CTD Intro Week 1

Programming Fundamentals:

JavaScript Basics

Programming Fundamentals

- Write programs with future maintainers in mind
  - Clarity, simplicity, comments
  - Most programming involves updating/fixing code someone else wrote
- Understand the problem
  - Inputs, outputs, user interface, steps from inputs to outputs
- High-level steps
  - Pseudocode
- Divide and conquer
  - Code and test simpler components which taken together solve the problem
- DRY – Don’t Repeat Yourself
  - Capture reused components in one place
    - usually a function or method
  - Don’t copy and paste

JavaScript

- Javascript is not java!
- Invented in 1995 at Netscape
  - Called javascript because java was new, popular and exciting
    - But it is unrelated to java
- Standardized as ECMAScript (ECMA-262) in 1997
  - European Computer Manufacturers Association (ECMA)
- Important revisions
  - ES5 (2009)
    - Var for non-global scope, function scope only
  - ES6 (2015)
    - Lexical (block) scope with let and const
    - class, module
    - Anonymous function shorthand, arrow notation (a, b) => { }
- Most popular computer language
- Lots of built-in capabilities
- Rich set of packages available
- Highly optimized, good performance
- In all browsers
- Node.js for servers and command line apps (Google javascript engine)

Some JavaScript facts

- First class functions
  - Functions can be assigned to variable (not true in every language!)
    - myObject.func returns the function
    - myObject.func() calls the function
- Very permissive
  - Doesn’t, by default report errors on many things which are probably wrong
  - Automatic conversions between types
  - Doesn’t check type or number of function arguments
    - Fills in with undefined values if necessary
  - Typescript was invented to fix this
- Convenient object model
  - Any mix of indexed arrays […] and associative arrays {…}
    - Mixed datatypes
  - So simple and useful it became a data exchange standard
    - JavaScript Object Notation (JSON)

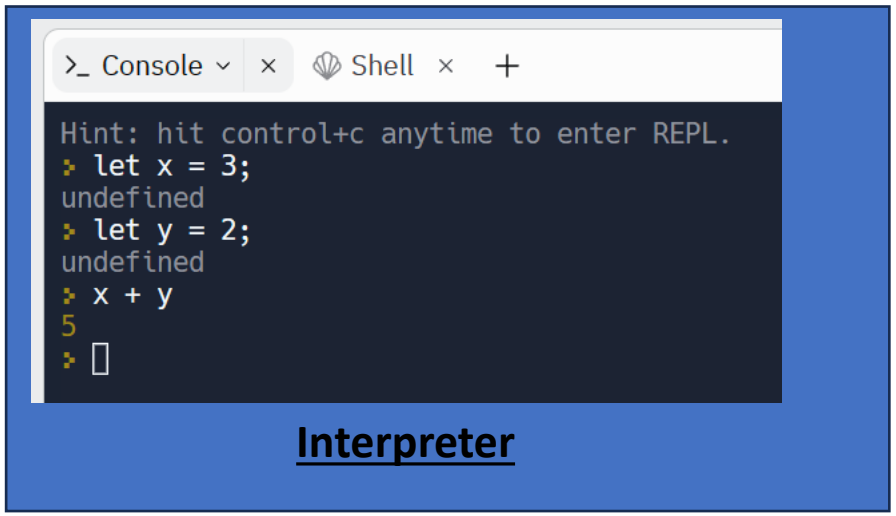
The 8 Data Types in JavaScript

- Number
  - Double precision floating point, also used to represent integers
- String
  - Characters (and anything representable by Unicode)
- Boolean
  - True/false
- Undefined
  - Its type is ‘undefined’, Lack of a value, never assigned, tests as false
- Null
  - Its type is ‘object’, absence of an object, tests as false
- Object
  - Combinations of indexed and associative arrays
- Symbol
  - Unique, immutable value to use as a key for objects
- BigInt
  - Integers with unlimited precision (subject to resource limitations)
- Use typeof(<name>) to find out what a variable’s datatype is
  - Where <name> is a placeholder for any variable name or literal

Behind the Scenes

- Don’t need to know details of compilation and data types for the intro class!
  - Context and background
- Different datatypes have varying internal representations
- Use explicit conversions between datatypes

Software to Hardware



Interpreter

```
// This function adds two numbers and returns the result
function add(x, y) {
  // Push the arguments to the stack
  LdaSmi x
  Star r0
  LdaSmi y
  Star r1
  // Add the two values and return the result
  Add r0, r1
  Return
}
```

Javascript Virtual Machine

```
int add(int x, int y) {
    return(x + y);
}
int x = 3;
int y = 2;
add(x, y);
```

Compiler – C++

```
define double @add(double %x, double %y) {
  ; Add the two values and return the result
  %1 = fadd double %x, %y
  ret double %1
}
```

LLVM – Low Level Virtual Machine

```
addsd %xmm1, %xmm0 ; add xmm1 to xmm0 and store in xmm0
```

Assembler

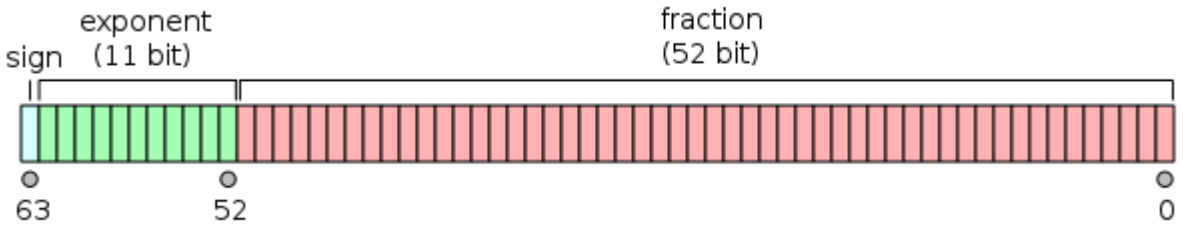
```
f2 0f 58 c1
```

Hexidecimal Machine Code

```
11110010 00001111 01011000 11000001
```

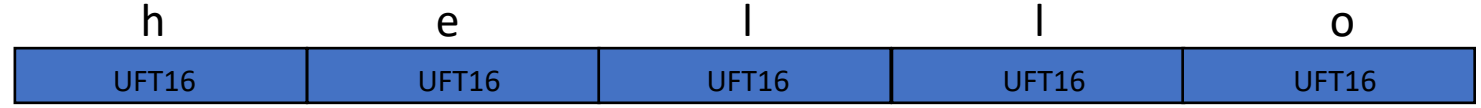
Binary Machine Code

Data Types Generically and in JavaScript



Floating Point – Number in JavaScript

Integer – Not used for JavaScript Numbers



Can also be UTF8, UTF32…

String – Characters in memory

Object Header

Objects – combinations of indexed and associative arrays

Explicit Conversions

- Number()
- String()
- parseInt()
- parseFloat()
- Boolean()
- <num>.toFixed(<decimalPlaces>)
  - String with fixed formatting
- Math.floor()
- Math.round()

JavaScript Syntax

- airbnb/javascript: JavaScript Style Guide (github.com)
  - Common set of conventions for code
- Use lesson content for a comprehensive syntax guide
  - Just highlights in the presentation
- Variable naming
  - Use camelCase, longNameCamelCase
  - Use UPPERCASE constants to remember values (sometimes globally)
    - Const FINESTRUCTURECONSTANT = 1.0/137.0;
  - Case sensitive: thisVar is not the same as thisvar
  - Reserved words, can't use parts of the language as variable names
    - let let = 5; // won't work

JavaScript Syntax – Strings

- Literals
  - ‘a string’ and “a string” the same except
    - Need to escape quotes inside strings, so
      - “isn’t” works without escaping
      - Vs ‘isn\’t’
    - JSON only accepts “”
  - `allows interpolation of ${anyVar}` // string representation is inserted
    - Can also interpolate expressions
- Concatenate using ‘+’
  - Foobar = ‘foo’ + bar’;
- Accessing individual characters
  - charAt() method or []
- Length attribute (works for string and arrays)
  - “abcde”.length will return 5

More Syntax

- Operator precedence
  - When in doubt, use ( ) to group
- ‘;’ at the end of every statement line
  - Not worth worrying about where they can be left out
- Functions and methods
  - Variables can contain functions (first class functions)
    - Call by adding (), can contain an argument list (arg1, arg2…)
    - aFunction is a variable, running it returns the function
    - Running aFunction() calls the function
  - Methods are functions which are part of an object and which act on it
    - Let num = 63;
    - Num.toFixed()

Variables and Scoping

- Variables give a name to a value
  - The value will have a data type
- Variable scoping
  - Defines the places a variable name is recognized
- Global scope
  - Dangerous and not advised
  - Valid everywhere, changing a global might impact code anywhere which references it
- Lexical scope
  - Value is local to a block { … }
  - Preferred
  - Defined using let or const
- Function scope
  - Defined using var
  - Value is defined anywhere in the enclosing function
  - Obsolete in most cases. Use let and const.

Let and Const

- If you don’t expect the value change, use const
  - For single values it can’t be changed
  - For objects, it is a constant reference, which means it’s the same data structure, but the content can be changed.
- Use let for everything else
  - Lexically (block) scoped
  - Scope the variable as narrowly as possible, but not too narrowly

```
let stabelAcrossLoop = 1;
while(someTest()) {
    let newEachLoop = 0;
    stableAcrossLoop = someFunction(stableAcrossLoop, newEachLoop);
}
// newEachLoop is undefined here
// stableAcrossLoop contains the value returned by someFunction during the last loop
```

Truth and Equality

- Javascript does lots of automatic conversions
  - == can produce unexpected results
    - 0 == ‘’
    - null == undefined
    - [] == ![]
    - [2] == 2
    - \n == 0
  - Almost always, use ===, checks for same type and value
- What is truth?
  - true (false) – explicit
  - true: non-zero Number, non-empty string, any (even empty) object
- Logical operators &&, ||, ! To create logical expressions
  - Short circuit – only executes what is needed to determine the final value
    - false && ‘this never runs’
    - false || ‘this does run’
- Truth values are used in if/else statements and loops

```
if (pair1[0] === pair2[0] && pair1[1] === pair2[1]) {
  return true;
}
else {
  return false;
}
```

```
// Anatomy of a function declaration
function aNewFunc(parm, anotherParm) { // parameter definitions
    // This is the function body, it has its own scope inside { }.
    // Computations are performed here in the body and the result is returned
    // A return statement can occur anywhere and multiple times.
    // Return exits the function and provides a value.
    // Return is not required, but if not specified, 'undefined' is returned.
    return parm + anotherParm;
}
```

Functions

- DRY Principal – Don't Repeat Yourself
- A way to encapsulate and reuse a piece of code
- Parameterized
  - Parameters define values which can be passed to the function
    - Function myFunc(parameter1, parameter2)
      - Parameters 1 and 2 can be referenced inside the function body { …. }
  - Arguments are the actual values used when a function is called
    - let result = myFunc(53, "myString");
- Returns a value using a 'return' statement

Defining Functions

- Named function declaractions
- Anonymous function declarations
- Shorthand function declaractions (arrow notation)
  - function(a, b) {a + b}
  - (a, b) => {a + b}
- Hoisting
  - Definitions are hoisted to the beginning of the scope
- Missing or extra parameters
  - Filled in with undefined unless defaulted
- Default values
  - function(a = true, b = 63) { … }
- Can use typeof() to check arguments
  - If (typeof(param1) != ‘string’) {throw…
- Throwing an error:
  - throw new Error(“an error message”);

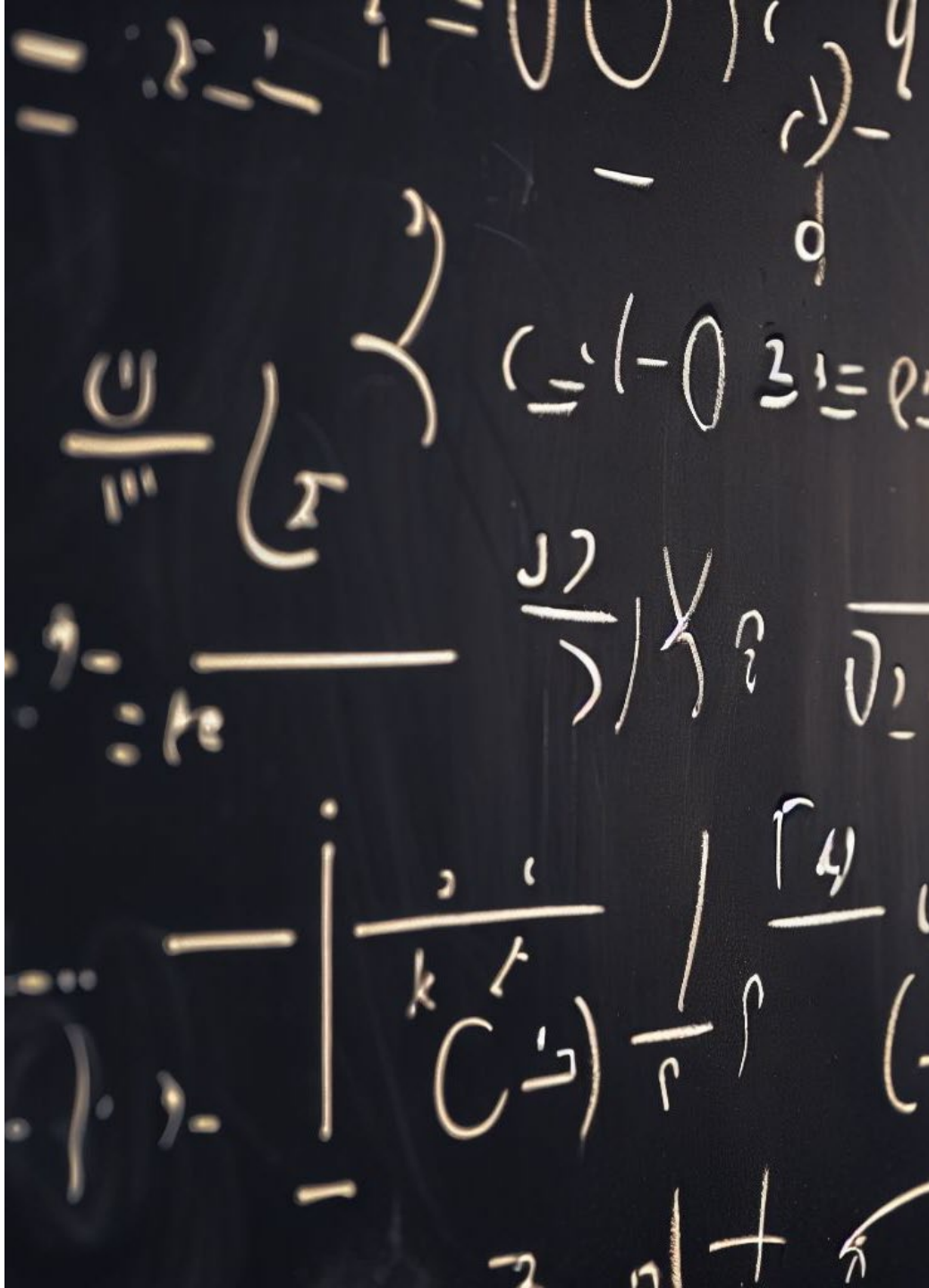
```
// anonymous function assigned to a lexically scoped variable
let funcInAVar = function(oneParam, twoParam) {
    return hoistedFunc(oneParam * twoParam);
}

// functions can be passed as parameters
// It is common in JavaScript
// Shorthand notation was invented to make it less verbose

// anonymous function calling in setTimeout
for (var i = 0; i < 10; i++) {
    setTimeout(function() {
      console.log(i);
    }, 1000 * i);
}

// shorter and simpler with => notation
for (var i = 0; i < 10; i++) {
    setTimeout(() => console.log(i) , 1000 * i);
}

// This named function can be called before it is defined.
// This is called hoisting.
function hoistedFunc(param) {
    return Math.random() * param;
}

// this function has defaulted parameters
function defParam(p1 = 53, p2 = "Tom") {
    return `${p2}'s favorite number is ${p1}`;
}
```

Dates and Times

- Unix time (epoch)
  - The number of seconds since 1/1/1970
  - Date.now() returns the number of milliseconds since 1/1/1970
- Date module
  - let today = new Date() creates a date object at the current date and time
  - today.getTime() unix epoch at the time ‘today’ was created
  - getFullYear(), getMonth(), getDate(), getDay()
  - getHours(), getMinutes(), getSeconds(), getMilliseconds()

The Math module

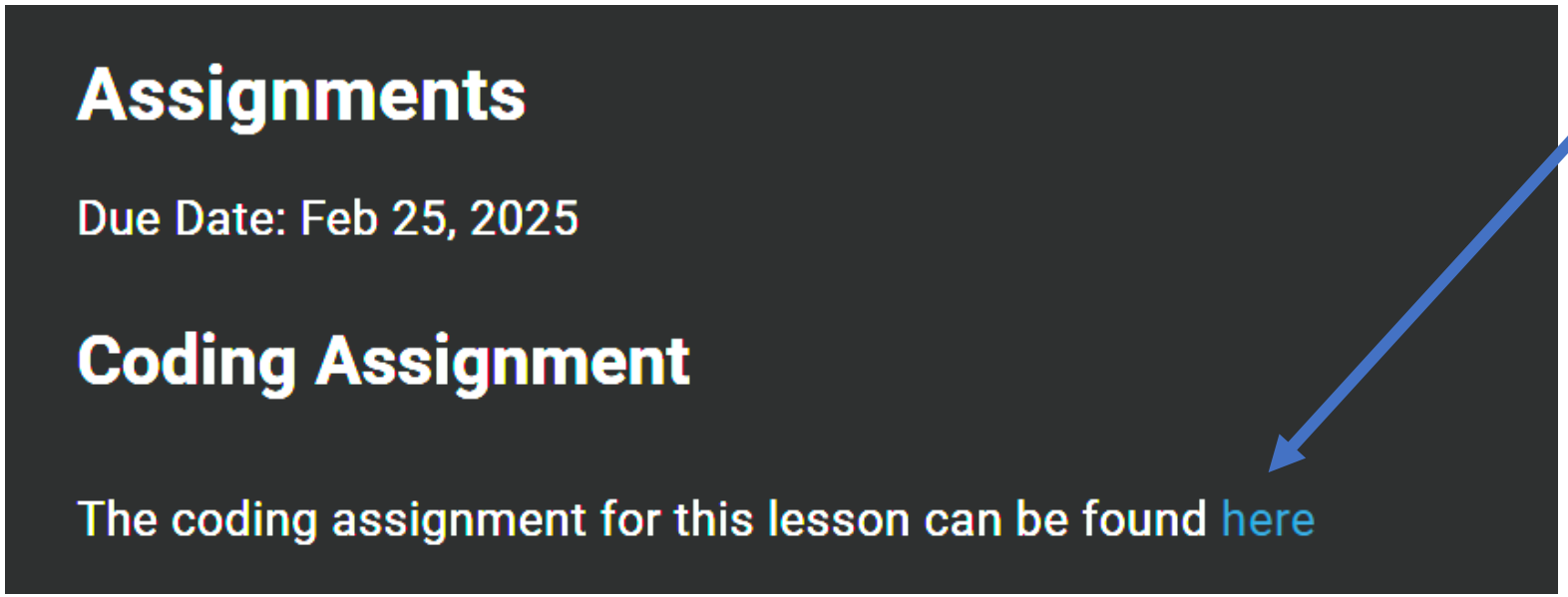
- Math.random()
  - Returns a floating point number from zero to 1
    - Zero is included, 1 is excluded (0.0 -> 0.9999999999)
    - Often scaled to create a random integer in a range
      - Math.floor(scaleInt * Math.random()) + 1 // integer in the range 1 -> scaleInt
- Math.floor(num) // next lower integer, remove fractional part
- Math.round(num) // rounds up or down depending on >= 0.5
- Math.abs(num) // absolute value
- Math.max(n1, n2, …) // maximum of the list of numbers

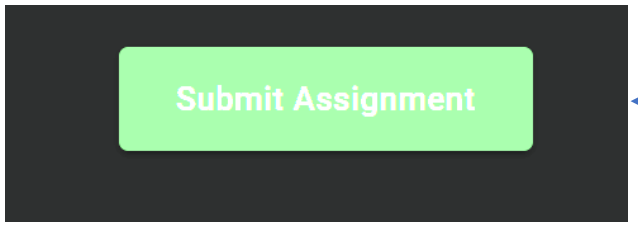


Coding Assignment

- The coding assignment is at the bottom of each lesson page

Click here to go to the codesandbox or github lesson

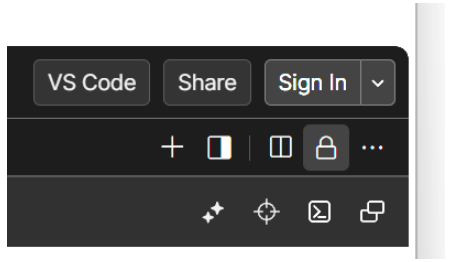




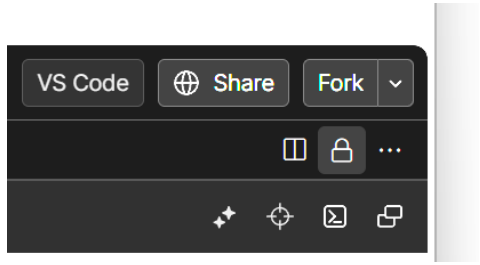
Click here for the assignment submission form (bottom right)

Using CodeSandBox

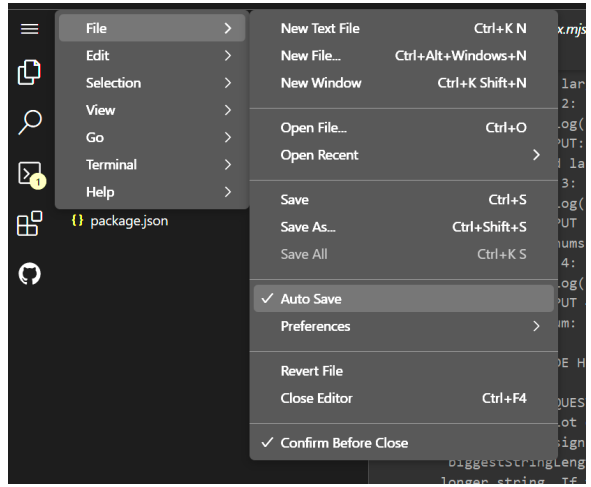
- Login using google or github:



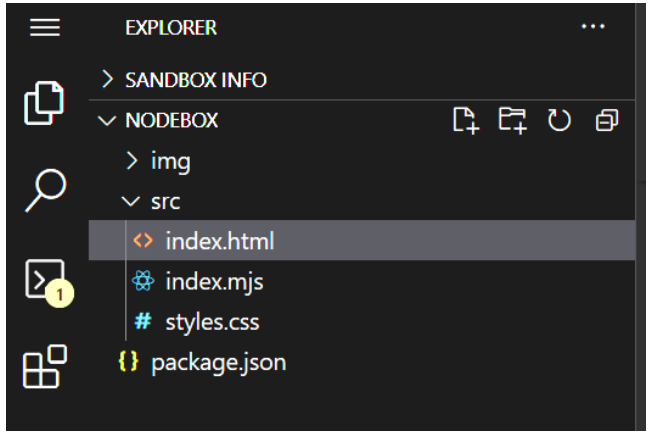
- Fork the lesson
  - Make your own copy



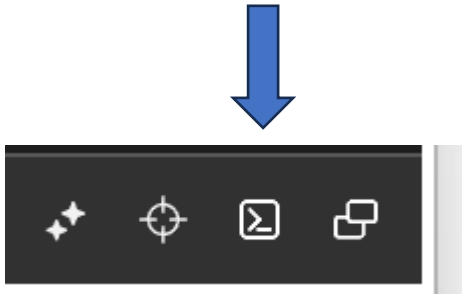
- Editing window
  - Central window where you write your code
  - Turn on word wrap (alt-z on Windows, cmd-z on Mac, or in the menu view->word wrap)
  - Check/turn on autosave in the file menu



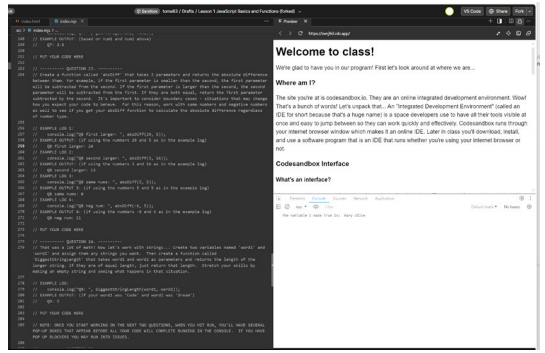
  - Edit index.mjs by clicking on it
- File browser



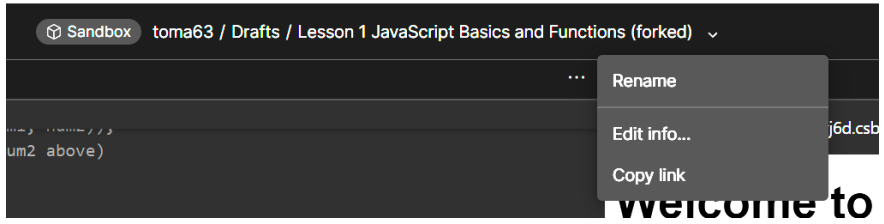
Using CodeSandBox

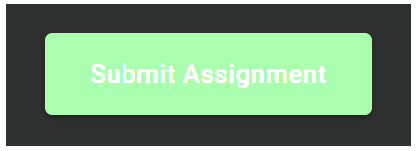


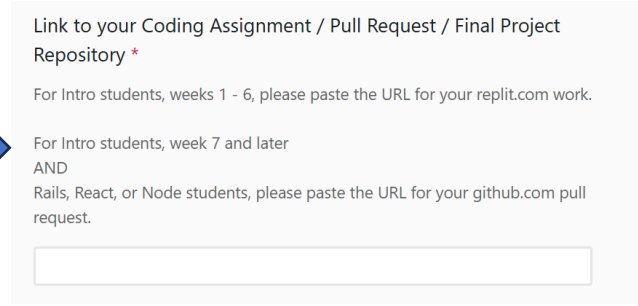
- Open devtools to see console logs
- The console appear in the lower pane on the right



- The console updates are live, so you may see errors while typing
- Once you are done with the lesson and all results have been logged to the console, paste your forked sandbox into the lesson submission form.





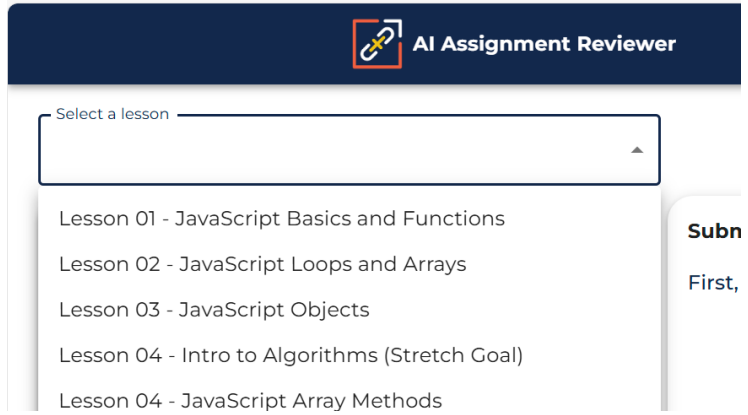


CodeSandBox Video

- Here’s a video explaining how to use CodeSandBox
- CodeSandBox Video

AI Reviewer

- Quick way to get detailed feedback
- Experimental
  - Check with Mentors or CILs if you think it's incorrect
  - Can file issues using the bug icon
- Your official code reviews are done by a human mentor
- Access it here: AI Assignment Reviewer
- Select your lesson in the dropdown
- Paste your code into the middle pane
- You can ask follow-up questions in the chat
  - Right side pane



Debugging

- Find out what the variables contain
- Test the functions and methods individually
- Console.log()
  - In codesandbox, goes to the console tab/window in the devtools window
  - In a browser, goes to developer's tools console
- Developer's tools
  - Debugger, console
  - Lots of other goodies
    - Coming in the debugging lesson
  - Not needed for codesandbox based lessons

Demo and Q&A