D3 Tutorial

Introduction of Basic Components: HTML, CSS, SVG, and JavaScript

D3.js Setup

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HTML - **H**yper **T**ext **M**arkup **L**anguage

- HTML is the standard markup language for creating Web pages
  - HTML describes the structure of Web pages using markup
- HTML elements
  - HTML elements are the building blocks of HTML pages
  - represented by tags
- Tags
  - HTML tags label pieces of content such as
    - <head> tag for “heading”
    - <p> for “paragraph”
    - <table> for “table” and so on
  - Browsers do not display the HTML tags, but use them to render the content of the page

HTML - Plain Text

- If we display the information only by plain text

HTML Basics

HTML is designed for marking up text by adding tags such as <p> to create HTML elements.

Example image:

HTML - Codes and the Result

```html
<!DOCTYPE html>
<html>
    <head>
        <title>HTML Tutorial</title>
    </head>
    <body>
        <h1>HTML Basics</h1>
        <p>
            <strong>HTML</strong> is designed for <em>marking up text</em> by adding tags such as <code>&lt;p&gt;</code> to create HTML elements.
        </p>

        <p>
            <strong>Example image:</strong>
        </p>
        <img src="https://www.osu.edu/assets/web/logo-web/TheOhioStateUniversity-Stacked.jpg" style="width: 200px" />
    </body>
</html>
```

HTML Basics

HTML is designed for *marking up text* by adding tags such as <p> to create HTML elements.

Example image:

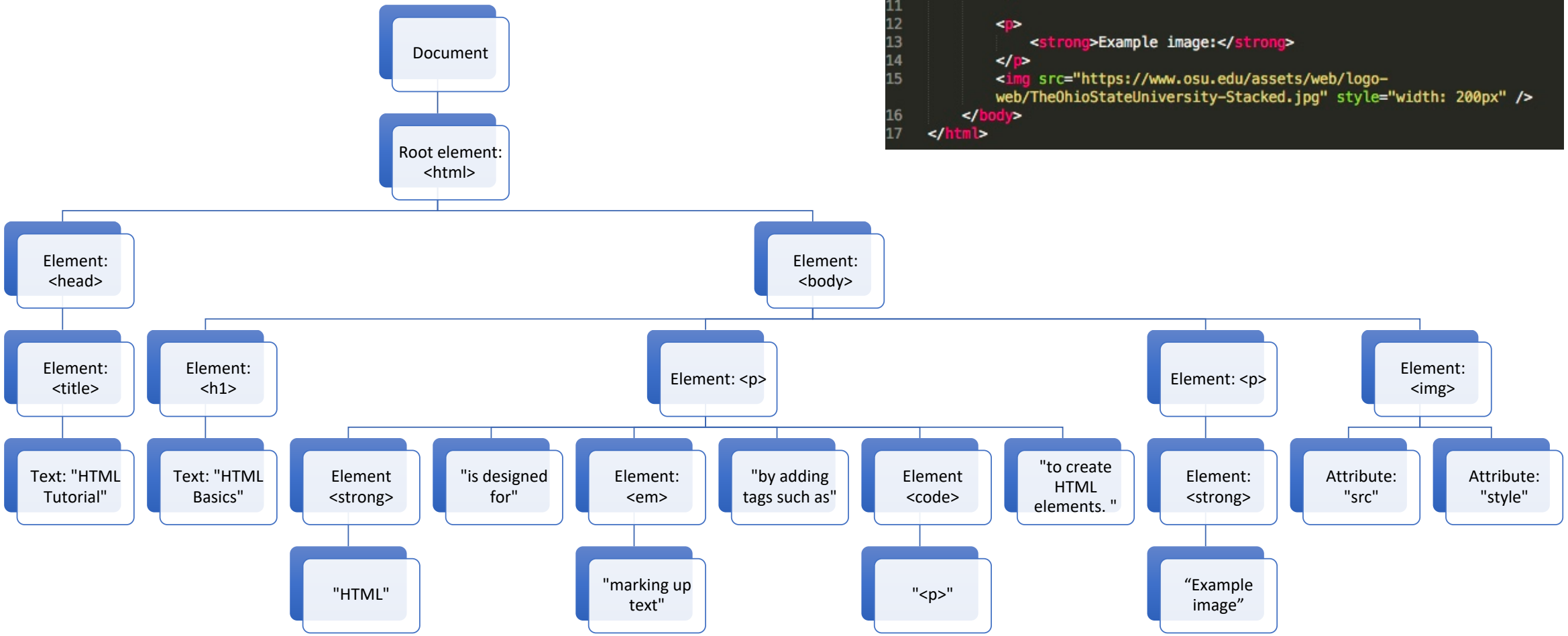
THE OHIO STATE UNIVERSITY

HTML - DOM

- When a web page is loaded, the browser creates a Document Object Model of the page
- The HTML DOM model is constructed as a tree of Objects

HTML - DOM

```html
<!DOCTYPE html>
<html>
    <head>
        <title>HTML Tutorial</title>
    </head>
    <body>
        <h1>HTML Basics</h1>
        <p>
            <strong>HTML</strong> is designed for <em>marking up text</em> by adding tags such as <code>&lt;p&gt;</code> to create HTML elements.
        </p>

        <p>
            <strong>Example image:</strong>
        </p>
        <img src="https://www.osu.edu/assets/web/logo-web/TheOhioStateUniversity-Stacked.jpg" style="width: 200px" />
    </body>
</html>
```



HTML - DOM

- With the object model, **JavaScript** can create **dynamic** HTML by manipulating the objects:
  - JavaScript can change all the HTML elements in the page
  - Change all the HTML attributes in the page
  - Change all the CSS styles
  - Remove existing HTML elements and attributes
  - Add new HTML elements and attributes
  - React to all existing HTML events in the page
  - Create new HTML events in the page

Click on this text!

```html
<!DOCTYPE html>
<html>
    <head>
        <title>HTML DOM</title>
    </head>
    <body>
        <h1 onclick="this.innerHTML = 'Hello World!'">
            Click on this text!
        </h1>
    </body>
</html>
```

CSS - Cascading Style Sheets

- CSS describes how HTML elements are to be displayed on screen
- CSS saves a lot of work
  - It can control the appearance of multiple elements and web pages all at once

```
<p style="background-color:DodgerBlue;">Hello World</p>
```

Hello World

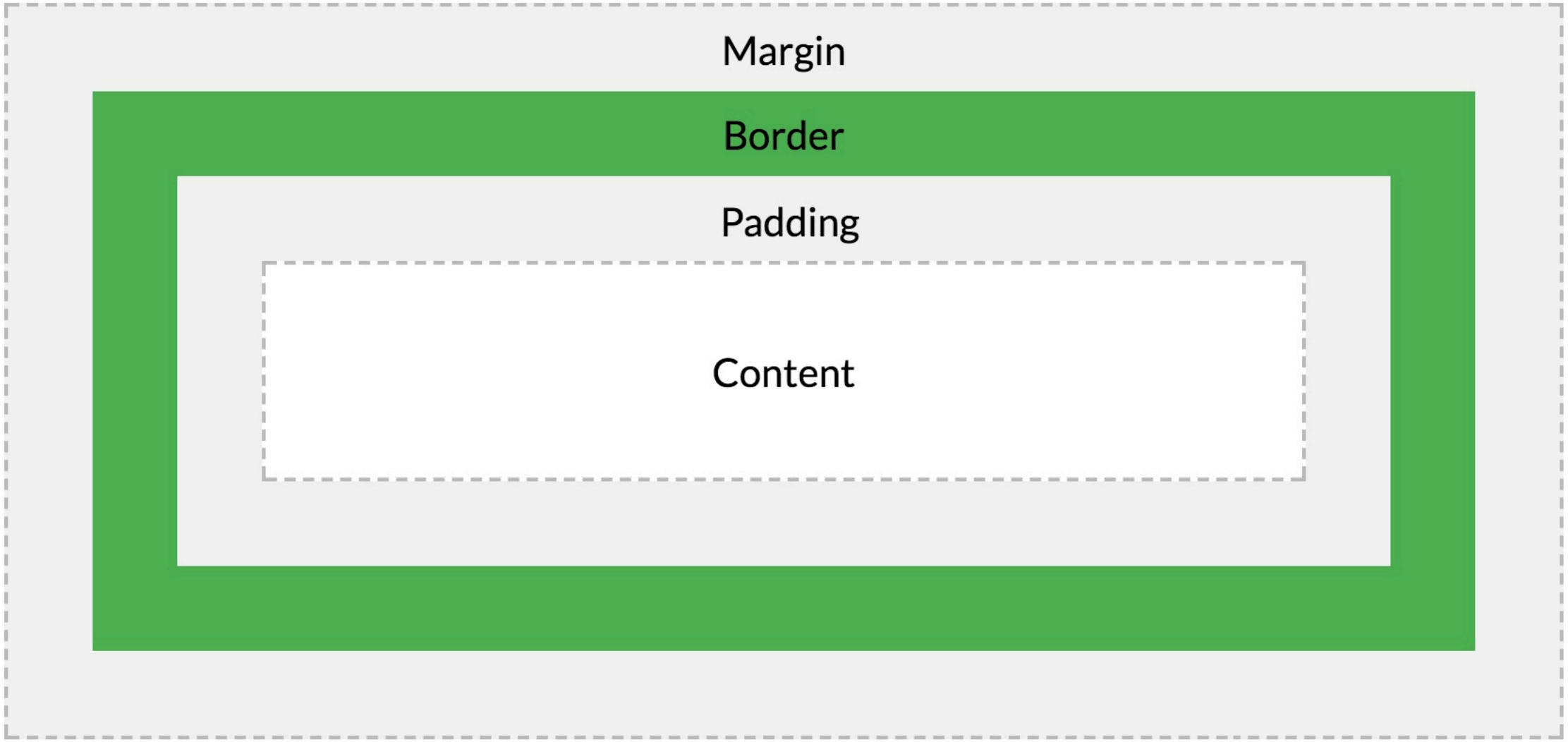
```
<p style="background-color:Tomato;">Hello World</p>
```

Hello World

CSS

```
<style>
    body {
        background-color: black;
    }

    h1 {
        color: white;
        text-align: center;
    }

    p {
        color: white;
        font-family: verdana;
        font-size: 20px;
    }

    img {
        width: 200px;
        border-radius: 50%;
    }
</style>
```

CSS - Box Model



CSS - Box Model

- Margin
- 20px

Box Model

40px

Box Model

60px

Box Model

CSS - Box Model

- Border
- 10px

15px

20px

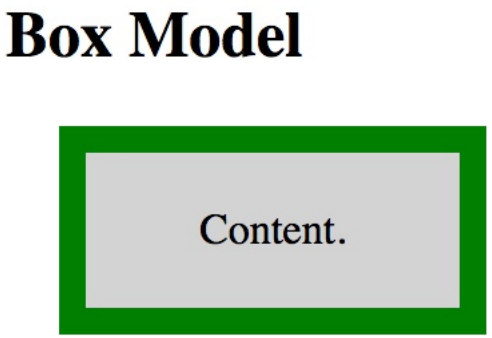
Box Model

Box Model

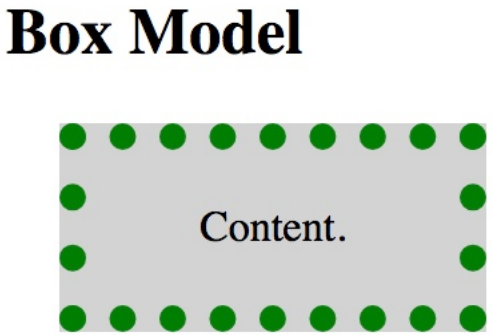
Box Model

CSS - Box Model

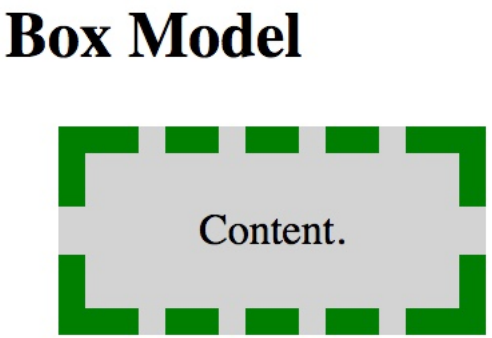
- Border style
- solid



dotted



dashed



- Other styles
  - double, groove, ridge, insert, outset, none, hidden

CSS - Box Model

- Padding
- 20px

15px

20px

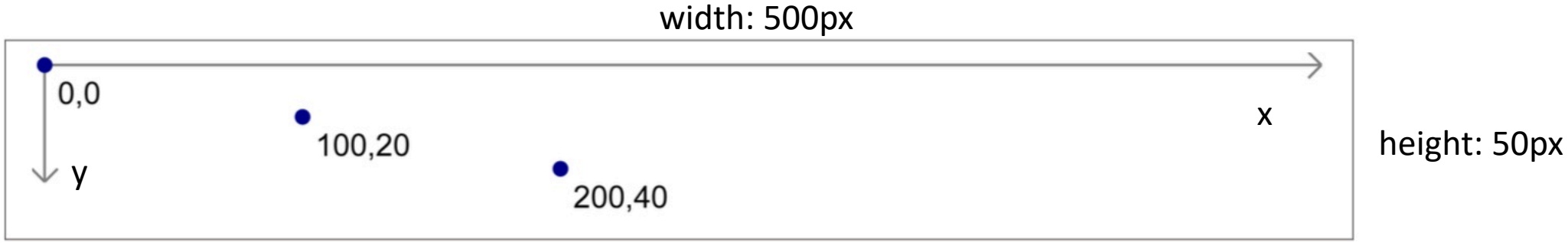
Box Model

Box Model

Box Model

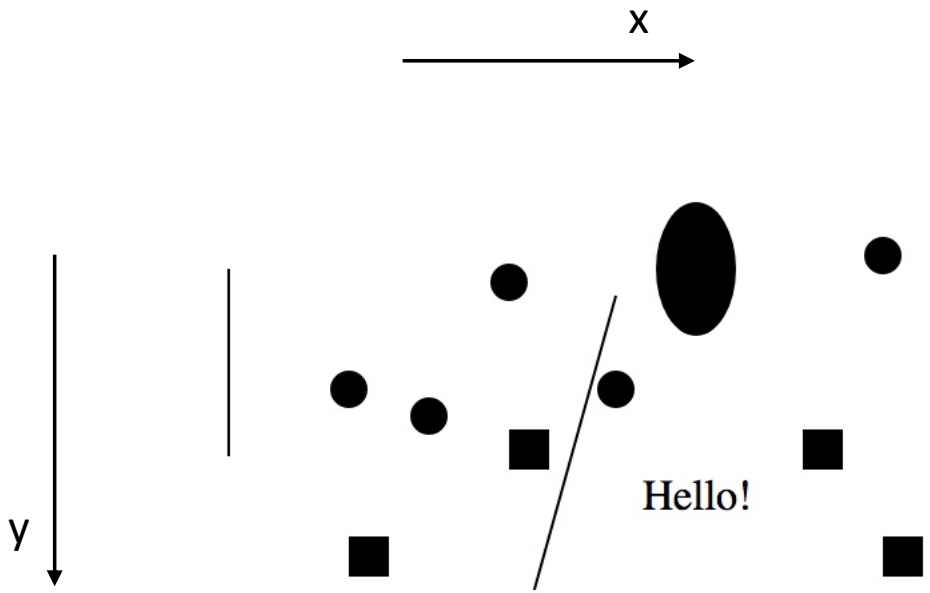
SVG - **S**calable **V**ector **G**raphics

- SVG defines vector-based graphics for the Web
- svg HTML tag
  - <svg width="500" height="50"> </svg>
    - Create a SVG canvas with 500px width and 50px height
- svg coordinates system



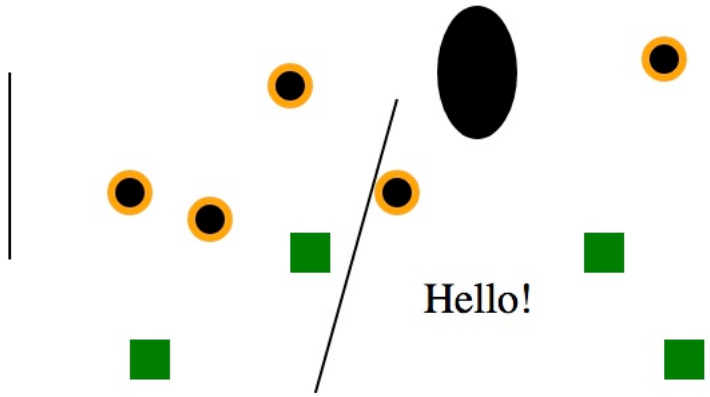
SVG - Shapes

```svg
<svg>
  <line x1="5" x2="5" y1="100" y2="30" stroke="black"/>
  <line x1="100" x2="150" y1="220" y2="40" stroke="black"/>

  <rect x="150" y="150" width="15" height="15"/>
  <rect x="220" y="90" width="15" height="15"/>
  <rect x="110" y="90" width="15" height="15"/>
  <rect x="220" y="90" width="15" height="15"/>
  <rect x="50" y="130" width="15" height="15"/>
  <rect x="250" y="130" width="15" height="15"/>

  <circle cx="250" cy="25" r="7"/>
  <circle cx="150" cy="75" r="7"/>
  <circle cx="80" cy="85" r="7"/>
  <circle cx="110" cy="35" r="7"/>
  <circle cx="50" cy="75" r="7"/>

  <ellipse cx="180" cy="30" rx="15" ry="25"/>

  <text x="160" y="120">Hello!</text>
</svg>
```



SVG - Shapes + CSS

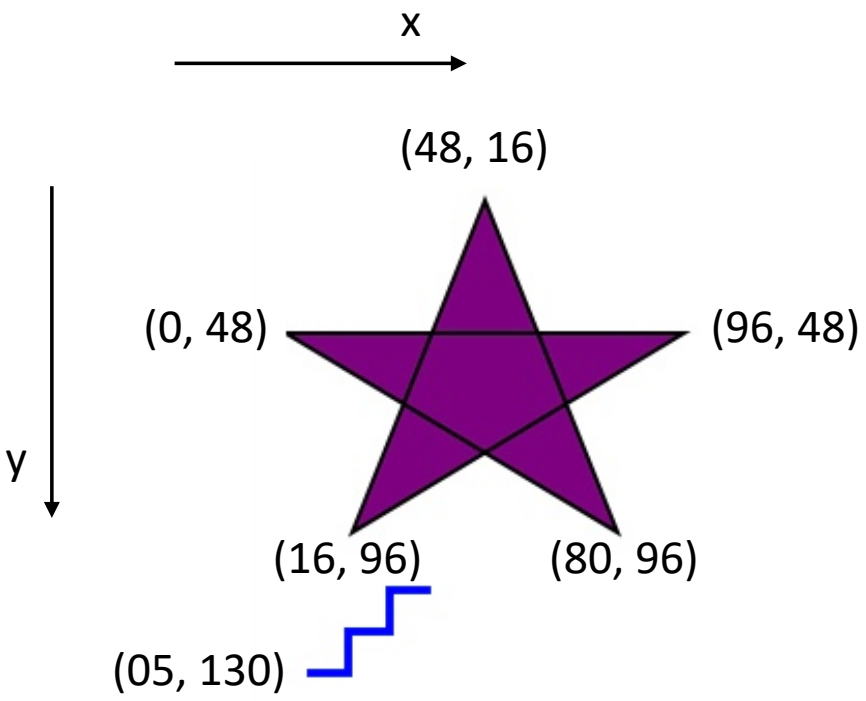
```
<style>
    rect{
      fill: green;
    }

    circle{
      stroke: orange;
      stroke-width: 3;
    }
</style>
```



SVG - Polygon and Polyline

- Use coordinates to specify path

```
<svg>
  <polygon style="fill: purple; stroke: black;"
    points="48,16  16,96  96,48  0,48  80,96" />

  <polyline fill="none" stroke="blue" stroke-width="2"
     points="05,130
             15,130
             15,120
             25,120
             25,110
             35,110" />
</svg>
```

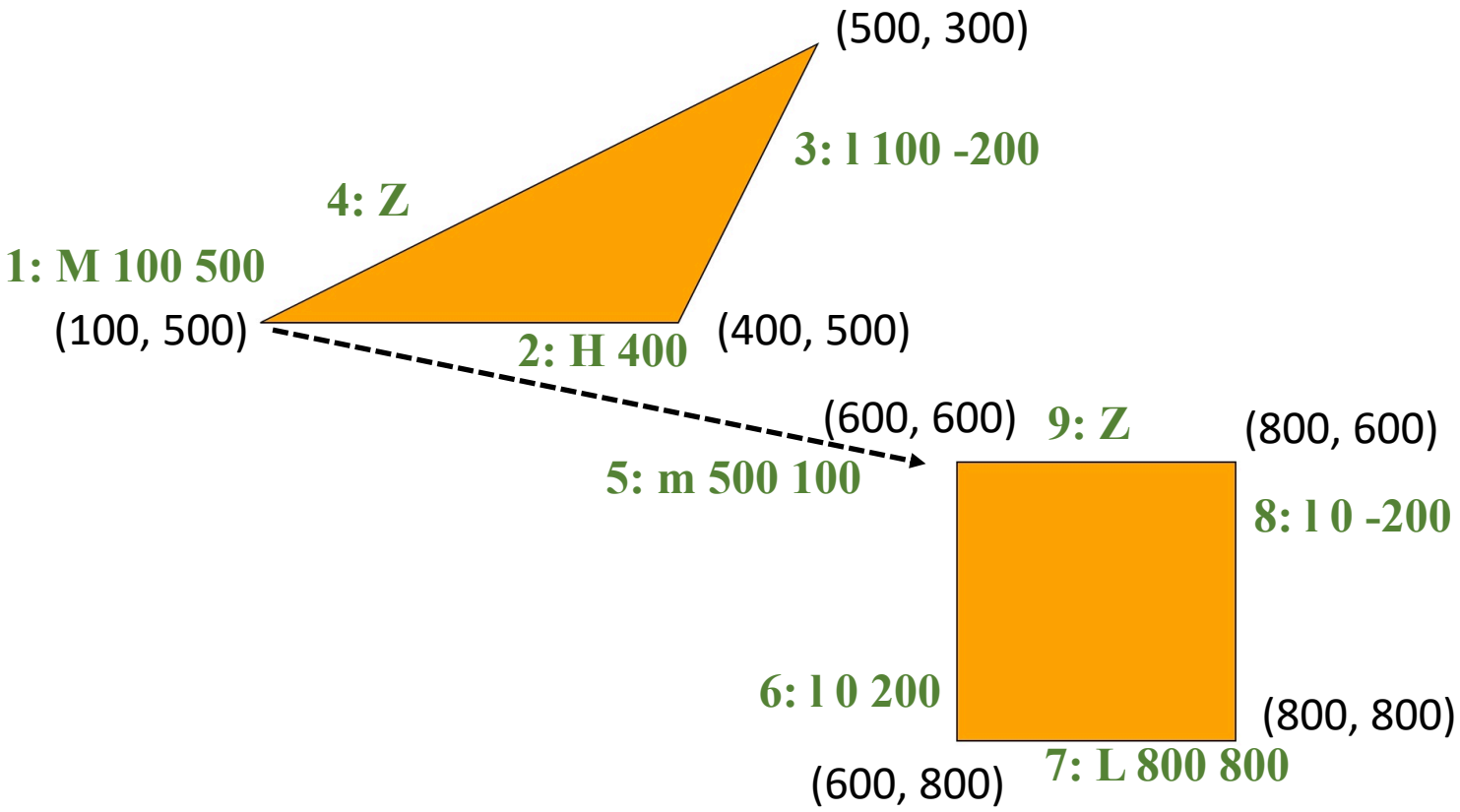


SVG - PATH

- M x y – Move to (x,y)
  - m dx dy – Move by (dx,dy)
- L x y – Line to (x,y)
  - l dx dy
- H x, V y – draw horizontal and vertical lines
  - h dx, v dy
- Z, z close path
- Curve commands (Bezier Curves and Arcs)
  - https://developer.mozilla.org/en-US/docs/Web/SVG/Tutorial/Paths?redirectlocale=en-US&redirectslug=SVG%2FTutorial%2FPaths#Curve_commands

SVG - PATH

```svg
<svg width="1000" height="1000">
  <path d="
  M 100 500
  H 400
  l 100 -200
  Z

  m 500 100
  l 0 200
  L 800 800
  l 0 -200
  Z"
  fill="orange" stroke="black"/>
</svg>
```



SVG - Transform

- translate(*dx, dy*)
  - move a shape by (*dx, dy*)

```
<text x="20" y="20">
    Hello
</text>

<text x="60" y ="20">
    World!
</text>
```

Hello World!

```
<text x="60" y ="20" transform="translate(10, 10)">
    World!
</text>
```

Hello World!

SVG - Transform

- rotate(*a, x, y*)
  - rotate a shape by *a* degrees about a given point (*x, y*)

```
<text x="20" y="20">
    Hello
</text>

<text x="60" y ="20">
    World!
</text>
```

```
<text x="60" y ="20" transform="rotate(90, 60, 20)">
    World!
</text>
```

Hello World!

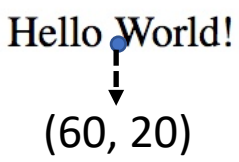
Hello World!

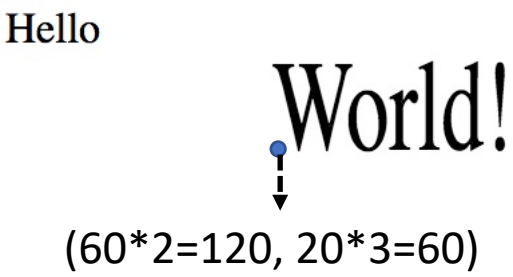
SVG - Transform

- scale(*x, y*)
  - scales both the shape's size and its coordinates

```
<text x="20" y="20">
    Hello
</text>

<text x="60" y ="20">
    World!
</text>
```

```
<text x="60" y ="20" transform="scale(2, 3)">
    World!
</text>
```





SVG - Transform

- Multiple functions

```
<text x="20" y="20">
    Hello
</text>

<text x="60" y ="20">
    World!
</text>
```

Hello World!

Transform in the reverse order, i.e. the order of rotate, translate, and scale

```
<text x="60" y ="20" transform="scale(2, 3) translate(10, 10) rotate(90, 60, 20)">
    World!
</text>
```

Hello

World!

SVG - Group + Transform

- Group multiple shapes
  - <g> tag

```
<g>
    <text x="20" y="20">
        Hello
    </text>

    <text x="60" y ="20">
        World!
    </text>
</g>
```

Hello World!

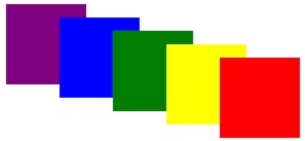
```
<g transform="rotate(90, 20, 20)">
    <text x="20" y="20">
        Hello
    </text>

    <text x="60" y ="20">
        World!
    </text>
</g>
```

Hello World!

SVG - No Layer

- Any pixel-paint applied later obscure any earlier paint and therefore appear to be "in front"

```svg
<svg>
    <rect x="0" y="0" width="30" height="30" fill="purple"/>
    <rect x="20" y="5" width="30" height="30" fill="blue"/>
    <rect x="40" y="10" width="30" height="30" fill="green"/>
    <rect x="60" y="15" width="30" height="30" fill="yellow"/>
    <rect x="80" y="20" width="30" height="30" fill="red"/>
</svg>
```



JavaScript

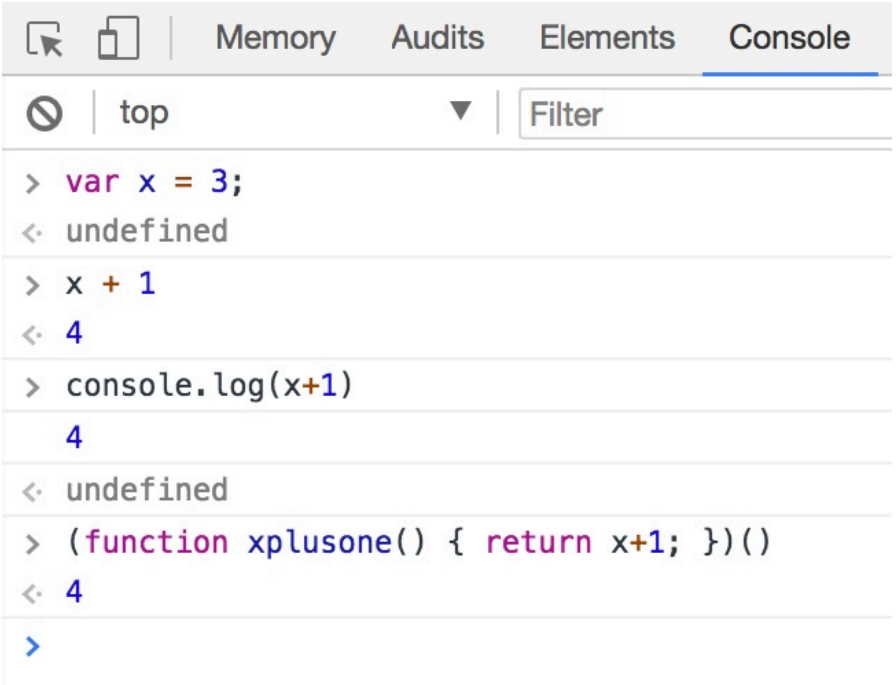
- JavaScript works with HTML and CSS
  - HTML to define the content of web pages
  - CSS to specify the appearance of web pages
  - JavaScript to program the behavior of web pages
- JavaScript is the programming language with C/C++ style syntax
  - *for, while, continue, break, if/else, switch* are similar to C/C++
  - *operators (+,-,*,/,%)* are also similar (except *==,!=,||*)

JavaScript - Hello, Console

- Easy and quick way to test JavaScript code and debug
  - The result of “console.log()” will appear here
- You can type JavaScript code directly into your browser in a web page
  - The console accepts one line of code at a time
- Open Console
  - Chrome
    - Select View -> Developer -> JavaScript Console
  - Firefox
    - Tools -> Web Developer -> Web Console
  - Safari
    - Safari -> Preferences -> Advanced -> Show Develop menu in menu bar
    - Develop -> Show JavaScript Console

JavaScript - Hello, Console

- An example using Chrome Console
- Line 1: var x = 3;
  - Assign value 3 to the variable x
  - The value of the statement “var x = 3; ” is undefined
- Line 2: x + 1
  - The Console evaluates the value of “x + 1”, which is 4
- Line 3: console.log(x+1)
  - Print the value of “x+1”, which is 4
  - The value of the statement “console.log(x+1)” is undefined
- Line 4: (function xplusone() { return x+1; })()
  - Define a function to compute x+1 and then, execute the function



JavaScript - Data Types

- Numbers
  - 42, 3.1415926
- Logical
  - true, false
- Strings
  - "Hello", 'Hello’
- null
- undefined*
  - Yes. undefined is not null!
  - Usually to indicate a variable is not defined

JavaScript - Data Types

- functions
  - function(x) { return x+1; }
  - Can be assigned to variables like: var xPlusOne = function(x) { return x+1; }
    - Same as: function xPlusOne(x) { return x+1; }
- Objects
  - An object in JavaScript is an associative array of property names (Strings) and values (Objects)
  - {from: “Tom”, to: “Jerry”, message: “We are good friends!” }
- Arrays
  - var numbers = [5, 10, 15, 20, 25];
  - var mixedValues = [1,3, 4.5, 5.6, "string", null, undefined, true];

JavaScript - Data Types

- Javascript uses dynamic typing
- var x = “The answer is ” + 42;
  - The value of x is the string “The answer is 42”
- var x = “37” - 7;
  - The value of x is the number 30
- var x = “37” + 7;
  - The value of x is the string ”377”
- var x = “1.1” + “1.1”;
  - String “1.11.1”
- var x = (+“1.1”)
  - Number 1.1
- var x = (+“1.1”) + (+“1.1”);
  - Number 2.2

JavaScript - Control Flow

- C-Style `for`, `while`, `continue`, `break`, `if`/`else`, `switch/case`

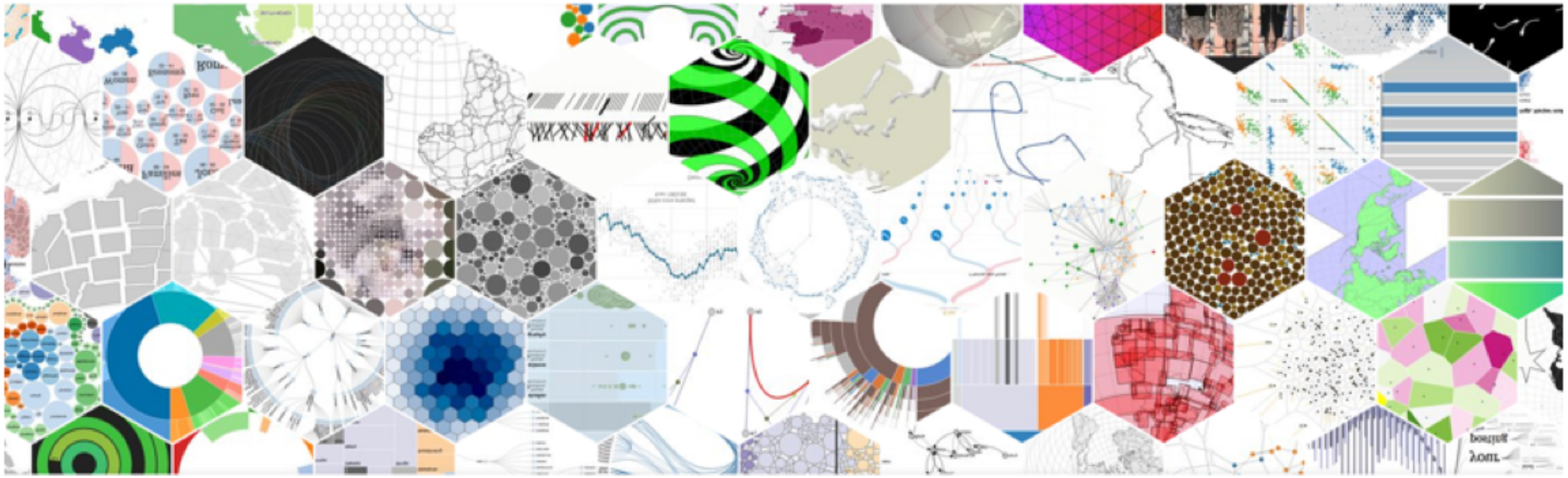
```
for (var i=0; i < 10; i++) {
    if (condition) {
        statement_1_runs_if_condition_is_true();
        break;
    }
    else {
        statement_2_runs_if_condition_is_false();
        continue;
    }
}
```

JavaScript - Manipulating DOM

- As mentioned, with the HTML DOM, JavaScript can access and change all the elements of an HTML document.
- But, the JavaScript APIs for DOM are complex
  - Link of JavaScript DOM methods
    - https://www.w3schools.com/js/js_htmldom.asp
  - We will learn how to use D3.js to manipulate DOM in a simple way

D3.js

- A JavaScript library
  - Support visualizing data with the aid of HTML, SVG, and CSS



D3.js - Downloading and Referencing D3

- Downloading
  - Official website: https://d3js.org/
- Referencing

```html
<!DOCTYPE html>
<html>
    <head>
        <title>D3</title>
        <script type="text/javascript" src="d3/d3.min.js"></script>
    </head>
    <body>
        <script type="text/javascript">
            // Your beautiful D3 code will go here
        </script>
    </body>
</html>
```

- Referencing without downloading

```html
<script src="https://d3js.org/d3.v4.min.js"></script>
```

D3.js - Open Web Pages with D3.js

- Usually, you can view local HTML files directly in your web browser
- However, some browsers have restrictions that prevent them from loading local files via JavaScript, for security reasons
  - That means if your D3 code is trying to pull in any external data files (like CSVs or JSONs), it will fail with no good explanation
  - For this reason, it is much more reliable to load your page via a web server
  - To set up a simple local server
    - See **D3 example to test your browser** of our course website: http://web.cse.ohio-state.edu/~shen.94/5544/

Good Resources

- W3School: Tutorial, Manual
  - HTML: https://www.w3schools.com/html/default.asp
  - CSS: https://www.w3schools.com/css/default.asp
  - SVG: https://www.w3schools.com/graphics/svg_intro.asp
  - JavaScript: https://www.w3schools.com/js/default.asp
- MDN web docs: Tutorial, Manual
  - SVG: https://developer.mozilla.org/en-US/docs/Web/SVG/Tutorial
  - MDN web docs also have tutorials and manuals for HTML, CSS, and JavaScript
- D3.js: https://d3js.org/
  - Manual/API: https://github.com/d3/d3/blob/master/API.md
  - Examples: https://github.com/d3/d3/wiki/Gallery
  - Collection of Tutorials: https://github.com/d3/d3/wiki/Tutorials

Recommended Book