INTRODUCTION TO

D3.js

INTRODUCTIONS

GitHub

jmeade11

Skype

jmeade11

LinkedIn

linkedin.com/in/jenniferannmeade

CREATING CAREERS DAILY

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CODING

DATA

PRODUCT MANAGEMENT

UX & DESIGN

DIGITAL MARKETING

BY THE NUMBERS

20
WORLDWIDE CAMPUSES

60k+
GLOBAL ALMUNI

2,500+
HIRING PARTNERS

250+
EXPERT INSTRUCTORS

FOR THIS WORKSHOP

- To work through the **Code Along** and **Lab** exercises, install the Atom text editor from **atom.io**
- Then, in the Atom menubar, go to Atom > Preferences > Install and search for and install **Emmet**
- Create an account at **codepen.io** if you don't already have one!
- Wifi: **GA Guest** Password: **yellowpencil**
- Live presentation link: **slides.com/jennifermeade/d3js/live**

A QUIZ ALREADY?

CHECKPOINT #1: About You

What is your comfort level with HTML & CSS:

- [ ] I'm a super-HTML-coding-ninja-master (expert-level)
- [ ] It ain't all that hard, ya' know? (intermediate-level)
- [ ] Wait, what's HTML & CSS? (novice -level)

How about Javascript:

- [ ] Oh yeah, Javascript is my jam.
- [ ] Meh, I dabble.
- [ ] Wait, what's Javascript...am I in the wrong room?

WORKSHOP TOPICS

- What is D3.js?
- How Web Pages Work
- HTML & SVG Basics
- Using D3.js to Create SVGs
- Building a Data-Driven SVG
- Understanding Scales
- Animating with Transitions
- Working with Events in D3.js
- Fetching Data

WHAT IS D3?

D3 stands for **data-driven documents**. It's a powerful javascript-based toolset for visualizing data.

D3 REQUIREMENTS

HTML 5

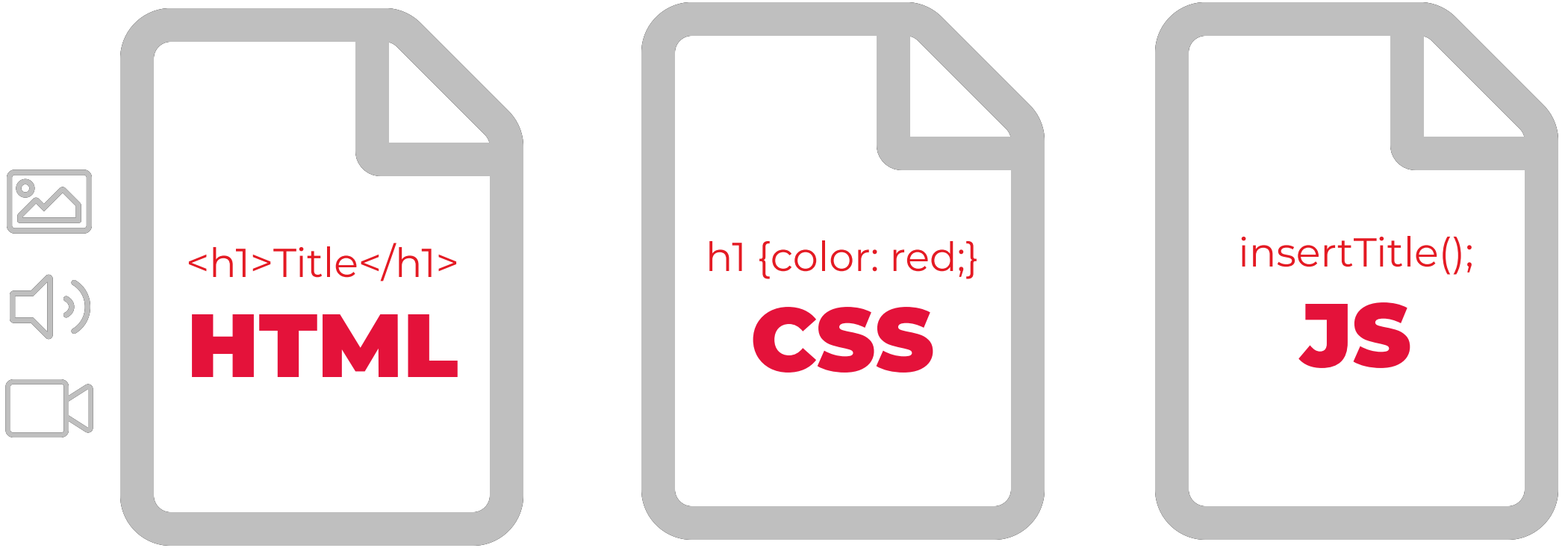
CSS 3

D3.js

A browser that supports inline SVG,
modern CSS and the D3.js file.

HOW WEB PAGES WORK

WEB PAGE COMPONENTS



HYPERTEXT MARKUP LANGUAGE

HTML provides the ***structure*** for your web pages

CASCADING STYLE SHEETS

CSS defines how the elements of the web page ***look***

JAVASCRIPT

Javascript allows us to incorporate ***interactivity***

SCALABLE VECTOR GRAPHICS

SVG is a ***markup language*** used to create vector graphics.

SVG IN HTML

With HTML5, we can add SVG markup directly inside our HTML page, known as ***inline SVG***.

INLINE SVG SUPPORT TABLE

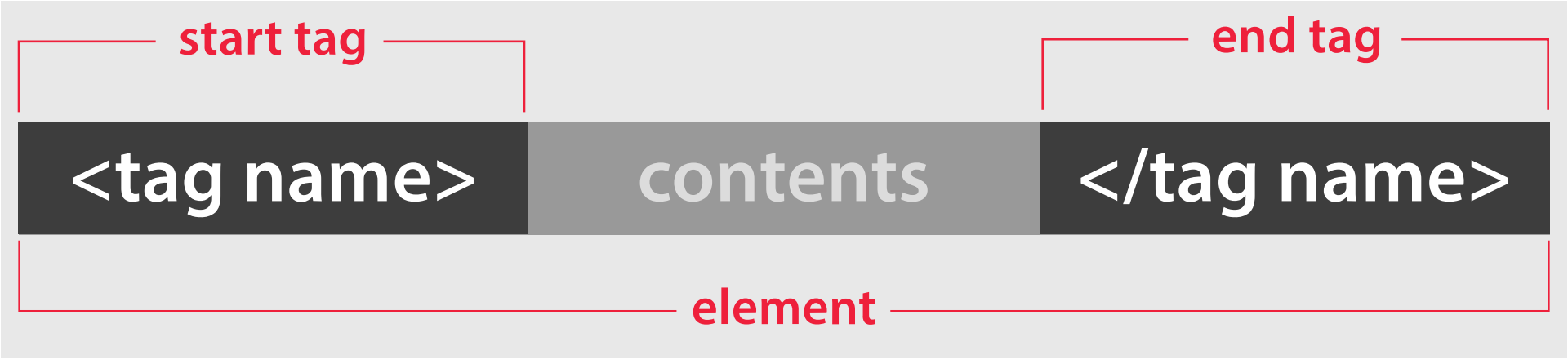
https://caniuse.com/#search=inline%20svg

HTML & SVG BASICS

OBJECTIVES

- Understand the basics of HTML and SVG markup.
- Understand the essential anatomy of a web page and create a valid HTML page.
- Create links to external files within the HTML page.
- Understand SVG primitives and their corresponding required attributes.

XML SYNTAX



Some tags only have a start tag. In HTML5, we just leave off the end tag for those, **but for SVG** we end the start tag with `/>`.

ADDING ATTRIBUTES

GETTIN' ALL MARKUPY

```
<!-- XML Tags -->
<customer-invoice>
    <invoice-date>Wed Sep 12 2018 18:57:00</invoice-date>
    <customer-account>003492748</customer-account>
</customer-invoice>

<!-- HTML Tags -->
<p>This is a paragraph.  The p tag requires no attributes.</p>

<ul>
    <li>This is an unordered list item.</li>
</ul>

<a href="https://developer.mozilla.org">Anchor tags require an href attribute</a>

<input type="text" placeholder="input tags are forbidden to have an end tag">

<!-- SVG Tags -->
<svg viewBox="0 0 400 200">
    <circle cx="50" cy="50" r="10" />
    <rect width="20" height="20" x="100" y="100" />
</svg>
```

WHAT'S UP DOC?

- The doctype is the first thing that goes on an html page
- The **HTML5** doctype below tells the browser to behave strictly according to the standards
- Case-insensitive but conventionally written as:

```
<!DOCTYPE html>
```

ANATOMY OF A WEBPAGE

Every HTML page has the same foundational structure

```
<!DOCTYPE html>
<html>
    <head>

        <meta charset="UTF-8">
        <title>Page Title</title>

    </head>
    <body>

        <!-- Where your content goes -->

    </body>
</html>
```

HTML BOILERPLATE

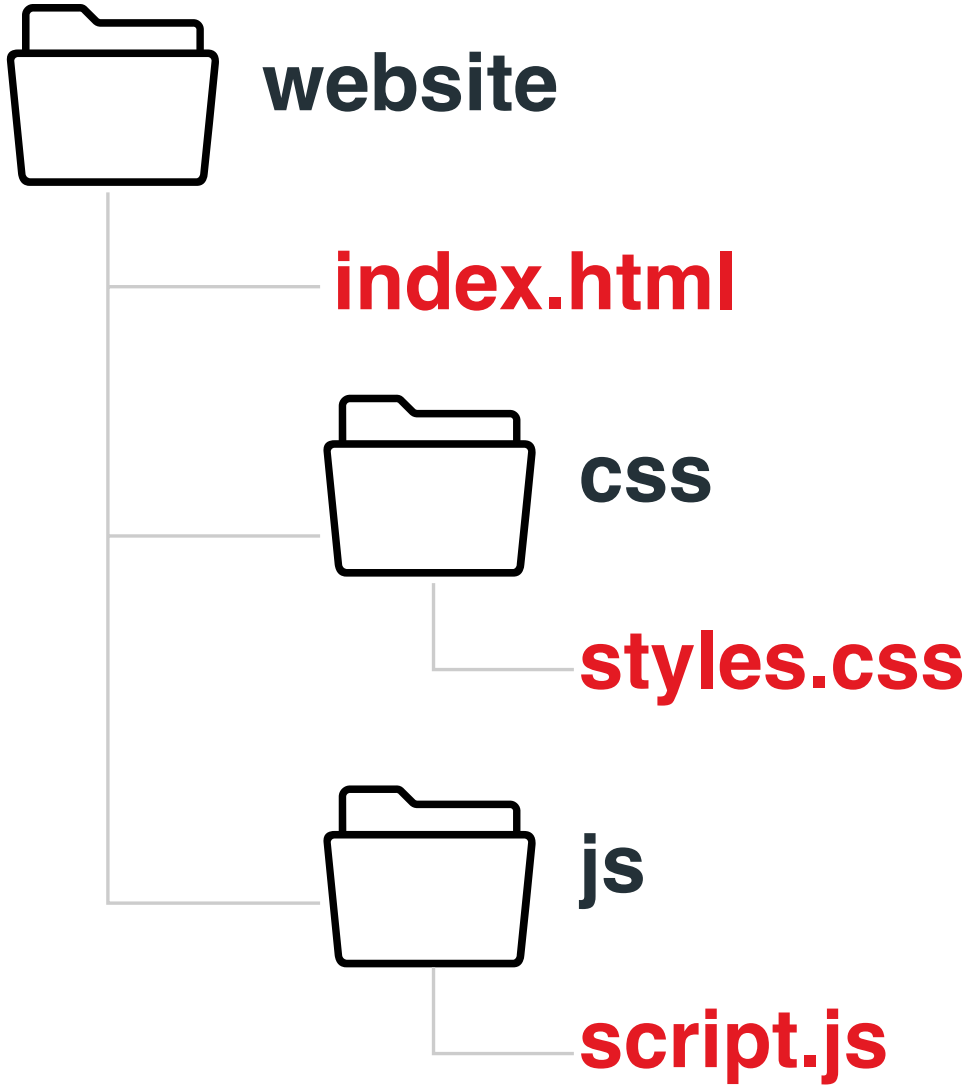
LINKING FILES TO HTML

To keep our HTML manageable and maintainable, we link separate files for our CSS and Javascript.

```
<!DOCTYPE html>
<html>
    <head>
        <meta charset="UTF-8">
        <title>Page Title</title>
        <link rel="stylesheet" href="styles.css">
    </head>
    <body>

        <!-- Where your content AND Javascript goes -->
        <script src="scripts.js">
    </body>
</html>
```


Notice how the link tag goes in the head but the script tag is in the body.

LINKING FILES RELATIVELY



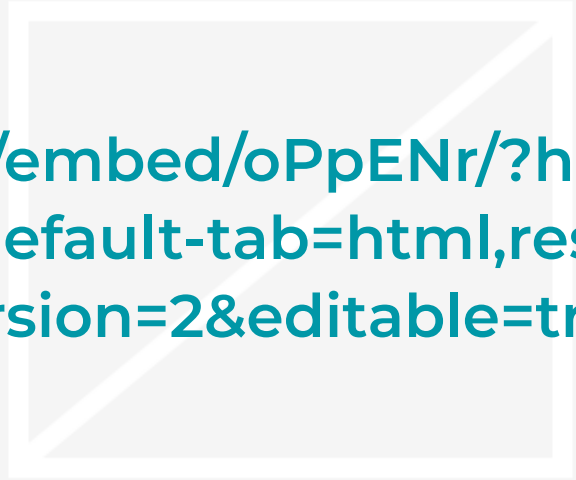
- index.html → styles.css:

```
href="css/styles.css"
```

- What would the javascript link look like?

```
src="js/scripts.js"
```

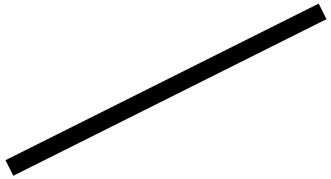
SVG BASICS



//codepen.io/jme11/embed/oPpENr/?height=265&theme-id=default&default-tab=html,result&embed-version=2&editable=true

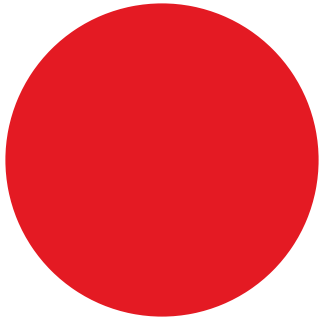
https://codepen.io/jme11/pen/oPpENr/

REQUIRED ATTRIBUTES



line

- x1
- y1
- x2
- y2

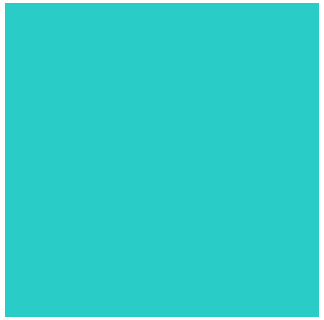


circle

- cx
- cy
- r

path

- d



rect

- width
- height
- x
- y
- rx
- ry

USING D3 TO GENERATE SVGS

SELECTIONS

- Selections target the page elements we want to operate on
- D3.js uses selection methods similar to jQuery and the .querySelector() and .querySelectorAll() methods in Javascript
- Any valid CSS selector except pseudo elements can be used in the selection method

SELECTION METHODS

```
// Select only the element with an id of chart

d3.select('#chart');

// Select only the first element with a class of triangle

d3.select('.triangle');

// Select ALL of the elements with a tag of div

d3.selectAll('div');
```

APPENDING ELEMENTS

- The .append() method is used to append elements to the selection.

```
// Select the element with an id of chart
// Append an SVG element

d3.select('#chart')
  .append('svg');
```

It's conventional to break chained methods on to separate lines and indent them to make them more readable.

STORING THE SELECTION

- Storing the selection in a variable makes it easier and more efficient to access this element later in our script

```
// Select the element with an id of chart

let chart = d3.select('#chart')
              .append('svg');
```

ADDING ATTRIBUTES

- The .attr() method allows us to add attributes.
- Takes two parameters: the attribute name and the value to be applied.

```
let svg = d3.select('#chart')
                .append('svg');

// Add a viewBox attribute to the svg
svg.attr('viewBox', '0 0 100 100');
```

ADDING CLASSES

- The .classed() method adds or removes classes.
- Takes two parameters: the class name and true to add or false to remove.

```
// Add a highlight class to all divs
// Remove the active class from any divs

d3.selectAll('div')
  .classed('highlight', true)
  .classed('active', false);
```

ADDING INLINE STYLES

- The .style() method adds an inline style.
- Takes two parameters: the style property and its corresponding value.

```
// Set the opacity of all divs to .9

d3.selectAll('div')
  .style('opacity', .9);
```

MAKING SVGS WITH D3

BINDING DATA

WHAT IS DATA BINDING ABOUT?

- Binding is like “attaching” data to specific elements in our SVG, so that later we can reference those values.
- D3 lets us use the data associated with an element to drive its properties, such as setting its position, height, width or color.
- D3 is so powerful because it lets us use the data in any way we want.

DATA BINDING IN D3

To bind data in D3 we need 2 things: data and a **selection** of elements

Data

[15, 30, 22]

3 PIECES OF DATA

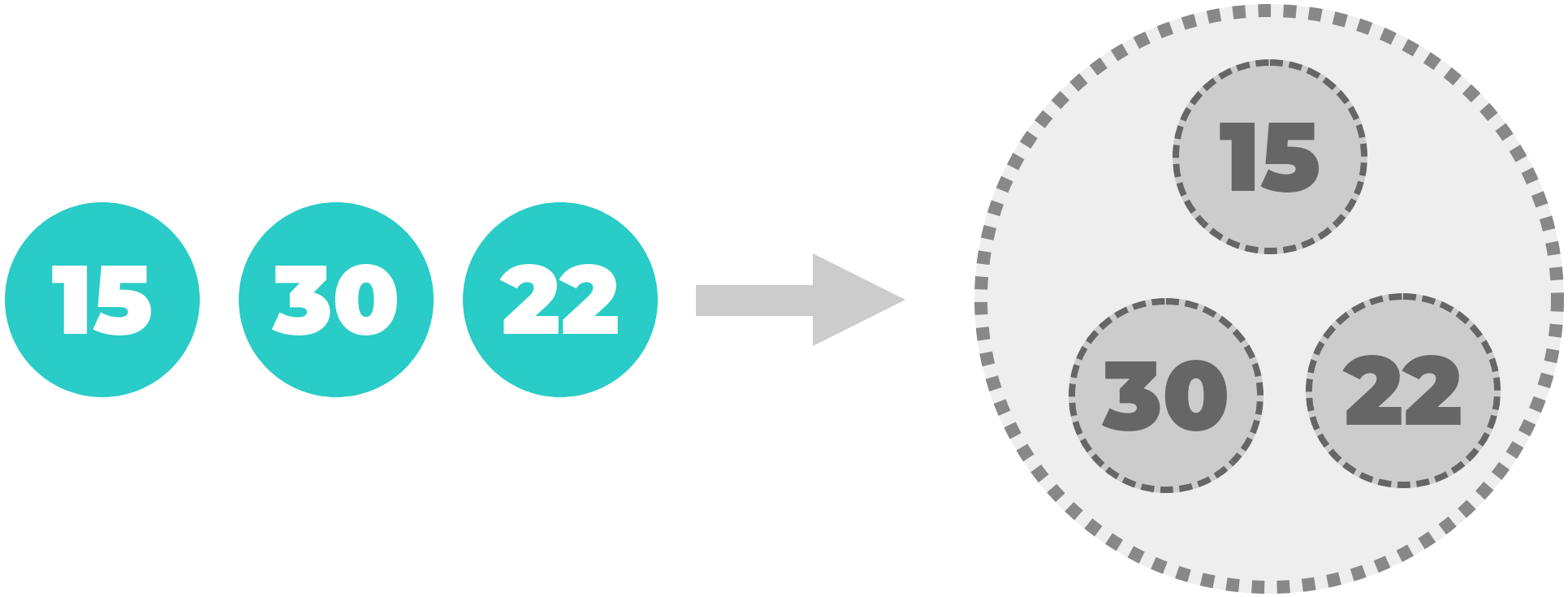
+

Selection

svg.selectAll('rect')

UNKNOWN NUMBER OF ELEMENTS

3 PIECES OF DATA NEED 3 ELEMENTS



Let's see how we achieve this...

DATA METHOD

- The .data() method is how we bind our data to a selection.
- The data method attaches each data element in your data array to an element within the **current selection**.

```
// Select all of the rect elements and
// bind the data array to them

d3.selectAll('rect')
  .data([30,20,10,15]);
```

DATA + SELECTION

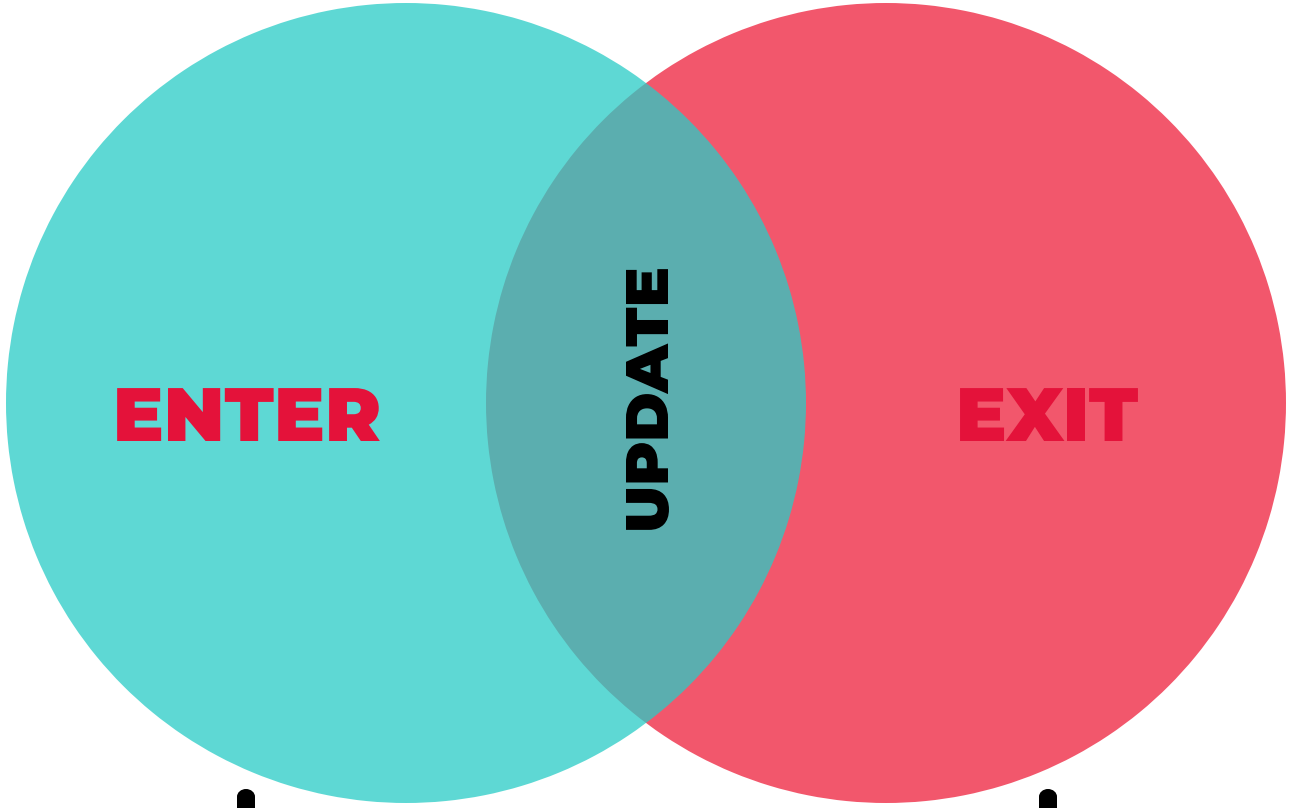
Because our selection may contain a different number of elements than the number of data elements, D3 places the results in three buckets:

ENTER

UPDATE

EXIT

ENTER, UPDATE, EXIT



contains data that have no elements

contains elements that have no data

DATA BUT NO ELEMENT

ENTER

Any data element for which there is no corresponding element in the selection goes into the **enter selection**. The enter selection can be accessed with the .enter() method. This gives us the ability to append a new element for each of the extra data elements.

DATA AND EXISTING ELEMENT

UPDATE

When the data can be attached to an element in the selection, it is. Once the new data is attached, we'll want to merge any new elements that we created from the enter selection and then modify all of properties based on the current data values.

MORE ELEMENTS THAN DATA

EXIT

If there are more elements in the selection than data, the extra elements from the selection go into the **exit selection**. The exit selection can be accessed with the .exit() method. Usually, we use the exit selection to allow us to remove the excess elements.

GENERAL UPDATE PATTERN

```
// Run this function whenever the data changes.

function update(data) {

  // Join new data with old elements, if any.
  const selection = svg.selectAll(/* your selector here */)
                       .data(data);

  // Update old elements as needed.
  selection
    .text('Updated!') // run whatever updates methods

  // Create new elements as needed in the enter selection.
  selection
    .enter().append(/* your selector here */)
    .text('Added!') // run whatever updates methods

  // Merge the entered elements with the update selection.
  // Apply operations to both.
  .merge(selection) // merge takes the selection as its argument
    .text('Merged and added!') // run whatever updates methods

  // Update the elements in the exit selection
  // Most of the time we'll run the remove method here
  div.exit()
    .text('Ready for removal!') // run whatever updates methods
    .remove();
}
```

ENTER-UPDATE-EXIT

USING THE ATTACHED DATA

```
// d is the data on the currently selected element
// i is the index of the currently selected element

d3.method(function(d, i){
  return d;
});
```

- We can use a callback function to access the data on the element.
- In D3, the callback always gets passed 2 values: the **data** on the element and its **index**.
- The value in the return statement is the value that is used in the method for the current element.

DATA-DRIVEN ELEMENTS

//codepen.io/jme11/embed/wRMqPm/?height=265&theme-id=default&default-tab=html,result&embed-version=2&editable=true

https://codepen.io/jme11/pen/LBpQdG

Creating Shapes in D3:

LAB TASKS

1. Add rect elements to the svg for each data point.
2. Remember to use the enter() selection followed by append() since there are no rect elements in the svg
3. Also, make sure that you add the following required attributes for rect elements: x, y, height, width
4. **Bonus:** Can you think of how to evenly space them apart?
   Hint: the iterator is a good multiplier 😉

LET'S SEE HOW YOU'RE DOING

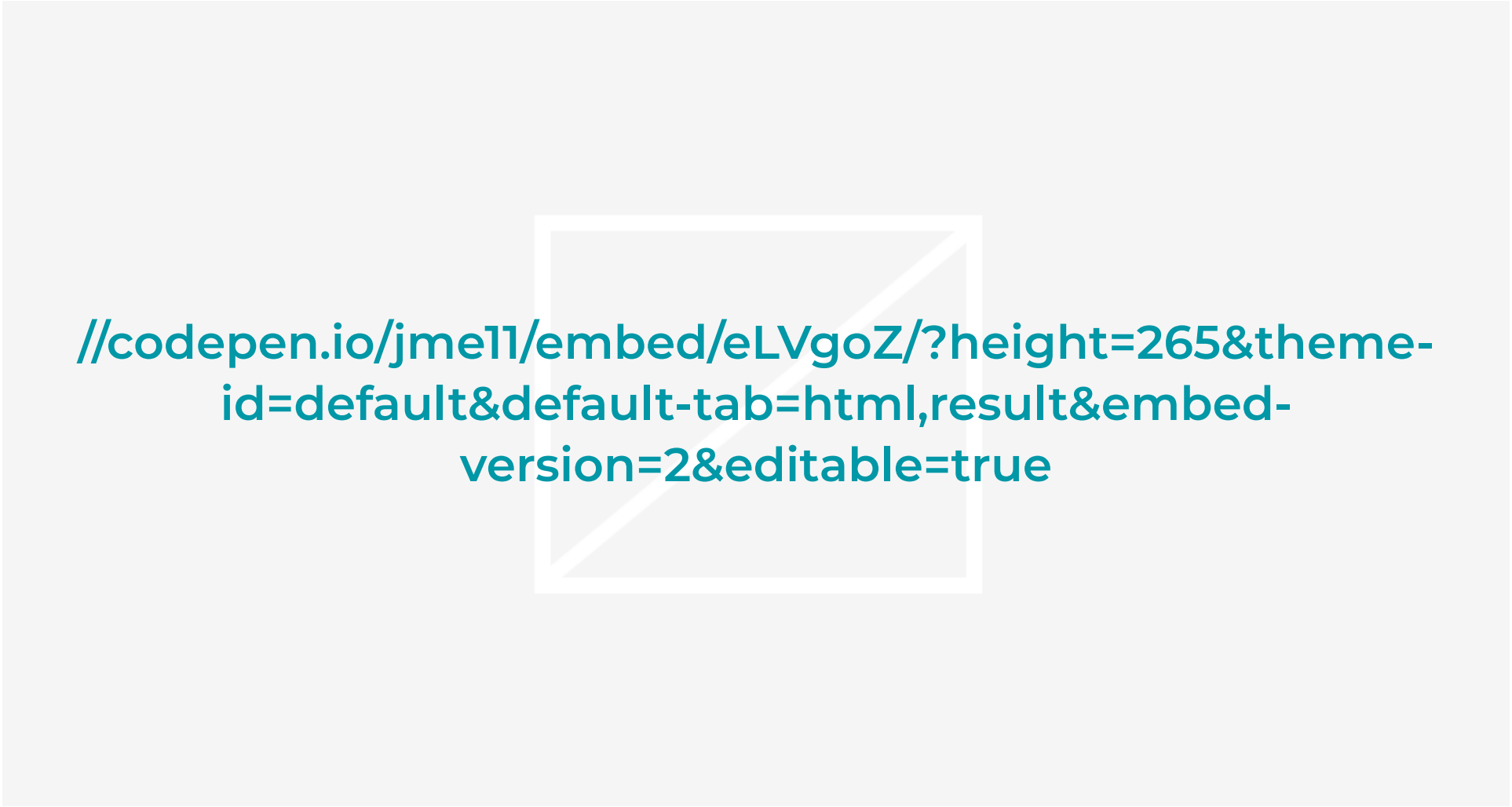
CHECKPOINT #2: Just Checking In

On a scale of 1 to 4 — where 1 is completely lost, and 4 is feeling pretty comfortable — how are you feeling about your grasp of the content so far?

1	2	3	4
○	○	○	○
Wait, what just happened?	Dazed and confused	Patiently waiting for Nirvana	So far, so good!

BUILDING A BARCHART

SOLUTION



https://codepen.io/jme11/pen/eLVgoZ

FLIPPING THE BARS

In SVG, **y values increase from top to bottom.** This is inconsistent with how we tend to visualize data in a Cartesian coordinate system.

```
/* To flip our bars we will subtract their y value
   from the height of the SVG
*/
      .attr('y', function(d,i){
        return svgHeight - y;
      })
```

LINEAR SCALES

The linear scales in D3 **map data to a specific range of values**. Linear scales are also called continuous scales because it maps a serial set of input values to output values.

- d3.scaleLinear()
- domain([*min*, *max*]) **input**
- range([*newmin*, *newmax*]) **output**

MAKING THE BARS FIT VERTICALLY

Linear scale maps the data to the height of the SVG.

```
const yScale = d3.scaleLinear()
                 .domain([0, d3.max(data)])
                 .range([0, height]);


// Use this for our height attribute
// and y attribute

... .attr('height', function(d) {
       return yScale(d)
    })
    .attr('y', function(d){
        return height - yScale(d);
    });
```

ORDINAL SCALES

Sometimes the **order** of the data matters most, such as when we're plotting data that corresponds to dates. In these cases, we'll use an ordinal scale.

- d3.scaleOrdinal()
- scaleBand() **helpful for barcharts**
- padding(), paddingInner(), paddingOuter()

FIT THE DATA HORIZONTALLY

```
const xScale = d3.scaleBand()
        .domain(bardata)
        .paddingInner(.3) // also padding()
        .range([0, width]);


// Use this for our width attribute
// and x attribute

... .attr('width', function(d,i){
        return xScale.bandwidth(); //bandwidth built in method
    })
    .attr('x', function(d,i){
        return xScale(d);
    })
```

ORDINAL SCALE FOR COLORS

```
const colors = d3.scaleOrdinal()
        .range([
         'yellowgreen',
         'darkorange',
         'deepskyblue',
         'darkviolet',
         'deeppink'
]);

// or use built in ones with

// const colors = d3.scaleOrdinal(d3.schemeAccent);

// then use them to style our bars

...   .style('fill', function(d,i){
        return colors(i);
       });
```

GROUPING & TRANSFORMS

The `<g>` element allows us to **group** multiple elements together so that we can apply a single transform to them.

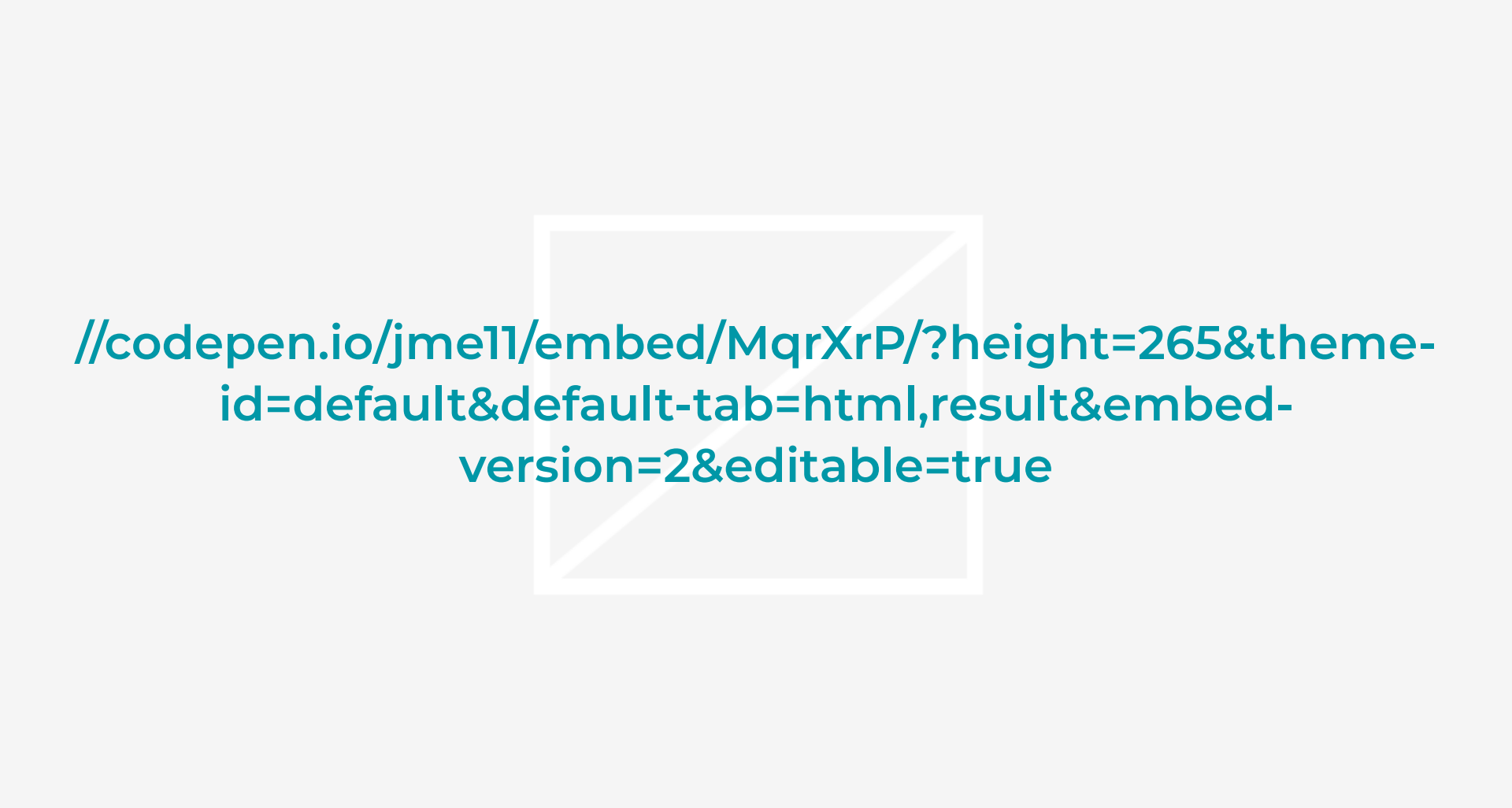
```
/* Our g elements can wrap other elements in SVG */

<g transform="translate(x, y)">
    <circle ... >
    <circle ... >
    <circle ... >
</g>
```

CREATING MARGINS THE D3 WAY

The `<g>` element allows us to **group** multiple elements together so that we can apply a single transform to them.

```
const margin = {top: 15, right: 15, bottom: 15, left: 30},
      w = 400,
      h = 300,
      height = h - margin.top - margin.bottom,
      width = w - margin.left - margin.right;
```

UNDERSTANDING VIEWBOX



https://codepen.io/jme11/pen/MqrXrP

ADDING A Y-AXIS

```
// This scale is identical to our yScale that fits
// the data to the height of the svg EXCEPT that the
// range is reversed so the 0 is at the bottom ;-)

yAxisValues = d3.scaleLinear()
                .domain([0, d3.max(bardata)])
                .range([height,0]),

// The ticks method value is just a suggestion.  D3
// figures out what makes sense based on the range
// of values supplied.

yAxisTicks = d3.axisLeft(yAxisValues)
                .ticks(3);

// Append a group so the axis can be transformed into
// position easily and call the axis method stored in
// our yAxisTicks variable.

svg.append('g')
  .attr('transform', 'translate('+margin.left+','+margin.top+')')
      .call(yAxisTicks);
```

TRANSITIONS

TRANSITIONS IN D3

- transition() **set up**
- duration(*ms*) **controls speed**
- delay(*ms*) **when to start**
- ease(*predefined*)

Using ease requires an additional Javascript file (see: **https://github.com/d3/d3-ease**)

WORKING WITH EVENTS

EVENTS IN D3

- on(*event*, function(*d*){ return ;})

Standard Javascript events (e.g., click or mouseover) and some additional D3 specific events can be used in the on method.

FETCHING DATA

FETCHING DATA

```
d3.json(url)
    .then(function(json) {
      /* Do Something with the Data */
    });
```


This uses the Javascript Fetch API. That means, we can't run this as a file locally (it requires an actual server).

YOU DID IT! 👏

GO BUILD AWESOME THINGS!