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Open Data:
Datenmanagement und Visualisierung
Skalen und Achsen, Programming Coaching

Termin 11, 8. Mai 2014

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11: Skalen und Achsen, Programming Coaching

Donnerstag, 8. Mai 2014

- Buch „Interactive Data Visualization for the Web“
  Kapitel: 7. Scales, 8. Axes
- Links:
  http://chimera.labs.oreilly.com/books/1230000000345/ch07.html
  http://chimera.labs.oreilly.com/books/1230000000345/ch08.html
- Skalierungen von Daten, Minimum und Maximum, Achsen zeichnen

Programming Coaching im zweiten Teil der Vorlesung:

- **Khôi Tran, Open Data App Entwickler**

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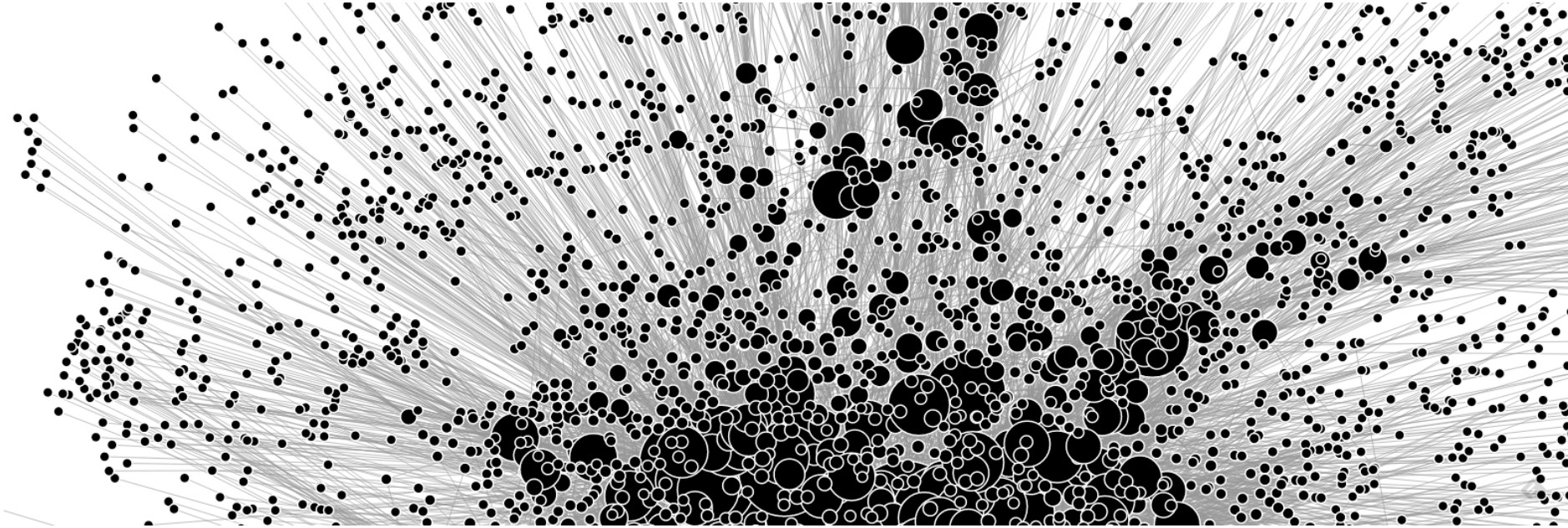
Agenda

1. **Infos zur Open Data App**
2. Skalen
3. Achsen



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Infos zur Open Data App

> Kurzpräsentation in der Vorlesung vom **Donnerstag, 22. Mai 2014** ist **Voraussetzung für Anrechnung und Note. Mindestens eine Person muss anwesend** sein. App zählt 50% der Note, Prüfung zählt 50% der Note.

> **Minimalanforderungen an die App (für Note "genügend"):**

1. Neue Daten aufbereiten und visualisieren (Data Coach, Datenportal, eigene Daten)
2. Mindestens eine kreative Visualisierung, nicht bloss Balken oder Kuchendiagramm
3. Mindestens eine interaktive Funktion (Hover, Mouse Click, Scroll Wheel, Button etc.)
4. Aufwand von rund 40 bis 50 Stunden pro Person muss erkennbar sein

> **Bewertungskriterien:**

1. **Komplexität:** Wie anspruchsvoll sind die visualisierten Daten und der behandelte Themenkomplex als ganzes?
2. **Kreativität:** Wie neuartig und attraktiv sind die Visualisierung der Daten und technische Implementierung der Open Data App?
3. **Umsetzung:** Wie benutzerfreundlich, verständlich und gut dokumentiert ist die Open Data App?
4. **Impact:** Wie hoch ist die Bedeutung und die Aussagekraft der Datenvisualisierung und der Open Data App als gesamtes?

Vorgehen Präsentationen Open Data App

- **Folien** zu den 5 Punkten:
  1. Team (wer, welchen Hintergrund)
  2. Ziel, Motivation (Aufgabestellung)
  3. Resultat (mit öffentlich zugänglichem Link)
  4. Datenquellen (Ursprungsformat, Endformat)
  5. Vorgehen (notwendige Schritte)
- Kurze **Live App-Demo**
- Zeitvorgabe: maximal 4 Minuten! (je nach Anzahl Apps mehr)
- Anmeldung für Kurzpräsentation:
  Mail an Rahel Winkelmann rahel.winkelmann@iwi.unibe.ch
  bis 20. Mai 2014 mit den Folien als PowerPoint oder PDF

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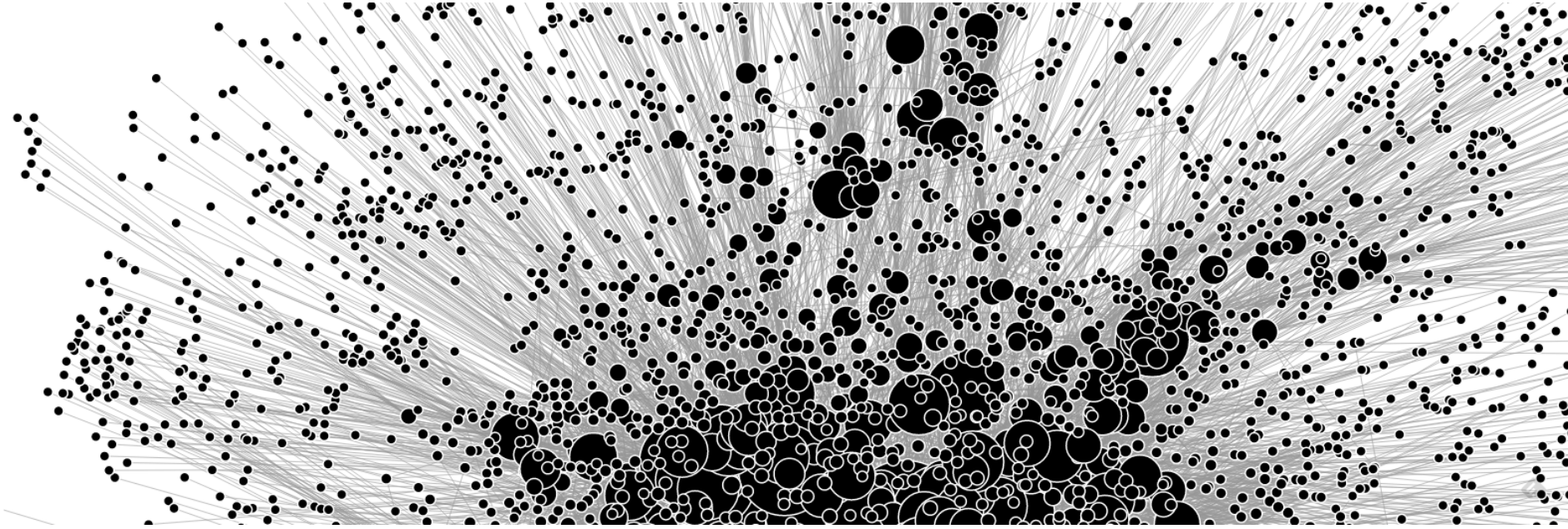
Agenda

1. Infos zur Open Data App
2. **Skalen**
3. Achsen



Skalen vs. Achsen

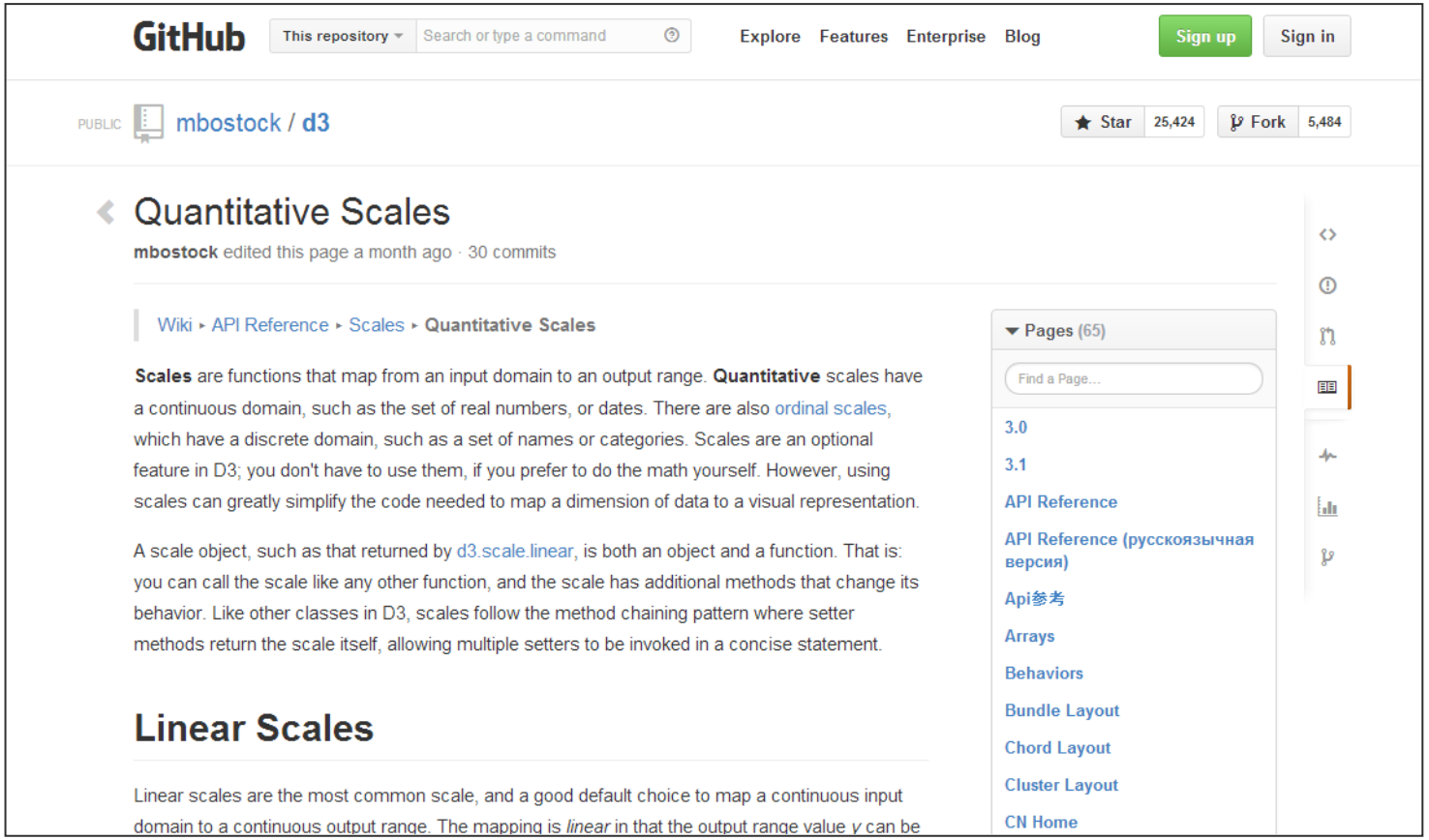
Scales

- **`scale()`** function: pass it a data value, it returns a scaled output value
- Scales are functions that map from an input domain to an output range.
- A scale is a mathematical relationship, with no direct visual output.
- Linear, ordinal, logarithmic, square root scales
- Used with domains and ranges

Axes

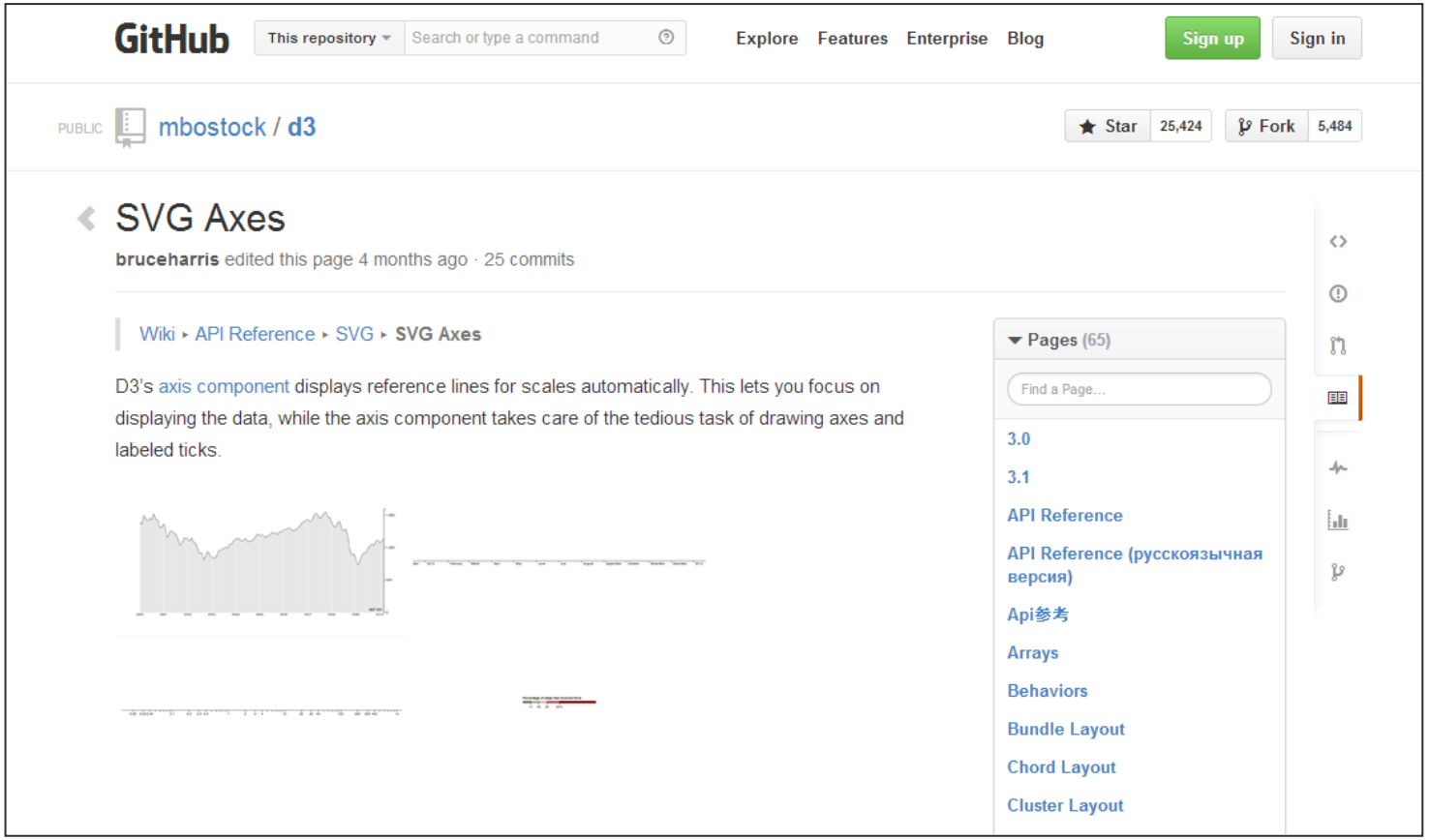
- **`axis()`** function: they generate SVG elements
- Axes don't return a value, but generate the visual elements of the axis, including lines, labels, and ticks.
- Linear, ordinal, logarithmic, square root Axes
- Each axis needs to be told on what *scale* to operate

API Reference of Scales



Link: https://github.com/mbostock/d3/wiki/Quantitative-Scales

API Reference of Axes



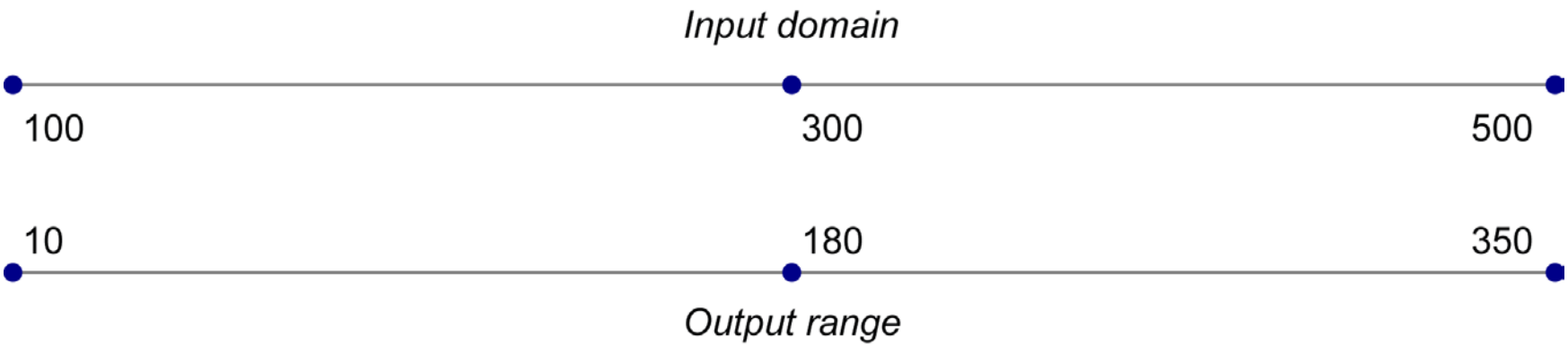
Link: https://github.com/mbostock/d3/wiki/SVG-Axes

Domains and Ranges

- A scale's *input domain* is the domain of possible input data values.
- A scale's *output range* is the range of possible output values, pixels.

Example:

A scale with *input domain* of [100,500] and *output range* of [10,350]:



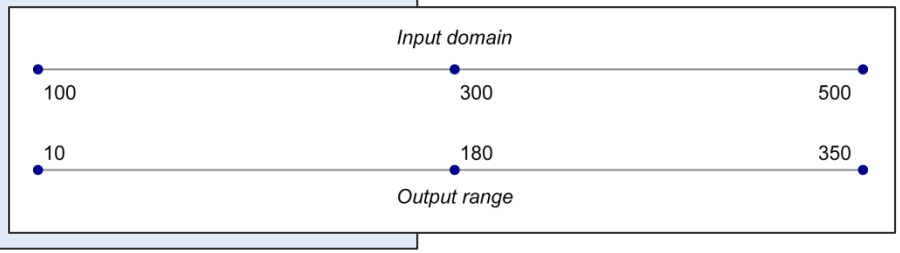
Creating a Scale

Einer Variable eine Skala zuweisen:

```
var scale = d3.scale.linear()
                    .domain([100, 500])
                    .range([10, 350]);
```

Folgende Werte können in der Konsole generiert werden:

```
scale(100); //Returns 10
scale(300); //Returns 180
scale(500); //Returns 350
```



d3.max()

Den Maximal-Wert bestimmen:

```
var simpleDataset = [7, 8, 4, 5, 2];
d3.max(simpleDataset);  // Returns 8
```

Maximal-Wert eines zweidimensionalen Arrays (array of arrays):

```
var dataset = [[5, 20],[480, 90],[250, 50],[100, 33],
               [330, 95],[410, 12],[475, 44],[25, 67],
               [85, 21], [220, 88]];
d3.max(dataset, function(d) {
      return d[0];  //Returns 480
});
```

Setting Up Dynamic Scales

Die x-Skala definieren:

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

- **`xScale`** ist der Name der Skala
- Domain und Range sind in zwei eckigen Klammern definiert
- Input Domain beginnt bei 0 (könnte auch **`min()`** verwendet werden)
- Input Domain endet bei höchsten Wert: **`max(dataset)`**
- Output Range liegt zwischen 0 und w (width) der SVG-Fläche

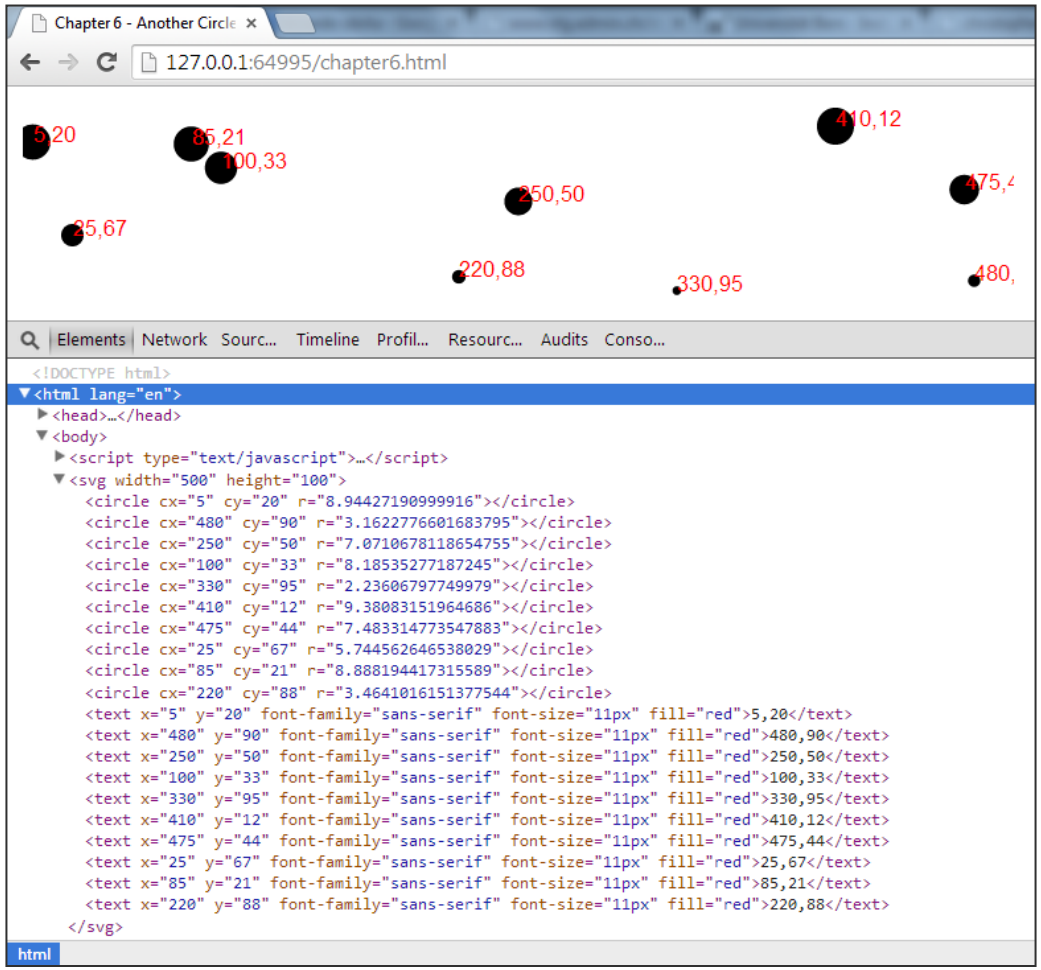
Setting Up Dynamic Scales

Die y-Skala definieren:

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

D3.js Scatterplot (Chapter 6)

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="utf-8">
        <title>Chapter 6 - Another Circles Example</title>
        <script type="text/javascript" src="/js/vendor/d3.min.js"></script>
    </head>
    <body>
        <script type="text/javascript">

            var w = 500;
            var h = 100;
            var dataset = [
                          [5, 20], [480, 90], [250, 50], [100, 33], [330, 95],
                          [410, 12], [475, 44], [25, 67], [85, 21], [220, 88]
                        ];

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

            svg.selectAll("circle")
               .data(dataset)
               .enter()
               .append("circle")
               .attr("cx", function(d) {
                        return d[0];
               })
               .attr("cy", function(d) {
                        return d[1];
               })
               .attr("r", function(d) {
                        return Math.sqrt(h - d[1]);
               });

            svg.selectAll("text")
               .data(dataset)
               .enter()
               .append("text")
               .text(function(d) {
                        return d[0] + "," + d[1];
               })
               .attr("x", function(d) {
                        return d[0];
               })
               .attr("y", function(d) {
                        return d[1];
               })
               .attr("font-family", "sans-serif")
               .attr("font-size", "11px")
               .attr("fill", "red");

        </script>
    </body>
</html>
```



Incorporating Scaled Values

Positionierung **ohne Skala:**

```
.attr("cx", function(d) {
    return d[0];
})
.attr("cy", function(d) {
    return d[1];
})
```

Positionierung **mit Skala:**

```
.attr("cx", function(d) {
    return xScale(d[0]);
})
.attr("cy", function(d) {
    return yScale(d[1]);
})
```

Incorporating Scaled Values

Text-Label
ohne Skala:

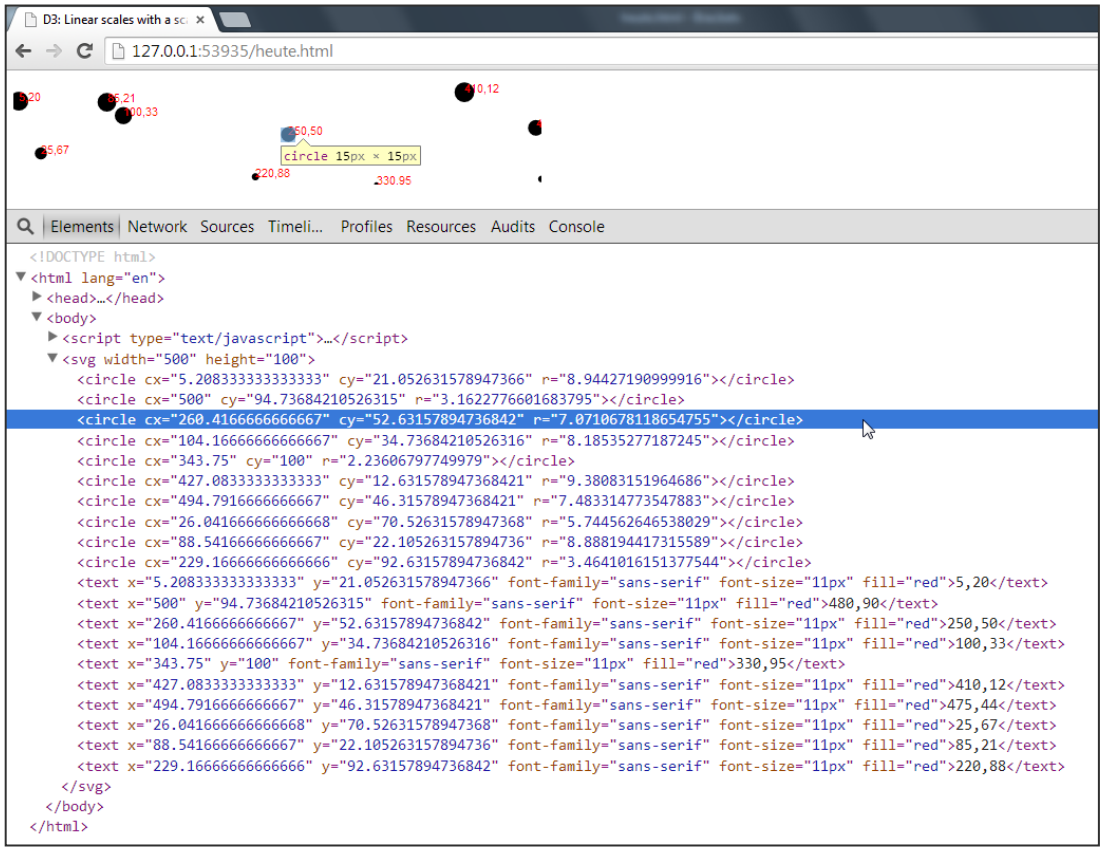
```
.attr("x", function(d) {
    return d[0];
})
.attr("y", function(d) {
    return d[1];
})
```

Text-Label
mit Skala:

```
.attr("x", function(d) {
    return xScale(d[0]);
})
.attr("y", function(d) {
    return yScale(d[1]);
})
```

D3.js Scatterplot mit dynamischer Skala


```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="utf-8">
        <title>D3: Linear scales with a scatterplot</title>
        <script type="text/javascript" src="/js/vendor/d3.min.js"></script>
        <style type="text/css">
            /* No style rules here yet */
        </style>
    </head>
    <body>
        <script type="text/javascript">

            //Width and height
            var w = 500;
            var h = 100;

            var dataset = [
                            [5, 20], [480, 90], [250, 50], [100, 33], [330, 95],
                            [410, 12], [475, 44], [25, 67], [85, 21], [220, 88]
                          ];

            //Create scale functions
            var xScale = d3.scale.linear()
                                 .domain([0, d3.max(dataset, function(d) { return d[0]; })])
                                 .range([0, w]);

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

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

            svg.selectAll("circle")
               .data(dataset)
               .enter()
               .append("circle")
               .attr("cx", function(d) {
                        return xScale(d[0]);
               })
               .attr("cy", function(d) {
                        return yScale(d[1]);
               })
               .attr("r", function(d) {
                        return Math.sqrt(h - d[1]);
               });

            svg.selectAll("text")
               .data(dataset)
               .enter()
               .append("text")
               .text(function(d) {
                        return d[0] + "," + d[1];
               })
               .attr("x", function(d) {
                        return xScale(d[0]);
               })
               .attr("y", function(d) {
                        return yScale(d[1]);
               })
               .attr("font-family", "sans-serif")
               .attr("font-size", "11px")
               .attr("fill", "red");

        </script>
    </body>
</html>
```

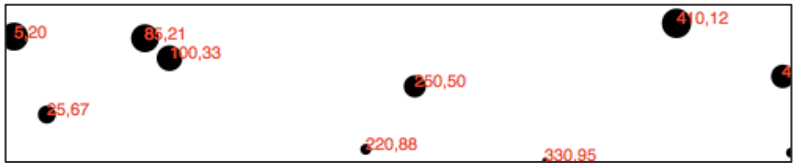


Refining the Plot

Smaller y values are at the top of the plot, and the larger y values are toward the bottom.

Original:

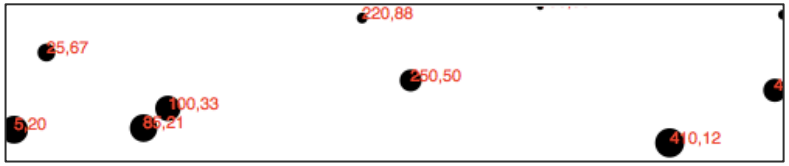
```
.range([0, h]);
```



Reverse that, so greater values are higher up.

Reversed:

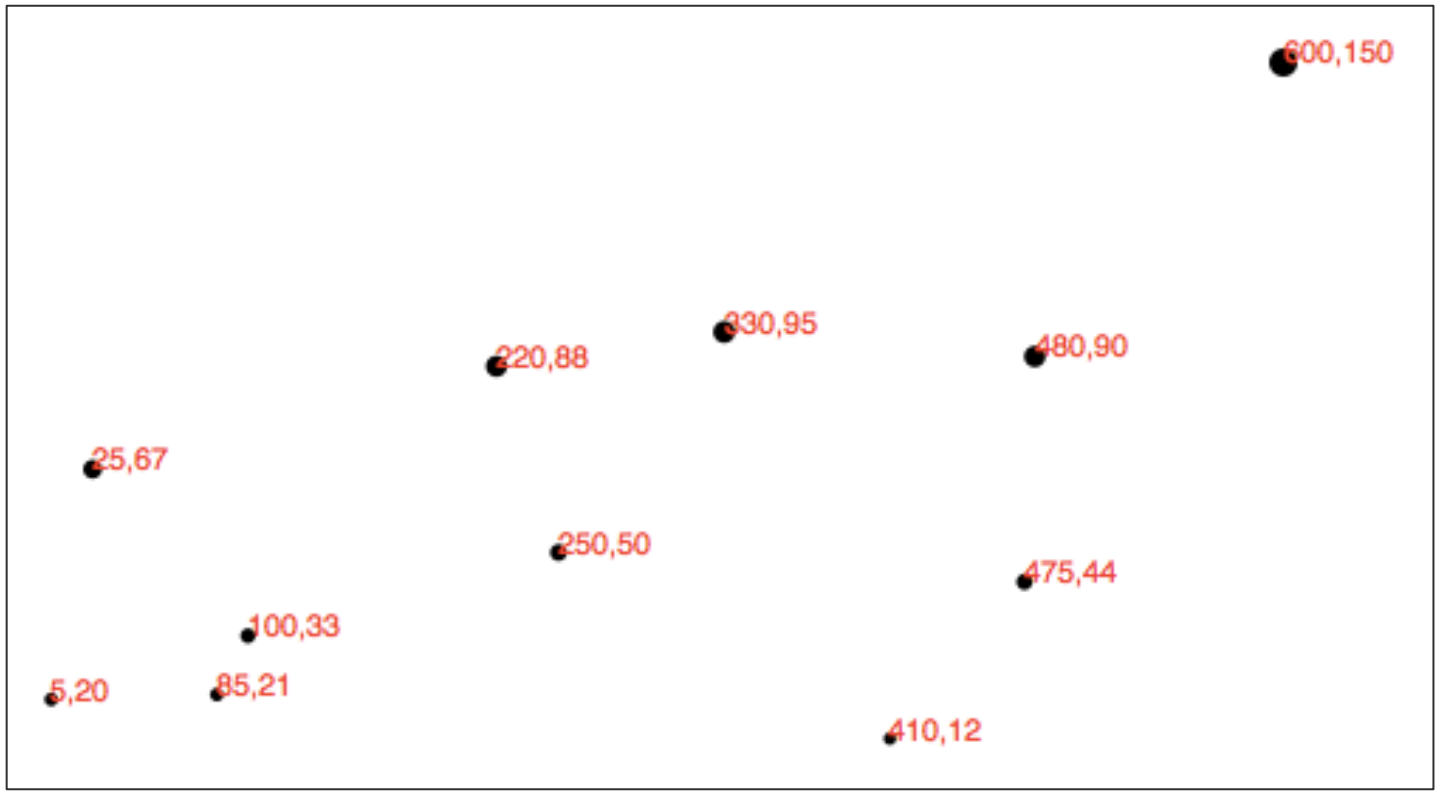
```
.range([h, 0]);
```



Now a smaller input to yScale will produce a larger output value, thereby pushing those circles and text elements down, closer to the base of the image.

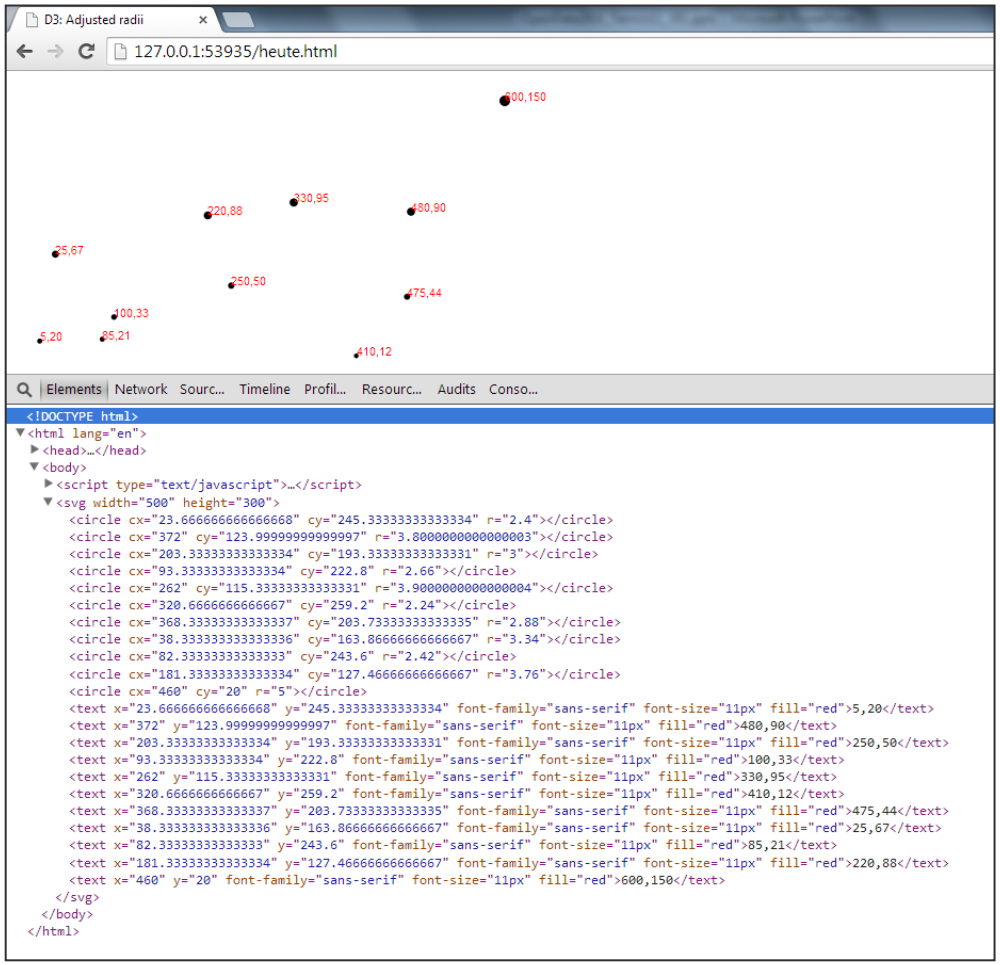
Neuer Datenpunkt, grössere SVG-Fläche

- Neuer Datenpunkt: **`[600, 150]`**
- Grössere SVG-Fläche: **`var h = 300;`**



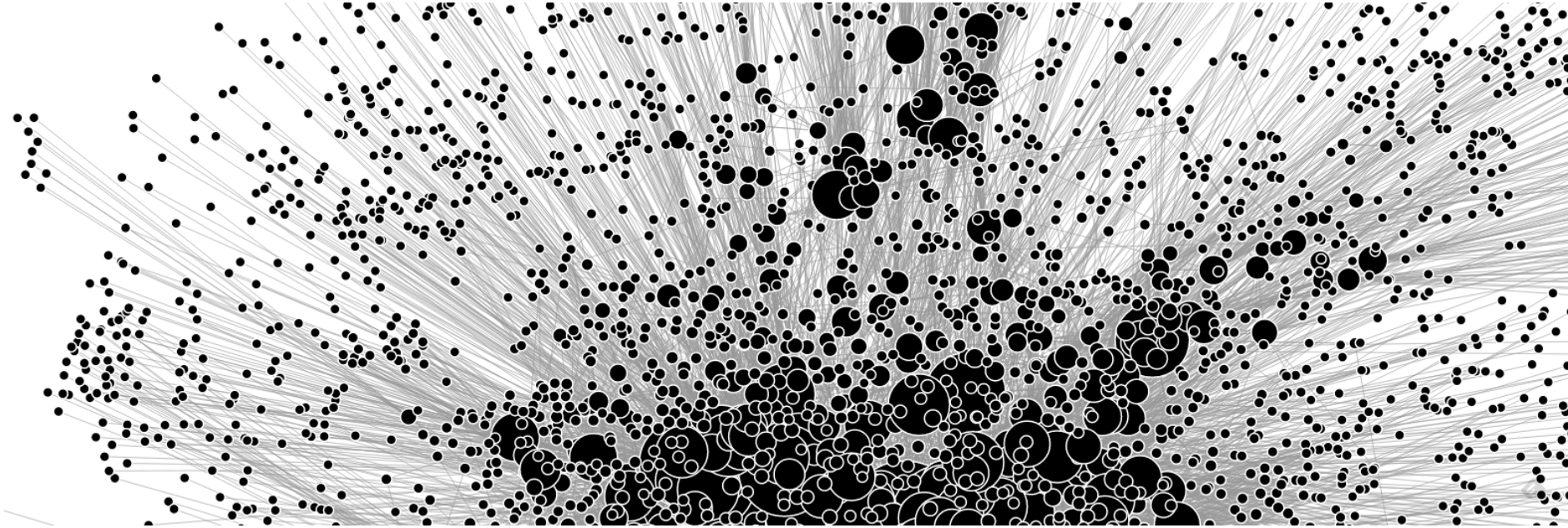
D3.js verbesserter Scatterplot mit dynamischer Skala

```
<!DOCTYPE html>
<html lang="en">
    <head>
        <meta charset="utf-8">
        <title>D3: Adjusted radii</title>
        <script type="text/javascript" src="/js/vendor/d3.min.js"></script>
    </head>
    <body>
        <script type="text/javascript">

            //Width and height
            var w = 500;
            var h = 300;
            var padding = 20;

            var dataset = [
                        [5, 20], [480, 90], [250, 50], [100, 33], [330, 95],
                        [410, 12], [475, 44], [25, 67], [85, 21], [220, 88], [600, 150]
                      ];

            //Create scale functions
            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[1]; })])
                                 .range([2, 5]);

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

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

            svg.selectAll("text")
               .data(dataset)
               .enter()
               .append("text")
               .text(function(d) {
                        return d[0] + "," + d[1];
               })
               .attr("x", function(d) {
                        return xScale(d[0]);
               })
               .attr("y", function(d) {
                        return yScale(d[1]);
               })
               .attr("font-family", "sans-serif")
               .attr("font-size", "11px")
               .attr("fill", "red");

        </script>
    </body>
</html>
```



Agenda

1. Infos zur Open Data App
2. Skalen
3. **Achsen**



Setting Up an Axis

Eine Achse erstellen:

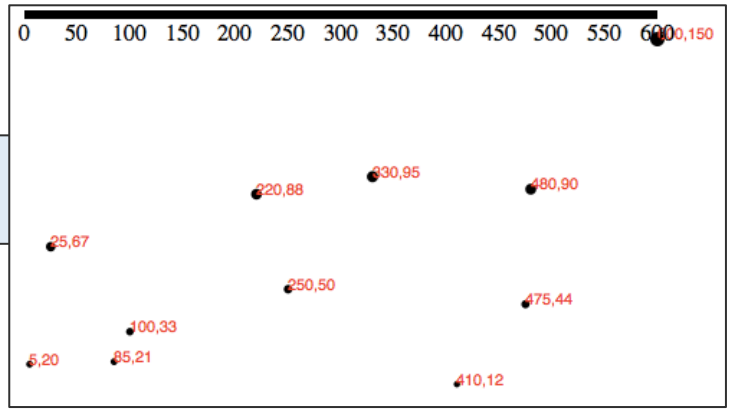
```
var xAxis = d3.svg.axis();
```

Der Achse eine Skala zuweisen:

```
xAxis.scale(xScale);
```

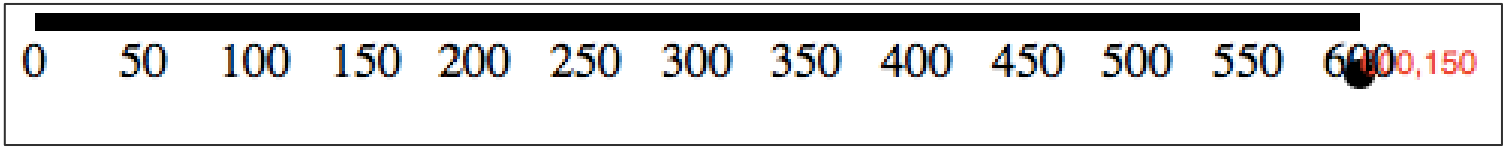
Die Achse zeichnen:

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



Setting Up an Axis

> Gezeichnete Achse:



> Generierter SVG-Code:

```
▼<g>
  ▶<g class="tick" transform="translate(20,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(56.66666666666667,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(93.33333333333334,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(130,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(166.66666666666669,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(203.33333333333334,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(240,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(276.6666666666667,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(313.33333333333337,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(350,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(386.6666666666667,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(423.33333333333337,0)" style="opacity: 1;">…</g>
  ▶<g class="tick" transform="translate(460,0)" style="opacity: 1;">…</g>
    <path class="domain" d="M20,6V0H460V6"></path>
  </g>
```

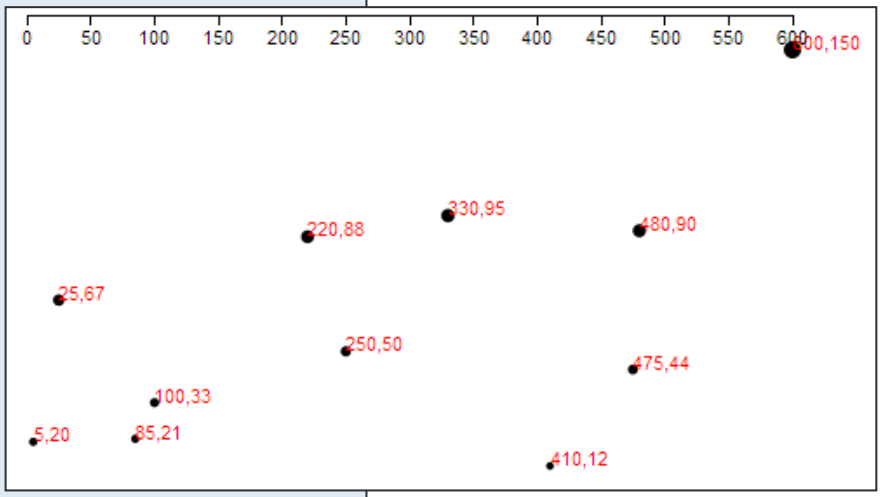
Cleaning It Up

Der Achse die CSS Klasse **`axis`** zuweisen:

```
svg.append("g")
   .attr("class", "axis") //Assign "axis" class
   .call(xAxis);
```

CSS Styles definieren:

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



SVG transforms

Die Achse soll nach unten verschoben werden. Das wird bei SVG-Elementen mit **`transform`** und **`translate`** erreicht:

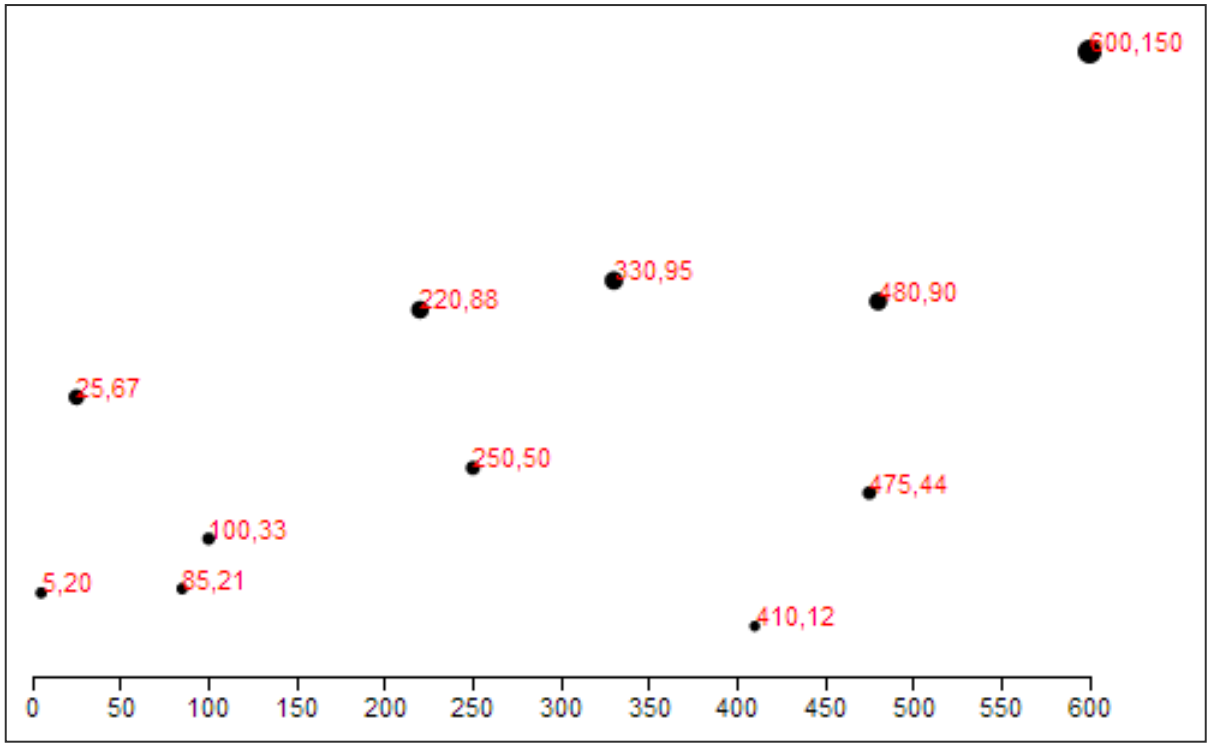
```
<g class="axis" transform="translate(0,280)">
```

Im JavaScript Code muss der Achse hinzugefügt werden:

```
.attr("transform","translate(0," + (h-padding) + ")")
```

SVG transforms

> Resultat:



> Transform:

```
<g class="axis" transform="translate(0,280)">
```

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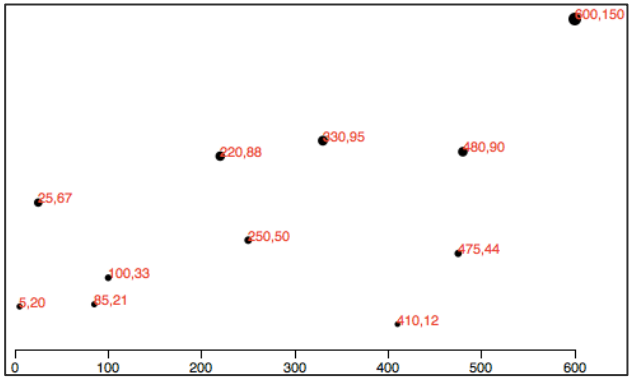
Check for Ticks

You can customize all aspects of your axes, starting with the rough number of ticks, using **`ticks()`**:

```
var xAxis = d3.svg.axis()
                  .scale(xScale)
                  .orient("bottom")
                  .ticks(5);  //Set rough # of ticks
```

D3 inteprets the **`ticks()`** value as merely a suggestion and will override your suggestion with what it determines to be the most clean and human-readable values:



Y Achse

Oben im Code Variable für die Y Achse erstellen:

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

Unten im Code die Y Achse hinzufügen:

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

D3.js Scatterplot mit Achsen


```
<!DOCTYPE html>
<html lang="en">
  <head>
    <meta charset="utf-8">
    <title>D3: Vertical axis added</title>
    <script type="text/javascript" src="/js/vendor/d3.min.js"></script>
    <style type="text/css">

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

      .axis text {
        font-family: sans-serif;
        font-size: 11px;
      }

    </style>
  </head>
  <body>
    <script type="text/javascript">

      //Width and height
      var w = 500;
      var h = 300;
      var padding = 30;

      var dataset = [
                  [5, 20], [480, 90], [250, 50], [100, 33], [330, 95],
                  [410, 12], [475, 44], [25, 67], [85, 21], [220, 88],
                  [600, 150]
                  ];

      //Create scale functions
      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[1]; })])
                   .range([2, 5]);

      //Define X axis
      var xAxis = d3.svg.axis()
                .scale(xScale)
                .orient("bottom")
                .ticks(5);

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

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

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

      //Create labels
      svg.selectAll("text")
         .data(dataset)
         .enter()
         .append("text")
         .text(function(d) {
              return d[0] + "," + d[1];
         })
         .attr("x", function(d) {
              return xScale(d[0]);
         })
         .attr("y", function(d) {
              return yScale(d[1]);
         })
         .attr("font-family", "sans-serif")
         .attr("font-size", "11px")
         .attr("fill", "red");

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

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

    </script>
  </body>
</html>
```