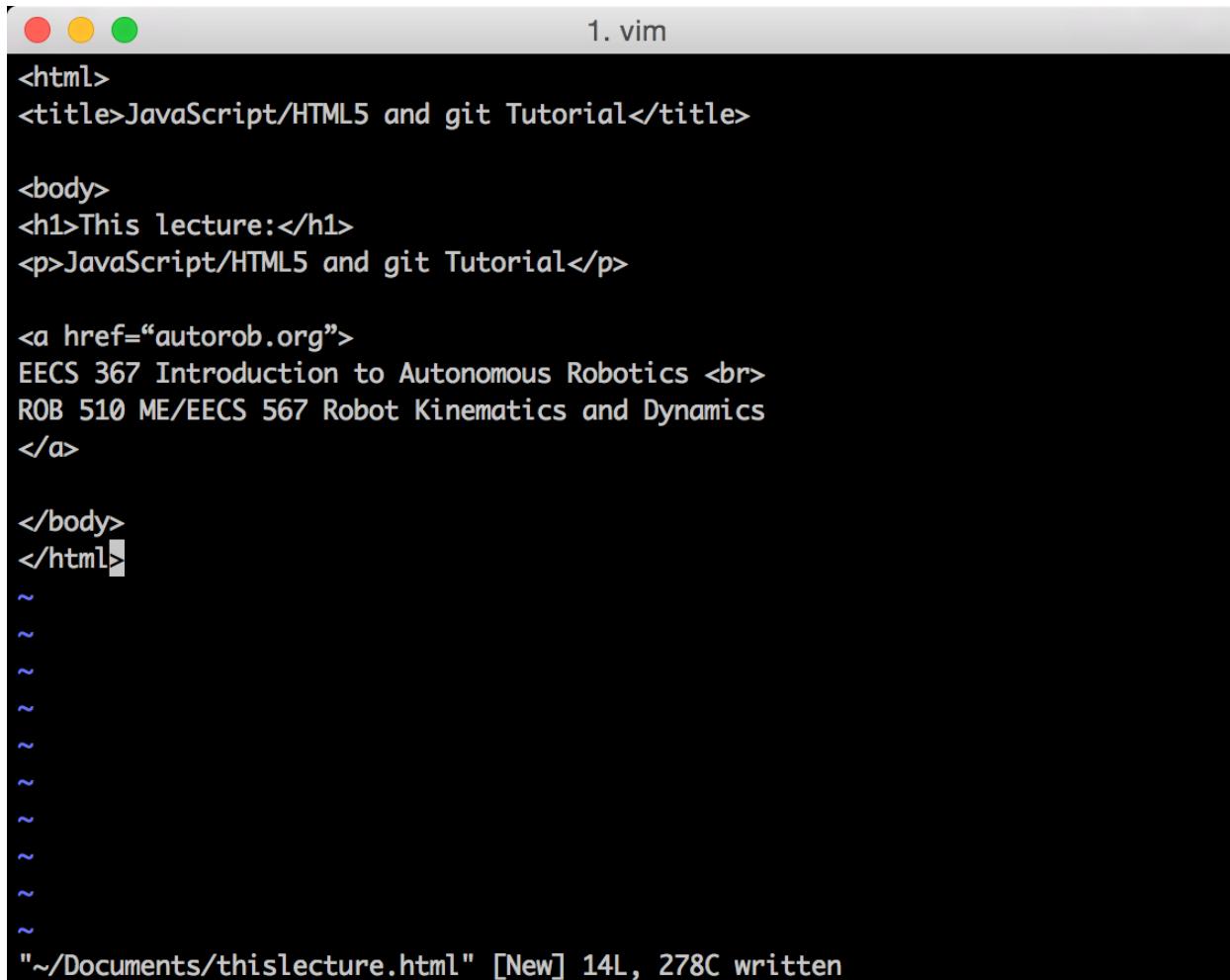


```
<html>
<title>JavaScripT/HTML5 and git Tutorial</title>

<body>
<h1>This lecture:</h1>
<p>JavaScripT/HTML5 and git Tutorial</p>

<a href="autorob.org">
EECS 367 Introduction to Autonomous Robotics <br>
ROB 510 ME/EECS 567 Robot Kinematics and Dynamics
</a>

</body>
</html>
```



The screenshot shows a terminal window titled "1. vim". The content of the file is an HTML document with the following structure:

```
<html>
<title>JavaScript/HTML5 and git Tutorial</title>

<body>
<h1>This lecture:</h1>
<p>JavaScript/HTML5 and git Tutorial</p>

<a href="autorob.org">
EECS 367 Introduction to Autonomous Robotics <br>
ROB 510 ME/EECS 567 Robot Kinematics and Dynamics
</a>

</body>
</html>
~
~
```

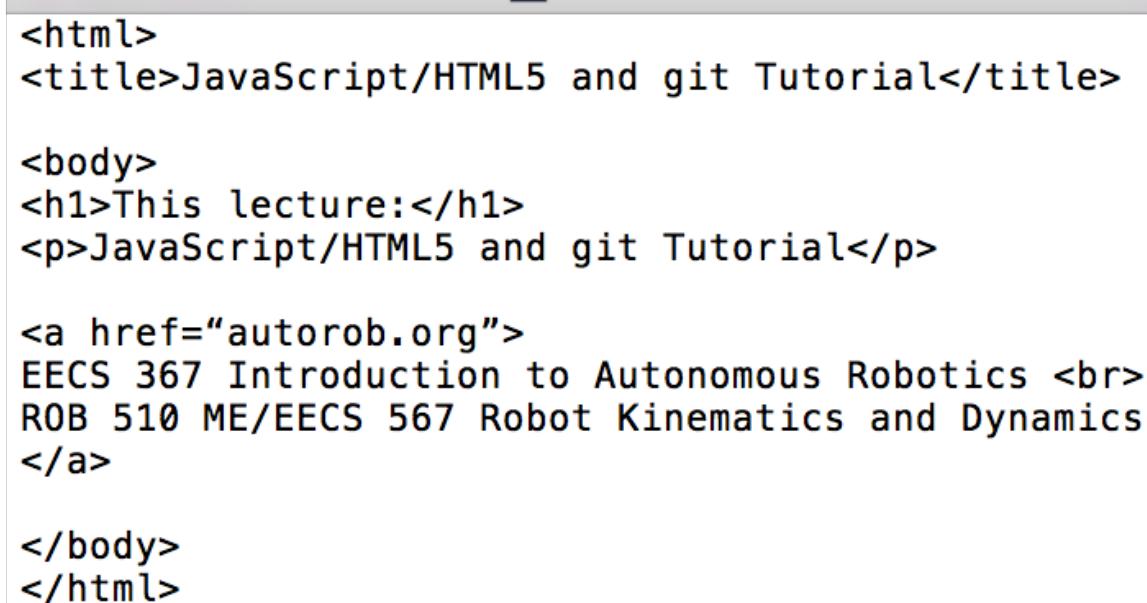
The cursor is positioned at the end of the file, indicated by a blue vertical bar. The status bar at the bottom of the terminal window shows the path and file statistics: "~/Documents/thislecture.html" [New] 14L, 278C written.

vi text editor

Put this text into a file named “thislecture.html”

Michigan Robotics 367/510/567 - autorob.org

TextEdit on
Mac OS X



A screenshot of a Mac OS X TextEdit window titled "thislecture.html". The window contains the following HTML code:

```
<html>
<title>JavaScript/HTML5 and git Tutorial</title>

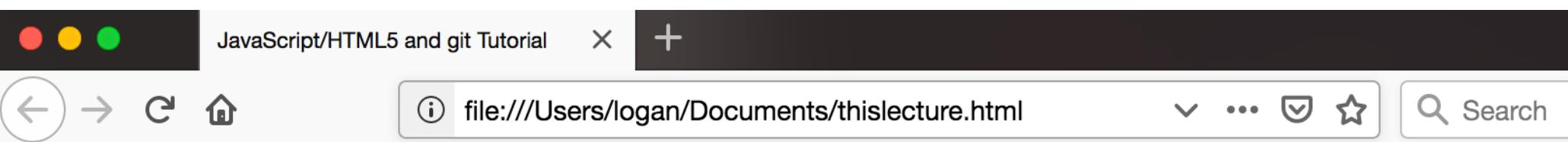
<body>
<h1>This lecture:</h1>
<p>JavaScript/HTML5 and git Tutorial</p>

<a href="autorob.org">
EECS 367 Introduction to Autonomous Robotics <br>
ROB 510 ME/EECS 567 Robot Kinematics and Dynamics
</a>

</body>
</html>
```

Put this text into a file named “thislecture.html”

Michigan Robotics 367/510/567 - autorob.org



This lecture:

JavaScript/HTML5 and git Tutorial

[EECS 367 Introduction to Autonomous Robotics](#)

[ROB 510 ME/EECS 567 Robot Kinematics and Dynamics](#)

Open “thislecture.html” in a web browser

```
<html>
<title>JavaScript/HTML5 and git Tutorial</title>

<body>
<h1>This lecture:</h1>
<p>JavaScript/HTML5 and git Tutorial</p>

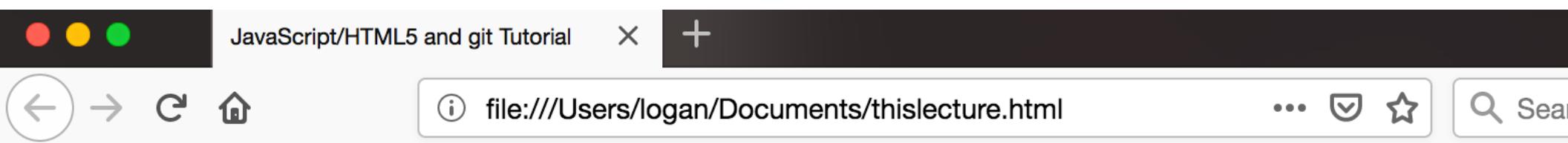
<a href="autorob.org">
EECS 367 Introduction to Autonomous Robotics <br>
ROB 510 ME/EECS 567 Robot Kinematics and Dynamics
</a>

<script>
  document.body.innerHTML += "<br><br>and some JavaScript to add 2 + 2 = " + (2+2);
</script>

</body>
</html>
~
~
~
~
~
~
~
~/Documents/thislecture.html" line 14 of 18 --77%-- col 82
```

Change “thislecture.html” with JavaScript code to execute

Michigan Robotics 367/510/567 - autorob.org



This lecture:

JavaScript/HTML5 and git Tutorial

[EECS 367 Introduction to Autonomous Robotics](#)

[ROB 510 ME/EECS 567 Robot Kinematics and Dynamics](#)

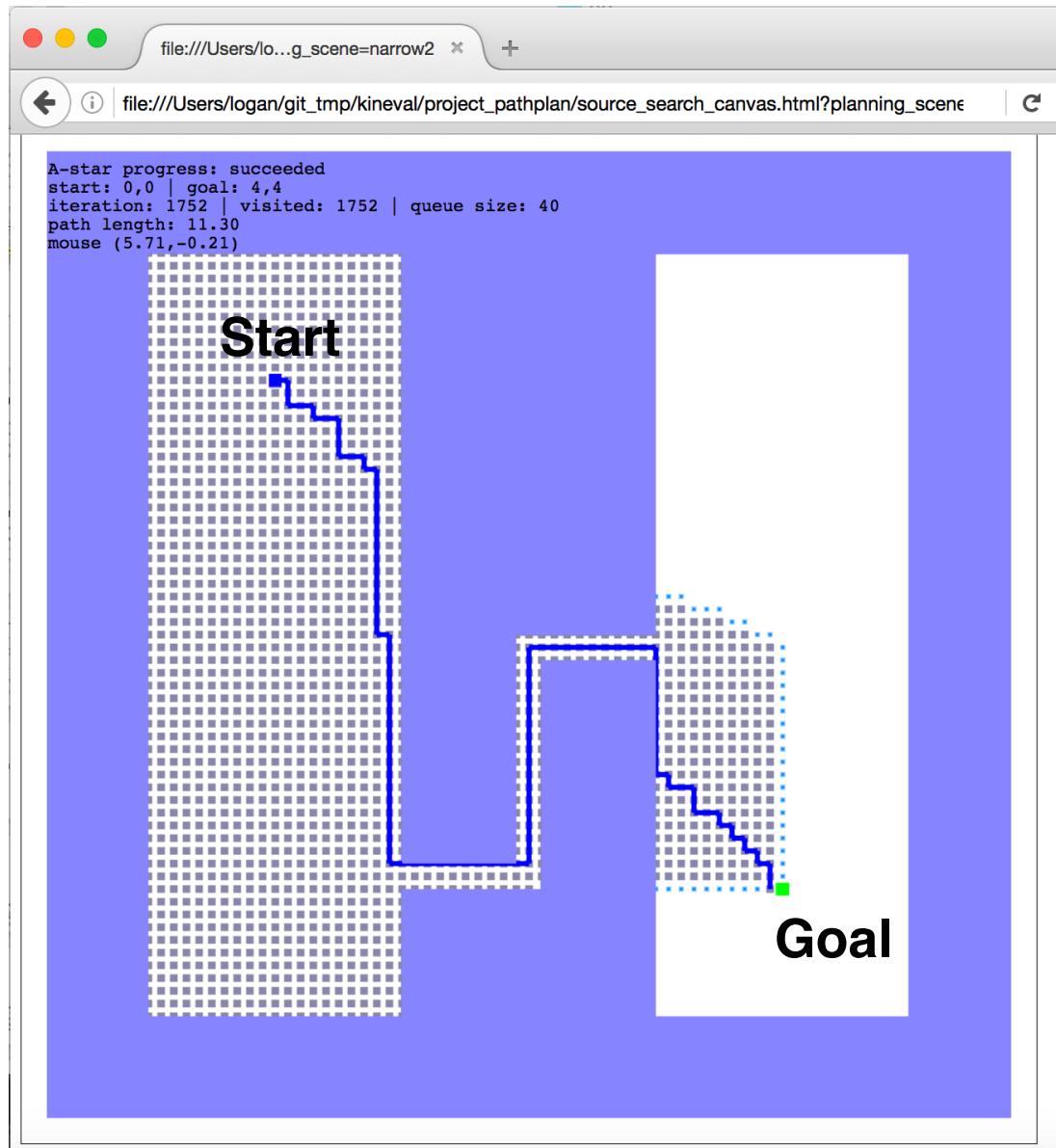
and some JavaScript to add $2 + 2 = 4$

Reload “thislecture.html” in browser to see result of this code

Similar workflow for Project 1

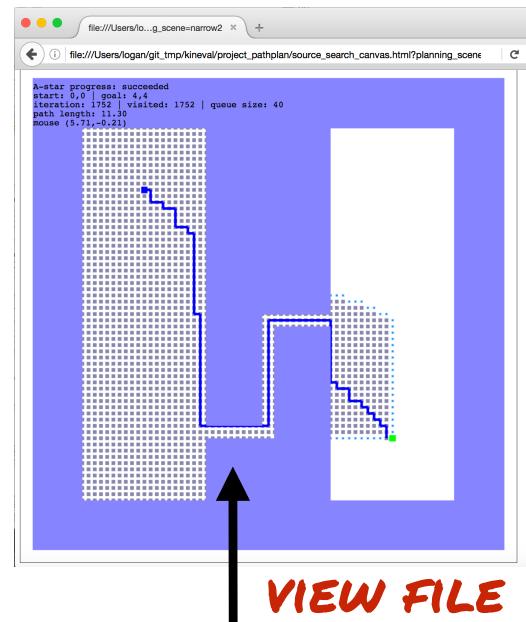
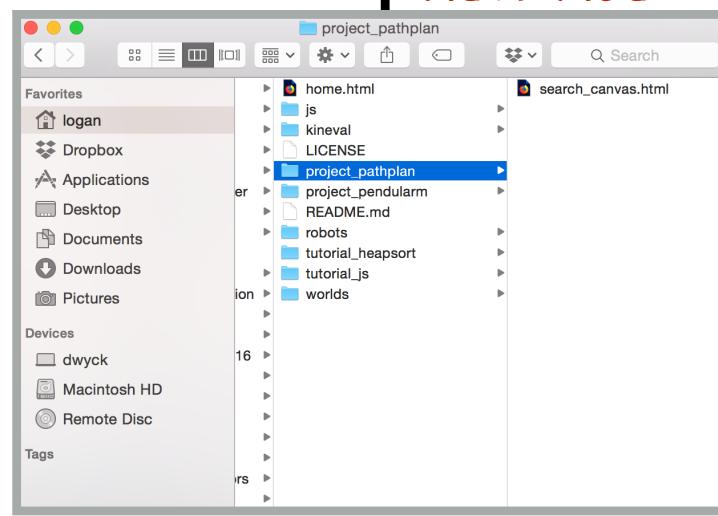
Project 1: 2D Path Planning

- A-star algorithm for search in a specified 2D world
- Implement planner in JavaScript/HTML5 file
- View planner run time behavior in web browser
- Submit by committing code to your git repository



Source code

HTML and JS files
containing your code



VIEW FILE

Browser
See HTML and JS
code working

Text editor

Make changes to
HTML and JS code

```
4. vim

// callback request for the animate function be called again
// more details online: http://learningwebgl.com/blog/?p=3189
requestAnimationFrame( animate );
}

function iterateGraphSearch() {

    // STENCIL: implement a single iteration of a graph search algorithm
    // for A-star (or DFS, BFS, Greedy Best-First)
    // An asynch timing mechanism is used instead of a for loop to avoid
    // blocking and non-responsiveness in the browser.
    //
    // Return "failed" if the search fails on this iteration.
    // Return "succeeded" if the search succeeds on this iteration.
    // Return "iterating" otherwise.
    //
    // Provided support functions:
    //
    // testCollision - returns whether a given configuration is in collision
}

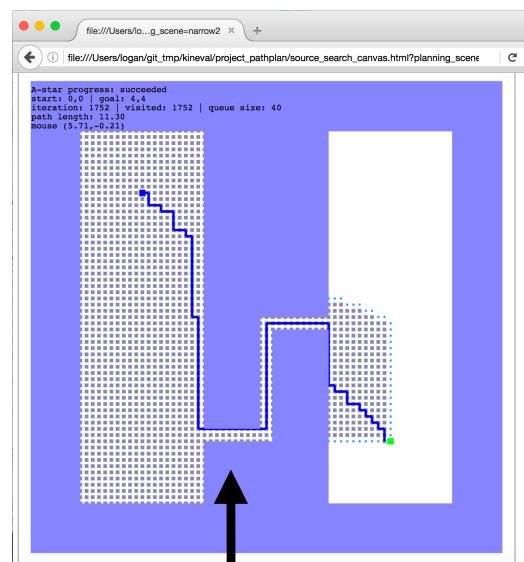
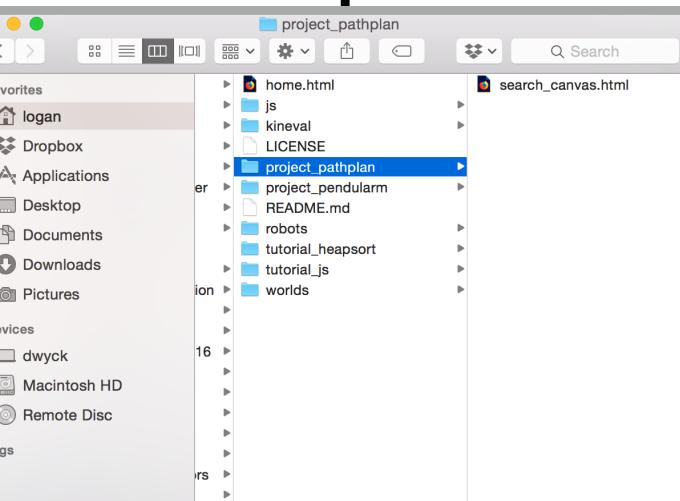
// "project_pathplan/search_canvas.html" line 283 of 559 --50%-- col 1
```

OPEN FILE

SAVE FILE

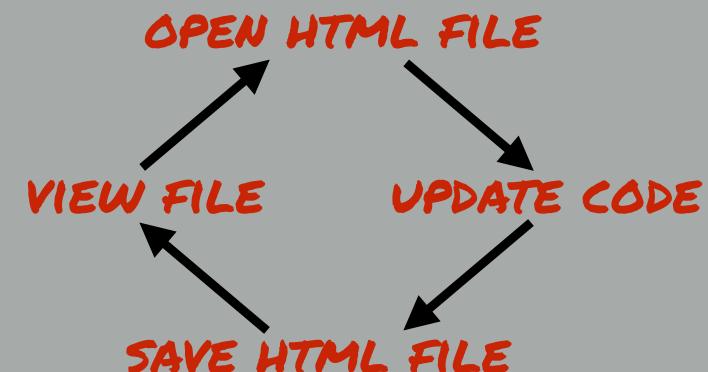
Source code

HTML and JS files
containing your code



VIEW FILE

Coding process



Text editor

Make changes to
HTML and JS code

```
// callback request for the animate function be called again
// more details online: http://learningwebgl.com/blog/?p=3189
requestAnimationFrame( animate );
}

function iterateGraphSearch() {

    // STENCIL: implement a single iteration of a graph search algorithm
    // for A-star (or DFS, BFS, Greedy Best-First)
    // An asynch timing mechanism is used instead of a for loop to avoid
    // blocking and non-responsiveness in the browser.
    //
    // Return "failed" if the search fails on this iteration.
    // Return "succeeded" if the search succeeds on this iteration.
    // Return "iterating" otherwise.
    //
    // Provided support functions:
    //
    // testCollision - returns whether a given configuration is in collision
}

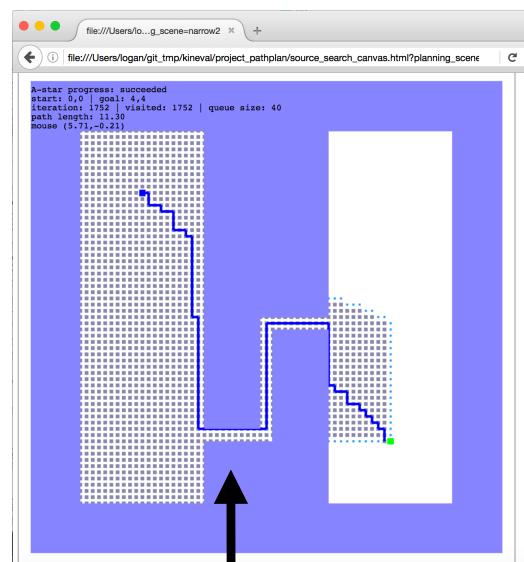
"project_pathplan/search_canvas.html" line 283 of 559 --50%-- col 1
```

OPEN FILE

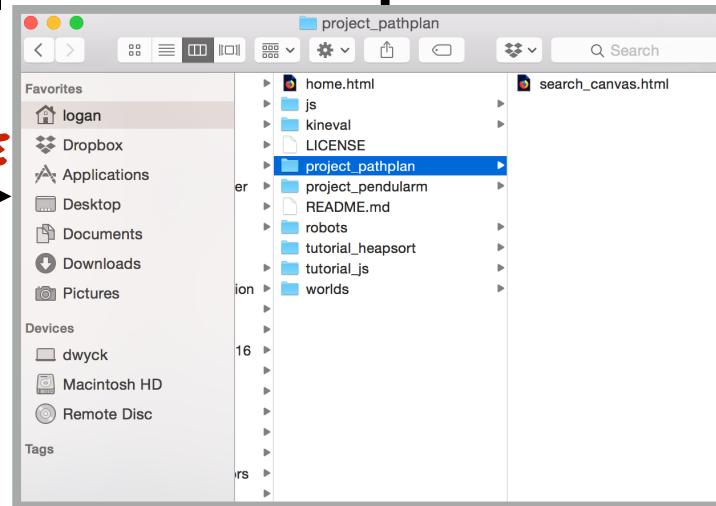
SAVE FILE

Source code

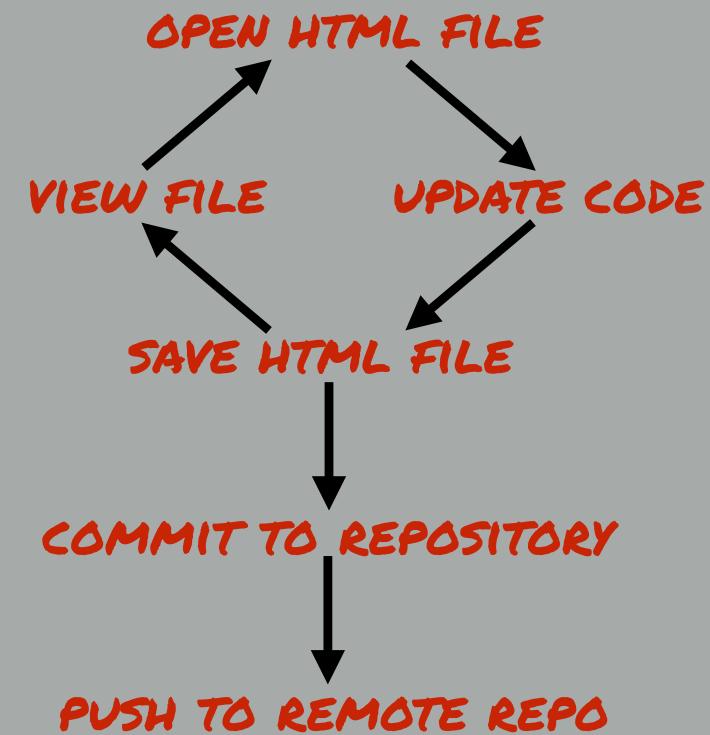
HTML and JS files
containing your code



VIEW FILE



Coding process



Text editor

Make changes to
HTML and JS code

```
// callback request for the animate function be called again
// more details online: http://learningwebgl.com/blog/?p=3189
requestAnimationFrame( animate );
}

function iterateGraphSearch() {

    // STENCIL: implement a single iteration of a graph search algorithm
    // for A-star (or DFS, BFS, Greedy Best-First)
    // An asynch timing mechanism is used instead of a for loop to avoid
    // blocking and non-responsiveness in the browser.
    //
    // Return "failed" if the search fails on this iteration.
    // Return "succeeded" if the search succeeds on this iteration.
    // Return "iterating" otherwise.
    //
    // Provided support functions:
    //
    // testCollision - returns whether a given configuration is in collision
}

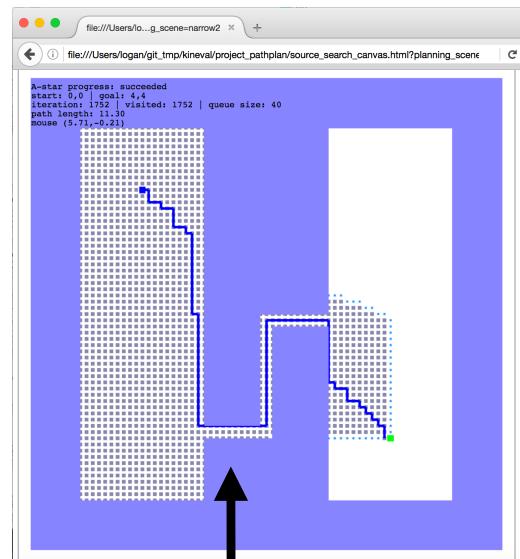
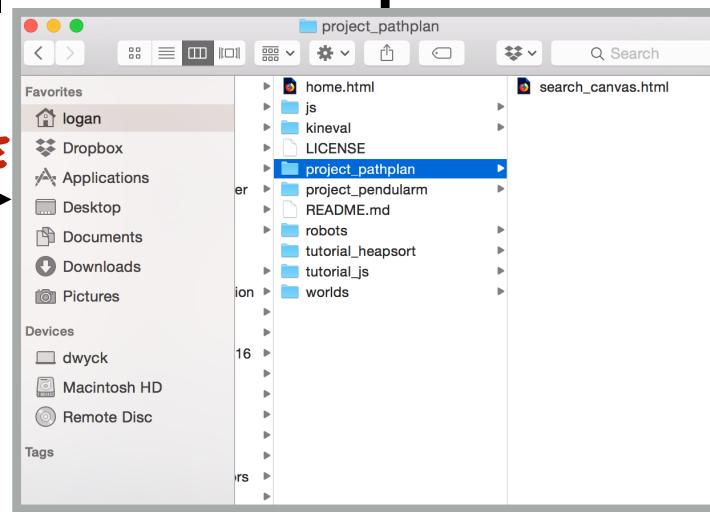
// "project_pathplan/search_canvas.html" line 283 of 559 --50%-- col 1
```

OPEN FILE

SAVE FILE

Source code

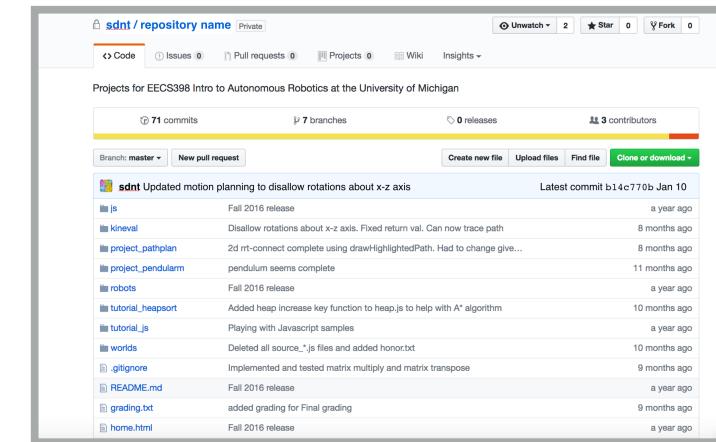
HTML and JS files
containing your code



VIEW FILE

Browser

See HTML and JS
code working



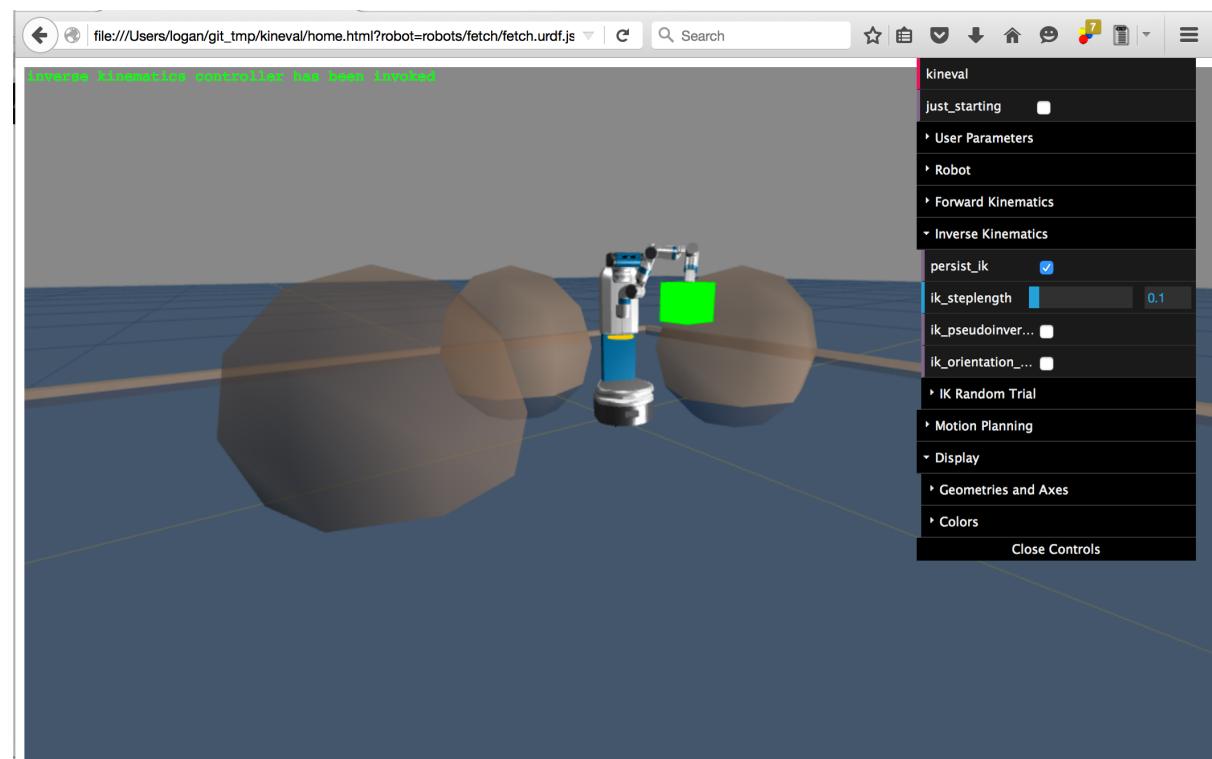
PUSH REPO

PULL REPO

git repository
store history of
code changes
and pull grading

AutoRob and JavaScript/HTML5

- AutoRob course projects implemented for web browsers using JavaScript/HTML5
- KinEval code stencil was created for this purpose
- Works in commonly-used modern web browsers (Firefox, Chrome, Opera, ...)



AUTOROB

schedule

kineval

git

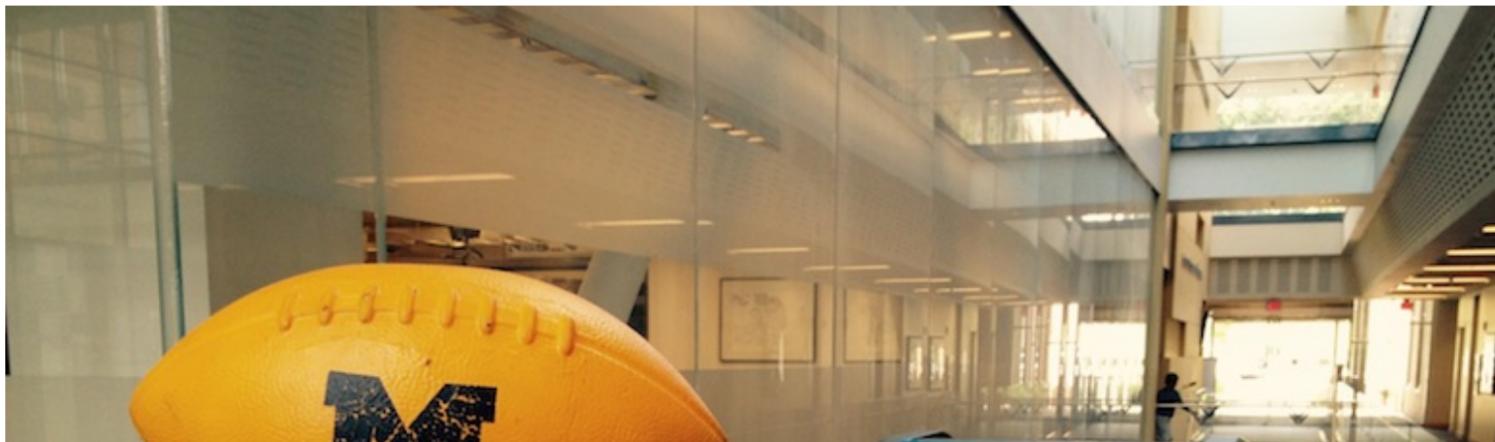
assignments: 1

AutoRob

Introduction to Autonomous Robotics
Michigan EECS 398

Robot Kinematics and Dynamics
Michigan ME 567 EECS 567 ROB 510

Fall 2018



Screenshot of a GitHub repository page for `autorob / kineval-stencil`.

The URL in the browser bar is <https://github.com/autorob/kineval-stencil>.

The repository summary shows:

- Code: 2 commits
- Issues: 0
- Pull requests: 0
- Projects: 0
- Wiki: 0
- Unwatch: 2
- Star: 0
- Fork: 0

The repository description is: "Stencil code for KinEval (Kinematic Evaluator) for robot control, kinematics, decision, and dynamics in JavaScript/HTML5".

The repository owner is `odestcj`, and it was created in Fall 2018.

The repository structure includes:

- `js`: initial commit Fall 2018
- `kineval`: initial commit Fall 2018
- `project_pathplan`: initial commit Fall 2018
- `project_pendularm`: initial commit Fall 2018
- `robots`: initial commit Fall 2018
- `tutorial_heapsort`: initial commit Fall 2018
- `tutorial_js`: initial commit Fall 2018
- `worlds`: initial commit Fall 2018

A screenshot of a web browser window titled "autorob.org" is shown on the right side of the page, displaying the "AutoRob" website. The website content includes:

- Introduction to Autonomous Robotics
- Michigan EECS 398
- Robot Kinematics and Dynamics
- Michigan ME 567 EECS 567 ROB 510
- Fall 2018



Why JavaScript/HTML5?

Why JavaScript/HTML5?

Spectrum of programming languages

Spectrum of programming languages

C

C++ (maybe)

Python

Matlab
(for numerics)

JavaScript



“Get it done right”

Performance

Robustness

Reusability

Suboptimal tradeoffs

Readability
(e.g., scoping by whitespace)

Mixed Performance
(e.g., compiling down to C)

Overhead Cost
(e.g., complex build and run time)

“Get it done quickly”

Rapid development

Visualization/UI

Dissemination

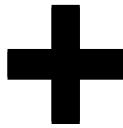
JavaScript has
Pros and Cons

Pros



Cons





- It's free! (and open)
- Portability (Browsers are everywhere!)
- Excellent UI and visualization
(see threejs.org for examples)
- Reasonable learning curve
(No complicated build process)
- Translates to C++ style thinking
- Weak typing (**JavaScript is C without discipline**)
- Live introspection and coding



- Network access limited to HTTP
(for security)
- Limited file I/O (sandboxed run time for security)
- Floating point issues
(all numbers represented in IEEE 754)
- Speed and efficiency
(typically JavaScript is interpreted or compiled to intermediate code)
- Weak typing
- Cryptic debugging messages

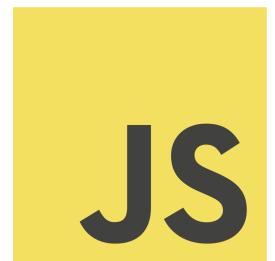
JavaScript is C without discipline

- If you are fluent in C or a “classical” programming language, JavaScript has prototyping and minor syntactical differences
 - your instincts and stackoverflow should be enough
- If you are familiar with Matlab or an “scientific” language, you may need time to become familiar with syntax and some data structures
- If you are new to programming: EECS 402 or EECS 280 or Programming for Robotics are highly recommended to be taken in parallel or as a prerequisite

What is JavaScript/HTML5

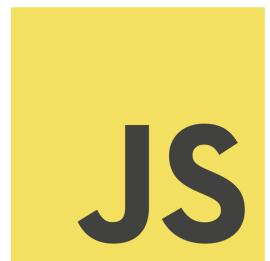
What is JavaScript/HTML5

- The essential technologies for creating and rendering web pages are HTML5, JavaScript, and CSS
- These technologies structure the run-time environment of web browsers



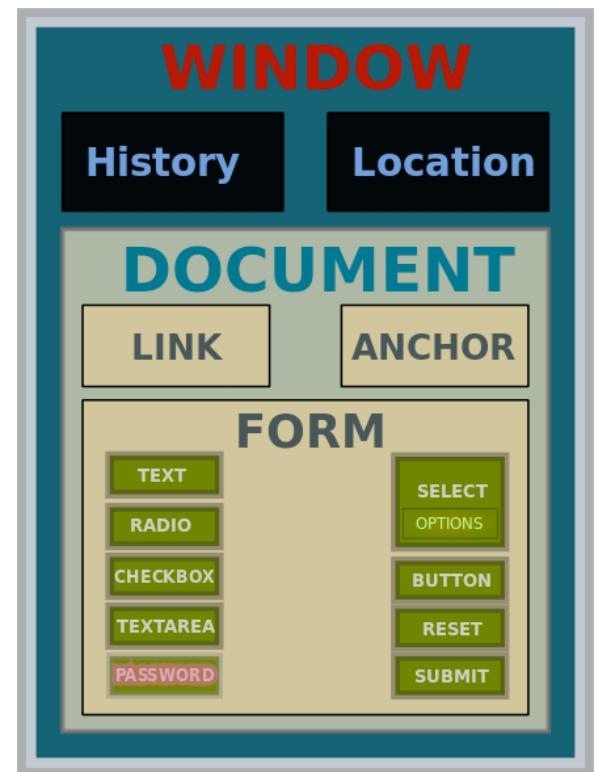
What is JavaScript/HTML5

- **HyperText Markup Language** (HTML5): a markup language for expressing web pages as documents
 - Web browsers read HTML files and render to display
 - Based on the Document Object Model representation
- **JavaScript** (formally ECMAScript): a high-level, dynamic, untyped, interpreted programming language for making “dynamic” web pages
- **Cascading Style Sheets** (CSS): a style sheet language used for describing the presentation of a document



Document Object Model (DOM)

- HTML document defined by elements nested within markup tags (e.g.,
 <h1>text</h1>)
- DOM provides programmatic access to these elements as JavaScript objects
- DOM provides 2 important global objects:
 - “**window**” is the DOM root for a browser tab (a global variable “x” is actually “window.x”)
 - “**document**” maintains the current state of the document; auto-populated upon loading
- Each element has a “style” property for CSS



Start with a simple example

AUTOROB

schedule kineval git assignments: 1

Course Schedule (tentative and subject to change)

Note: Assignment descriptions will have updated assignment due dates. Assignment due dates listed in the schedule are merely a guide.

Date	Topic	Reading	Project
Sep 5	Initialization: Course overview, Robotics roadmap, Path planning quick start	Spong Ch.1 Corke Ch.1	Setup git repository

JAVASCRIPT/HTML5 HELLO EXAMPLE

Week 2

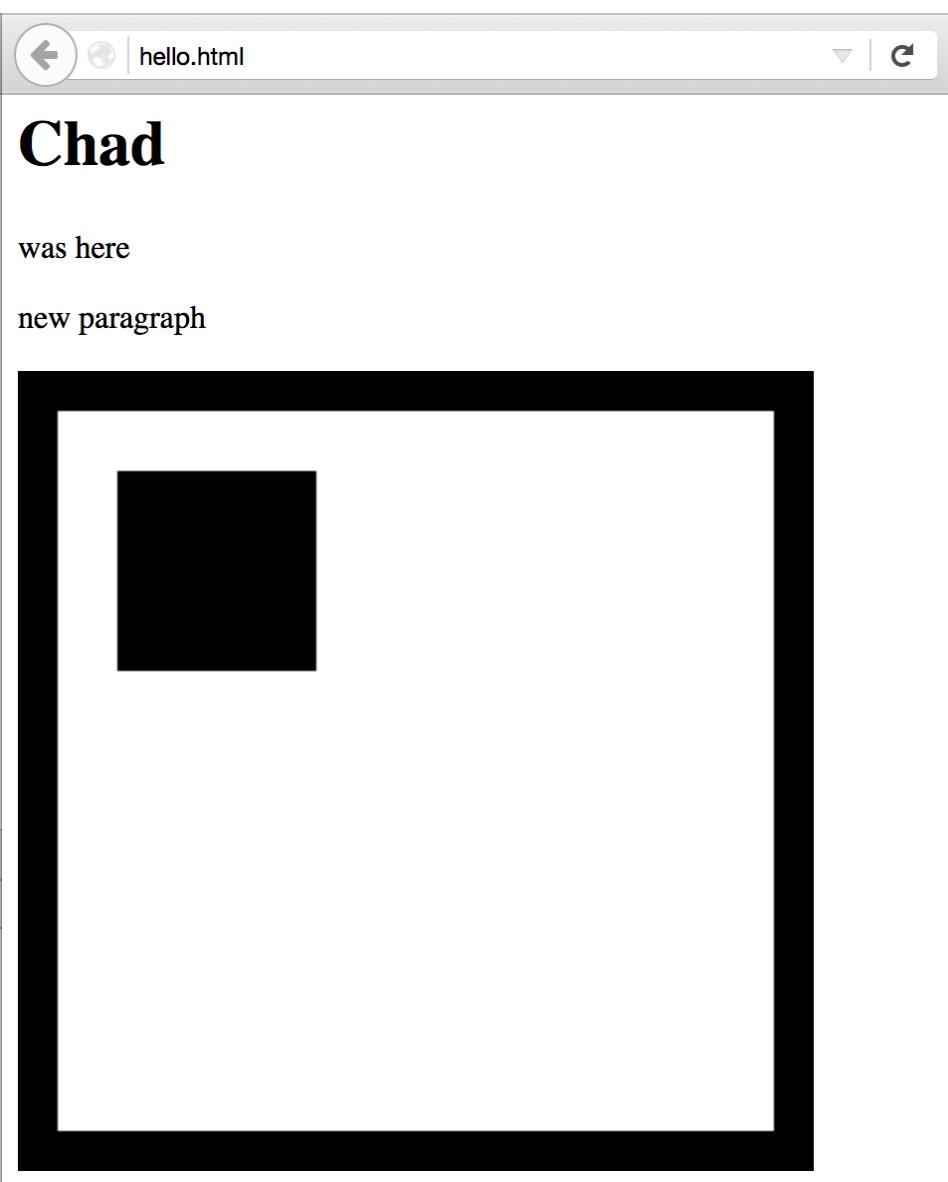
Sep 10	Path Planning: DFS, BFS, A-star, Greedy best first	Wikipedia	Out: Path Planning
--------	--	-----------	--------------------

JavaScript and git tutorial: Heap sort example

Crockford,
[HTML Sandbox](#),
[hello.html \(source\)](#),
[JavaScript by Example \(source\)](#),
[hello_anim \(source\)](#),
[hello_anim_text \(source\)](#)

Sep 12	Pendulum Simulation and Numerical Integration: Lagrangian equation(s) of motion, Initial value problem, Explicit integrators: Euler, Verlet, and Runge-Kutta 4	Euler's Method Verlet Integration , Runge-Kutta ; Witkin&Baraff 1998: Dynamics Witkin&Baraff 1998: Integrators
--------	---	--

Week 3



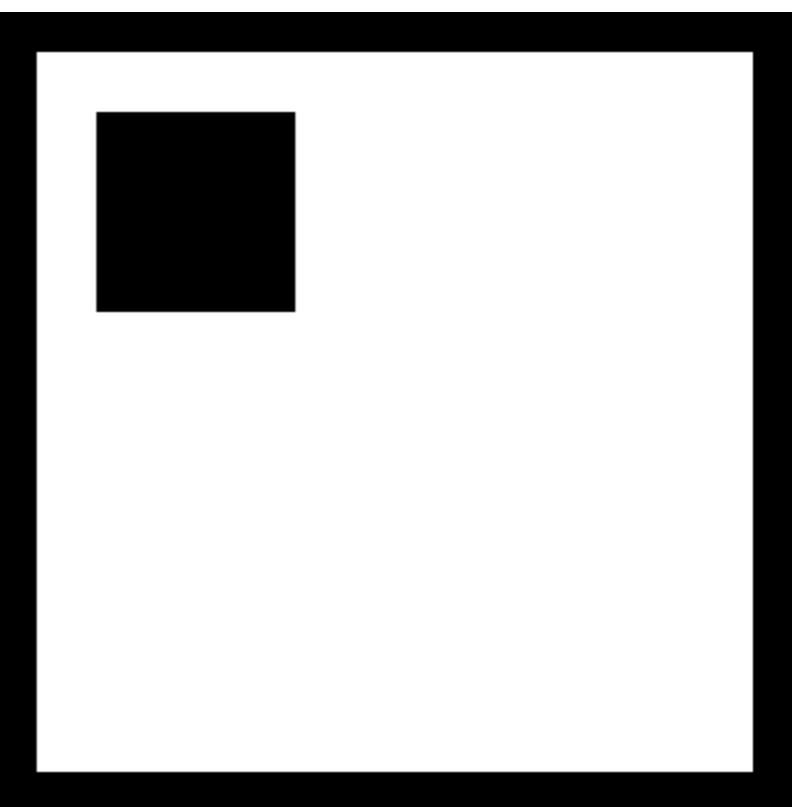
hello example

- <http://autorob.github.io/examples/hello.html>

Chad

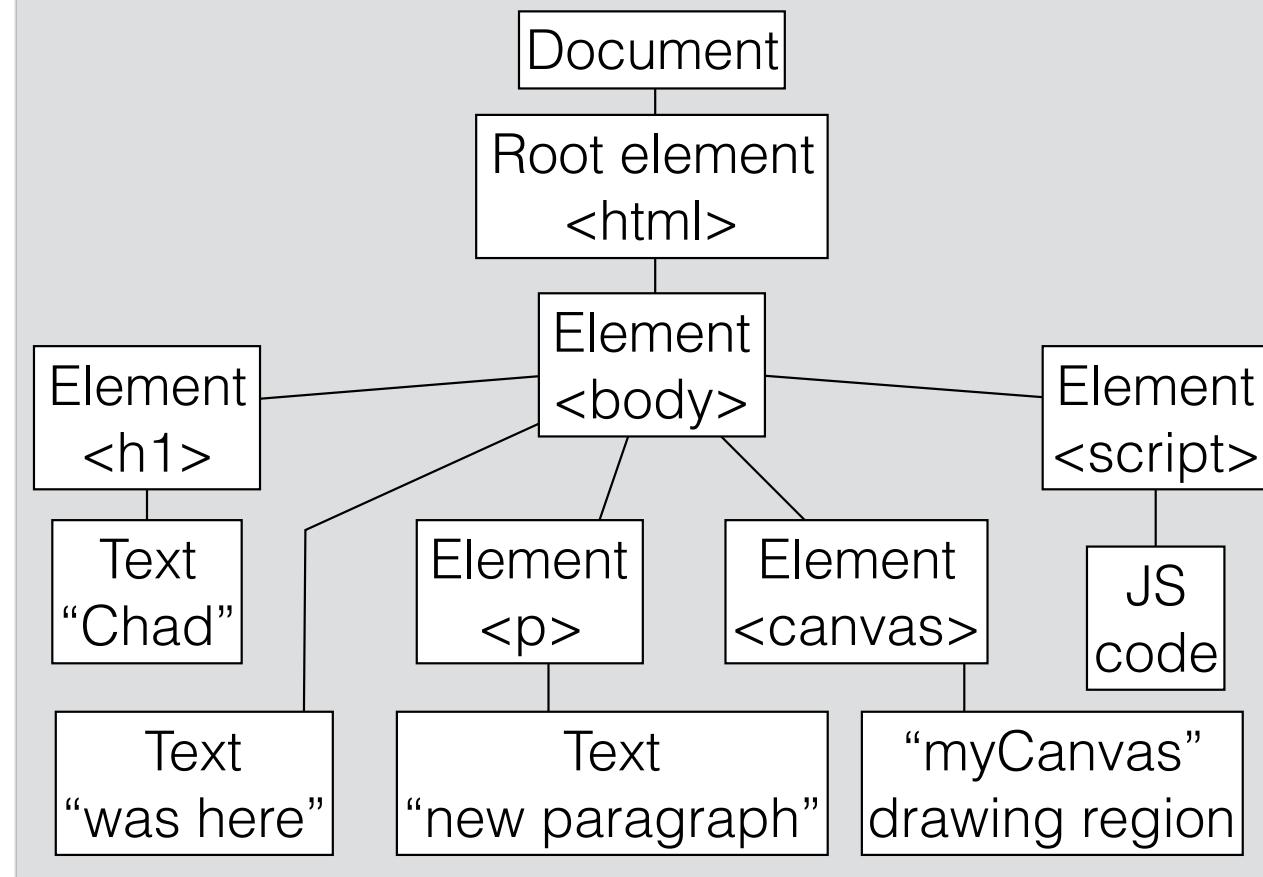
was here

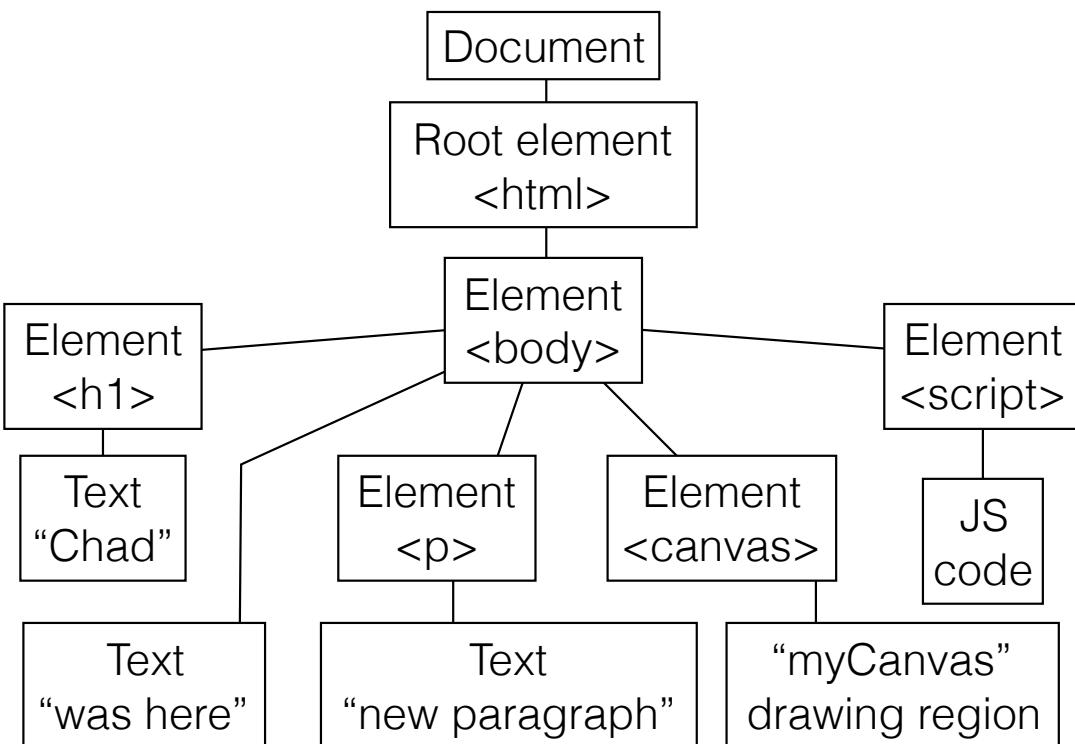
new paragraph



hello example

DOM created by browser upon loading hello.html





```

<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

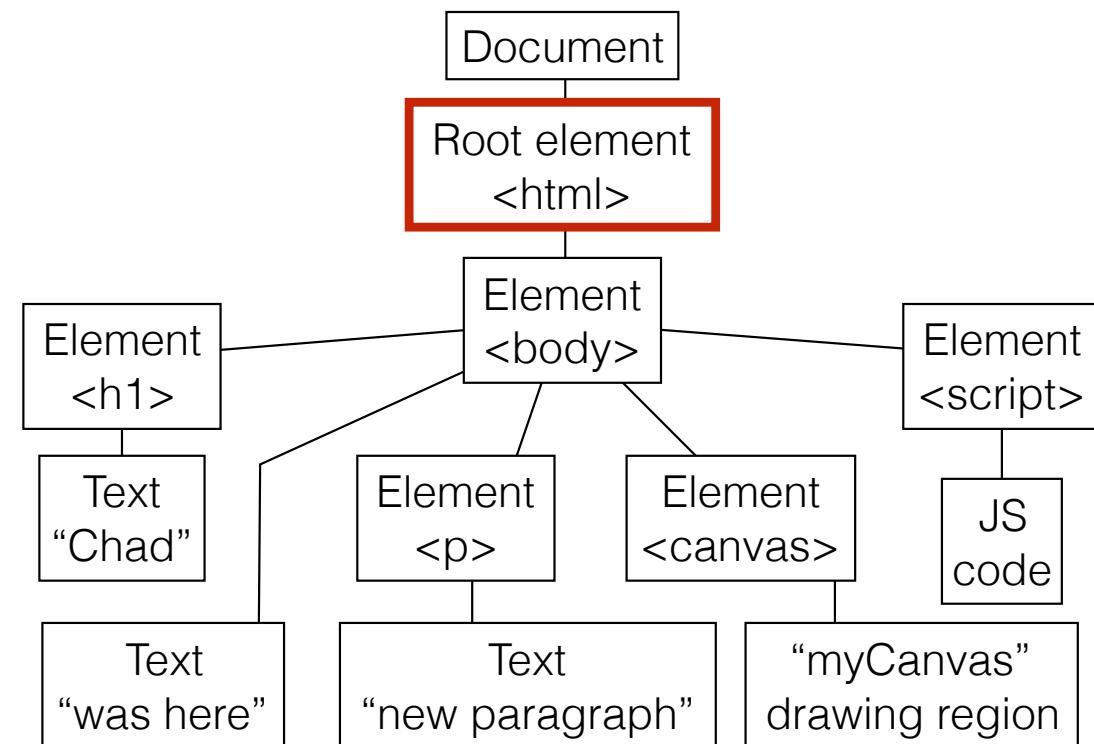
    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

</script>
</body> </html>

```

hello.html file



```

<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
  // this is a comment in JavaScript. it is ignored

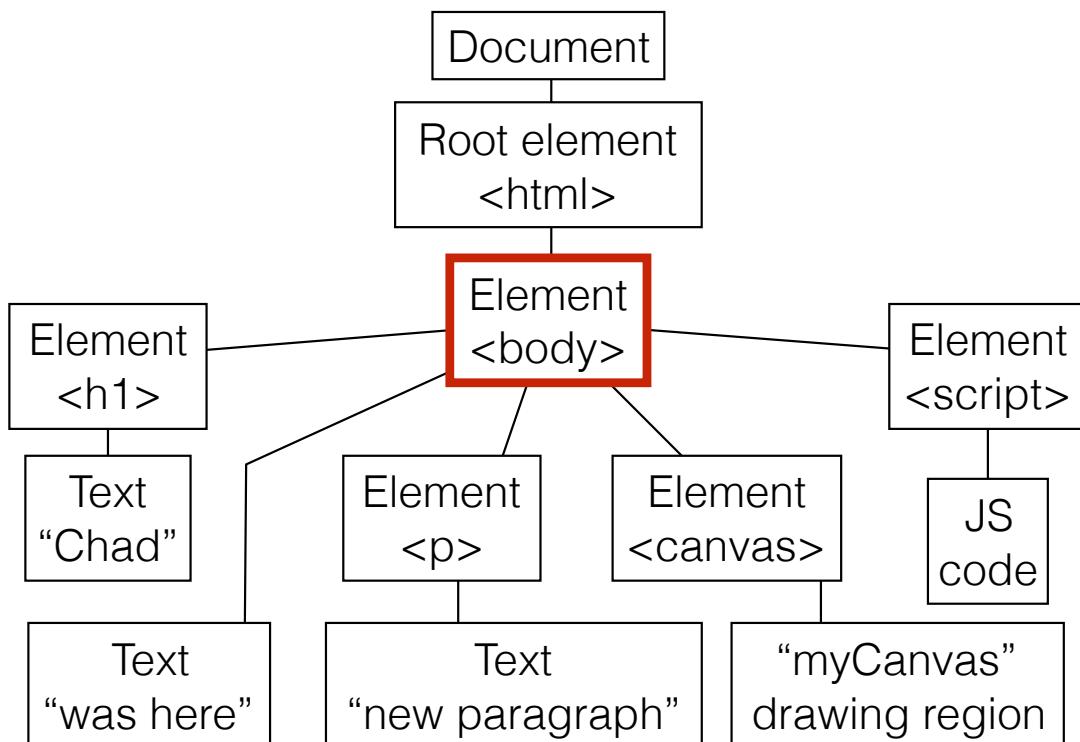
  // grab the canvas HTML element for drawing
  var canvas = document.getElementById("myCanvas");

  // grab the canvas drawing context
  var ctx = canvas.getContext("2d");

  // draw rectangles
  ctx.fillRect(50,50,100,100);
  ctx.fillRect(0,0,20,400);
  ctx.fillRect(0,0,400,20);
  ctx.fillRect(0,380,400,20);
  ctx.fillRect(380,0,20,400);

</script>
</body> </html>
  
```

hello.html file



```
<html> <body><!-- this is a comment in HTML. it is ignored --&gt;

&lt;h1&gt;Chad&lt;/h1&gt; &lt;!-- say your name big --&gt;

was here &lt;!-- say something smaller --&gt;

&lt;p&gt; &lt;!-- start a new paragraph --&gt; new paragraph &lt;/p&gt;

&lt;!-- create a element for drawing --&gt;
&lt;canvas id="myCanvas" width="400" height="400"&gt;&lt;/canvas&gt;

&lt;!-- create an element with JavaScript code to execute --&gt;
&lt;script&gt;
  // this is a comment in JavaScript. it is ignored

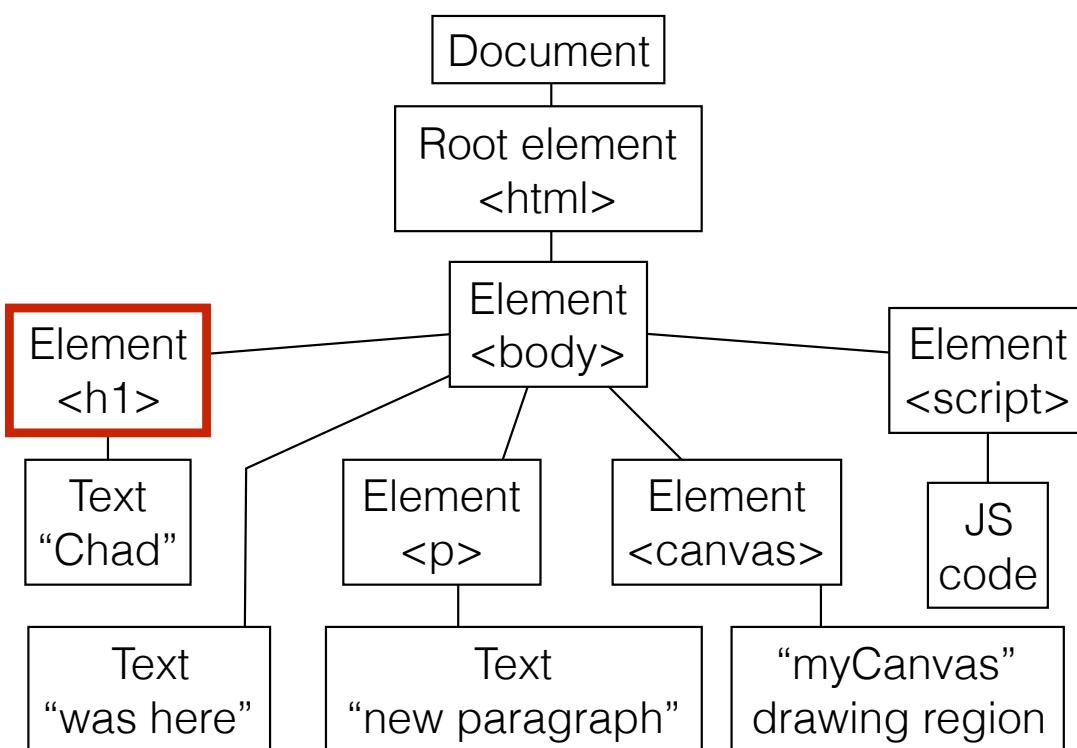
  // grab the canvas HTML element for drawing
  var canvas = document.getElementById("myCanvas");

  // grab the canvas drawing context
  var ctx = canvas.getContext("2d");

  // draw rectangles
  ctx.fillRect(50,50,100,100);
  ctx.fillRect(0,0,20,400);
  ctx.fillRect(0,0,400,20);
  ctx.fillRect(0,380,400,20);
  ctx.fillRect(380,0,20,400);

&lt;/script&gt;
&lt;/body&gt; &lt;/html&gt;</pre>
```

hello.html file



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

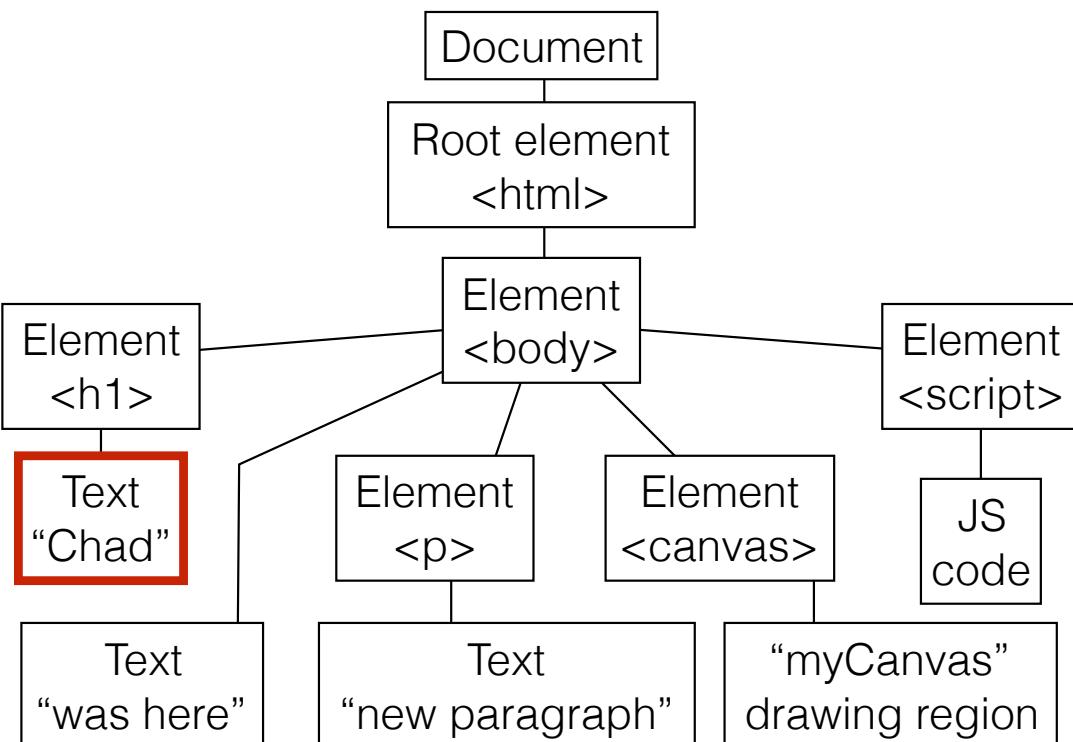
    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

</script>
</body> </html>
```

hello.html file



Chad



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

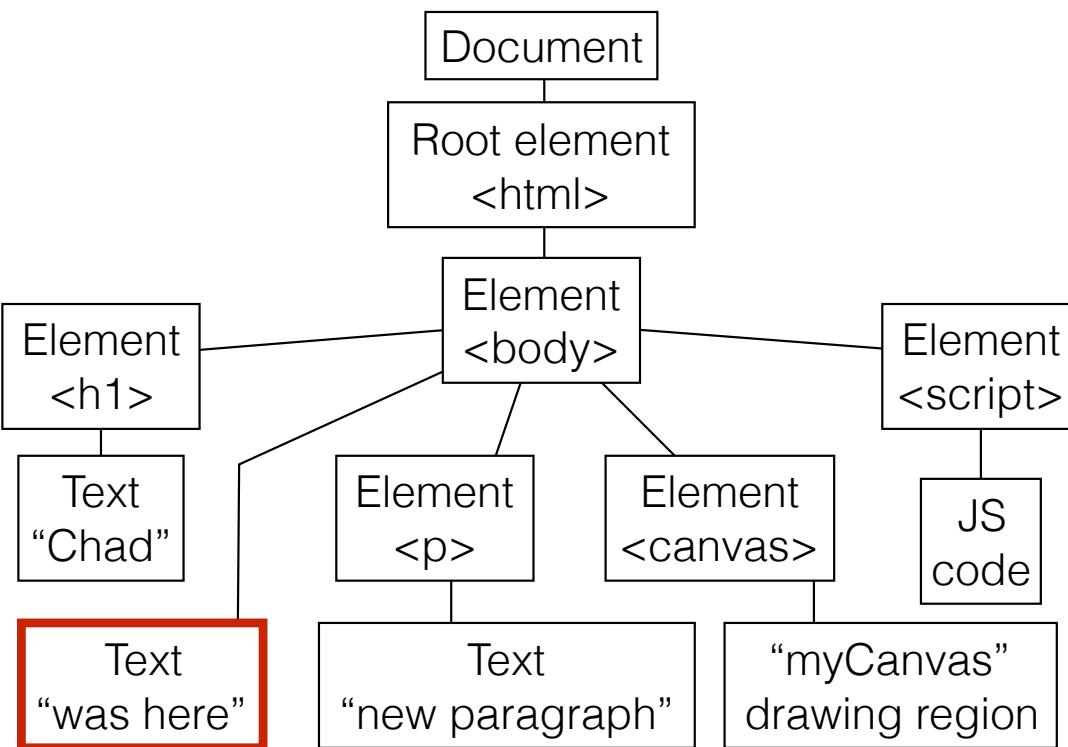
</script>
</body> </html>
```

hello.html file



Chad

was here



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

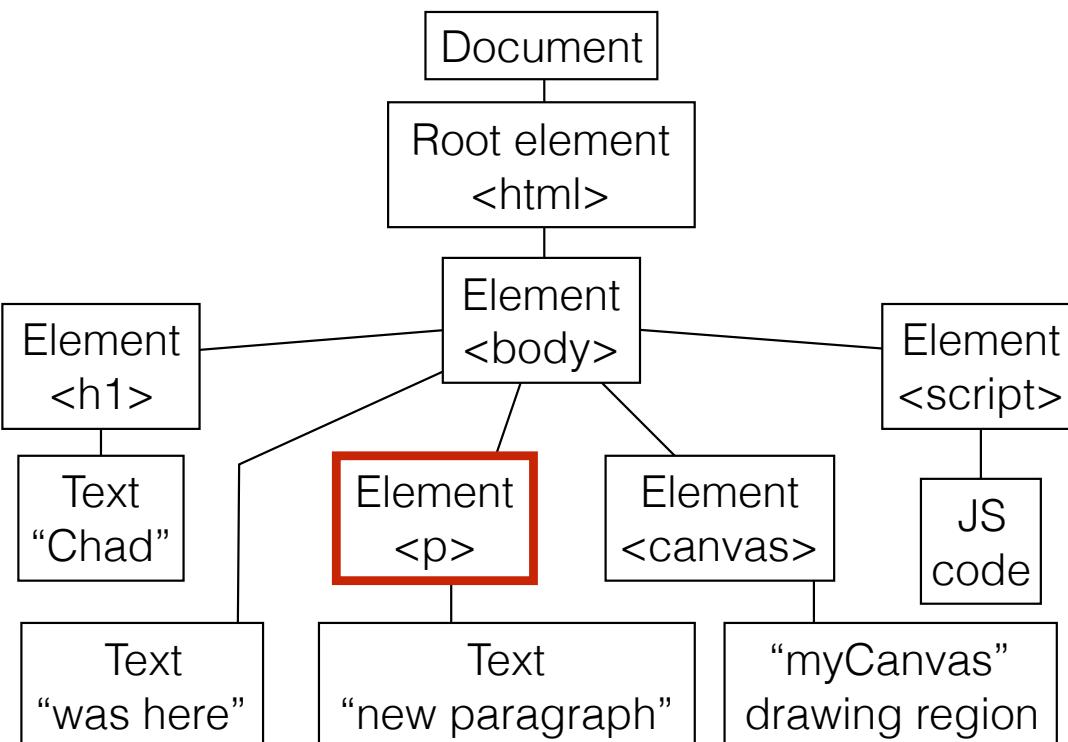
</script>
</body> </html>
```

hello.html file



Chad

was here



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

</script>
</body> </html>
```

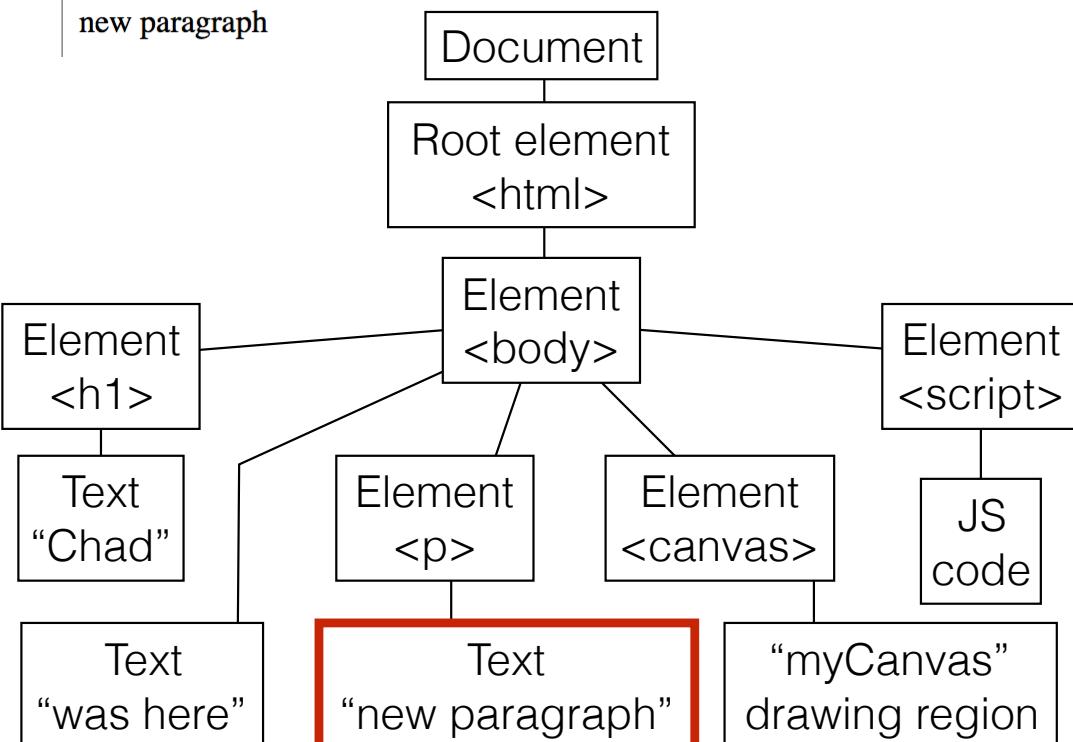
hello.html file



Chad

was here

new paragraph



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

</script>
</body> </html>
```

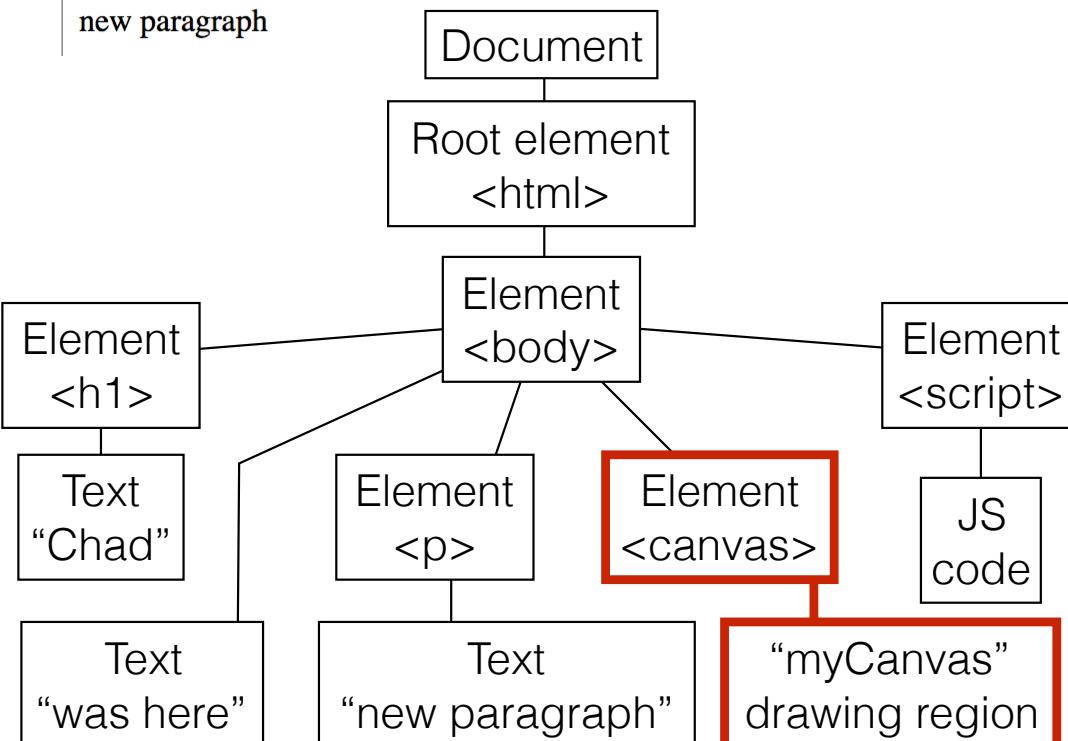
hello.html file



Chad

was here

new paragraph



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);
</script>
</body> </html>
```

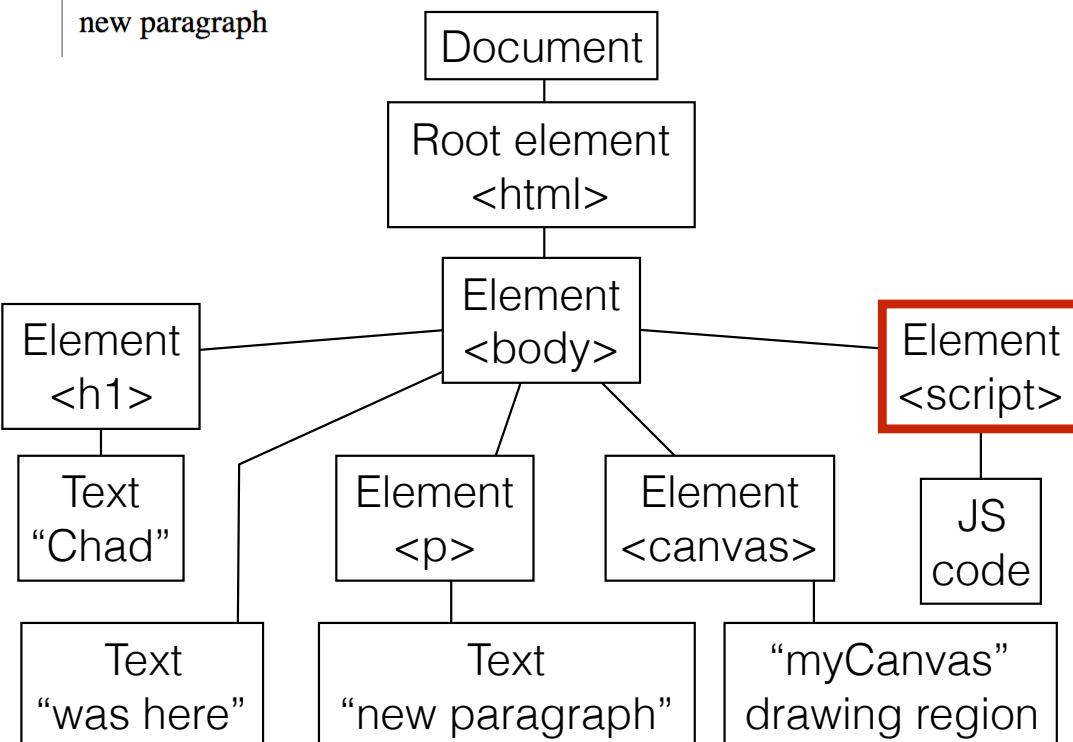
hello.html file



Chad

was here

new paragraph



```
<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
    // this is a comment in JavaScript. it is ignored

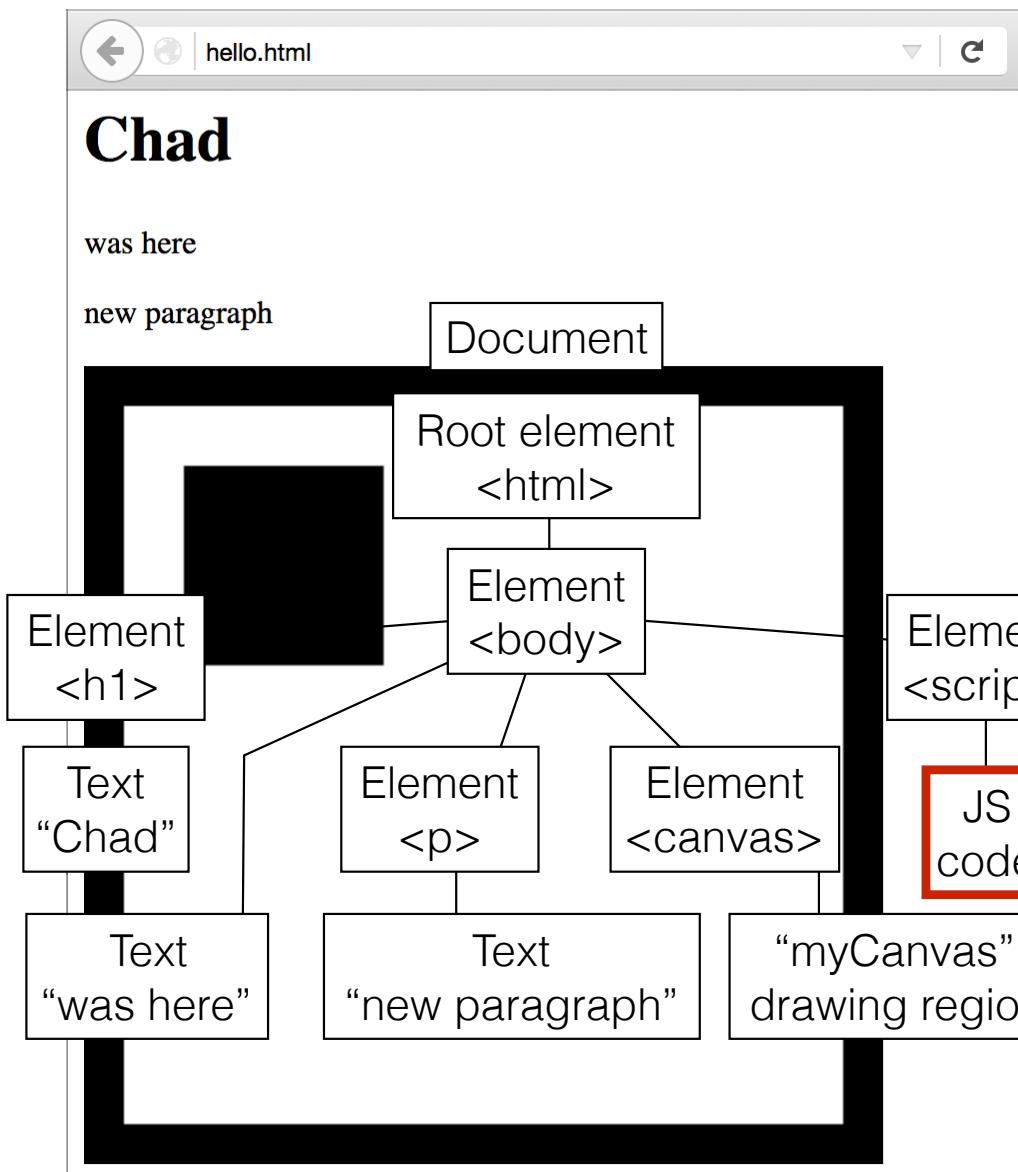
    // grab the canvas HTML element for drawing
    var canvas = document.getElementById("myCanvas");

    // grab the canvas drawing context
    var ctx = canvas.getContext("2d");

    // draw rectangles
    ctx.fillRect(50,50,100,100);
    ctx.fillRect(0,0,20,400);
    ctx.fillRect(0,0,400,20);
    ctx.fillRect(0,380,400,20);
    ctx.fillRect(380,0,20,400);

</script>
</body> </html>
```

hello.html file



```

<html> <body> <!-- this is a comment in HTML. it is ignored -->

<h1>Chad</h1> <!-- say your name big -->

was here <!-- say something smaller -->

<p> <!-- start a new paragraph --> new paragraph </p>

<!-- create a element for drawing -->
<canvas id="myCanvas" width="400" height="400"></canvas>

<!-- create an element with JavaScript code to execute -->
<script>
  // this is a comment in JavaScript. it is ignored

  // grab the canvas HTML element for drawing
  var canvas = document.getElementById("myCanvas");

  // grab the canvas drawing context
  var ctx = canvas.getContext("2d");

  // draw rectangles
  ctx.fillRect(50,50,100,100);
  ctx.fillRect(0,0,20,400);
  ctx.fillRect(0,0,400,20);
  ctx.fillRect(0,380,400,20);
  ctx.fillRect(380,0,20,400);

</script>
</body> </html>

```

hello.html file

Using the browser console

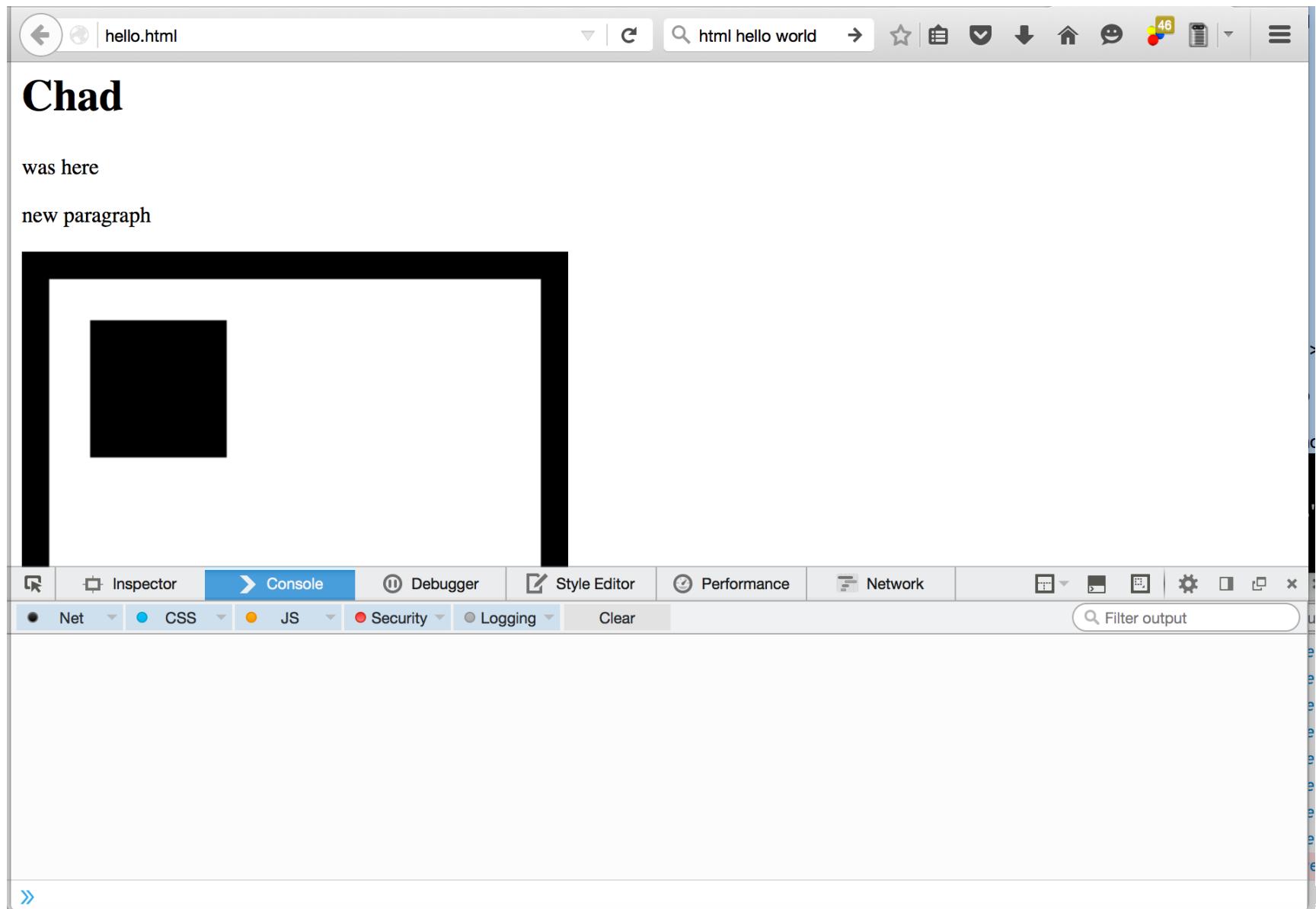
The Browser Console

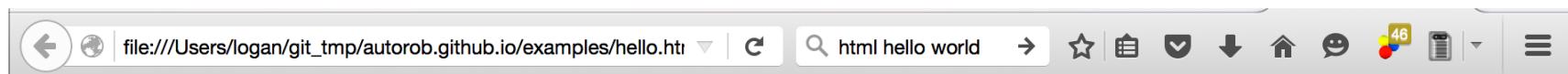
- Provided by the web browser to:
 - Log information associated with a web page: errors, warnings, explicit logging messages, network requests, security errors, etc.
 - Live interaction with a web page by executing JavaScript expressions in the context of the page

A screenshot of a web browser window titled "hello.html". The address bar shows "html hello world". The main content area displays the text "Chad", "was here", and "new paragraph". A large black rectangular box is overlaid on the page. On the right side, the "WEB DEVELOPER" tools menu is open, listing various developer tools with their keyboard shortcuts:

- Cut
- Toggle Tools ⌘I
- Inspector ⌘C
- Web Console ⌘K
- Debugger ⌘S
- Style Editor ⇧F7
- Performance ⇧F5
- Network ⌘Q
- Developer Toolbar ⇧F2
- WebIDE ⇧F8
- Browser Console ⇧⌘J
- Responsive Design View ⌘M
- Eyedropper
- Scratchpad ⇧F4
- Page Source ⌘U
- Get More Tools
- Work Offline

The "Web Console" option is highlighted with a blue selection bar. The bottom of the browser window shows "Sign in to..." and "Customize".





Chad

was here

some paragraph text

```
>> 6+2
← 8
>> Math.pow(2,3)
← 8
>> "6" + "2"
← "62"
>> new_text = "more things to say"
← "more things to say"
>> for (i=0;i<10;i++) { new_text += " " + i; }
← "more things to say 0 1 2 3 4 5 6 7 8 9"
>> expressions entered here are evaluated live
```

```
>> 6+2
← 8
>> Math.pow(2,3)
← 8
>> "6" + "2"
← "62"
>> new_text = "more things to say"
← "more things to say"
>> for (i=0;i<10;i++) { new_text += " " + i; }
← "more things to say 0 1 2 3 4 5 6 7 8 9"
>> expressions entered here are evaluated live
```

The screenshot shows a browser window with developer tools open. The address bar indicates the file is at `file:///Users/logan/git_tmp/autorob.github.io/examples/hello.html`. The search bar contains "html hello world". The toolbar includes icons for back, forward, search, and various developer options.

The main content area displays the output of a script execution:

```
>> for (i=0;i<10;i++) { new_text += " " + i; }
← "more things to say 0 1 2 3 4 5 6 7 8 9"
>> document.body.innerHTML = "wiped everything out and replaced with " + new_text;
← "wiped everything out and replaced with more things to say 0 1 2 3 4 5 6 7 8 9"

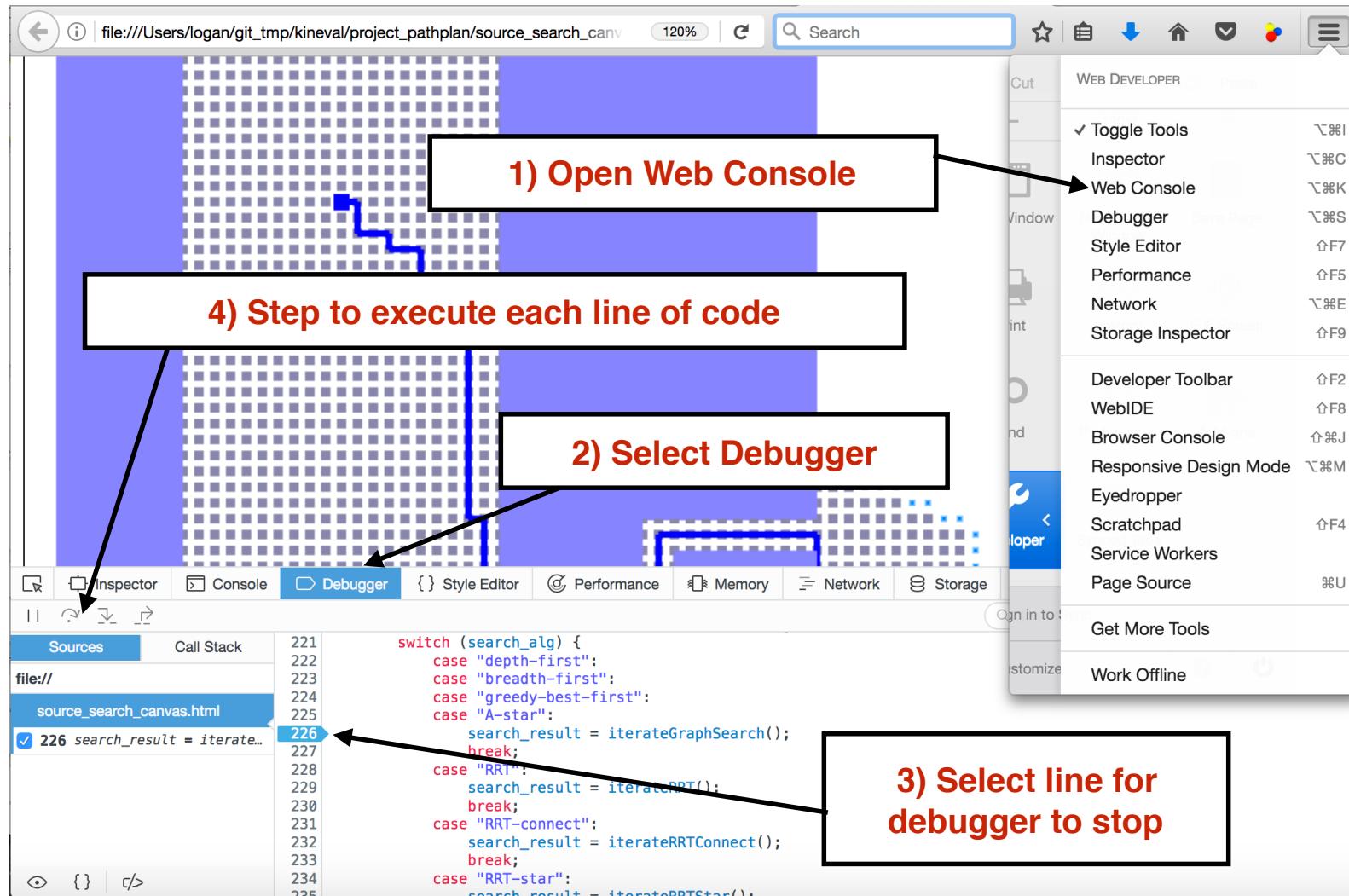
```

The bottom left panel shows the network and CSS tabs, with the Net tab currently selected. The history pane shows previous commands and their results:

```
>> Math.pow(2,3)
← 8
>> "6" + "2"
← "62"
>> new_text = "more things to say"
← "more things to say"
>> for (i=0;i<10;i++) { new_text += " " + i; }
← "more things to say 0 1 2 3 4 5 6 7 8 9"
>> document.body.innerHTML = "wiped everything out and replaced with " + new_text;
← "wiped everything out and replaced with more things to say 0 1 2 3 4 5 6 7 8 9"
```

A large black rectangular box highlights the final two lines of the output, which are the result of the `document.body.innerHTML` assignment.

Using the browser debugger



JavaScript: the quick and dirty

AUTOROB

schedule kineval git assignments: 1

Course Schedule (tentative and subject to change)

Note: Assignment descriptions will have updated assignment due dates. Assignment due dates listed in the schedule are merely a guide.

Date	Topic	Reading	Project
Sep 5	Initialization: Course overview, Robotics roadmap, Path planning quick start What is a robot? : Brief history and definitions for robotics	Spong Ch.1 <hr/> Corke Ch.1	Setup git repository
	Week 2		
Sep 10	Path Planning: DFS, BFS, A-star, Greedy best first JavaScript and git tutorial: Heap sort example	Wikipedia	Out: Path Planning
		Crockford, HTML Sandbox, hello.html (source) , JavaScript by Example (source) , hello_anim (source) , hello_anim_text (source)	
Sep 12	Pendulum Simulation and Numerical Integration: Lagrangian equation(s) of motion, Initial value problem, Explicit integrators: Euler, Verlet, and Runge-Kutta 4	Euler's Method Verlet Integration , Runge-Kutta ; Witkin&Baraff 1998: Dynamics Witkin&Baraff 1998: Integrators	
	Week 3		

Quick JavaScript Code-by-Example Tutorial
Chad Jenkins (ocj)

OPEN "VIEW SOURCE" IN BROWSER TO SEE THIS CODE

```
autorob.org|autorob.online|autorob.github.io
--> Please review the tutorialJSCoding() function
autorobObject contents:
AutoRob university is Michigan
AutoRob department is EECS
AutoRob course_number is 367-002
AutoRob subject is autonomous_robotics
AutoRob stringContaining_the_word_subject is an irrelevant property
AutoRob phoneArray is 8,6,7,5,3,0,ni-i-i-ine
AutoRob instructor is ocj
AutoRob printCourseInfo is function myFunction(inputObject) { // create array that will be returned var outputArray = []; // Object.keys() method returns an array of top-level keys in an object myObjectKeys = Object.keys(inputObject); // format and output strings for each key/value element of myObject for (i=0;i
```



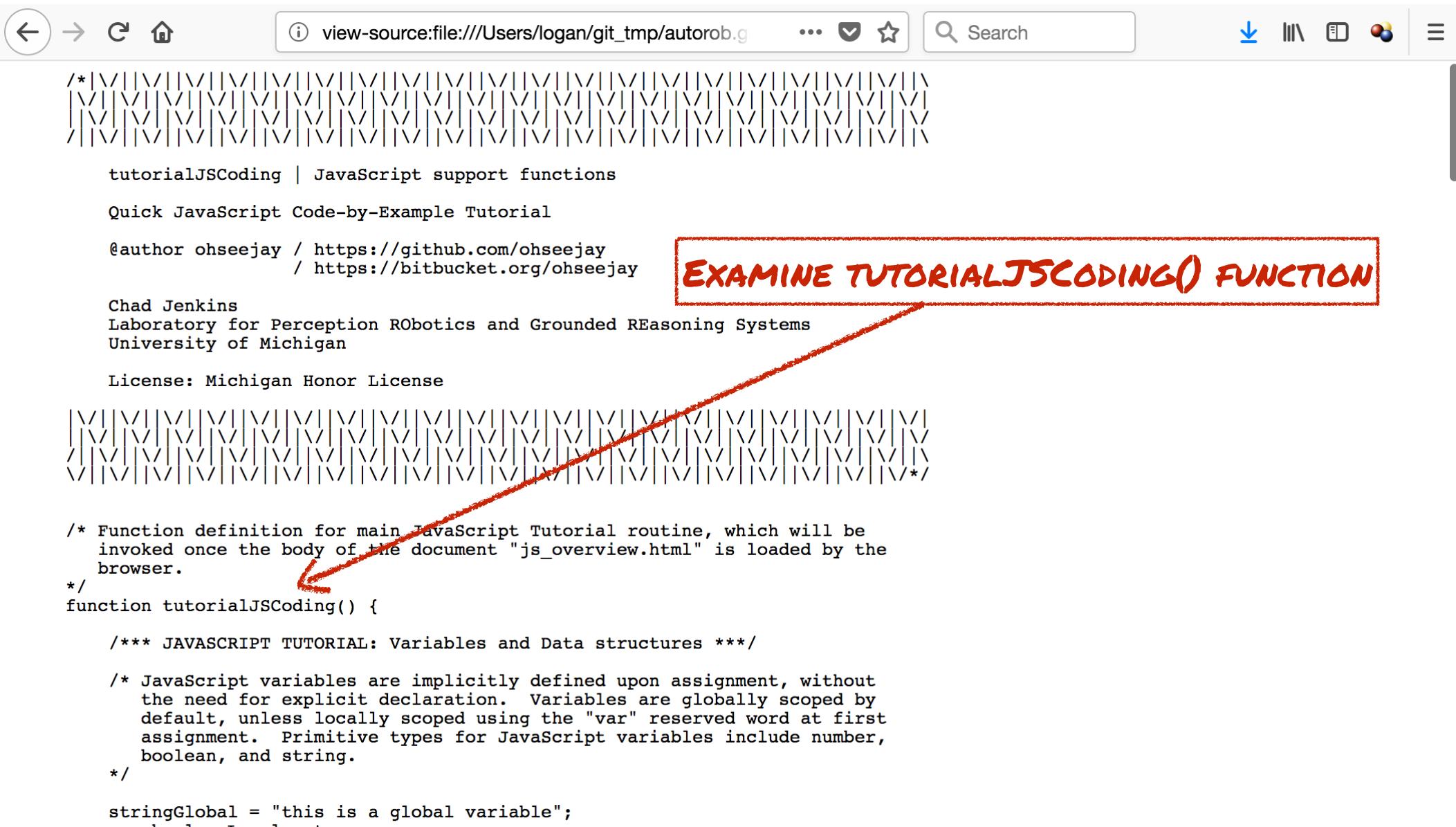
```

31 Firefox Web Console: Control-Shift-K or (Mac OS X) Option-Command-K;
32 Chrome JavaScript Console: Control-Shift-J or (Mac OS X) Option-Command-J;
33 Opera Developer Tools: Control-Shift-I or (Mac OS X) Option-Command-I
34 Safari Web Inspector: Option-Command-I (after enabling Develop mode)
35 Internet Explorer Developer Tools: F12
36 -->
37
38 <!-- DOCTYPE specifies of the document type as HTML -->
39 <!DOCTYPE html>
40
41 <!-- Start tag for the HTML document -->
42 <html>
43
44 <!-- The onload property will execute upon the browser completely loading
45     the body of the HTML document. This onload routine will call the
46     function "tutorialJSCoding" that is in the "js_overview.js" file.
47 -->
48 <body onload="tutorialJSCoding()">
49   <p>
50     Quick JavaScript Code-by-Example Tutorial <br>
51     <i><a href="ocj.name">Chad Jenkins (ocj)</a></i>
52   </p>
53
54   <p>
55     <br><br><br>
56     (Remember to open the <a href="https://webmasters.stackexchange.com/questions/8525/how-do-i-open-the-javascript-console-in-my-browser">
57     </p>
58 </body>
59
60 <head>
61   <title>Quick JavaScript Code-by-Example Tutorial</title>
62
63   <!-- the script tag contains JavaScript code that the browser will
64       execute, either as code inside the tag markers or inside the
65       file specified in the src property
66   -->
67   <script type="text/javascript" src="js_overview.js"> </script>
68
69   <!-- this tag removes the annoying error message about garbled text -->
70   <meta charset="UTF-8">
71 </head>
72 </html>
73
74

```

EXAMINE TUTORIALJSCODING() FUNCTION





JavaScript Variables

- JavaScript has primitive data types for Number, String, Boolean, etc.
- Variables become declared when they are first assigned
- Variables are globally scoped by default, unless first used with “var”

EQUAL SIGN (=) WILL ASSIGN A VALUE TO A VARIABLE

```
stringGlobal = "this is a global variable";
var booleanLocal = true;
numberLocal = 20 - 18; // is this variable local?
```

DOUBLE FORWARD SLASH (//) WILL IGNORE THE REMAINDER OF A LINE

Variable Assignment Examples

```
stringGlobal = "this is a global variable";
```

ASSIGNS STRING "THIS IS A GLOBAL VARIABLE" IN
A VARIABLE NAMED STRINGGLOBAL

```
var booleanLocal = true;
```

ASSIGNS BOOLEAN VALUE OF TRUE IN
A VARIABLE NAMED BOOLEANLOCAL

```
numberLocal = 20 - 18;
```

ASSIGNS NUMERIC VALUE OF 20 MINUS 18 IN
A VARIABLE NAMED NUMBERLOCAL

VARIABLE NAME	VARIABLE VALUE
stringGlobal	"this is a global variable"

VARIABLE NAME	VARIABLE VALUE
booleanLocal	true

VARIABLE NAME	VARIABLE VALUE
numberLocal	2

JavaScript Data Structures

- Object is the core data type for more complex data structures
- Object is an associative data structure; it stores a collection of variables as “keys” (or “properties”) each with an associated “value”

```
myObject = {};  
// objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"
```

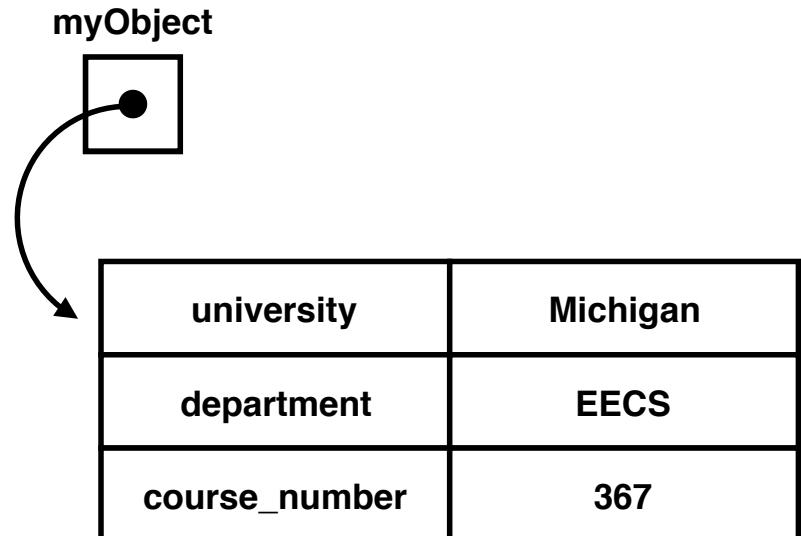


DOUBLE FORWARD SLASH (//) WILL COMMENT THE REMAINDER OF A LINE

Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

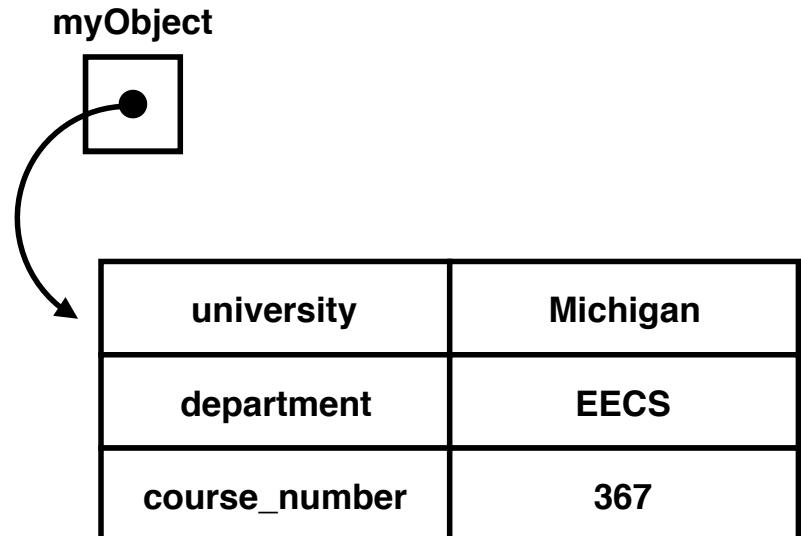
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"
```



Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

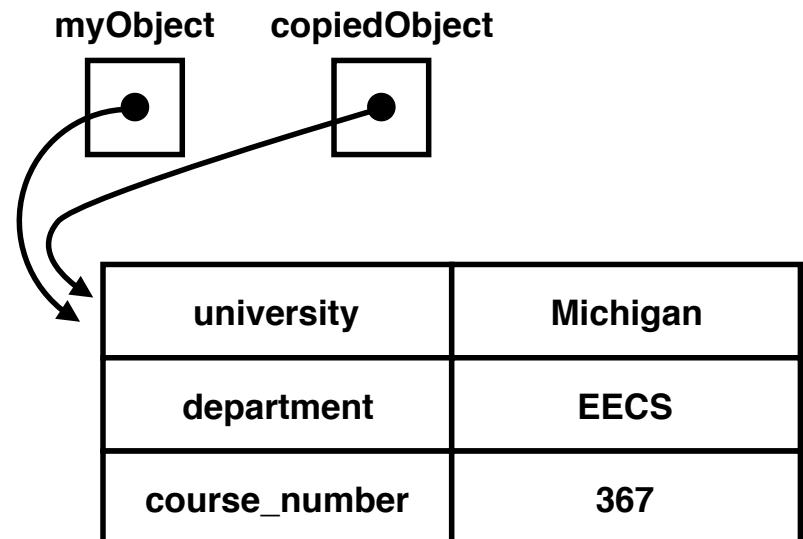
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"  
  
copiedObject = myObject;
```



Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

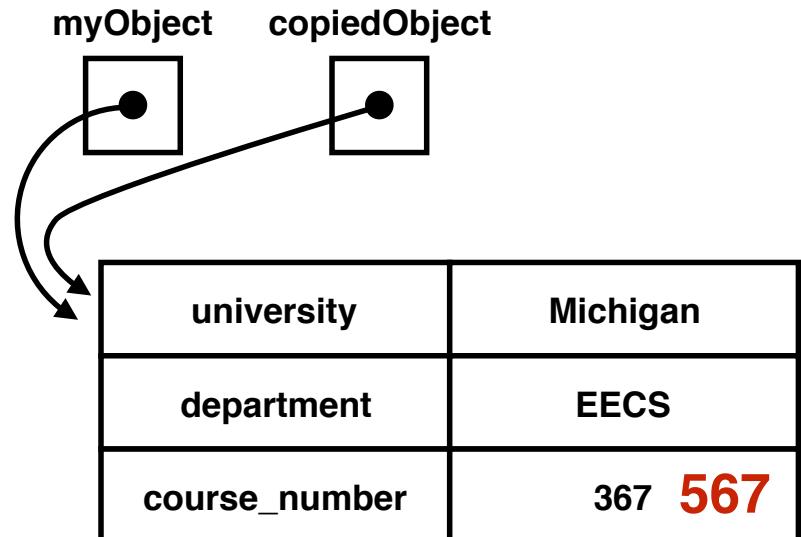
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"  
  
copiedObject = myObject;
```



Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

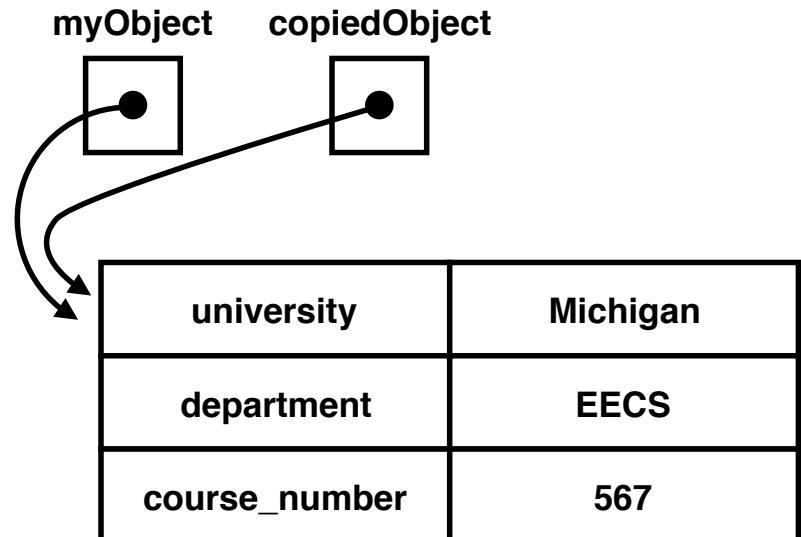
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"  
  
copiedObject = myObject;  
  
copiedObject.course_number = 567;
```



Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

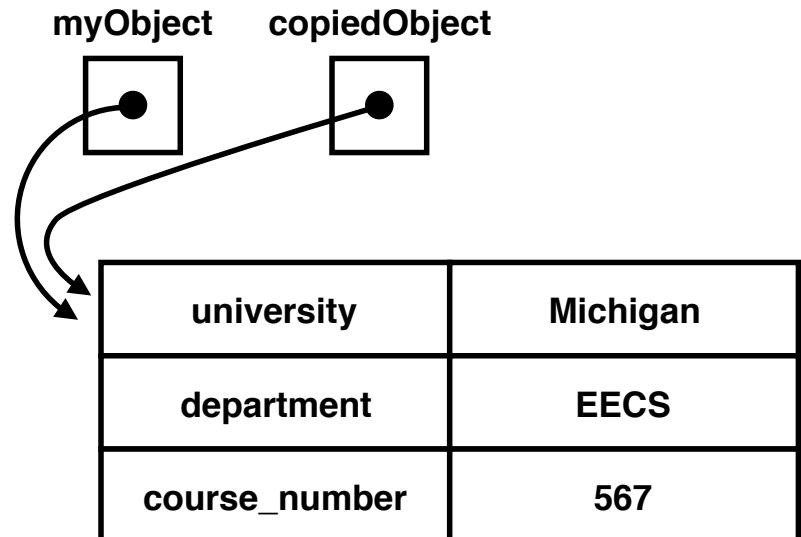
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"  
  
copiedObject = myObject;  
  
copiedObject.course_number = 567;
```



Objects and References

- An object variable is not itself a data structure, but rather a reference to a data structure

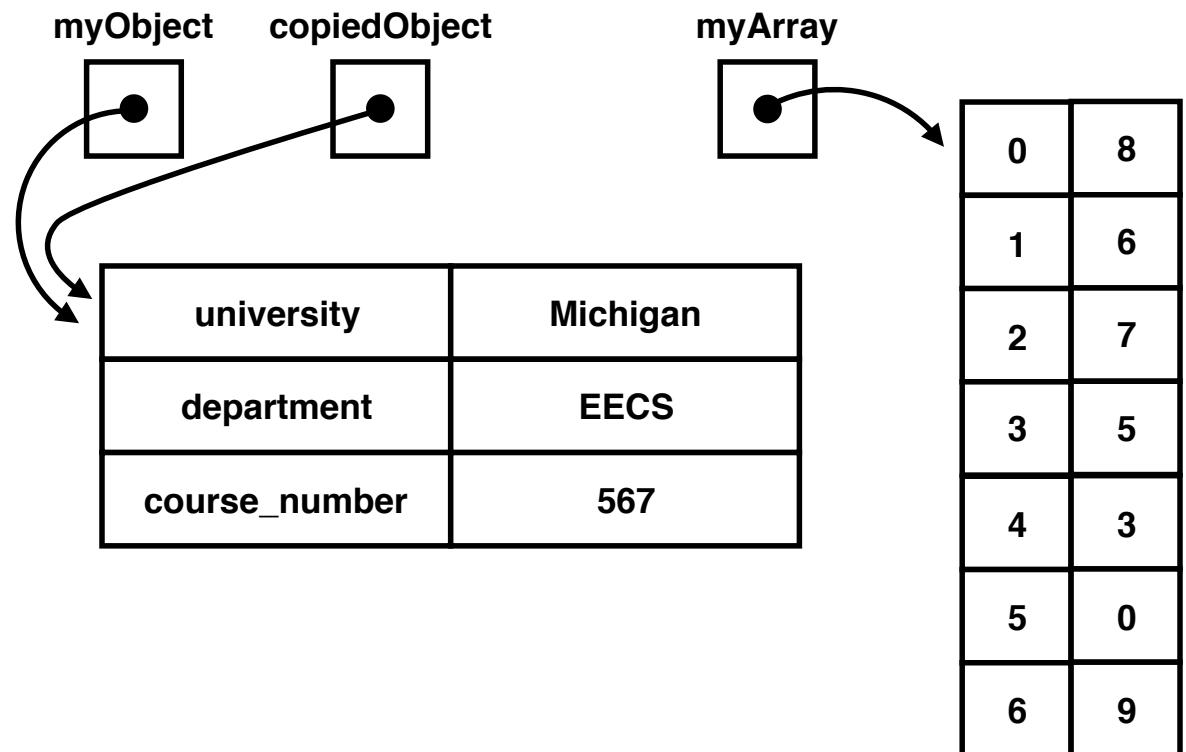
```
myObject = {} // objects can also be created dynamically  
  
// create object property "university" with an assignment of "Michigan"  
myObject.university = "Michigan"; // this variable is of type "string"  
  
// equivalent to myObject.department = "EECS";  
myObject["department"] = "EECS"; // this variable is of type "string"  
  
myObject.course_number = 367; // this variable is of type "number"  
  
copiedObject = myObject;  
  
copiedObject.course_number = 567;  
  
console.log(myObject.course_number); // this will be 567
```



Arrays

- An array is an instance of an object data type with numeric keys

```
myArray = [8,6,7,5,3,0,9];
```



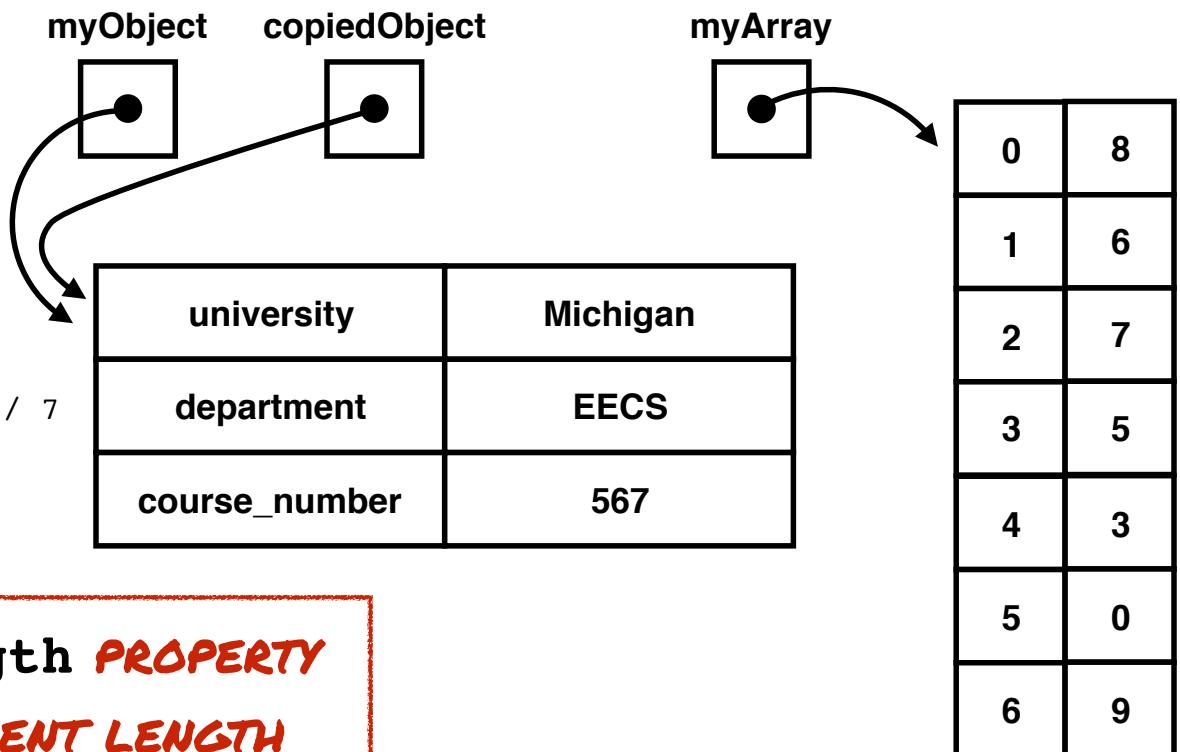
Arrays

- An array is an instance of an object data type with numeric keys

```
myArray = [8,6,7,5,3,0,9];
```

```
numberOfArrayElements = myArray.length; // 7
```

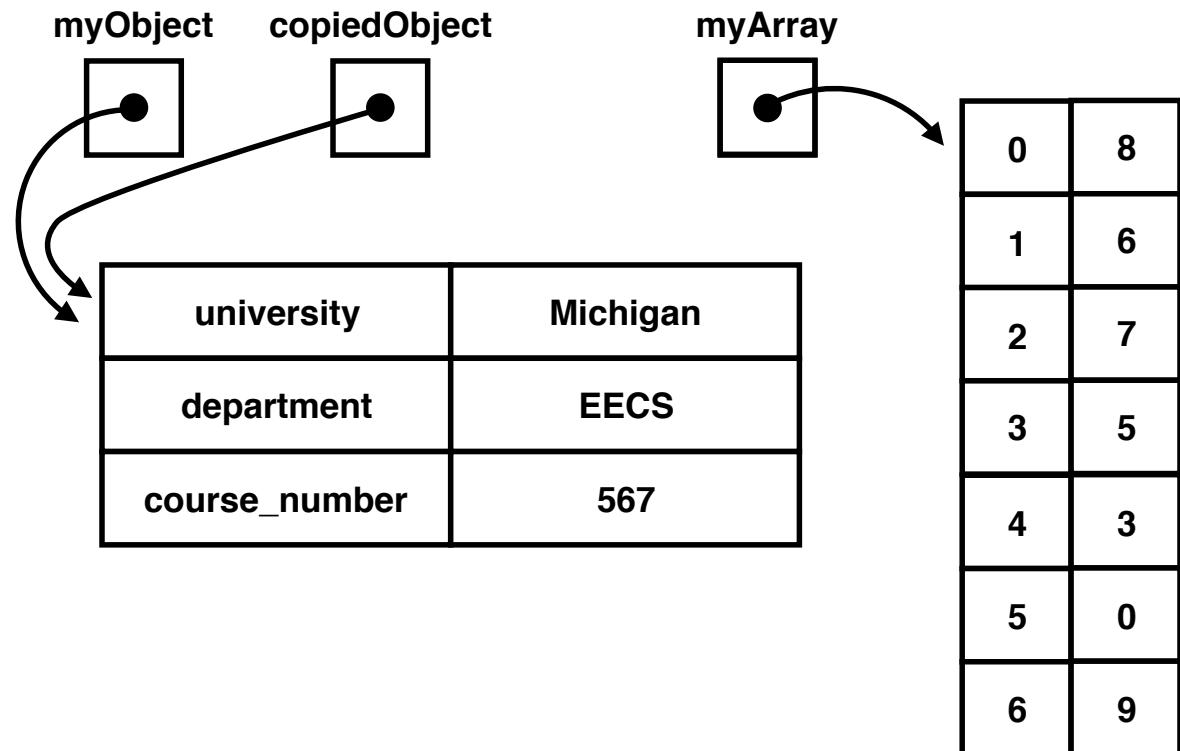
**ALL ARRAYS HAVE A `.length` PROPERTY
THAT MAINTAINS ITS CURRENT LENGTH**



Nesting Objects in Objects

- An object can be used as the value for another object's property

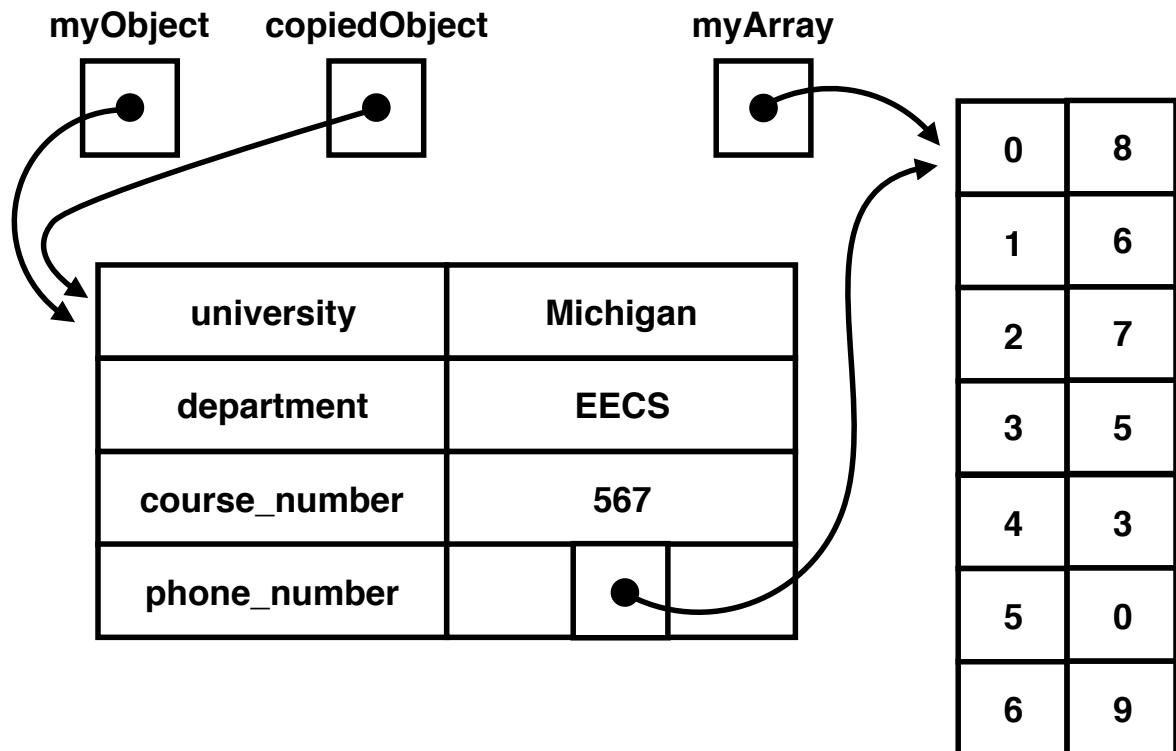
```
myArray = [8,6,7,5,3,0,9];  
  
myObject.phone_number = myArray;
```



Nesting Objects in Objects

- An object can be used as the value for another object's property

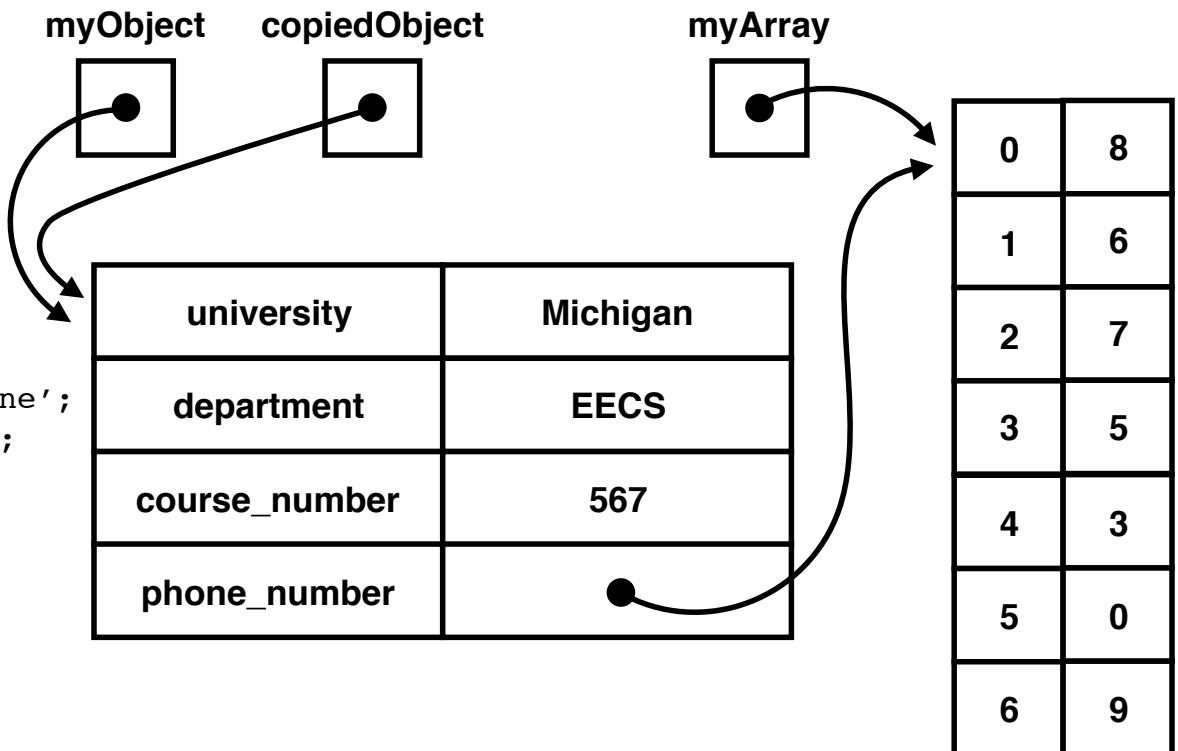
```
myArray = [8,6,7,5,3,0,9];  
  
myObject.phone_number = myArray;
```



Dynamic Typing

- The type of a variable changes upon assignment

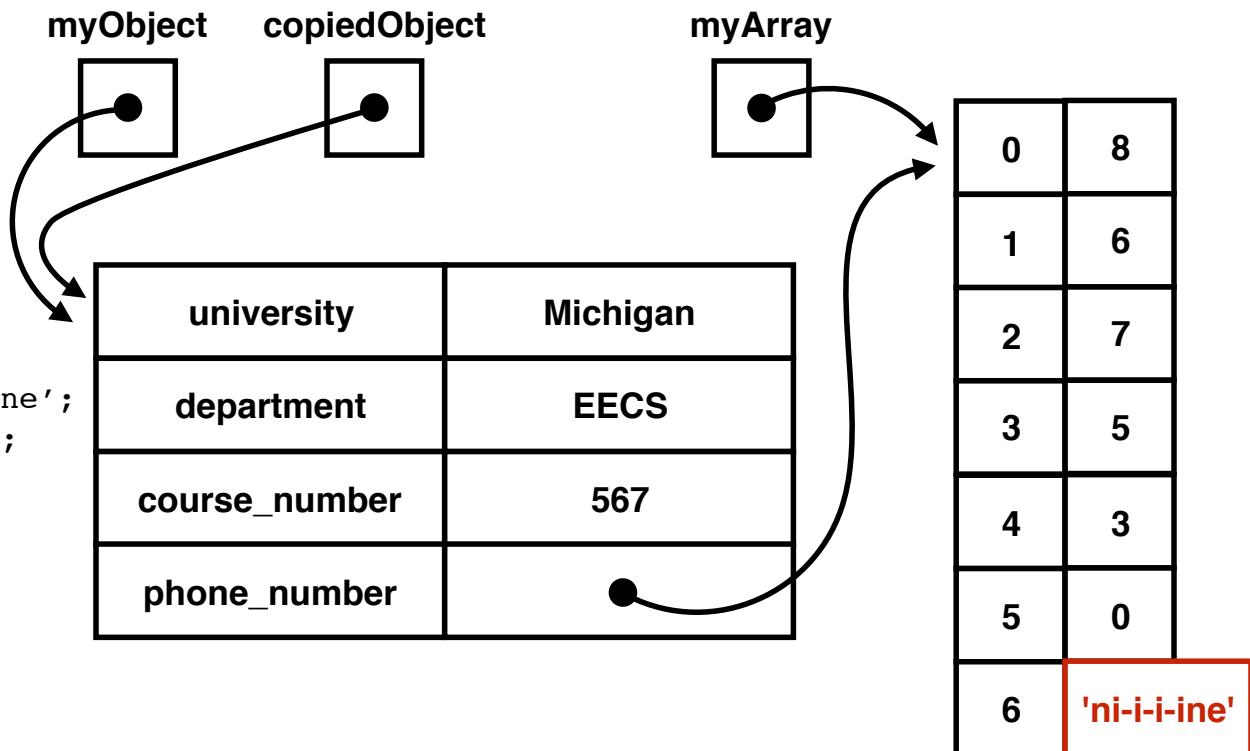
```
myArray = [8,6,7,5,3,0,9];  
  
myObject.phone_number = myArray;  
  
myObject.phone_number[6] = 'ni-i-i-ine';  
// same as myArray[6] = 'ni-i-i-ine';
```



Dynamic Typing

- The type of a variable changes upon assignment

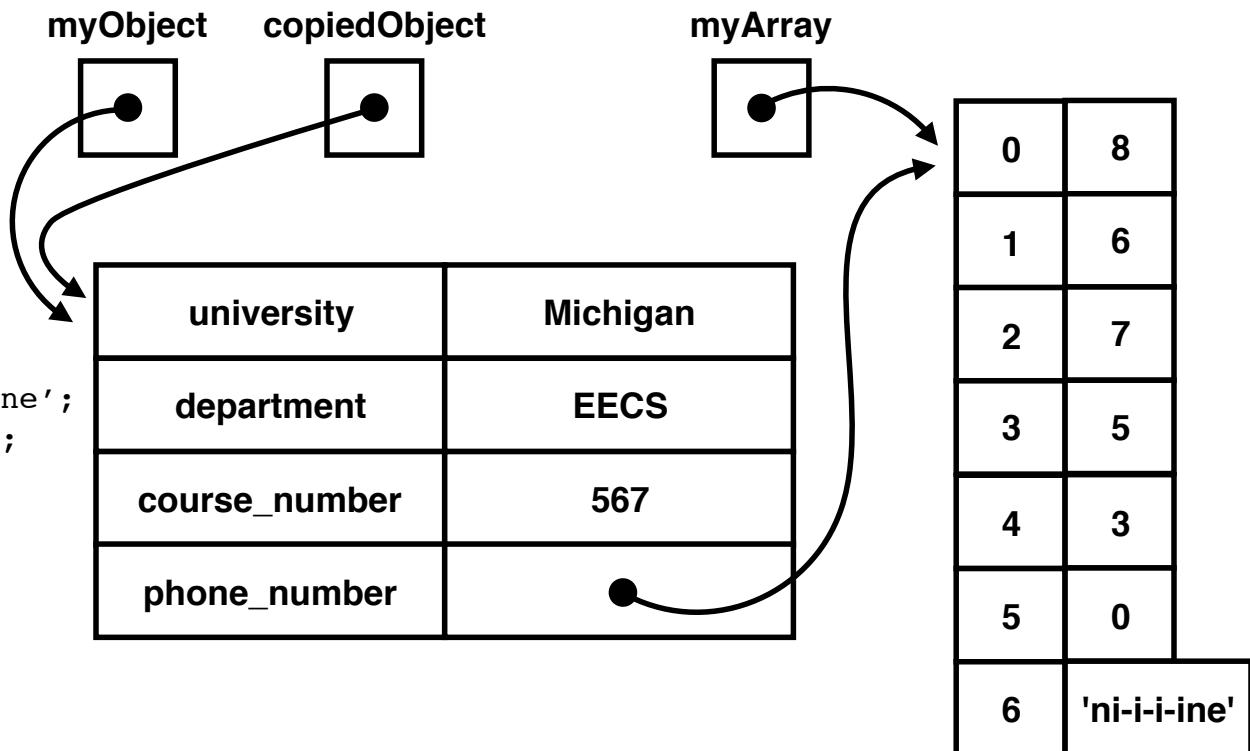
```
myArray = [8,6,7,5,3,0,9];  
  
myObject.phone_number = myArray;  
  
myObject.phone_number[6] = 'ni-i-i-ine';  
// same as myArray[6] = 'ni-i-i-ine';
```



Dynamic Typing

- The type of a variable changes upon assignment

```
myArray = [8,6,7,5,3,0,9];  
  
myObject.phone_number = myArray;  
  
myObject.phone_number[6] = 'ni-i-i-ine';  
// same as myArray[6] = 'ni-i-i-ine';
```

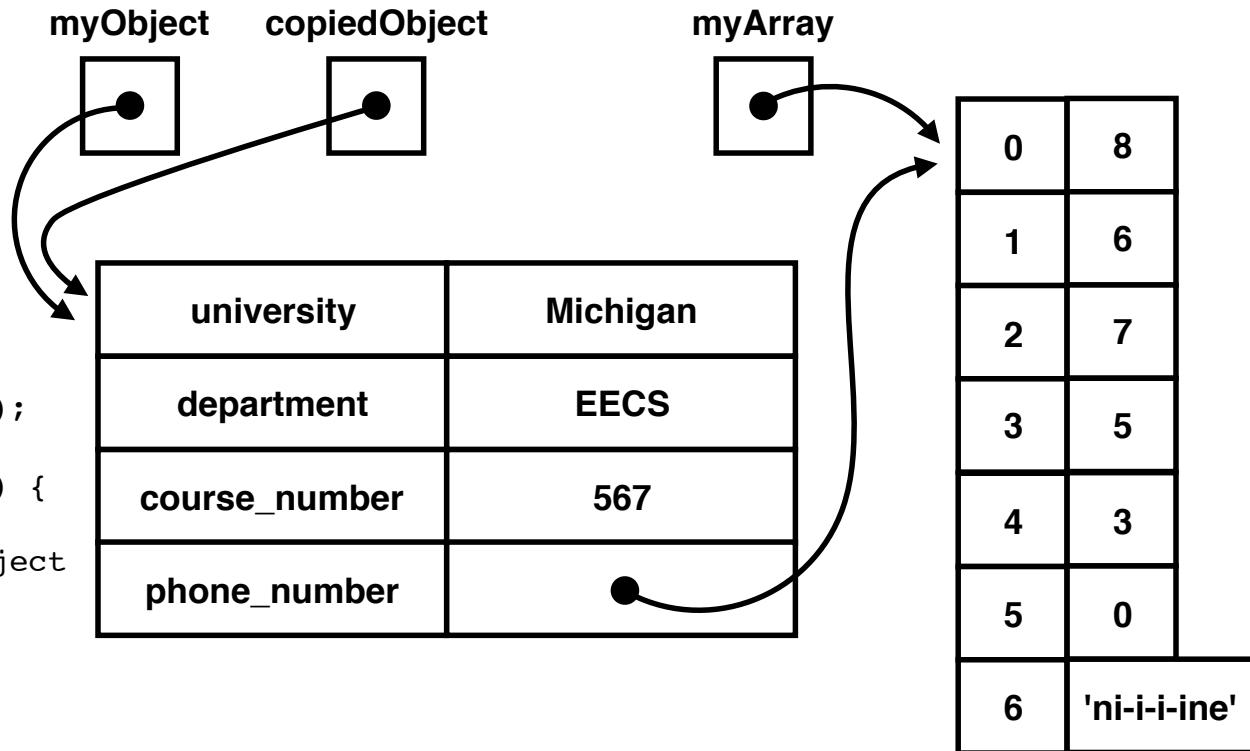


Control Statements

- JavaScript supports C-style “if-else” statements and “for” loops

```
// output the phone number to console
var i; // iterator local variable
for (i=0; i<myArray.length; i++) {
    console.log(myArray[i]);
    // console output: 867530ni-i-i-ne
}

// output the course section to console
if (myObject.course_number === 367) {
    console.log('undergraduate section');
}
else if (myObject.course_number === 567) {
    console.log('graduate section');
    // console will output 567 for myObject
}
else {
    console.log('ROB 510 maybe?');
}
```



Operators

- JavaScript supports C-style operators with order of precedence

- grouping: `/* */` `//` `()`
 open comment close comment comment to end of line open parenthesis close parenthesis

- increment/decrement: `++` `--`
 increment variable decrement variable

- arithmetic: `*` `/` `%` `+` `-`
 multiplication division modulus addition/concatenation subtraction

- comparison: `<` `<=` `>` `>=` `==` `!=` `=====` `!=====` `&&` `||`
 less than less than or equal greater than greater than or equal equality inequality strict equality strict inequality logical AND logical OR

- assignment: `=` `+=` `*=`
 assignment add to variable multiply to variable

STRICT EQUALITY (====) WILL NOT ATTEMPT TO MATCH TYPES



What is $8/2^*(2+2)$?

<https://heavy.com/news/2019/08/viral-math-problem-solution-answer/>

Michigan Robotics 367/510/567 - autorob.org

Operators

- JavaScript supports C-style operators with order of precedence

- grouping: `/* */` `//` `()`

open comment close comment comment to end of line open parenthesis close parenthesis

- increment/decrement: `++` `--`

increment variable decrement variable

- arithmetic: `*` `/` `%` `+` `-`

multiplication division modulus addition/concatenation subtraction

- comparison: `<` `<=` `>` `>=` `==` `!=` `=====` `!=====` `&&` `||`

less than less than or equal greater than greater than or equal equality inequality strict equality strict inequality logical AND logical OR

- assignment: `=` `+=` `*=`

assignment add to variable multiply to variable

PLUS (+) IS OVERLOADED TO ADD NUMBERS AND CONCATENATE STRINGS

Functions

- A function is an object type that modularly executes a set of statements with given parameters and (optionally) returns a variable.
- Unlike C, JavaScript functions do not declare a return type

```
// a simple function declaration that returns the sum of two given numbers
function sum(a,b) {
    return a + b;
}

// at some later point in the execution of the code . . .

// function call to add two numbers
sumNumber = sum(3,67); // 70

// function call to concatenate two strings
sumString = sum("3","67"); // "367"
```

Recursion

- JavaScript supports recursion (i.e., a function calling itself)
- Consider factorial example: $6! = 6 * 5 * 4 * 3 * 2 * 1 = 720$

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```



**FUNCTION CALL FAC(6) STACK PUSHES
NEW LOCAL VARIABLE SCOPE**

factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```



Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

RECURSIVE CALL FAC(5) PUSHES
NEW LOCAL VARIABLE SCOPE

fac(6) = 6 * fac(5)

factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

**RECURSIVE CALL FAC(5) PUSHES
NEW LOCAL VARIABLE SCOPE**

fac(5) = 5 * fac(4)

fac(6) = 6 * fac(5)

factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

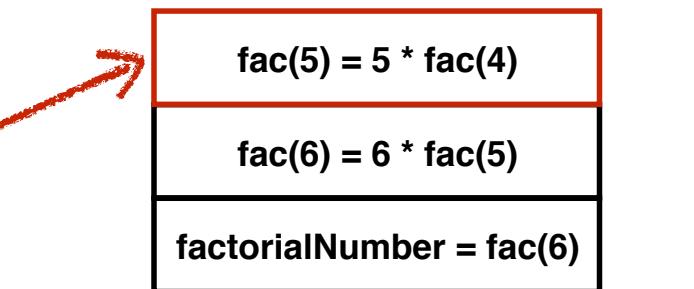
Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
// at some later point in the execution of the code . . .
```

```
factorialNumber = fac(6); // 720
```

**INPUTNUMBER VARIABLE IN FAC(5) IS DIFFERENT
VARIABLE THAN INPUTNUMBER IN FAC(6)**



Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

**RECURSIVE CALL FAC(4) PUSHES
NEW LOCAL VARIABLE SCOPE**

fac(4) = 4 * fac(3)

fac(5) = 5 * fac(4)

fac(6) = 6 * fac(5)

factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

RECURSIVE CALL FAC(3) PUSHES
NEW LOCAL VARIABLE SCOPE

fac(3) = 3 * fac(2)

fac(4) = 4 * fac(3)

fac(5) = 5 * fac(4)

fac(6) = 6 * fac(5)

factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

fac(2) = 2 * fac(1)

fac(3) = 3 * fac(2)

fac(4) = 4 * fac(3)

fac(5) = 5 * fac(4)

fac(6) = 6 * fac(5)

factorialNumber = fac(6)

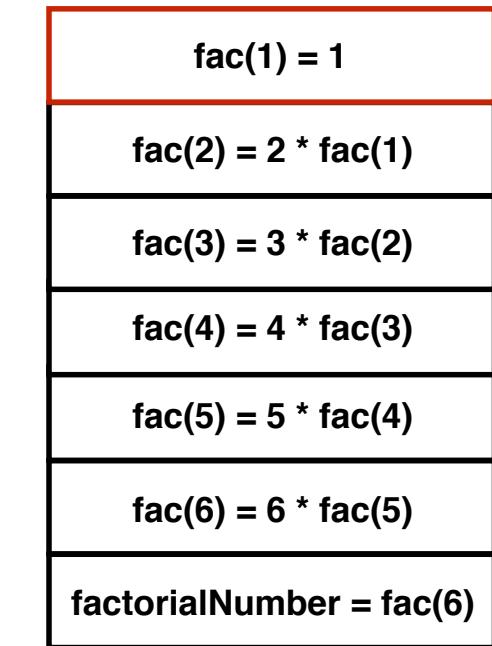
Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

RECURSIVE CALLS STOP WHEN BASE CONDITION ENCOUNTERED



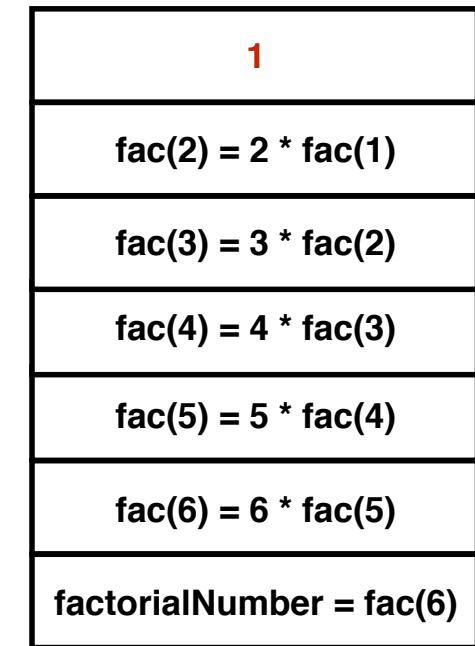
Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

**STACK POP FROM CALL STACK RETURNS A
CONSTANT VALUE TO CALLING FUNCTION**



Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

**STACK POP FROM CALL STACK RETURNS A
CONSTANT VALUE TO CALLING FUNCTION**

fac(2) = 2 * 1

fac(3) = 3 * fac(2)

fac(4) = 4 * fac(3)

fac(5) = 5 * fac(4)

fac(6) = 6 * fac(5)

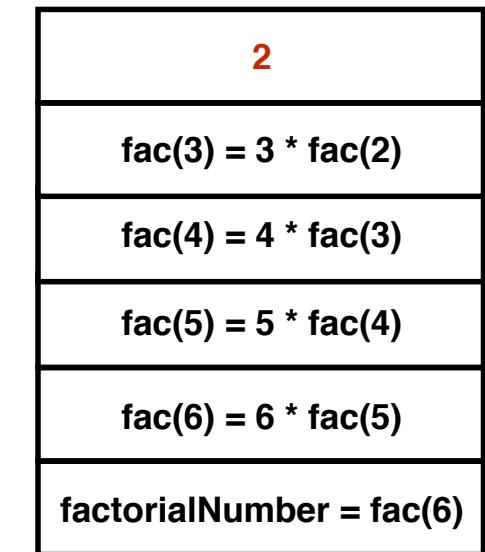
factorialNumber = fac(6)

Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

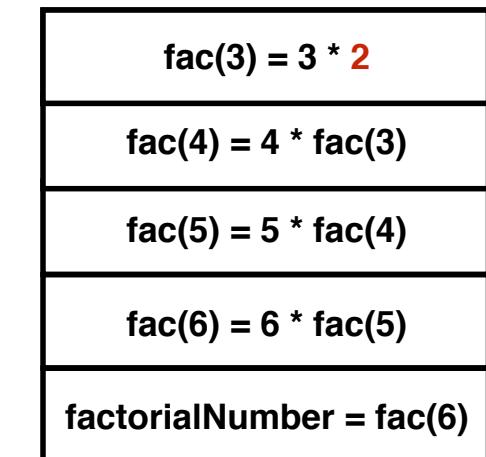


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

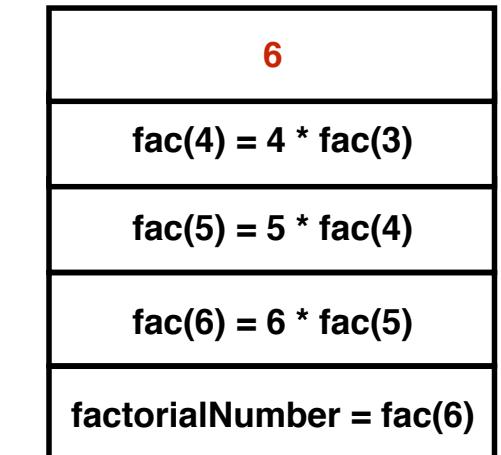


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

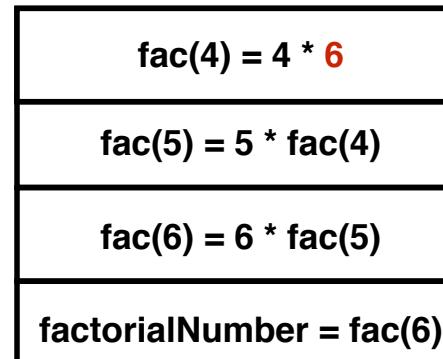


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

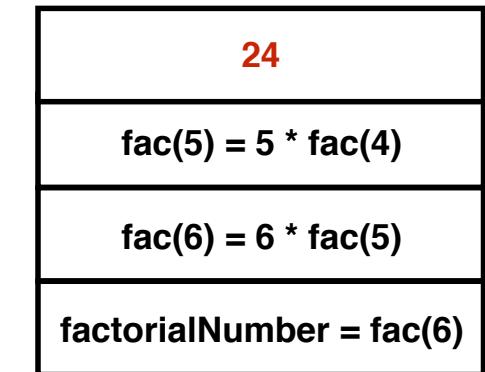


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

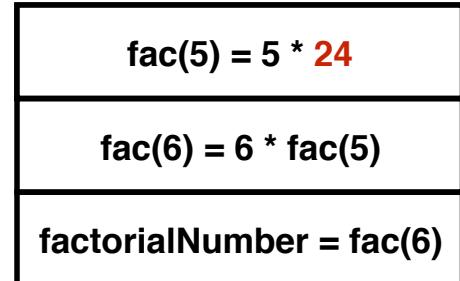


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

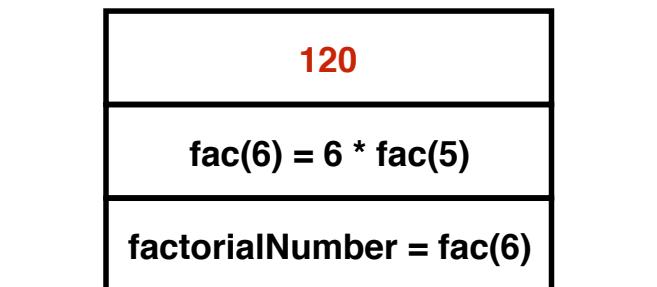


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

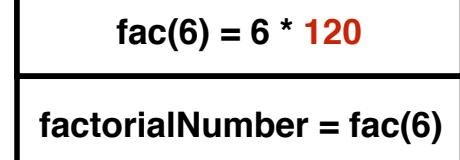


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

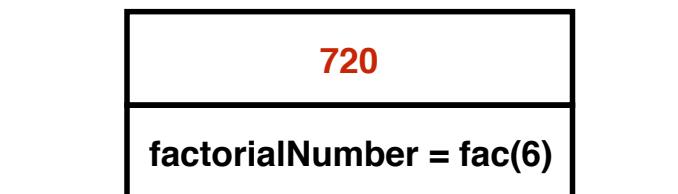


Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```



Call stack
Michigan Robotics 367/510/567 - autorob.org

Function call stack

- JavaScript maintains a call stack that stores the state of variables scoped local to each function call

```
fac = function factorialFunction(inputNumber) {  
    if (inputNumber > 1) // recursive case  
        { return inputNumber * factorialFunction(inputNumber-1); }  
    else { return 1; } //base case  
}  
  
// at some later point in the execution of the code . . .  
  
factorialNumber = fac(6); // 720
```

factorialNumber = 720

Call stack
Michigan Robotics 367/510/567 - autorob.org

Let's try an animation example

point_x = 30.00 point_y = 410.70

hello_anim example

http://autorob.org/examples/hello_anim.html



M4PRoGReS

rob.org

point_x = 30.00 point_y = 410.70

```
<html> <body onload=init()>
<!-- init function will be called when body loaded --&gt;

&lt;div id="text_output"&gt; going to put some text here &lt;/div&gt;

&lt;!-- create a element for drawing --&gt;
&lt;canvas id="draw_canvas" width=1000 height="400"&gt;&lt;/canvas&gt;

&lt;script&gt;
// define a function for initialization as: function <i>name_of_function { function_code }
function init() {

    // create a JavaScript object named "point" with two attributes
    // specifying the horizontal and vertical location of the circle
    point = {x: 50, y: 50}

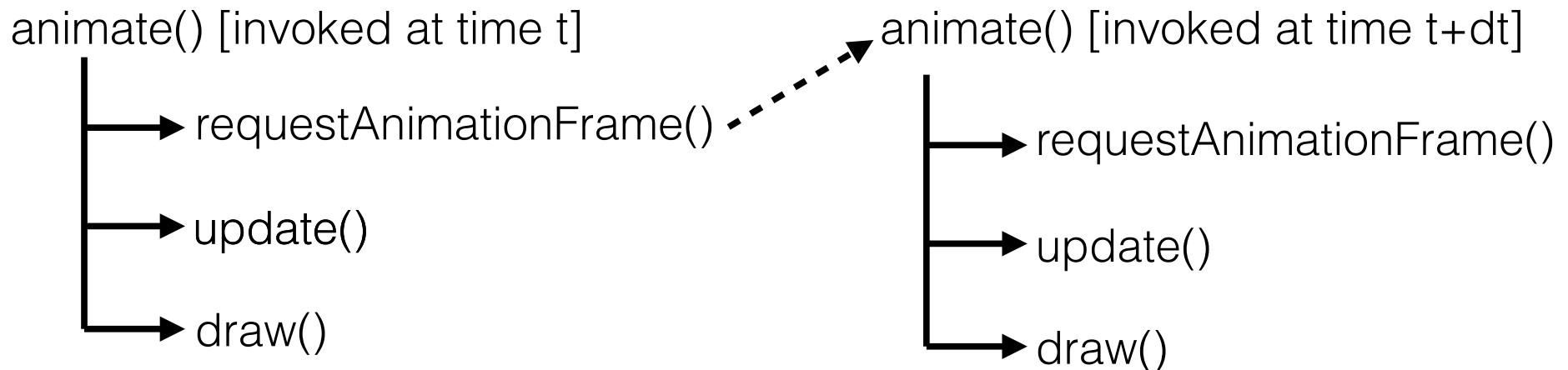
    // function call to start the animation loop
    animate();
}

function animate() {
    requestAnimationFrame(animate); // requests next time step
    update(); // function call to update the state of the animation
    draw(); // function call to draw the current state of the animation
}
...

</script>
</body> </html>
```

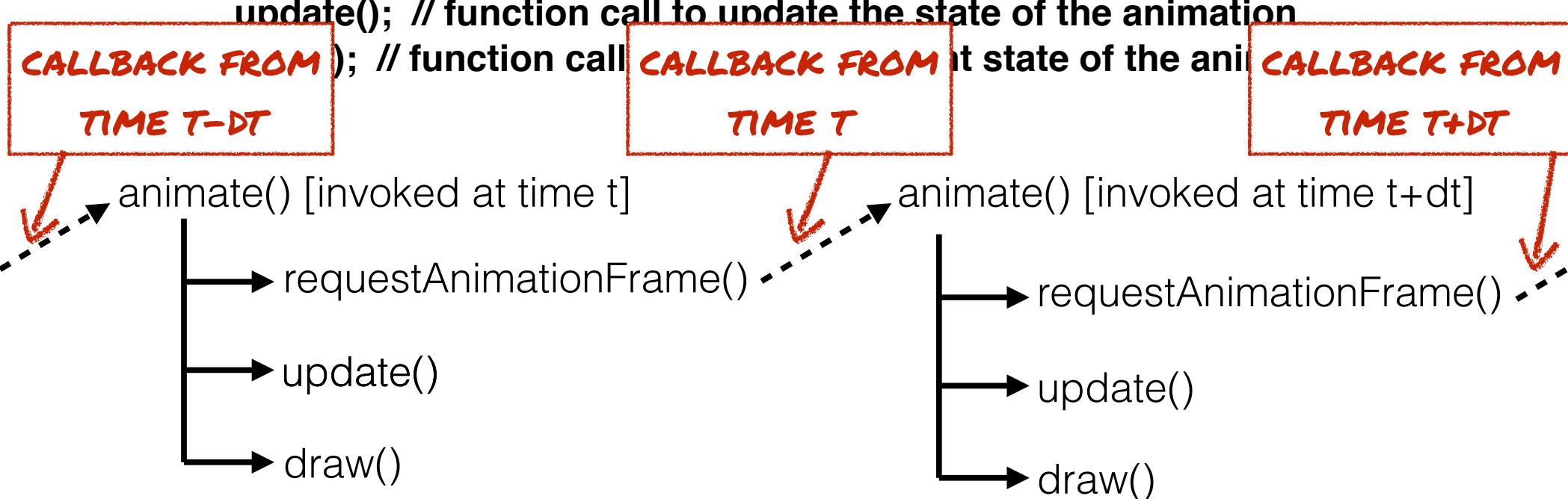


```
function animate() {
    requestAnimationFrame(animate); // requests next time step
    update(); // function call to update the state of the animation
    draw(); // function call to draw the current state of the animation
}
```



`requestAnimationFrame()` will have browser call `animate()` again.
IMPORTANT to avoid code that blocks in `animate()`

```
function animate() {  
    requestAnimationFrame(animate); // requests next time step  
    update(); // function call to update the state of the animation  
    draw(); // function call to draw the state of the animation
```



`requestAnimationFrame()` will have browser call `animate()` again.
IMPORTANT to avoid code that blocks in `animate()`

RETURNS A REFERENCE TO
ANY DOM ELEMENT

```
...
function update() {

    // get a reference to the canvas element "draw_canvas" in the document.
    var canvas = document.getElementById("draw_canvas");

    // update the size of the canvas based on dimensions of browser windows
    // note: window is a global object for the browser window
    canvas.width = window.innerWidth;
    canvas.height = window.innerHeight-50;

    // move the circle forward by assignment
    point.x = point.x + 5;

    // if statement conditionally executes with roughly this structure:
    // if (condition) { code } else if (condition) { code} else {code}

    // if the circle is at the extent of the canvas, move it back to the start
    if (point.x > canvas.width) {
        point.x = 0;
    }

    // make the circle look like it bouncing using a sin function
    // note: the Math object has a number of useful functions
    point.y = (canvas.height-60)-Math.abs((canvas.height/2)*Math.sin(point.x/(canvas.width*0.1)));}

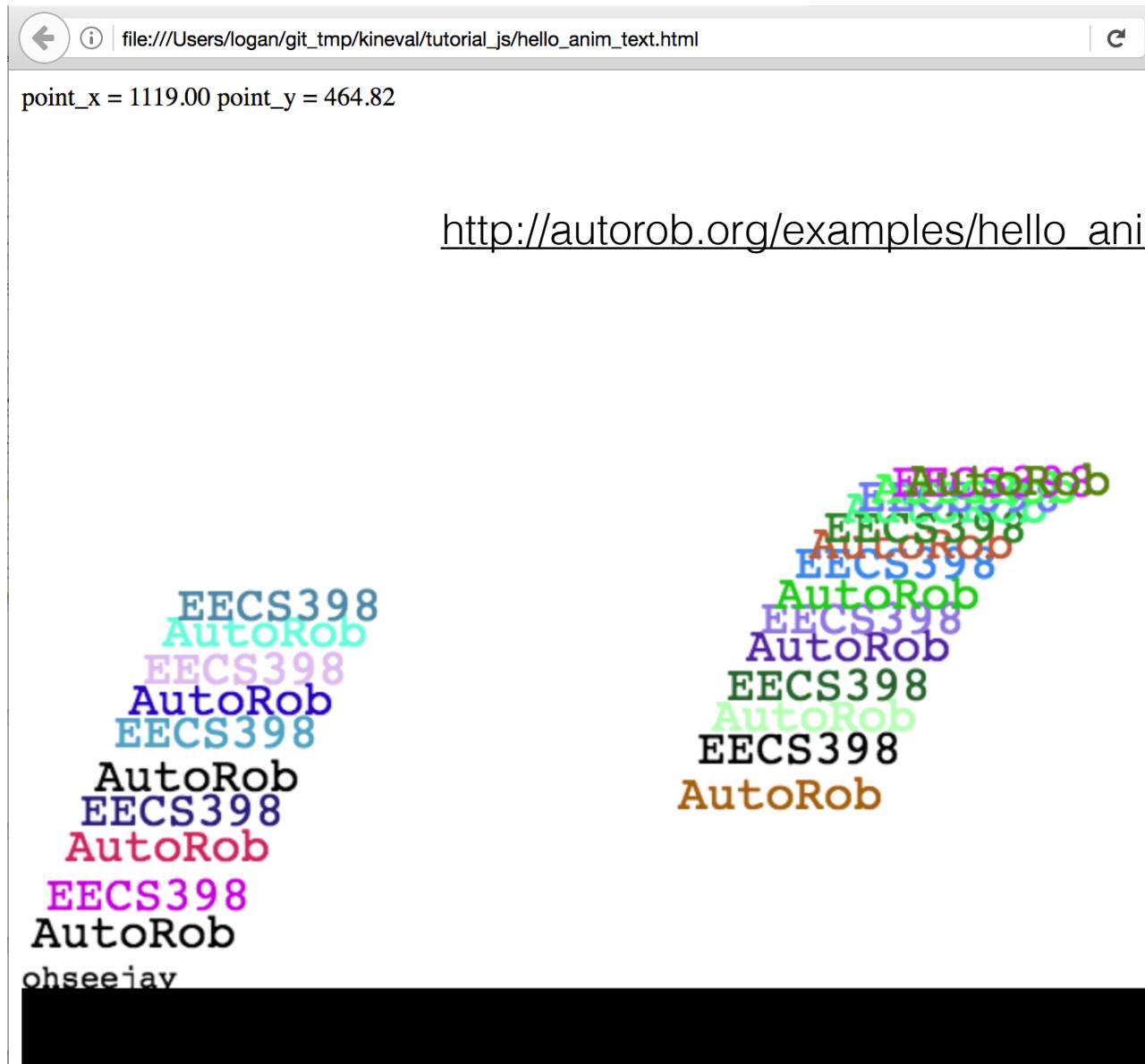
...
}
```

point_x = 30.00 point_y = 410.70



M4PRoGReS

One more animation example



http://autorob.org/examples/hello_anim_text.html

Many examples available online

GitHub, Inc. (US) | https://github.com/odestcj/superquadric/ | ⌛ Search | ⚙ | 📁 | 🗃 | ⬇️ | 🏠 | 💬 | 📈 | 3 | ☰

This repository Search Pull requests Issues Gist

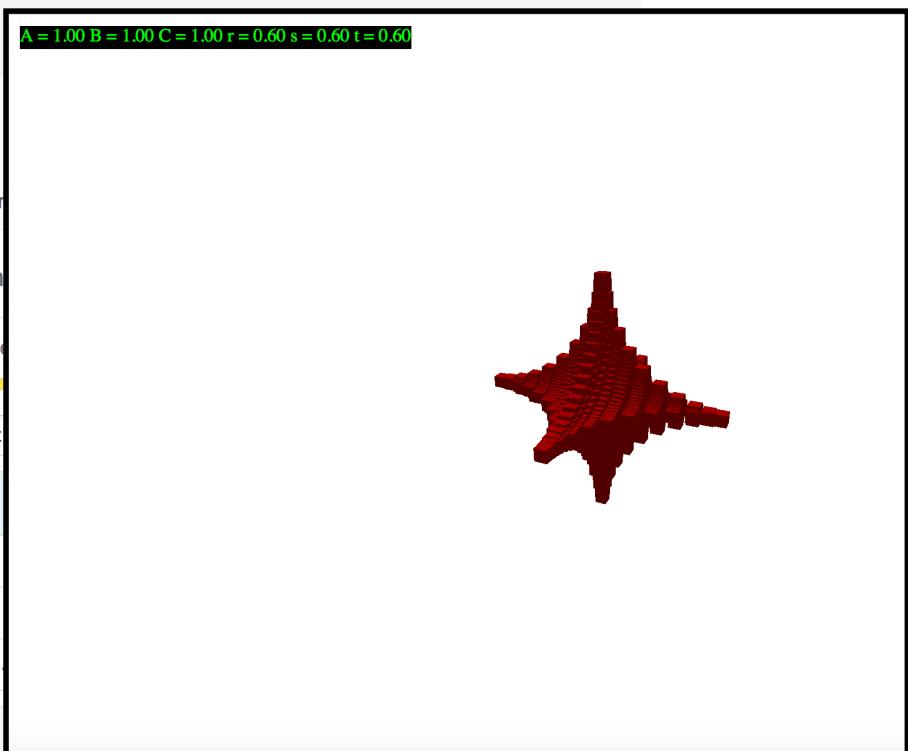
odestcj / superquadric

super quick superquadric Implementation of Barr's superquadric surface point visualization

2 commits 1 branch 0 releases

Branch: master New pull request New file Find file SSH git@git...

odestcj fixed Math.sign not being in Chrome and keyboard input; added paramet...
js Initial commit, working version of superquadric, but lighting and tes...
README Initial commit, working version of superquadric, but lighting and tes...
superquadric.html fixed Math.sign not being in Chrome and keyboard input; added paramet.
README



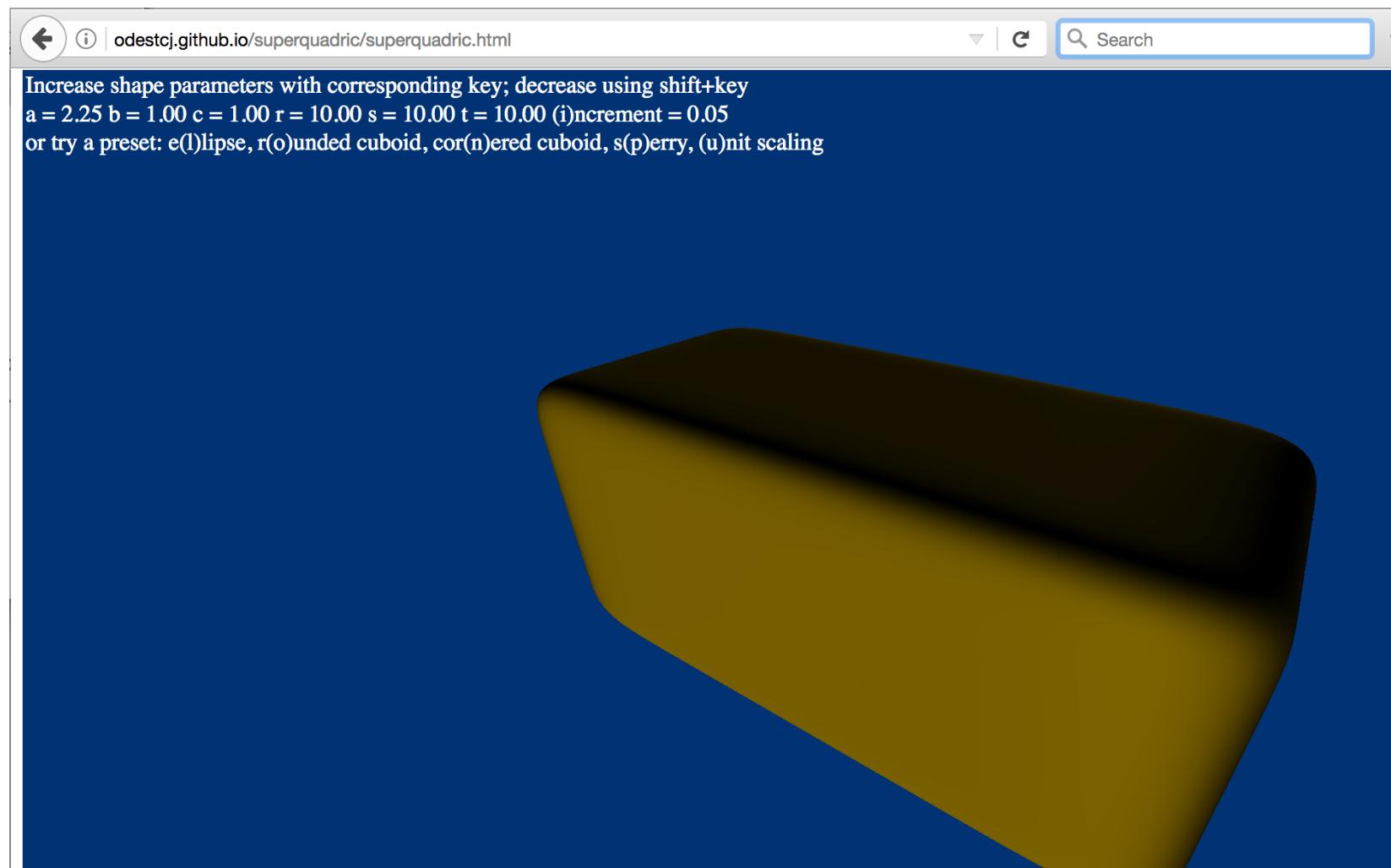
super quick superquadric
Implementation of Barr's superquadric surface point visualization in HTML5/JavaScript and threejs

@author odestcj / <https://github.com/odestcj>

Change view by click-and-drag mouse

Increase shape parameters with r,s,t keys;
Decrease shape parameters with R,S,T

Another example:
<https://github.com/odestcj/superquadric>



Rounded cuboid:

<http://odestcj.github.io/superquadric/superquadric.html>

Screenshot of a GitHub repository page for `autorob / kineval-stencil`.

The URL in the browser bar is <https://github.com/autorob/kineval-stencil>.

The repository summary shows:

- Code: 2 commits
- Issues: 0
- Pull requests: 0
- Projects: 0
- Wiki: 0
- Unwatch: 2
- Star: 0
- Fork: 0

The repository description is: "Stencil code for KinEval (Kinematic Evaluator) for robot control, kinematics, decision, and dynamics in JavaScript/HTML5".

The repository owner is `odestcj`, and it was created in Fall 2018.

The repository structure includes:

- `js`: initial commit Fall 2018
- `kineval`: initial commit Fall 2018
- `project_pathplan`: initial commit Fall 2018
- `project_pendularm`: initial commit Fall 2018
- `robots`: initial commit Fall 2018
- `tutorial_heapsort`: initial commit Fall 2018
- `tutorial_js`: initial commit Fall 2018
- `worlds`: initial commit Fall 2018

A screenshot of a web browser window titled "autorob.org" is shown on the right side of the page, displaying the "AutoRob" website. The website content includes:

- Introduction to Autonomous Robotics
- Michigan EECS 398
- Robot Kinematics and Dynamics
- Michigan ME 567 EECS 567 ROB 510
- Fall 2018



What is version control?

What is version control?

- Maintains a past history of changes for your code (or any project)
- History of changes (or “commits”) maintained in a repository
- Basic workflow
 - Code is “checked out” (or “pulled”) from a repository, then modified
 - These updates are then “checked in” (or “committed”) to the repository
 - Repository maintains history as “diffs”, the changes between before and after checking in a commit

For example... ocj's TED talk

[Watch](#)[Discover](#)[Attend](#)[Participate](#)[About](#)[Log in](#)

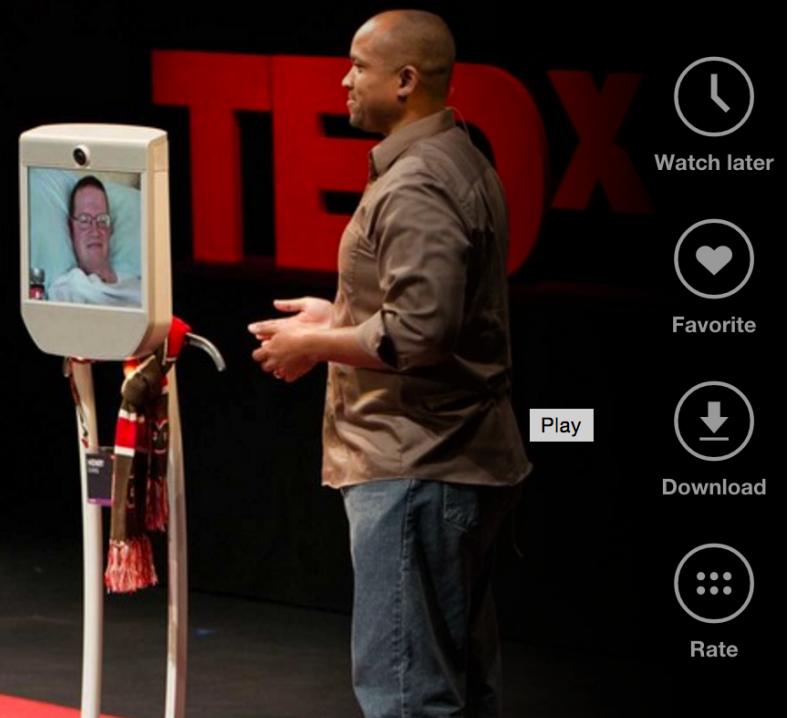
Henry Evans and Chad Jenkins:

Meet the robots for humanity

TEDxMidAtlantic · 10:21 · Filmed Oct 2013

28 subtitle languages [?](#)

[View interactive transcript](#)

[Play](#)[Watch later](#)[Favorite](#)[Download](#)[Rate](#)

Share this idea

[Facebook](#)[Twitter](#)[Email](#)[Embed](#)[More](#)

1,145,408 Total views

Share this talk and
track your influence!

TED Talks are free
thanks to support from

Infosys

https://www.ted.com/talks/henry_evans_and_chad_jenkins_meet_the_robots_for_humanity?language=en#

The screenshot shows a TED Talk page. At the top, there's a navigation bar with 'TED' in red, 'Watch', 'Discover', 'Attend', and a search bar. Below the navigation is a large video thumbnail. The thumbnail features a man in a hospital bed on the left, with the text 'HENRY EVANS IN PALO ALTO CA' overlaid. On the right, a man stands on a stage with a robot, with the text 'OCJ IN WASHINGTON DC' overlaid. The main title 'Meet the robots for humanity' is displayed prominently in white text. Below the title is a play button icon. To the right of the video thumbnail, there are several interactive icons: 'Watch later' (clock), 'Favorite' (heart), 'Download' (down arrow), and a 'Play' button. The video thumbnail also shows a small image of a quadcopter drone in flight.

Share this idea



1,145,408 Total views

Share this talk and track your influence!

TED Talks are free thanks to support from

Infosys®

https://www.ted.com/talks/henry_evans_and_chad_jenkins_meet_the_robots_for_humanity?language=en#

TED Talks are free thanks to support from

rg



Michigan Robotics 3677510/567 - autorob.org

[GitHub, Inc. \(US\) | https://github.com/odestcj/tutorial_rosbridge_ar drone](https://github.com/odestcj/tutorial_rosbridge_ar drone)

[rosbridge suite](#)

This repository Search Pull requests Issues Gist

odestcj / [tutorial_rosbridge_ar drone](#) Unwatch 6 Star 3 Fork 3

Issues 0 Pull requests 0 Wiki Pulse Graphs Settings

Front-end web interface code associated with teleoperation tutorial for AR.Drone using rosbridge/ROS. This is a simple interface to illustrate basic concepts, and not a maintained release. Please refer to robotwebtools.org for the latest and greatest. <http://rosbridge.org/doku.php?do=search&id=ar.drone> — Edit

7 commits 1 branch 0 releases 2 contributors

Branch: master New pull request New file Find file SSH git@github.com:odestcj/tuto Download ZIP

alicef Create Fly ar.drone through ROS Hydro ... 7 Latest commit 3eb5113 on May 15, 2014

rosbridge_ar drone Initial commit 3 years ago

rosbridge_ar drone_buttons added actual drone_browser_teleop.html with buttons 3 years ago

Fly ar.drone through ROS H... Create Fly ar.drone through ROS Hydro 2 years ago

README.md Added rosbridge tutorial for ROS Fuerte 2 years ago

rosbridge_ar drone.launch added launch file 3 years ago

README.md

tutorial_rosbridge_ar drone

[GitHub, Inc. \(US\)](#) | https://github.com/oestcj/tutorial_rosbridge_ardrone/cc | [C](#) | Search | [Star](#) | [Unwatch](#) | [Graphs](#) | [Pulse](#) | [Wiki](#) | [Pull requests](#) | [Issues](#) | [Code](#) | [Settings](#) | [Fork](#) | [3](#)

oestcj / tutorial_rosbridge_ardrone

Branch: **master**

Commits on May 15, 2014

 **Create Fly ar.drone through ROS Hydro** [...](#)
alicef committed on May 15, 2014

Commits on May 6, 2014

 **Added rosbridge tutorial for ROS Fuerte**
oestcj committed on May 6, 2014

 **Create README.md**
oestcj committed on May 6, 2014

Commits on Apr 30, 2013

 **added launch file**
oestcj committed on Apr 30, 2013

Commits on Apr 18, 2013

 **added actual drone_browser_teleop.html with buttons**
oestcj committed on Apr 18, 2013

 **Fixed mappings of buttons and keys to drone commands**
oestcj committed on Apr 18, 2013

Commits on Apr 5, 2013

Large open source projects...

← → ⌂ i robotwebtools.org



 **3D INTERACTIONS**
USING THE LATEST IN WEBGL

 **MULTI-PLATFORM SUPPORT**
HARNESSING THE POWER OF ROS

 **TOWARDS COMPATIBILITY**
MORE BROWSERS, MORE ROBOTS.

ROBOT WEB ARCHITECTURE

BRIDGING ROBOTS AND THE WEB

A variety of routes are available for architecting a robot web

ROSBRIDGE AS A TRANSPORT

USING JSON TO SPEAK TO YOUR ROBOT

While ROS works great for applications on the robot, another layer is

 GitHub, Inc. (US) | https://github.com/RobotWebTools/rosbridge_suite |  Search |         

This repository Search Pull requests Issues Gist

RobotWebTools / rosbridge_suite Unwatch 26 ★ Unstar 42 Fork 71

Code Issues 15 Pull requests 2 Pulse Graphs Settings

Server Implementations of the rosbridge v2 Protocol <http://robotwebtools.org/> — Edit

September 2016

523 commits 7 branches 37 releases 33 contributors

 **523 commits**

 **33 contributors**

File/Folder	Description	Time Ago
rosapi	Update proxy.py	4 months ago
rosbridge_library	0.7.13	5 months ago
rosbridge_server	enable udp	2 months ago
rosbridge_suite	0.7.13	5 months ago
.gitignore	cleanup of old misc. files from old merge of new features	2 years ago
.travis.yml	ci: test with and without ujson	a year ago
AUTHORS.md	authors and license added	2 years ago
CHANGELOG.md	update the change log	2 years ago
LICENSE	authors and license added	2 years ago
README.md	Update README.md	a year ago
ROSPBRIDGE_PROTOCOL...	protocol documented for advertise service functions	a year ago

GitHub, Inc. [US] | https://github.com/RobotWebTools/rosbridge_suite

This repository Search Pull requests Issues Marketplace Explore Watch 38 Star 106 Fork 114

RobotWebTools / rosbridge_suite

Code Issues 36 Pull requests 1 Projects 0 Insights

Server Implementations of the rosbridge v2 Protocol <http://robotwebtools.org/>

September 2017

623 commits 9 branches 48 releases 47 contributors BSD-3-Clause

623 commits 47 contributors

7 hours ago 2 months ago a year ago 3 years ago 4 years ago 3 years ago 3 years ago

File	Commit Message	Date
rosapi	0.8.3	7 hours ago
rosbridge_library	0.8.3	7 hours ago
rosbridge_server	0.8.3	7 hours ago
rosbridge_suite	0.8.3	7 hours ago
.gitignore	Gitignore vim swapfile	a year ago
.travis.yml	Cleaning up travis configuration (#283)	2 months ago
AUTHORS.md	authors and license added	3 years ago
CHANGELOG.md	update the change log	4 years ago
LICENSE	authors and license added	3 years ago
README.md	Update README.md	3 years ago

GitHub, Inc. (US) https://github.com/RobotWebTools ... Search

RobotWebTools / rosbridge_suite

Code Issues 38 Pull requests 3 Insights Settings

Server Implementations of the rosbridge v2 Protocol <http://robotwebtools.org/>

Add topics Edit September 2018

653 commits 12 branches 52 releases 58 contributors

653 commits (#350) ...

58 contributors

rosapi	Fix a few problems (#350)	25 days ago
rosbridge_library	use package format 2, remove unnecessary dependencies (#348)	25 days ago
rosbridge_server	Fix a few problems (#350)	25 days ago
rosbridge_suite	use package format 2, remove unnecessary dependencies (#348)	25 days ago
.gitignore	Gitignore vim swapfile	2 years ago
.travis.yml	Fix Travis config (#311)	8 months ago
AUTHORS.md	authors and license added	5 years ago
CHANGELOG.md	update the change log	5 years ago

rob.org

RobotWebTools / **rosbridge_suite**

Code Issues Pull requests Security Insights Settings

Server Implementations of the rosbridge v2 Protocol <http://robotwebtools.org/>

Manage topics

September 2019

685 commits 12 branches 59 releases 66 contributors View license

685 commits

66 contributors

Clone or download

jihoonl 0.11.3 release (#424) ... Latest commit d2065f0 28 days ago

File	Description	Time
.github	Add GitHub issue template and TROUBLESHOOTING.md (#397)	5 months ago
rosapi	0.11.3 release (#424)	28 days ago
rosbridge_library	0.11.3 release (#424)	28 days ago
rosbridge_msgs	0.11.3 release (#424)	28 days ago
rosbridge_server	0.11.3 release (#424)	28 days ago
rosbridge_suite	0.11.3 release (#424)	28 days ago
.gitignore	Gitignore vim swapfile	3 years ago
.travis.yml	Travis CI: Look for Python syntax errors and undefined name (#420)	2 months ago
AUTHORS.md	authors and license added	6 years ago

GitHub, Inc. (US) | https://github.com/RobotWebTools/rosbridge_suite/com | Search | Unwatch | 26 | Star | Unstar | 42 | Fork | 71

This repository Search Pull requests Issues Gist

RobotWebTools / rosbridge_suite

Code Issues 15 Pull requests 2 Pulse Graphs Settings

Branch: develop

Commits on Nov 12, 2015

Merge pull request #197 from xuhao1/UDP ...
rctoris committed on Nov 12, 2015

Commits on Nov 11, 2015

enable udp
xuhao1 committed on Nov 11, 2015

Commits on Nov 10, 2015

?
xuhao1 committed on Nov 10, 2015

Commits on Nov 9, 2015

Adding UDP
xuhao1 committed on Nov 9, 2015

Commits on Sep 28, 2015

Merge pull request #195 from rcodddow/patch-1 ...
rctoris committed on Sep 28, 2015

Commit History

CAN COPY OR REVERT TO ANY PAST STATE OF THE REPOSITORY

changelog updated

develop 0.7.13

rctoris committed on Aug 14, 2015 1 parent 3fcfc76b commit a2b3f869a67eea0e4d17a358d5346b464731544a

Showing 4 changed files with 36 additions and 0 deletions.

Unified Split

5 rosapi/CHANGELOG.rst

Change log

YOU CAN VIEW ALL CHANGES MADE BETWEEN CONSECUTIVE COMMITS

23 23 @@ -23,6 +23,11 @@ Changelog for package rosapi
24 24 0.7.0 (2014-12-02)
25 25 +-----
26 26 +0.7.13 (2015-08-14)
27 27 +-----
28 28 ** Fix catkin_lint issues
29 29 ** Contributors: Matt Vollrath
30 30 +
31 31 0.7.12 (2015-04-07)
32 32 +-----
33 33

14 rosbridge_library/CHANGELOG.rst

34 34 @@ -34,6 +34,20 @@ Changelog for package rosbridge_library
35 35 * request_id --> id
36 36 * Contributors: Russell Toris
37 37 +0.7.13 (2015-08-14)
38 38 +-----
39 39 ** Nevermind o_0
40 40 ** Add test_depend too (just in case)
41 41 ** Add dependency on python bson
42 42 ** Get parameter at encode time

Version control options

Version control options

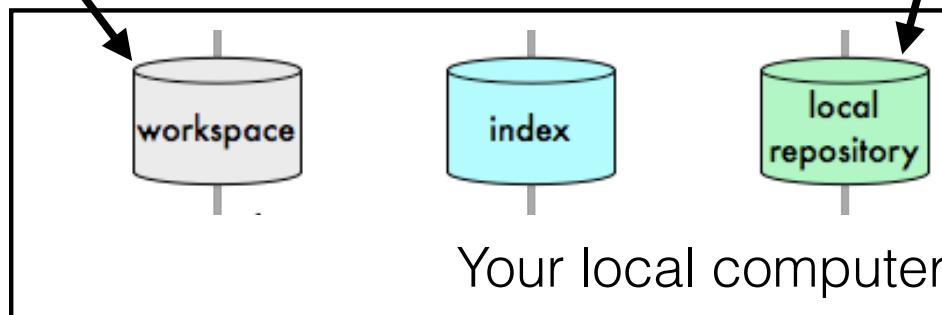
- Concurrent Versioning System (CVS): very old school
- Subversion (SVN): still in significant use
- Mercurial (hg)
- **git: used in AutoRob**

Git Data Transport Commands

<http://csteelle.com>

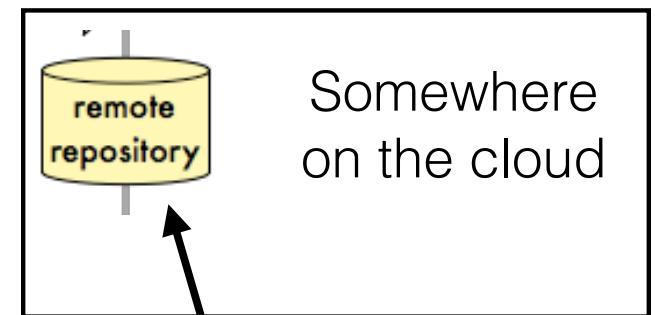
The directory where
you are working

(~/uname/reponame or
C:\Users\uname\reponame)



The repository on your
local computer

(~/uname/reponame/.git)

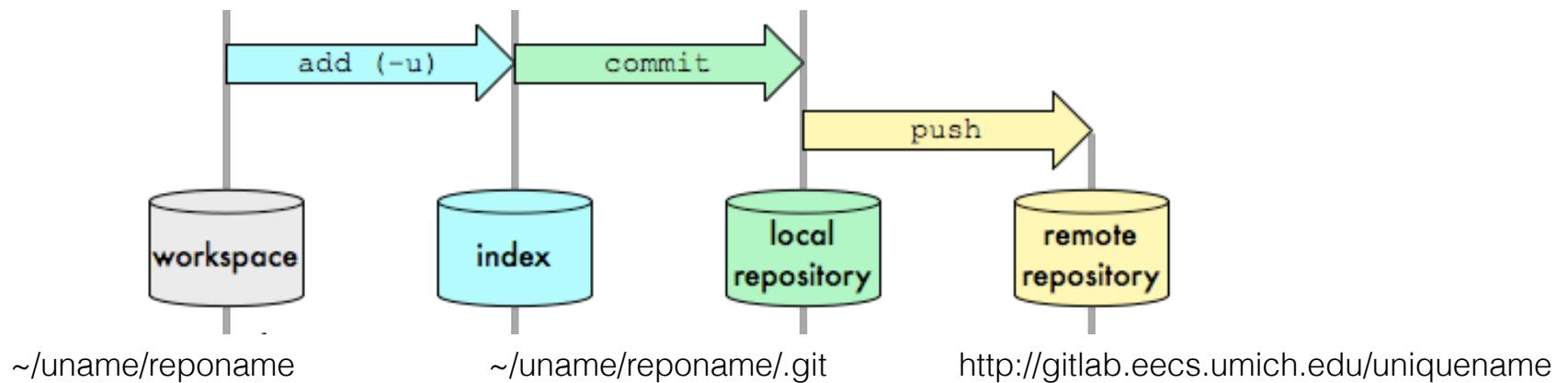


The repository on
a remote server

(<http://gitlab.eecs.umich.edu/uniquename>)

Git Data Transport Commands

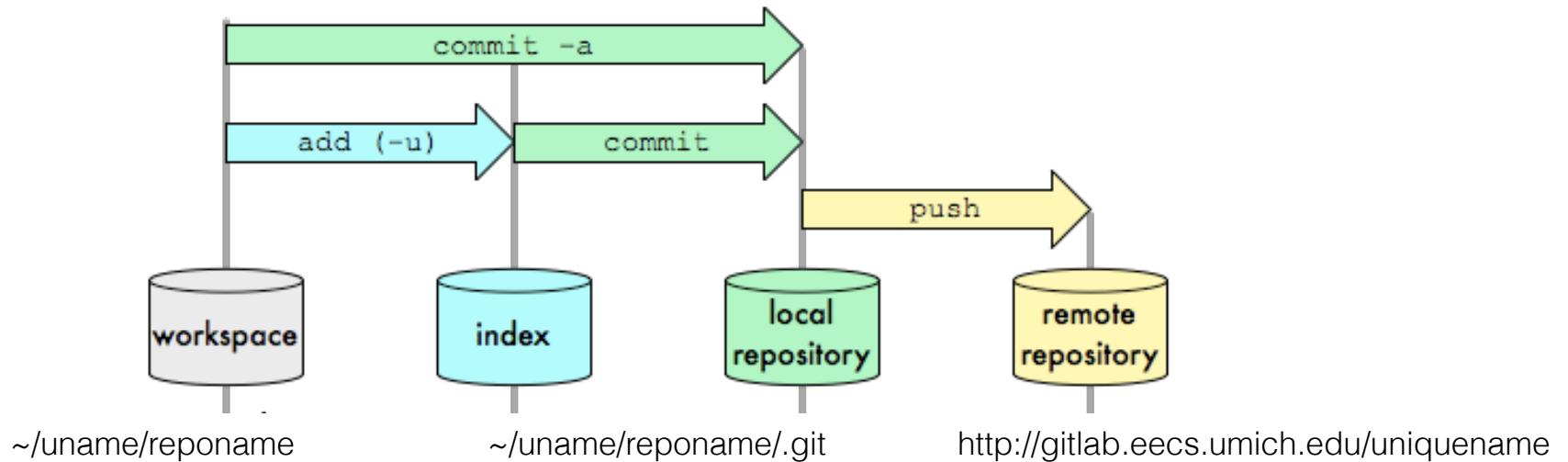
<http://csteelle.com>



After making local changes, you can add, commit, and push to your remote repository

Git Data Transport Commands

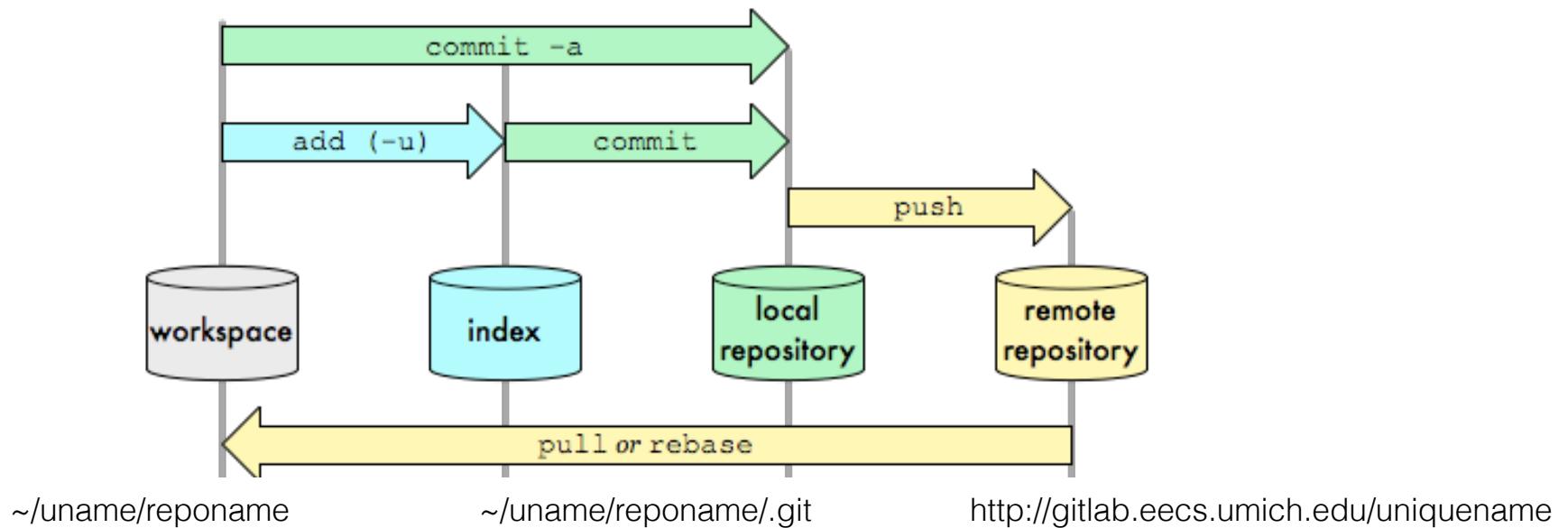
<http://csteelle.com>



If there are no files to add, just commit and push

Git Data Transport Commands

<http://csteelle.com>



A pull command updates the local workspace with changes from the remote repository

git basics: commands

- Push completed project to repository (or just to update)
 - add files to a repository: `git add <file listing>`
 - commit changes to local repo: `git commit -a -m "<msg>"`
 - push local changes to a remote repository: `git push`
- Pull to updates your local repository (and workspace) from remote
 - pull remote changes to a local repository: `git pull`

C <https://github.com/ohseejay/kineval-stencil-f16>

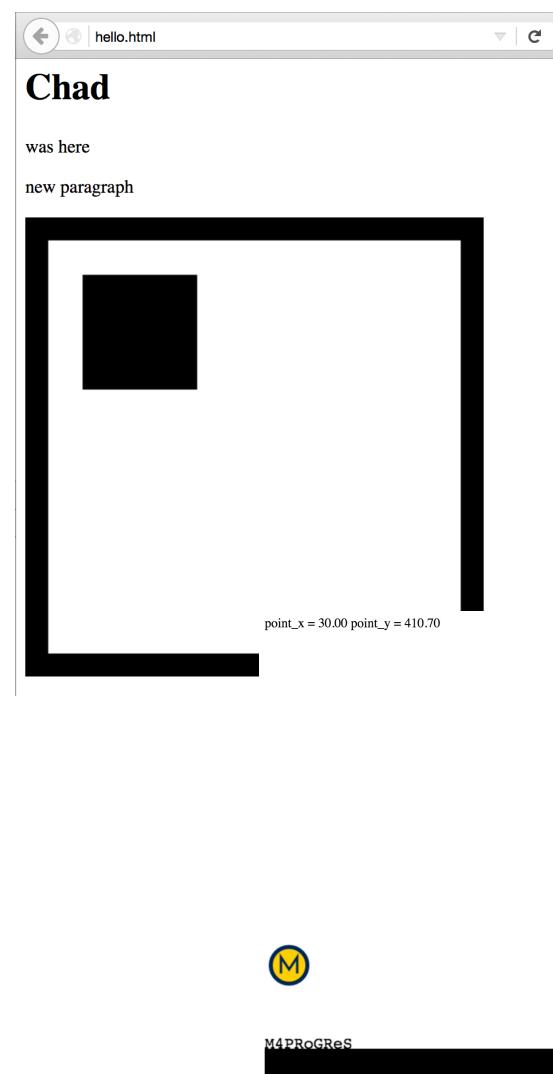
2 commits 1 branch

Branch: master ▾ New pull request

 odestcj Fall 2016 release

-  js
-  kineval
-  project_pathplan
-  project_pendularm
-  robots
-  tutorial_heapsort
-  tutorial_js
-  worlds
-  README.md
-  home.html

 README.md



Tutorial Examples

<https://github.com/ohseejay/kineval-stencil-f16>

2 commits 1 branch

Branch: master New pull request

odestcj Fall 2016 release

- js
- kineval
- project_pathplan
- project_pendularm
- robots
- tutorial_heapsort**
- tutorial_js
- worlds
- README.md
- home.html

README.md

My Heap Sort

file:///Users/logan/git_tmp/kineval/tutorial_heapsort/source_heap

Search

My Heap Sort

```

check
numbers to sort: 5949 8320 1472 6409 3865 4921 3157 459 5185 797 8465 3911 2575 100 1165 4631 9772 3413 78 319
heap (insert 5949): 5949
heap (insert 8320): 5949 8320
heap (insert 1472): 1472 8320 5949
heap (insert 6409): 1472 6409 5949 8320
heap (insert 3865): 1472 3865 5949 8320 6409
heap (insert 4921): 1472 3865 4921 8320 6409 5949
heap (insert 3157): 1472 3865 3157 8320 6409 5949 4921
heap (insert 459): 459 1472 3157 3865 6409 5949 4921 8320
heap (insert 5185): 459 1472 3157 3865 6409 5949 4921 8320 5185
heap (insert 797): 459 797 3157 3865 1472 5949 4921 8320 5185 6409
heap (insert 8465): 459 797 3157 3865 1472 5949 4921 8320 5185 6409 8465
heap (insert 3911): 459 797 3157 3865 1472 3911 4921 8320 5185 6409 8465 5949
heap (insert 2575): 459 797 2575 3865 1472 3157 4921 8320 5185 6409 8465 5949 3911
heap (insert 100): 100 797 459 3865 1472 3157 2575 8320 5185 6409 8465 5949 3911 4921
heap (insert 1165): 100 797 459 3865 1472 3157 1165 8320 5185 6409 8465 5949 3911 4921 2575
heap (insert 4631): 100 797 459 3865 1472 3157 1165 4631 5185 6409 8465 5949 3911 4921 2575 8320
heap (insert 9772): 100 797 459 3865 1472 3157 1165 4631 5185 6409 8465 5949 3911 4921 2575 8320 9772 5185
heap (insert 3413): 100 797 459 3865 1472 3157 1165 4631 3865 6409 8465 5949 3911 4921 2575 8320 9772 5185
heap (insert 78): 78 100 459 797 1472 3157 1165 4631 3413 6409 8465 5949 3911 4921 2575 8320 9772 5185 3865
heap (insert 319): 78 100 459 797 319 3157 1165 4631 3413 1472 8465 5949 3911 4921 2575 8320 9772 5185 3865
heap (extract 78): 100 319 459 797 1472 3157 1165 4631 3413 6409 8465 5949 3911 4921 2575 8320 9772 5185 3865
heap (extract 100): 319 797 459 3413 1472 3157 1165 4631 3865 6409 8465 5949 3911 4921 2575 8320 9772 5185
heap (extract 319): 459 797 1165 3413 1472 3157 2575 4631 3865 6409 8465 5949 3911 4921 5185 8320 9772
heap (extract 459): 797 1472 1165 3413 6409 3157 2575 4631 3865 6409 8465 5949 3911 4921 5185 8320
heap (extract 797): 1165 1472 2575 3413 6409 3157 4921 4631 3865 9772 8465 5949 3911 8320 5185
heap (extract 1165): 1472 3413 2575 3865 6409 3157 4921 4631 8465 9772 8465 5949 3911 8320
heap (extract 1472): 2575 3413 3157 3865 6409 3911 4921 4631 5185 9772 8465 5949 8320
heap (extract 2575): 3157 3413 3911 3865 6409 5949 4921 4631 5185 9772 8465 8320
heap (extract 3157): 3413 3865 3911 4631 6409 5949 4921 8320 5185 9772 8465
heap (extract 3413): 3865 4631 3911 5185 6409 5949 4921 8320 8465 9772
heap (extract 3865): 3911 4631 4921 5185 6409 5949 9772 8320 8465
heap (extract 3911): 4631 5185 4921 8320 6409 5949 9772 8465
heap (extract 4631): 4921 5185 5949 8320 6409 8465 9772
heap (extract 4921): 5185 6409 5949 8320 9772 8465
heap (extract 5185): 5949 6409 8465 8320 9772
heap (extract 5949): 6409 8320 8465 9772
heap (extract 6409): 8320 9772 8465
heap (extract 8320): 8465 9772
heap (extract 8465): 9772
heap (extract 9772):
```

sorted: 78 100 319 459 797 1165 1472 2575 3157 3413 3865 3911 4631 4921 5185 5949 6409 8320 8465 9772

Project 0:
Heap sort

C <https://github.com/ohseejay/kineval-stencil-f16>

2 commits 1 branch

Branch: master ▾ New pull request

 odestcj Fall 2016 release

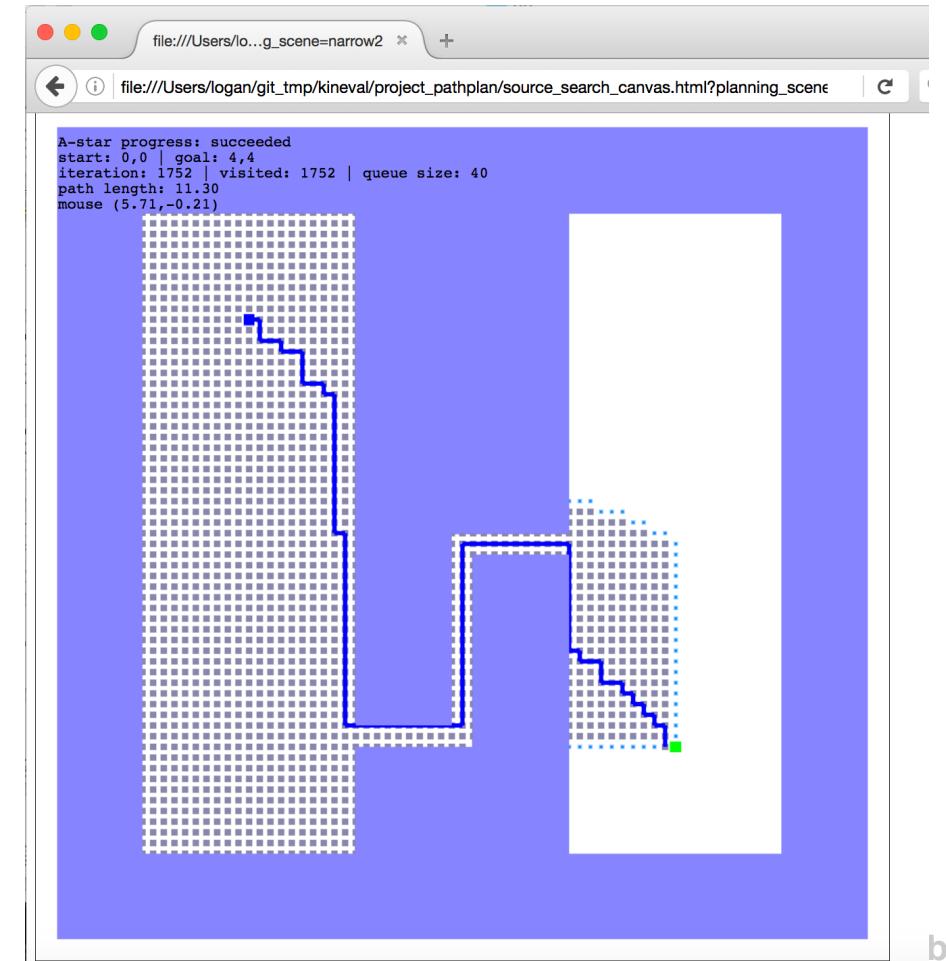
- js
- kineval
- project_pathplan**
- project_pendularm
- robots
- tutorial_heapsort
- tutorial_js
- worlds

README.md

home.html

README.md

Project 1: 2D Path Planning



C <https://github.com/ohseejay/kineval-stencil-f16>

2 commits 1 branch

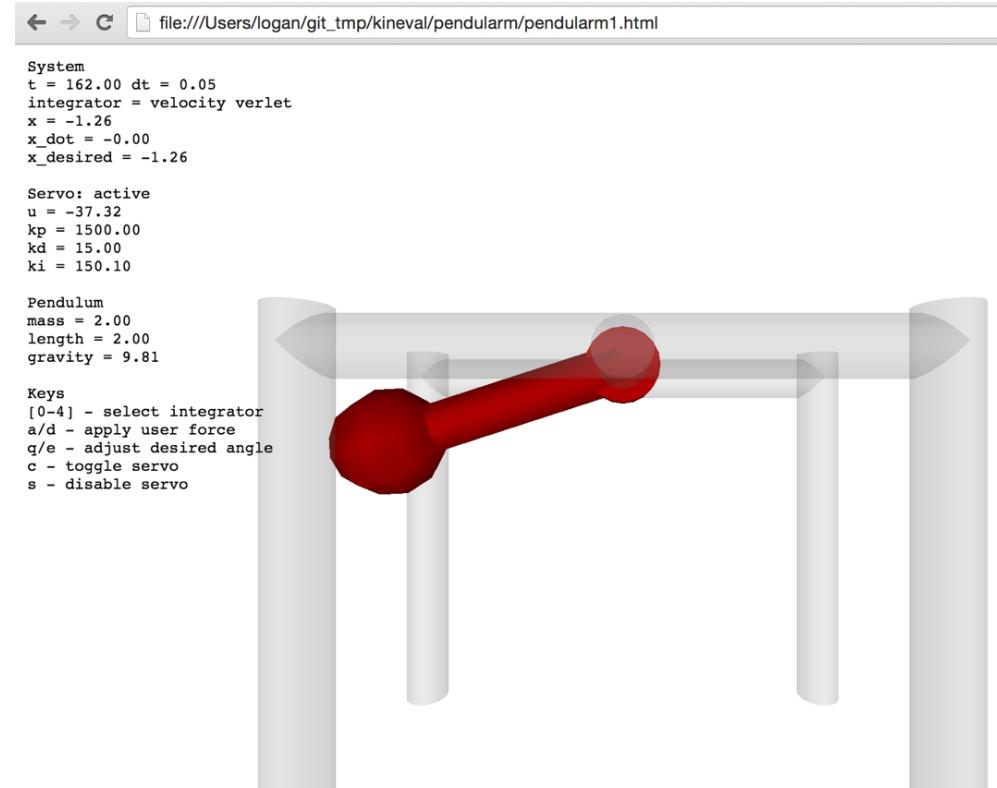
Branch: master ▾ New pull request

 odestcj Fall 2016 release

js
kineval
project_pathplan
project_pendularm
robots
tutorial_heapsort
tutorial_js
worlds
README.md
home.html

README.md

Project 2: Pendularm



C <https://github.com/ohseejay/kineval-stencil-f16>

2 commits 1 branch

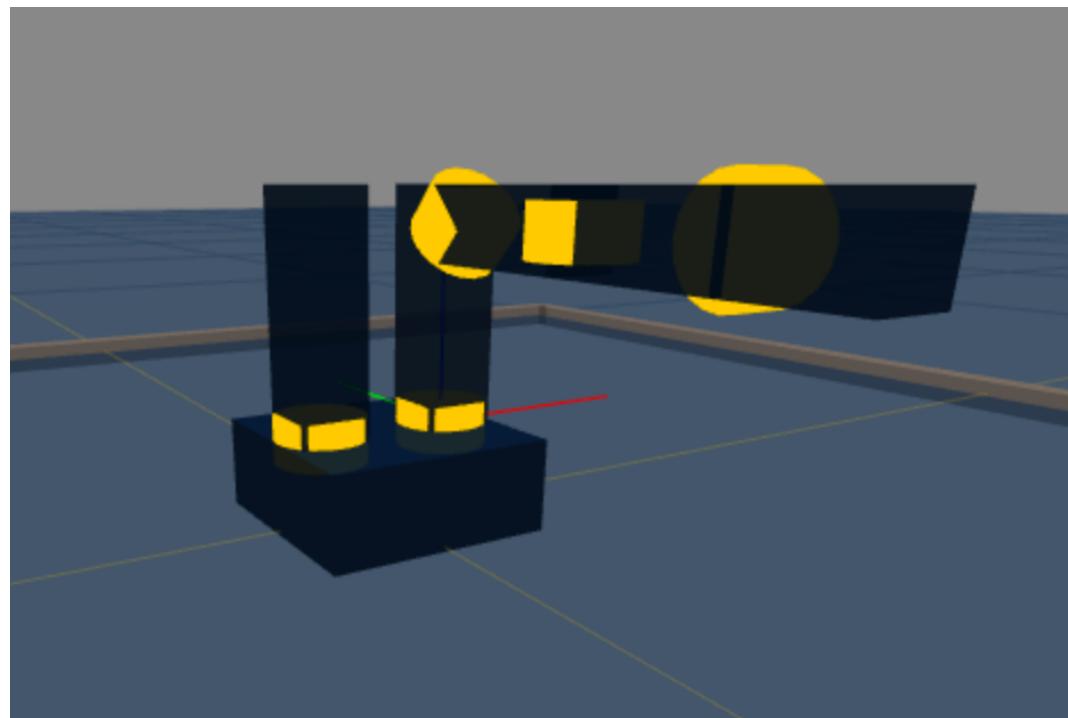
Branch: master ▾ New pull request

 odestcj Fall 2016 release

-  js
-  kineval
-  project_pathplan
-  project_pendularm
-  robots
-  tutorial_heapsort
-  tutorial_js
-  worlds
-  README.md
-  home.html

 README.md

Projects 3-6: KinEval



- Helpful for projects with multiple collaborators
- Allows different versions to be modified in parallel
- Branches are tagged with a descriptive name
- A branch is “checked out” into the local workspace
- Conflicts between branches must be resolved in merging (“pull request”)

Branching

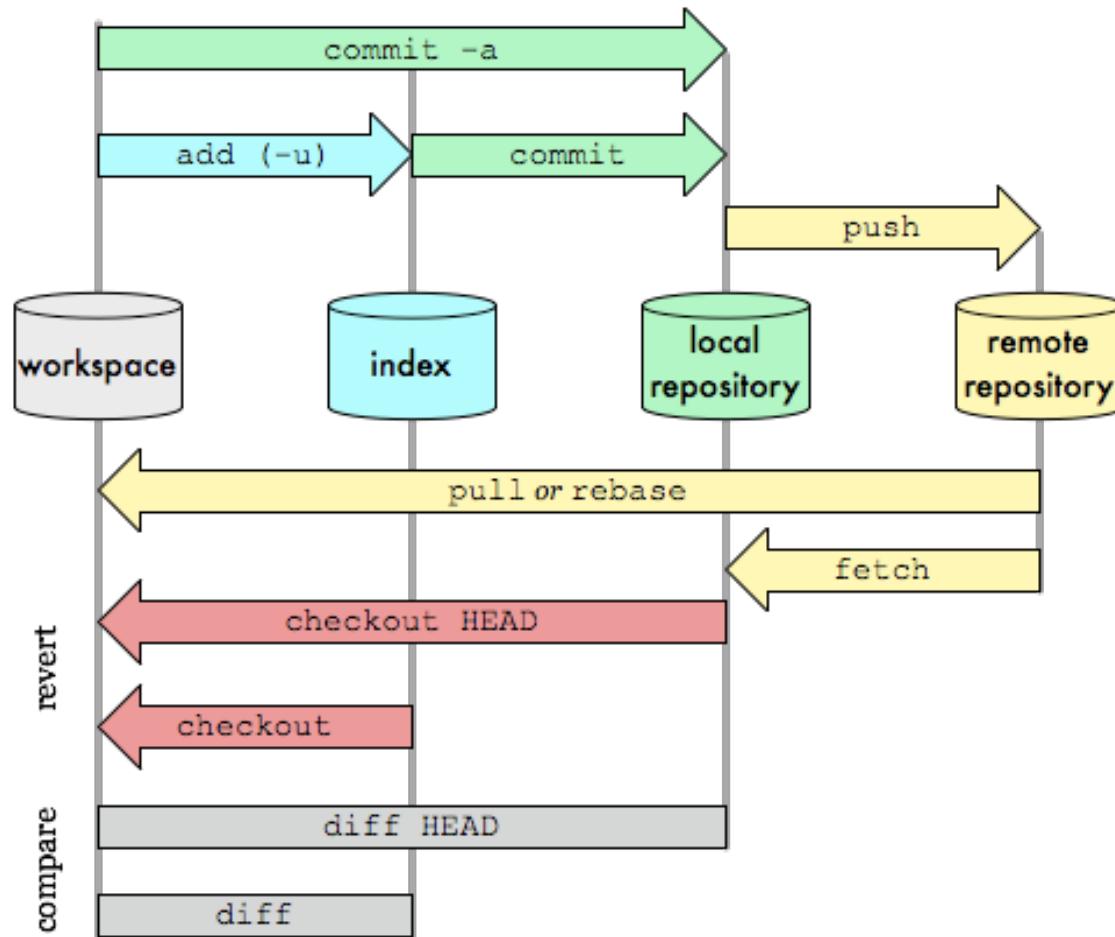


git basics: commands

- create a local copy of a repository branch:
 - `git clone -b <branch_name> <repo url>`
- switch workspace to a branch of a local repository:
 - `git checkout <branch_name>`

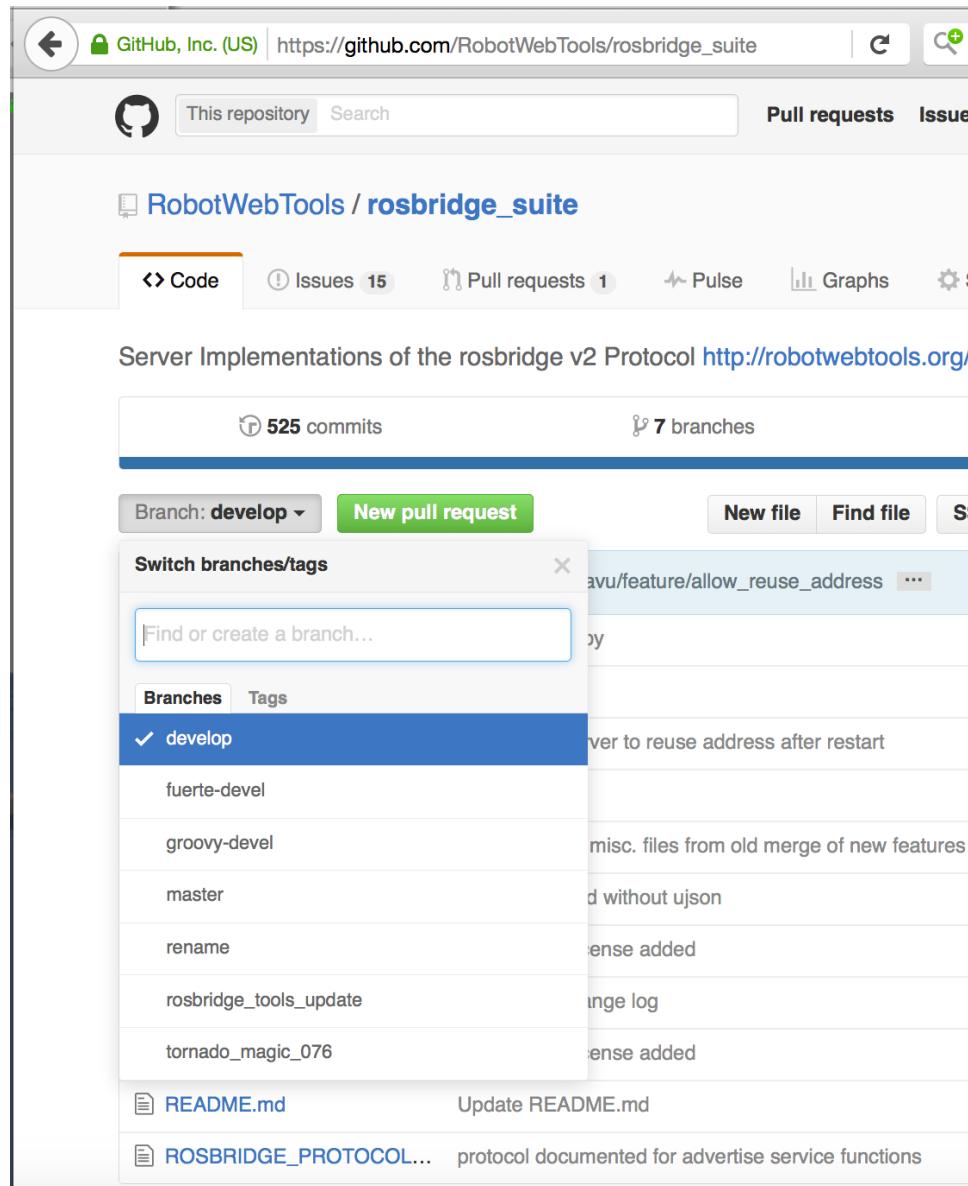
Git Data Transport Commands

<http://csteelle.com>



AutoRob branches

- There will be no collaborator conflicts.
- You contribute code to the **master** branch. We contribute grading.
- But, you need to keep working while your submitted projects are graded
- You can create a new branch to build upon your code in parallel to grading
- Once complete, your new branch can be merged back into master branch



Foreshadowing: Project 3

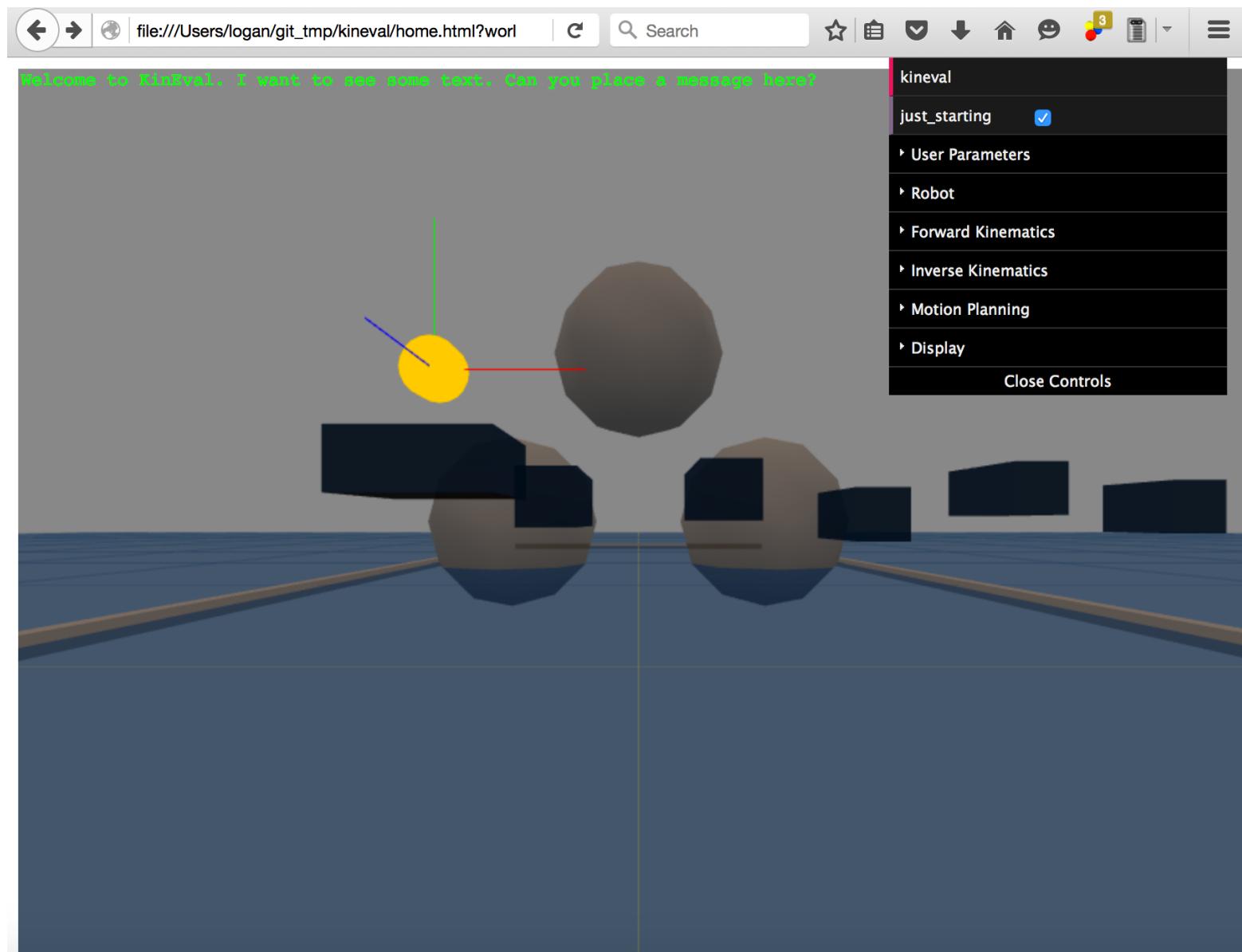
- create a local copy of a repository: `git clone <repo url>`
 - for KinEval, you should now see repo contents in cloned directory
 - view “home.html” in a web browser
 - examine “kineval/kineval_startingpoint.js”
- Note: you might need to clone stencil into a temporary directory and copy into a clone of the repository you have created

Running KinEval

- In Firefox browser, simply open “home.html”
- For other browsers, “home.html” may need to be served to avoid throwing a “security” error
 - If you have **python**, run the simpleHTTPServer from the directory containing “home.html”
 - `python -m SimpleHTTPServer`
 - point browser to <http://localhost:8000/>

Running KinEval

- In Firefox browser, simply open “home.html”
- For other browsers, “home.html” may need to be served to avoid throwing a “security” error
 - If you have **nodejs**, install and run simple-server module from the directory containing “home.html”
 - npm install simple-server
 - node simple-server
 - point browser to <http://localhost:3000/home.html>





Michigan Robotics 367/510/567 - autorob.org