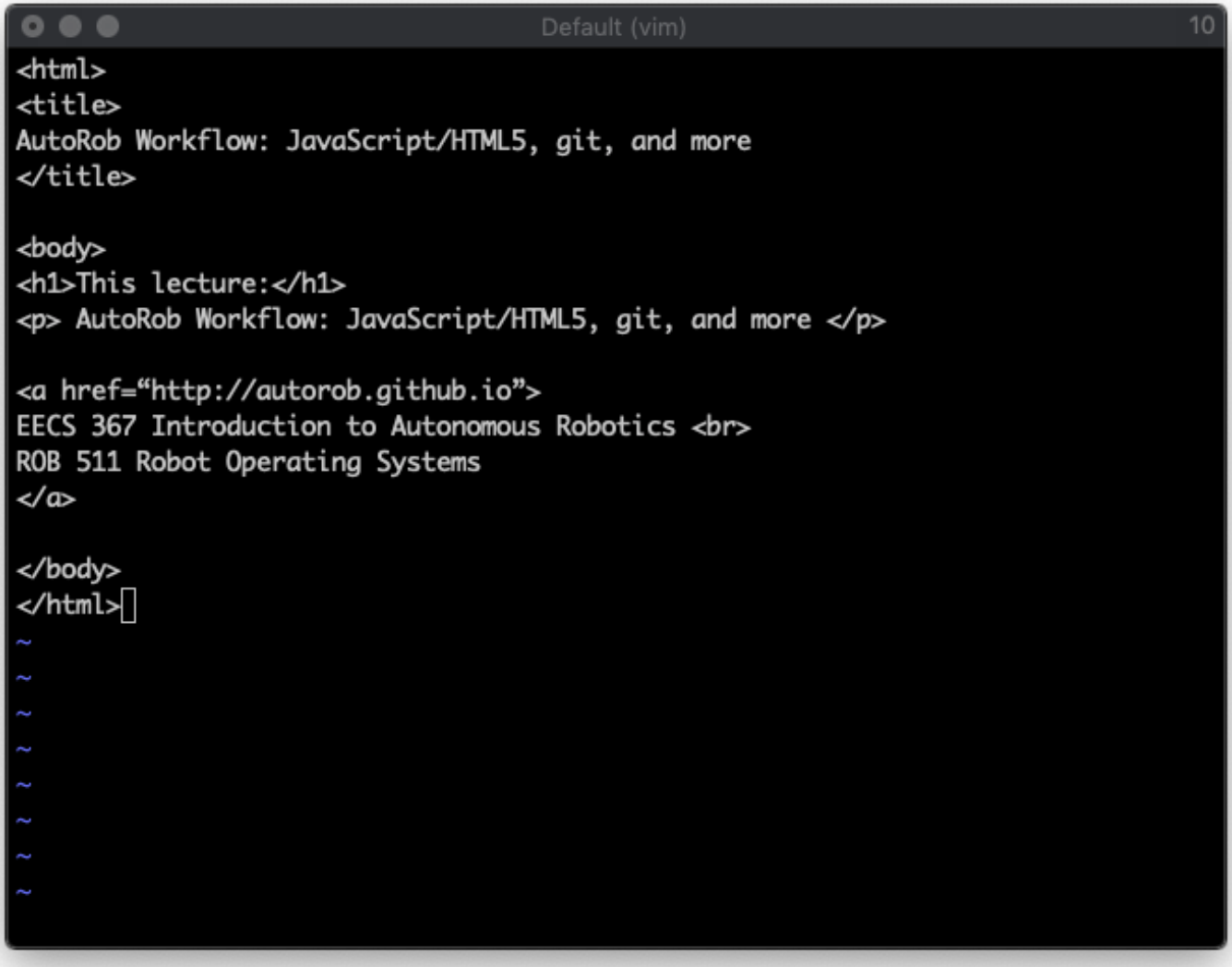
```
<html>
<title>
AutoRob Workflow: JavaScript/HTML5, git, and more
</title>

<body>
<h1>This lecture:</h1>
<p> AutoRob Workflow: JavaScript/HTML5, git, and more </p>

<a href="http://autorob.org">
EECS 367 Introduction to Autonomous Robotics <br>
ROB 511 Robot Operating Systems
</a>

</body>
</html>
```



vi text editor

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

this_lecture.html

```
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TextEdit on Mac OS X

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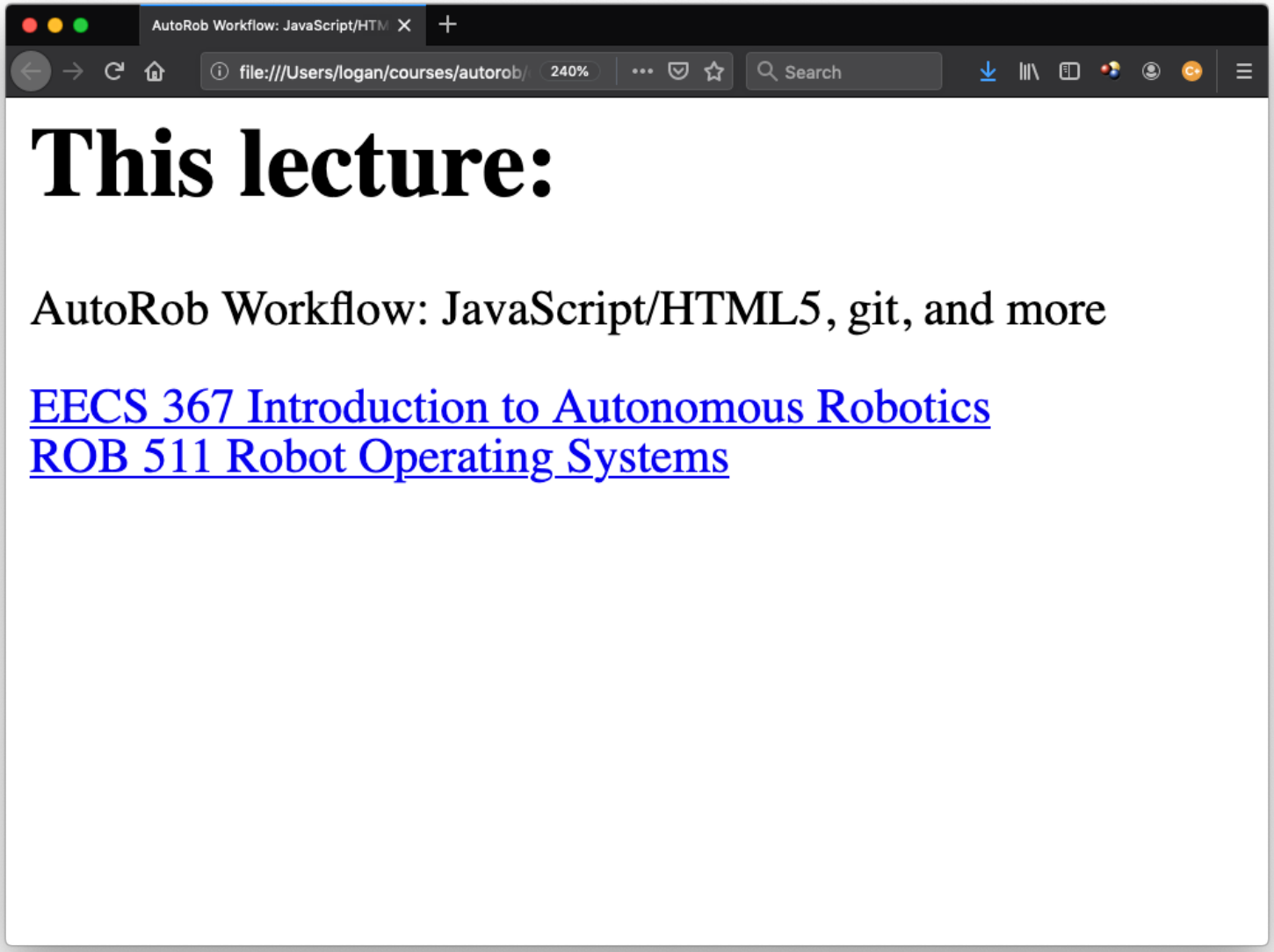
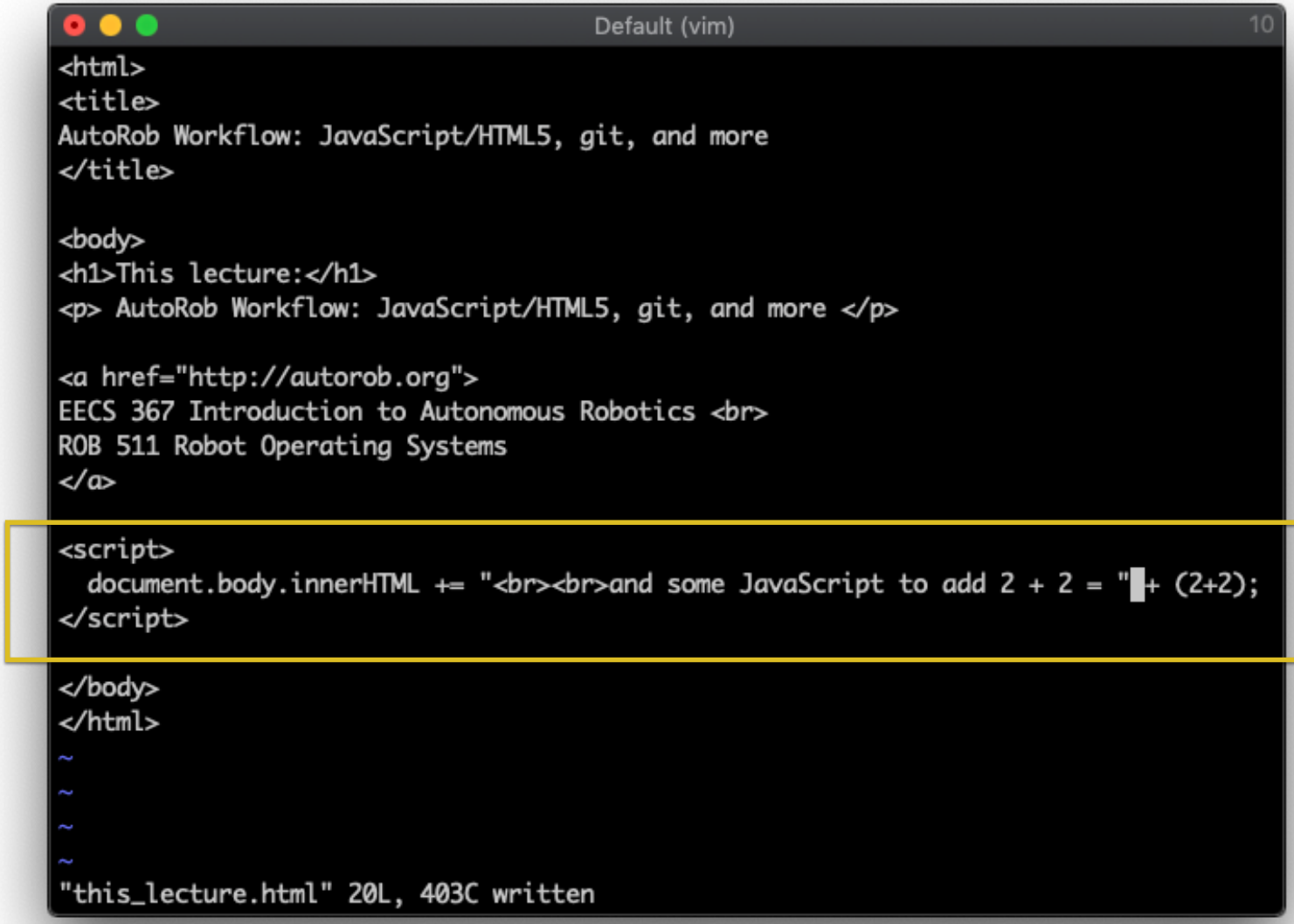
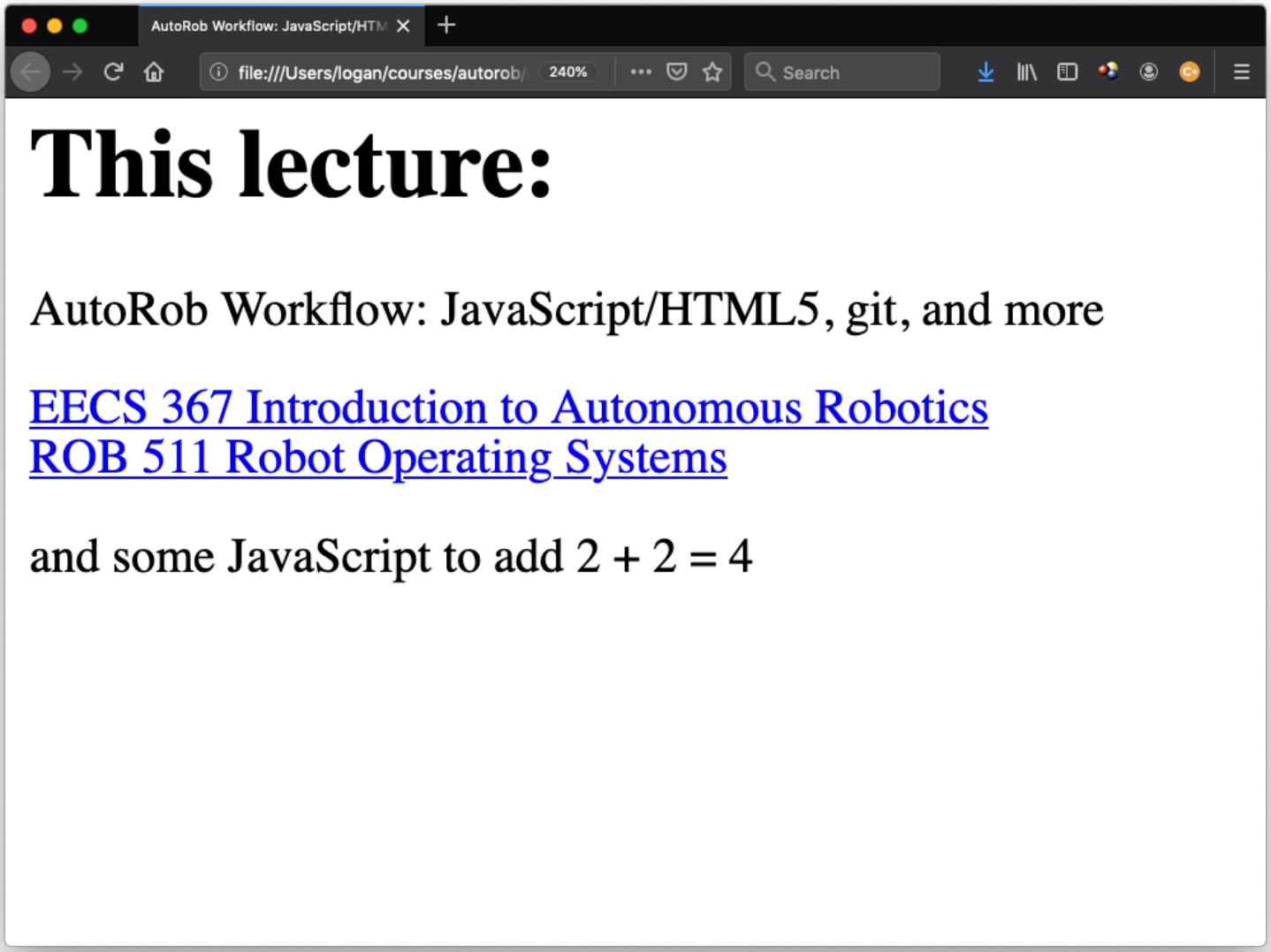


Open “this_lecture.html” in a web browser



Change “this_lecture.html” with JavaScript code to execute

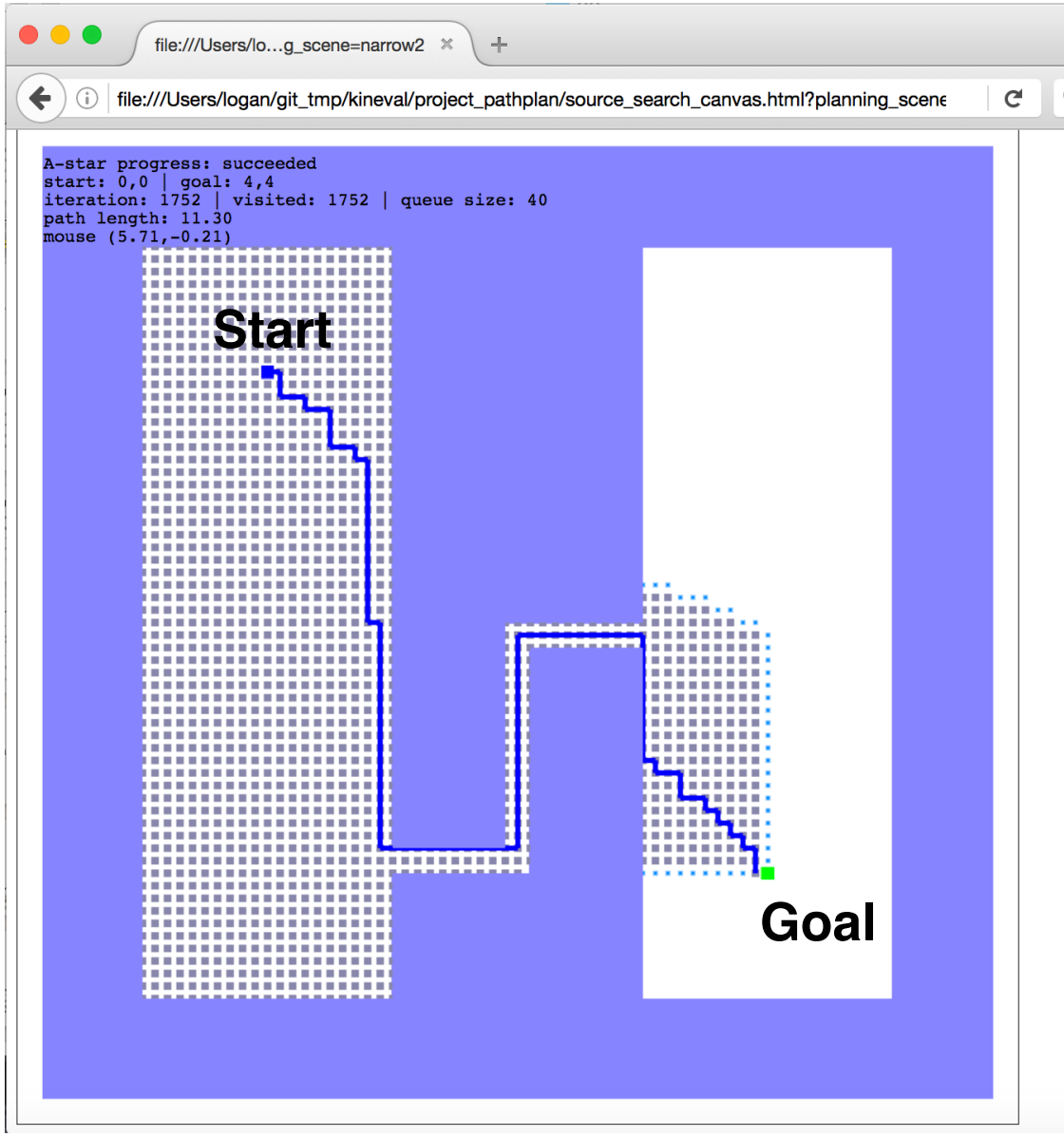


Reload “this_lecture.html” in browser to see result of this code

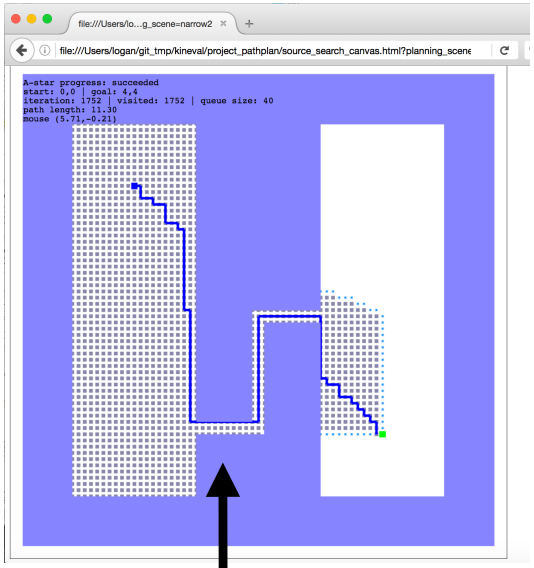
Similar workflow for Project 1

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



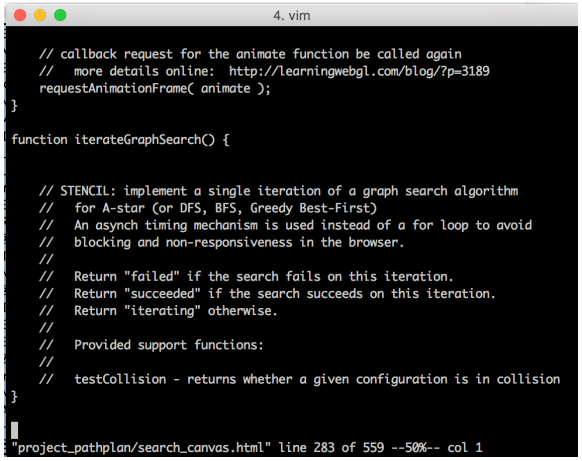
Browser
See HTML and JS code working



Source code
HTML and JS files containing your code

Text editor

Make changes to HTML and JS code

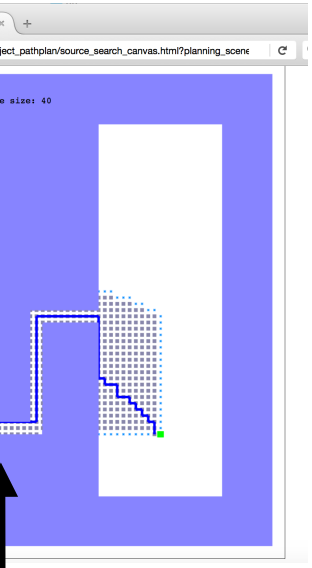


OPEN FILE

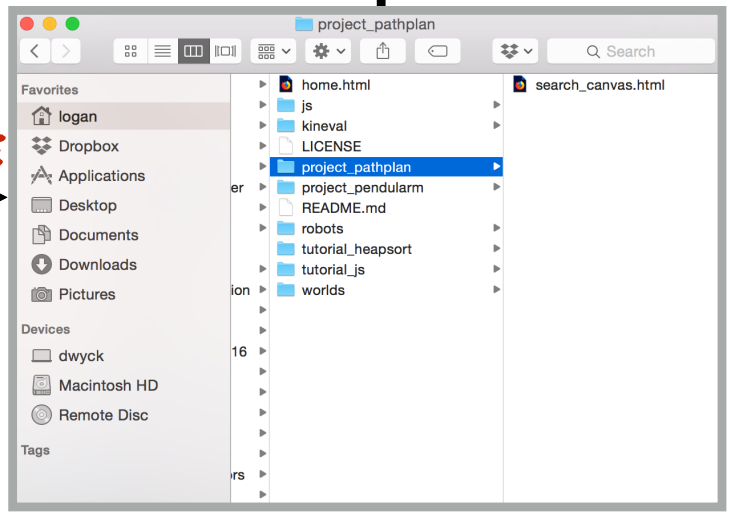
SAVE FILE

Source code

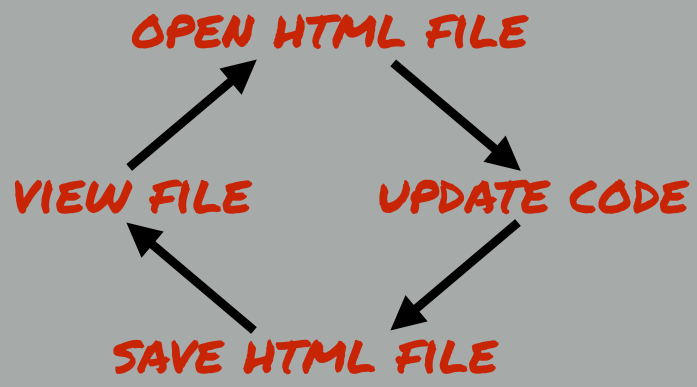
HTML and JS files containing your code



VIEW FILE

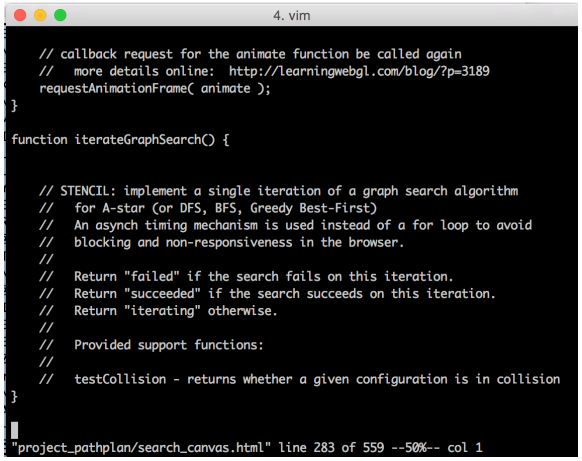


Coding process



Text editor

Make changes to HTML and JS code



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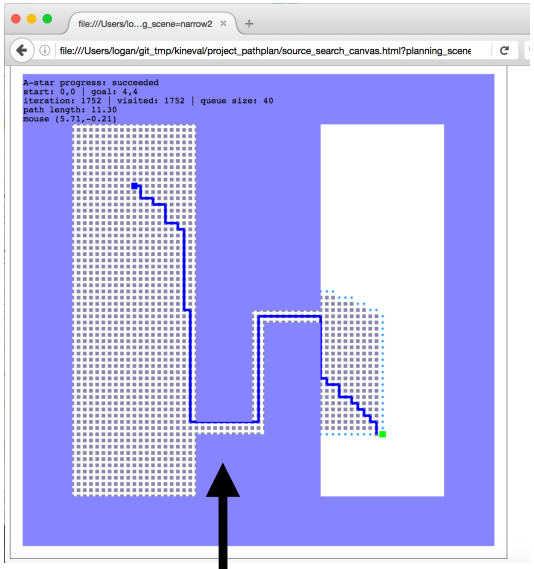

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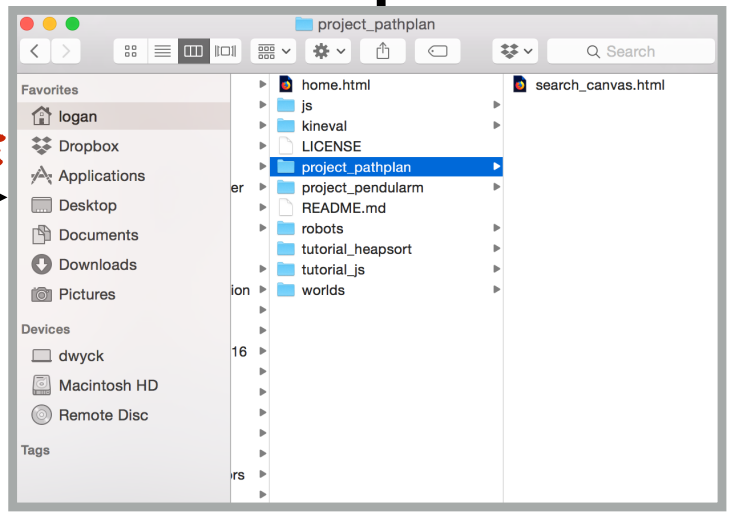
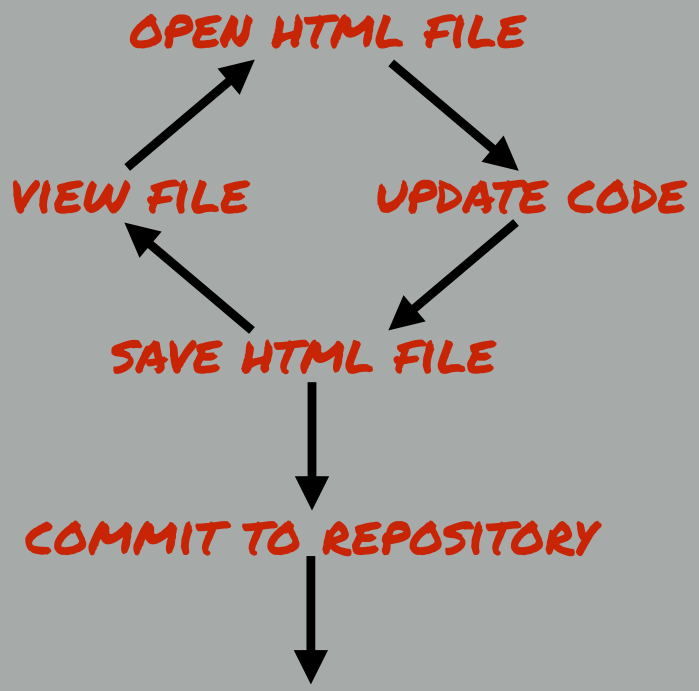


Source code

HTML and JS files containing your code

Coding process



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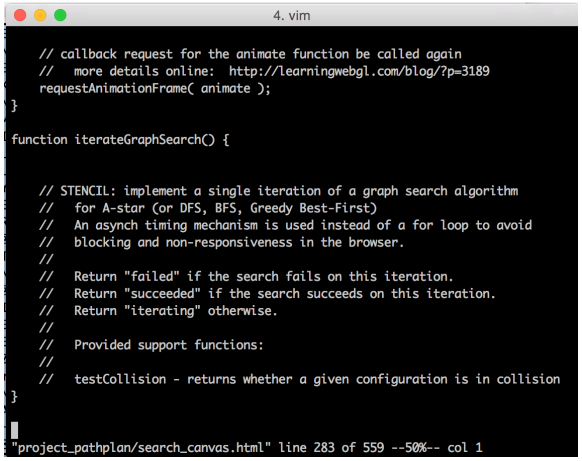

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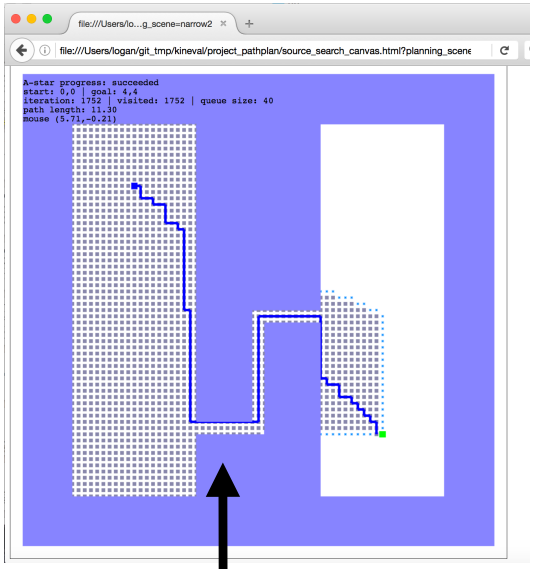

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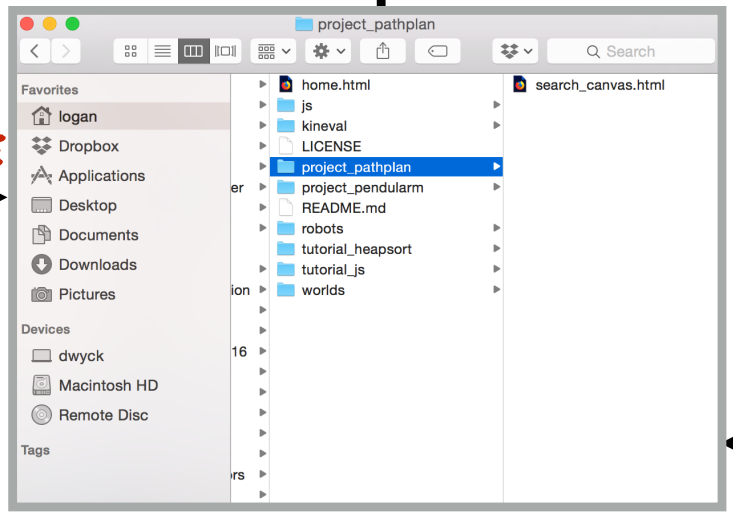
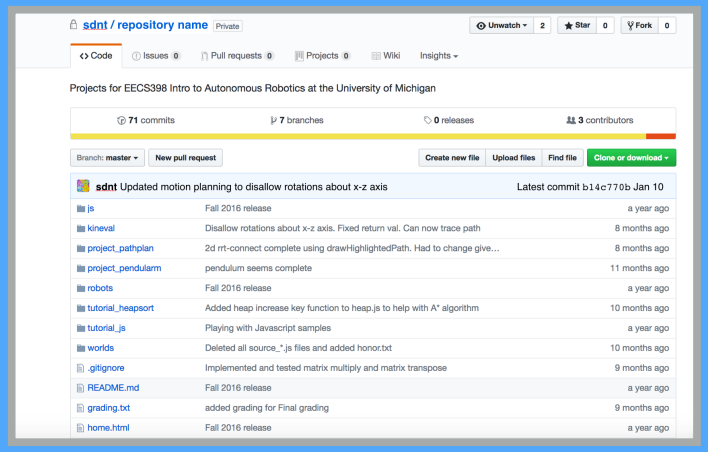


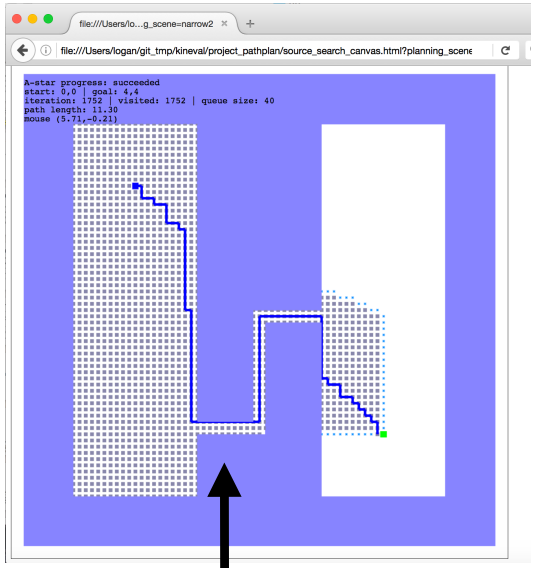
git repository

store history of code changes and pull grading



PUSH REPO

PULL REPO



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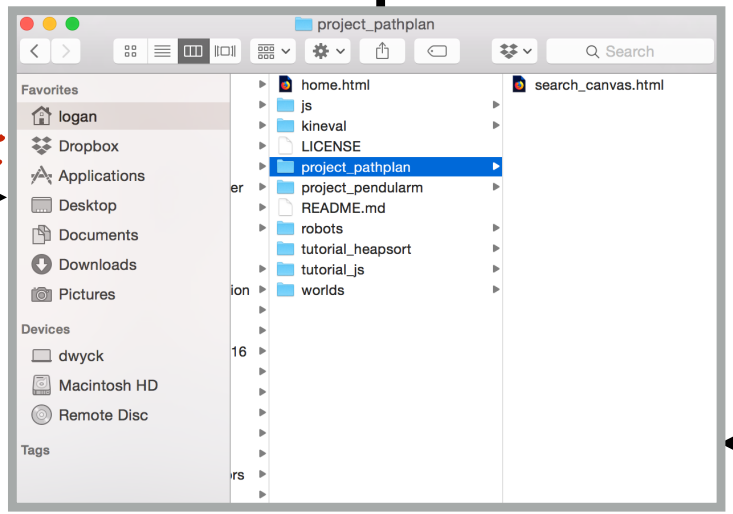

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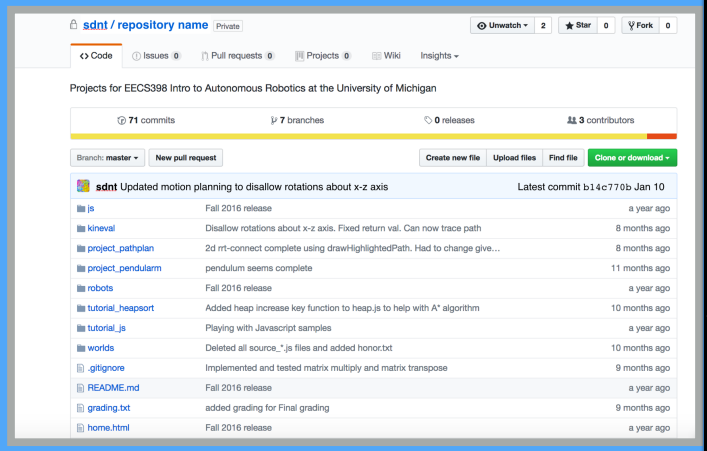


PUSH REPO

PULL REPO

CI Grader

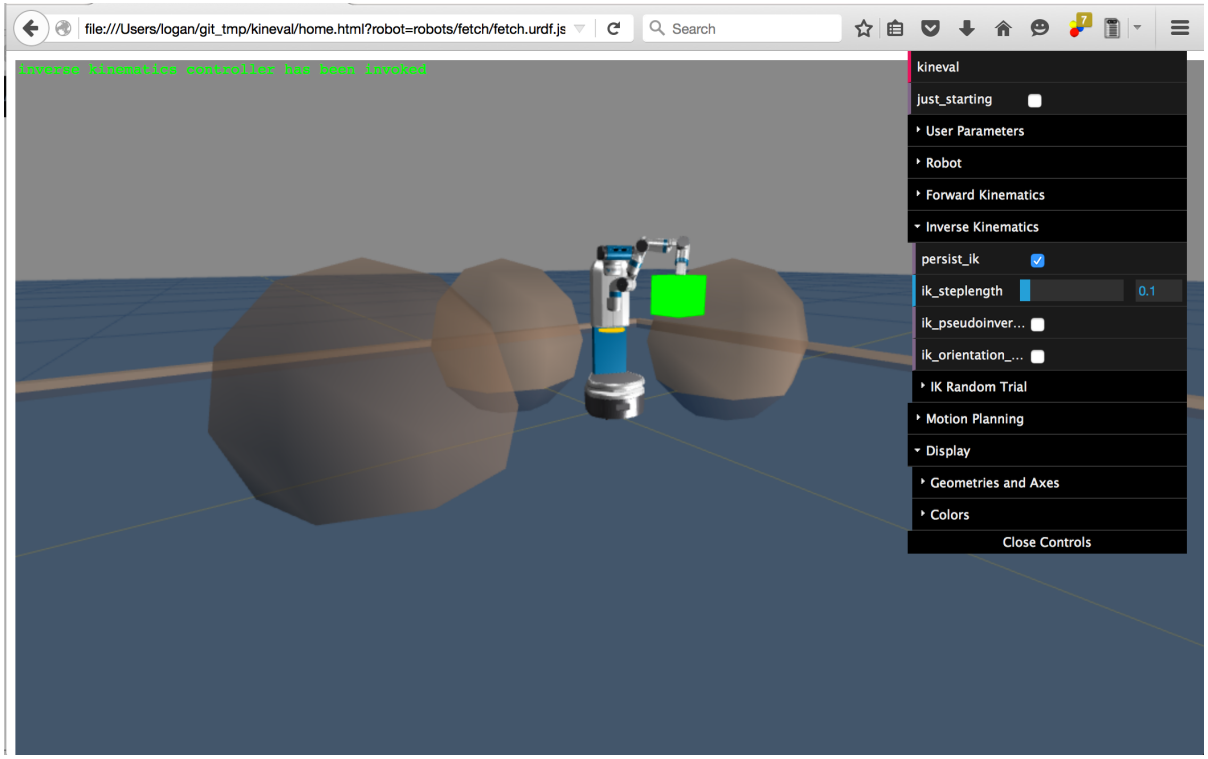
Continuous Integration testing of project code

This is new to AutoRob for remote work.

All grades reviewed by course staff

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.org

Search

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

GitHub, Inc. (US) https://github.com/autorob/ki

Search or jump to... / Pull requests Issues Marketplace Explore

autorob / **kineval-stencil**

Unwatch 2 | Star 0 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wi

https://github.com/autorob/kineval-stencil

Stencil code for KinEval (Kinematic Evaluator) for robot control, kinematics, decision, and dynamics in JavaScript/HTML5 Edit

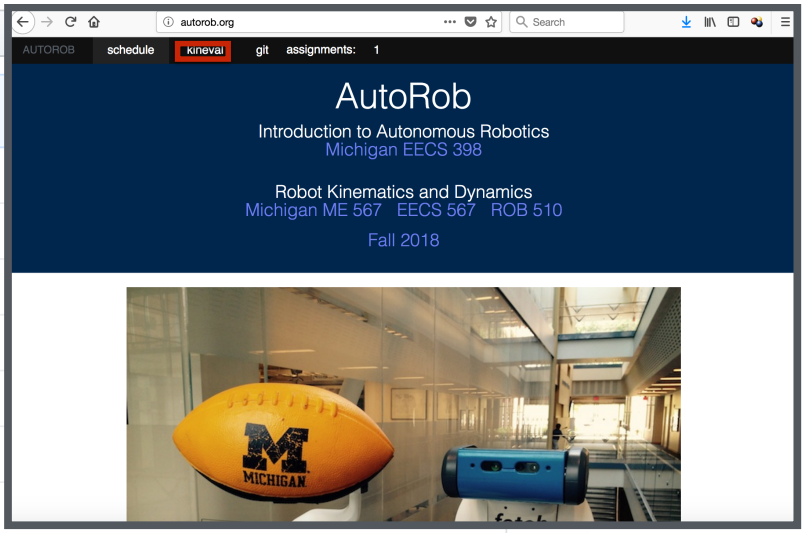
Add topics

2 commits | **1** branch | **0** releases | **2** contributors

Branch: **master** | **New pull request** | **Create new file**

odestcj initial commit Fall 2018

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	4 hours ago



Why JavaScript/HTML5?

Why JavaScript/HTML5?

Spectrum of programming languages

Spectrum of programming languages

C

C++ (maybe)

Matlab
(for numerics)

Python

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 (JavaScript is C without discipline)
- Cryptic debugging messages

JavaScript is C without discipline

- If you are fluent in C or a “classical” programming language, JavaScript has prototyped objects and minor syntactical differences
    - your instincts and stackoverflow should be enough
- If you are familiar with Matlab or a “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 ROB 502 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

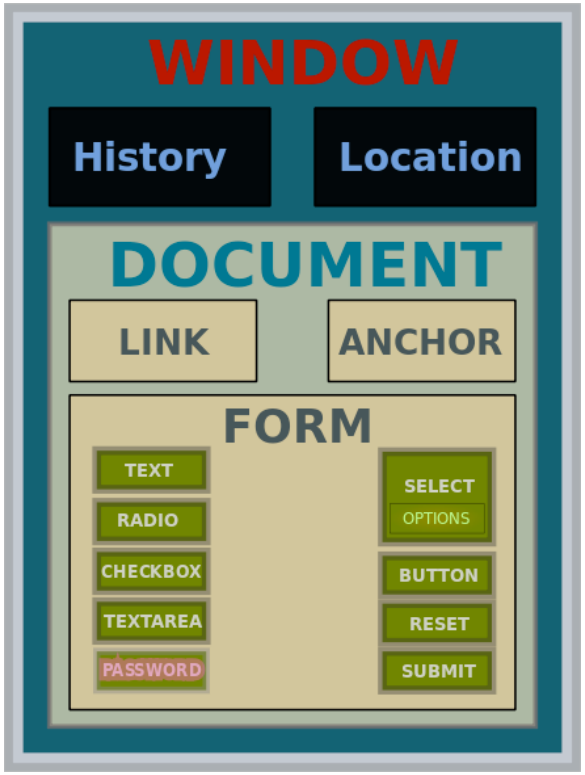
What is JavaScript/HTML5?

- **HyperText Markup Language** (HTML5): a markup language for expressing web pages as documents
  - Web browsers read HTML files and render to display
  - **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

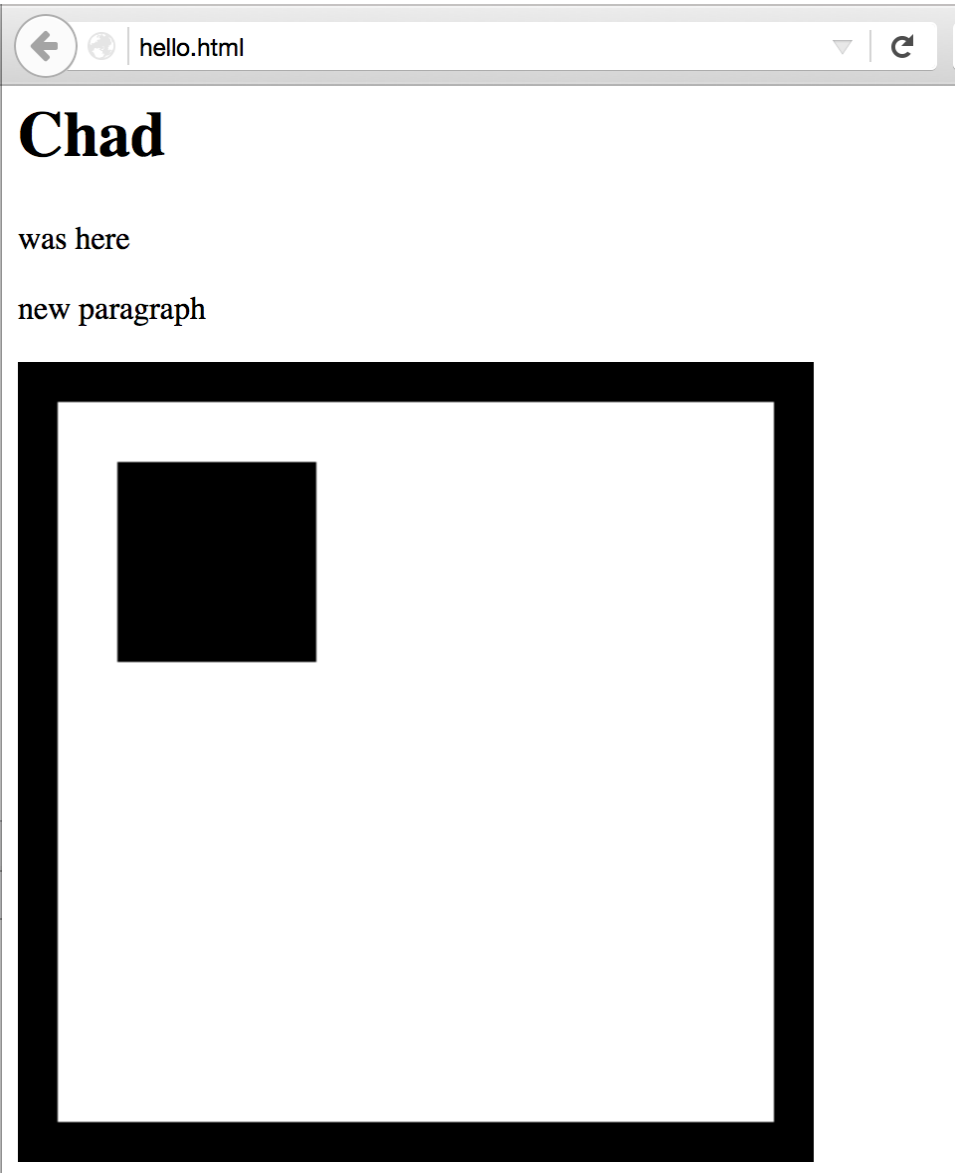
AUTOROB schedule kineval git assignments: 1

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.

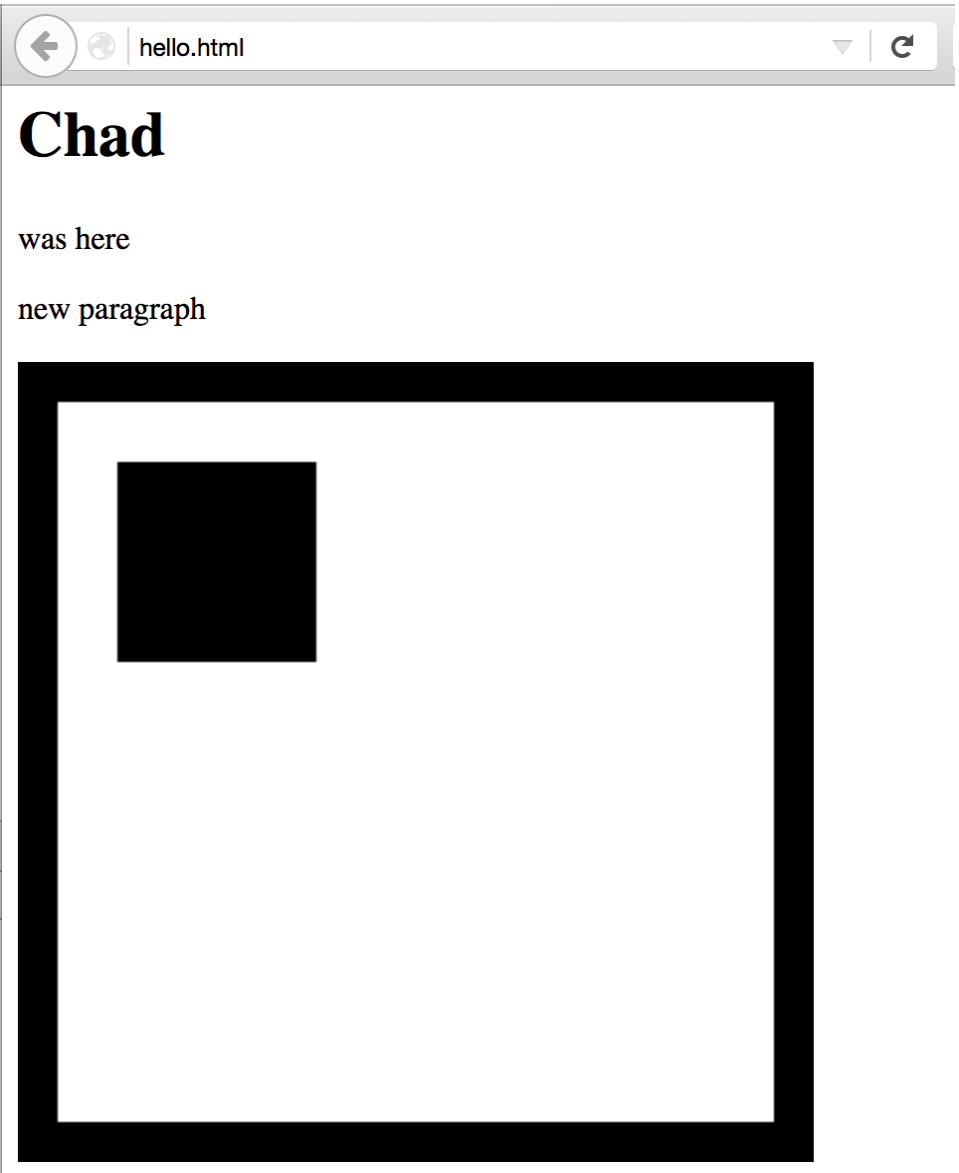
Date	Topic	Reading	Project
Sep 5	Initialization: Course overview, Robotics roadmap, Path planning quick start	Spong Ch.1 Corke Ch.1	Setup git repository
	Week 2		
Sep 10	Path Planning: DFS, BFS, A-star, Greedy best first	Wikipedia	Out: Path Planning
	JavaScript and git tutorial: Heap sort example	Crockford, 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		

JAVASCRIPT/HTML5 HELLO EXAMPLE



hello example

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



hello example

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

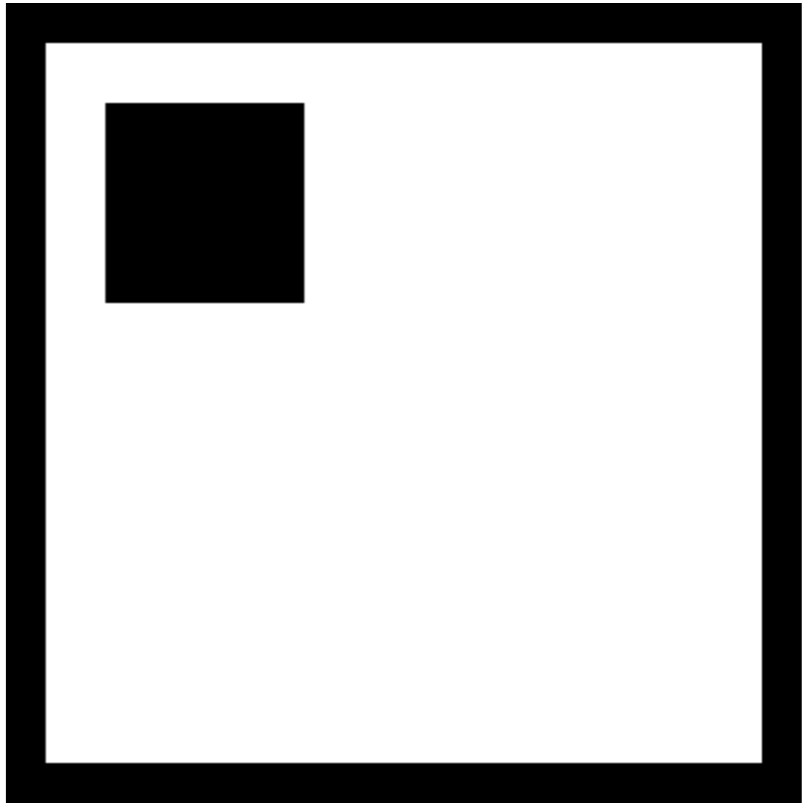
Loading...

hello.html

Chad

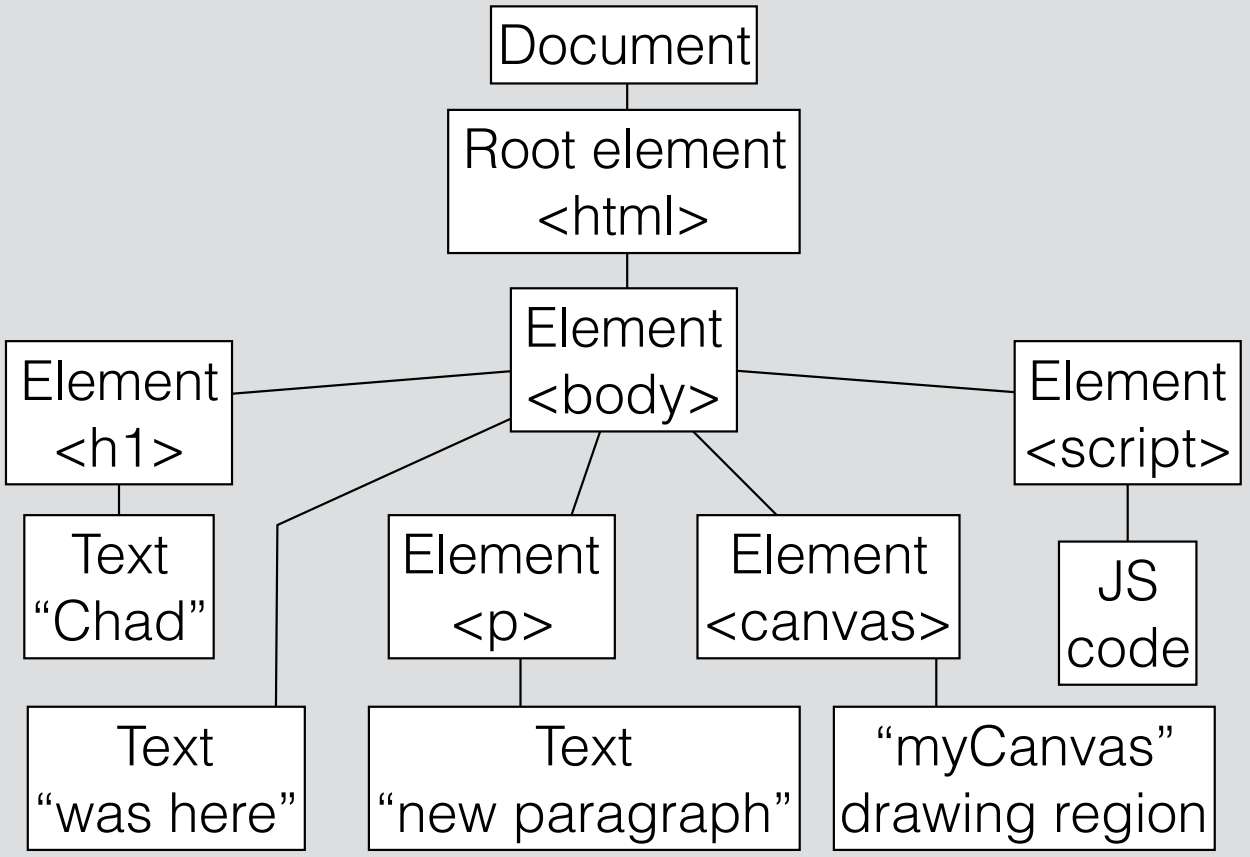
was here

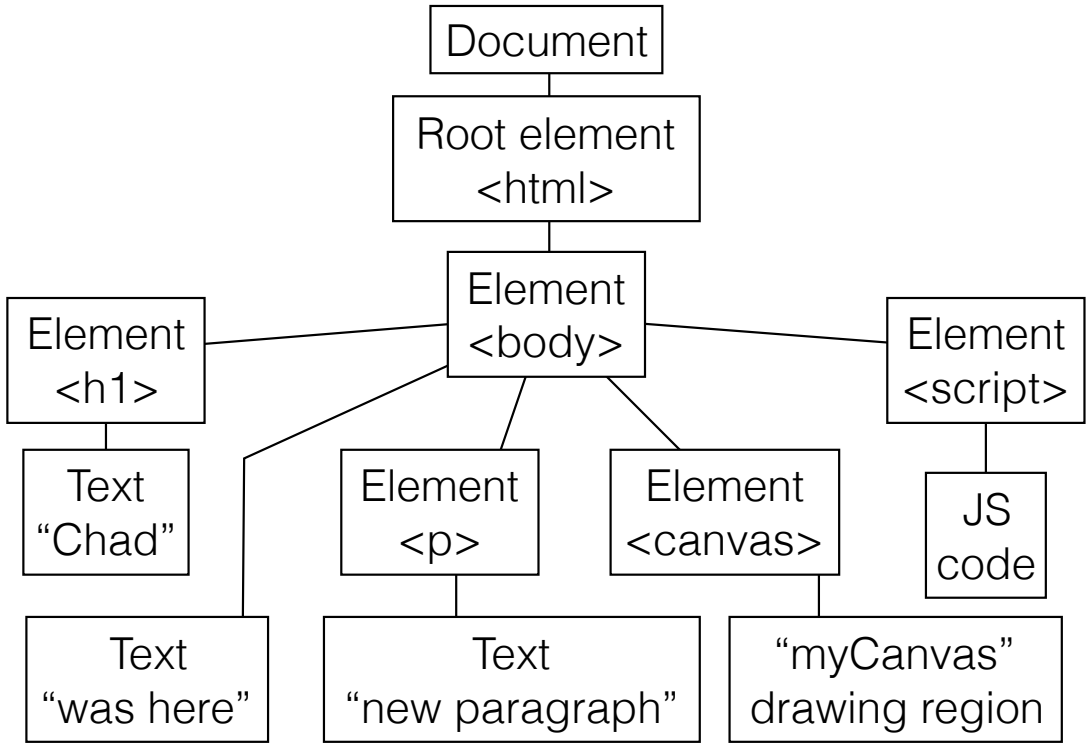
new paragraph



hello example

DOM created by browser upon loading hello.html



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<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>
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   // 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);
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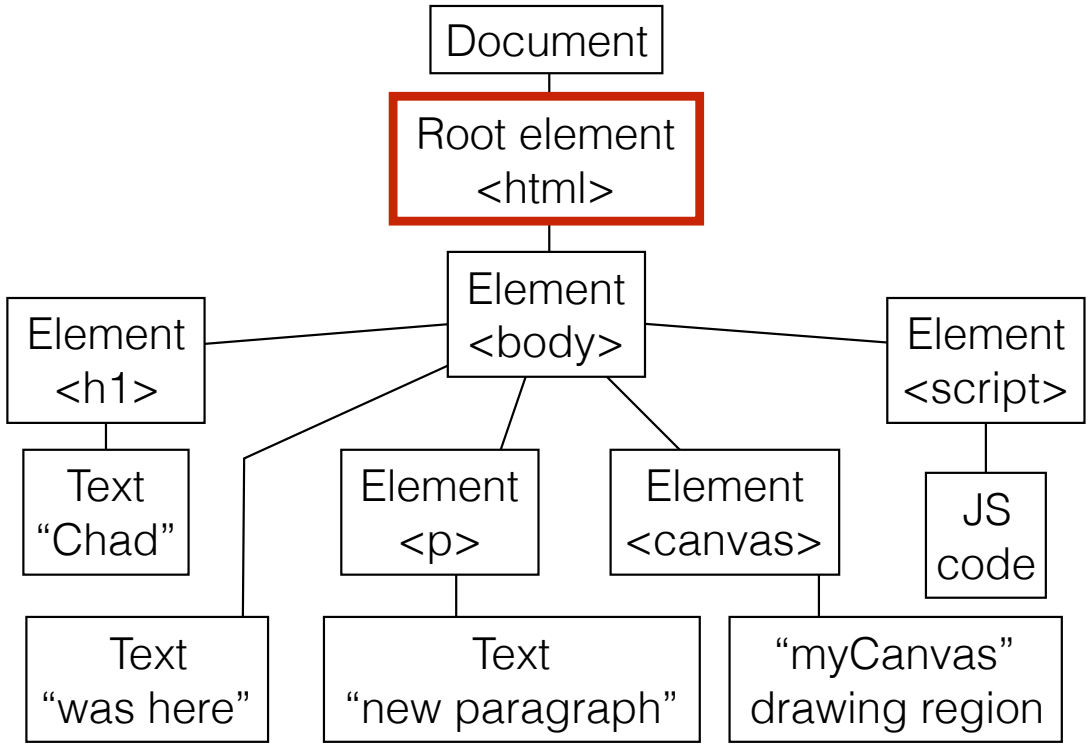


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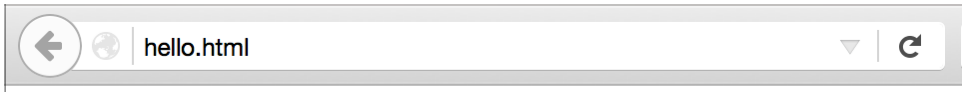

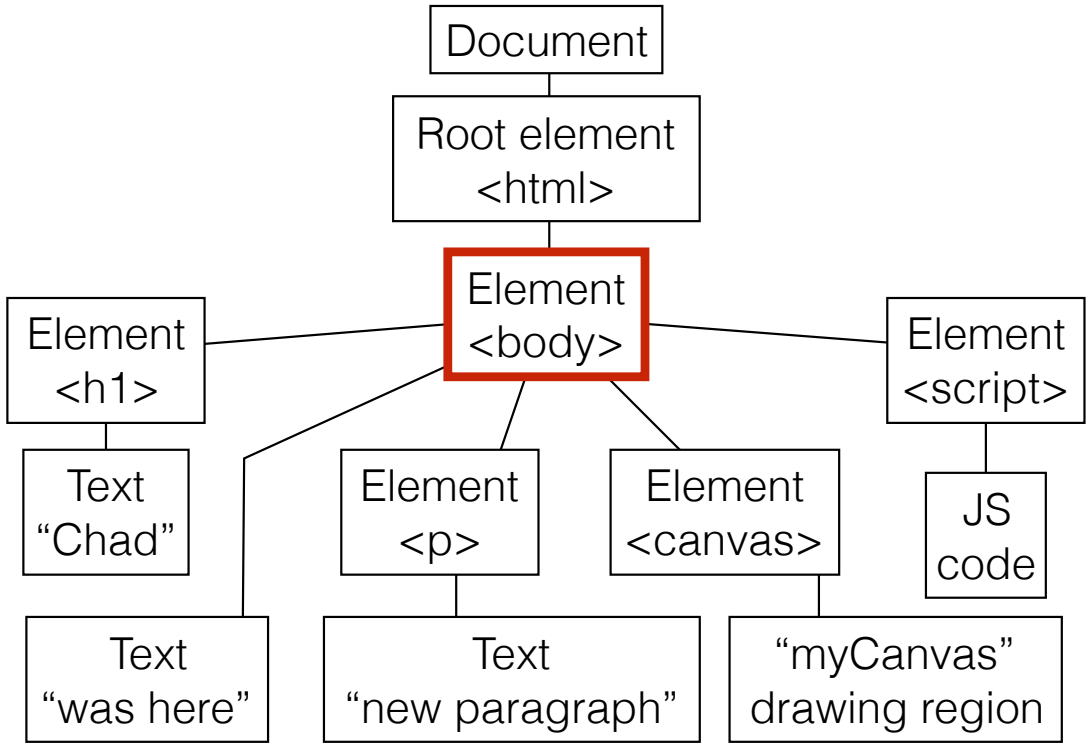


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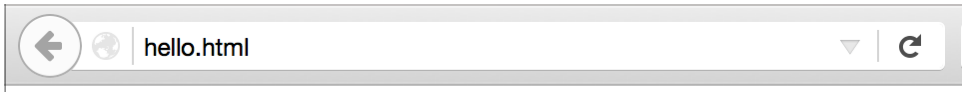

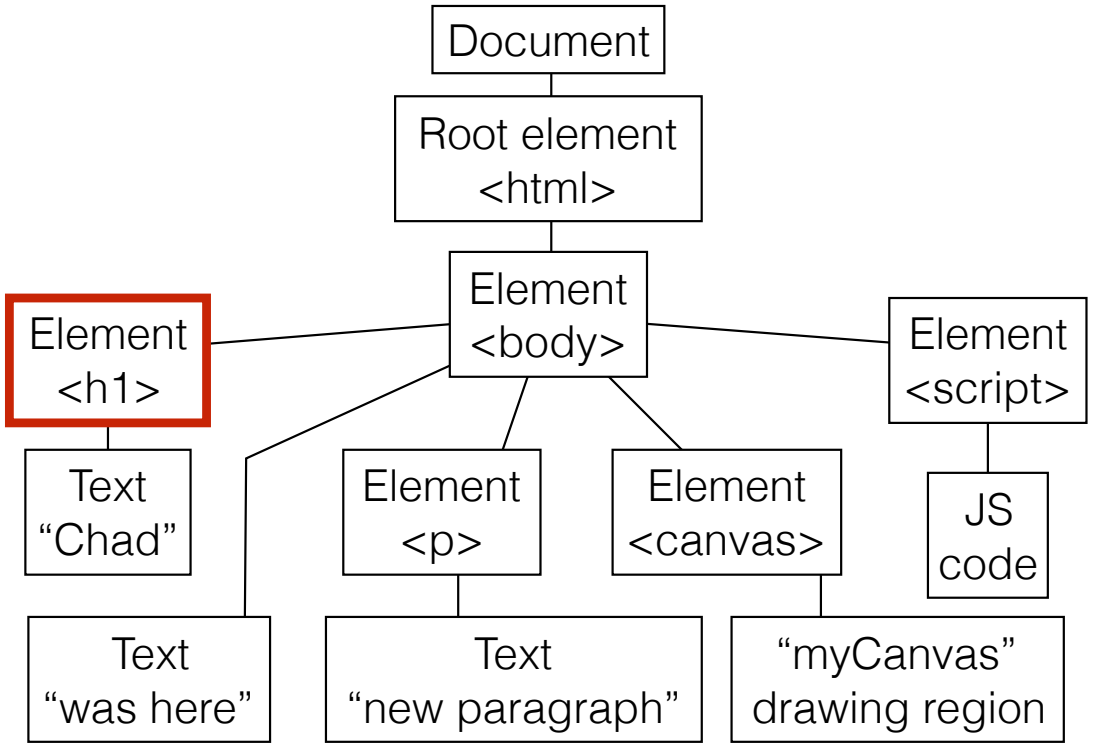


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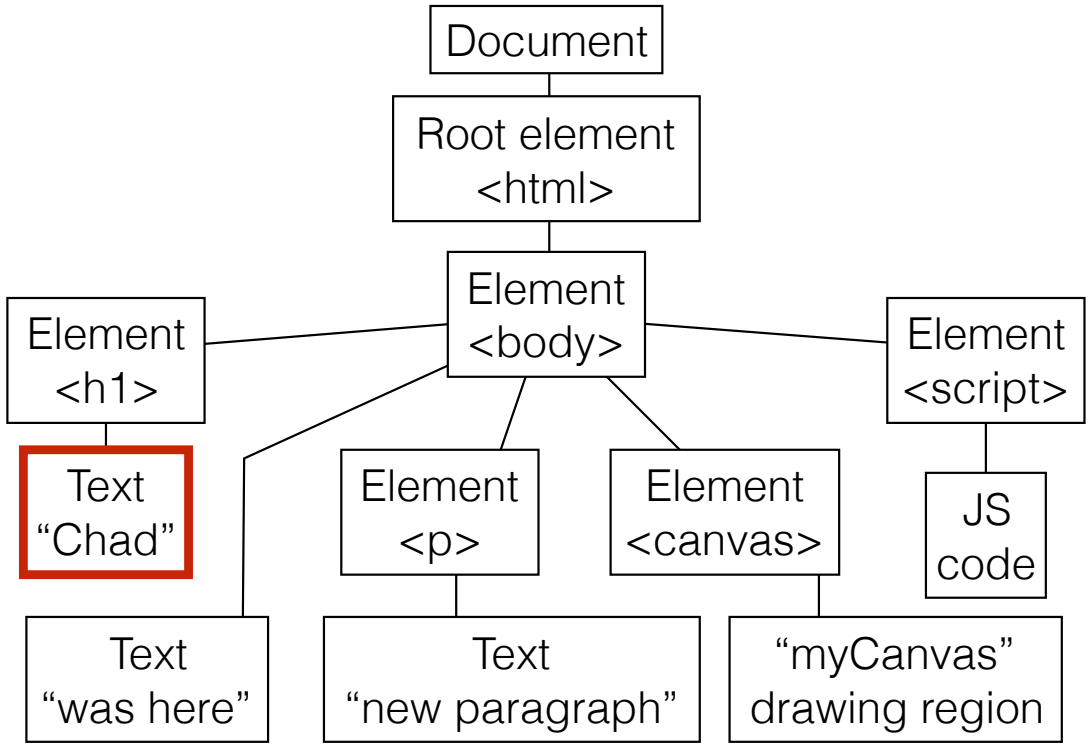


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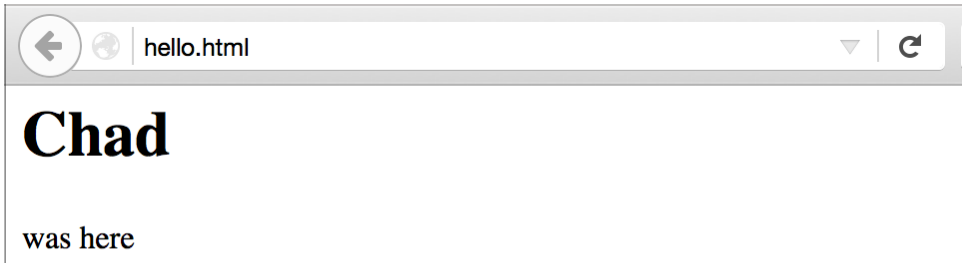
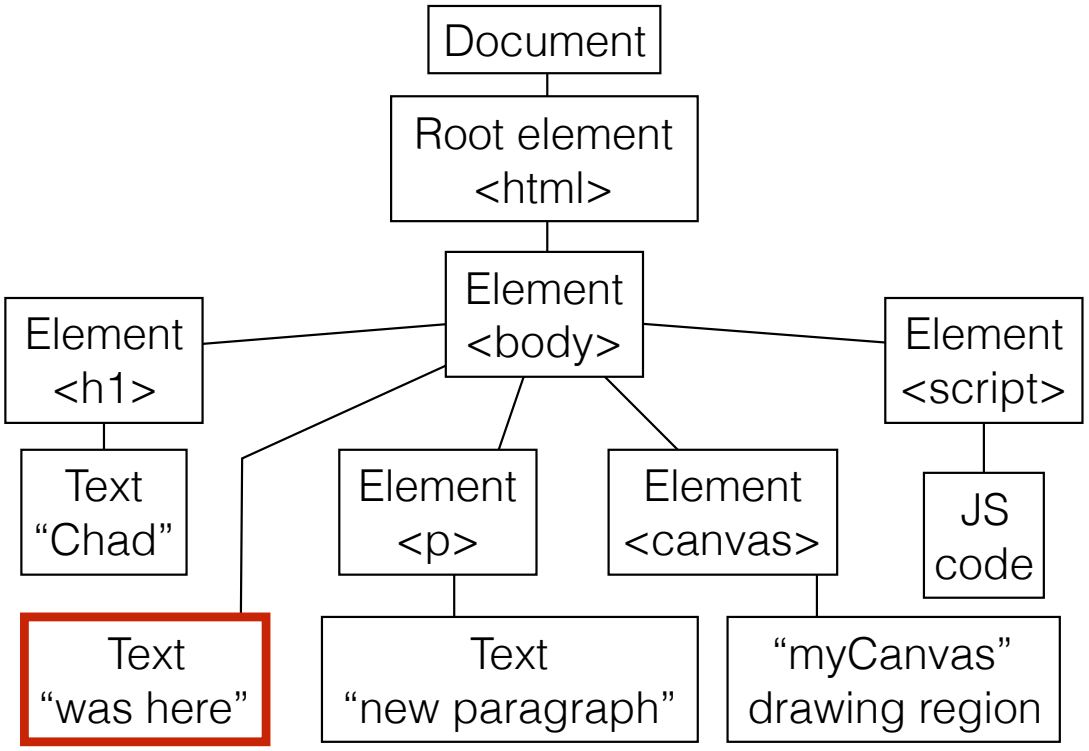
```

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 -->
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<!-- create an element with JavaScript code to execute -->
<script>
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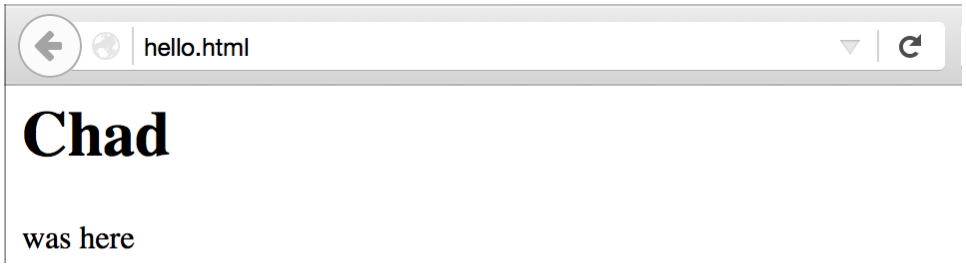
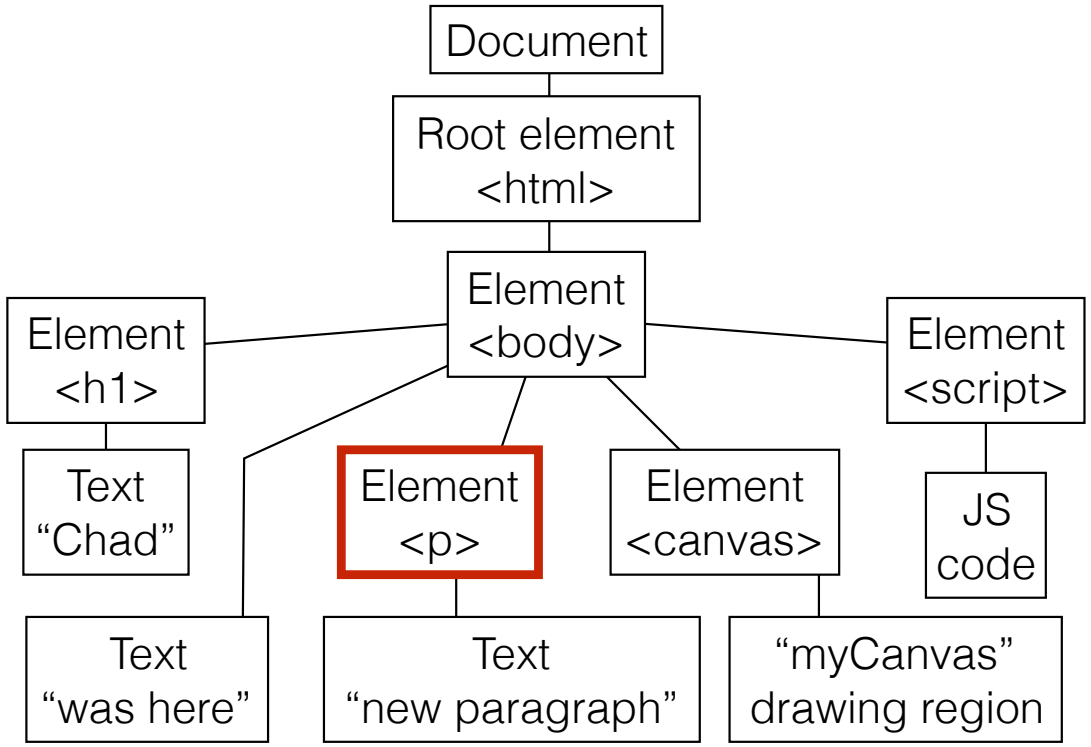
   // grab the canvas drawing context
   var ctx = canvas.getContext("2d");

   // 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



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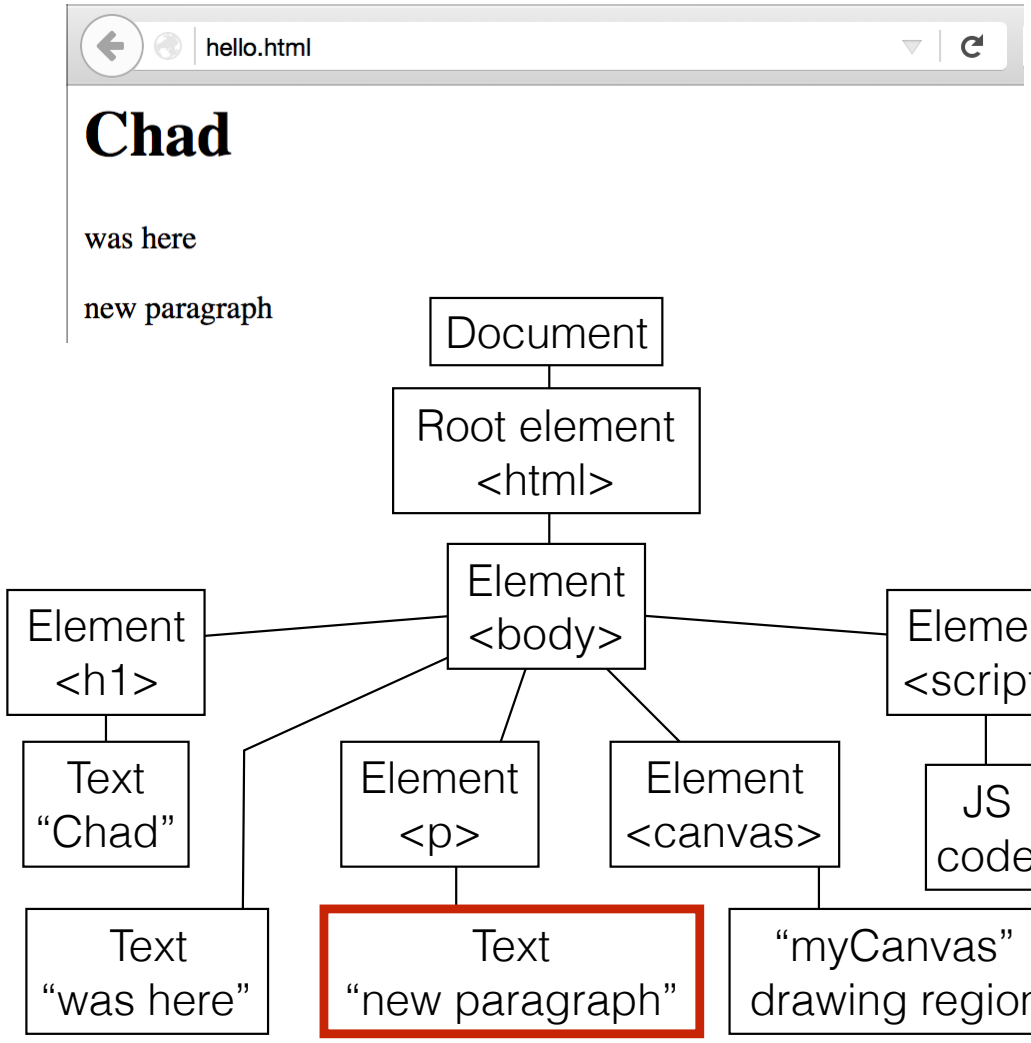


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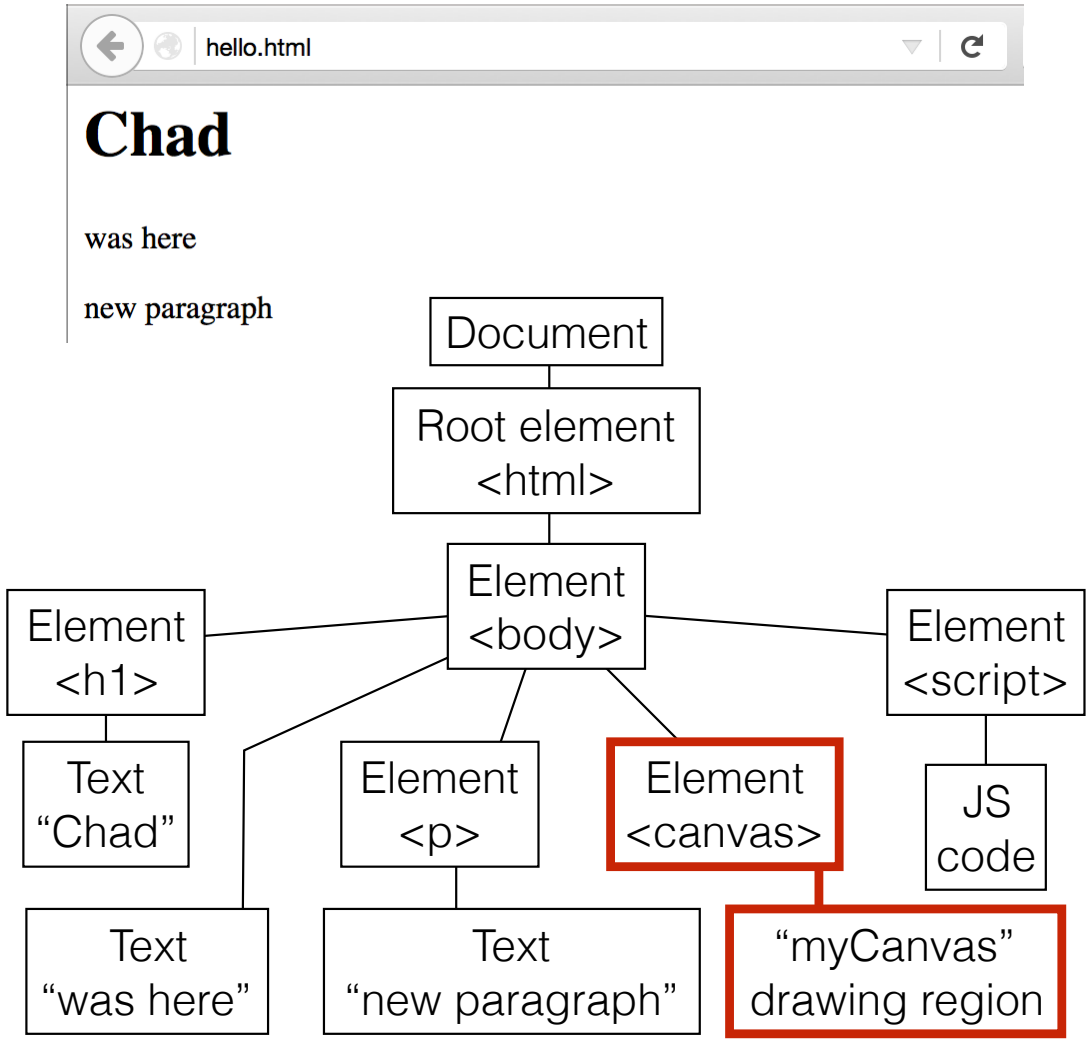


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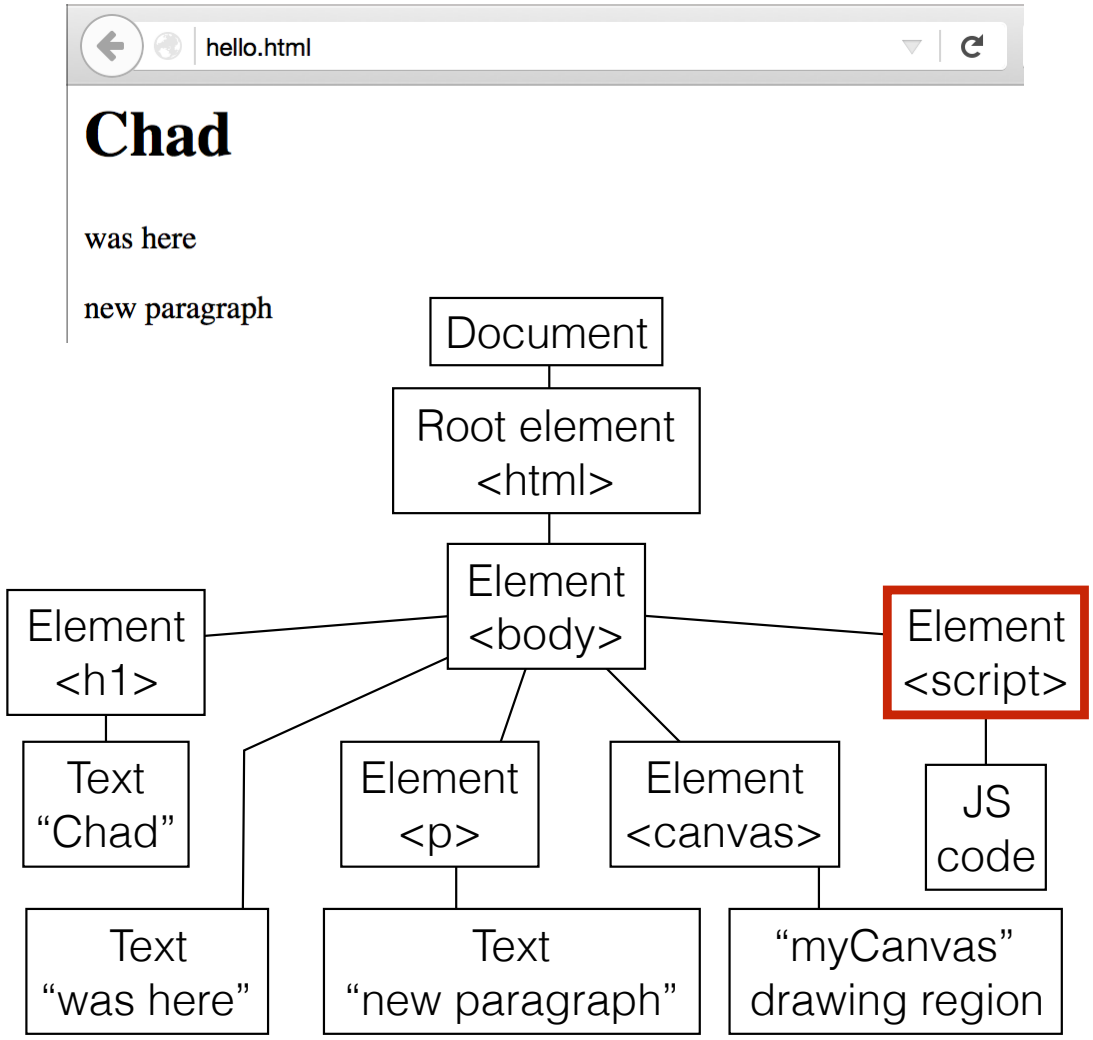


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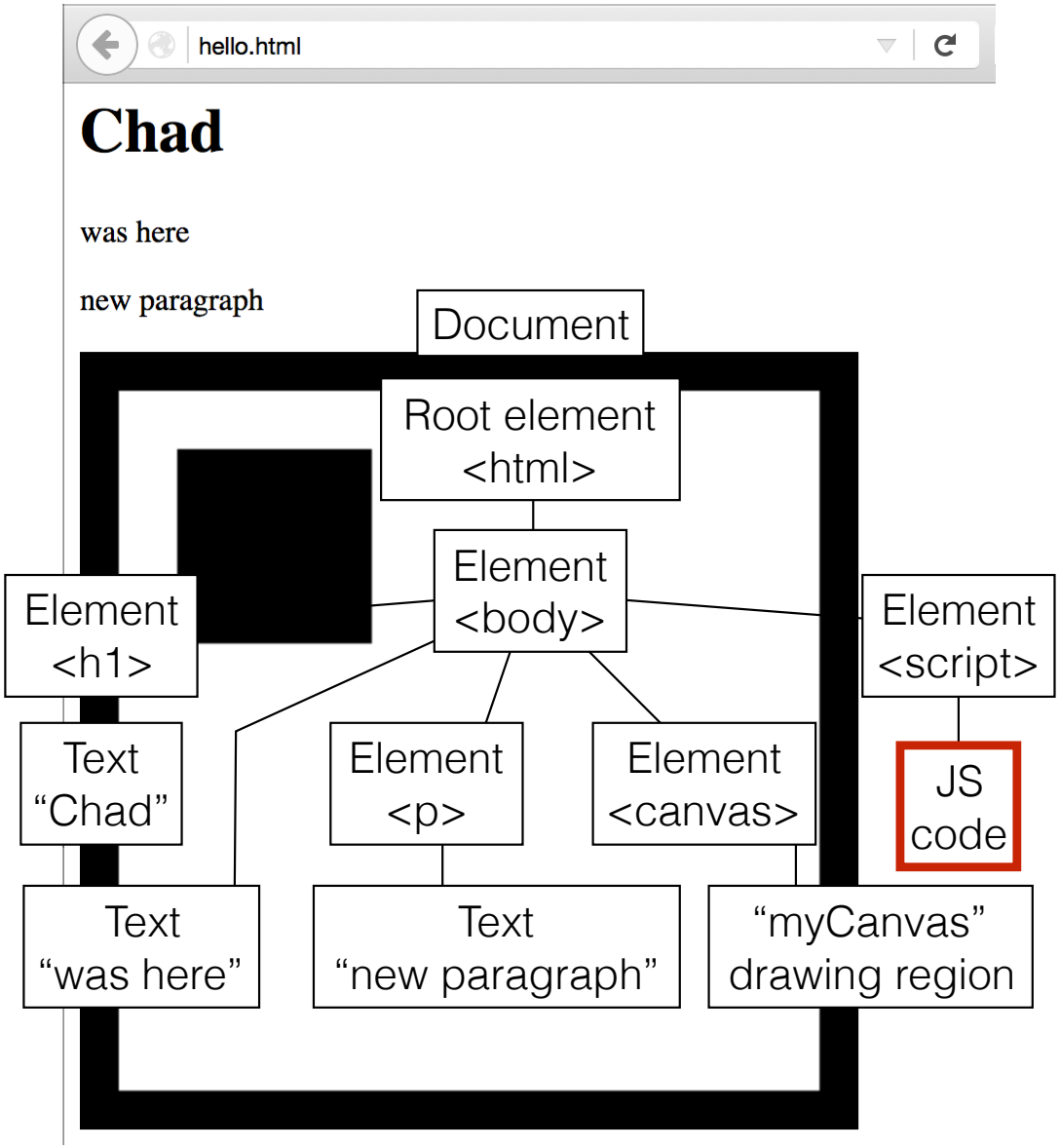


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   ctx.fillRect(0,380,400,20);
   ctx.fillRect(380,0,20,400);
</script>
</body> </html>
```

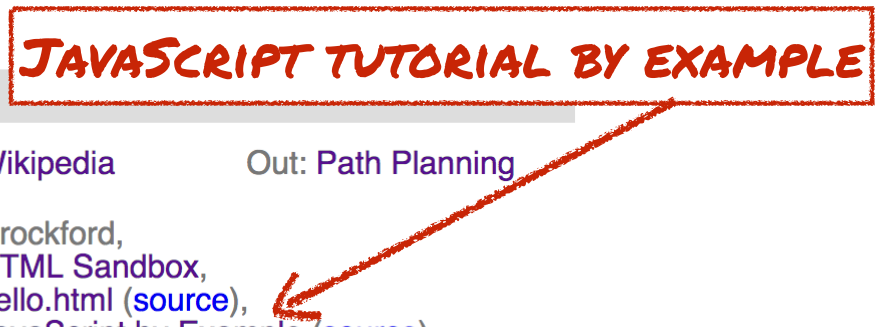
hello.html file

JavaScript:
the quick and dirty

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 Corke Ch.1	Setup git repository
	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		




autorob.org/examples/js_overview.html
Search
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 string_containing_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

view-source:http://autorob.org/examples/js_over

Search

```html
<!--|\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/|
|\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/|
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    tutorialJSCoding | HTML front page

    Quick JavaScript Code-by-Example Tutorial

    @author ohseejay / https://github.com/ohseejay
                     / https://bitbucket.org/ohseejay

    Chad Jenkins
    Laboratory for Perception RObotics and Grounded REasoning Systems
    University of Michigan

    License: Michigan Honor License

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\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\-->

<!-- IMPORTANT: Remember to open the console

     For this tutorial, it will be very helpful to open the "console" for
     introspection of variables and other items in the browser run-time
     environment.  At the time this code was written, the console can be
     opened from the keyboard:

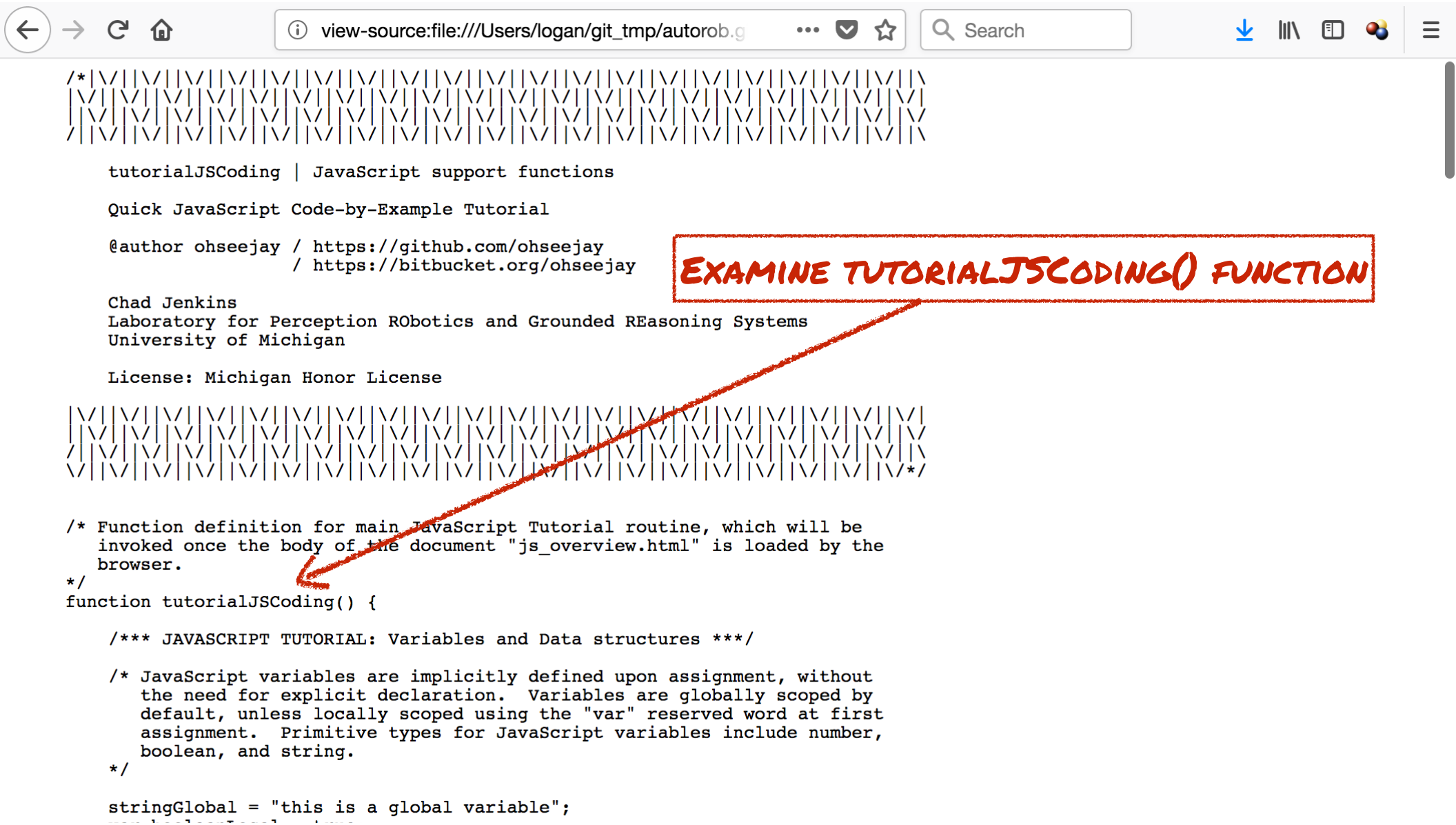
     Firefox Web Console: Control-Shift-K or (Mac OS X) Option-Command-K;
     Chrome JavaScript Console: Control-Shift-J or (Mac OS X) Option-Command-J;
     Opera Developer Tools: Control-Shift-I or (Mac OS X) Option-Command-I
     Safari Web Inspector: Option-Command-I (after enabling Develop mode)
     Internet Explorer Developer Tools: F12
-->

<!-- DOCTYPE specifies of the document type as HTML -->
<!DOCTYPE html>

<!-- Start tag for the HTML document -->
```

```
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-i
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




```
/*|\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\
|\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/|
||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/
/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\

    tutorialJSCoding | JavaScript support functions

    Quick JavaScript Code-by-Example Tutorial

    @author ohseejay / https://github.com/ohseejay
                     / https://bitbucket.org/ohseejay

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/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\
\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\/||\*/


/* Function definition for main JavaScript Tutorial routine, which will be
   invoked once the body of the document "js_overview.html" is loaded by the
   browser.
*/
function tutorialJSCoding() {

    /*** JAVASCRIPT TUTORIAL: Variables and Data structures ***/

    /* JavaScript variables are implicitly defined upon assignment, without
       the need for explicit declaration.  Variables are globally scoped by
       default, unless locally scoped using the "var" reserved word at first
       assignment.  Primitive types for JavaScript variables include number,
       boolean, and string.
    */

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

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

VARIABLE NAME	VARIABLE VALUE
stringGlobal	“this is a global variable”

```
var booleanLocal = true;
```

ASSIGNS BOOLEAN VALUE OF TRUE IN A VARIABLE NAMED BOOLEANLOCAL

VARIABLE NAME	VARIABLE VALUE
booleanLocal	true

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

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

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

JavaScript Object Notation (JSON)

- Objects in JavaScript can be alternatively assigned through JSON https://en.wikipedia.org/wiki/JSON

The same object created through JavaScript statements and separately in JSON

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myObject = {};  // objects can also be created dynamically

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myObject.course_number = 367;  // this variable is of type "number"
```

```
myObject = {
    university : "Michigan",
    department : "EECS",
    course_number : 367
}
```

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

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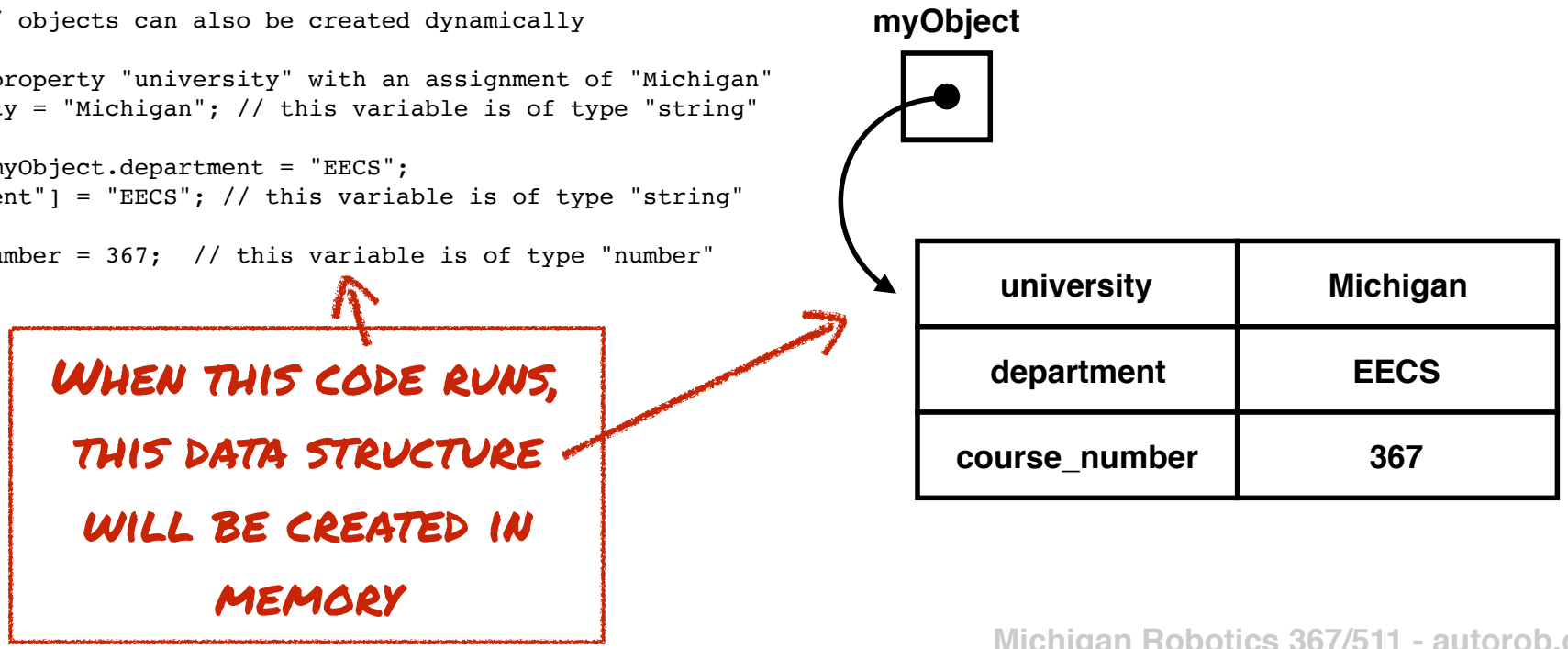

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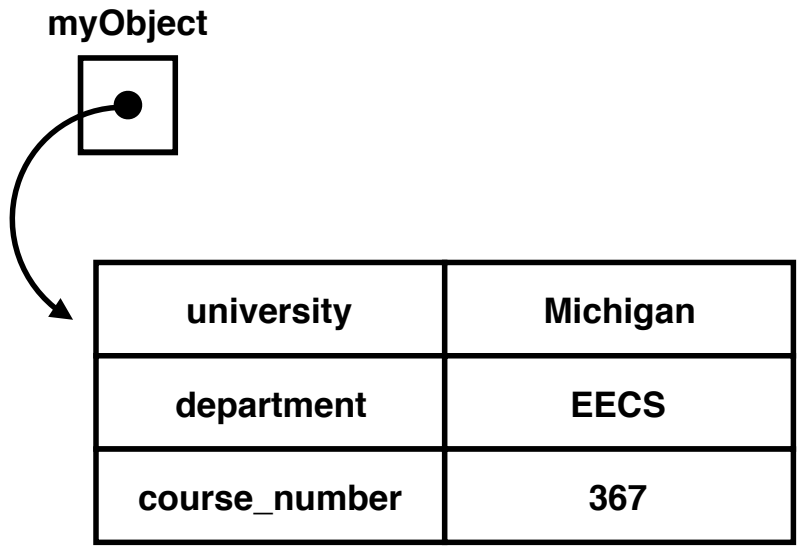
myObject.course_number = 367;  // this variable is of type "number"
```

```
copiedObject = myObject;
```

WHAT WILL HAPPEN WE ASSIGN THIS STRUCTURE TO A NEW VARIABLE?



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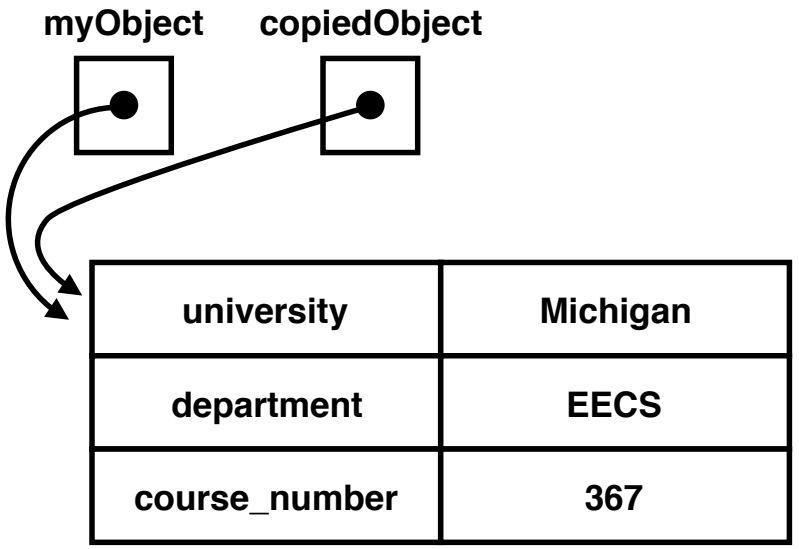

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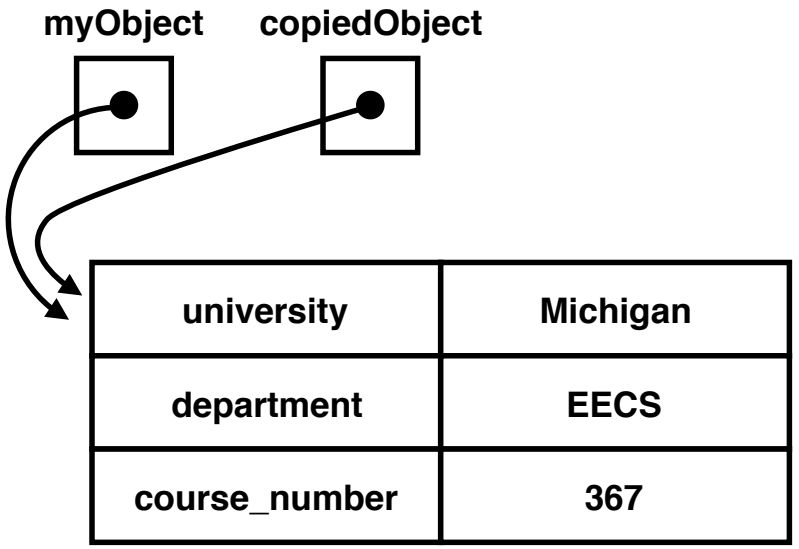
myObject["department"] = "EECS"; // this variable is of type "string"

myObject.course_number = 367;  // this variable is of type "number"

 copiedObject = myObject;
```

```
copiedObject.course_number = 567;
```

WHAT WILL HAPPEN WE MODIFY THE NEW VARIABLE?



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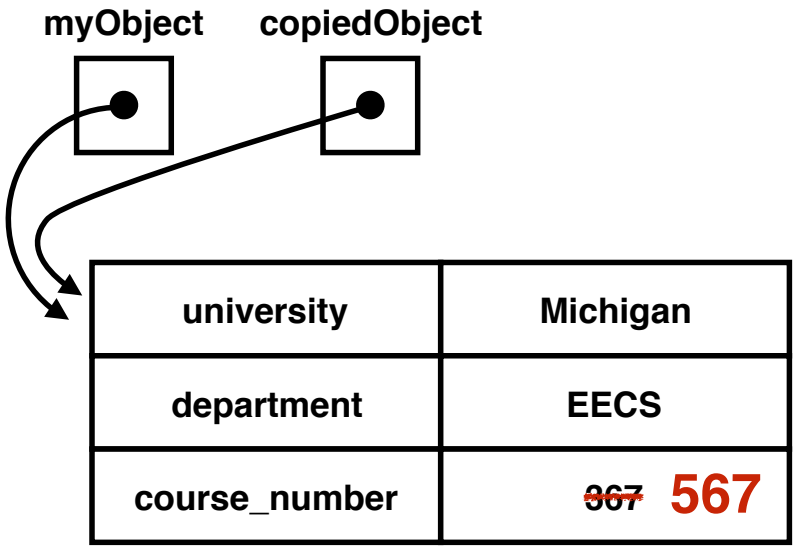
myObject.course_number = 367;  // this variable is of type "number"

 copiedObject = myObject;
```

```
copiedObject.course_number = 567;
```

WHAT WILL HAPPEN WE MODIFY THE NEW VARIABLE?



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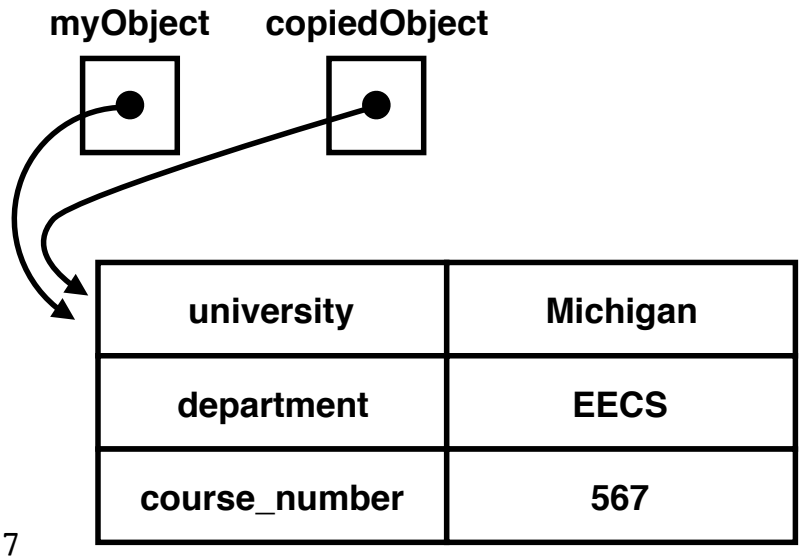
// equivalent to myObject.department = "EECS";
myObject["department"] = "EECS"; // this variable is of type "string"

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
```

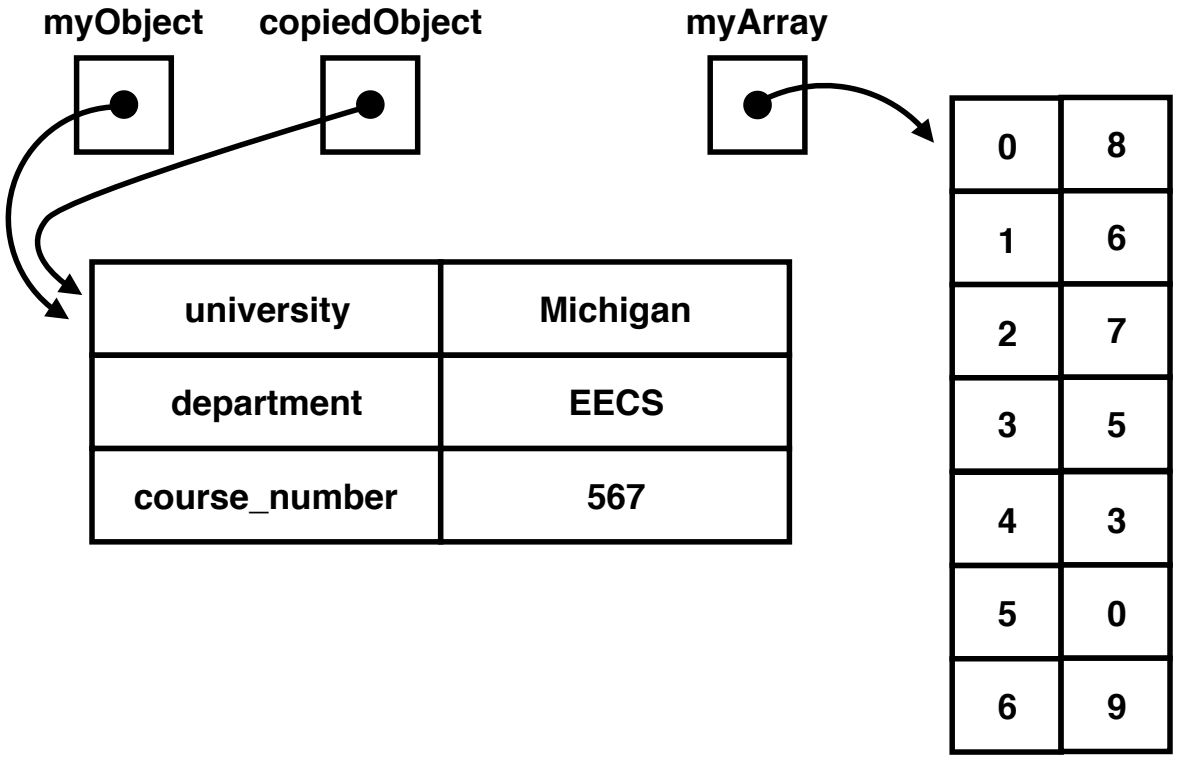


THIS RESULT CAN BE VERIFIED IN THE BROWSER CONSOLE

Arrays

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

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

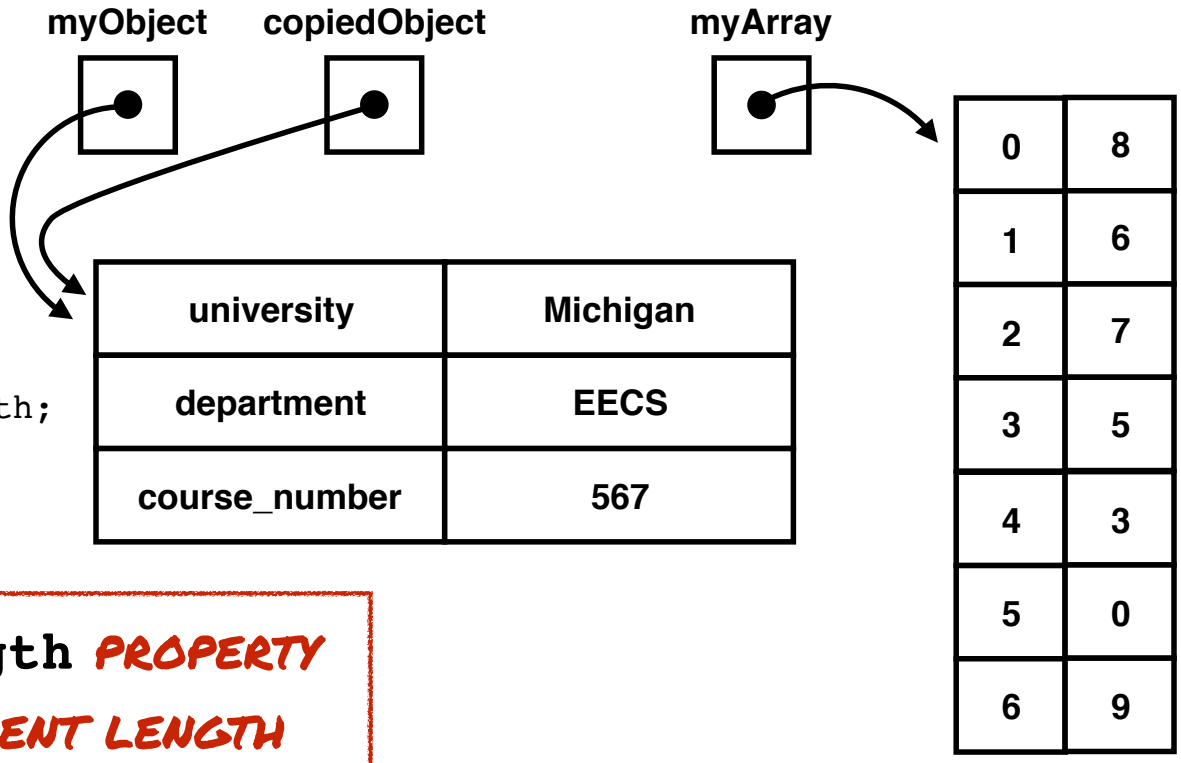


Arrays

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

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

// this statement will output 7
numberOfArrayElements = myArray.length;
```



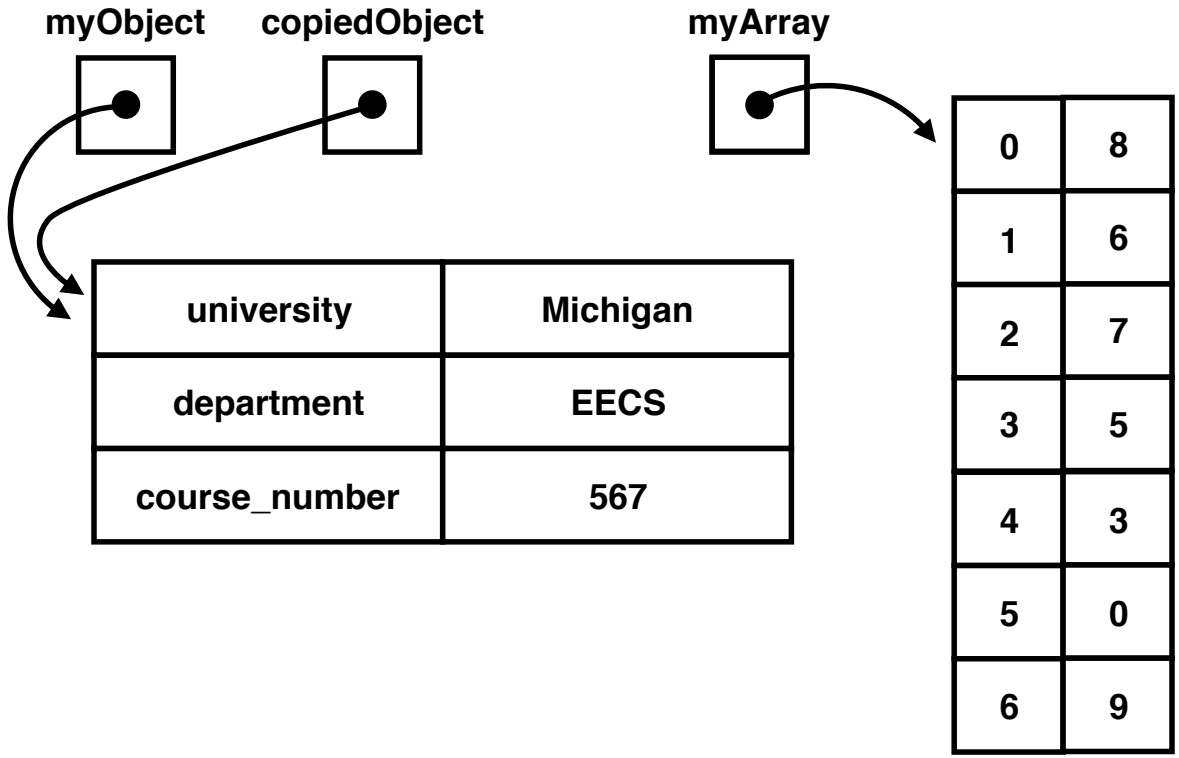
ALL ARRAYS HAVE A `.length` PROPERTY THAT MAINTAINS ITS CURRENT LENGTH

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;
```



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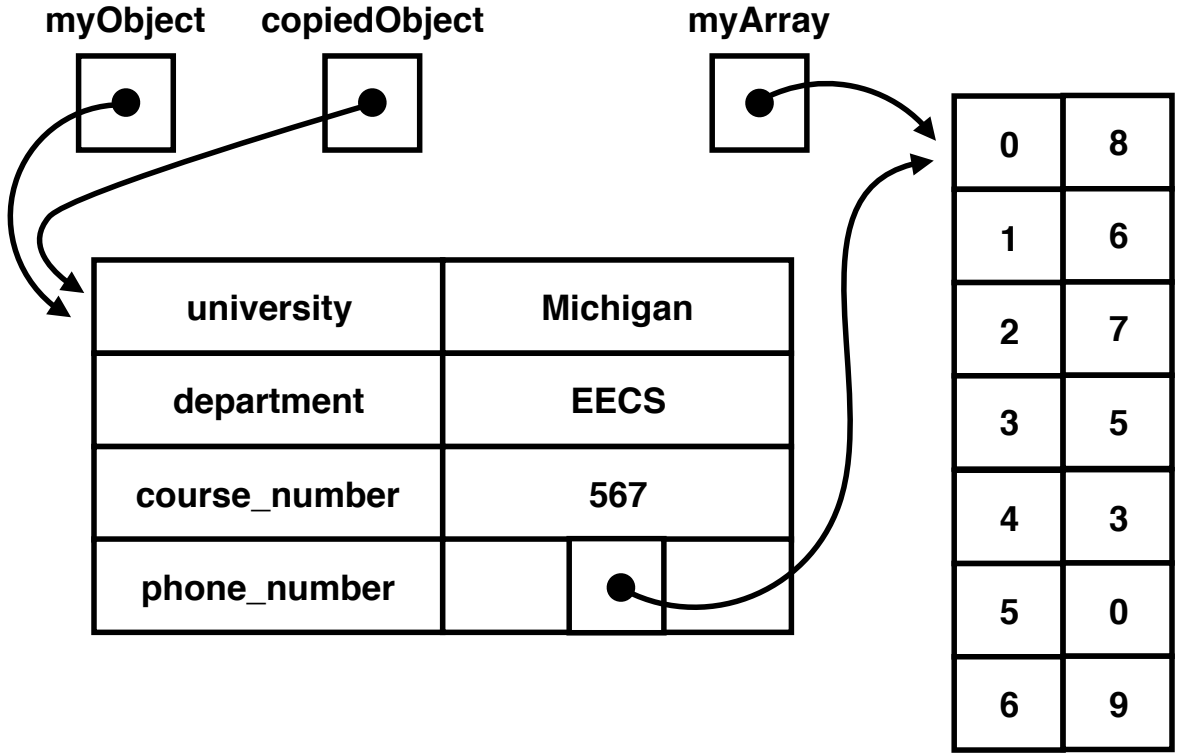


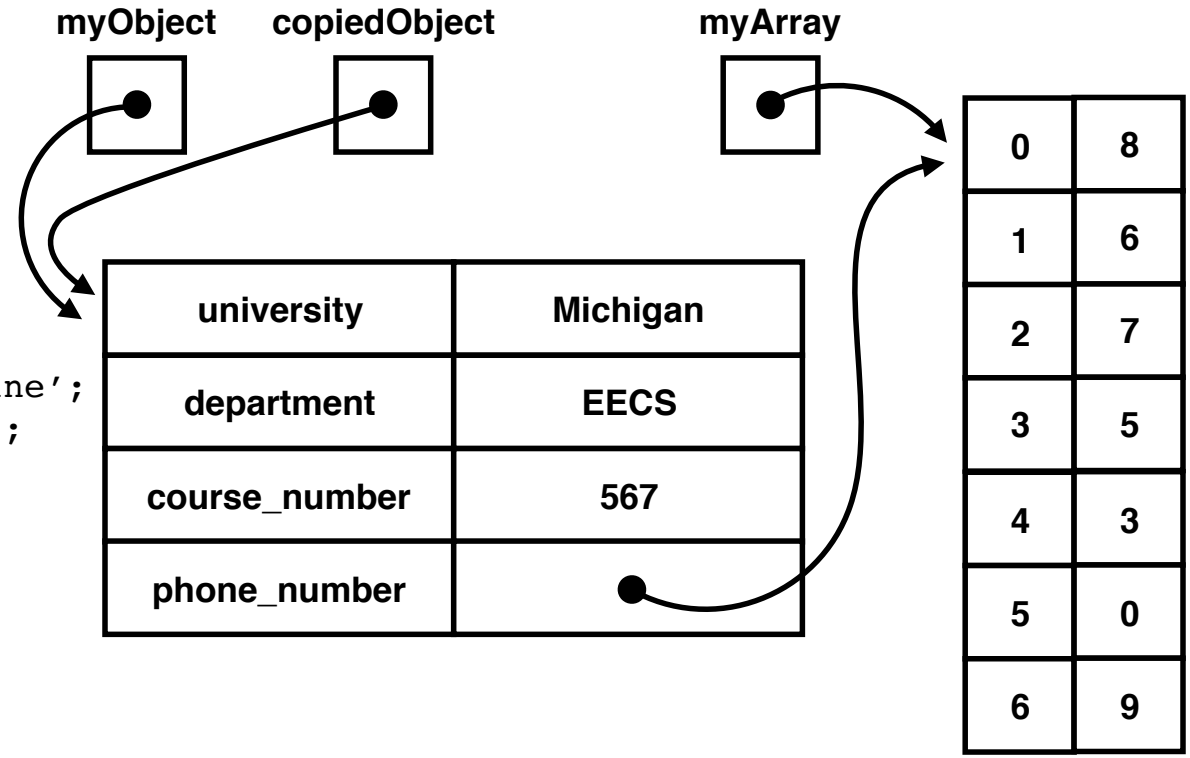
Dynamic Typing

- 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';
```



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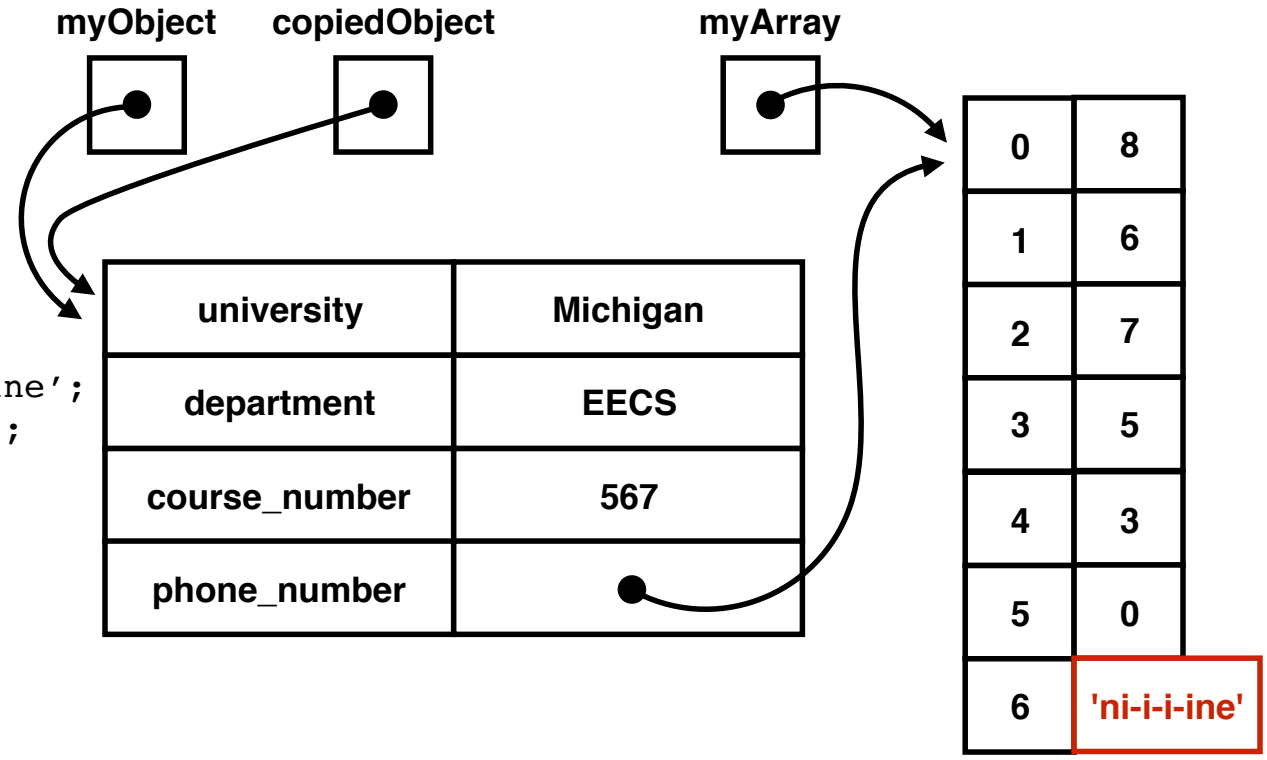

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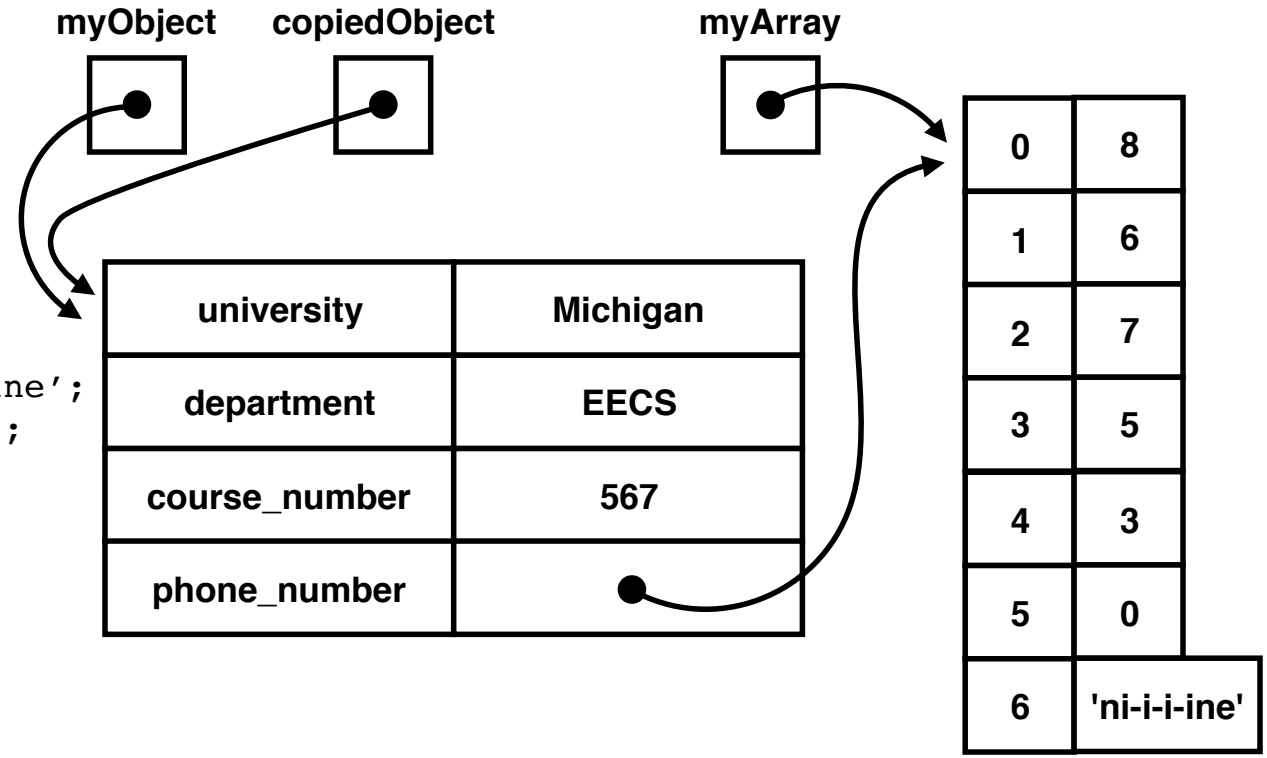
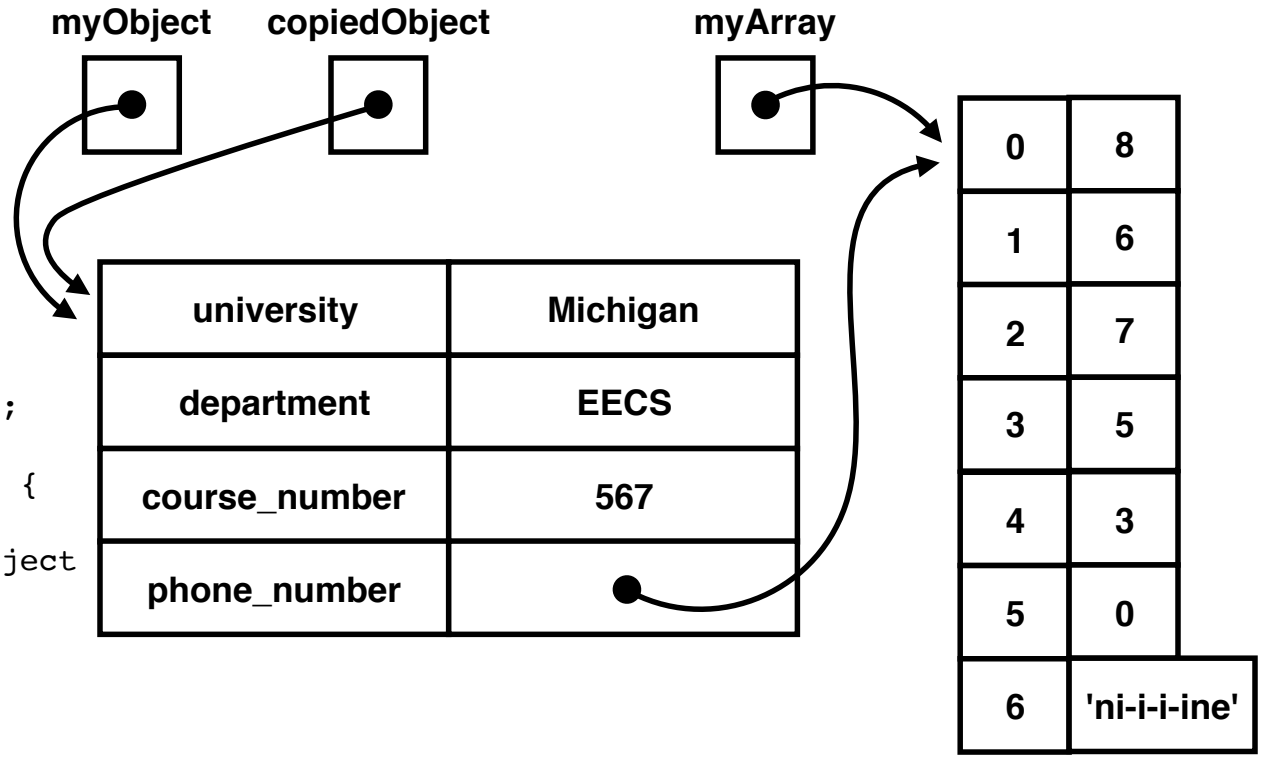


Control Statements

- 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-ine
}

// output the course section to console
if (myObject.course_number ≡≡≡ 367) {
    console.log('undergraduate section');
}
else if (myObject.course_number === 567) {
    console.log('old graduate section');
    // console will output this for myObject
}
else {
    console.log('ROB 511 is awesome');
}
```



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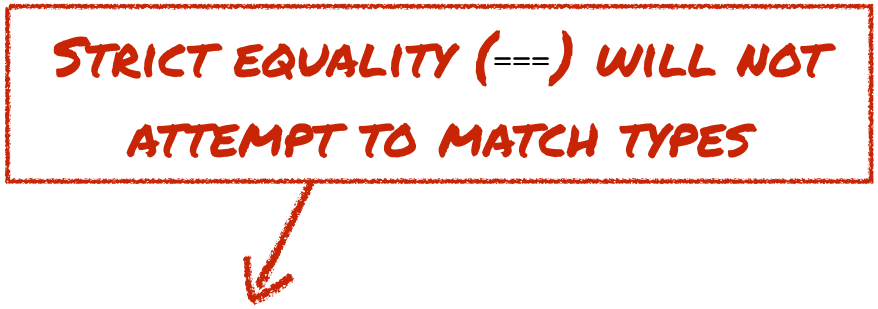
  - increment/decrement: `++` increment variable, `--` decrement variable
  - arithmetic: `*` multiplication, `/` division, `%` modulus, `+` addition/concatenation, `-` subtraction
  - comparison: `<` less than, `<=` less than or equal, `>` greater than, `>=` greater than or equal, `==` equality, `!=` inequality, `===` strict equality, `!===` strict inequality, `&&` logical AND, `||` logical OR
  - assignment: `=` assignment, `+=` add to variable, `*=` multiply to variable



Brief Tangent

LaTeX Math Mode

Our default convention for writing mathematical expressions in text.

For example…

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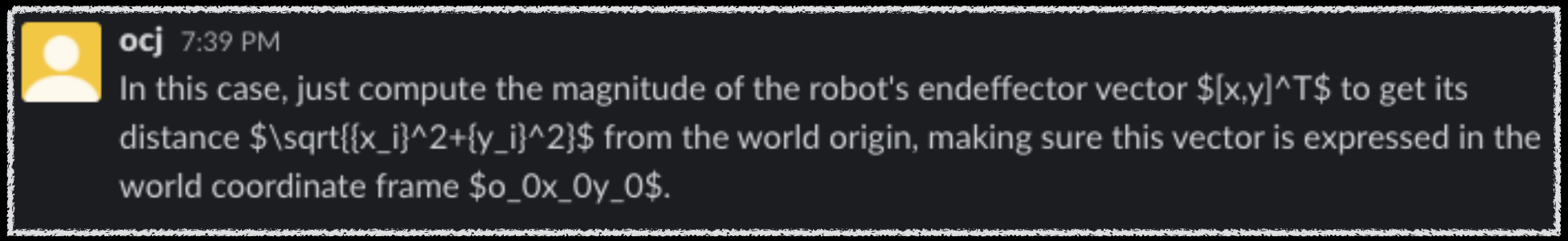
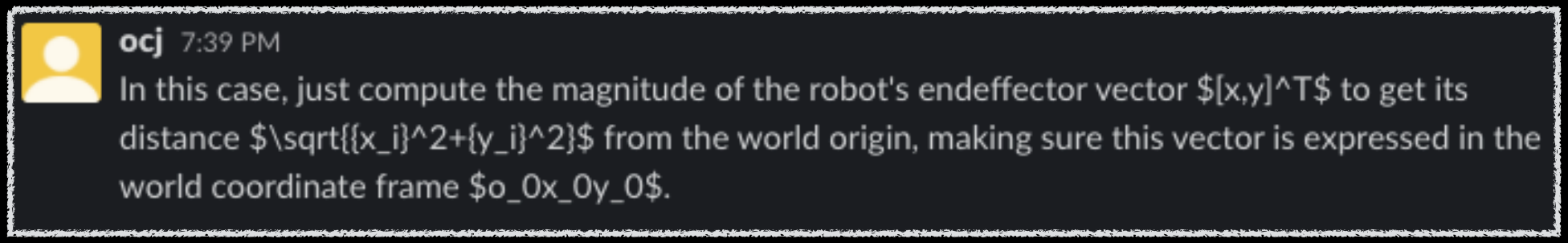

ocj 7:39 PM
In this case, just compute the magnitude of the robot's endeffector vector $[x,y]^T$ to get its distance $\sqrt{{x_i}^2+{y_i}^2}$ from the world origin, making sure this vector is expressed in the world coordinate frame $o_0x_0y_0$.

For example…



is meant to be read as…

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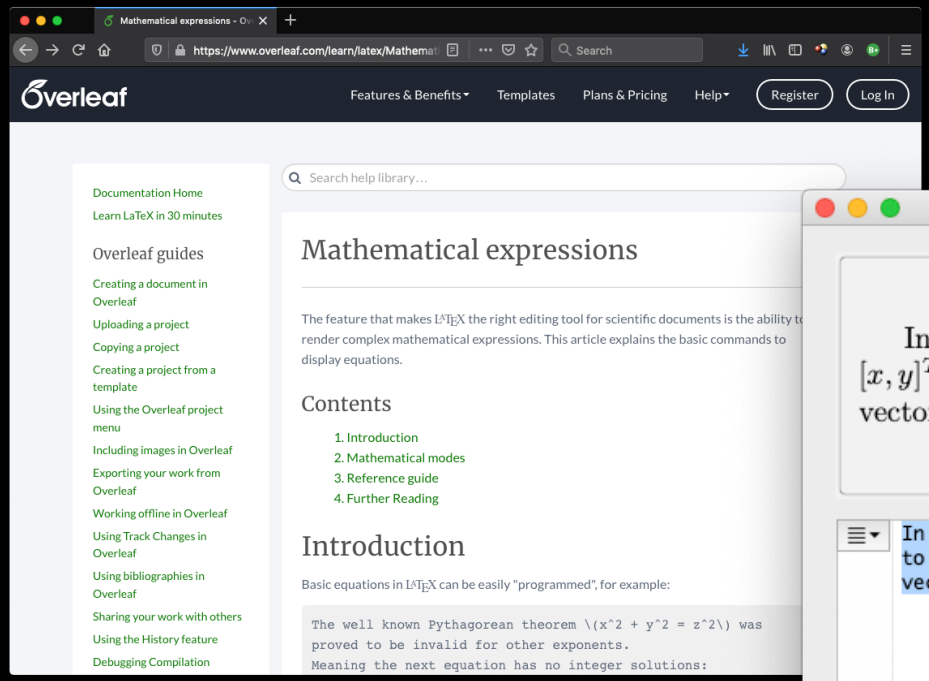
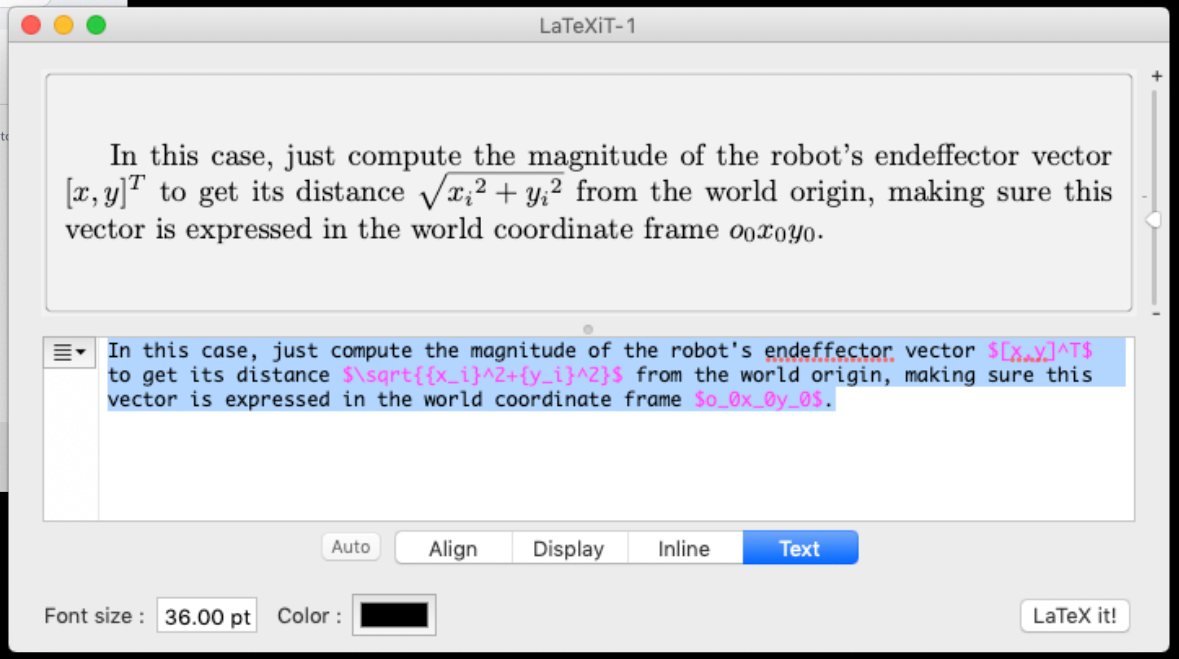
Overleaf LaTeX Math Mode Guide



LaTeXiT Equation Editor



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

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

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  - 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*

```
// define a function to compute the factorial of a number
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 . . .

// evaluate this function of the number 6
factorialNumber = fac(6);  // 720
```

Function call stack

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

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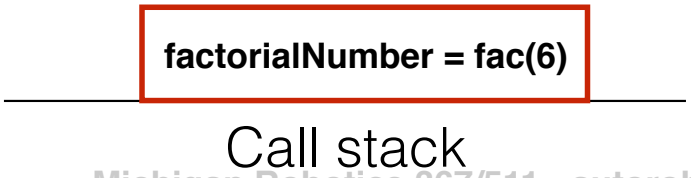
Function call fac(6) stack pushes new local variable scope



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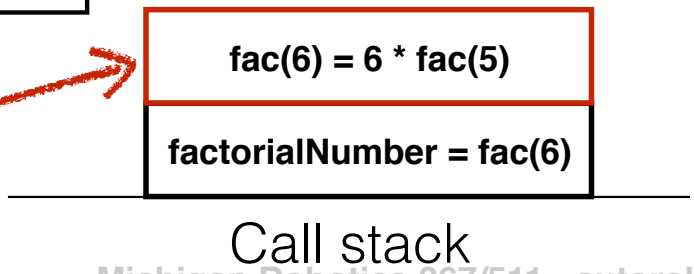
factorialNumber = fac(6);  // 720
```

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



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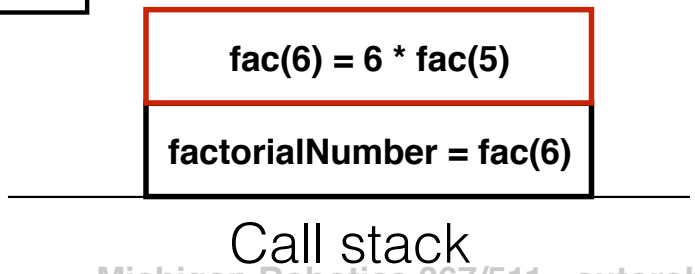
```

RECURSIVE CALL FAC(5) PUSHES NEW LOCAL VARIABLE SCOPE



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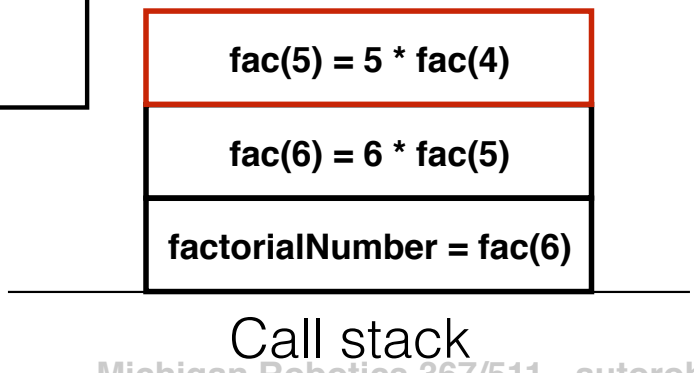

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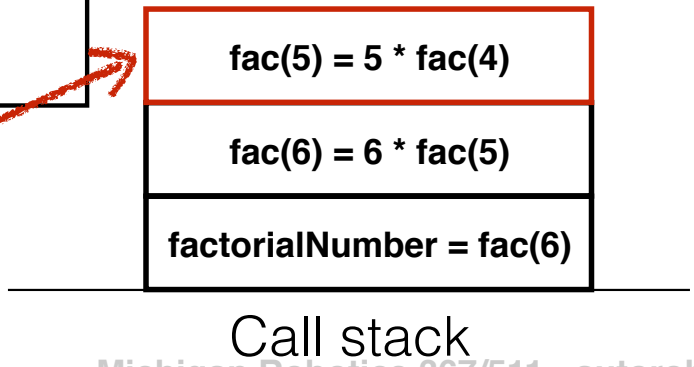
```

inputNumber variable in fac(5) is different variable than inputNumber in fac(6)



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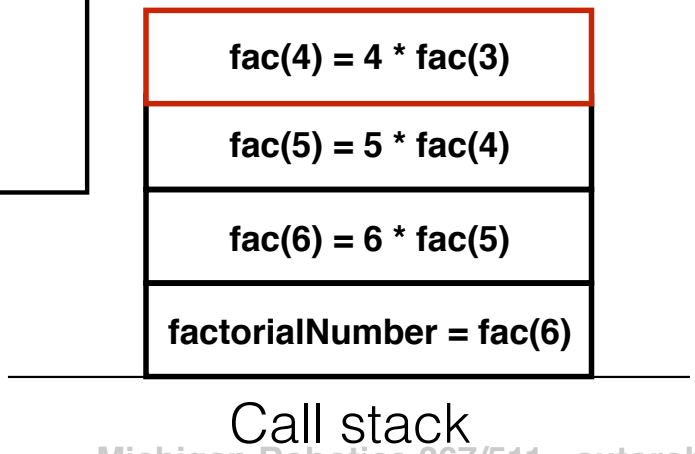
RECURSIVE CALL FAC(4) PUSHES NEW LOCAL VARIABLE SCOPE



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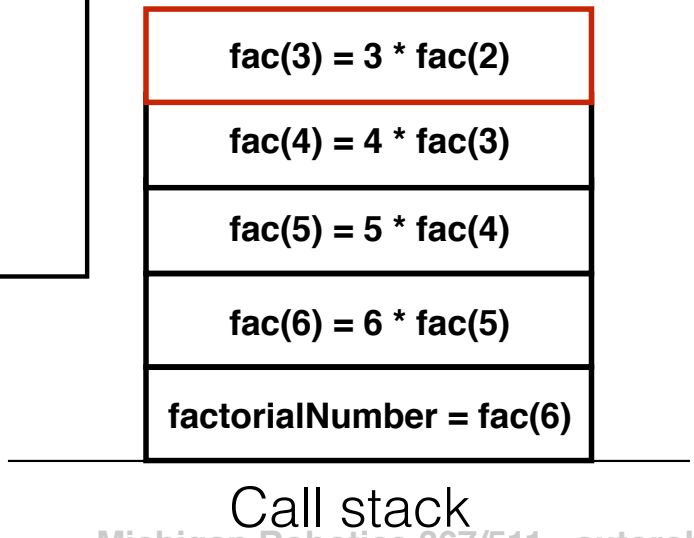
RECURSIVE CALL FAC(3) PUSHES NEW LOCAL VARIABLE SCOPE



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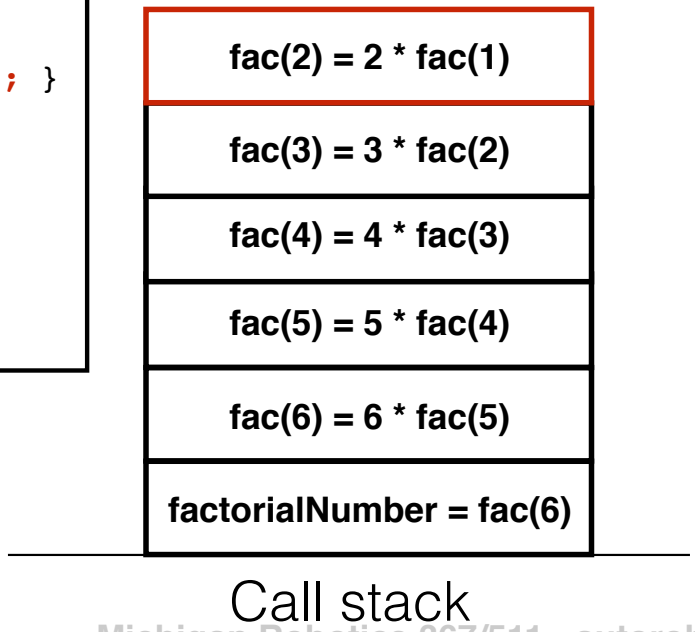

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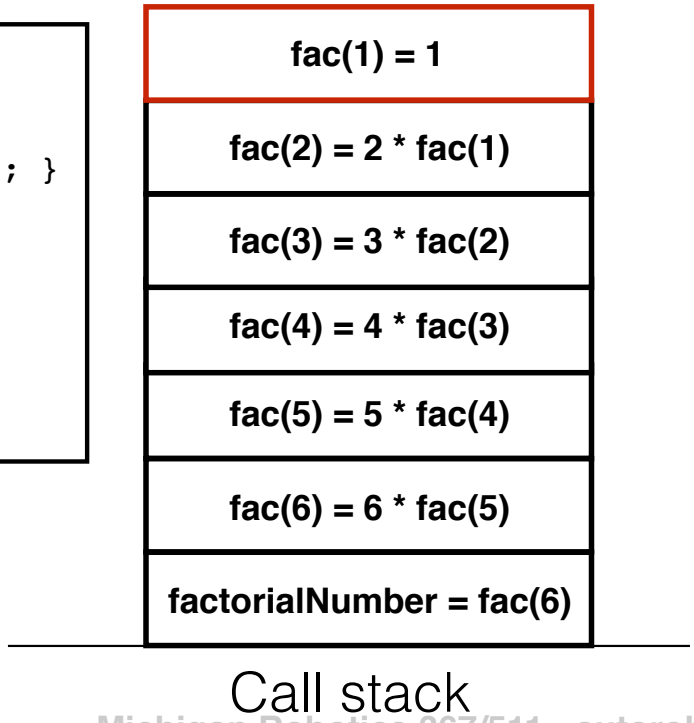
```

RECURSIVE CALLS STOP WHEN BASE CONDITION ENCOUNTERED



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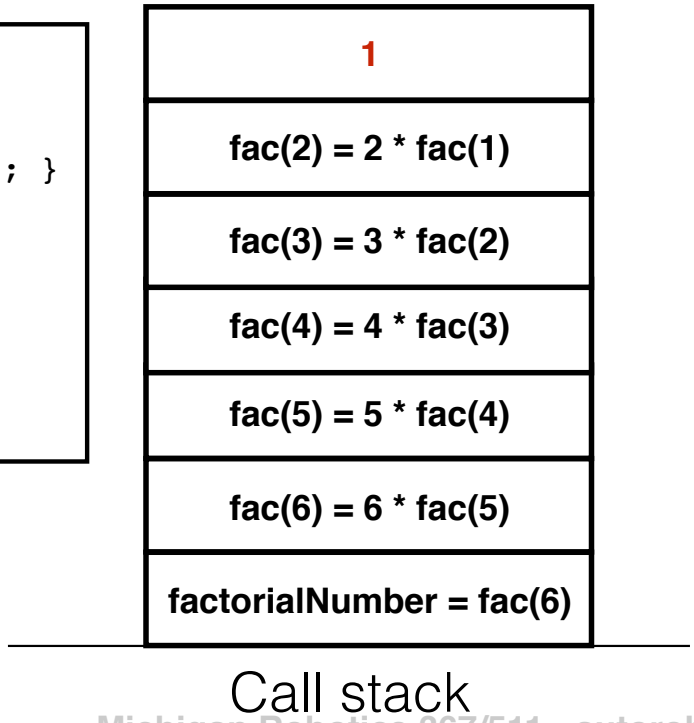

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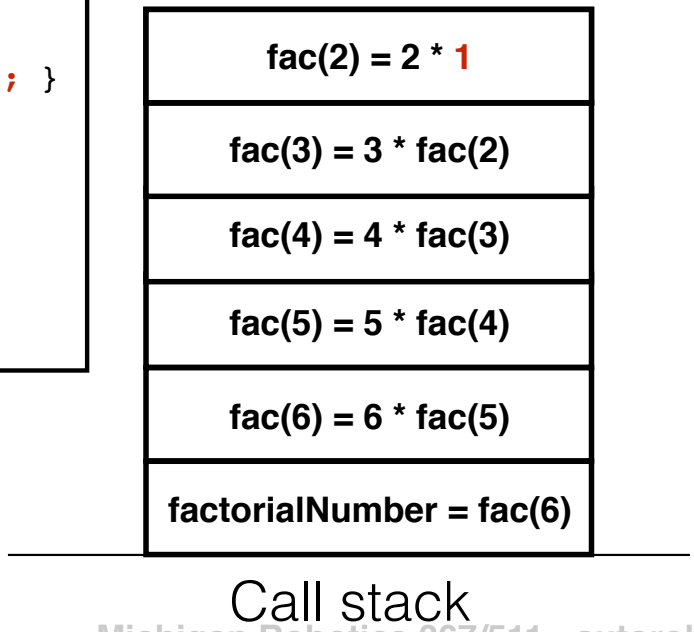

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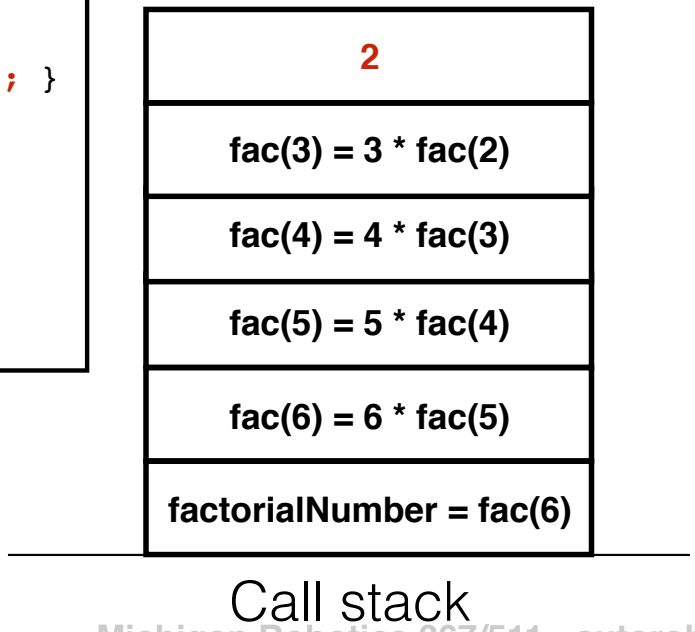

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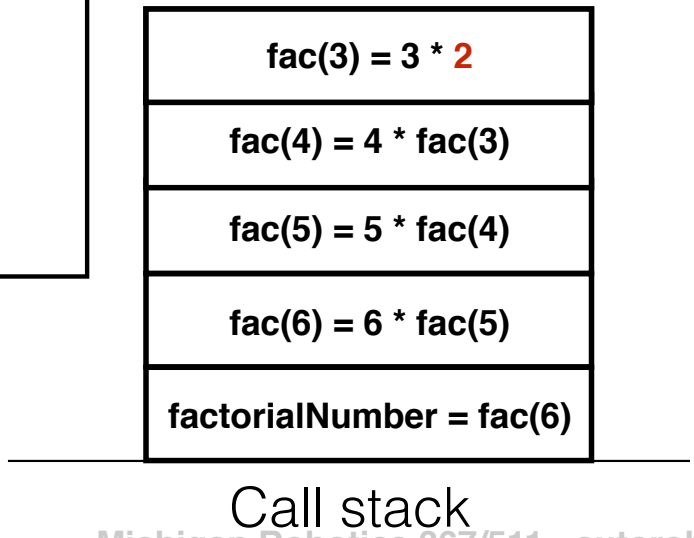

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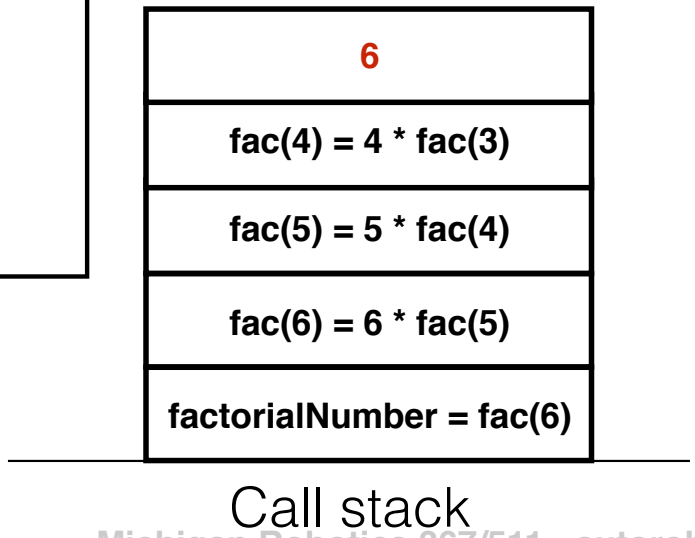

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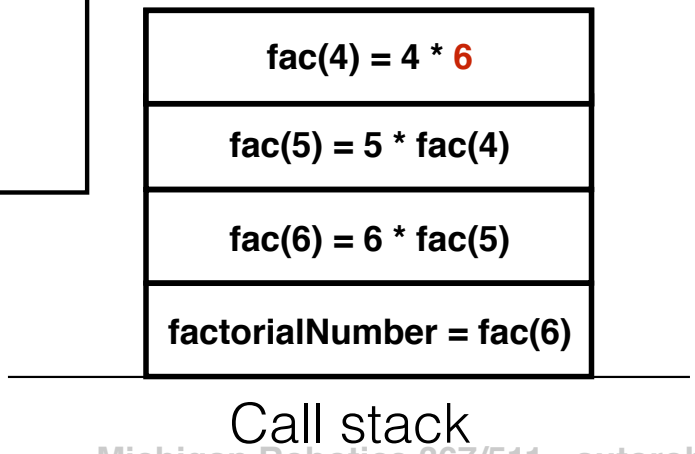

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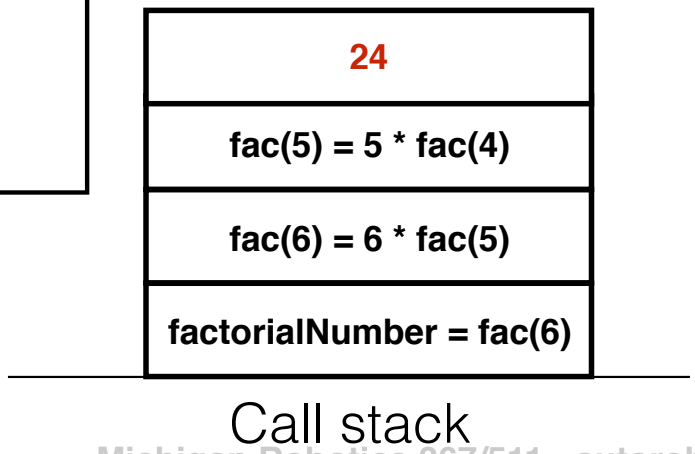
// evaluate this function of the number 6
factorialNumber = fac(6);  // 720
```



Function call stack

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

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// define a function to compute the factorial of a number
fac = function factorialFunction(inputNumber) {
   if (inputNumber > 1) // recursive case
       { return inputNumber * factorialFunction(inputNumber-1); }
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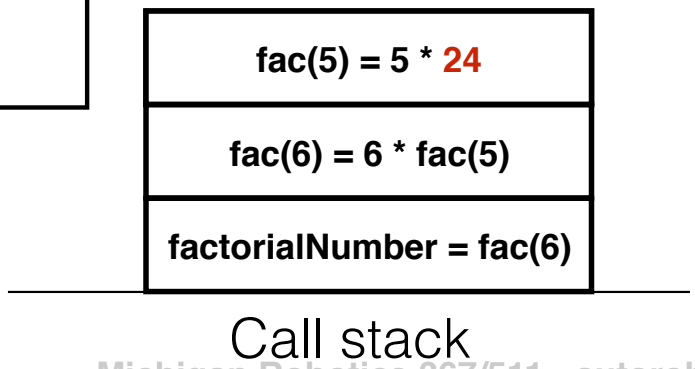

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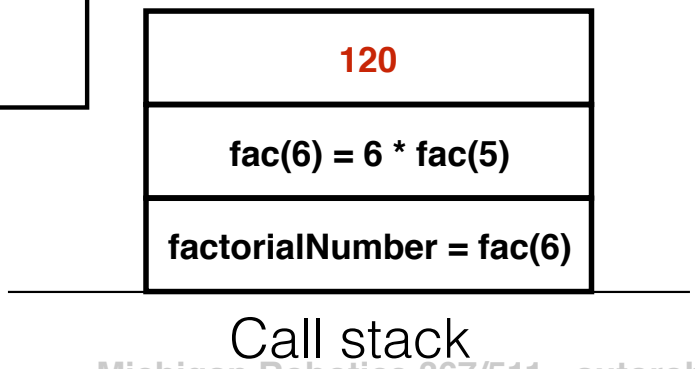

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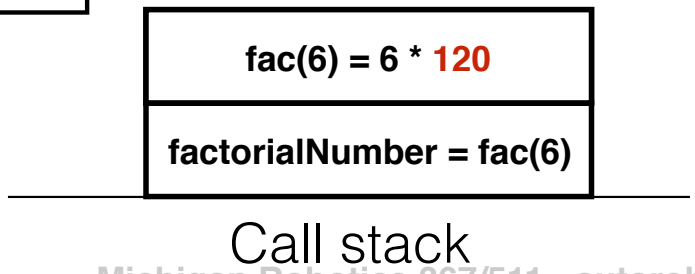

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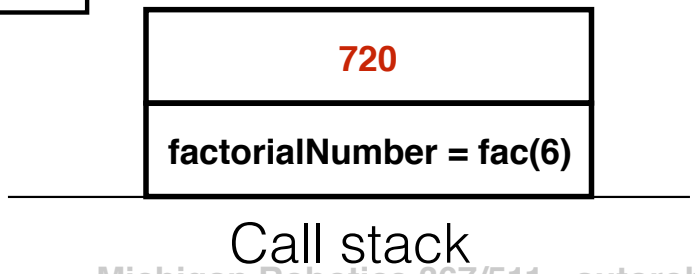

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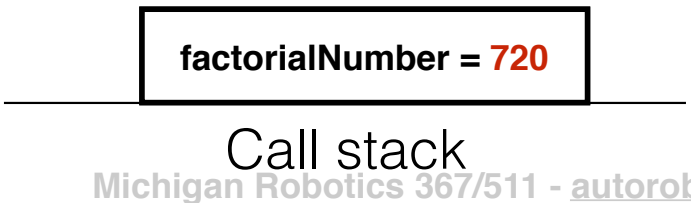
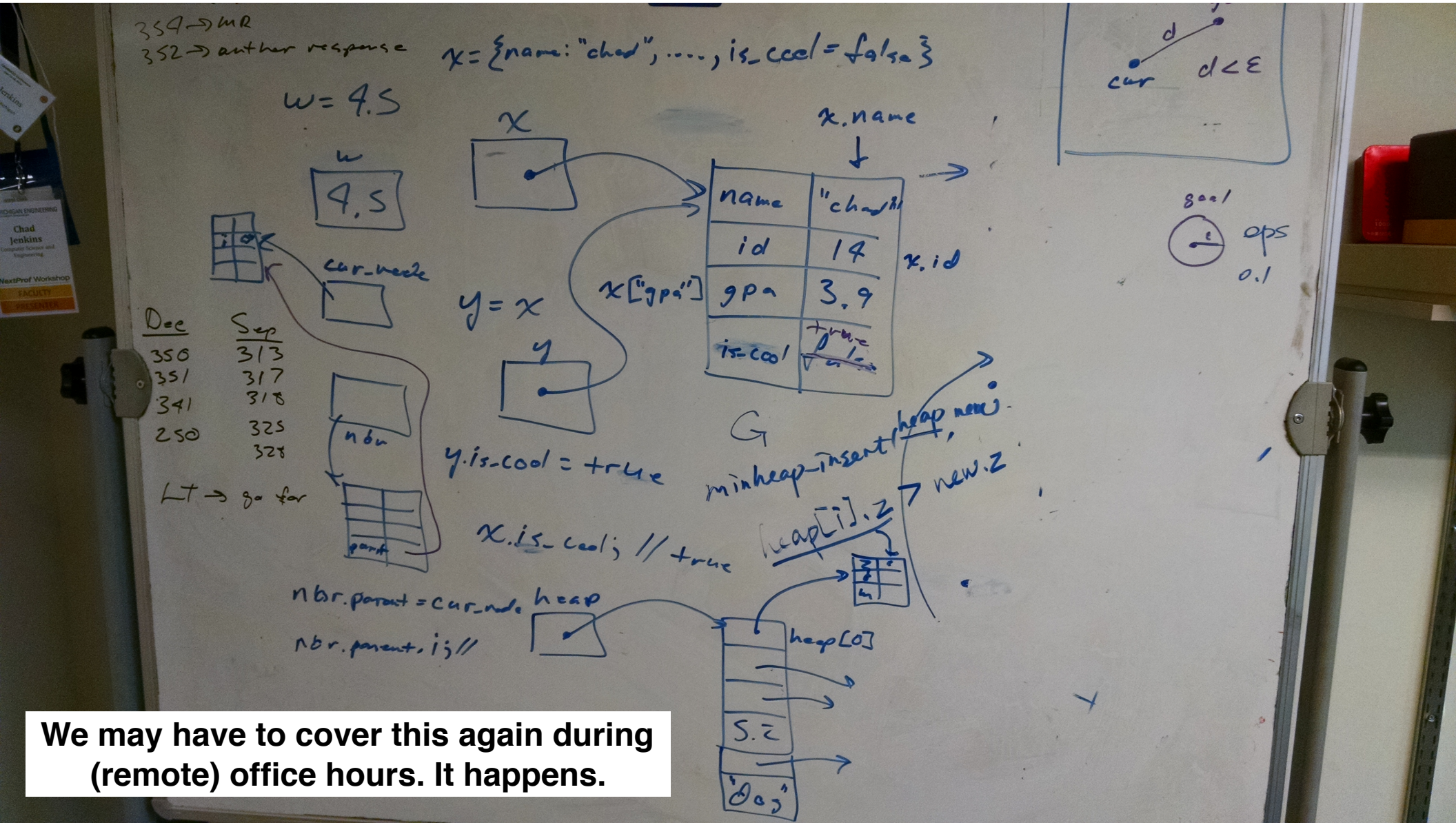


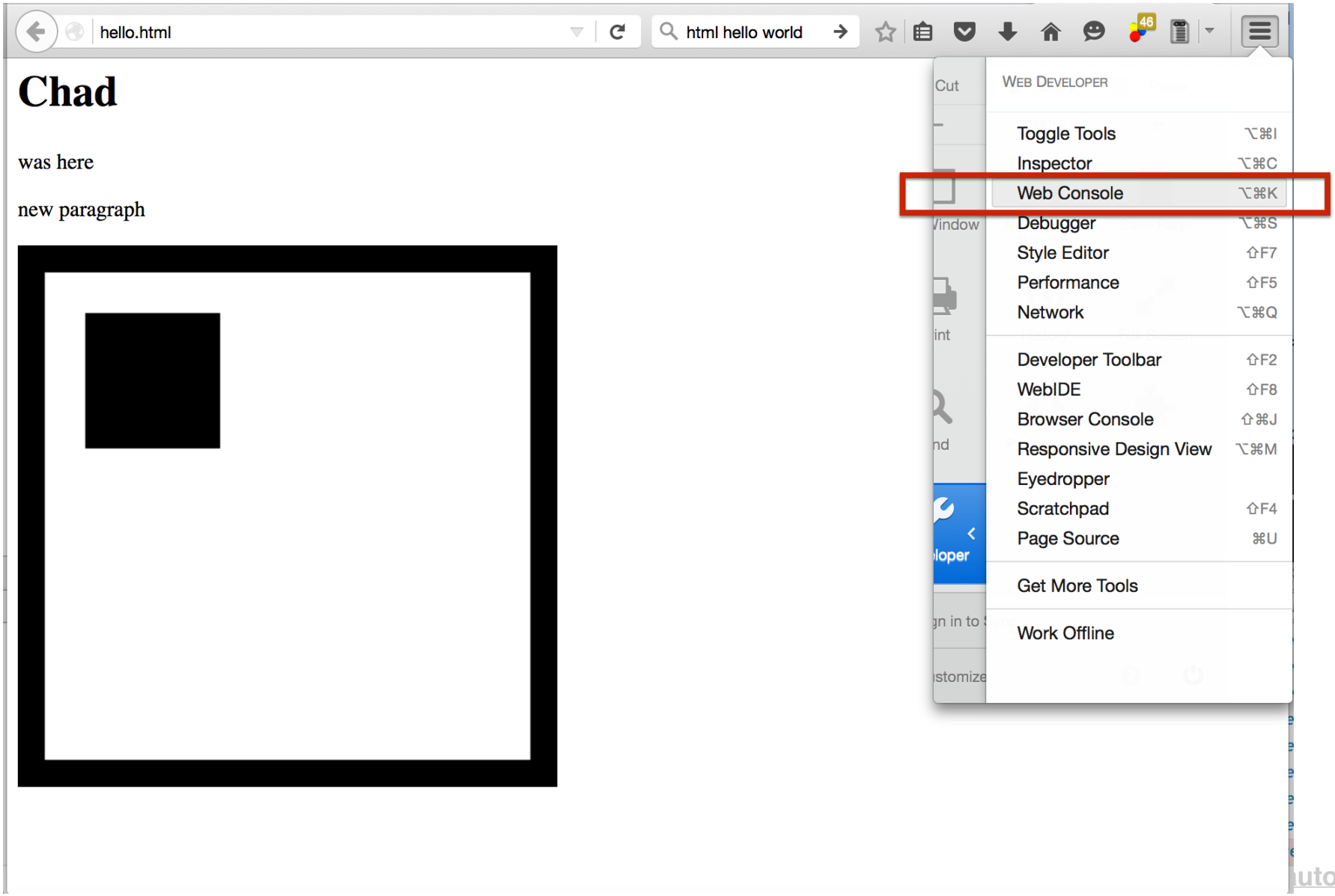


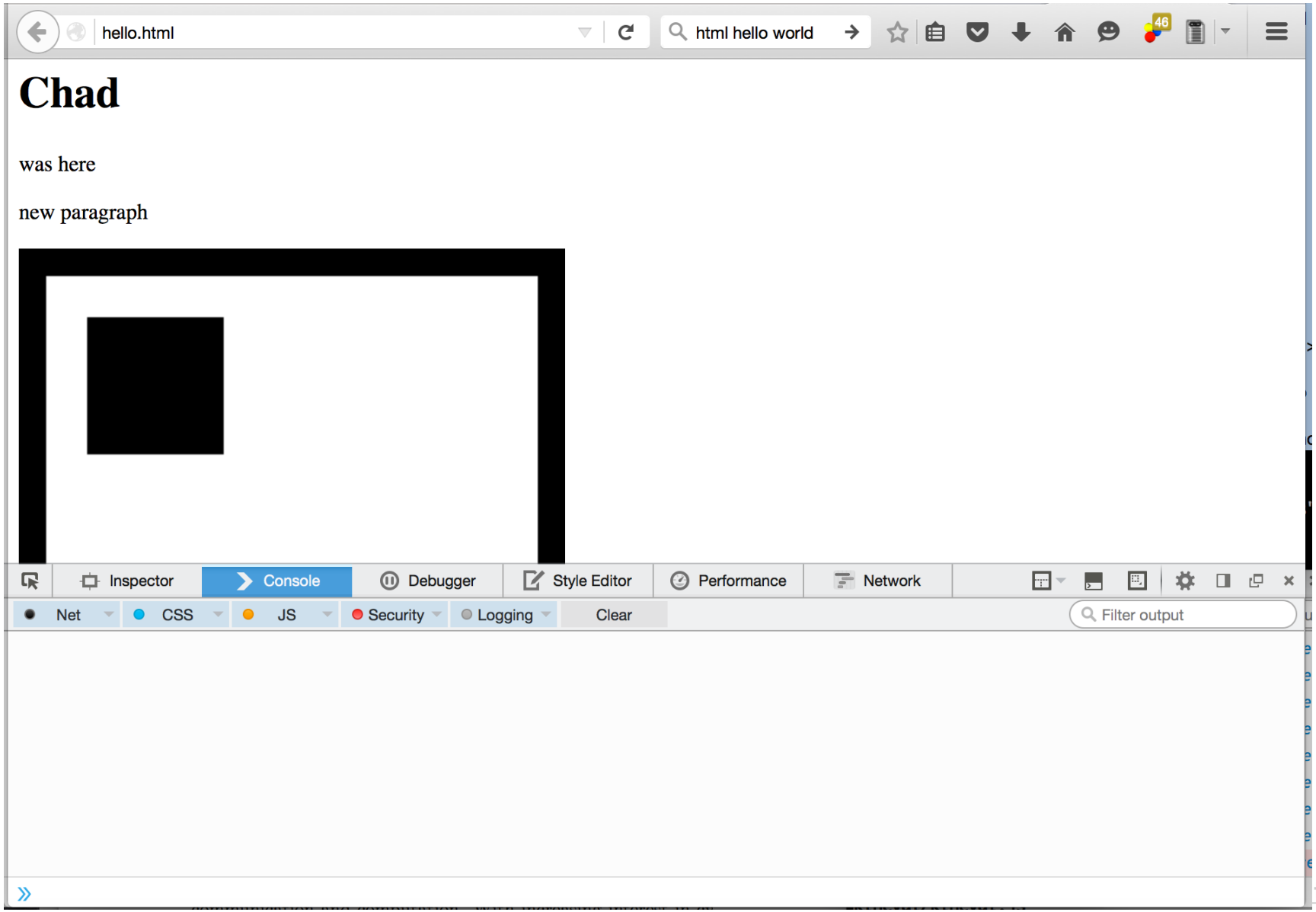
We may have to cover this again during (remote) office hours. It happens.

The browser console can be a good friend

The Browser Console

- Provided by the web browser to:
  - Log information associated with running 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


hello.html
html hello world
Chad
was here
new paragraph
Cut
Window
int
nd
loper
gn in to
stomize
WEB DEVELOPER
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


hello.html
html hello world
Chad
was here
new paragraph
Inspector
Console
Debugger
Style Editor
Performance
Network
Net
CSS
JS
Security
Logging
Clear
Filter output

file:///Users/logan/git_tmp/autorob.github.io/examples/hello.ht

html hello world

Chad

was here

some paragraph text

Inspector | Console | Debugger | Style Editor | Perf

Net | CSS | JS | Security | Logging | Clear

```
» 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
```


```
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← 8
» Math.pow(2,3)
← 8
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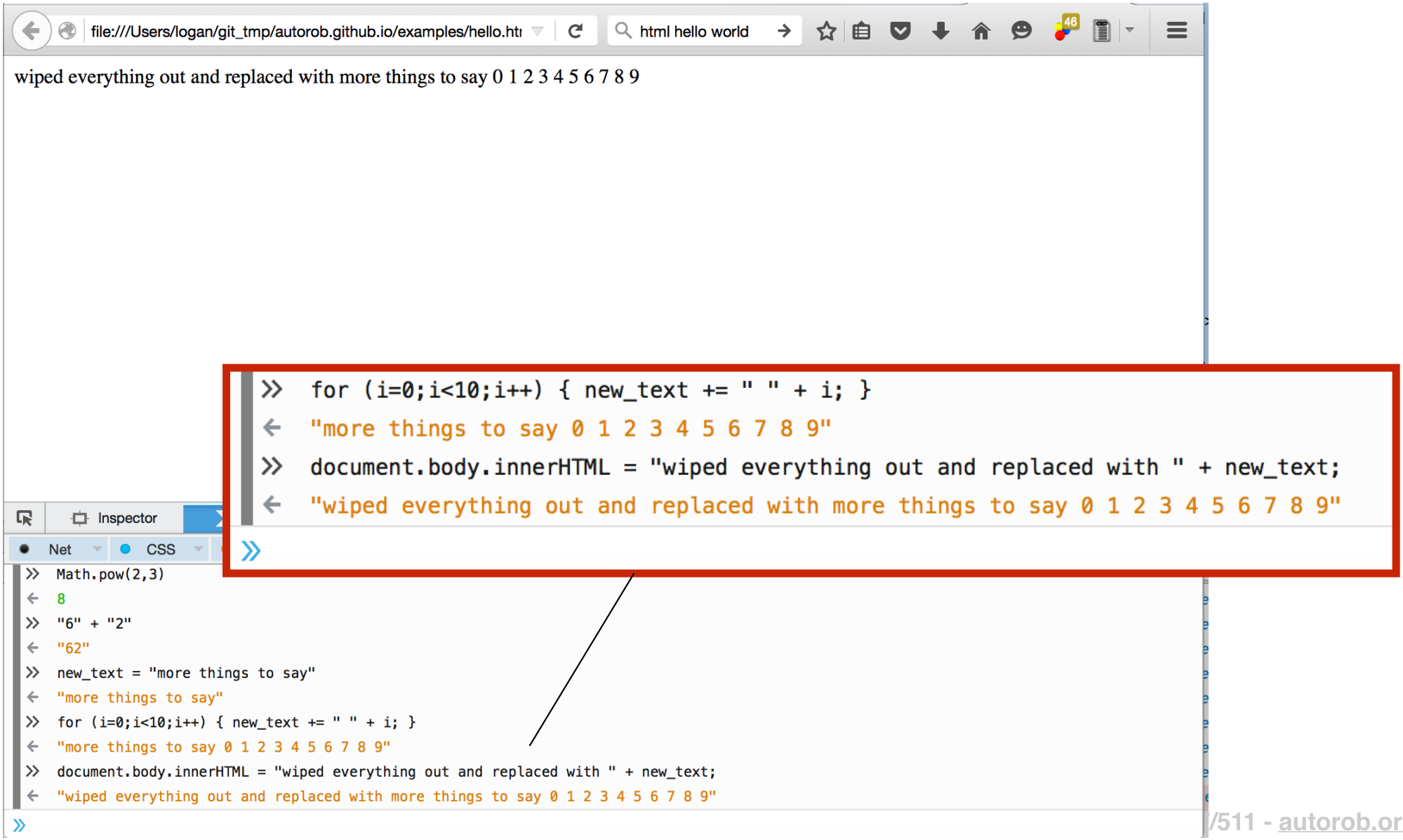
file:///Users/logan/git_tmp/autorob.github.io/examples/hello.ht
html hello world
wiped everything out and replaced with more things to say 0 1 2 3 4 5 6 7 8 9
for (i=0;i<10;i++) { new_text += " " + i; }
"more things to say 0 1 2 3 4 5 6 7 8 9"
document.body.innerHTML = "wiped everything out and replaced with " + new_text;
"wiped everything out and replaced with more things to say 0 1 2 3 4 5 6 7 8 9"
Inspector
Net
CSS
Math.pow(2,3)
8
"6" + "2"
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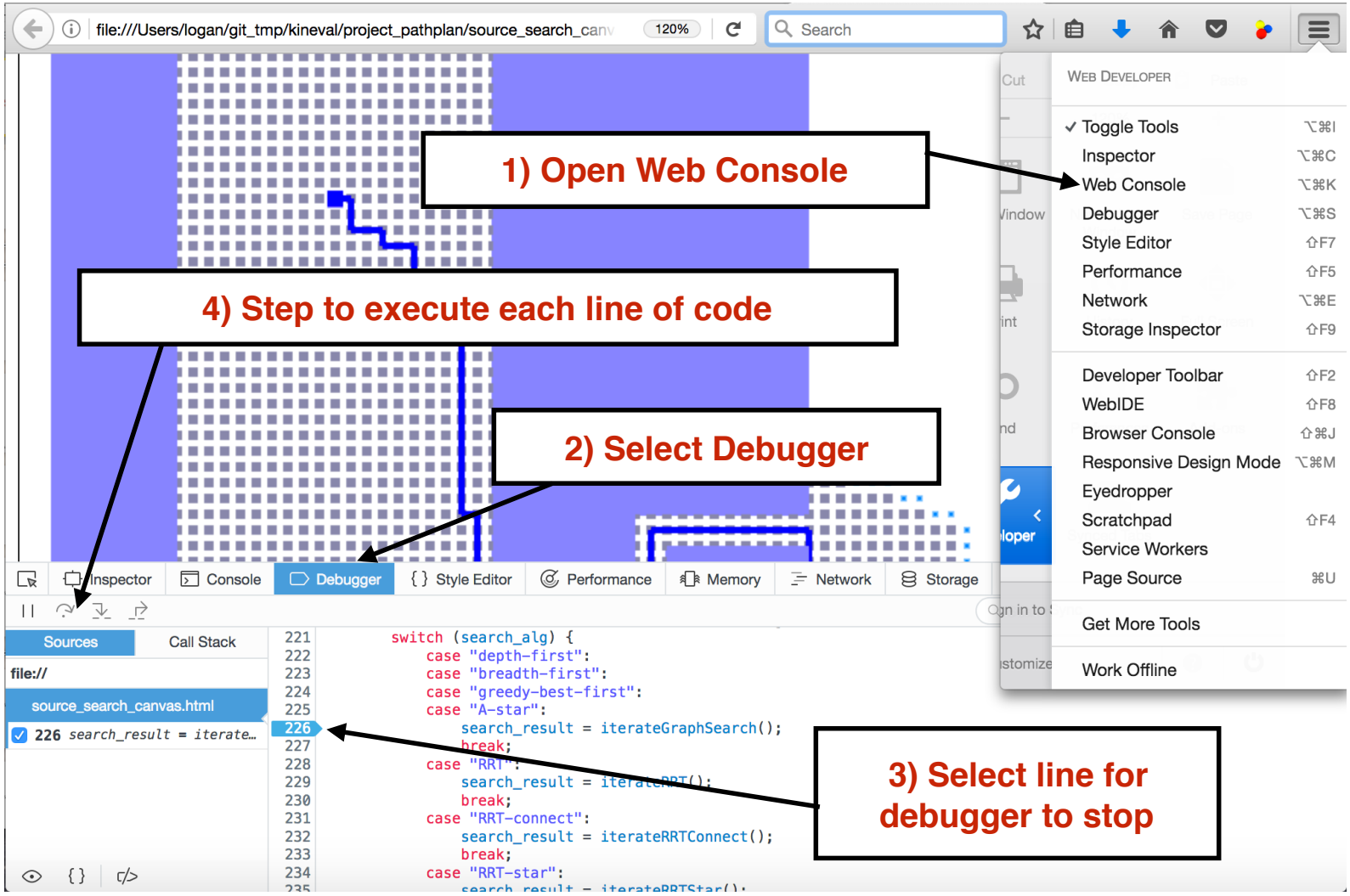
"wiped everything out and replaced with more things to say 0 1 2 3 4 5 6 7 8 9"

Using the browser debugger

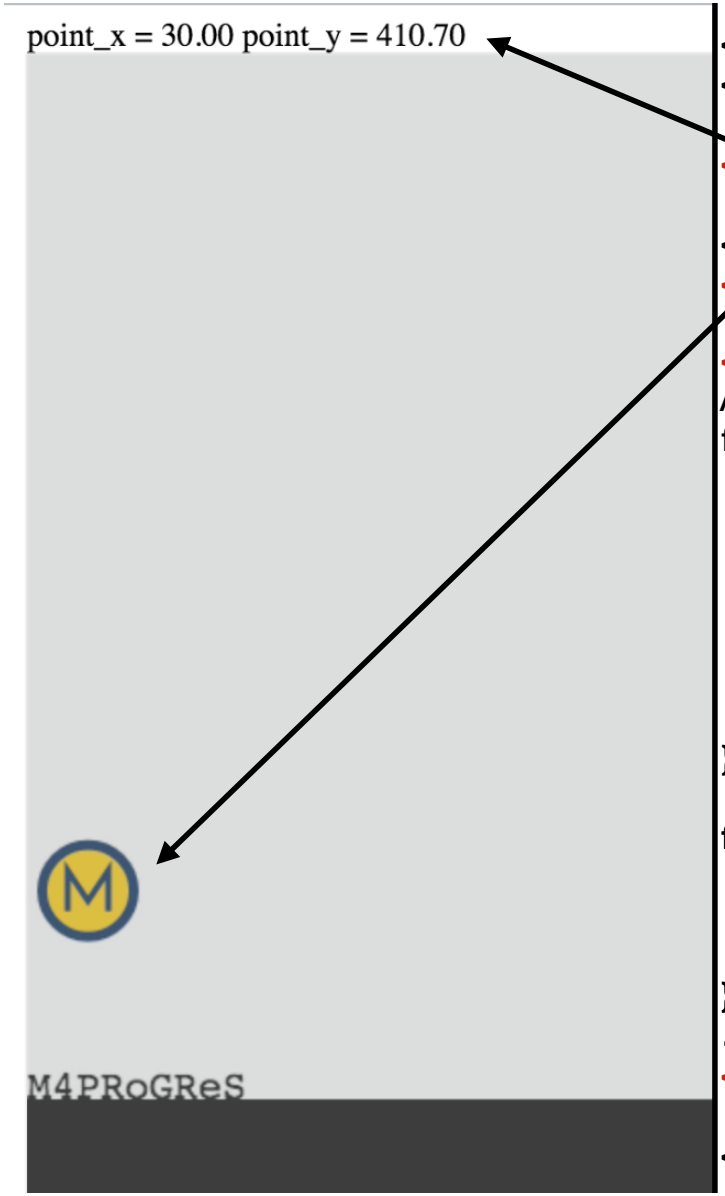

file:///Users/logan/git_tmp/kineval/project_pathplan/source_search_canv
120%
Search
1) Open Web Console
4) Step to execute each line of code
2) Select Debugger
3) Select line for debugger to stop
Web Developer
Toggle Tools ⌥⌘I
Inspector ⌥⌘C
Web Console ⌥⌘K
Debugger ⌥⌘S
Style Editor ⇧F7
Performance ⇧F5
Network ⌥⌘E
Storage Inspector ⇧F9
Developer Toolbar ⇧F2
WebIDE ⇧F8
Browser Console ⇧⌘J
Responsive Design Mode ⌥⌘M
Eyedropper
Scratchpad ⇧F4
Service Workers
Page Source ⌘U
Get More Tools
Work Offline
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Storage
Sources
Call Stack
file://
source_search_canvas.html
226 search_result = iterate…
switch (search_alg) {
case "depth-first":
case "breadth-first":
case "greedy-best-first":
case "A-star":
search_result = iterateGraphSearch();
break;
case "RRT":
break;
case "RRT-connect":
search_result = iterateRRTConnect();
break;
case "RRT-star":

Let’s try an animation example

point_x = 30.00 point_y = 410.70

hello_anim example

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




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

<div id="text_output"> going to put some text here </div>

<!-- create a element for drawing -->
<canvas id="draw_canvas" width=1000 height="400"></canvas>

<script>
// define a function for initialization as: function name_of_function { function_code }
function init() {

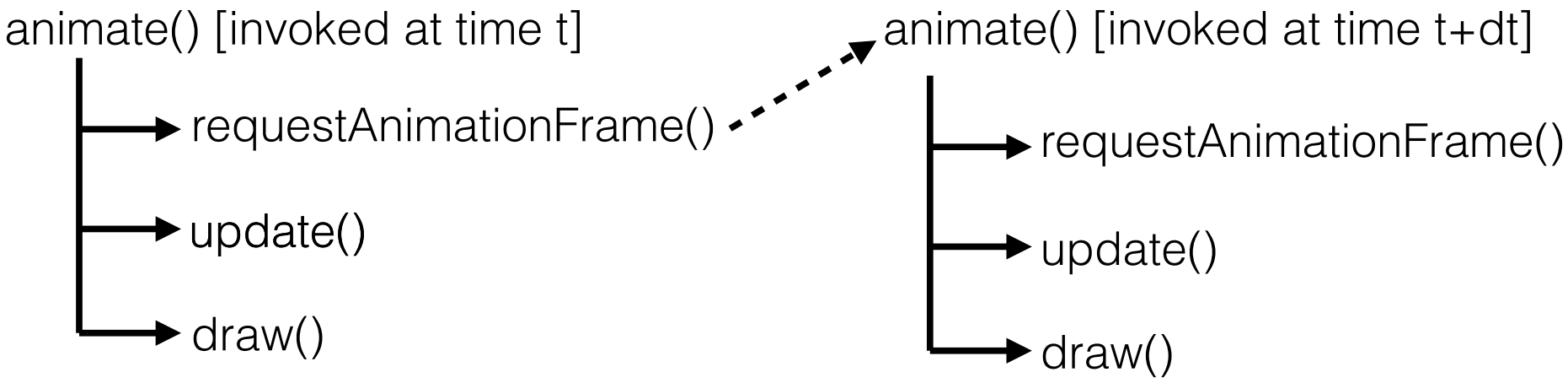
    // create a JavaScript object named "point" with two attributes
    //   specifying the horizontal and vertical location of the circle
    point = {x: 50, y: 50}

    // 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()

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function animate() {
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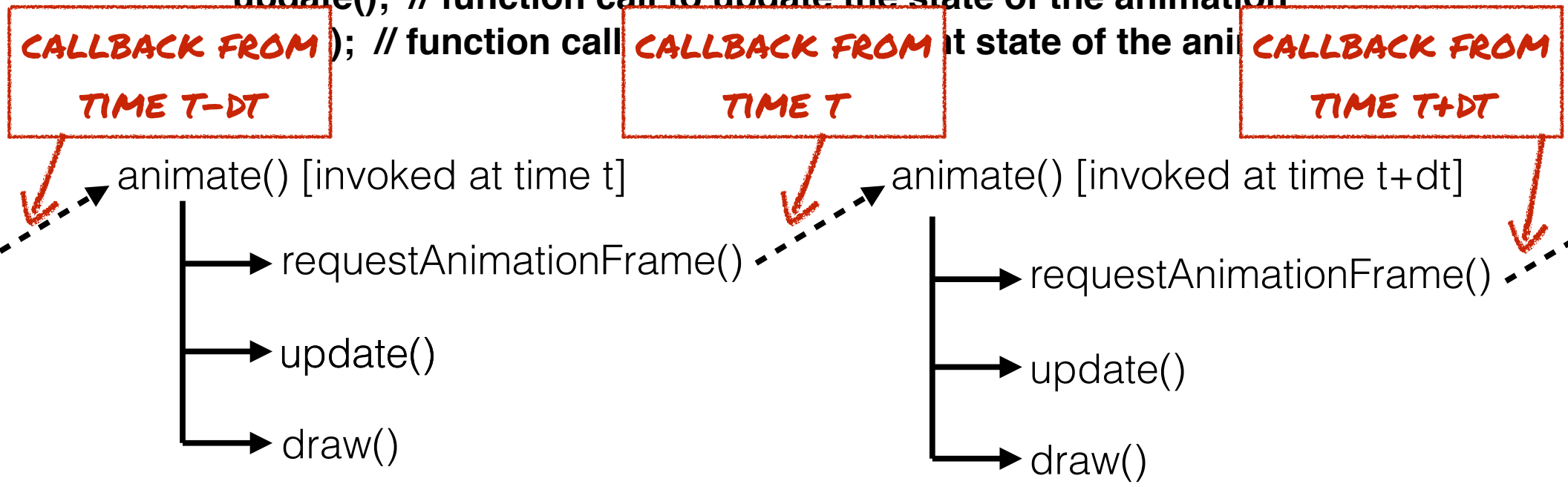
```



requestAnimationFrame() will have browser call animate() again.

IMPORTANT to avoid code that blocks in animate()

point_x = 30.00 point_y = 410.70

M4PRoGReS

```
...

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}

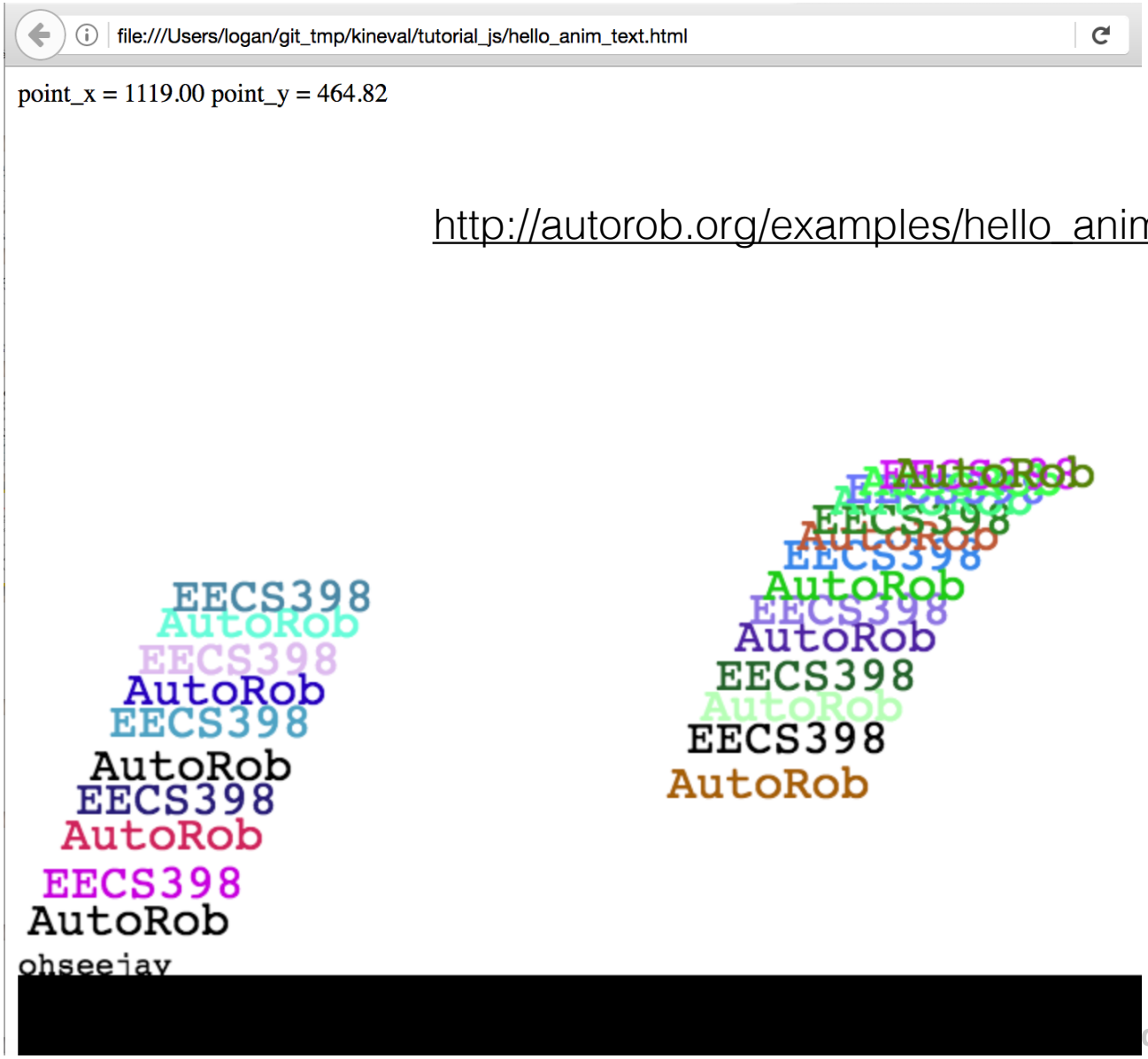
   // if the circle is at the extent of the canvas, move it back to the start
   if (point.x > canvas.width) {
       point.x = 0;
   }

   // 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)));}

...
```

RETURNS A REFERENCE TO ANY DOM OBJECT

Run one more animation example on your own


file:///Users/logan/git_tmp/kineval/tutorial_js/hello_anim_text.html
point_x = 1119.00 point_y = 464.82
http://autorob.org/examples/hello_anim_text.html
EECS398
AutoRob
EECS398
AutoRob
EECS398
AutoRob
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EECS398
AutoRob
EECS398
AutoRob
ohseejay

Many examples available online

GitHub, Inc. (US) https://github.com/odestcj/superquadric/

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odestcj / superquadric

Code Issues 0 Pull requests 0 Wiki Pulse Graphs Settin

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

2 commits 1 branch 0 releas

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…

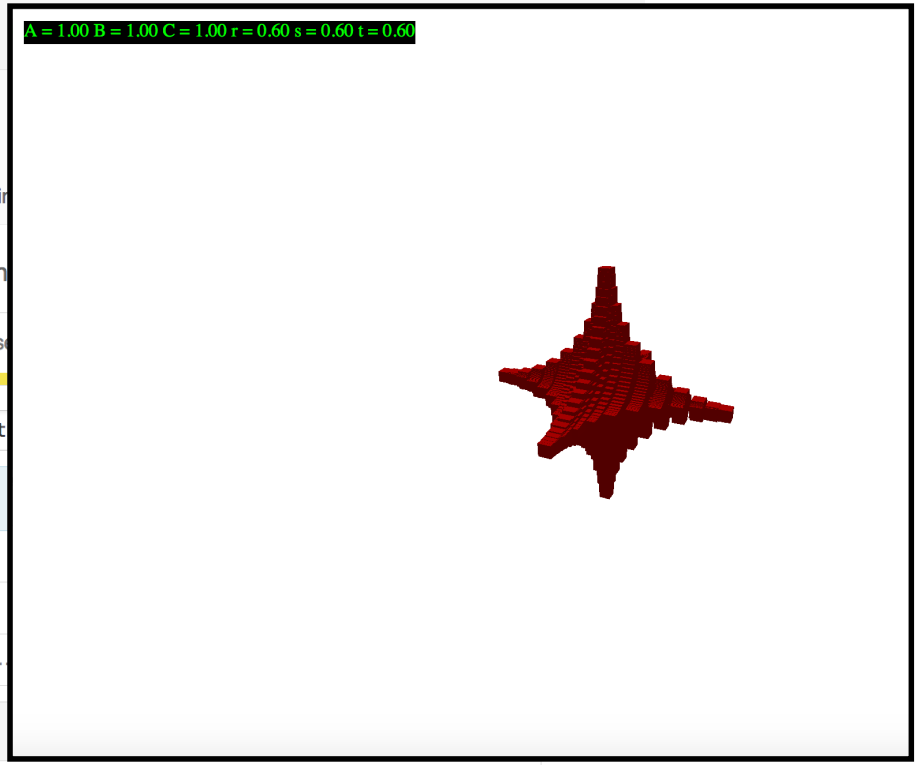
README

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

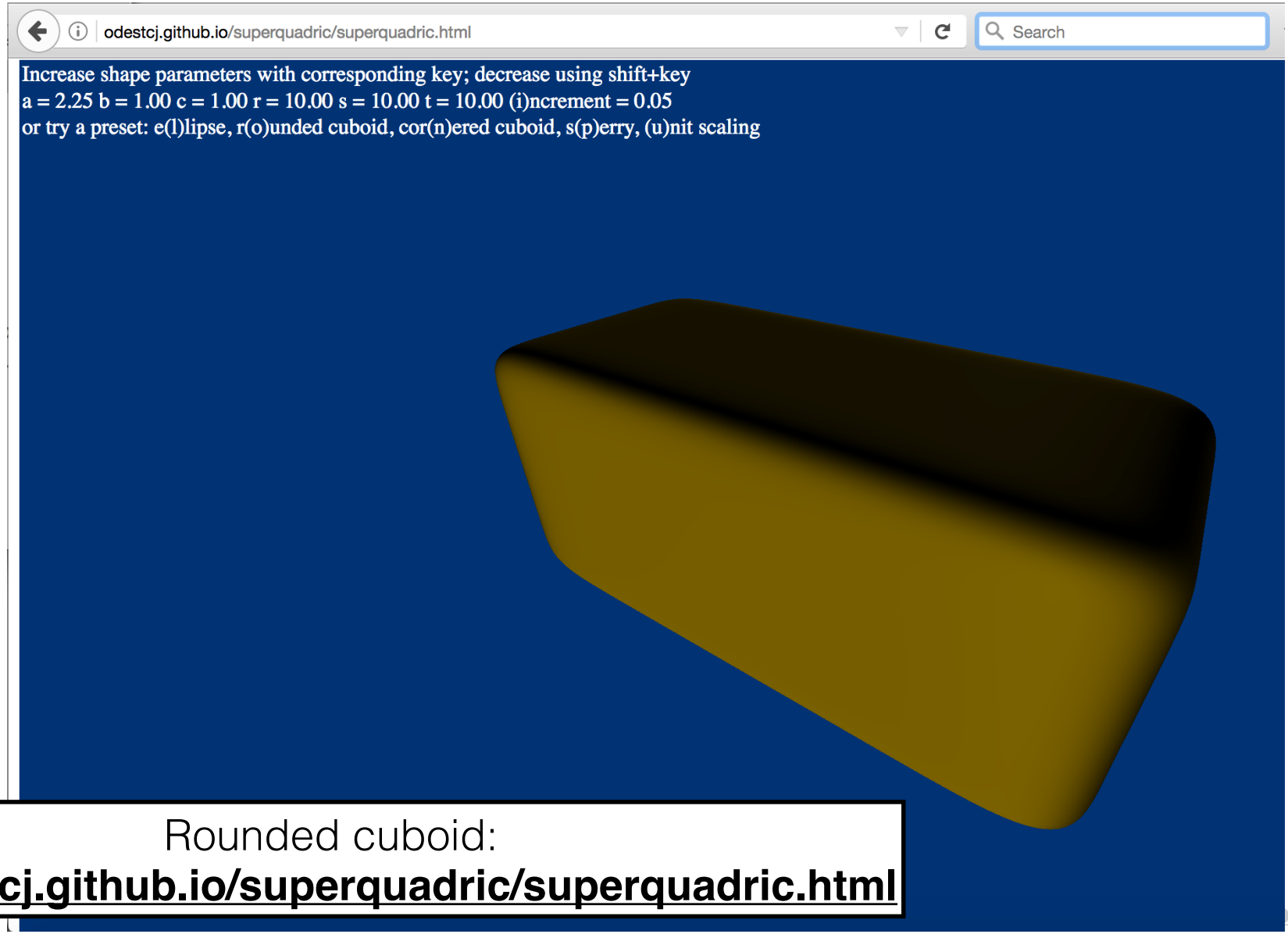
@author odestcj / https://github.com/odestcj

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

GitHub, Inc. (US) https://github.com/autorob/ki

Search or jump to... / Pull requests Issues Marketplace Explore

autorob / **kineval-stencil**

Unwatch 2 | Star 0 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wi

https://github.com/autorob/kineval-stencil

Stencil code for KinEval (Kinematic Evaluator) for robot control, kinematics, decision, and dynamics in JavaScript/HTML5 Edit

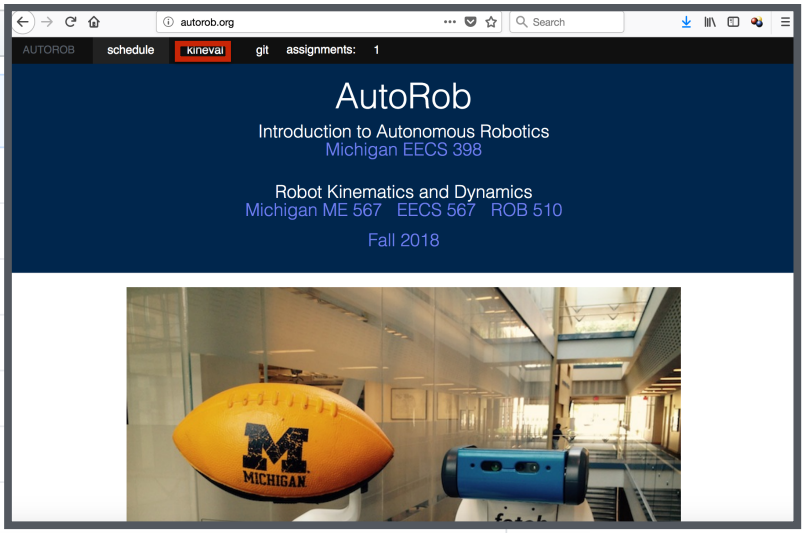
Add topics

2 commits | **1** branch | **0** releases | **2** contributors

Branch: **master** | **New pull request** | **Create new file**

odestcj initial commit Fall 2018

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	4 hours ago



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

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

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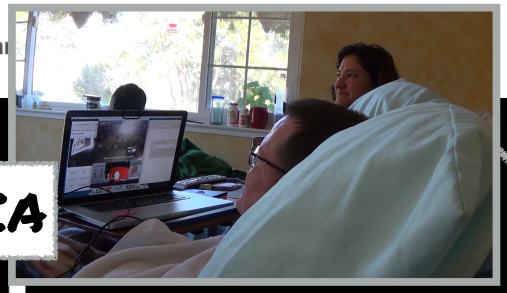

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TEDxMidAtlantic · 10:21 · **Filmed** Oct 2013

28 subtitle languages

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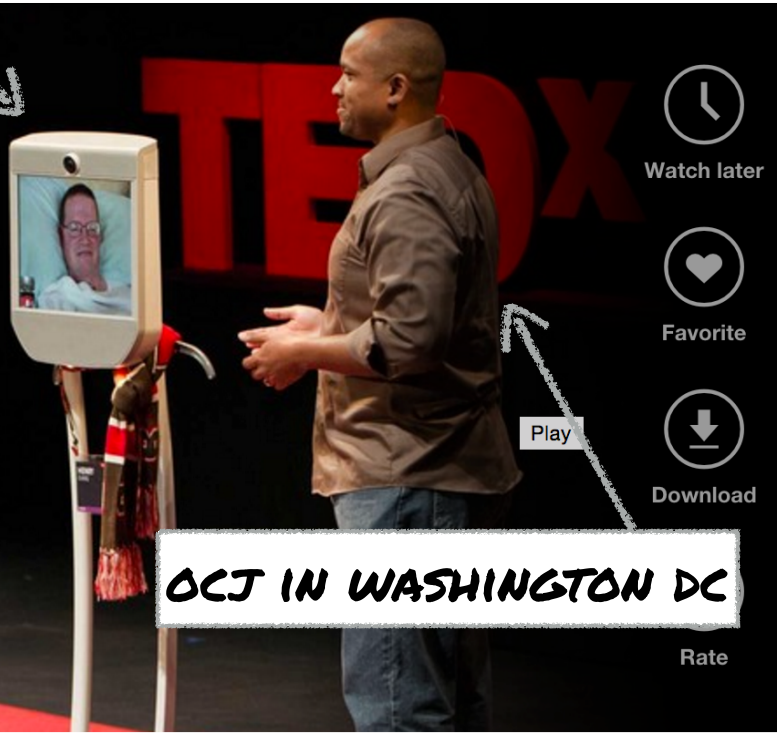

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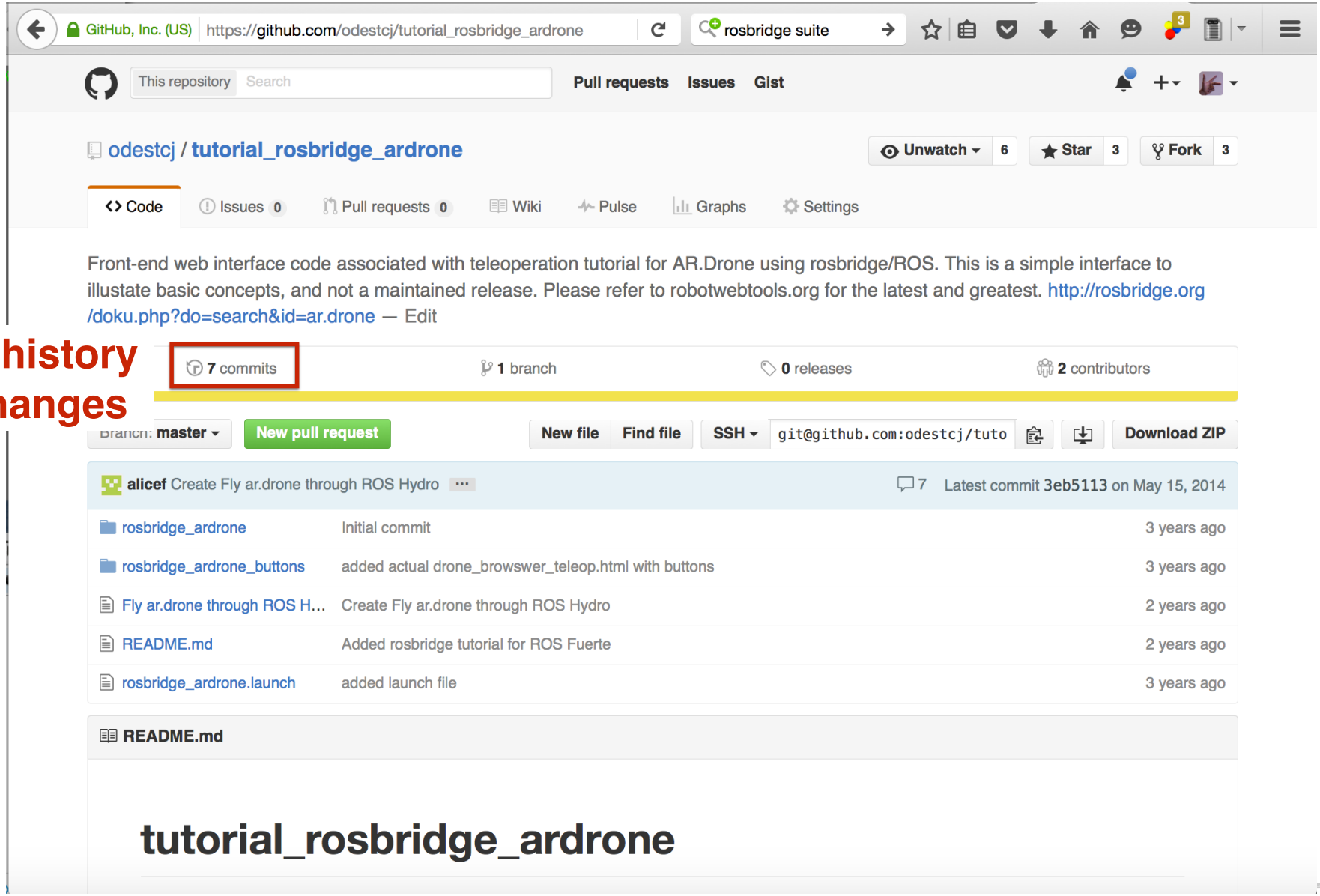
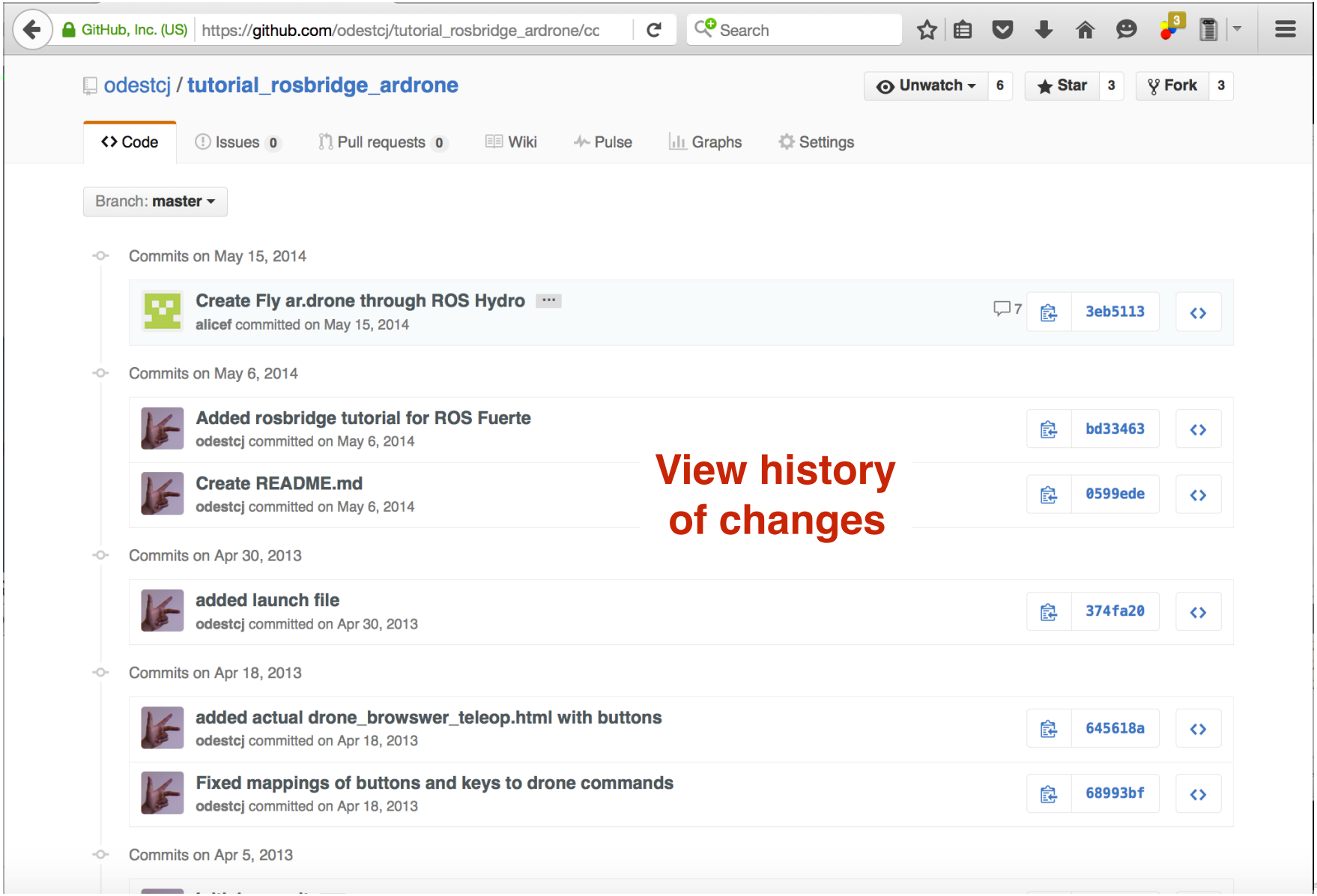
Your microphone is muted.



View history of changes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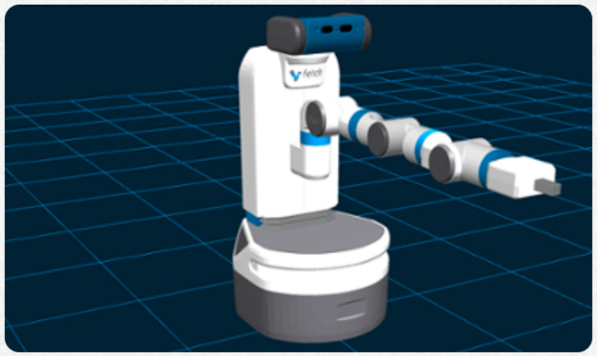
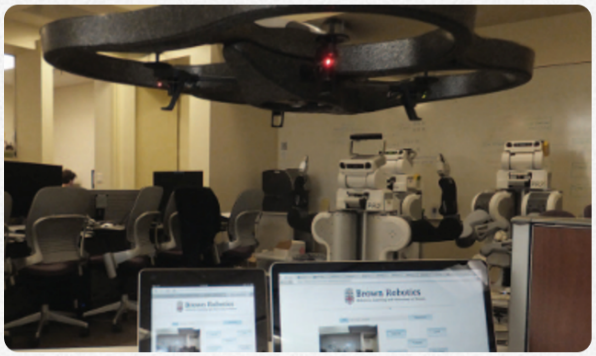
Star 3
Fork 3
Code
Issues 0
Pull requests 0
Wiki
Pulse
Graphs
Settings
Branch: master
Commits on May 15, 2014
Create Fly ar.drone through ROS Hydro
alicef committed on May 15, 2014
7
3eb5113
Commits on May 6, 2014
Added rosbridge tutorial for ROS Fuerte
odestcj committed on May 6, 2014
bd33463
Create README.md
odestcj committed on May 6, 2014
0599ede
View history of changes
Commits on Apr 30, 2013
added launch file
odestcj committed on Apr 30, 2013
374fa20
Commits on Apr 18, 2013
added actual drone_browswer_teleop.html with buttons
odestcj committed on Apr 18, 2013
645618a
Fixed mappings of buttons and keys to drone commands
odestcj committed on Apr 18, 2013
68993bf
Commits on Apr 5, 2013

Large open source projects…

robotwebtools.org





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ROBOT WEB ARCHITECTURE

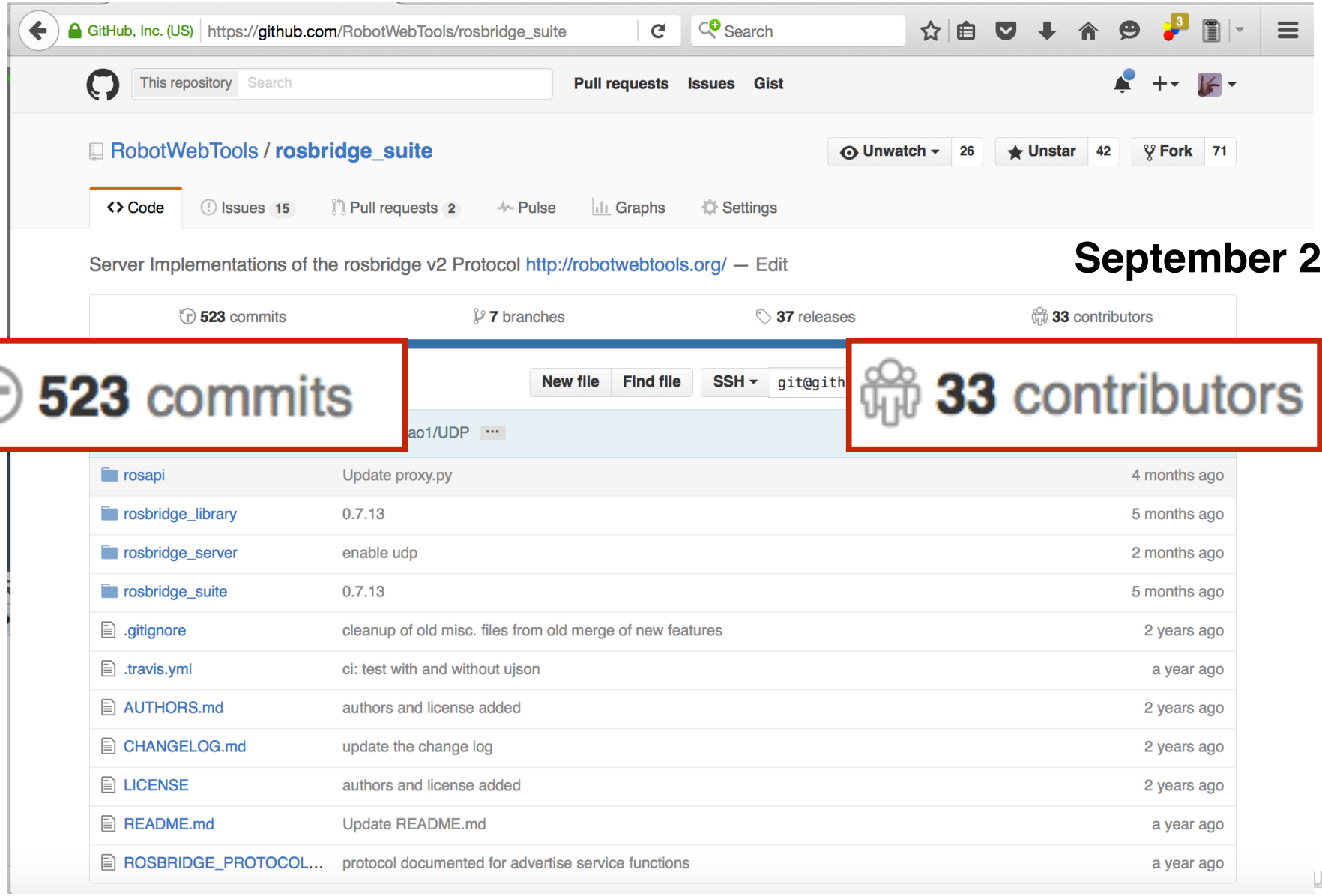
BRIDGING ROBOTS AND THE WEB

A variety of routes are available for architecting a robot web

ROSBRIDGE AS A TRANSPORT

USING JSON TO SPEAK TO YOUR ROBOT

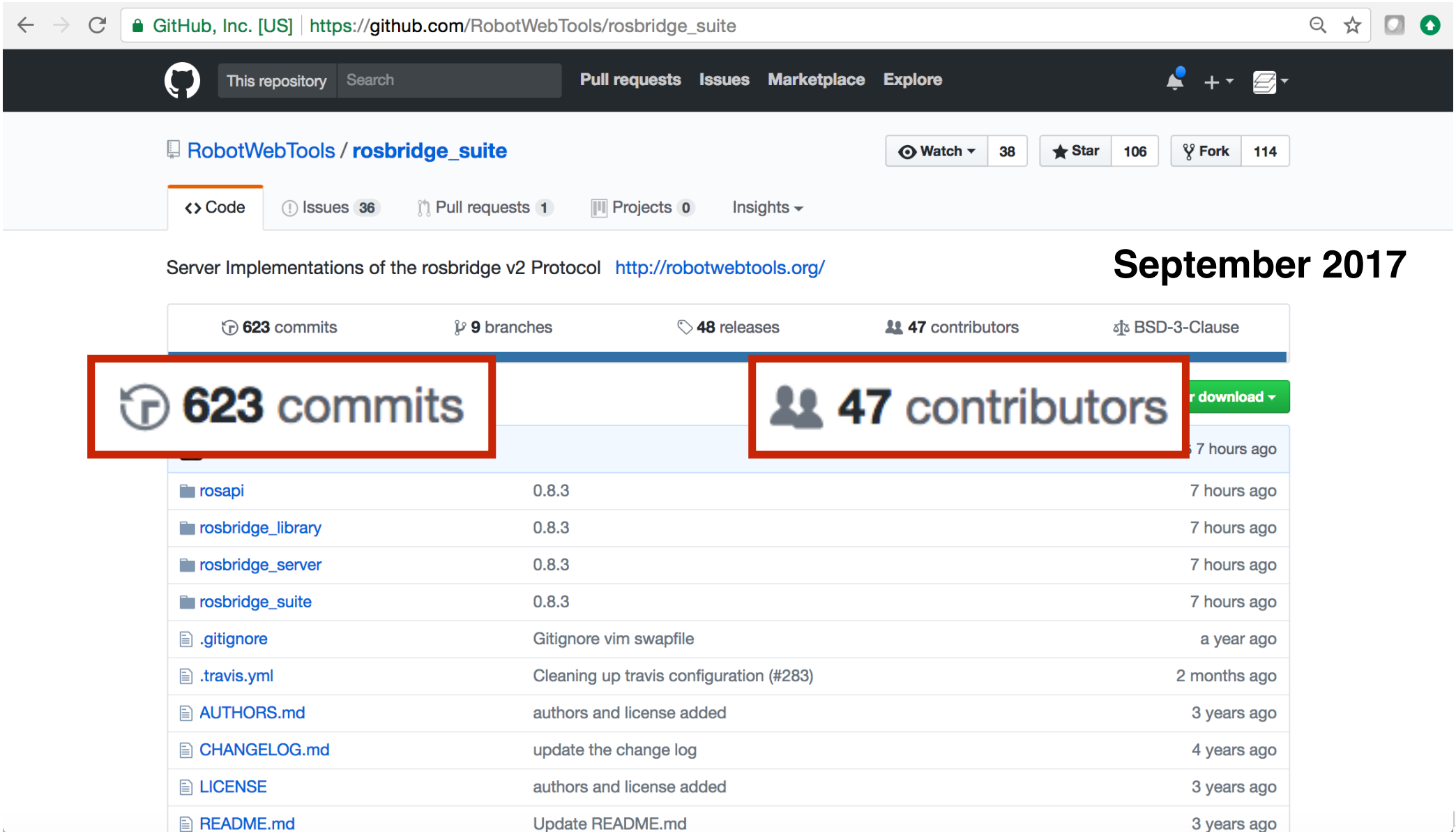
While ROS works great for applications on the robot, another layer is

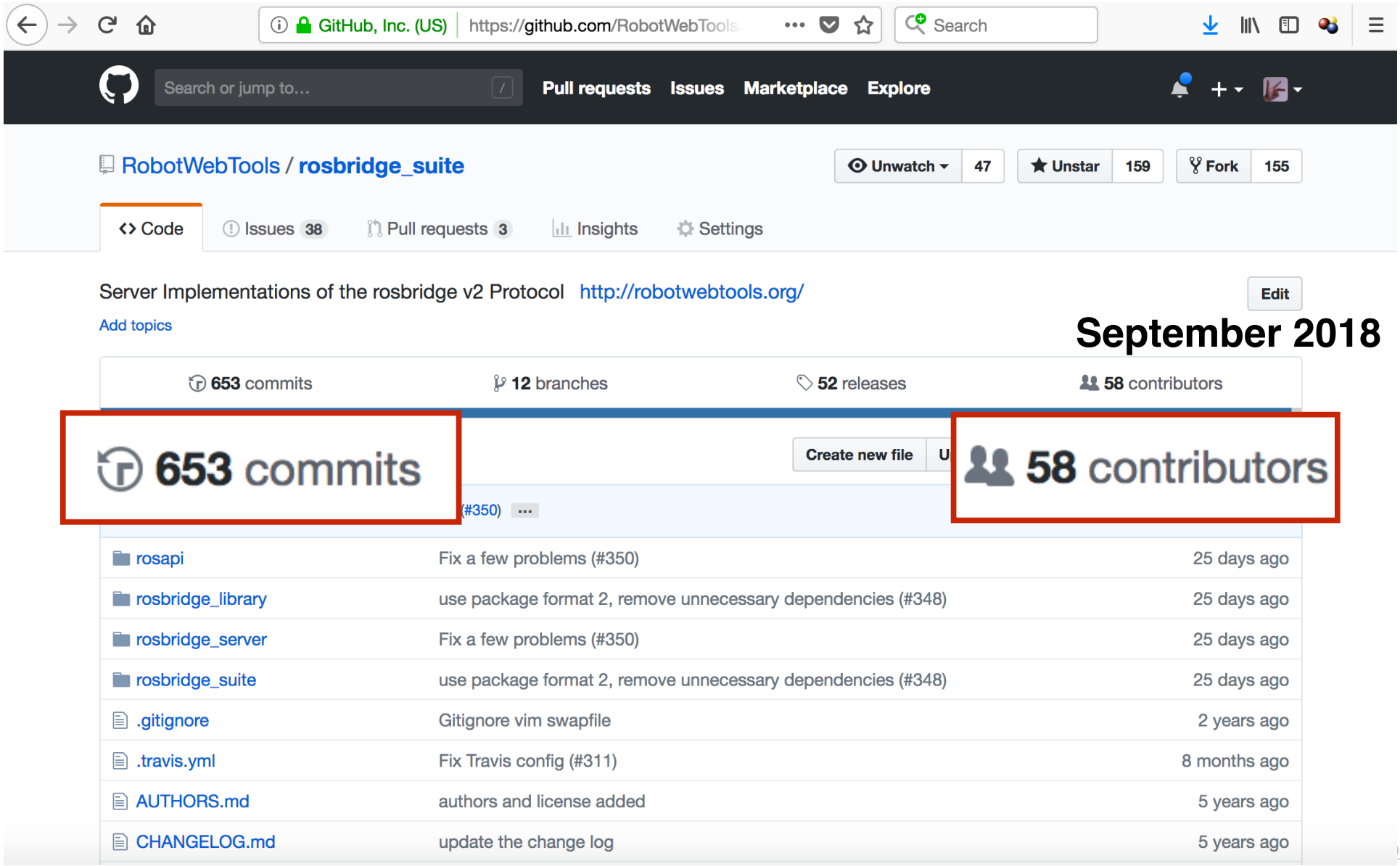


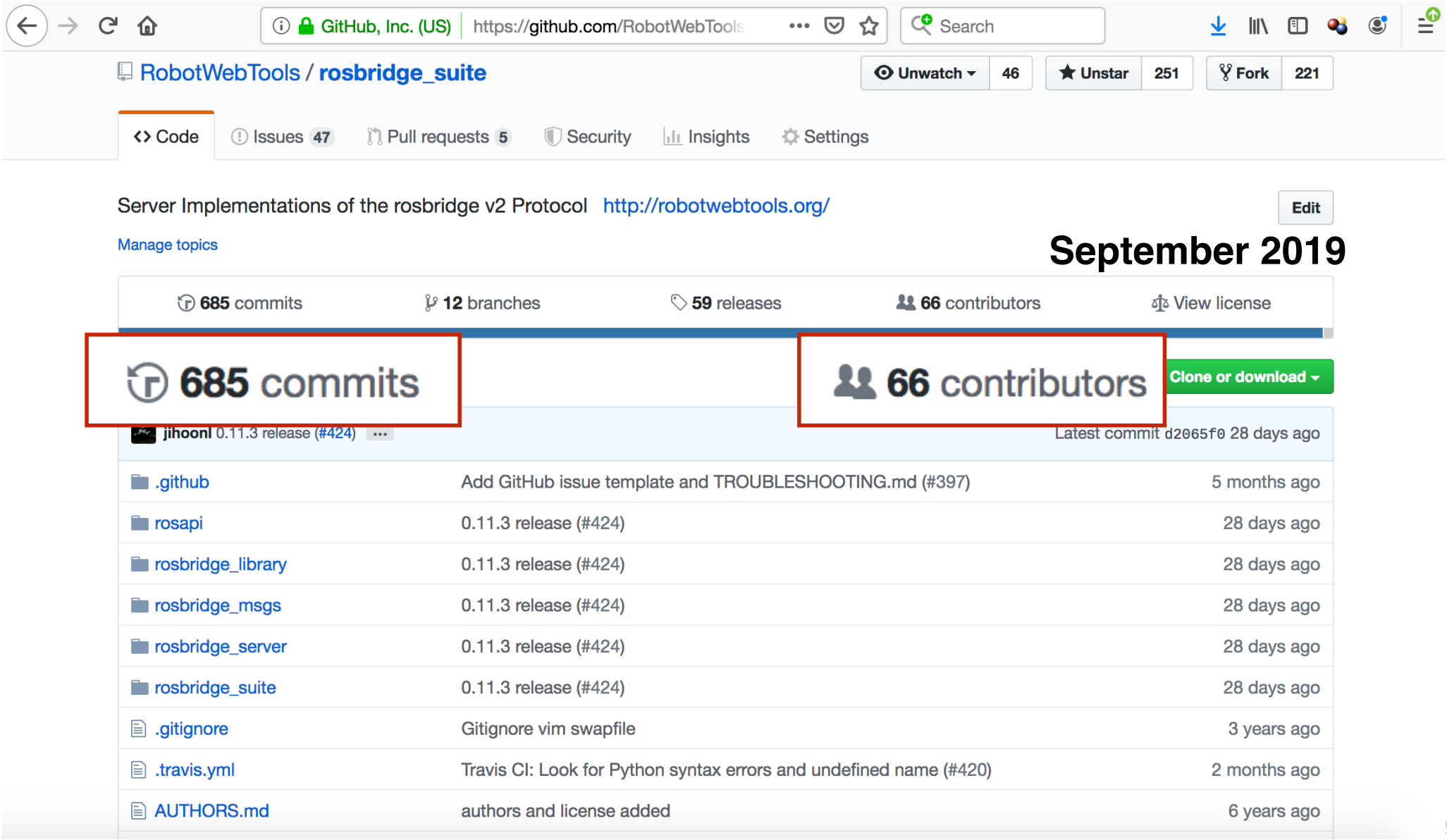
September 2016

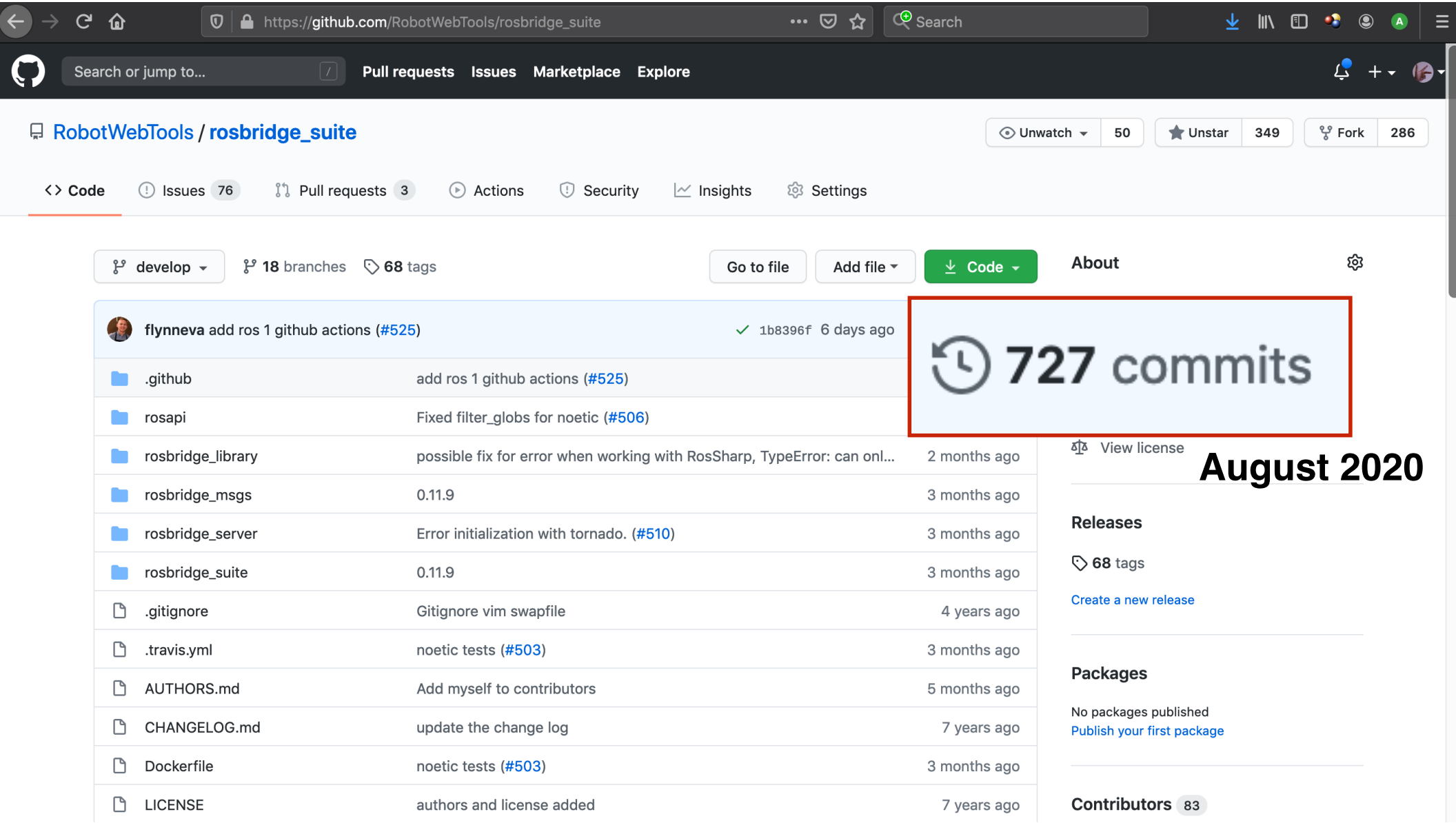
523 commits

33 contributors


GitHub, Inc. [US] https://github.com/RobotWebTools/rosbridge_suite
This repository Search
Pull requests Issues Marketplace Explore
RobotWebTools / rosbridge_suite
Watch 38 Star 106 Fork 114
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
download
7 hours ago
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
Search or jump to…
Pull requests
Issues
Marketplace
Explore
RobotWebTools / rosbridge_suite
Unwatch 47
Unstar 159
Fork 155
Code
Issues 38
Pull requests 3
Insights
Settings
Server Implementations of the rosbridge v2 Protocol http://robotwebtools.org/
Edit
Add topics
September 2018
653 commits
12 branches
52 releases
58 contributors
653 commits
Create new file
58 contributors
(#350)
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


GitHub, Inc. (US)
https://github.com/RobotWebTools
Search
RobotWebTools / rosbridge_suite
Unwatch 46
Unstar 251
Fork 221
Code
Issues 47
Pull requests 5
Security
Insights
Settings
Server Implementations of the rosbridge v2 Protocol http://robotwebtools.org/
Edit
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
.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


https://github.com/RobotWebTools/rosbridge_suite
Search
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Issues
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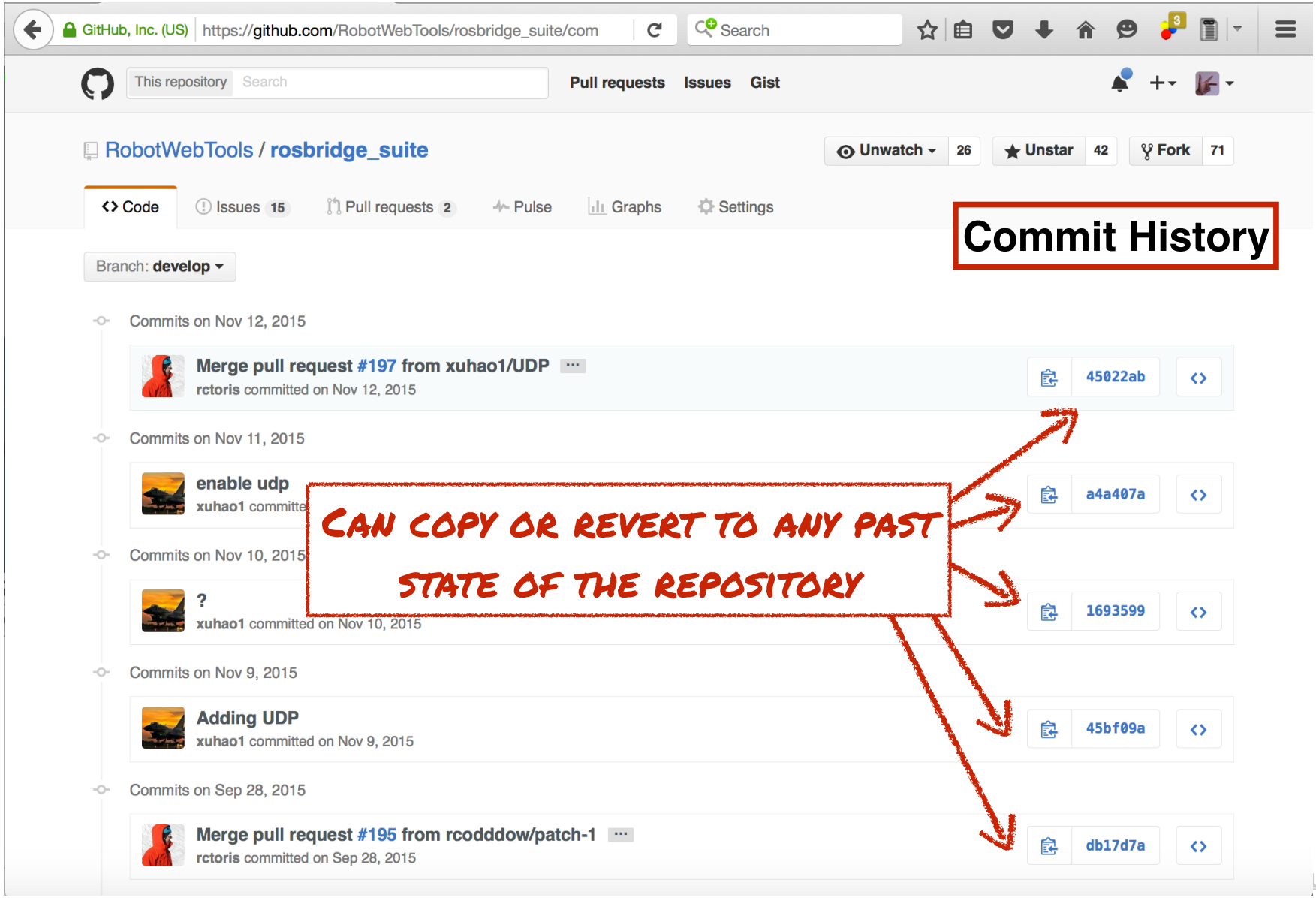
Explore
RobotWebTools / rosbridge_suite
Unwatch 50
Unstar 349
Fork 286
Code
Issues 76
Pull requests 3
Actions
Security
Insights
Settings
develop
18 branches
68 tags
Go to file
Add file
Code
About
flynneva add ros 1 github actions (#525)
1b8396f 6 days ago
727 commits
.github add ros 1 github actions (#525)
rosapi Fixed filter_globs for noetic (#506)
rosbridge_library possible fix for error when working with RosSharp, TypeError: can onl... 2 months ago
rosbridge_msgs 0.11.9 3 months ago
rosbridge_server Error initialization with tornado. (#510) 3 months ago
rosbridge_suite 0.11.9 3 months ago
.gitignore Gitignore vim swapfile 4 years ago
.travis.yml noetic tests (#503) 3 months ago
AUTHORS.md Add myself to contributors 5 months ago
CHANGELOG.md update the change log 7 years ago
Dockerfile noetic tests (#503) 3 months ago
LICENSE authors and license added 7 years ago
View license
August 2020
Releases
68 tags
Create a new release
Packages
No packages published
Publish your first package
Contributors 83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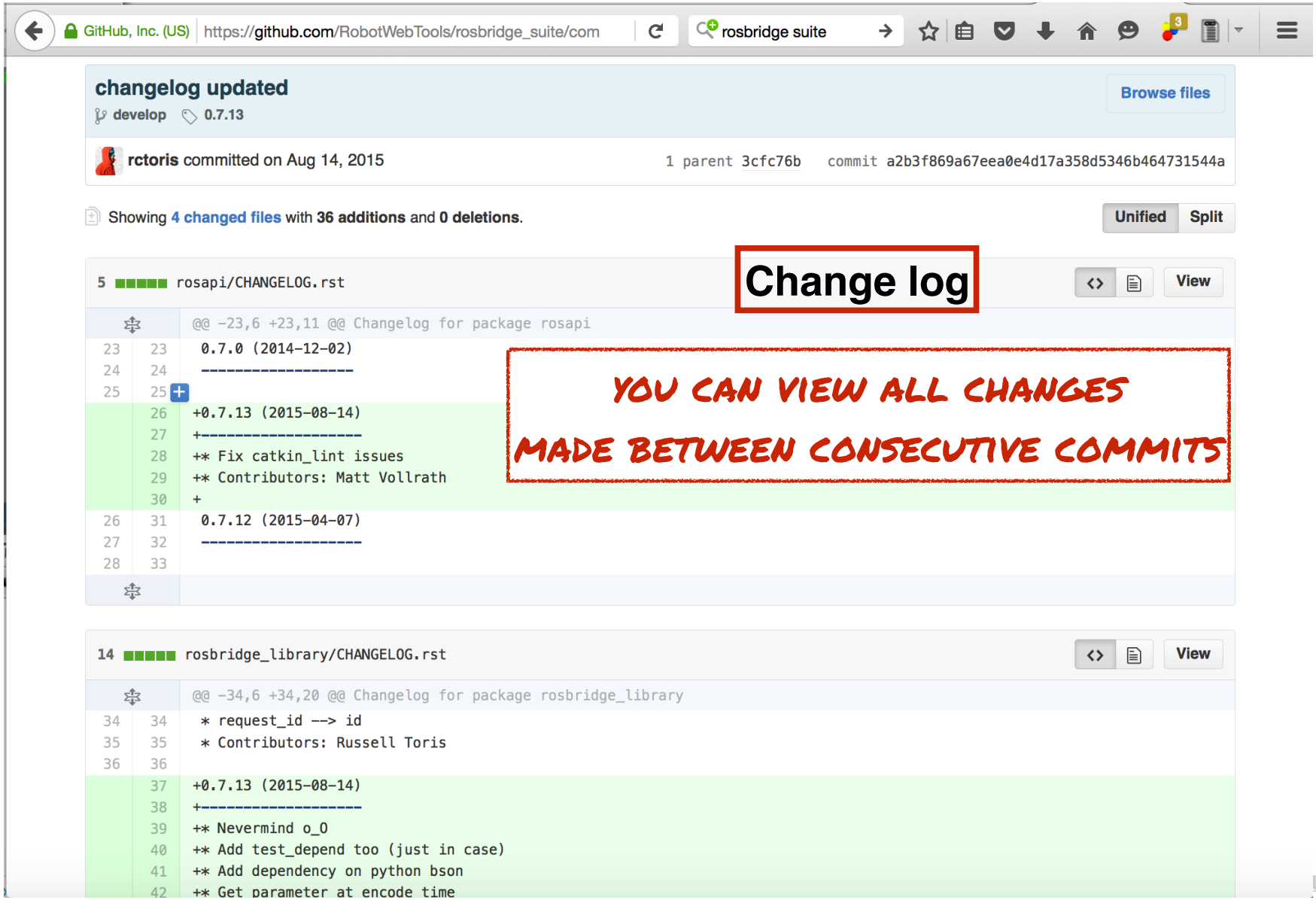
Issues
Gist
RobotWebTools / rosbridge_suite
Unwatch 26
Unstar 42
Fork 71
Code
Issues 15
Pull requests 2
Pulse
Graphs
Settings
Commit History
Branch: develop
Commits on Nov 12, 2015
Merge pull request #197 from xuhao1/UDP
rctoris committed on Nov 12, 2015
45022ab
Commits on Nov 11, 2015
enable udp
xuhao1 committe
a4a407a
Commits on Nov 10, 2015
?
xuhao1 committed on Nov 10, 2015
1693599
Commits on Nov 9, 2015
Adding UDP
xuhao1 committed on Nov 9, 2015
45bf09a
Commits on Sep 28, 2015
Merge pull request #195 from rcodddow/patch-1
rctoris committed on Sep 28, 2015
db17d7a
CAN COPY OR REVERT TO ANY PAST STATE OF THE REPOSITORY


GitHub, Inc. (US)
https://github.com/RobotWebTools/rosbridge_suite/com
rosbridge suite
changelog updated
develop
0.7.13
Browse files
rctoris committed on Aug 14, 2015
1 parent 3cfc76b
commit a2b3f869a67eea0e4d17a358d5346b464731544a
Showing 4 changed files with 36 additions and 0 deletions.
Unified
Split
Change log
5 rosapi/CHANGELOG.rst
View
@@ -23,6 +23,11 @@ Changelog for package rosapi
0.7.0 (2014-12-02)
+0.7.13 (2015-08-14)
+* Fix catkin_lint issues
+* Contributors: Matt Vollrath
+
0.7.12 (2015-04-07)
YOU CAN VIEW ALL CHANGES
MADE BETWEEN CONSECUTIVE COMMITS
14 rosbridge_library/CHANGELOG.rst
View
@@ -34,6 +34,20 @@ Changelog for package rosbridge_library
* request_id --> id
* Contributors: Russell Toris
+0.7.13 (2015-08-14)
+* Nevermind o_O
+* Add test_depend too (just in case)
+* Add dependency on python bson
+* Get parameter at encode time

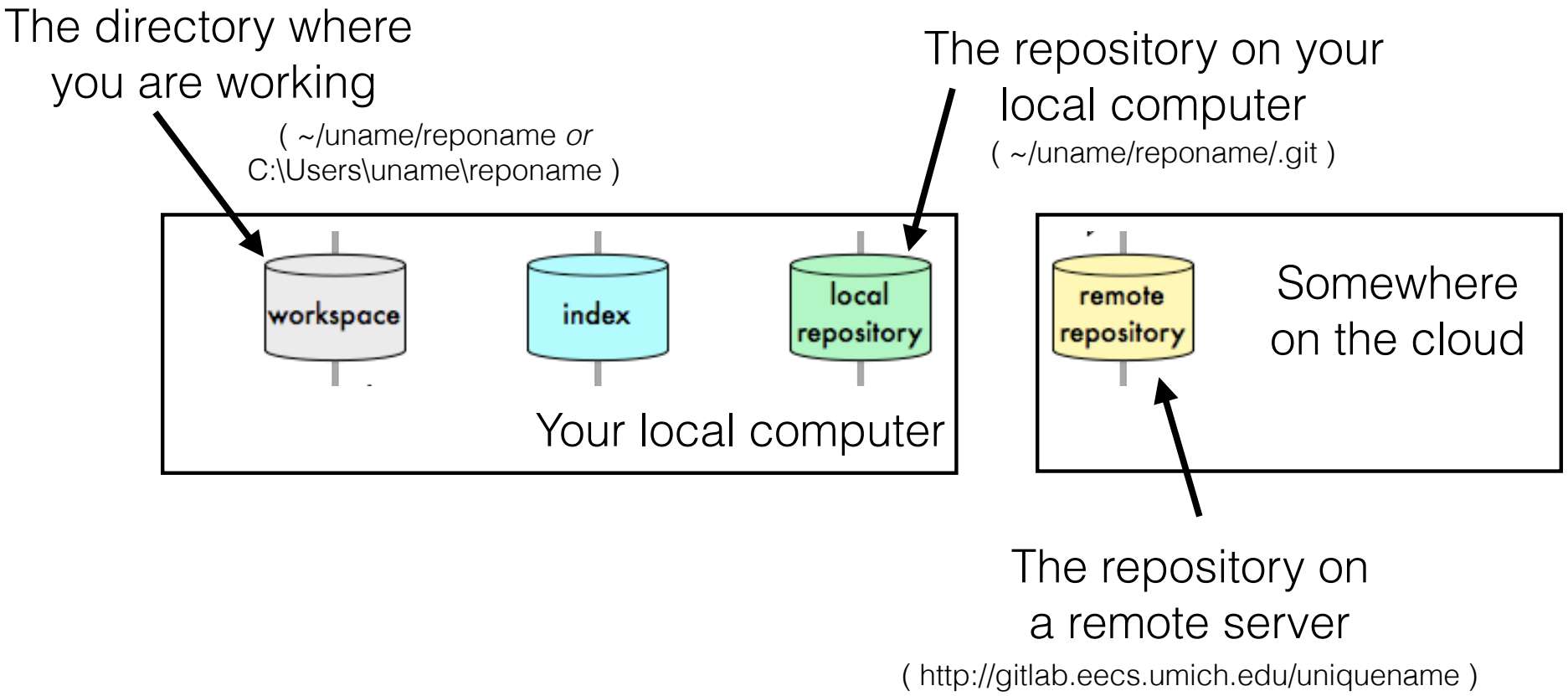
Version control options

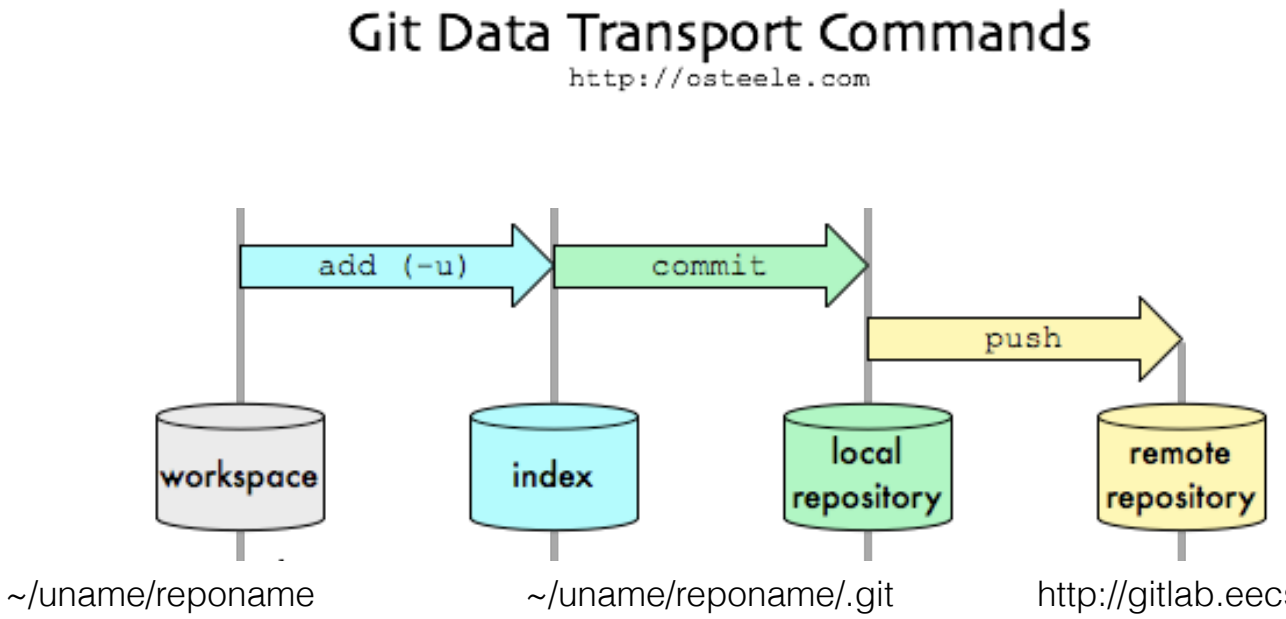
Version control options

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

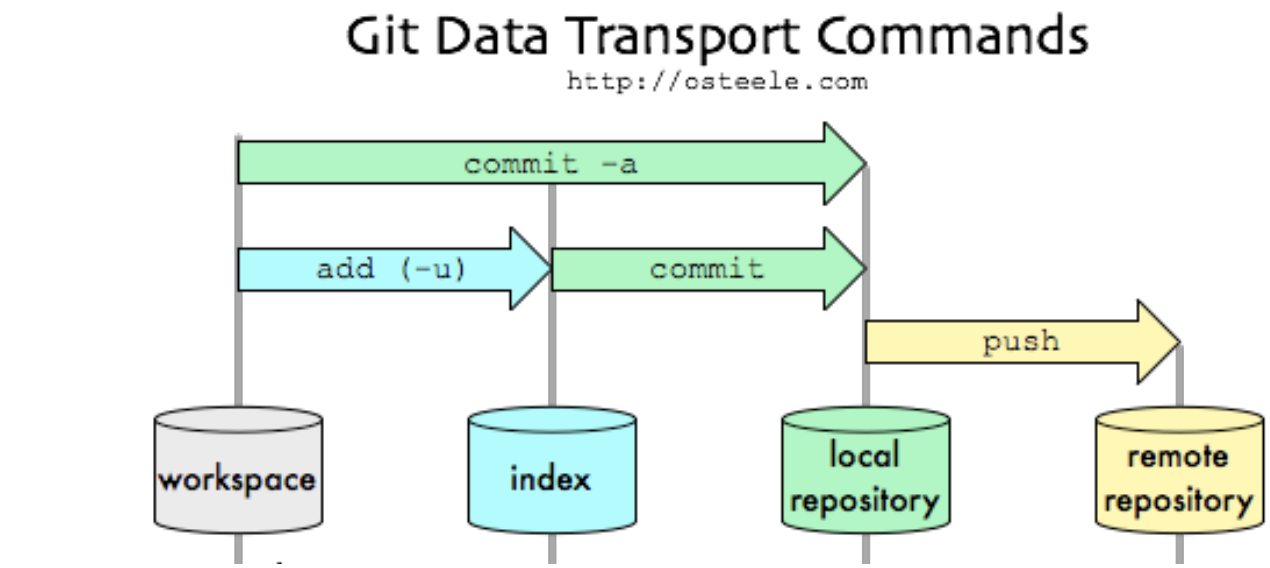
Git Data Transport Commands

http://osteele.com



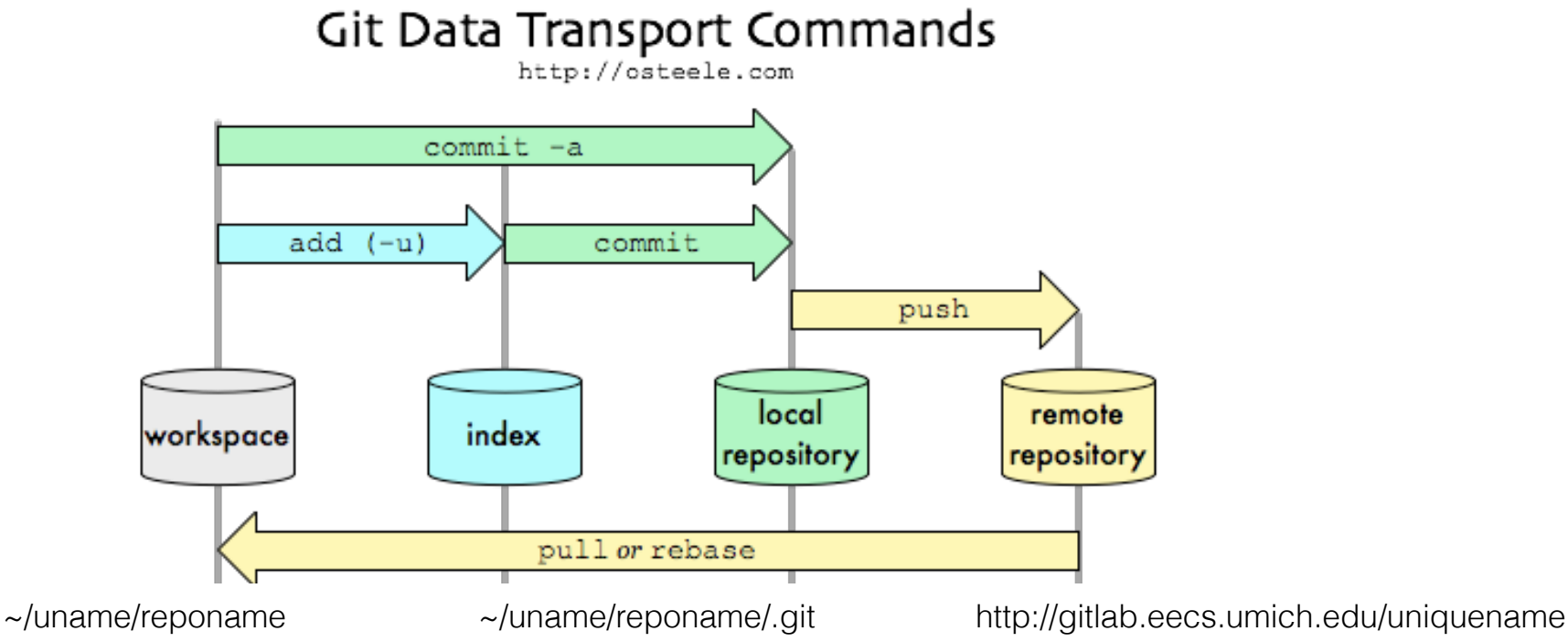


After making local changes, you can add, commit, and push to your remote repository



~/uname/reponame ~/uname/reponame/.git http://gitlab.eecs.umich.edu/uniquename

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



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`

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

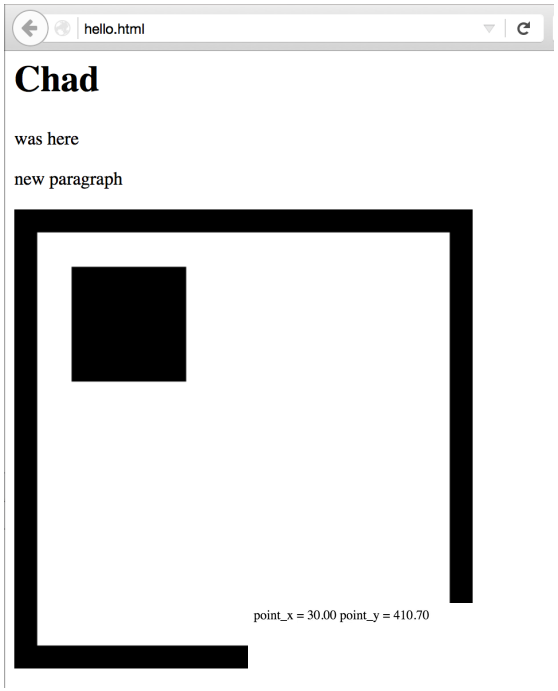
2 commits 1 branch

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

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README.md

My Heap Sort

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

Search

My Heap Sort

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

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
heap (insert 3413): 100 797 459 3413 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 6409
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 9772 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 5185 9772 8465 5949 3911 8320
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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
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heap (extract 4631): 4921 5185 5949 8320 6409 8465 9772
heap (extract 4921): 5185 6409 5949 8320 9772 8465
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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

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

2 commits 1 branch

Branch: master New pull request

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- project_pendularm
- robots
- tutorial_heapsort
- tutorial_js
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- README.md
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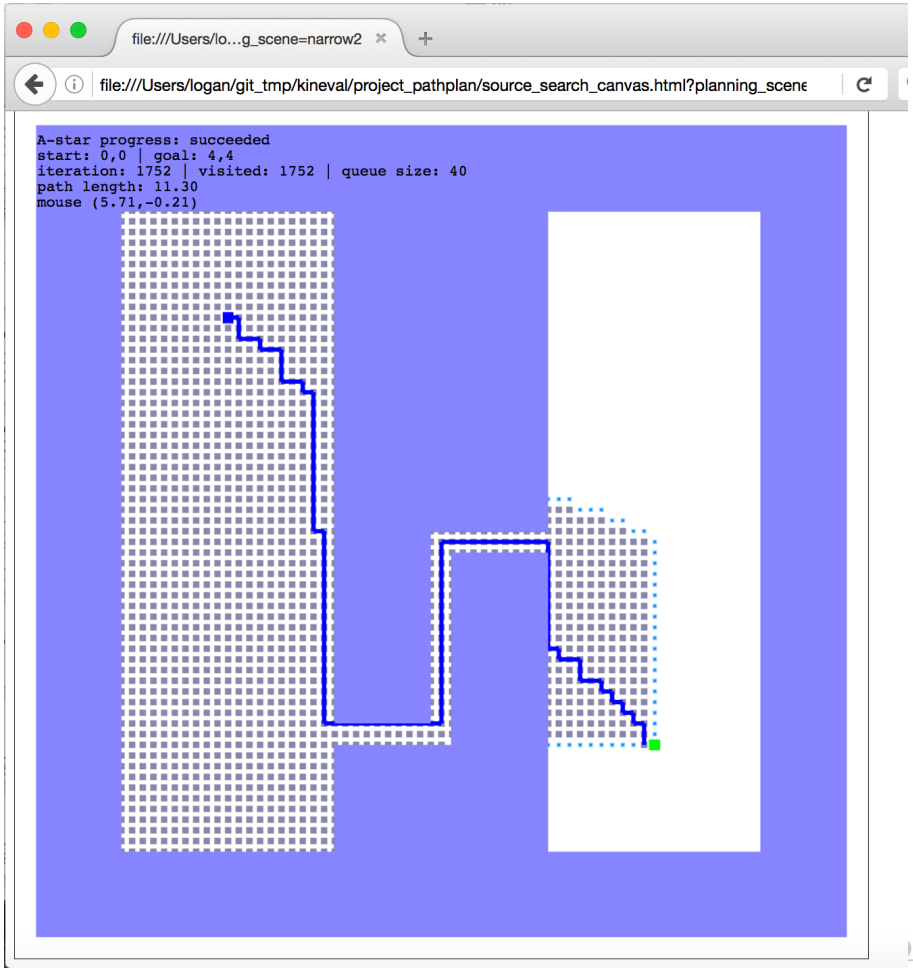
README.md

Project 1:
2D Path Planning



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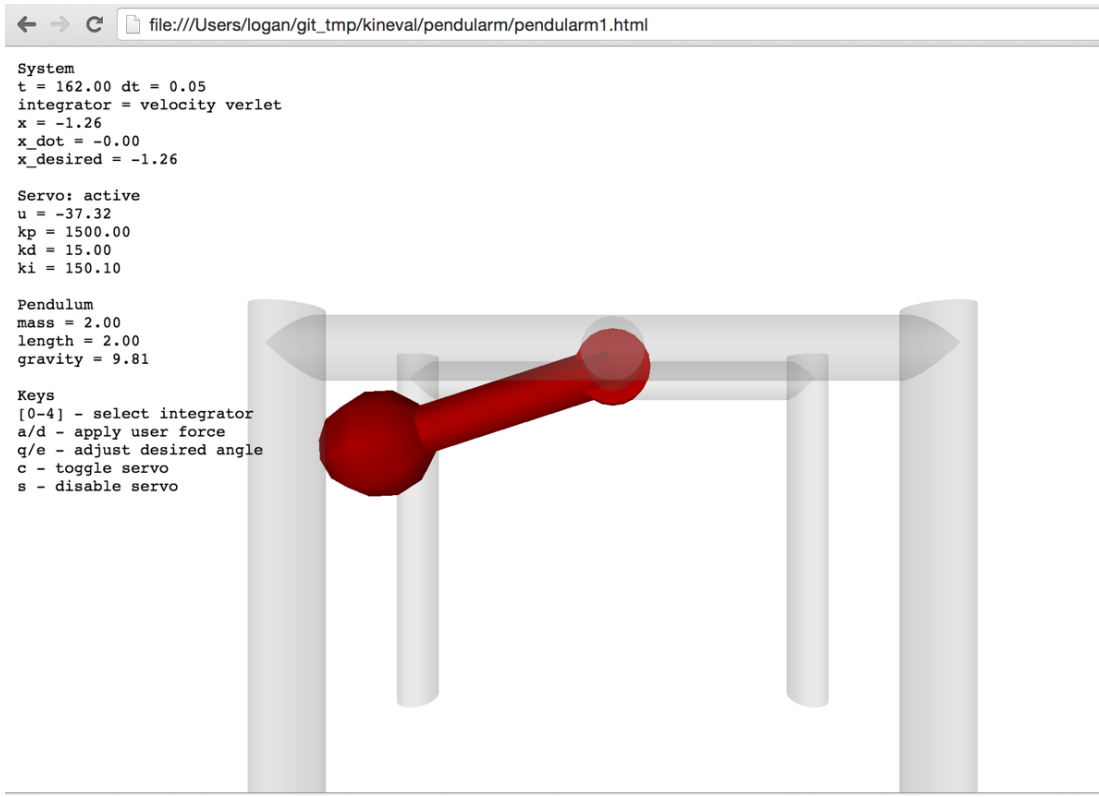
README.md

Project 2: Pendulum Dynamics/Control



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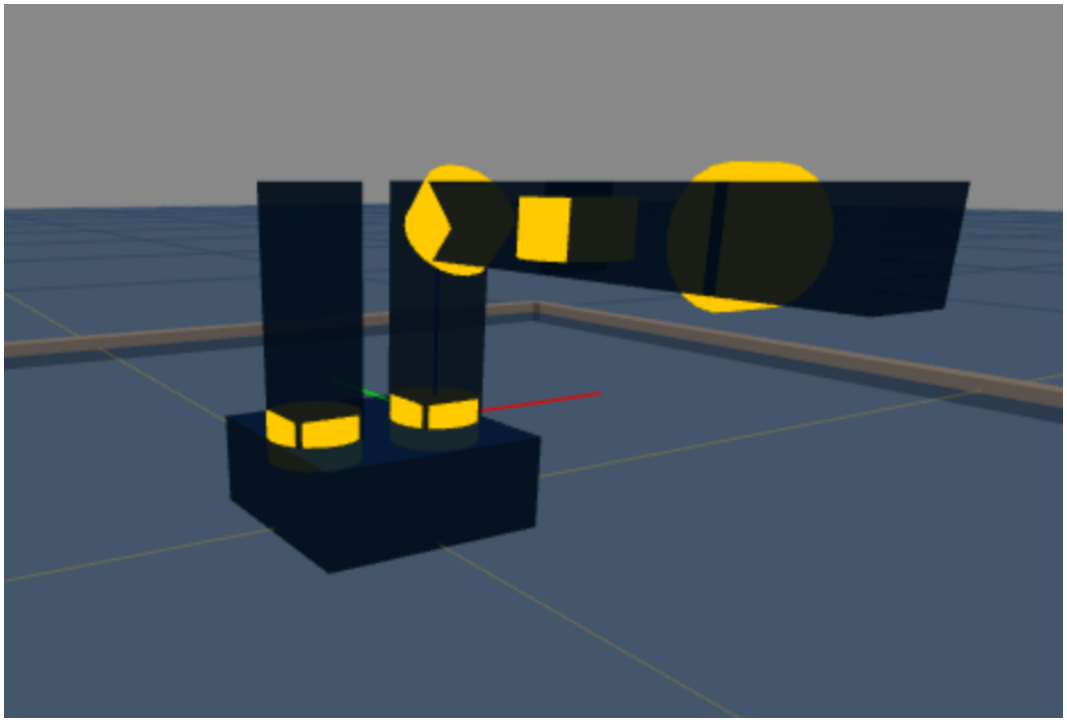
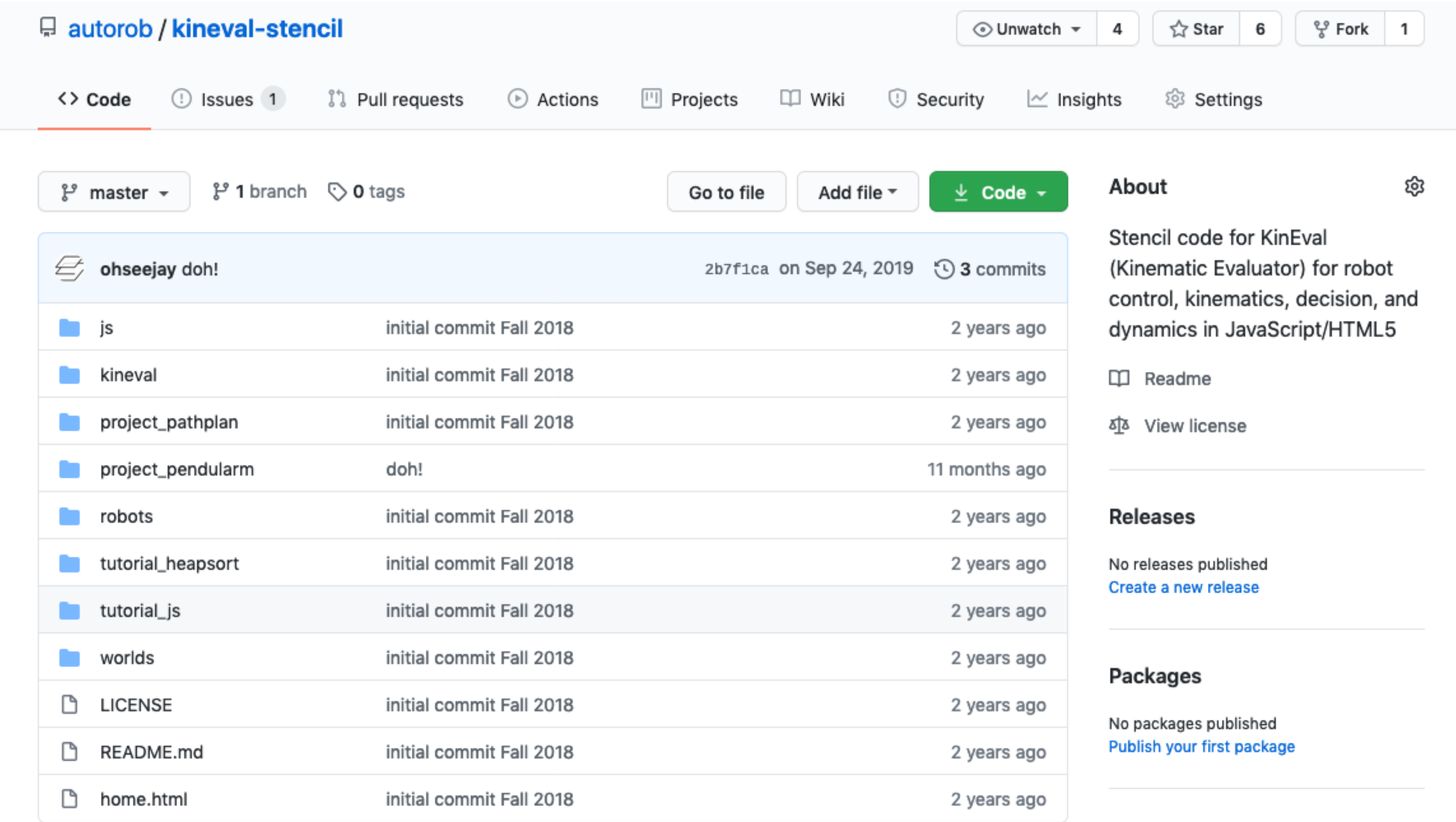
Projects 3-6: Robot Modeling and Control

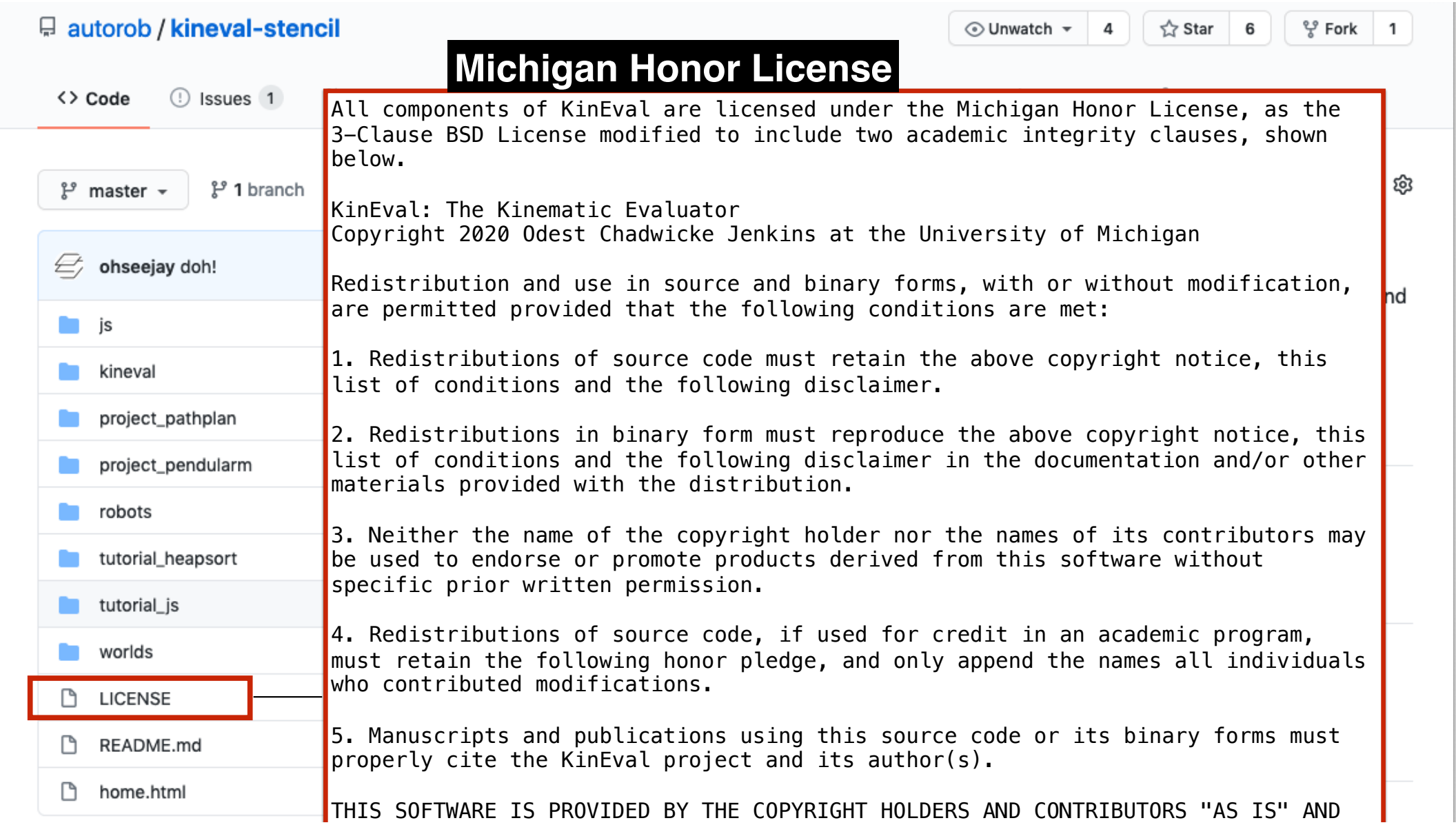


Who owns the code?

Who owns the code?

Both of us


autorob / kineval-stencil
Unwatch 4
Star 6
Fork 1
Code
Issues 1
Pull requests
Actions
Projects
Wiki
Security
Insights
Settings
master
1 branch
0 tags
Go to file
Add file
Code
ohseejay doh!
2b7f1ca on Sep 24, 2019
3 commits
js initial commit Fall 2018 2 years ago
kineval initial commit Fall 2018 2 years ago
project_pathplan initial commit Fall 2018 2 years ago
project_pendularm doh! 11 months ago
robots initial commit Fall 2018 2 years ago
tutorial_heapsort initial commit Fall 2018 2 years ago
tutorial_js initial commit Fall 2018 2 years ago
worlds initial commit Fall 2018 2 years ago
LICENSE initial commit Fall 2018 2 years ago
README.md initial commit Fall 2018 2 years ago
home.html initial commit Fall 2018 2 years ago
About
Stencil code for KinEval (Kinematic Evaluator) for robot control, kinematics, decision, and dynamics in JavaScript/HTML5
Readme
View license
Releases
No releases published
Create a new release
Packages
No packages published
Publish your first package


autorob / kineval-stencil
Unwatch 4
Star 6
Fork 1
Code
Issues 1
master
1 branch
ohseejay doh!
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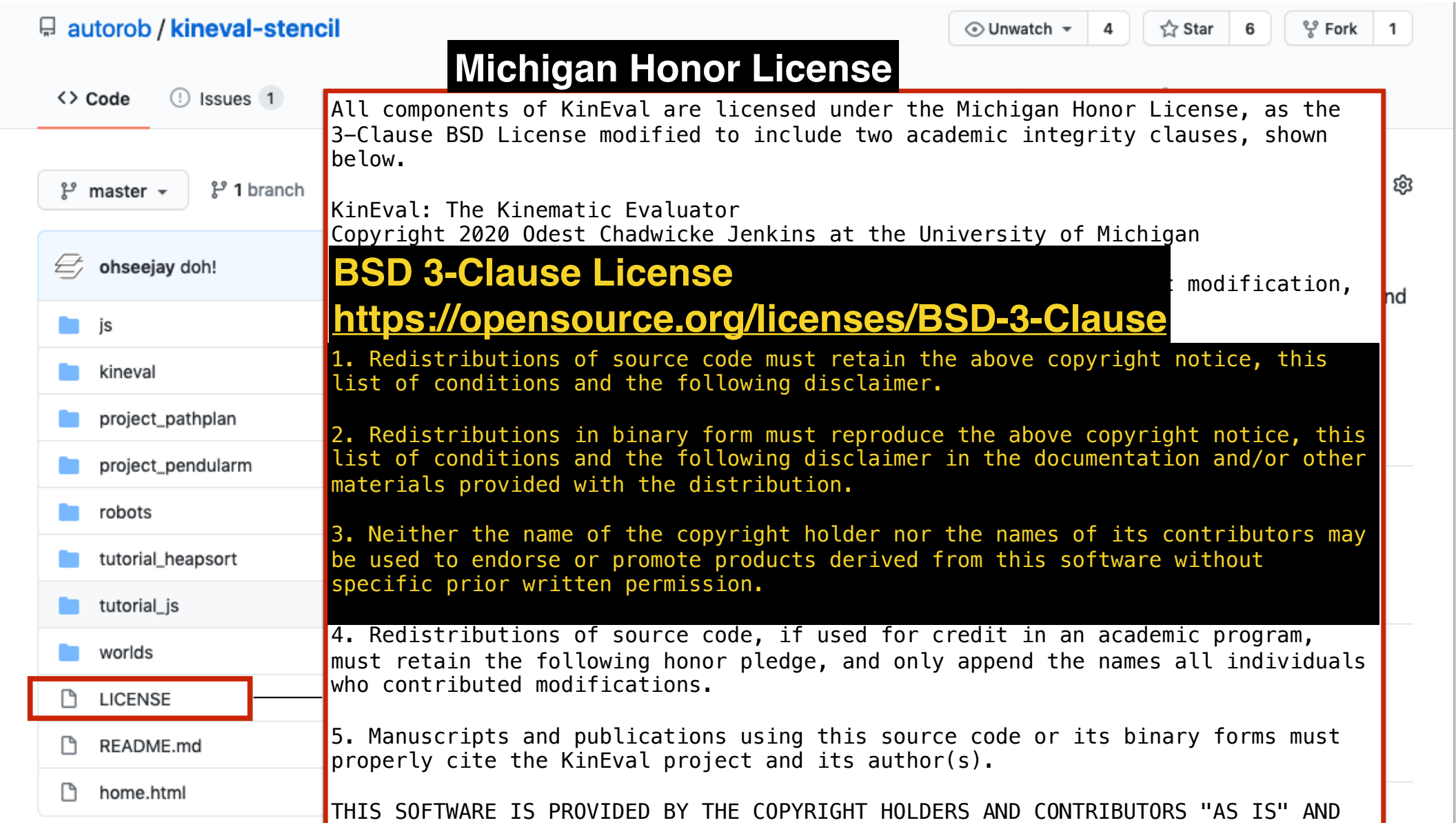
autorob / kineval-stencil
Unwatch 4
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Code
Issues 1
master
1 branch
ohseejay doh!
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kineval
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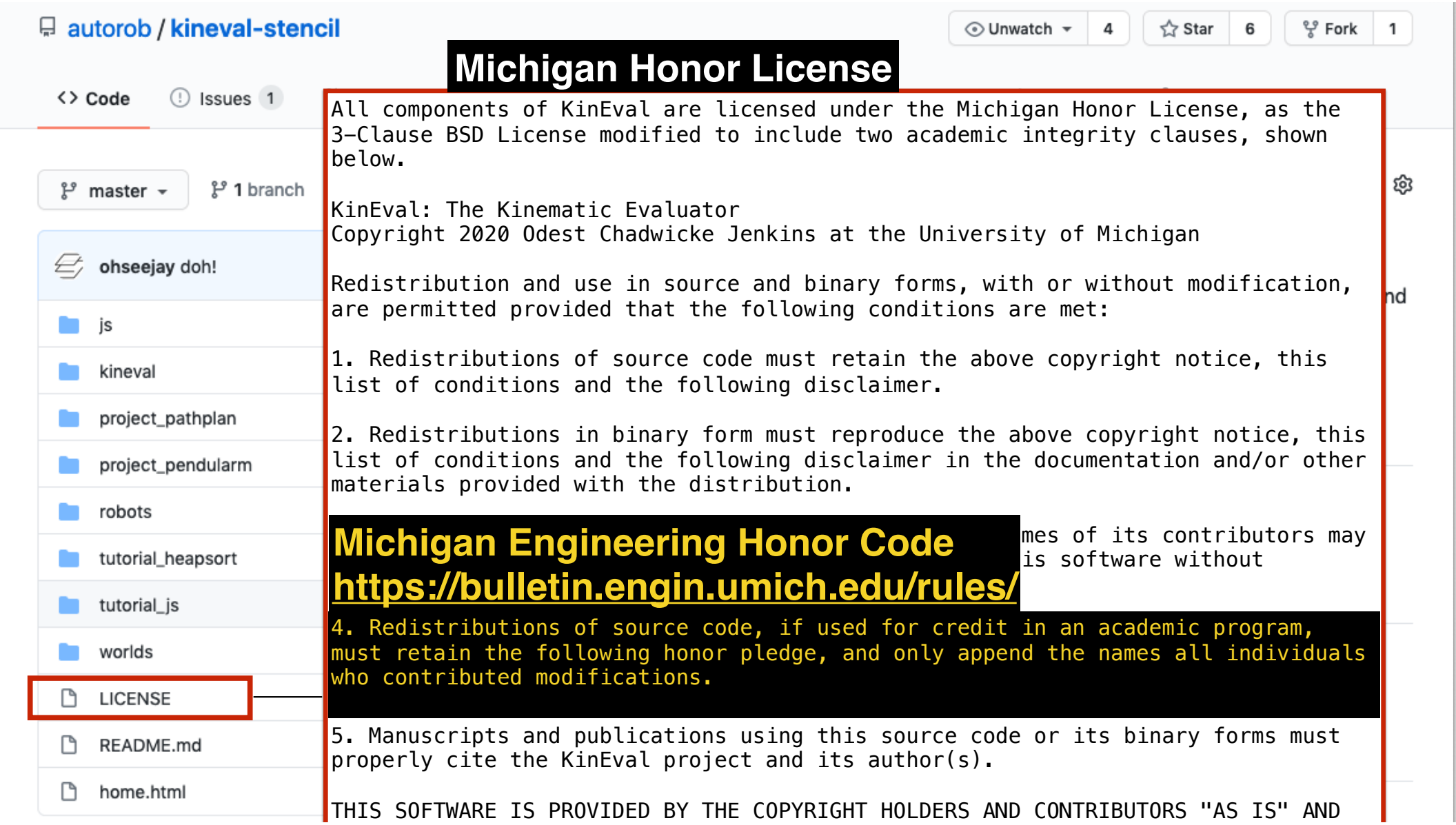
autorob / kineval-stencil
Unwatch 4
Star 6
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Code
Issues 1
master
1 branch
ohseejay doh!
js
kineval
project_pathplan
project_pendularm
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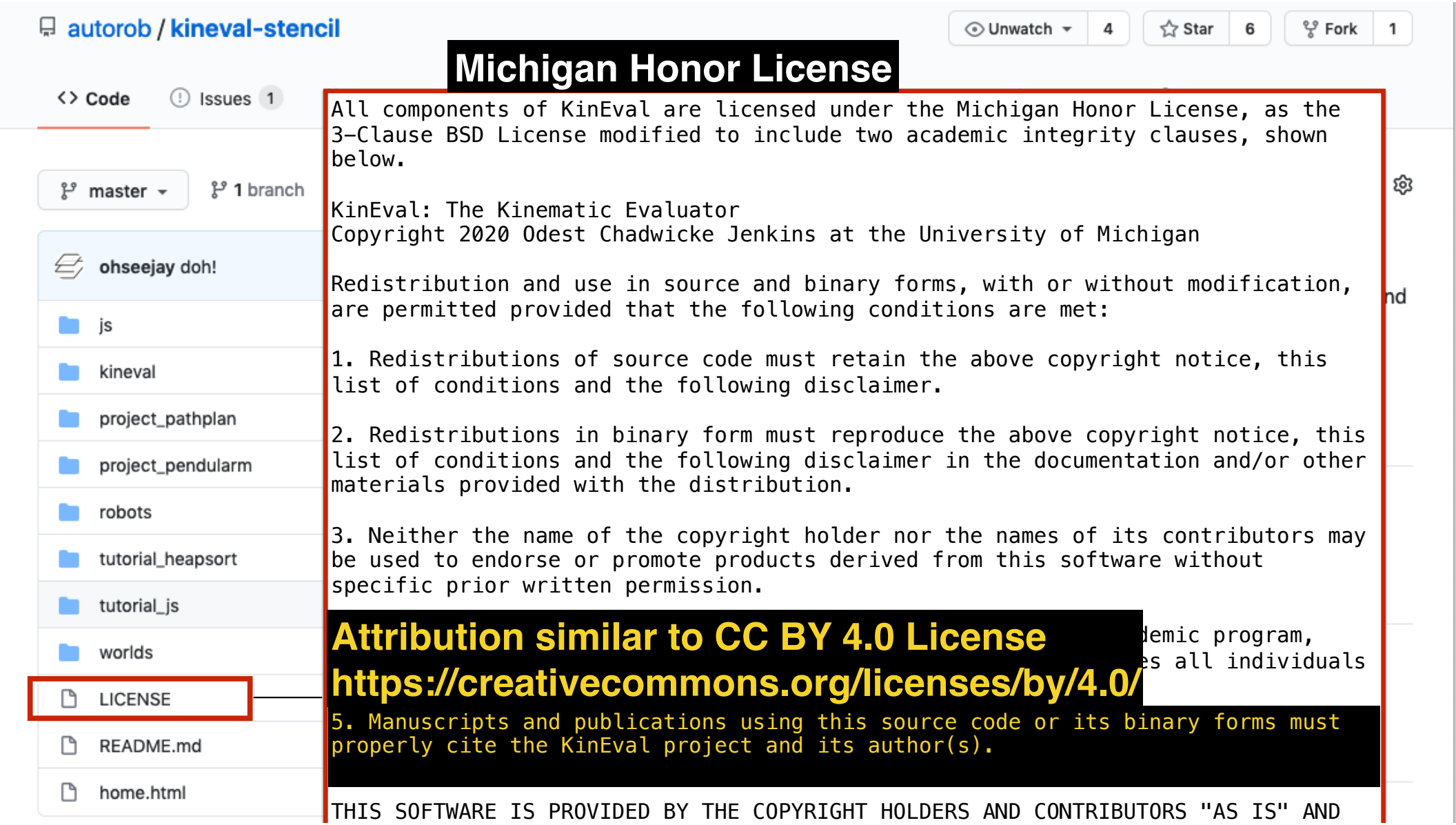
autorob / kineval-stencil
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master
1 branch
ohseejay doh!
js
kineval
project_pathplan
project_pendularm
robots
tutorial_heapsort
tutorial_js
worlds
LICENSE
README.md
home.html
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KinEval: The Kinematic Evaluator
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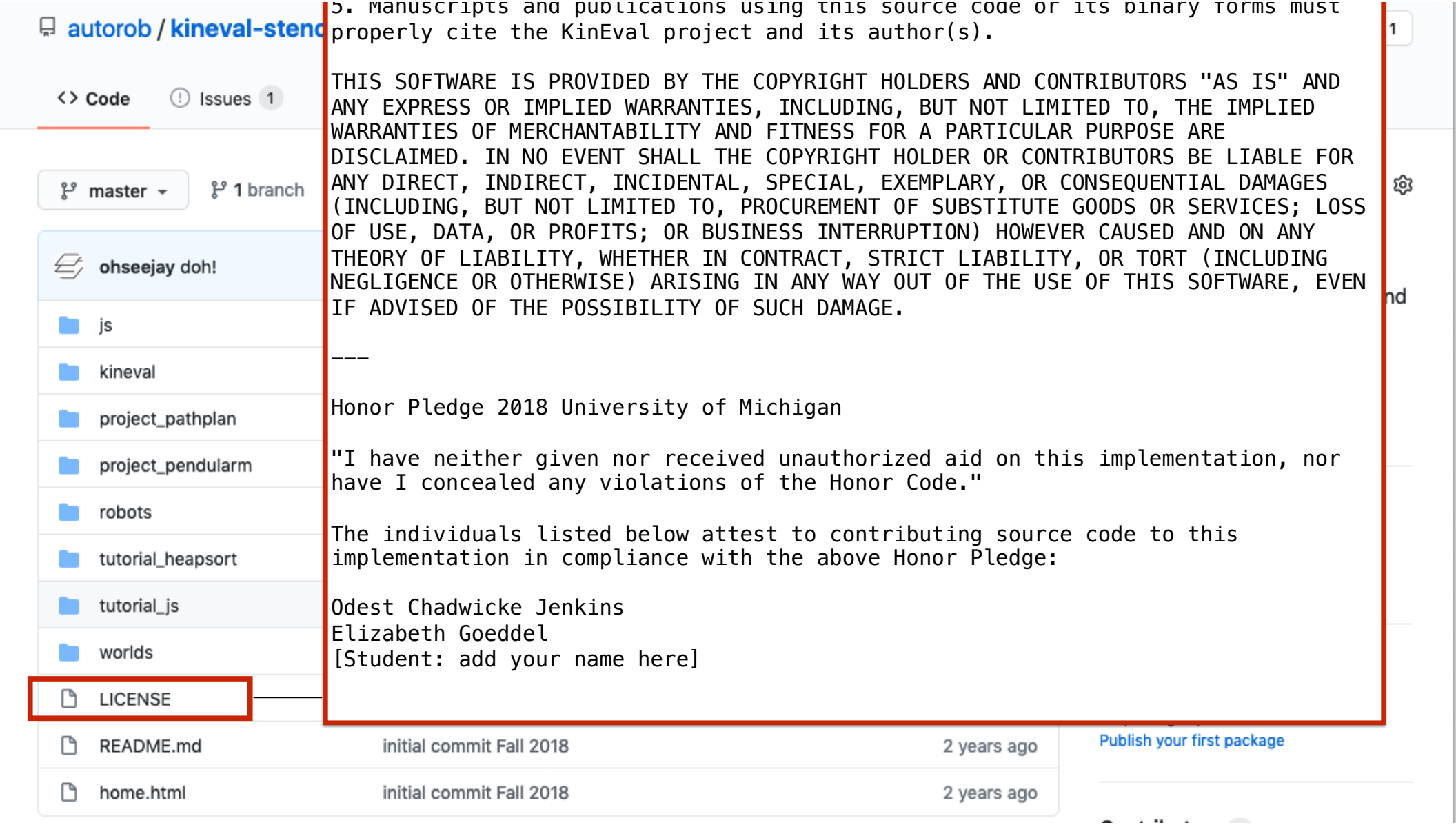

autorob / kineval-stenc

Code Issues 1

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- README.md — initial commit Fall 2018 — 2 years ago
- home.html — initial commit Fall 2018 — 2 years ago

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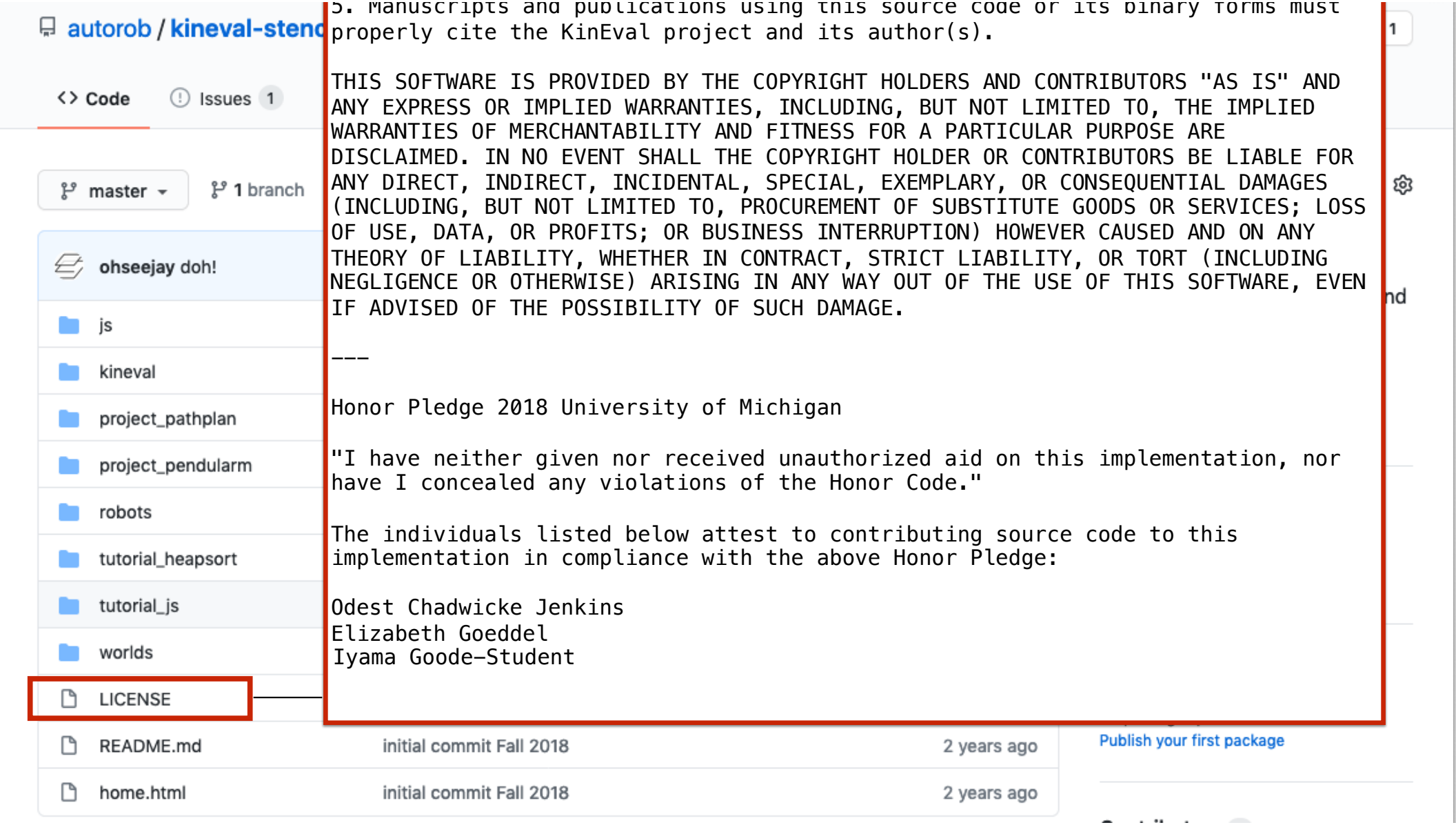
Publish your first package



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Code Issues 1

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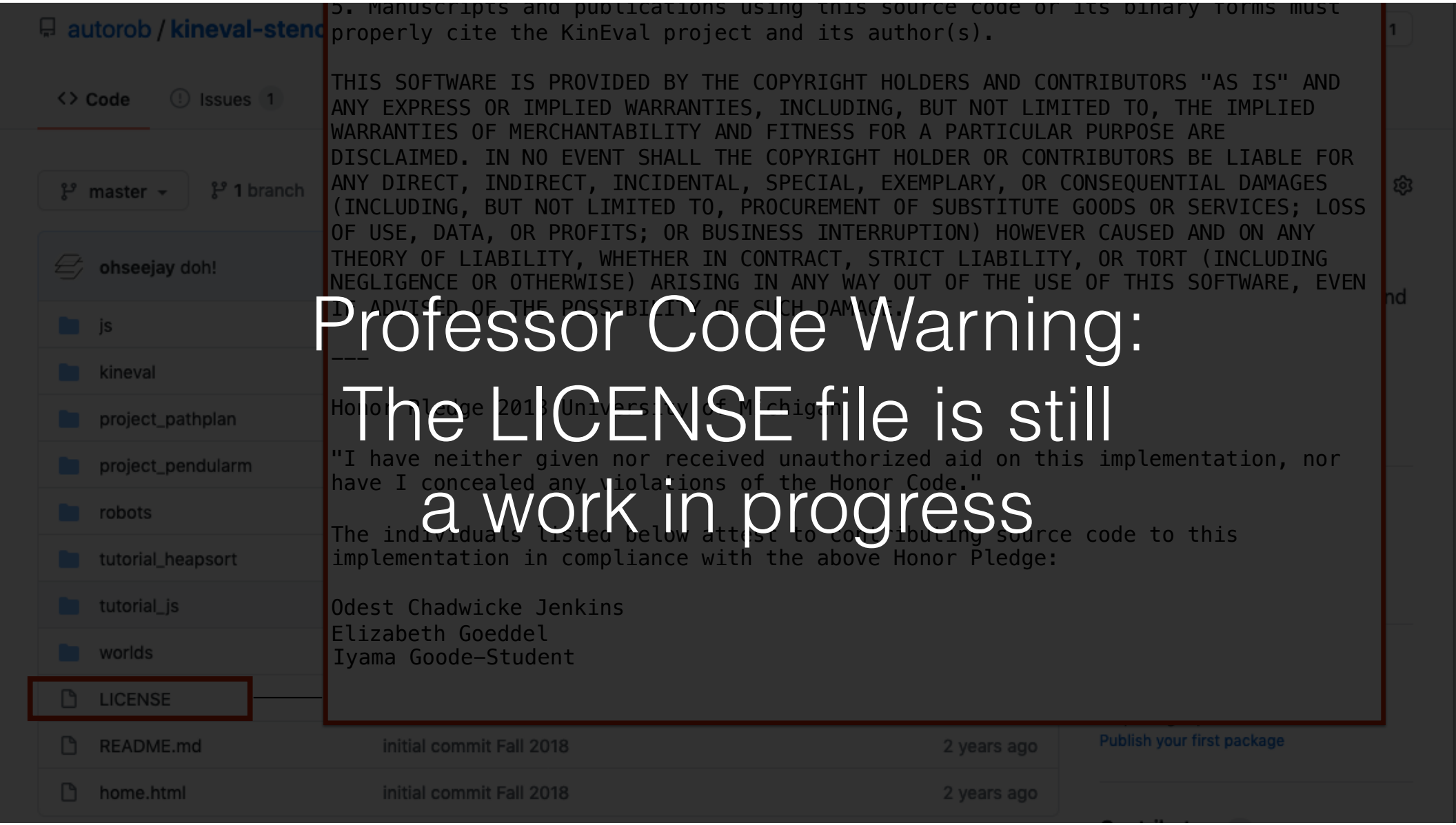


Professor Code Warning: The LICENSE file is still a work in progress

How do you work on your next project while we are grading your last project?

How do you work on your next project while we are grading your last project?

Branching

Branching

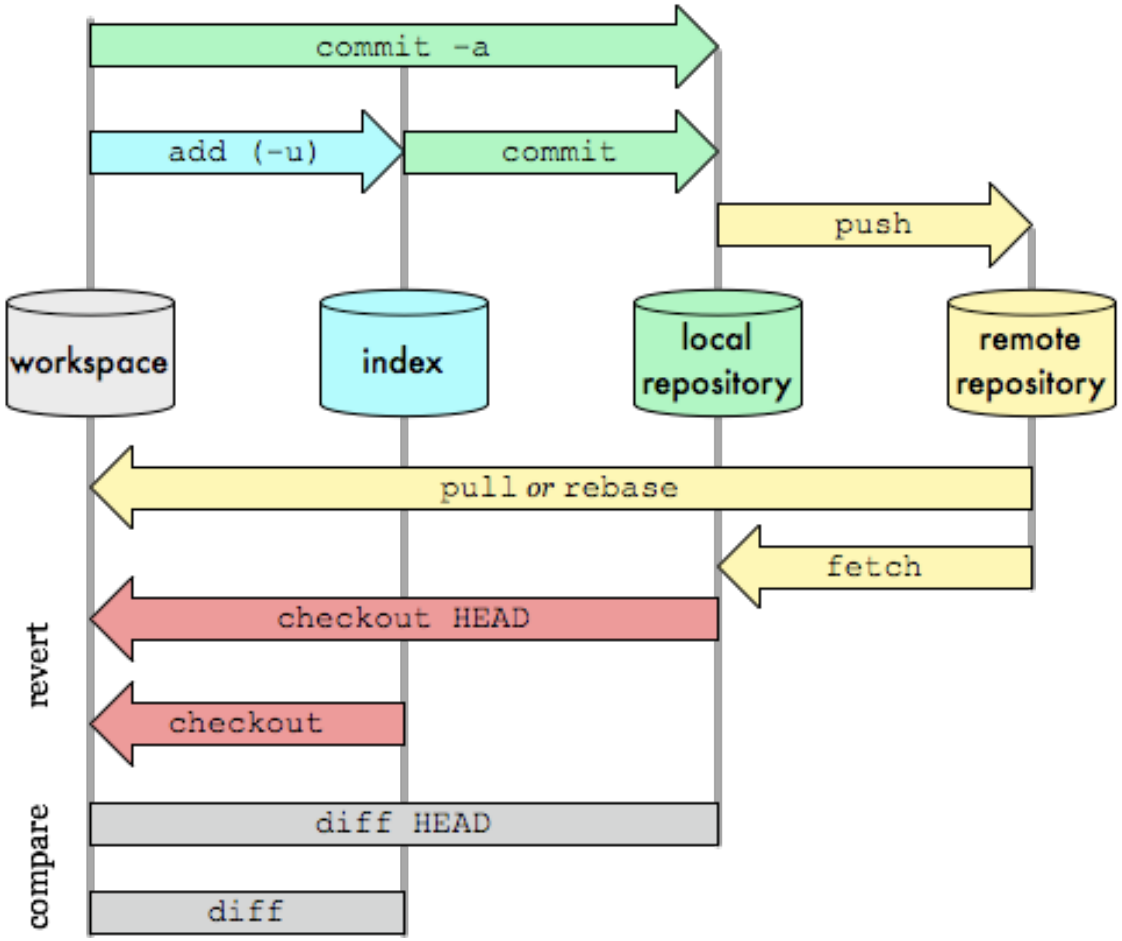
- Helpful for projects with multiple collaborators
- Allows different versions to be modified in parallel
- Branches are tagged with a descriptive name
- A branch is “checked out” into the local workspace
- Conflicts between branches must be resolved in merging (“pull request”)

git basics: commands

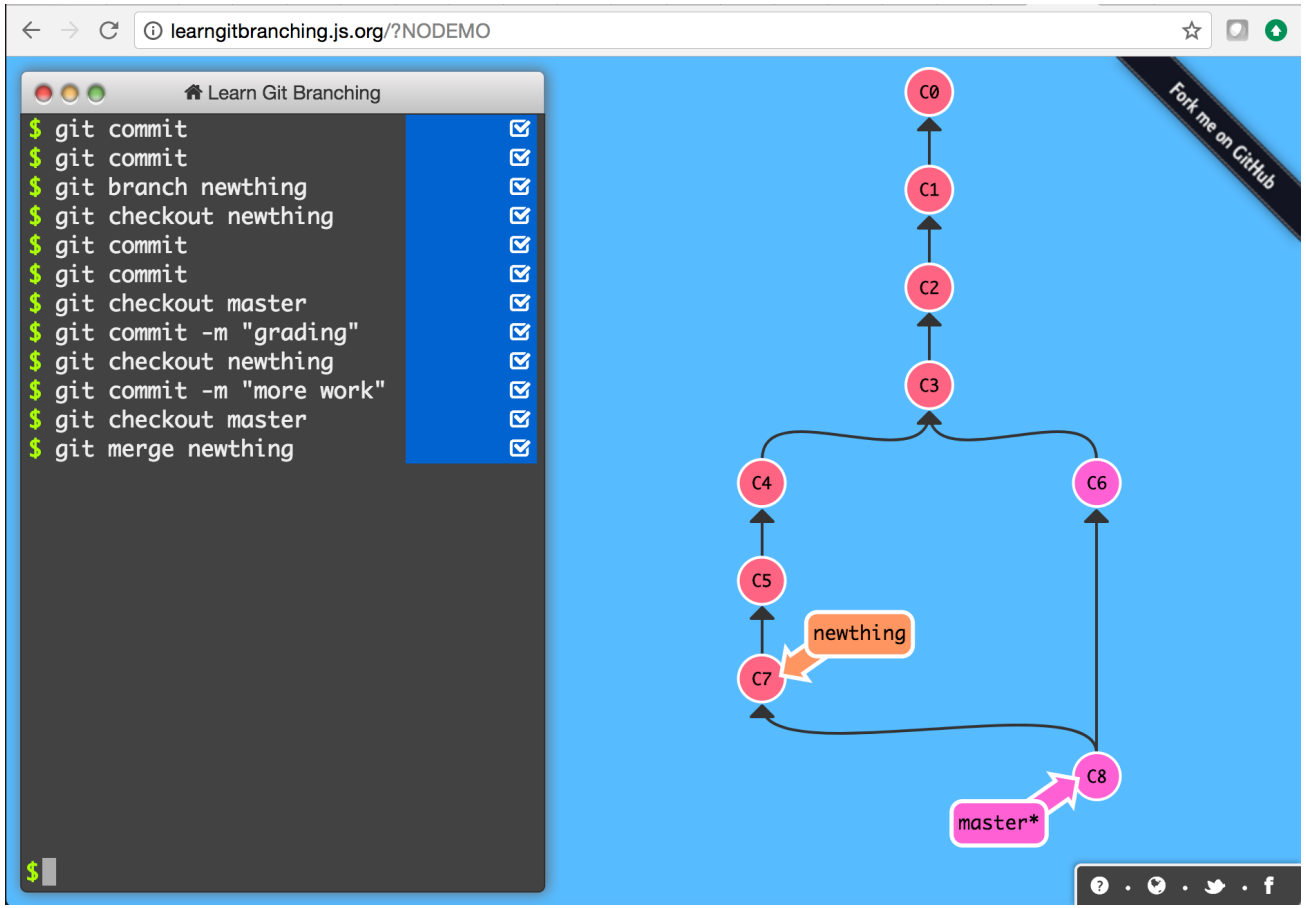
- switch workspace to a branch (or create branch) of a local repository:
  - `git checkout <branch_name>`
- merge another branch into currently currently checked out branch:
  - `git merge <branch_name>`

Git Data Transport Commands

http://osteele.com



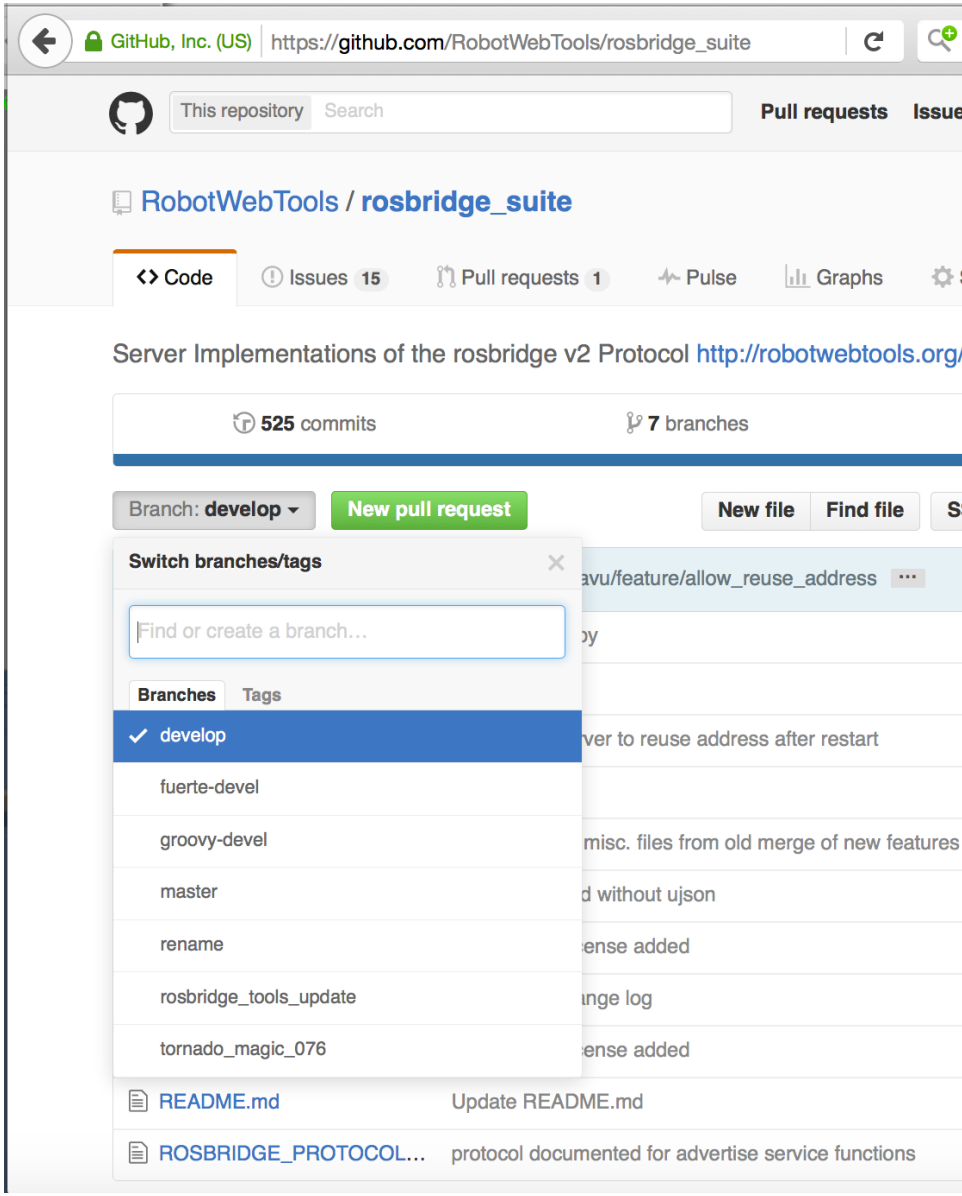
Highly recommended tutorial



http://learngitbranching.js.org/

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

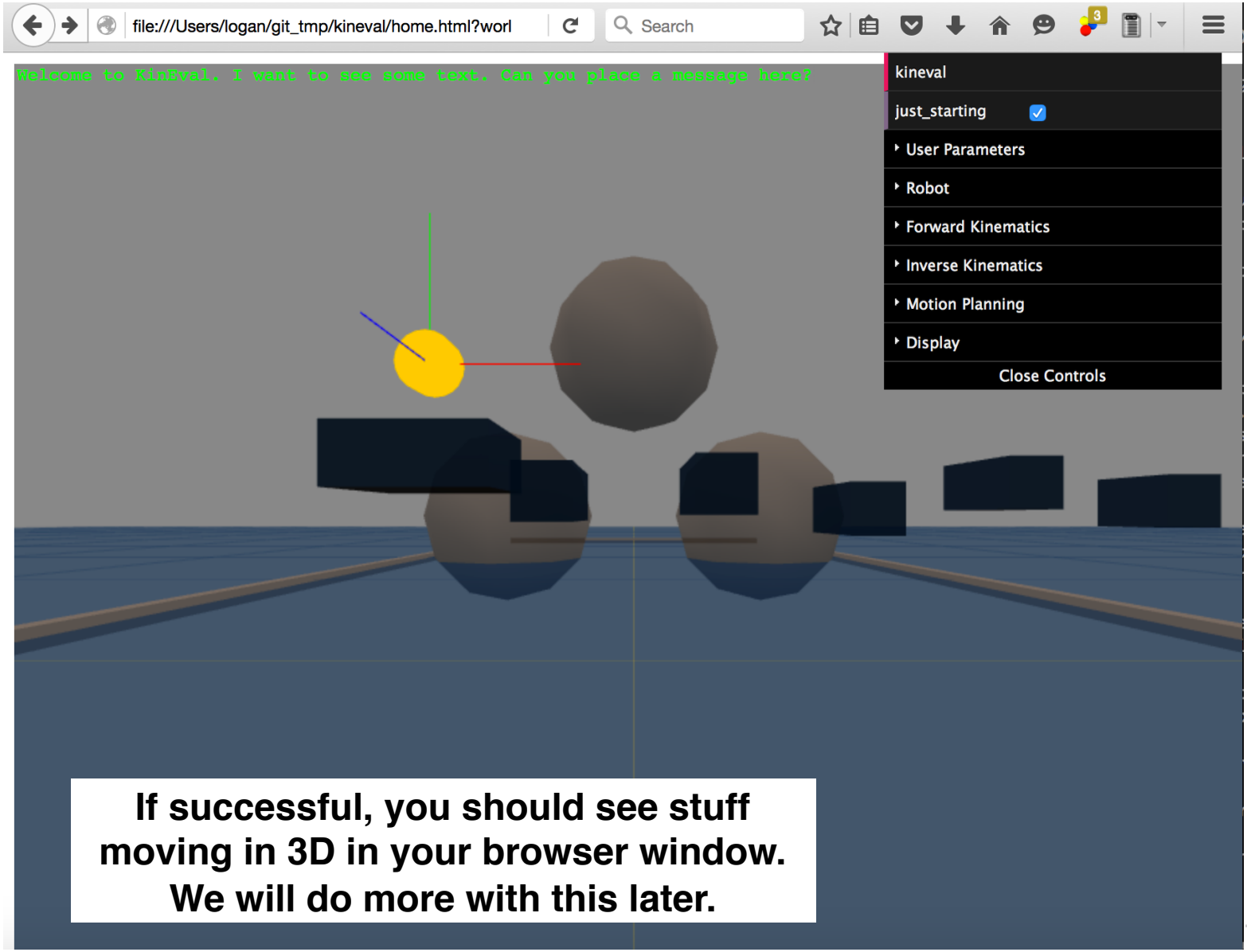
- clone copy of kineval-stencil repository: `git clone <repo url>`
  - for KinEval, you should now see repo contents in cloned directory
  - view “home.html” in a web browser
  - examine “kineval/kineval_startingpoint.js”
- Note: you might need to clone stencil into a temporary directory and copy into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


file:///Users/logan/git_tmp/kineval/home.html?worl
Search
Welcome to KinEval. I want to see some text. Can you place a message here?
kineval
just_starting
User Parameters
Robot
Forward Kinematics
Inverse Kinematics
Motion Planning
Display
Close Controls
If successful, you should see stuff moving in 3D in your browser window. We will do more with this later.


Happy hacking and make progress!