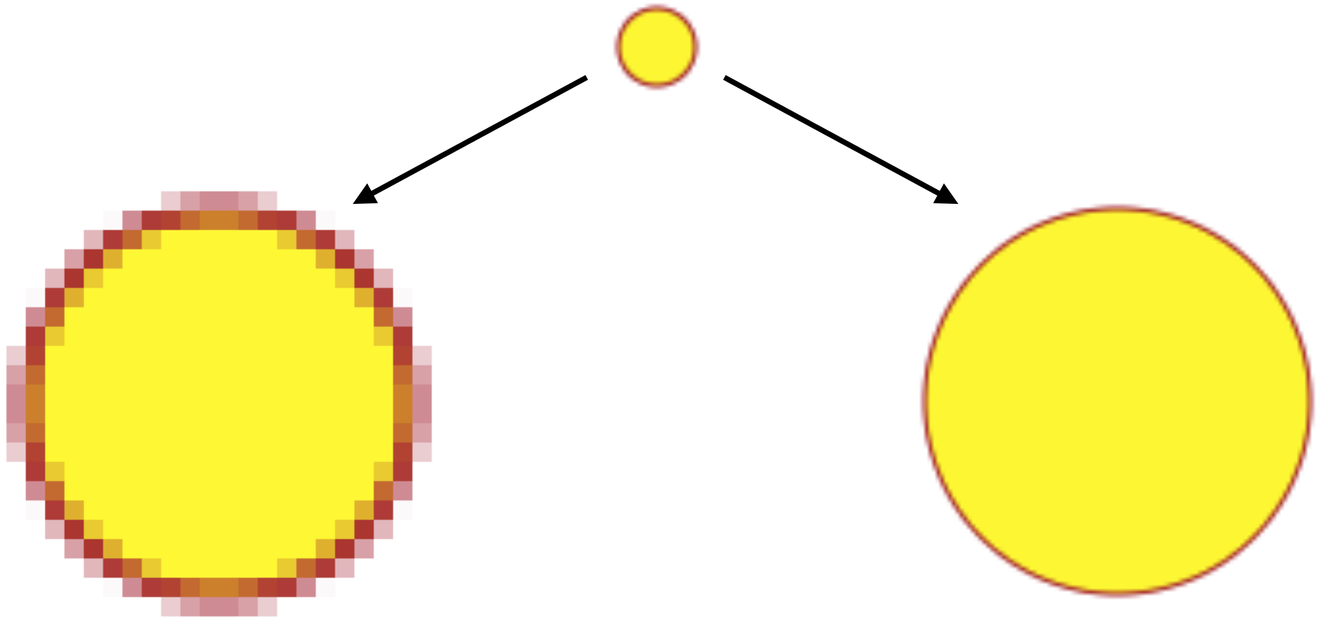
Data Visualization (CSCI 627/490)

Data

Dr. David Koop

Scalable Vector Graphics (SVG)

- Vector graphics vs. Raster graphics
- Drawing commands versus a grid of pixels
- Why vector graphics?



JavaScript in one slide

- Interpreted and Dynamically-typed Programming Language
- Statements end with semi-colons, normal blocking with brackets
- Variables: `var a = 0; let b = 2; const c = 4;`
- Operators: `+, -, *, /, [ ]`
- Control Statements: `if (<expr>){…} else {…}, switch`
- Loops: `for, while, do-while`
- Arrays: `var a = [1,2,3]; a[99] = 100; console.log(a.length);`
- Functions: `function myFunction(a,b) { return a + b; }`
- Objects: `var obj; obj.x = 3; obj.y = 5;`
  - Prototypes for instance functions
- Comments are `/* Comment */` or `// Single-line Comment`

Including JavaScript in HTML

- Use the script tag
- Can either inline JavaScript or load it from an external file

```
- <script type="text/javascript">
      a = 5, b = 8;
      c = a * b + b - a;
  </script>
  <script type="text/javascript" src="script.js"/>
```

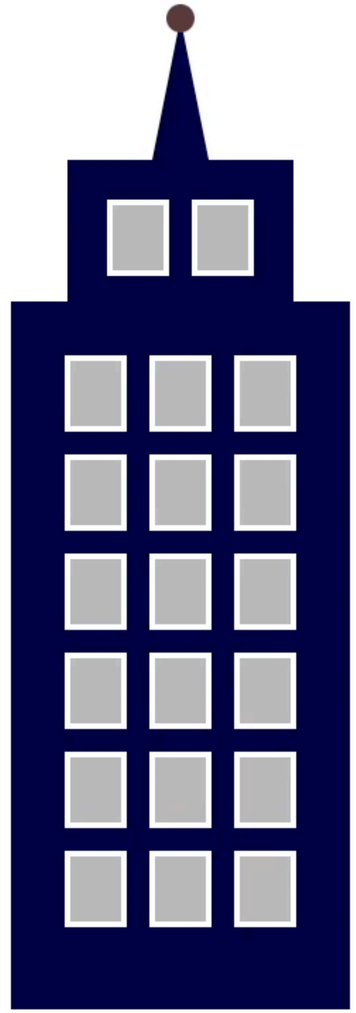
- Script tag can reference local or **remote** external javascript files
- The order the javascript is in is the order it is executed
- Example: in the above, `script.js` can access the variables `a`, `b`, and `c`

JavaScript Objects

- `var student = {name: "John Smith", id: "000012345", class: "Senior", hometown: "Peoria, IL, USA"};`
- Objects contain multiple values: key-value pairs called **properties**
- Accessing properties via dot-notation: `student.name`
- Always works via bracket-notation: `student["name"]`
- May also contain functions:
  -
```
var student = {firstName: "John",
               lastName: "Smith",
               fullName: function() { return this.firstName +
                                           " " + this.lastName; }};
```
  -
```
student.fullName()
```

Assignment 1

- Due Tonight
- Write HTML, CSS, and SVG
- Use Plot library
- Text markup and styling (information)
- Drawing markup and styling (tower)
- Draw Bar chart
- Questions?



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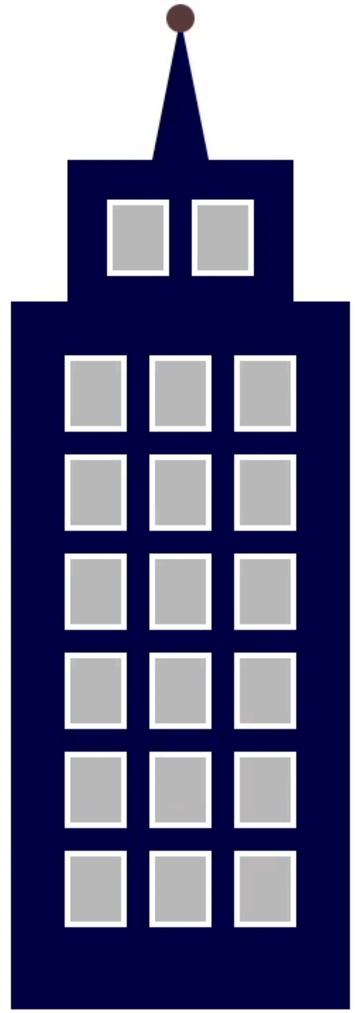

Functional Programming in JavaScript

- Functions are first-class objects in JavaScript
- You can pass a function to a method just like you can pass an integer, string, or object
- Instead of writing loops to process data, we can instead use a `map/filter/reduce/forEach` function on the data that runs our logic for each data item
- `map`: transform each element of an array
- `filter`: check each element of an array and keep only ones that pass
- `forEach`: run the function for each element of the array
- `reduce`: collapse an array to a single object

Quiz

- Using `map`, `filter`, `reduce`, and `foreach`, and given this data:
  - `var a = [6, 2, 6, 10, 7, 18, 0, 17, 20, 6];`
- Questions:
  - How would I return a new array with values one less than in a?
  - How would I find only the values >= 10?
  - How would I sum the array?
  - How would I create a reversed version of the array?

Quiz Answers: Notebook

- Data: `var a = [6, 2, 6, 10, 7, 18, 0, 17, 20, 6];`
- How would I subtract one from each item?
  - `a.map(function(d) { return d-1; })`
- How would I find only the values >= 10?
  - `a.filter(function(d) { return d >= 10; })`
- How would I sum the array?
  - `a.reduce(function(s,d) { return s + d; })`
- How would I create a reversed version of the array?
  - `b = []; a.forEach(function(d) { b.unshift(d); });`
  - ...or `a.reverse() // modifies in place`
- Arrow functions shorten such calls: `a.map(d => d-1);`
  `a.filter(d => d >= 10); a.reduce((s,d) => s+d);`

Function Chaining in JavaScript

- When programming functionally, it is useful to chain functions
- No intermediate variables!
- Often more readable code
- jQuery Example:
  - `$("#myElt").css("color", "blue").height(200).width(320)`
- Used a lot in Web programming, especially D3
- Can return the same object or a new object
- Lazy chaining keeps track of functions to be applied but will apply them later (e.g. when the page loads)

Closures in JavaScript

- Functions can return functions with some values set
- Allows assignment of some of the values
- Closures are functions that "remember their environments" [MDN]

```
function makeAdder(x) {
  return function(y) {
    return x + y;
  };
}
var add5 = makeAdder(5);
var add10 = makeAdder(10);

console.log(add5(2));  // 7
console.log(add10(2)); // 12
```

- Notebook

Example: JavaScript and the DOM

- Start with no real content, just divs:

```
<div id="firstSection"></div>
<div id="secondSection"></div>
<div id="finalSection"></div>
```

- Get existing elements:
  - `document.querySelector/querySelectorAll`
  - `document.getElementById`
- Programmatically add elements:
  - `document.createElement`
  - `document.createTextNode`
  - `Element.appendChild`
  - `Element.setAttribute`

Bears

Chicago, IL

2018-2019 NFC North Champions

What will happen this year?

Observable's HTML Templating

- Allows JavaScript expressions to be **inlined** in HTML (or SVG content)
- Use `${...}`
- Example:
  - [JavaScript] `name = "Prof. Koop"`
  - [HTML] `<p>Hello, my name is ${name}</p>`

Using Observable's HTML Templating

```
<div id="firstSection">
  <h1>Bears</h1><p>Chicago, IL</p>
</div>
<div id="secondSection">
  <h2>2018-2019 NFC North Champions</h2>
</div>
<div id="finalSection">
  ${scores.map((game) => html`<p>${game.date}:
        ${game.win ? "Win" : "Loss"} (${game.score})</p>`)}
  <img src="…Justin_Fields….jpg" width="240"></img>
  <p>What will happen this year?</p>
</div>
```

Notebook

SVG Manipulation Example

- Draw a horizontal bar chart
  - `var a = [6, 2, 6, 10, 7, 18, 0, 17, 20, 6];`
- Steps?

SVG Manipulation Example

- Draw a horizontal bar chart
  - `var a = [6, 2, 6, 10, 7, 18, 0, 17, 20, 6];`
- Steps:
  - Programmatically create SVG
  - Create individual rectangle for each item
- Notebook

…or Use Templating

- Same with SVG as with HTML
- Notebook

“Computer-based visualization systems provide visual representations of **datasets** designed to help people carry out tasks more effectively.”

— T. Munzner

Data

- What is this data?

R011	42ND STREET & 8TH AVENUE	00228985	00008471	00000441	00001455	00000134	00033341	00071255
R170	14TH STREET-UNION SQUARE	00224603	00011051	00000827	00003026	00000660	00089367	00199841
R046	42ND STREET & GRAND CENTRAL	00207758	00007908	00000323	00001183	00003001	00040759	00096613

- **Semantics**: real-world meaning of the data
- **Type**: structural or mathematical interpretation
- Both often require **metadata**
  - Sometimes we can infer some of this information
  - Line between data and metadata isn't always clear

Semantics

- The meaning of the data
- Example: 94023, 90210, 02747, 60115

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- The meaning of the data
- Example: 94023, 90210, 02747, 60115
  - Attendance at college football games?
  - Salaries?
  - Zip codes?
- Cannot always infer based on what the data looks like
- Often require semantics to better understand data
- Column names help with semantics
- May also include rules about data: a zip code is part of an address that uniquely identifies a residence
- Useful for asking good questions about the data