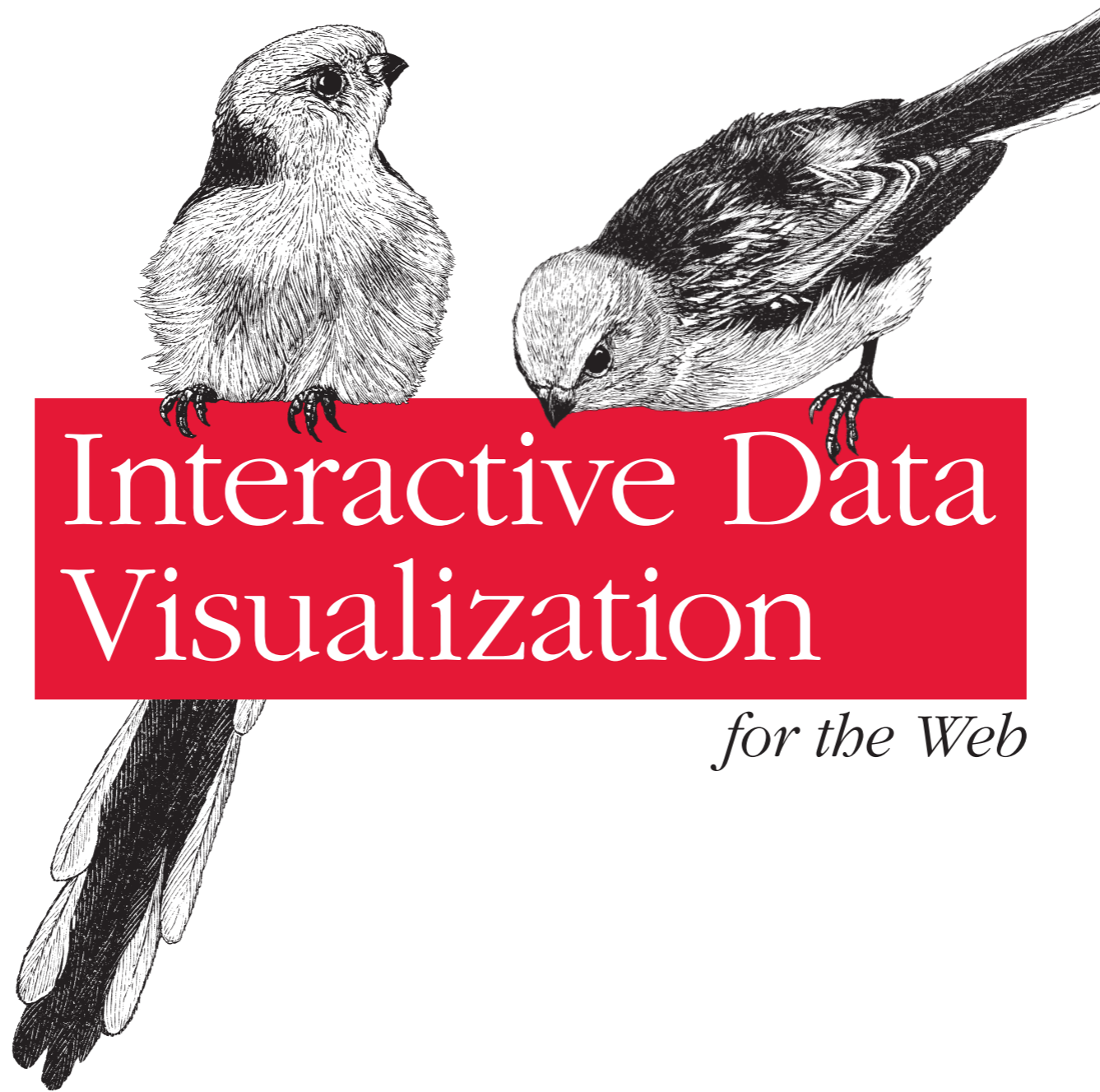
Data-Driven Documents



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](#).

An Introduction to Designing With D3



Interactive Data Visualization

for the Web

O'REILLY®

Scott Murray

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Thanks!