D3.js

Data Driven Documents

DOM Manipulation Library

- Provides methods for easily manipulating the Document Object Model (web page elements)
- SVGs are the most common scenario for D3.js
- Create graphs, charts, maps, etc.
- Update them based upon user input
- This project will plot number of births per month per year

Page 1

http://bclug.ca:8008/d3/kwlug/bar-chart/page1.html

Create an SVG

There is a `<div id="graph-div">` in HTML for our SVG:

```
d3.select("#graph-div")
    .append("svg")
        .attr("width", ...)
        .attr("height", ...)
        .attr("x", ...)
        .attr("y", ...)
```

That's all that is required to create an SVG.

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Data Source

- Our data source is a simple JSON file - an array of month objects with 3 key / value pairs each:

```json
[
        {
        "year": 1967,
        "month": "January",
        "births": 31502
        },
        {
        "year": 1967,
        "month": "February",
        "births": 26703
        },
        {
        "year": 1967,
        "month": "March",
        "births": 28853
        },
...

]
```

Fetch Data

- To fetch some data (several formats supported), queue request(s) for asynchronous retrieval into global variable birthData:

```
URL = "http://bclug.ca:8008/d3/kwlug/bar-
chart/birthData-JSON.js";


d3.queue()
    .defer(d3.json, URL)
    .await(function(error, birthData) {
        if (error) throw error;
...
```

Update DOM with data

```
...
// Add data to our input selector:
d3.select("#inputYear")
    .property("min", d3.min(birthData, d => (d.year))
    .property("max", d3.max(birthData, d => (d.year))
    .property("value", minYear)
    ;

// Update input selector's label
d3.select("label")
    .text(`${minYear} <— Year Range —> ${maxYear}`)
    ;
})
```

- Updating DOM elements is easier with D3.js

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Creating Scales

- Data visualization requires scales
- A scale's domain is the range of data to be plotted
- A scale's range is the location in the SVG to plot the data
- Many scales to choose from, we'll use `scaleLinear`:

```
xScale = d3.scaleLinear()
     // domain is number of months in a year:
     .domain([ 1,12 ])

     // Spread bars across width of SVG starting at padding offset:
     .range([ padding.left, padding.left + width ])
```

Axes

- Axes keep charts honest
- Axes take scales as parameters
- axisLeft has "ticks" & labels to left of the line
- create and append a Y axis:

```
yAxis = d3.axisLeft(yScale);

d3.select("svg")
      // Add a "group" to hold the axis and give an ID:
      .append("g")
            .attr("id", "yaxis")
```

Axis formatting

- There are many options to format an axis
- The "ticks" are the little marks indicating precise location
- Tick marks can have sizes:
    - `tickSizeOuter` for ends of axis line
    - `tickSizeInner` for normal scale delimiters
- This bar chart will have tick marks that stretch the width of the chart and the lines will be dashes, not solid
- CSS can be applied to SVG elements

Axis formatting: X Axis

For our X axis, our data is in the form of numbers 1 to 12 as set by:

```
xAxis
        .range( [1,12] )
```

It should display the months' names, which can be looked up in our months array:

```
d3.select("#xAxis")
        // Look up month names by number:
        .text( d => (months.find( m => (m.num === d)).name ))
```

Axis formatting: Y Axis

```
yAxis

    // Make ticks width of SVG in opposite direction of labels
    .tickSizeInner( -1 * width)


d3.select("#yaxis")

    // Apply our axis and formatted labels:

    .call(yAxis)

    .selectAll("text")

        // Format each data (d) as 2.0M vs 2000000:

        .text( d => (d3.format(".2s")(d) ))
```

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Binding data to graph elements

- Bar charts are made with rectangles

- D3.js will apply an array of data to a selection of elements

- When there are more data elements than DOM elements, DOM elements will be added by the `.enter()` selection

- Initially, we'll have 12 elements of birth data and zero bars, so we'll use .enter() to append some bars (rectangles)

Appending new bars: `.enter()`

- D3.js uses a "General Update Pattern" comprising **enter**, **update**, and **exit** selections. First, we'll use .enter() to add DOM elements.

```
d3.select("svg")
     // 1st page load, next selectAll returns nothing:
     .selectAll("rect")
     // Bind 1967's data to all existing rectangles:
     .data(birthData.filter( d => (d.year === 1967))
     .enter()
          // Append 12 rectangles for the 12 months
          .append("rect")
```

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Updating data

- Default selection is update

```
d3.select("svg")
    // Now selectAll returns array of 12 elements:
    .selectAll("rect")
    // Bind 1968's data to all existing rectangles:
    .data(birthData.filter( d => (d.year === 1968))
```

The app gets the year from the input selector, which has a "change" listener which invokes updateGraph, which reads value of input slider.

Updating data: shortcut

- Save time with `.merge()` - it joins `.enter()` and update
- Only **ONE** line of code has been added to page 5's JS code:

      .merge(bars)

- And we have updating bars in our chart because `.enter()` and update share all the code for applying attributes to the rectangles
- However, there's a **bug**: year 2015 has only May's data; January's bar moves to May's position. Tool tip changes mid-bar.

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Data "constancy": key functions

- Default data binding order is first-come first-serve
- Binding data to specific DOM elements is possible
- Just add a "key function" to the .data(), which returns an array of unique values which D3.js will bind to specific items:

```
.data(barData, function(d) {
    return d.month;
    })
```

- May 2015 now has correct data in correct location

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Removing data: `.exit()`

- Where there are more DOM elements than data array elements, items need to be removed from DOM

- We need to remove elements that no longer have data bound to them

- `.exit().remove()` does that:
```
bars
    .exit()
        .remove()
```

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Revisiting Scales: adding colour

- Our black bars need enhancement; it's easy to add colour based on our data - the month number:

```
let colourScaleX = d3.scaleLinear();
colourScaleX
    .domain([ 1,12 ])
    // D3 will interpolate between colours!
    .range([ "red", "blue" ])
```

Then, in our .merge() where we enter & update our bars, apply colour to fill attribute:

```
    .attr("fill", (d,index) => (colourScaleX(index+1) ))
```

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Transitions

- To make our bars transition between states, there's a `.transition()` function

- Transitions have durations, delays, and easing functions

- Many choices of "easing" between states, we'll use the default `.ease(d3.easeCubicInOut)`

- Delay function staggers the transitions

- Transition the `.exit().remove()` to a width of zero:

```
.transition().duration(1000)
.delay(...).attr("width", 0)
```

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More transitions

- Our bars are now nicely transitioning between states
- Notice the delay function to stagger transitions: take the data object and its index in the array, and return `index*50` ms:

```
.transition()
.duration(1000)
.delay( (data,index) => (index * 50))
```

- Transition the axes, labels, title,...