Data Visualization (CIS 490/680)

JavaScript

Dr. David Koop

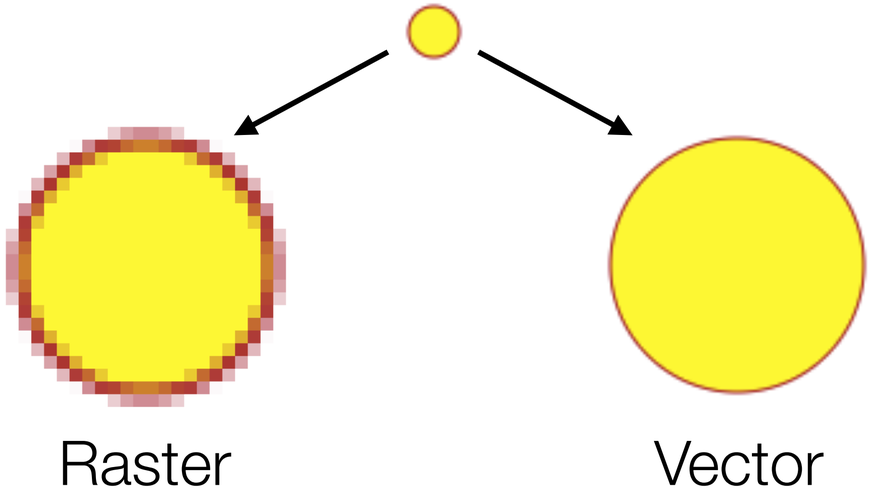
Hyper Text Markup Language (HTML)

- Markup languages allow users to encode the **semantics** of text
- Elements structure a document
  - Elements delineated by tags: `<h1>An element</h1>`
  - Document Object Model (DOM)
  - We can **navigate** this tree
- Identifying and Classifying elements: `id` and `class` attributes
  - `id` identifies a **single** element—use for a unique case
  - `class` may identify **multiple** elements—use for common cases
  - Each element may have multiple classes, separate by spaces
  - Use normal identifiers: don't start the name with a number

Cascading Style Sheets (CSS)

- Separate style from content, just specifies how to style the content
- Style information appears in three places: external, head, ~~individual elements~~
- Statement: `<selectors>: { <style definitions> }`
- Cascading:
  - use inheritance idea
  - properties that apply to children cascade down
- Selectors: element types (`strong`), ids (`#main-section`), classes (`.cool`)
  - Can combine to be more specific
    - `#main-section em, .cool > strong, p.cool`
  - Can group: `#main-section, p.cool { font-size: 16pt; }`

Scalable Vector Graphics (SVG)



- **Vector** graphics vs. Raster graphics
- Another markup language:
  - Describe the shapes and paths by their endpoints, characteristics
  - Lines, Circles, Rects, Ellipses, Text, Polylines, Paths
- SVG can be embedded in HTML5!
- Pixel Coordinates: **Top-left** origin
- We can specify styles of SVG elements in CSS!

Assignment 1

- Link
- HTML, CSS, and SVG
- Due Friday
- Questions?

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;`
- 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`

JavaScript References

- Interactive Data Visualization for the Web, Murray
- MDN Tutorials

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`
- May also contain functions:
  -
```
var student = {firstName: "John",
               lastName: "Smith",
               fullName: function() { return this.firstName +
                                            " " + this.lastName; }};
```
  - `student.fullName()`
- JavaScript Object Notation (JSON): data interchange format
  - nested objects and arrays (data only, no functions!), **subset** of JavaScript

Objects as Associative Arrays/Dictionaries

- Objects have key-value pairs and can be addressed via those keys, either via dot-notation or via bracket notation: `[<key>]`
- Example:

```
states = {"AZ": "Arizona", "IL": "Illinois", …};
// Get a state's name given it's abbreviation
console.log("IL is" + states["IL"]);
```

- Similar to dictionaries or associative arrays in other languages (e.g. Python)
- Dot-notation only works with certain identifiers, bracket notation works with more identifiers

Functional Programming

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

Manipulating the DOM with JavaScript

- Key global variables:
  - `window`: Global namespace
  - `document`: Current document
  - `document.getElementById(...)`: Get an element via its id
- HTML is parsed into an in-memory document (DOM)
- Can access and **modify** information stored in the DOM
- Can add information to the DOM

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`
  - `document.getElementById`
- Programmatically add elements:
  - `document.createElement`
  - `document.createTextNode`
  - `Element.appendChild`
  - `Element.setAttribute`
- Link

Creating SVG figures via JavaScript

- SVG elements can be accessed and modified just like HTML elements
- Create a new SVG programmatically and add it into a page:
  - ```
    var divElt = document.getElementById("chart");
    var svg = document.createElementNS(
                        "http://www.w3.org/2000/svg", "svg");
    divElt.appendChild(svg);
    ```
- You can assign attributes:
  - ```
    svg.setAttribute("height", 400);
    svg.setAttribute("width", 600);
    svgCircle.setAttribute("r", 50);
    ```