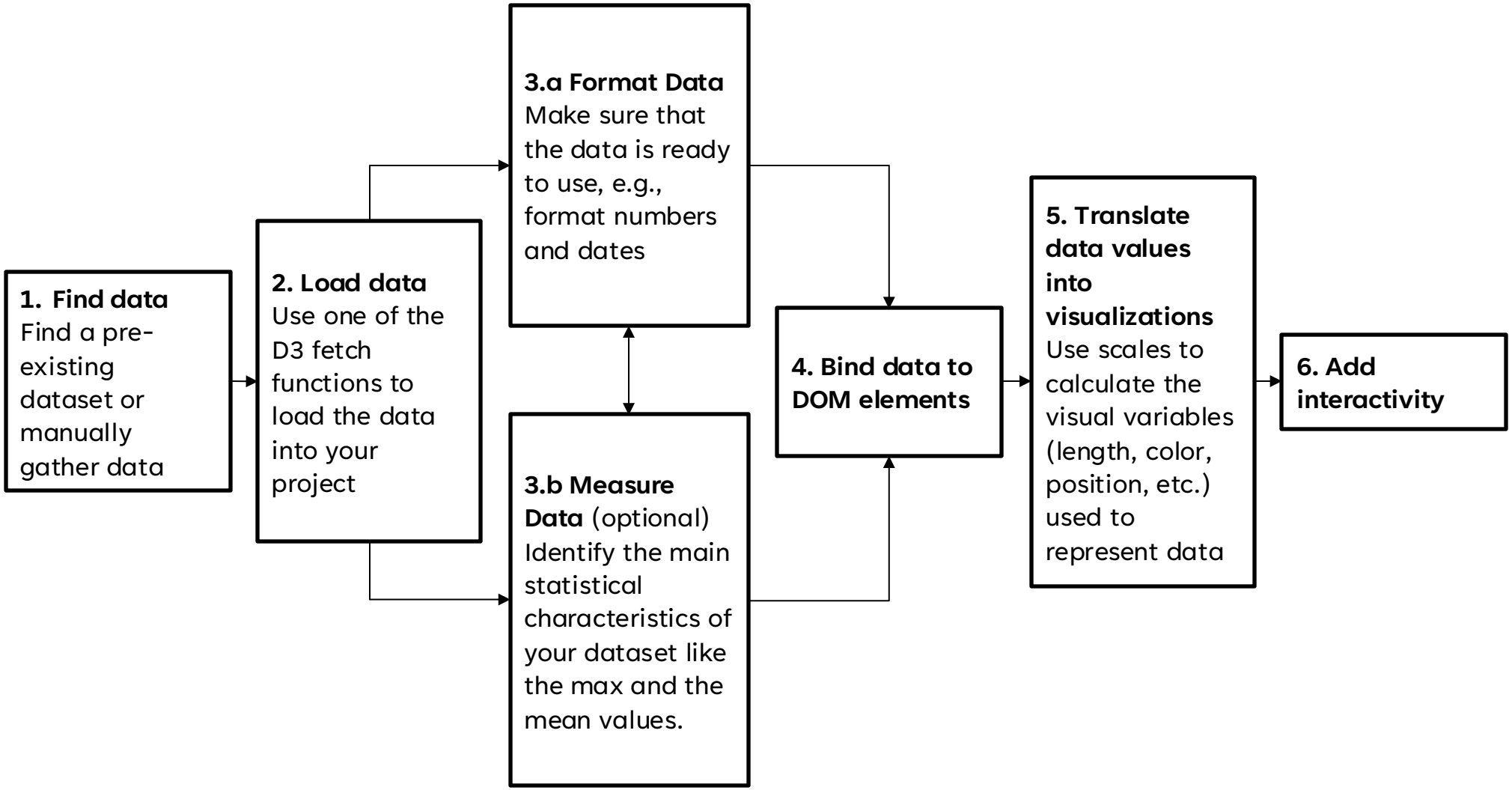
D3: Working with Data

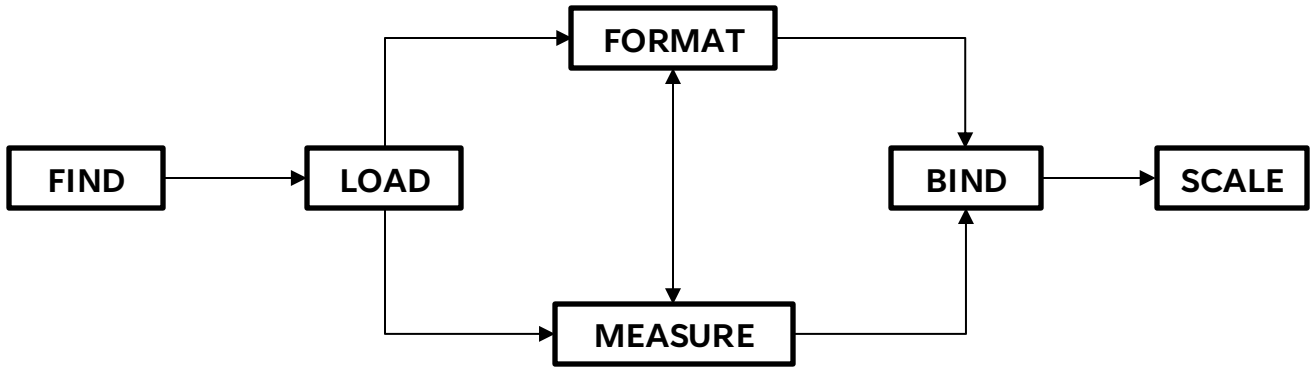
Tommaso Piselli

Lesson Topic



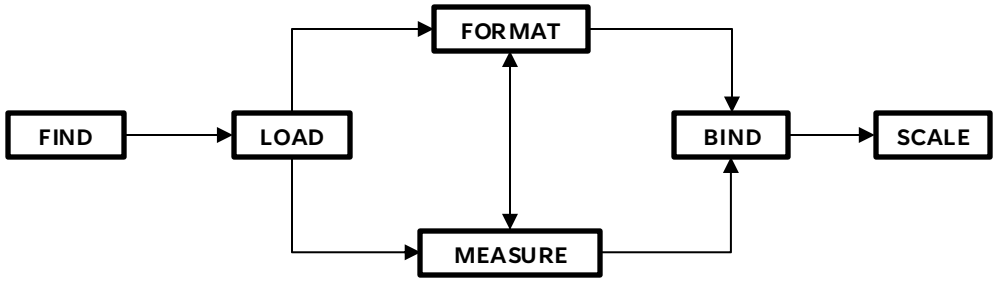
From «D3.js in Action» (third edition)

Lesson Topic



Lesson Topic

1. In the first half, we will discuss a **data workflow** that can be applied to D3 projects (and, in general, to any data visualization project).
   - **Finding (and cleaning) Data.**
   - **Loading Data to a D3 project.**
   - **Formatting the Dataset.**
   - **Measuring Data.**
   - **Binding Data to a Visualization.**
   - **Scaling the Data to fit the screen.**
2. In the second half of the lesson we will draw a more complex visualization using **svg paths** and some D3 functions.



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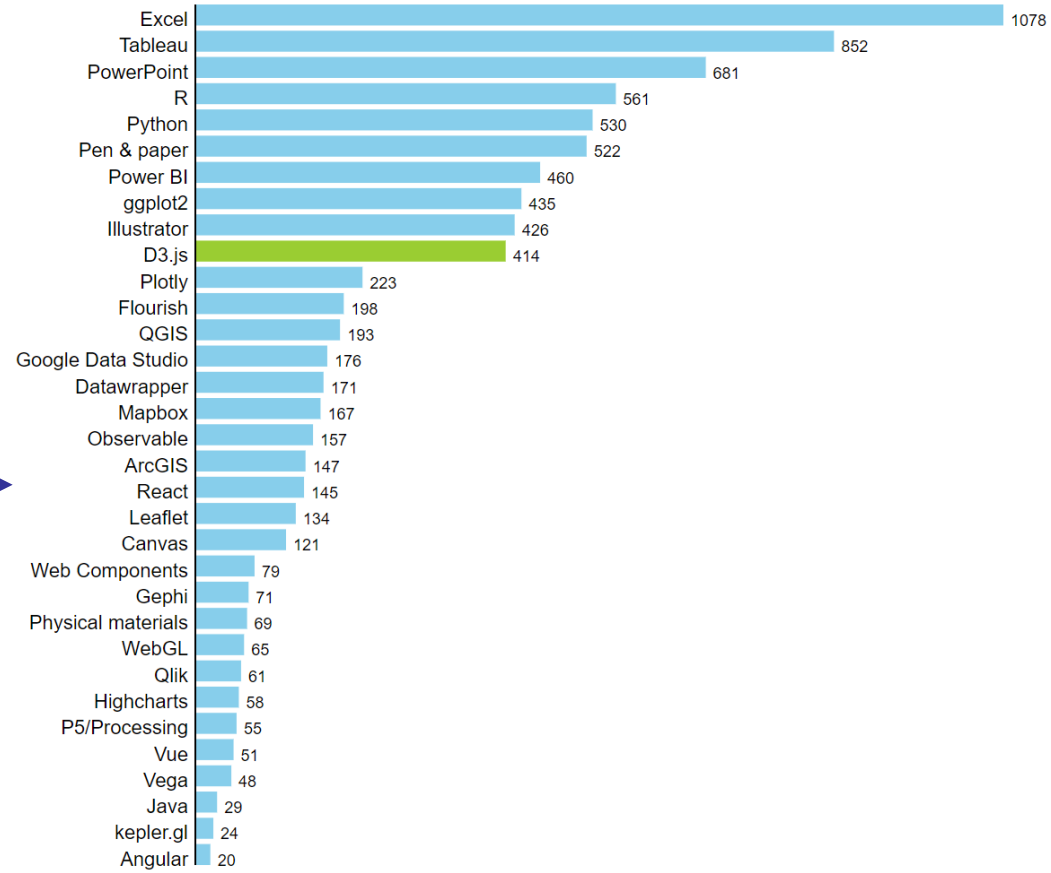
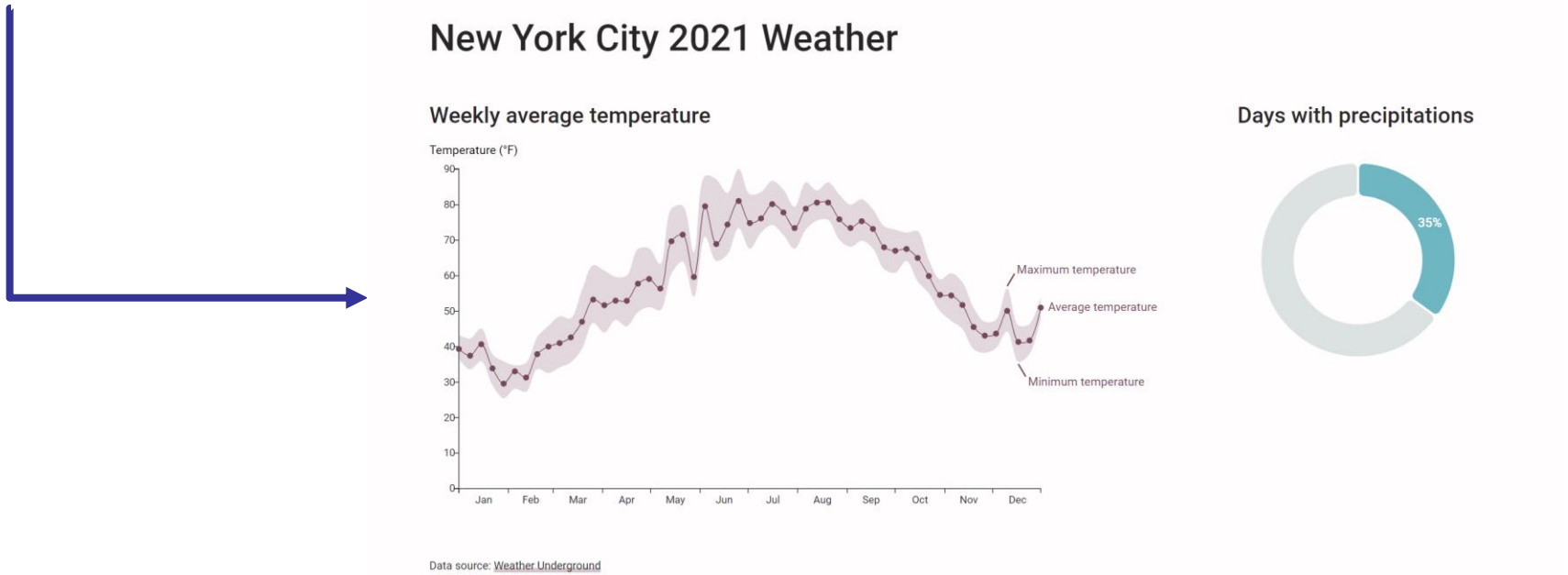
- This one for the first half



Lesson Topic

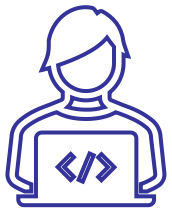
- As we present these topics, we will also produce a couple of visualizations.
- This one for the first half
- And this for the second half



D3: Data Handling

For a written guide of this tutorial, please refer to the **README.md** file in the **L2** folder. You can open the file either in VSCode or Github.

This tutorial was taken from Chapter 3 of “D3.js in Action, Third Edition”



Finding Data

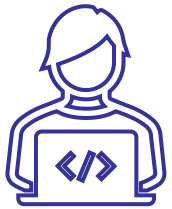
Some useful links for open datasets.

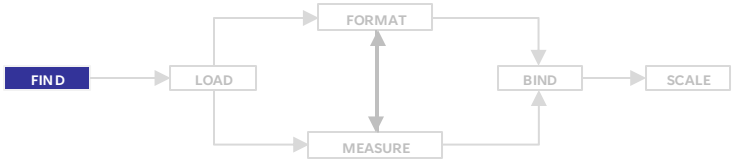
Mostly non-relational:

- https://www.cs.ubc.ca/group/infovis/resources.shtml#data-repos
- https://data.world/search?scope=_all
- https://www.kaggle.com/datasets
- https://www.tableau.com/learn/articles/free-public-data-sets

Relational:

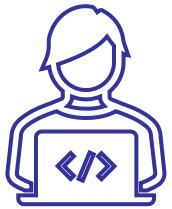
- https://visdunneright.github.io/gd_benchmark_sets/
- Graph Drawing contest (*creative topic* of the various editions):
  - https://mozart.diei.unipg.it/gdcontest/history/

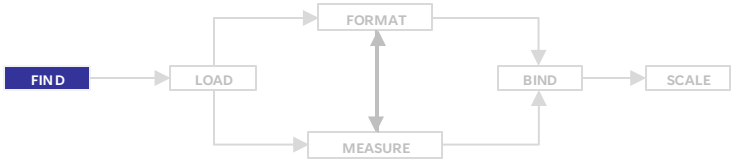




Finding Data

- In data visualization, there are two main types of data:
  - **Quantitative**: numerical information (e.g., temperature)
  - **Qualitative**: textual information (e.g., names)
- Using D3, we will work with **different formats** of datasets.
- The most common are:
  - Tabular dataset => csv files
  - JavaScript Objects => JSON files





Finding Data

Data Types

Quantitative

Numerical information:
Temperature, speed, …

Discrete

Integers that cannot be subdivided.
School grades

Continuous

Values that can be divided into smaller units.
Amount of rain drop

Qualitative

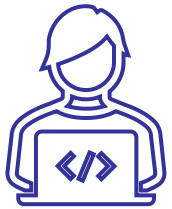
Non-numerical information:
Text, images, …

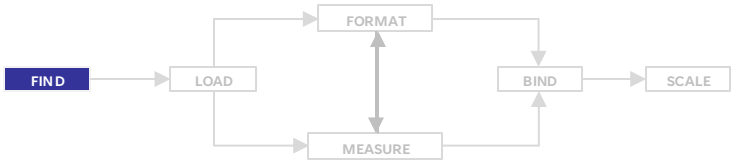
Nominal

Values that don't have a specific order.
Gender

Ordinal

Values that can be organized in order of magnitudes.
T-shirt sizes: S, M, L

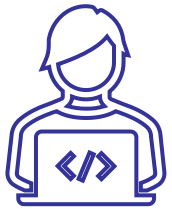


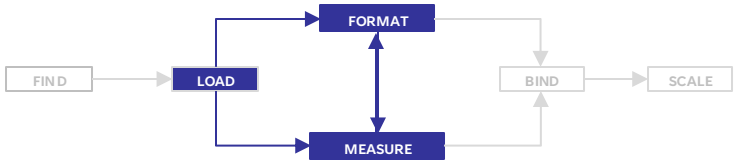


Preparing Data

Once we have the dataset ready and clean, we:

- **Load** it into D3,
- **Format** everything,
- **Measure** different aspects of the data.





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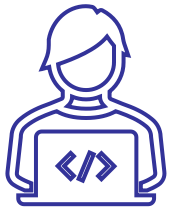
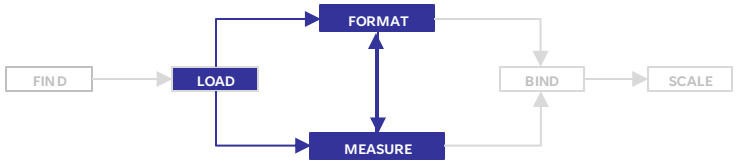
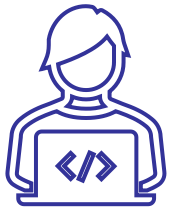


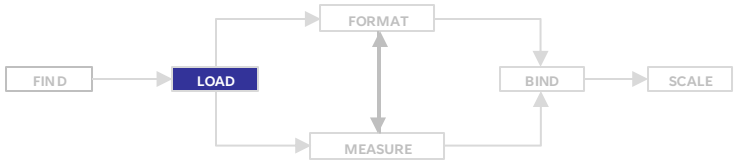


Loading Data

- D3 has different functions to load data into the project, depending on their type:
  - `d3.csv(filePath)`
  - `d3.json(filePath)`
  - and many more (see, for reference, the d3-fetch docs)
- As it loads, D3 transforms the dataset into an array of objects.

```
d3.csv("./data/data.csv", (d) => {console.log(d);});
```

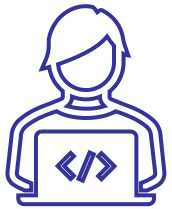




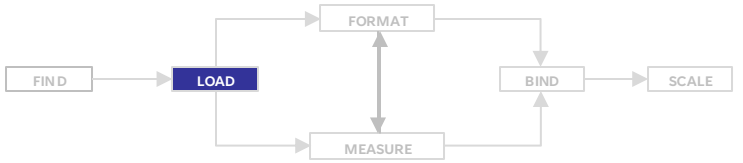
Loading Data

- Loading is an **asynchronous process**.
  - This means that the browser continues to read and execute the script while the data is being loaded.
  - To wait for the data to be fully available we can use the `then()` method for JS Promises.
  - The callback function of `then()` gives us access to the entire dataset once it is loaded.

```
d3.csv("./data/data.csv", (d) => {
// ...
}).then((data) => {
console.log(data);
});
```



The Promise object represents the eventual completion (or failure) of an asynchronous operation and its resulting value.



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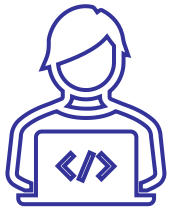
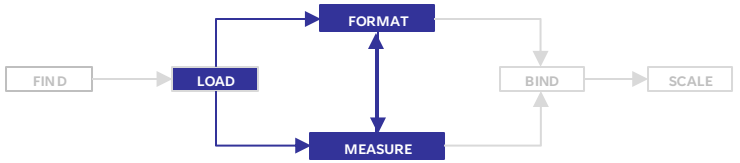




Formatting Data

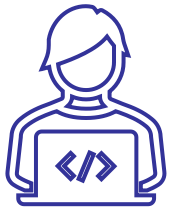
- The callback function of `d3.csv()` is called the **row conversion** function:
  - It gives access to data **row by row**.
- So, the previous example has this output in the console:

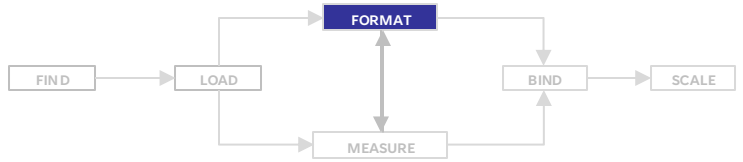
```
Live reload enabled.
▼ Object i
    count: "147"
    technology: "ArcGIS"
  ▶ [[Prototype]]: Object
▼ Object i
    count: "414"
    technology: "D3.js"
  ▶ [[Prototype]]: Object
▼ Object i
    count: "20"
    technology: "Angular"
  ▶ [[Prototype]]: Object
▼ Object i
    count: "171"
    technology: "Datawrapper"
  ▶ [[Prototype]]: Object
▶ Object
▶ Object
▶ Object
▶ Object
▶ Object
```

```
d3.csv("./data/data.csv", (d) => {console.log(d);});
```

Where the `data.csv` file has these rows

```
technology,count
ArcGIS,147
D3.js,414
Angular,20
Datawrapper,171
Excel,1078
Flourish,198
ggplot2,435
Gephi,71
Google Data Studio,176
```





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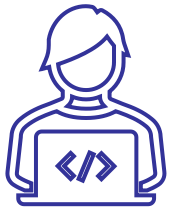
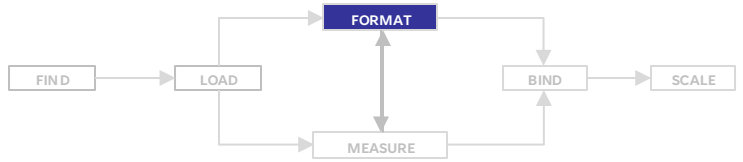
Note: values from `count` are parsed as strings instead of numbers





Formatting Data

- Since the callback function gives us the data one row at a time, it is a great place to start doing some formatting.
- In this way, data will be ready to use for any visualization.

```
d3.csv("./data/data.csv", (d) => {
console.log(`technology: ${d.technology}, count:
${+d.count}`);
});
```

- Here, we use a key-value formatting for the data.
- This is very handy if you need to clean up your dataset from useless information stored in some columns.
- However, if you need them all, you can wait to load the whole dataset before doing the formatting.

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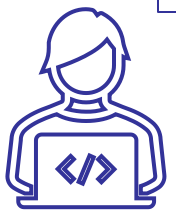
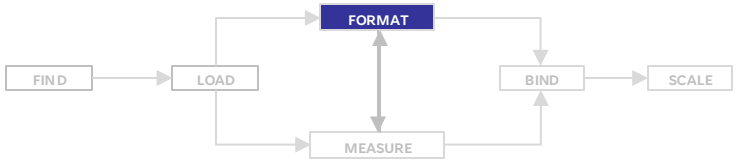
technology: Highcharts, count: 58
technology: Illustrator, count: 426
```





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(This + transforms a string into a number)

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technology: D3.js, count: 414
technology: Angular, count: 20
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technology: Excel, count: 1078
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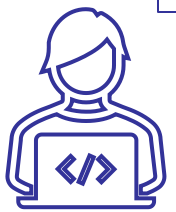

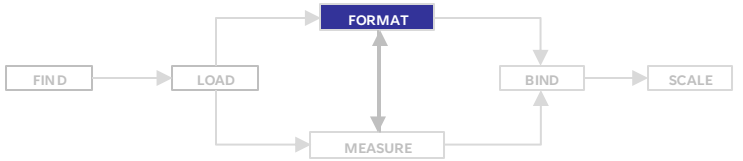

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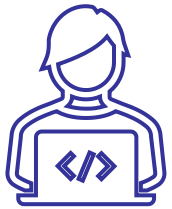
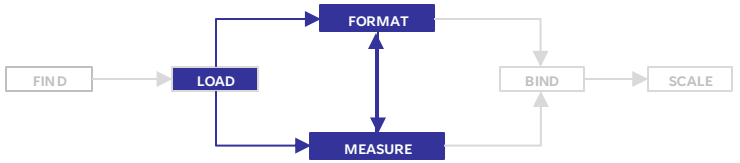
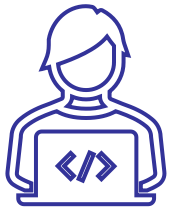


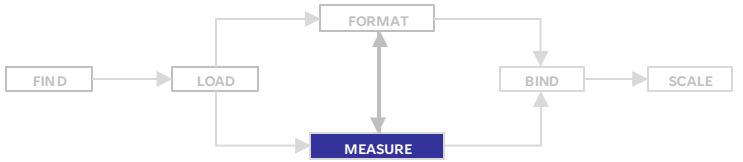


Measuring Data

- Now, we can finally see the JS Promise in action.
- Once the data is loaded, the **Promise is fulfilled**.
- The dataset is available in the callback of the `then()` method.
- Instead of just logging our formatted rows, we first **create** a JS object, storing the key-value pairs.
- Then, if we want to log the complete dataset of our example, we can write:

```
d3.csv("./data/data.csv", (d) => {
return { technology: d.technology, count: +d.count };
}).then((data) => { console.log(data);});
```





Measuring Data

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return { technology: d.technology, count: +d.count };
}).then((data) => { console.log(data);});
```

Our data are now converted into an **array of JS Objects**!

main.js:11

```
(33) [{…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, columns: Array(2)]
  0: {technology: 'ArcGIS', count: 147}
  1: {technology: 'D3.js', count: 414}
  2: {technology: 'Angular', count: 20}
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  5: {technology: 'Flourish', count: 198}
  6: {technology: 'ggplot2', count: 435}
  7: {technology: 'Gephi', count: 71}
  8: {technology: 'Google Data Studio', count: 176}
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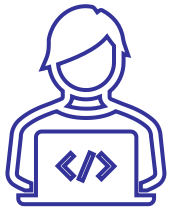

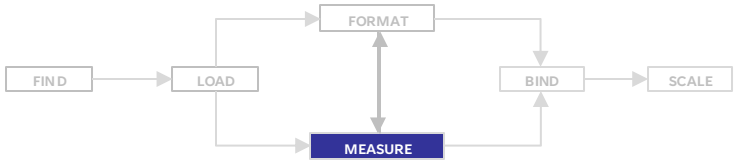

Measuring Data

- We can achieve the same result, but with an **automatic conversion**.
- The function `d3.autoType` detects data types and converts them into the corresponding JS type.
  - However, we know that the dynamic duo **JS-type** is not famous to be a clear and systematic concept.
  - If you want to be sure to have the correct conversion, continue to do it with the manual operation (or use TypeScript).

```
d3.csv("./data/data.csv", d3.autoType};
}).then((data) => { console.log(data);});
```

```
main.js:11
(33) [{…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, columns: Array(2)]
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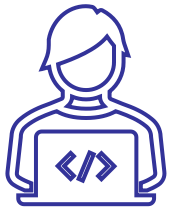
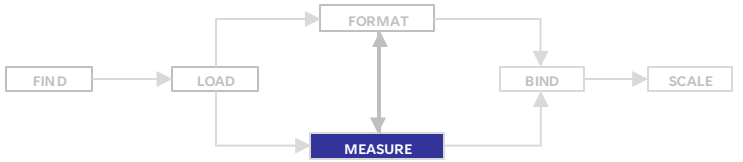
  8: {technology: 'Google Data Studio', count: 176}
```

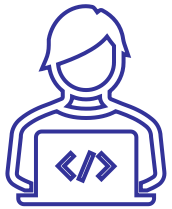


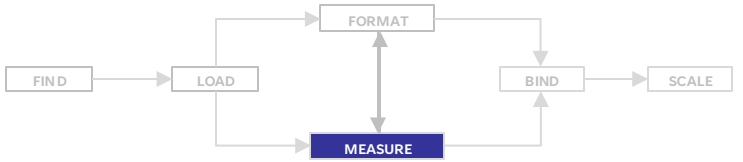


Measuring Data

- We can start to explore and measure the properties of this dataset.
- The most common methods are:
  - `data.length`: number of entries in the dataset
  - `d3.max(iterable element, accessor function):` max element in the iterable element
  - `d3.min(iterable element, accessor function):` min element in the iterable element.
  - `d3.extent(iterable element, accessor function):` returns an array containing the min and the max.

```
d3.max(data, d => d.count); // 1078
d3.min(data, d => d.count); // 20
d3.extent(data, d => d.count) // [20, 1078]
```





Measuring Data

- To enhance the readability of the dataset, we can **sort** our data.
- To do so, we use the JS `sort()` method.
- It takes a **compare function** as an argument.
- Here we are saying that, if the count of `b` is greater than the count of `a`, `b` should appear before `a` in the dataset (**descending sort**).

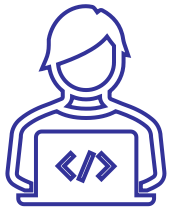
```
data.sort((a, b) => b.count - a.count);
```

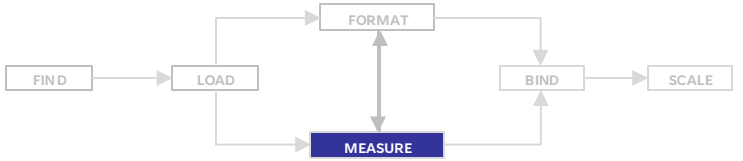
BEFORE

```
(33) [{…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, columns: Array(2)]
  0: {technology: 'ArcGIS', count: 147}
  1: {technology: 'D3.js', count: 414}
  2: {technology: 'Angular', count: 20}
  3: {technology: 'Datawrapper', count: 171}
  4: {technology: 'Excel', count: 1078}
  5: {technology: 'Flourish', count: 198}
  6: {technology: 'ggplot2', count: 435}
  7: {technology: 'Gephi', count: 71}
  8: {technology: 'Google Data Studio', count: 176}
```

AFTER

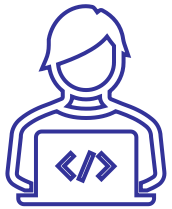
```
(33) [{…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, {…}, columns: Array(2)]
  0: {technology: 'Excel', count: 1078}
  1: {technology: 'Tableau', count: 852}
  2: {technology: 'PowerPoint', count: 681}
  3: {technology: 'R', count: 561}
  4: {technology: 'Python', count: 530}
  5: {technology: 'Pen & paper', count: 522}
  6: {technology: 'Power BI', count: 460}
  7: {technology: 'ggplot2', count: 435}
  8: {technology: 'Illustrator', count: 426}
```

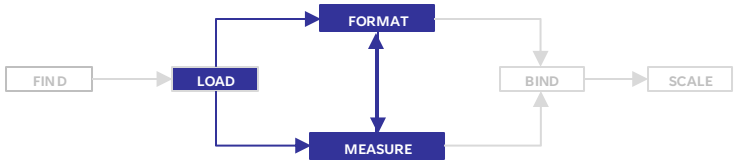




Preparing Data: Overview

1) **Loading** data with a fetch function
2) **Format** the data (row conversion)
3) **Chain** `then()` to access the entire dataset when is completely loaded.
    a) (Optional) **Refactor** the data.
    b) (Optional) **Measure** the data.
4) **Pass** the data to another function that will **handle** the visualization.



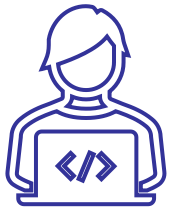


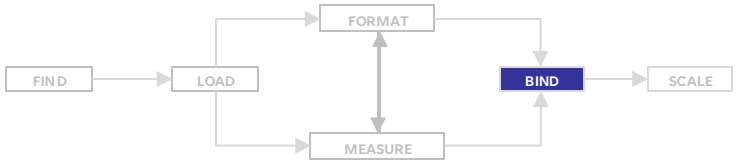
Binding data to DOM elements

- **Data-Binding** is one of the most useful features of D3.
- We can couple single pieces of the dataset to DOM elements.
  - Examples:
    - bind the length of a rectangle in a barchart to a number in our dataset;
    - bind the degree of a pie chart to a percentage from the data.
- The **pattern** used to bind data is the following:

```
selectAll("selector").data(myData).join("element")
```

- **Note**: you can find, for older versions of D3, the pattern `enter().append("element")` in place of `join("element")`.

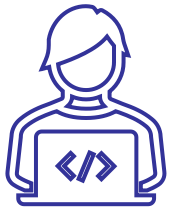


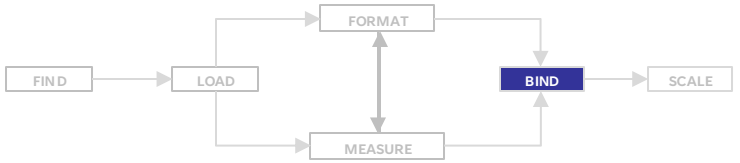


Binding data to DOM elements

- So, the data binding pattern **generates** an SVG for each data point.
- Once the elements are generated, we can access their attributes through **inline functions**.
- Data bound to an element is also **passed** to its children.

```
selectAll("selector").data(myData).join("element")
```

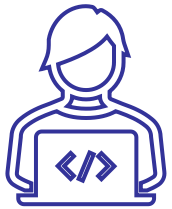


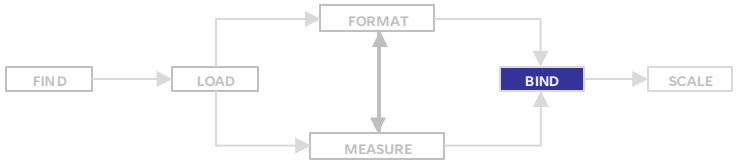


Binding data to DOM elements

```
selectAll("rect").data(data).join("rect")
```

- For example, we want to add one rectangle for each data point in our dataset.
- The first instruction `selectAll("rect")` will select elements that are not yet present in our DOM.
- This is called **empty selection**.

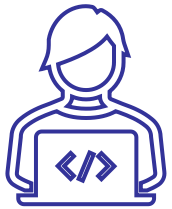


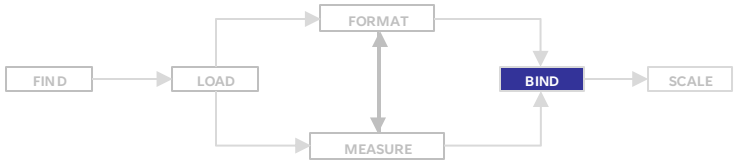


Binding data to DOM elements

```
selectAll("rect").data(data).join("rect")
```

- To tell the DOM how many rectangles it needs to place, we chain the `data()` method.
- The parameter of this method is our dataset.





Binding data to DOM elements

```
selectAll("rect").data(data).join("rect")
```

- Finally, the rectangles can enter the DOM with the `join()` method.
- If we look in the HTML page, we can see the following
- So, in D3, the **selection** becomes the combination of the DOM elements and the data together.

```
<head>…</head>
<body style>
  <div class="responsive-svg-container">
    <svg viewBox="0 0 1200 1600" style="border: 1px solid black;"> == $0
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
      <rect></rect>
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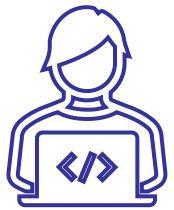
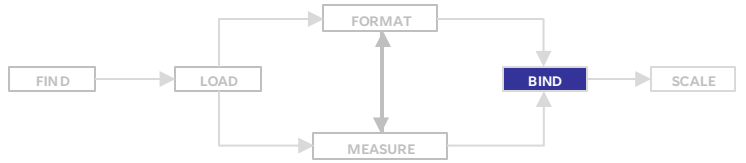
      <rect></rect>
    </svg>
  </div>
```

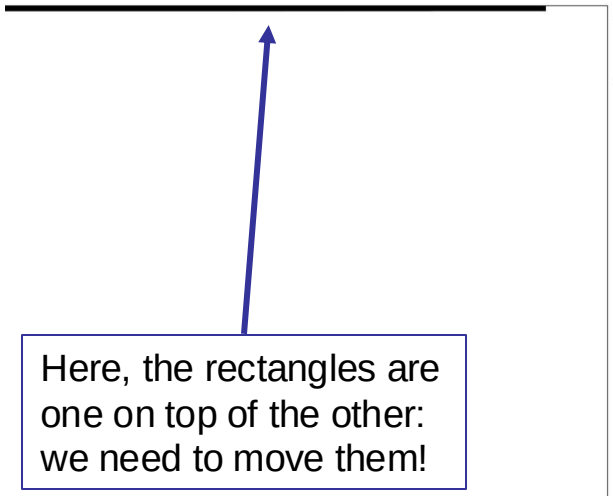


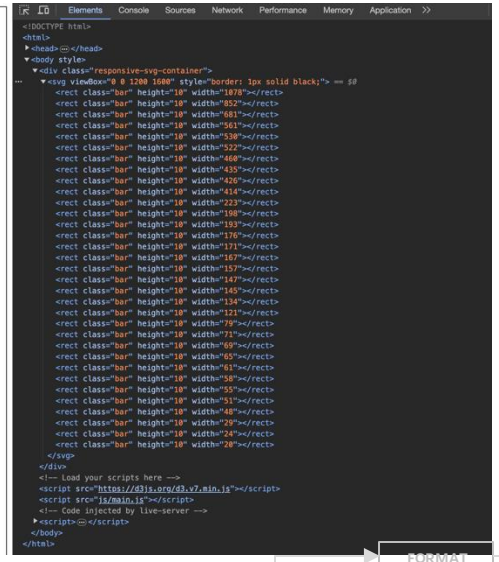


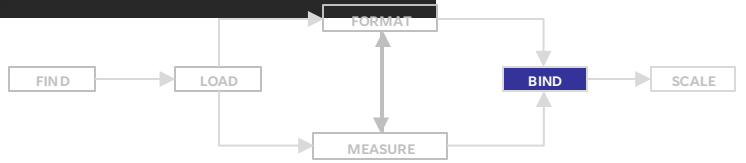
Setting attributes dynamically

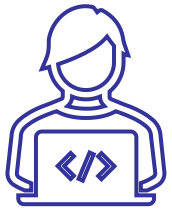
- Now, we can **access** the created elements in the DOM to **dynamically set** their attributes.
- In the following code, we set the same `class` for all the elements, the `height` is equal to a constant, and the `width` is read from the `count` value of each data point.

```
const barHeight = 10;
d3.select("svg")
.selectAll("rect")
.data(data)
.join("rect")
.attr("class", "bar")
.attr("height", barHeight)
.attr("width", (d) => d.count);
```

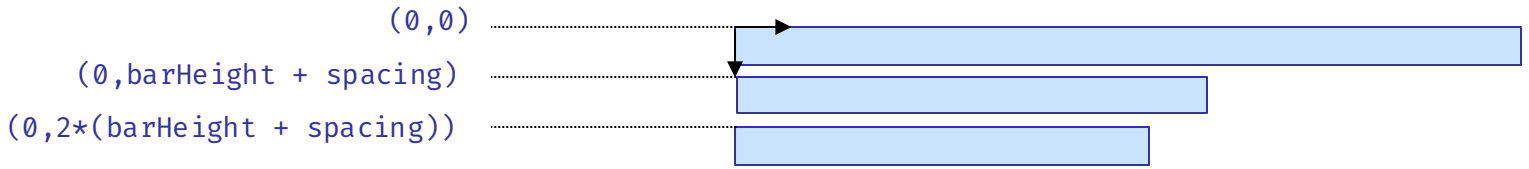






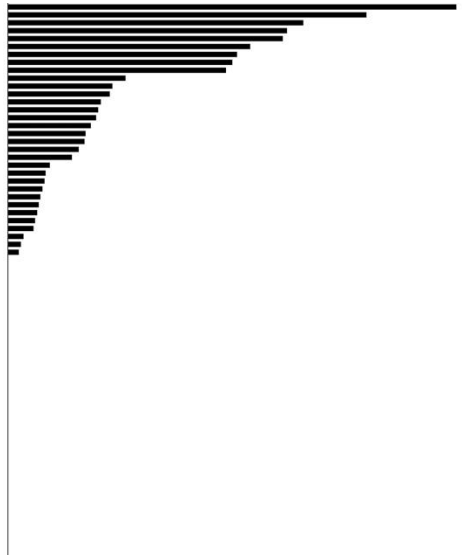


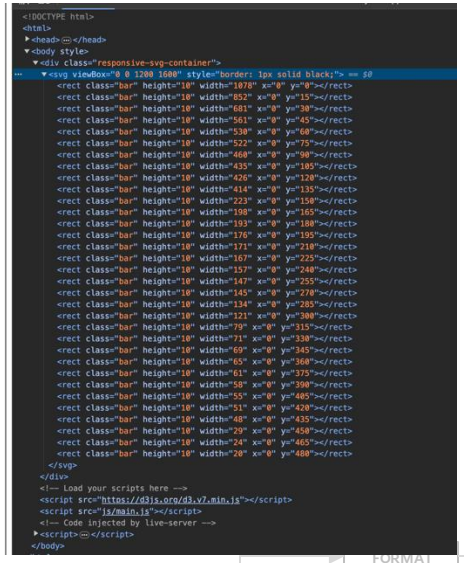
Setting attributes dynamically

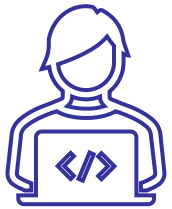


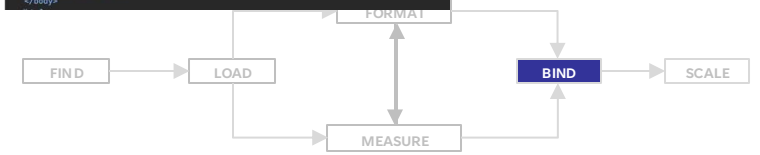
For now, we are doing this operation manually by setting x and y by ourselves.

```
const barHeight = 10;
d3.select("svg")
.selectAll("rect")
.data(data)
.join("rect")
.attr("class", "bar")
.attr("height", barHeight)
.attr("width", (d) => d.count)
.attr("x", 0)
.attr("y", (d, i) => i *
(barHeight + 5));
```



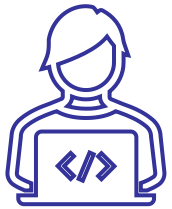


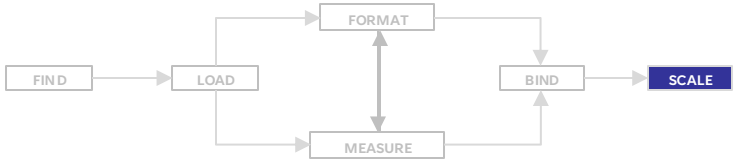




Adapting Data for the Screen

- In D3, the translation from data to screen is handled with **scales**.
- **Scales** map a dimension of abstract data to a visual representation.
  - Usually, the **output** of a scale is the position, the size, or the color of the element.
- More formally, in D3 we have:
  - `domain()`: all the possible values of the **input**;
  - `range()`: spectrum of all the **output** values.
- D3 has multiple **scale functions**. We will use:
  - **Linear Scale**: for quantitative data (continuous domain/continuous range)
  - **Band Scale**: for categorical/ordinal data (discrete domain/continuous range)
  - If you want to learn more about other scales: d3-scale





Adapting Data for the Screen

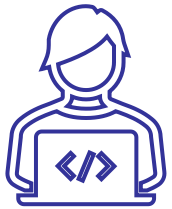
- For example:

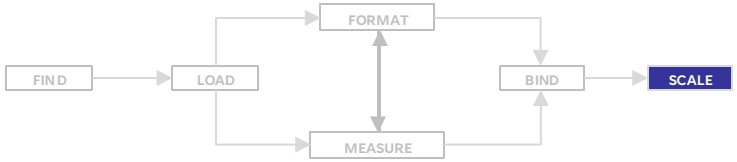
```
const myScale = d3.scaleLinear().domain([0, 100]).range([0, 1000]);
```

- Here, if we want to try the scale:

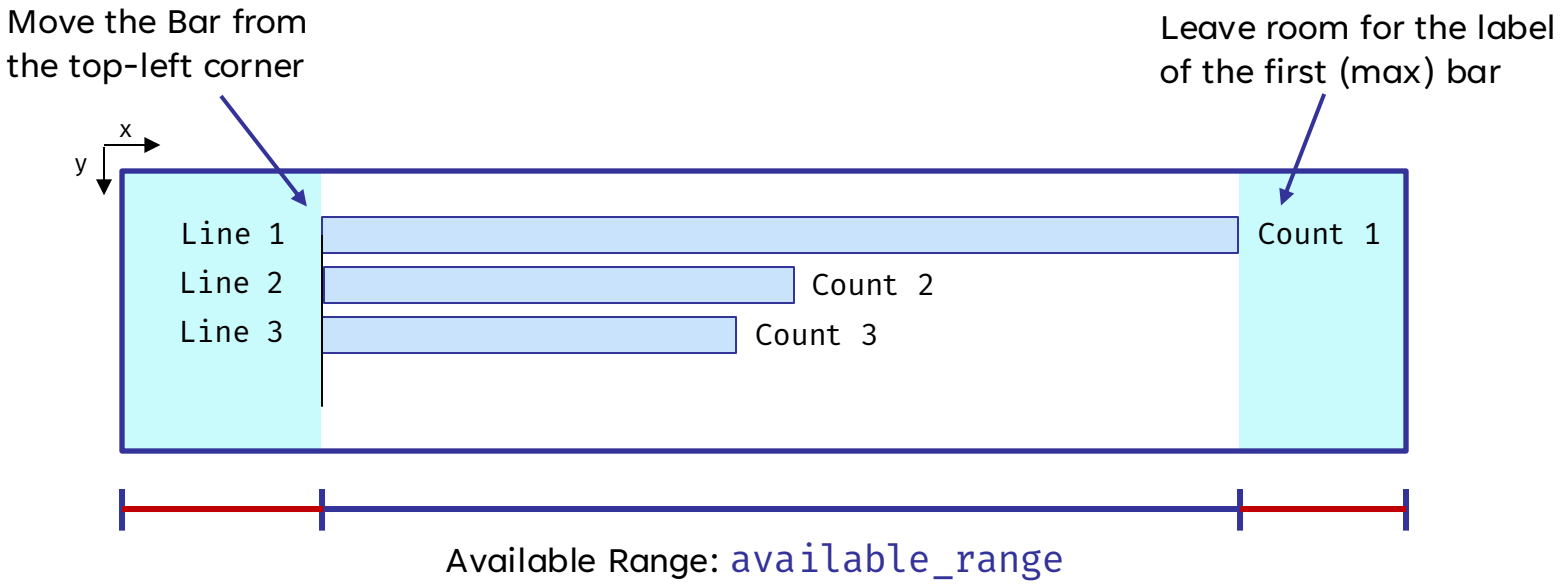
```
myScale(50); // 500
```

- The scale is linear, meaning that every 1 unit in the domain is mapped to its value multiplied by 10.
- How to use scales in our example?
  - We create two scales: one for fitting the data on the x-axis and one for the y-axis.



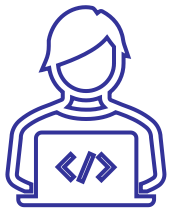


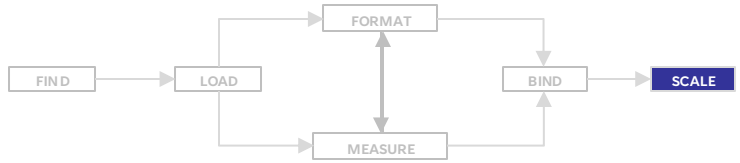
Adapting Data for the Screen




```
const xScale = d3.linearScale().domain([0, Count1]).range([0, available_range]);
```

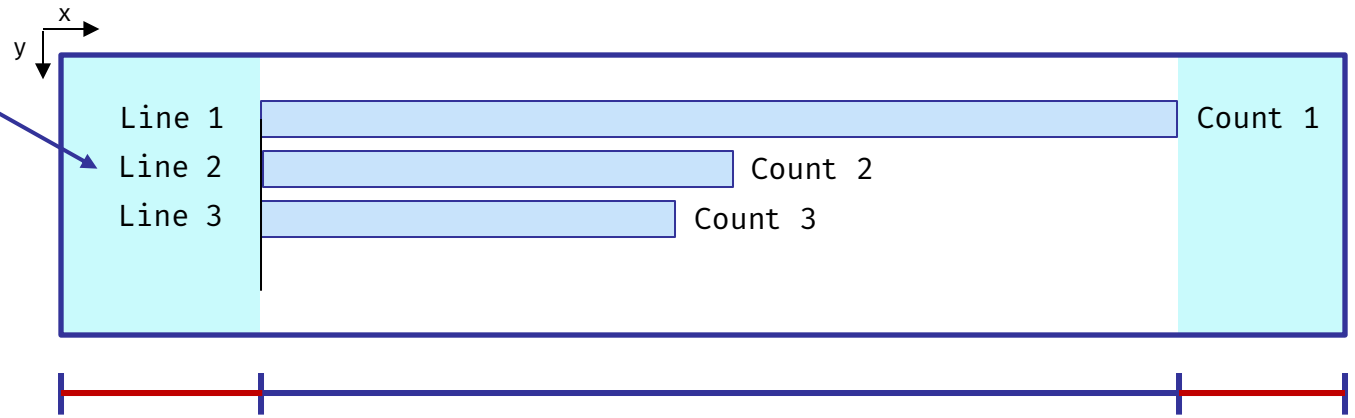
```
...
attr("width", d => xScale(d.count));
...
```





Adapting Data for the Screen

We don't need to position bars by hand like we did before



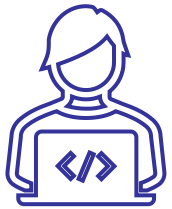
Available Range: `available_range`

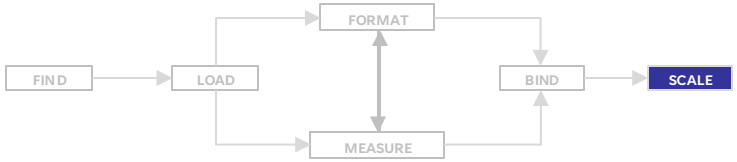
```
const yScale = d3.scaleBand().domain(data.map(d => d.technology)).range([0, svgHeight]);
```

```
...
attr("y", d => yScale(d.technology));
...
```

```
...
attr("height", d => yScale.bandwidth());
...
```

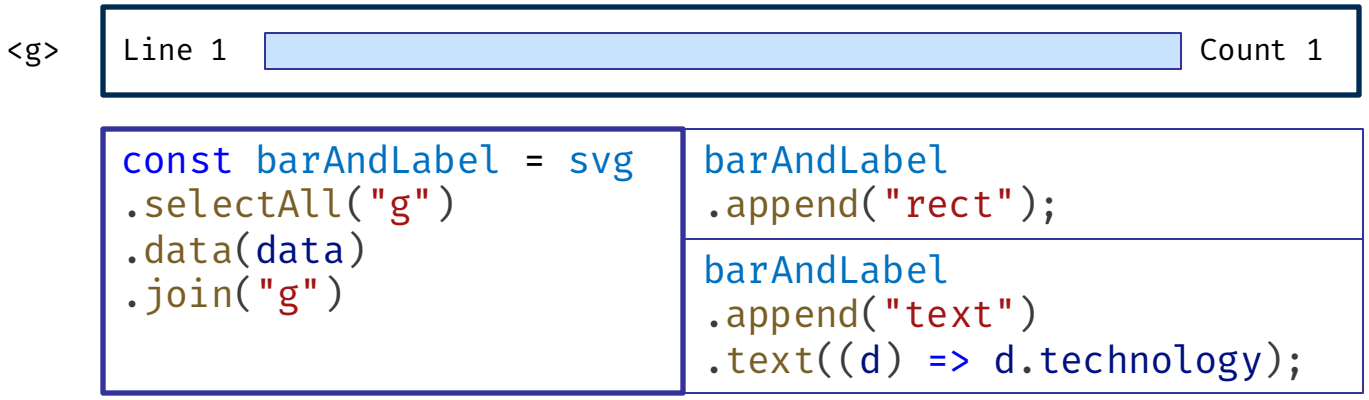
To compute the thickness of the bar, we can use the `bandwidth` function of the `scaleBand`

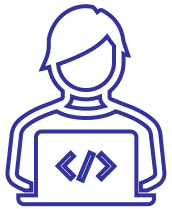


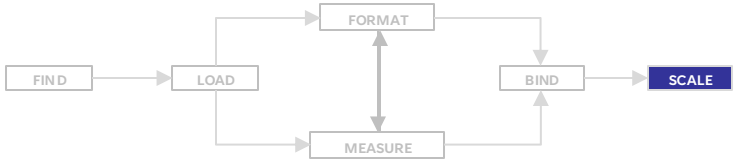


Adding labels to a chart

- In SVG-based images, we add labels with SVG **text elements**.
- Our strategy is the following:
  - We need to add two labels to our bars, one for the technology name and one for the count number.
  - We then **group bars** and labels together into a HTML <g> element so that we can translate everything in one go.

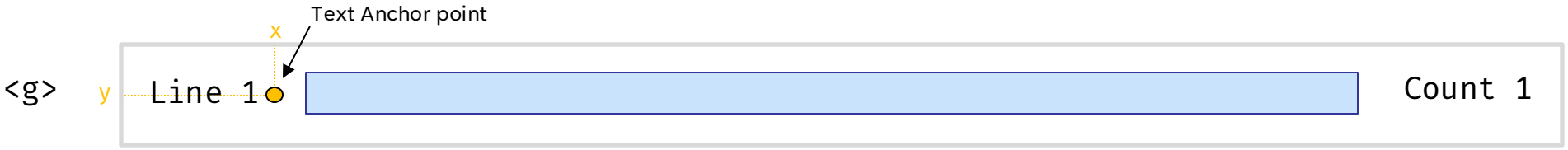






Adding labels to a chart

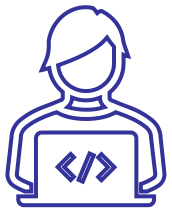
- To compute the exact position of our labels inside the group, we can easily set the x and y attribute.

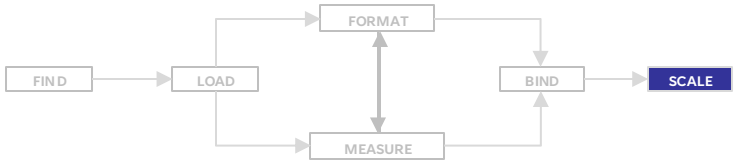



```
const barAndLabel = svg
.selectAll("g")
.data(data)
.join("g");
```

```
barAndLabel
.append("text")
.text ("Line 1")
.attr("x", x)
.attr("y", y)
.attr("text-anchor", "end")
.attr("font-family", "sans-serif");
```

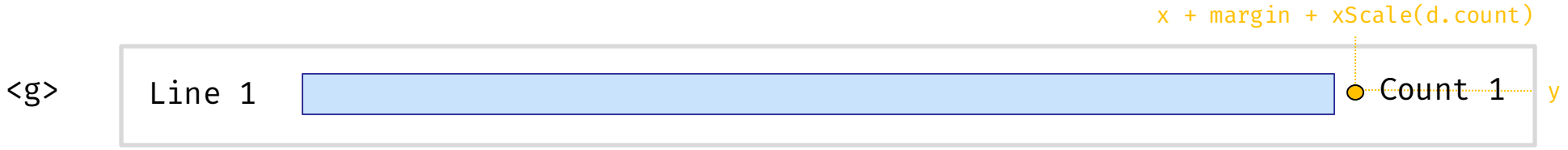
If we want that our text is aligned with the start of the bar, we can set the `text-anchor` to `end`.





Adding labels to a chart

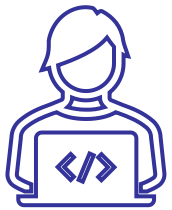
- To compute the exact position of our labels inside the group, we can easily set the x and y attribute.

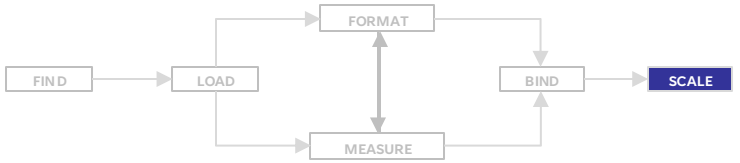



```
const barAndLabel = svg
.selectAll("g")
.data(data)
.join("g");
```

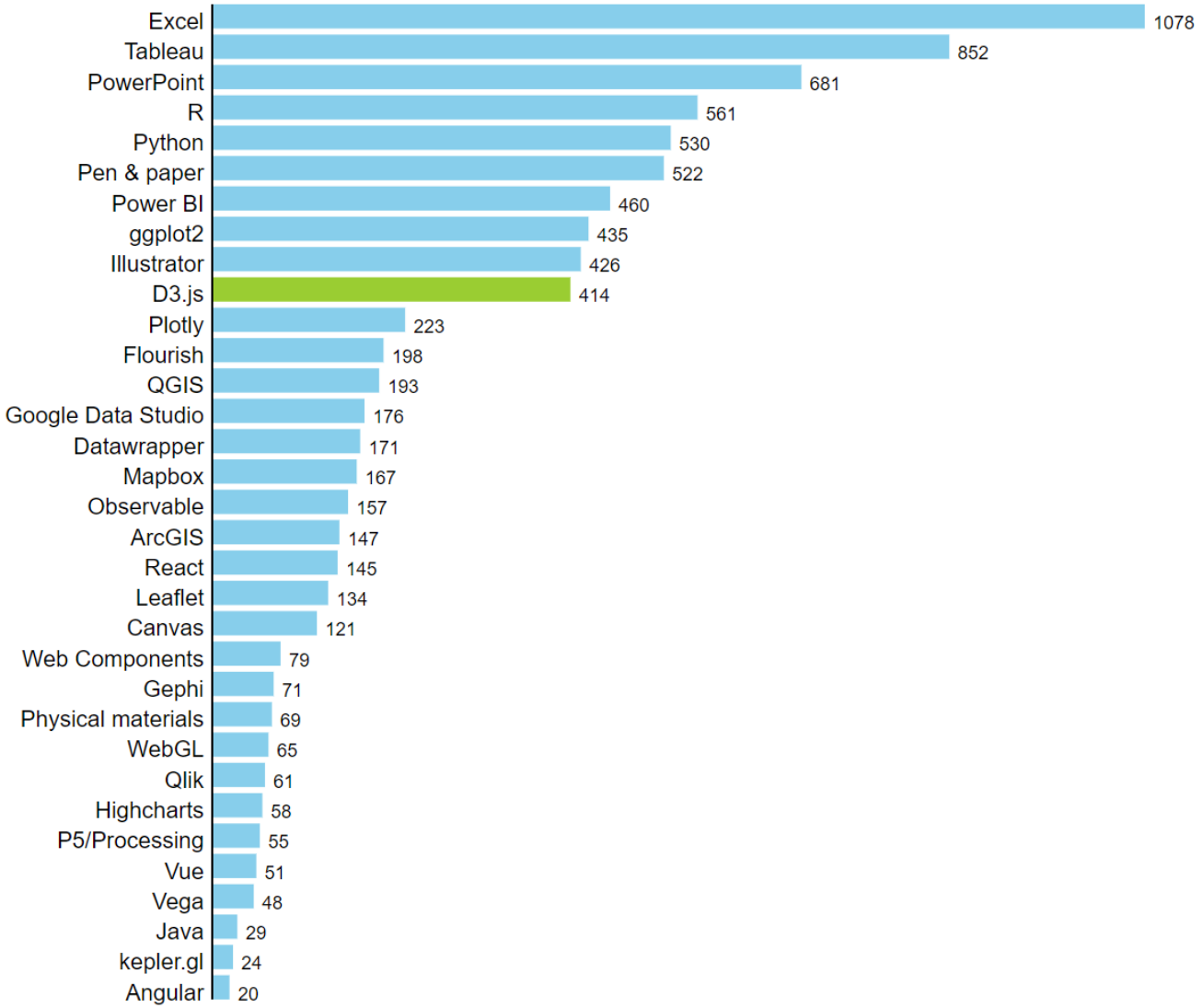
```
barAndLabel
.append("text")
.text ("Count 1")
.attr("x", x + xScale(d.count) + margin)
.attr("y", y)
.attr("font-family", "sans-serif");
```

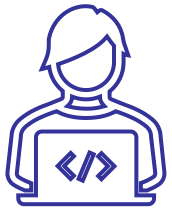
Here x is the starting point of the previous label.





Visualization

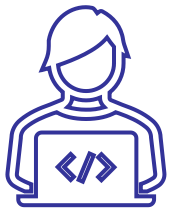




D3: Drawing Functions

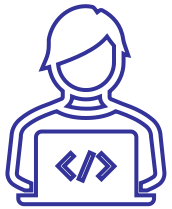
For a written guide of this tutorial, please refer to the **README.md** file in the **L2** folder. You can open the file either in VSCode or Github.

This tutorial was taken from Chapter 4 of “D3.js in Action, Third Edition”



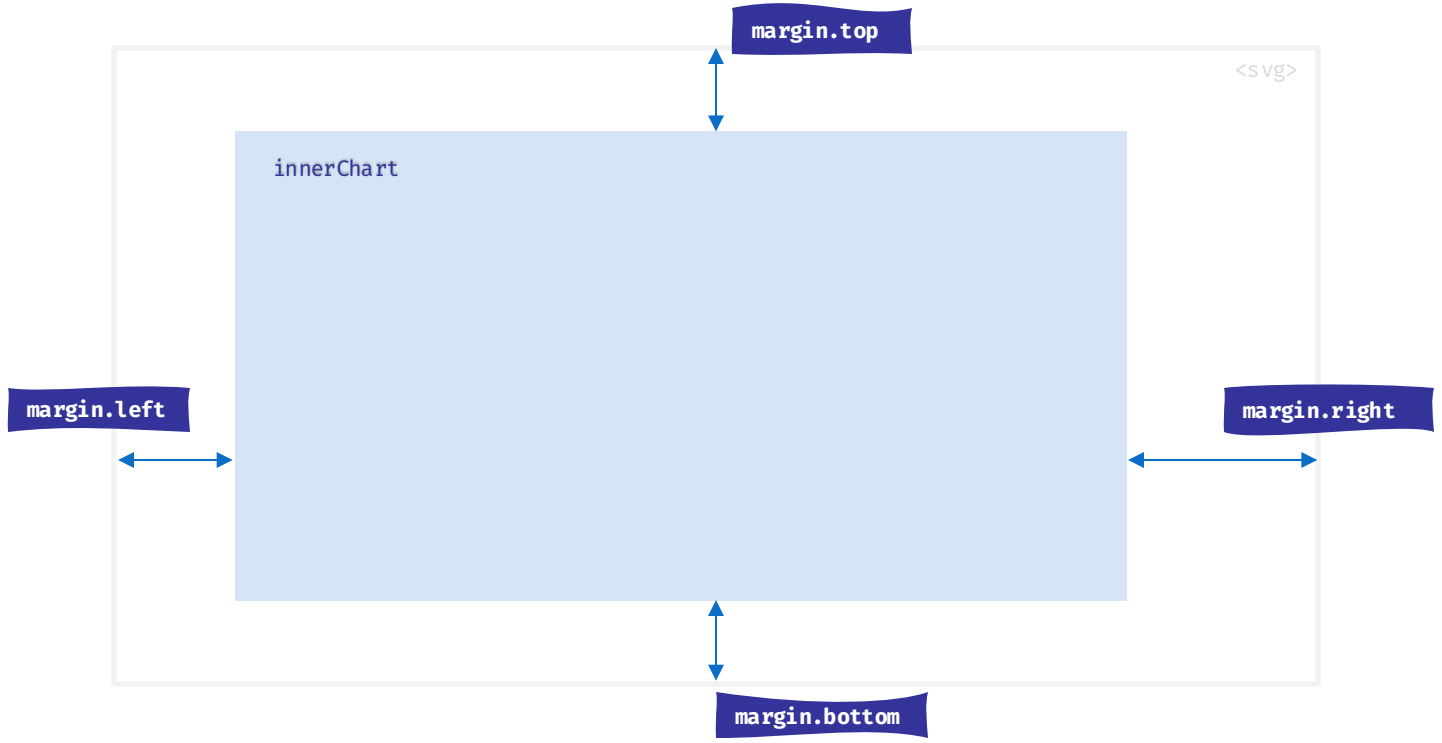
D3 and paths

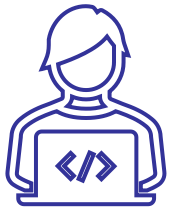
- In the last tutorial, we built a bar chart using only SVG primitives.
- However, to create more complex visualizations, we will generally use **SVG paths**.
- The shape of an SVG path is determined by its `d` attribute:
  - As we already saw in the previous lesson, the `d` attribute of a path can become very long, very fast.
- In this second tutorial, we will learn how to use **D3 shape generators** to automatically draw paths.



D3 Margin Convention

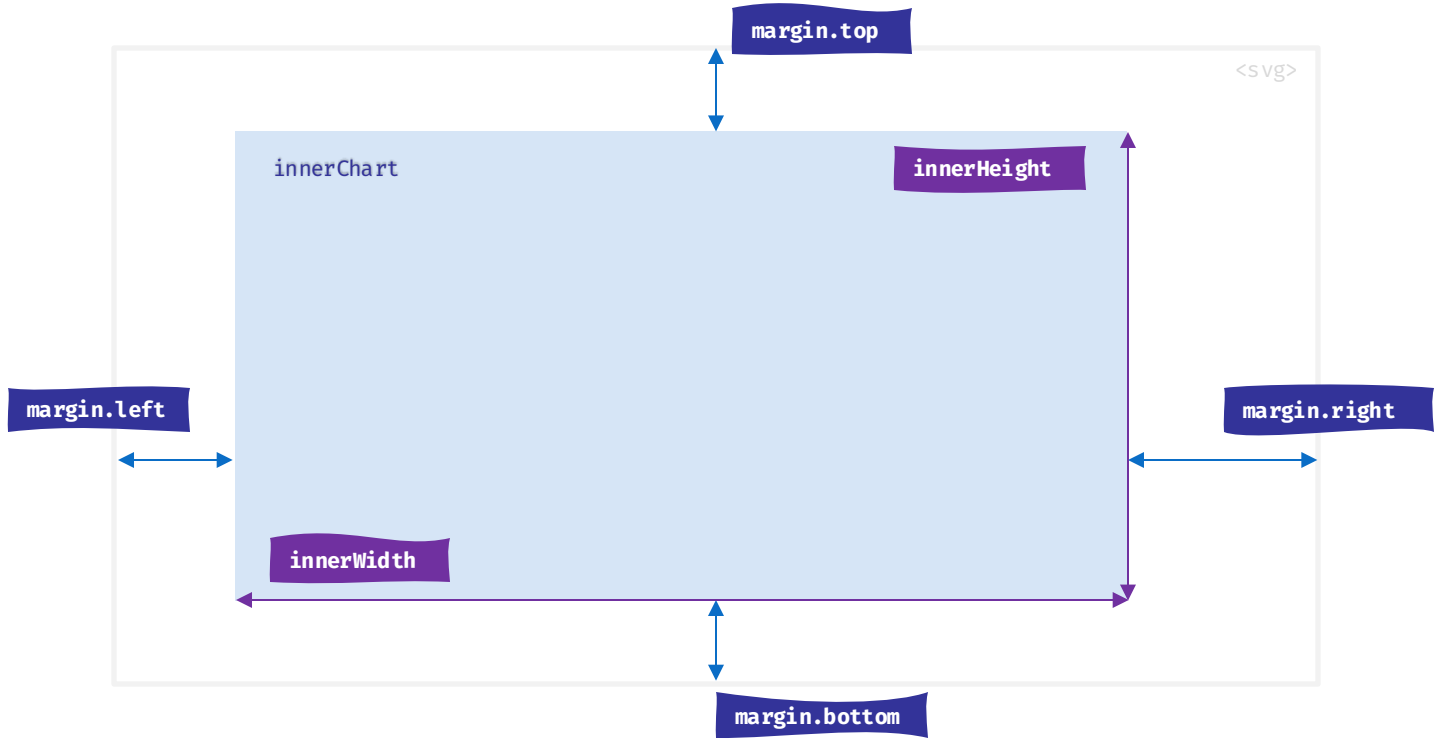
- Before introducing the shape generators, we will briefly talk about the **Margin Convention** and **Axes Generator**.
- D3 **Margin Convention** is a summary of best practices, aimed at reserving space around a chart for axes, labels, and legend in a systematic and reusable way.
- This convention use a `top`, `right`, `bottom`, and `left` margin.
- By defining these margins, we know the remaining area for the chart, usually called the **Inner Chart**.

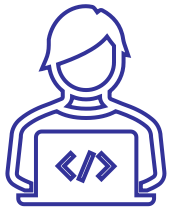




D3 Margin Convention

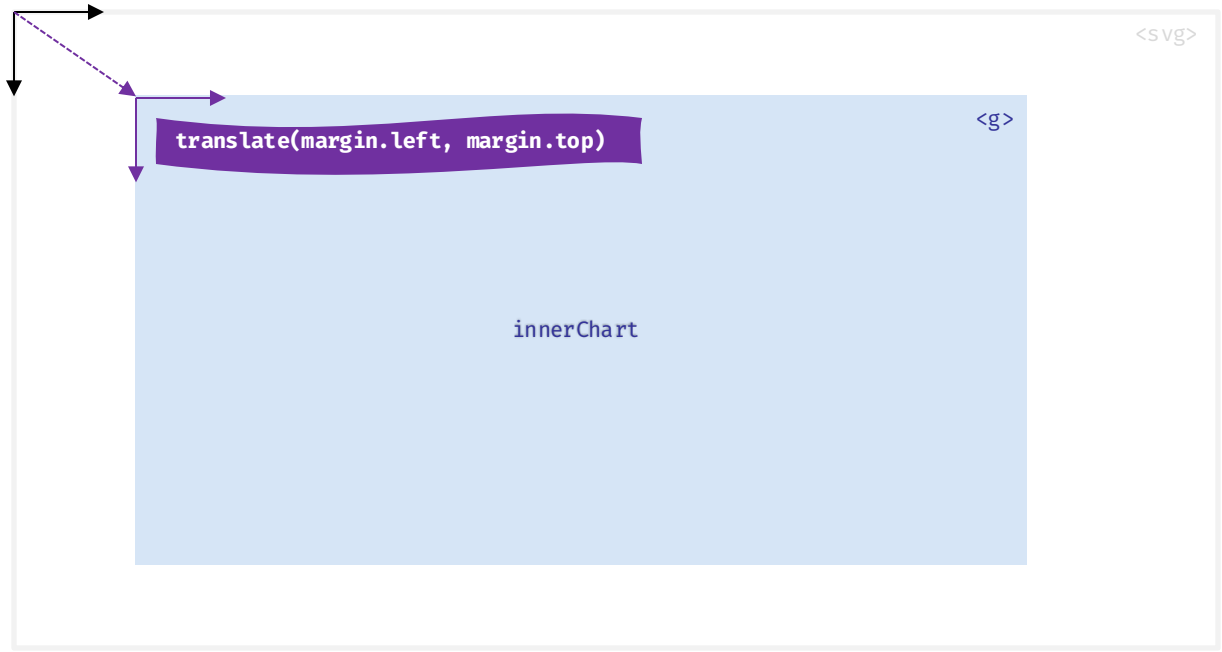
- If we know the size of the `svg` container and the **margins**, we can compute the `innerWidth` and `innerHeight` of the chart.
- By making these two variables proportional to the margins and the svg container size, we ensure that they will **automatically adjust** if we need to change these margins.
  - In fact, for now we are just guessing how much space we need to reserve.

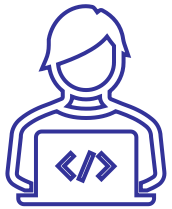




D3 Margin Convention

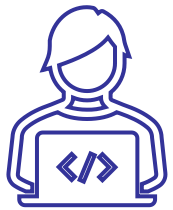
- A useful strategy is to **wrap** the elements constituting the chart itself into an **SVG group** and position this group inside the SVG container based on the margins.
- This creates a new origin for the chart elements and facilitates their implementation.





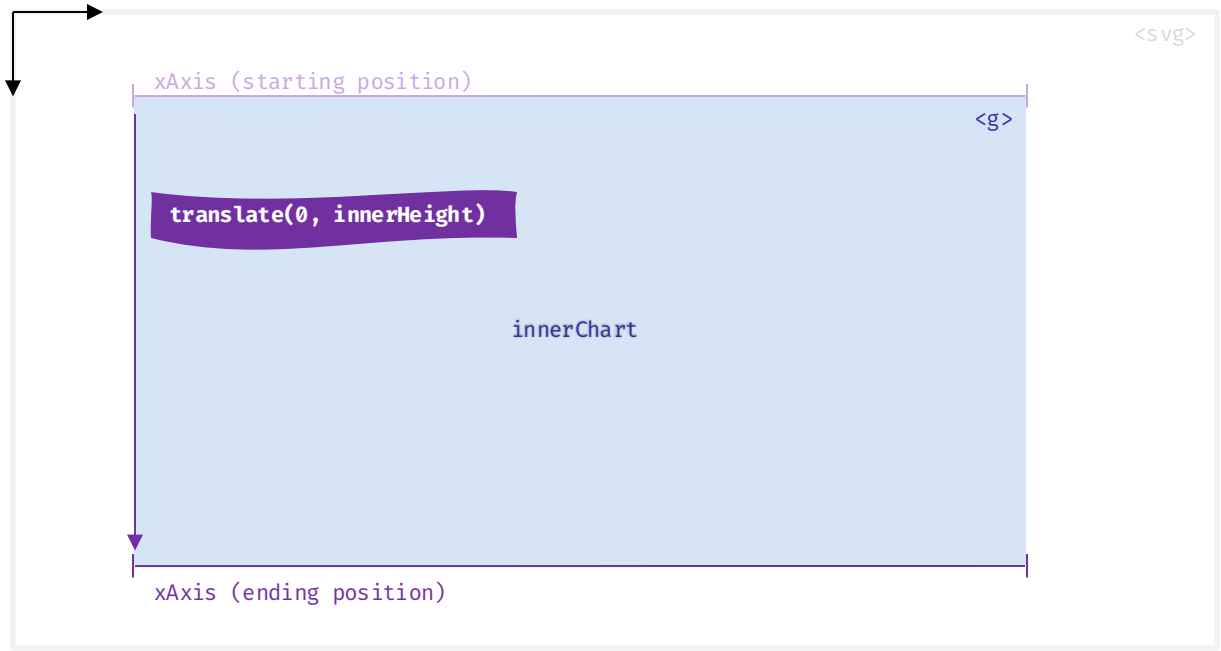
D3 Generating Axes

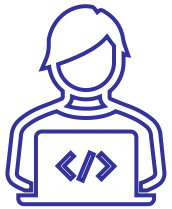
- **Axes** are references for the reader to better understand the numbers and values represented in the chart.
- D3 has four axis generators:
  - `axisTop()`, `axisRight()`, `axisBottom()`, and `axisLeft()`, that create the components of top, right, bottom, and left axis, respectively.
- These axis generators take a scale as an **input** and return the SVG elements composing an axis as an **output** (a line along the axis and multiple sets of tick and label).
- We append an axis to a chart by chaining the `call()` method to a selection and passing the axis as an argument.



D3 Generating Axes

- We usually use the `axis.bottom()` and `axis.left()` for the x-axis and y-axis, respectively.
- By default, D3 axes are displayed at the top-left corner of the selection.
  - **Note for the yScale**: the starting point of the range is the `maxValue`, and the last value is the `minValue`.
  - If we wrap an axis and its labels into a group, we can easily translate them in their specific position.





D3 Generating Axes

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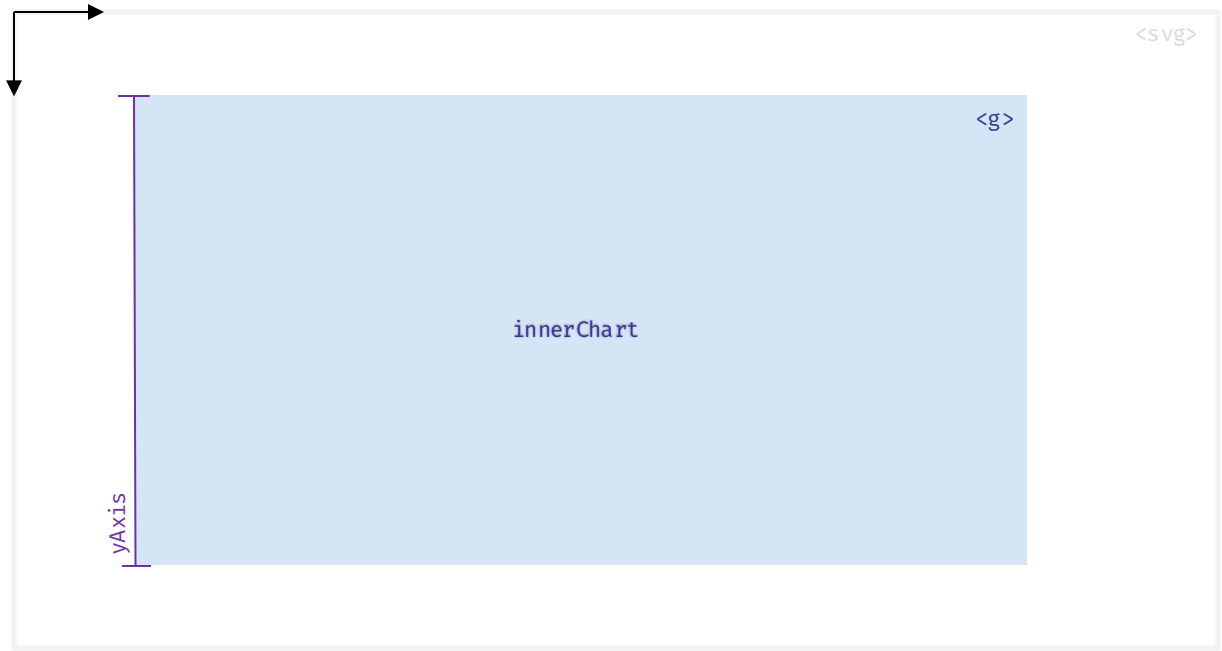
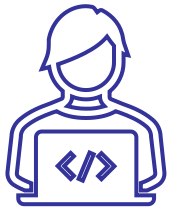
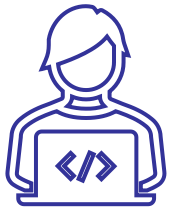




Drawing a Line Chart

- **Line charts** are lines (or curves) connecting (or interpolating) data points.
  - They are usually used to show the **evolution** of a phenomenon over time.
- To draw a line chart, we first initialize a **line generator** with the method `d3.line()`.
  - This will compute the d attribute of the path for us.
- The line generator has two accessor functions, `x()` and `y()`, which compute each data point's horizontal and vertical position.

```
const lineGenerator = d3.line()
    .x((d) => xScale(d.x))
    .y((d) => yScale(d.y));
```



Drawing a Line Chart

```
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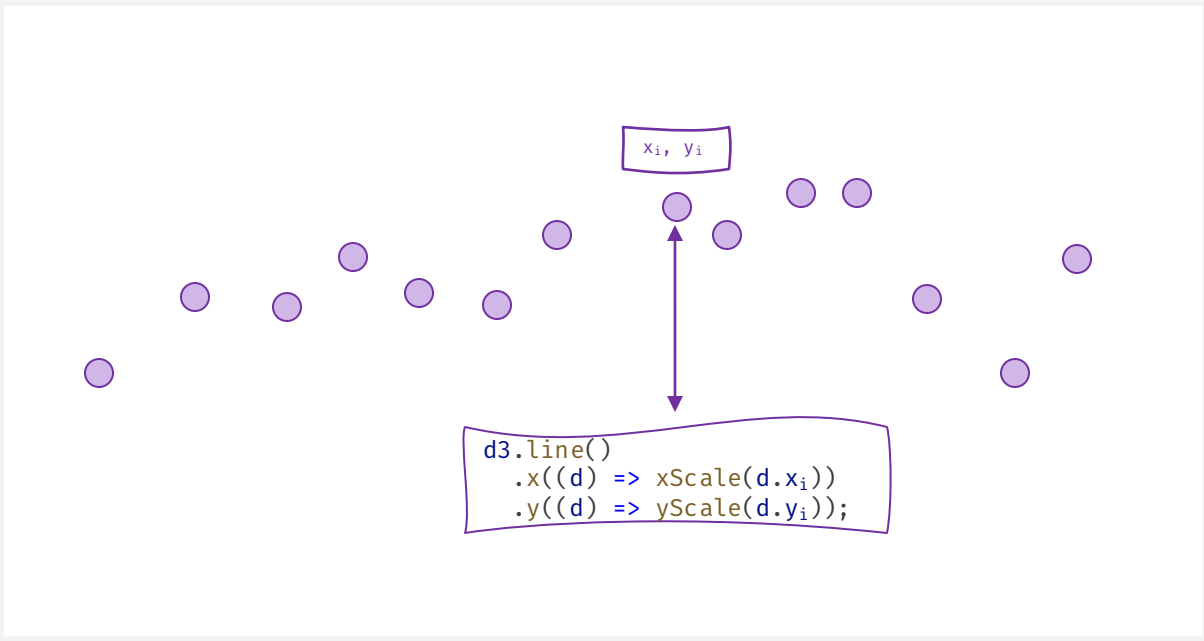
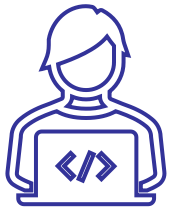
```





Drawing a Line Chart

- We can turn a line chart into a curve with the `curve()` accessor function.
- D3 offers multiple curve interpolation functions, which affect data representation and must be selected carefully.

```
const curveGenerator = d3
    .line()
    .x((d) => xScale(d.x))
    .y((d) => yScale(d.y))
    .curve(d3.curveCatmullRom);
```

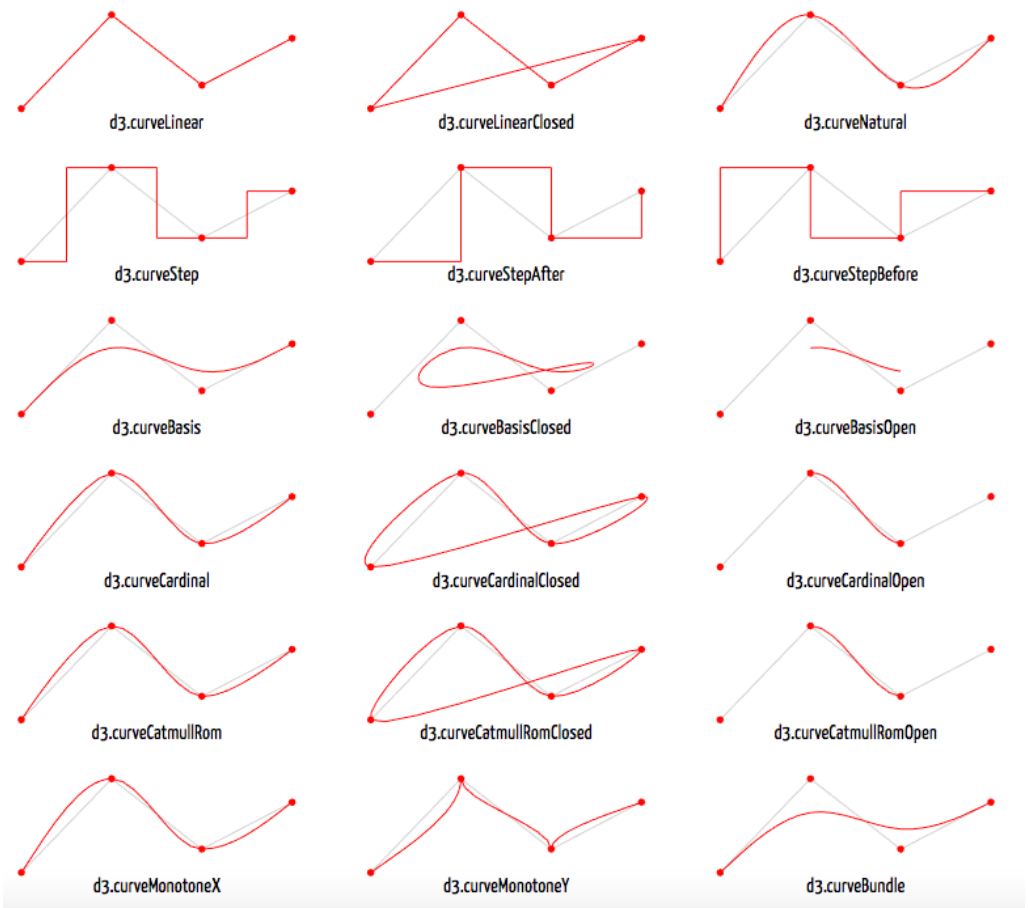
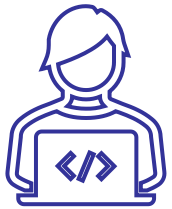


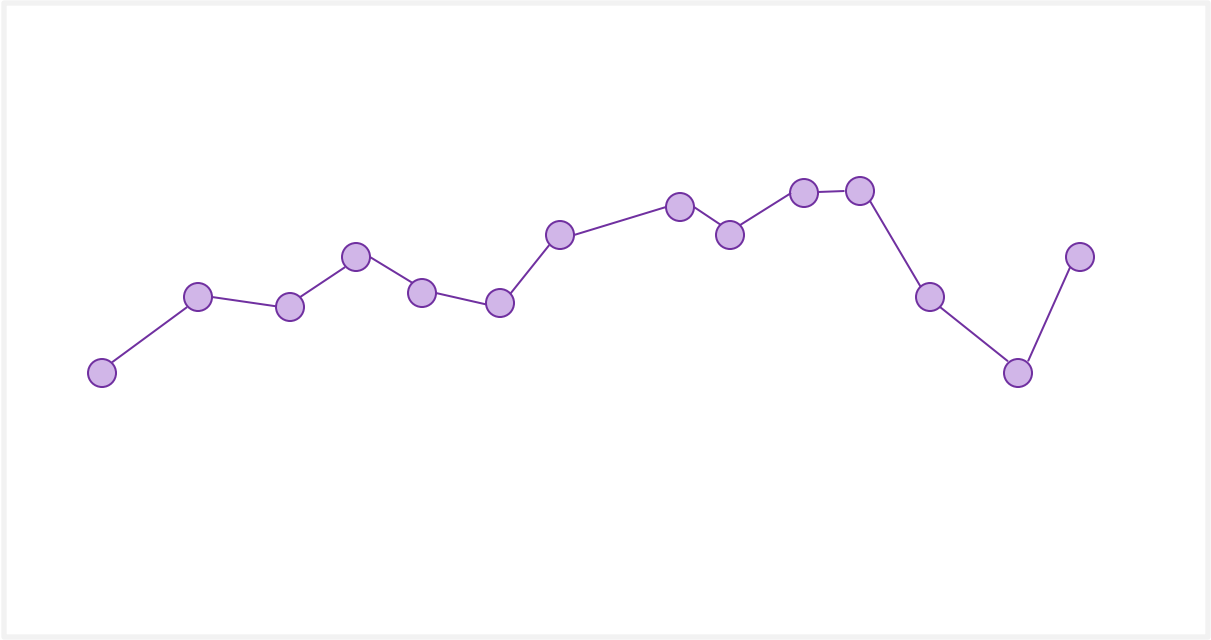
Image from: Learn D3.js

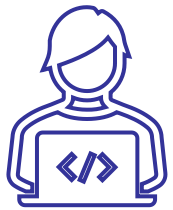


Drawing a Line Chart

- To make a line chart appear on the screen, we **append a path** element to a selection and set its d attribute by calling the line generator and passing the dataset as an attribute.

```
innerChart
    .append("path")
    .attr("d", lineGenerator(data))
    .attr("fill", "none")
    .attr("stroke", purple);
```

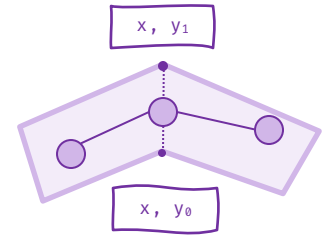


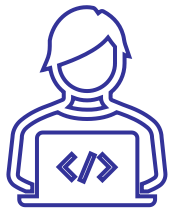


Drawing the Area

- An **area** is a region between two boundaries, and drawing an area with D3 is like drawing a line.
- To draw an area, we first declare an **area generator** with the method `d3.area()`.
  - This method requires at least three accessor functions to calculate the position of each data point along the edges of the area.

```
d3.area()
  .x((d) => xScale(d.xValue))
  .y0((d) => yScale(d.y0Value))
  .y1((d) => yScale(d.y1Value));
```

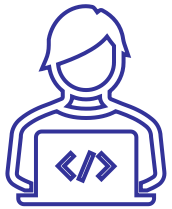




Drawing the Area

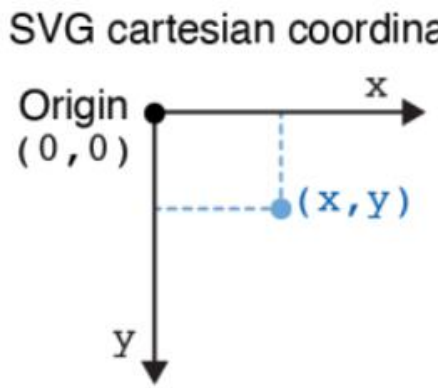
- All the things we saw for lines are **still valid** for areas. In particular:
  - D3 provides interpolation functions that can be applied with the `curve()` accessor function.
  - To make an area appear on the screen, we **append a path** element to a selection and set its `d` attribute by calling the area generator and passing the dataset as an attribute.

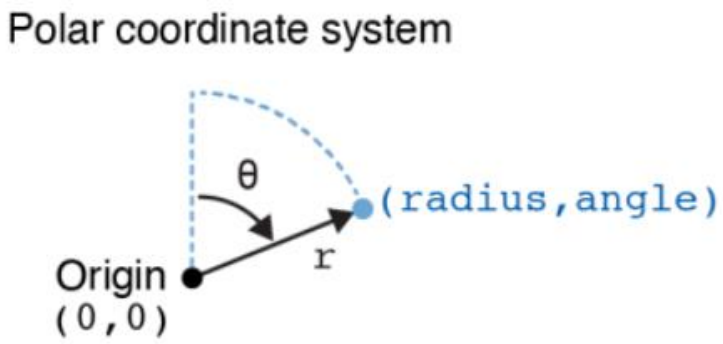
```
innerChart
  .append("path")
    .attr("d", areaGenerator(data))
    .attr("fill", aubergine)
    .attr("fill-opacity", 0.2)
```



Drawing Arcs

- **Arcs** are a common shape in pie charts.
- Like lines and areas, arcs are drawn with **SVG paths**.
- It is easier to work with a **polar coordinates** system when working with arcs:





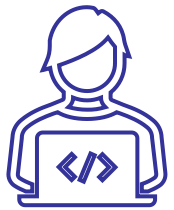
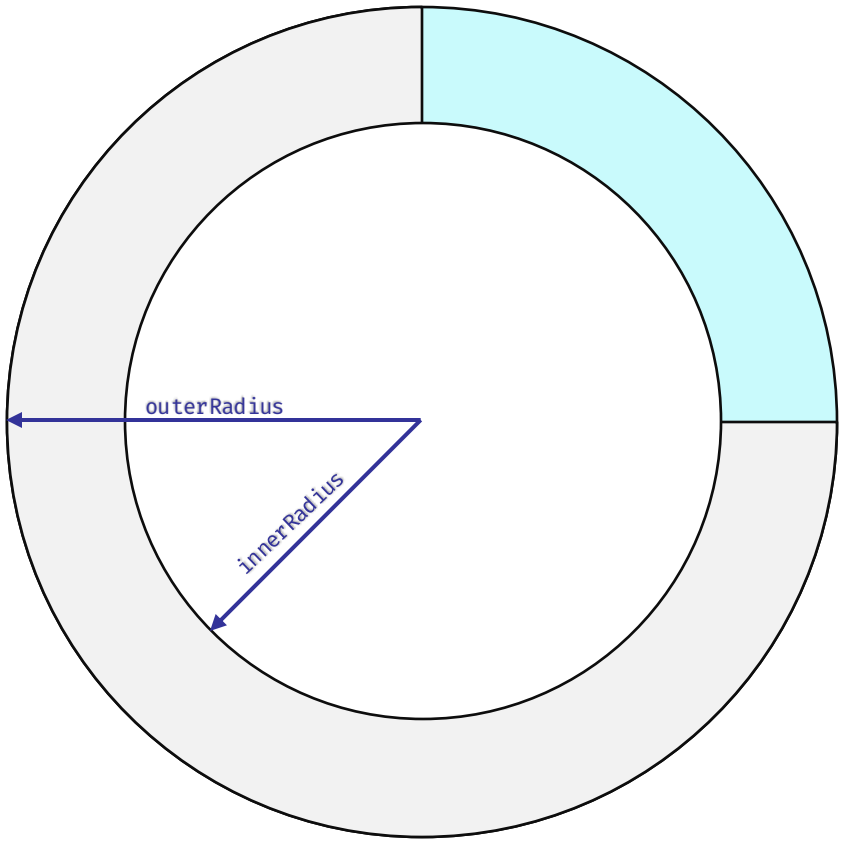


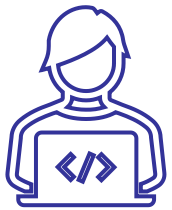
Image from: Chapter 4, “D3.js in Action”

Drawing Arcs

- We can use the `d3.arc()` function to compute the chart.
- It requires two main accessor functions:
  - `innerRadius(radius1)`
  - `outerRadius(radius2)`
- Then, one can also add, by chaining:
  - `padAngle(radians):` to add padding
  - `cornerRadius(pixels):` to smooth the corner

```
const arcGenerator = d3.arc()
    .innerRadius(radius1)
    .outerRadius(radius2)
    .padAngle(radians)
    .cornerRadius(pixels);
```



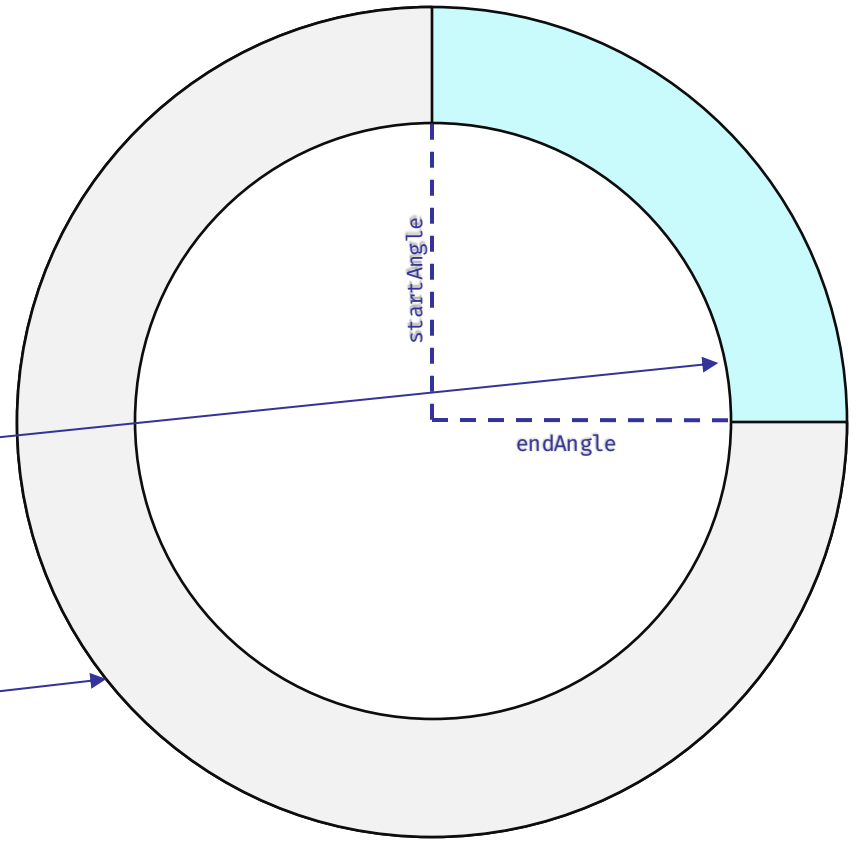


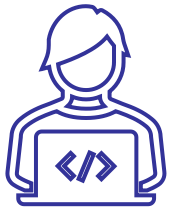
Drawing Arcs

- We can manually compute the start and end angle for our chart.
  - These values can then be passed to the generator.

```
innerChart.append("path").attr("d", () => {
  return arcGenerator({
    startAngle: 0,
    endAngle: endAngle,
  });
});
```

```
innerChart.append("path").attr("d", () => {
  return arcGenerator({
    startAngle: endAngle,
    endAngle: 2*Math.PI,
  });
});
```

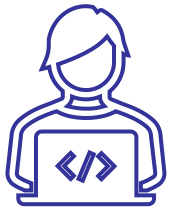




D3: Improving Readability

For a written guide of this tutorial, please refer to the **README.md** file in the **L2** folder. You can open the file either in VSCode or Github.

This tutorial was taken from Chapter 4 and Chapter 7 of “D3.js in Action, Third Edition”



Adding Labels

- **Labels** are particularly useful to help readers understand our data visualizations.
- In D3, labels are simply **text elements** that we need to position within the SVG container.
  - The position of SVG text is controlled by its `x` and `y` attributes.
- The `y` attribute sets the position of the text's baseline, which by default is positioned at its bottom.
- We shift the baseline of an SVG text with the attribute `dominant-baseline`.
- The value `middle` moves the baseline to the vertical middle of the text, while the value `hanging`, shifts the baseline to the top.

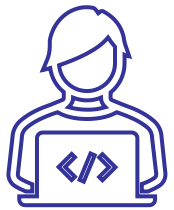
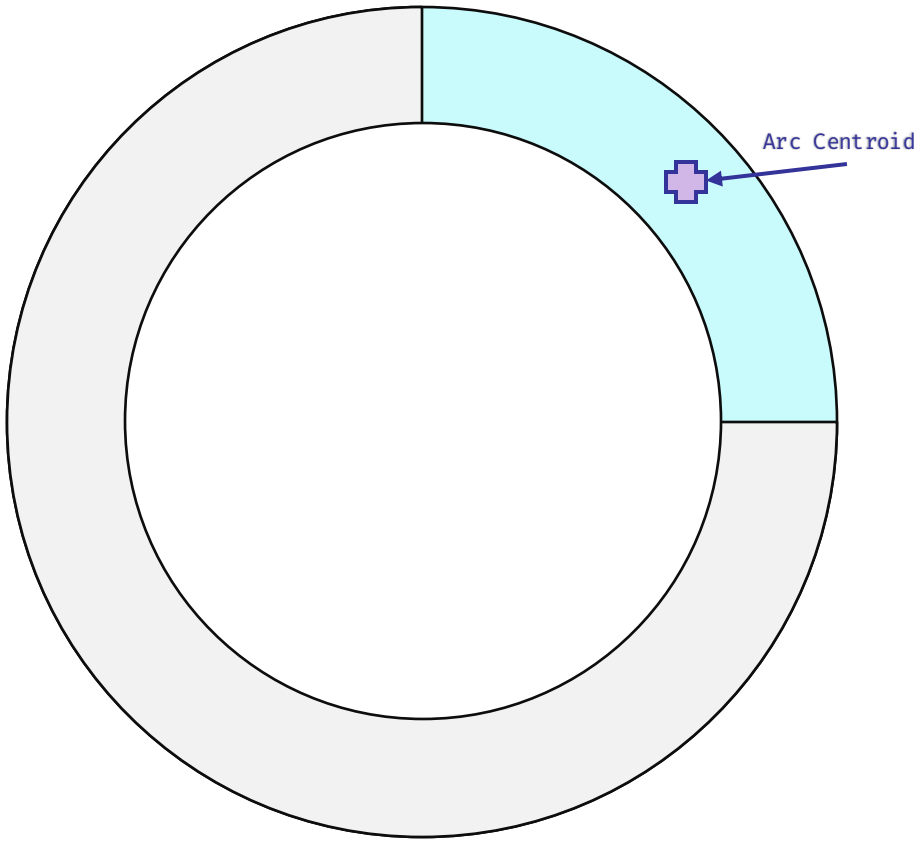


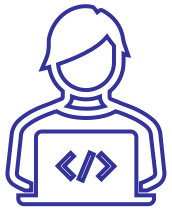
Image from: Chapter 4, "D3.js in Action"

Calculating the centroid of an Arc

- The **center of mass** of an arc can be calculated with the `centroid()` method.
- Chained to an arc generator, this accessor function returns an array containing the horizontal and vertical position of the center of mass.

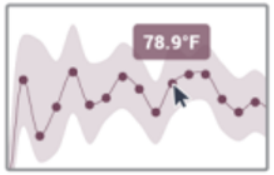
```
const centroid = arcGenerator
    .startAngle(0)
    .endAngle(radiansDaysWithPrec)
    .centroid();
```



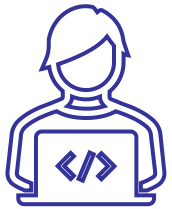


Add Tooltips

- **Tooltips** are the simplest interaction that one can add to a visualization.
- They enhance the readability of the chart by showing some information of the data without over-pollute the visualization.
- Tooltips are shown on **mouseover**.



- When building tooltips, it is better to avoid **obstructing** the view of the adjacent markers.
  - One trick is to make the tooltip's background **semi-transparent**.

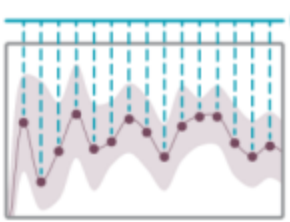


Add Tooltips

1. Build the tooltip with SVG elements and append it to the inner chart. Set its opacity to zero.

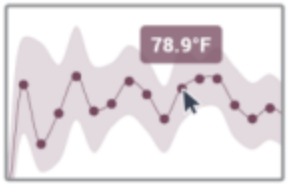

```
<g>
  <rect />
  <text></text>
</g>
```

2. Attach two event listeners to each circle: one for the "mouseenter" event and one for "mouseleave".




```
.on("mouseenter", (e, d) => {
  // Do something
})
.on("mouseleave", (e, d) => {
  // Do something
});
```

3. When the mouse is positioned over a circle, populate the tooltip with the average temperature data attached to the circle element. Then translate the tooltip over the circle, and set its opacity to 100%.

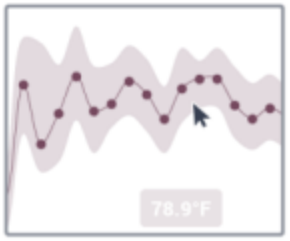



```
.on("mouseenter", (e, d) => {

  text => data
  position => above circle
  opacity => 100%

})
```

4. When the mouse leaves the circle, change the tooltip's opacity back to zero and move it away from the chart.




```
.on("mouseleave", (e, d) => {

  opacity => 0
  position => away from chart

})
```

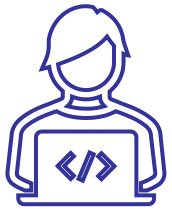


Image from: Chapter 7, “D3.js in Action”