ES2015

The Shape of JavaScript to Come

New to JavaScript? Go here first!

http://javascript-roadtrip.codeschool.com

Prerequisites

Previous experience building JavaScript applications is necessary. For those brand new to the language, you can check out our intro course, ***JavaScript Road Trip***.

What Is ES2015 (formerly known as ES6) ?

Previously called *ES6*, ES2015 is the most extensive update to the JavaScript language since the publication of its first edition in 1997.

Kind of a big deal.

This Course

We'll cover some of the new features in JavaScript, including:

- *Variable* and *function* declarations
- More efficient *data structures*
- *Promises* and *Generators*
- ...and more

Declarations with *let*

Level 1 – Section 1

Forum Web App

Together, we'll build features that are part of a web forum!

Loading Profiles

The *loadProfiles* function takes an **array of users** and adds their profile to the sidebar.

```
<!DOCTYPE html>
    //...
    <script src="./load-profiles.js">
    <script>
      loadProfiles(["Sam", "Tyler", "Brook"]);
    </script>
  </body>
</html>
```

displays active users for this topic

The loadProfiles Function

This function displays a different message according to the number of arguments.

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    var loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);
  }else{
    var flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  //... fetch names and build sidebar
}
```

Might take a while to process, so a loading message is displayed

Shouldn't take that long, so we display a different message

How loadProfiles Is Executed

```
loadProfiles(["Sam", "Tyler", "Brook", "Alex"]);
```

1. Executes the if block

2. The loadingMessage variable is declared and assigned a value

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    var loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);
  }else{
    var flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  //...
}
```

3. The displaySpinner function is called

The else block is not executed

Unexpected Behavior With var

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    var loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);
    console.log(flashMessage);
  } else{
    var flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  console.log(flashMessage);
}
```

```
> undefined
```

This indicates a console output

```
> undefined
```

...but outputs undefined and does not generate error (?!)

flashMessage is never declared...

Why no **ReferenceError** ?

Understanding Hoisting

Prior to executing our code, JavaScript moves *var* declarations all the way up to the top of the scope. This is known as **hoisting.**

```
function loadProfiles(userNames){
  var loadingMessage, flashMessage;

  if(userNames.length > 3){
    var loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);
  }else{
    var flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  //....
}
```

Automatically moved here by the JavaScript runtime

Declaring Variables With let

ES2015

let variables are scoped to the nearest **block** and are **NOT hoisted.**

(A block is any code section within **curly braces**, like *if*, *else*, *for*, *while*, etc.)

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    let loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);
  }else{
    let flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  //....
}
```

Not visible outside if block

Not visible outside else block

Expected Behavior With let

Using *let*, variables are “trapped” inside their respective *if* and *else* blocks.

```
loadProfiles(["Sam", "Tyler", "Brook", "Alex"]);
```

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    let loadingMessage = "This might take a while...";
    _displaySpinner(loadingMessage);

    console.log(flashMessage);
  }else{
    let flashMessage = "Loading Profiles";
    _displayFlash(flashMessage);
  }

  console.log(flashMessage);
}
```

> ReferenceError: flashMessage is not defined

Expected behavior, similar to other programming languages!

> ReferenceError: flashMessage is not defined

Declarations With *let* in *for* Loops

Level 1 – Section 2

Problem With var in for Loops

var is the reason behind a popular "gotcha" in *for* loops.

```
function loadProfiles(userNames){
//....

  for(var i in userNames){
    _fetchProfile("/users/" + userNames[i], function(){
      console.log("Fetched for ", userNames[i]);
    }
  }
}
```

Accessing i from inside the callback

```
loadProfiles(["Sam", "Tyler", "Brook", "Alex"]);
```

Unexpectedly outputs the same value on all iterations

```
> Fetched for Alex
> Fetched for Alex
> Fetched for Alex
> Fetched for Alex
```

Understanding Hoisting and for Loops

var i is hoisted to the top of the function and **shared** across each iteration of the loop.

```
function loadProfiles(userNames){
  var i;
  //....

  for(    i in userNames){
    _fetchProfile("/users/" + userNames[i], function(){
      console.log("Fetched for ", userNames[i]);
    }
  }
}
```

fetchProfile is called 4 times,
before any of the callbacks are invoked

i = 0
i = 1
i = 2
i = 3

i is incremented
on each iteration

Loop Values in Callbacks

When callbacks begin to run, *i* holds the last value assigned to it from the *for* loop.

```
function loadProfiles(userNames){
  var i;
  //....

  for(i in userNames){
    _fetchProfile("/users/" + userNames[i], function(){
      console.log("Fetched for ", userNames[i]);
    });
  }
}
```

Prints userNames[3] all 4 times

i = 3

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 3

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 3

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 3

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

Using let in for Loops

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With *let*, there's **no sharing** in *for* loops. A new variable is created on each iteration.

```
function loadProfiles(userNames){
  //....

  for(let i in userNames){
    _fetchProfile("/users/" + userNames[i], function(){
      console.log("Fetched for ", userNames[i]);
    });
  }
}
```

i = 0

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 1

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 2

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

i = 3

```
fetchProfile("/users/" + userNames[i], function(){
  console.log("Fetched for ", userNames[i]);
});
```

Using let in for Loops

Each callback function now holds a reference to their **own version** of *i*.

```
function loadProfiles(userNames){
  //....

  for(let i in userNames){
    _fetchProfile("/users/" + userNames[i], function(){
      console.log("Fetched for ", userNames[i]);
    });
  }
}
```

```
loadProfiles(["Sam", "Tyler", "Brook", "Alex"]);
```

Outputs the correct value for each iteration

```
> Fetched for Sam
> Fetched for Tyler
> Fetched for Brook
> Fetched for Alex
```

let Cannot Be Redeclared

Variables declared with *let* can be reassigned, but cannot be **redeclared** within the same scope.

```
let flashMessage = "Hello";
flashMessage = "Goodbye";
```

Reassigning is allowed

```
let flashMessage = "Hello";
let flashMessage = "Goodbye";
```

Redeclaring is not allowed

> TypeError: Identifier 'name' has already been declared

```
let flashMessage = "Hello";

function loadProfiles(userNames){
  let flashMessage = "Loading profiles";
  return flashMessage;
}
```

Different scopes

Declarations With *const*

Level 1 – Section 3

Magic Numbers

A magic number is a literal value without a clear meaning.

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    //...
  }else{
    //...
  }
}
```

The number 3 by itself doesn't tell us much

Issues With Magic Numbers

When used multiple times, magic numbers introduce **unnecessary duplication**, which can lead to **bad code!**

```
function loadProfiles(userNames){
  if(userNames.length > 3){
    //...
  }else{
    //...
  }

  if(someValue > 3){
    //...
  }
}
```

Hard to tell whether both numbers serve the same purpose

Replacing Magic Numbers With Constants

ES2015

The *const* keyword creates **read-only** named constants.

```
function loadProfiles(userNames){

  const MAX_USERS = 3;

  if(userNames.length > MAX_USERS){
    //...
  }else{
    //...
  }
  const MAX_REPLIES = 3;
  if(someElement > MAX_REPLIES){
    //...
  }
}
```

Conveys intent and facilitates maintenance

Constants Are Read-only

Once assigned, constants **cannot** be assigned a new value.

```
function loadProfiles(userNames){

  const MAX_USERS = 3;
  MAX_USERS = 10;

  if(userNames.length > MAX_USERS){
    //...
  }else{
    //...
  }

  const MAX_REPLIES = 3;
  if(someElement > MAX_REPLIES){
    //...
  }
}
```

Value does not change

Still holds the value 3

Constants Require an Initial Value

Variables declared with *const* must be assigned an initial value.

```
function loadProfiles(userNames){

  const MAX_USERS = 3;
  MAX_USERS = 10;

  if(userNames.length > MAX_USERS){
    //...
  }else{
    //...
  }

  const MAX_REPLIES = 3;
  if(someElement > MAX_REPLIES){

  }
}
```

> SyntaxError: Unexpected token

Constants Are Block Scoped

Variables declared with *const* are scoped to the nearest block.

```
function loadProfiles(userNames){

  const MAX_USERS = 3;

  if(userNames.length > MAX_USERS){
    const MAX_REPLIES = 15;
    //...
  }else{
    //...
  }

  console.log(MAX_REPLIES);
}
```

Not visible outside the if block

```
> ReferenceError, MAX_REPLIES is not defined.
```

let vs. const

In most cases, *let* and *const* will behave very similarly. Consider the semantics when choosing one over the other.

```
let loadingMessage = "This might take a while...";
let currentAge = 50;
let totalCost = cost + tax;
```

Use let when variables could be reassigned new values

```
const MAX_USERS  = 3;
const SEPARATOR  = "%%";
const ALLOW_EDIT = false;
```

Use const when new variables are not expected to be reassigned new values

Functions

Level 2 – Section 1

Issues With Flexible Function Arguments

Unexpected arguments might cause **errors** during function execution.

```
loadProfiles(["Sam", "Tyler", "Brook"]);
```

```
loadProfiles();
```

```
loadProfiles(undefined );
```

```
> TypeError: Cannot read property 'length' of undefined
```

Breaks when called with no arguments

```
function loadProfiles(userNames){
  let namesLength = userNames.length;
  //...
}
```

Cannot assume userNames will always be assigned

Manual Argument Checks Don't Scale Well

A common practice is to **check for presence** of arguments as the very first thing in the function.

```
function loadProfiles(userNames){
  let names = typeof userNames !== 'undefined' ? userNames : [];
  let namesLength = names.length;
  // ...
}
```

Too verbose and doesn't scale well for multiple arguments

Using Default Parameter Values

ES2015

Default parameter values help move **default values** from the function body to the **function signature**.

```
function loadProfiles(userNames = []){
  let namesLength = userNames.length;
  console.log(namesLength);
}
```

Uses empty array as default value when no argument is passed

Does not break when invoked with no arguments

```
loadProfiles();
```

```
> 0
```

Nor with explicit undefined as argument

```
loadProfiles(undefined);
```

```
> 0
```

The Options Object

The **options object** is a widely used pattern that allows user-defined settings to be passed to a function in the form of properties on an object.

```
setPageThread("New Version out Soon!", {
  popular: true,
  expires: 10000,
  activeClass: "is-page-thread"
});
```

Options object with 3 properties

```
function setPageThread(name, options = {}){

  let popular = options.popular;
  let expires = options.expires;
  let activeClass = options.activeClass;
  //...

}
```

Options object is second parameter

Assign from properties
to local variables

Issues With the Options Object

The **options object** makes it hard to know what options a function accepts.

```
setPageThread("New Version out Soon!", {
  popular: true,
  expires: 10000,
  activeClass: "is-page-thread"
});
```

```
function setPageThread(name, options = {}){

  let popular = options.popular;
  let expires = options.expires;
  let activeClass = options.activeClass;
  //...

}
```

Unclear what options this function expects just by looking at its signature

Boilerplate code

Using Named Parameters

ES2015

Using **named parameters** for optional settings makes it easier to understand how a function should be invoked.

```
function setPageThread(name, { popular, expires, activeClass }){

  console.log("Name: ",    name);
  console.log("Popular: ", popular);
  console.log("Expires: ", expires);
  console.log("Active: " , activeClass);
}
```

Now we know which arguments are available

Local variables

```
setPageThread("New Version out Soon!", {
  popular: true,
  expires: 10000,
  activeClass: "is-page-thread"
});
```

```
> Name: New Version out Soon!
> Popular: true
> Expires: 10000
> Active: is-page-thread
```

Omitting Certain Arguments on Call

It's okay to omit **some options** when invoking a function with named parameters.

```
function setPageThread(name, { popular, expires, activeClass }){

  console.log("Name: ",     name);
  console.log("Popular: ", popular);
  console.log("Expires: ", expires);
  console.log("Active: " , activeClass);
}
```

popular is the only named argument being passed

```
setPageThread("New Version out Soon!", {
  popular: true
});
```

```
> Name: New Version out Soon!
> Popular: true
> Expires: undefined
> Active: undefined
```

No value assigned to remaining parameters

Don’t Omit All Named Arguments on Call

It’s **NOT okay** to omit the options argument altogether when invoking a function with named parameters when no default value is set for them.

```
function setPageThread(name, { popular, expires, activeClass }){

  console.log("Name: ",     name);
  console.log("Popular: ", popular);
  console.log("Expires: ", expires);
  console.log("Active: " , activeClass);
}
```

```
setPageThread("New Version out Soon!");
```

Invoking this function without its second argument breaks our code

```
> TypeError: Cannot read property
  'popular' of undefined
```

Setting a Default for Named Parameters

ES2015

Setting a **default value** for the entire options argument allows this parameter to be omitted during function calls.

```
function setPageThread(name, { popular, expires, activeClass } = {}){

  console.log("Name: ",     name);
  console.log("Popular: ", popular);
  console.log("Expires: ", expires);
  console.log("Active: " , activeClass);
}
```

```
setPageThread("New Version out Soon!");
```

We can now safely invoke this function without its second argument

```
> Name: New Version out Soon!
> Popular: undefined
> Expires: undefined
> Active: undefined
```

Rest Parameter, Spread Operator, and Arrow Functions

Level 2 – Section 2

Adding Tags to a Thread

Tags related to this thread

Functions With a Variable List of Arguments

Here's how we want our *displayTags* function to look.

```
displayTags("songs");
```

or

```
displayTags("songs", "lyrics");
```

or

```
displayTags("songs", "lyrics", "bands");
```

variadic functions can accept any number of arguments

Issues With the arguments Object

The *arguments* object is a **built-in, Array-like** object that corresponds to the arguments of a function. Here's why relying on this object to read arguments is **not ideal:**

```
function displayTags(){
  for(let i in arguments){
    let tag = arguments[i];
    _addToTopic(tag);
  }
}
```

Hard to tell which parameters this function expects to be called with

Where did this come from?!

If we add an argument...

```
function displayTags(targetElement){

  let target = _findElement(targetElement);

  for(let i in arguments){
    let tag = arguments[i];
    _addToTopic(target, tag);
  }
}
```

...we'll break the loop, since the first argument is no longer a tag

Using Rest Parameters

ES2015

The new **rest parameter** syntax allows us to represent an indefinite number of arguments as an **Array.** This way, changes to function signature are **less likely to break code.**

```
function displayTags(...tags){
  for(let i in tags){
    let tag = tags[i];
    _addToTopic(tag);
  }
}
```

These 3 dots are part of the syntax

tags is an Array object

Must always go last

```
function displayTags(targetElement, ...tags){

  let target = _findElement(targetElement);

  for(let i in tags){
    let tag = tags[i];
    _addToTopic(target, tag);
  }
}
```

Not affected by changes to function signature

Seeing displayTags in Action

```
displayTags("songs");
```

```
displayTags("songs", "lyrics", "bands");
```

Splitting Arrays Into Individual Arguments

We need a way to convert an **Array** into individual arguments upon a **function call**.

```
getRequest("/topics/17/tags", function(data){
  let tags = data.tags;
  displayTags(tags);
})
```

tags is an Array, e.g., ["programming", "web", "HTML"] ...

...but displayTags expects to be called with individual arguments, like this:

```
displayTags("programming");
```

```
displayTags("programming", "javascript");
```

How can we convert* Arrays *into individual elements on a function call ?

Using the Spread Operator

ES2015

The spread operator allows us to **split an Array** argument into **individual elements**.

```
getRequest("/topics/17/tags", function(data){
  let tags = data.tags;
  displayTags(...tags);
})
```

The displayTags function is now receiving individual arguments, not an Array

Three dots are part of the syntax

Same as doing this

```
displayTags(tag, tag, tag);
```

Rest and Spread look the same

ES2015

Rest parameters and the spread operator **look the same**, but the former is used in function **definitions** and the latter in function **invocations**.

Rest Parameters

```
function displaytags(...tags){
  for(let i in tags){
    let tag = tags[i];
    _addToTopic(target, tag);
  }
}
```

Function definition

vs.

Function invocation

Spread Operator

```
getRequest("/topics/17/tags", function(data){
  let tags = data.tags;
  displayTags(...tags);
})
```

From Functions to Objects

JavaScript objects can help us with the **encapsulation, organization**, and **testability** of our code.

```
getRequest("/topics/17/tags", function(data){
  let tags = data.tags;
  displayTags(...tags);
})
```

Functions like getRequest and displayTags should not be exposed to caller code

We want to convert code like this...

...into code like this

```
let tagComponent = new TagComponent(targetDiv, "/topics/17/tags");
tagComponent.render();
```

Let's see how we can implement our* TagComponent *function!

Creating TagComponent

The *TagComponent* object **encapsulates** the code for fetching tags and adding them to a page.

```
function TagComponent(target, urlPath){
  this.targetElement = target;
  this.urlPath       = urlPath;
}

TagComponent.prototype.render = function(){

  getRequest(this.urlPath, function(data){
    //...
  });
}
```

Properties set on the constructor function...

...can be accessed from other instance methods

Passing target element and the URL path as arguments

```
let tagComponent = new TagComponent(targetDiv, "/topics/17/tags");
tagComponent.render();
```

Issues With Scope in Callback Functions

Anonymous functions passed as callbacks to other functions create **their own scope**.

```
function TagComponent(target, urlPath){
  this.targetElement = target;
  this.urlPath       = urlPath;
}

TagComponent.prototype.render = function(){

  getRequest(this.urlPath, function(data){
    let tags = data.tags;
    displayTags(this.targetElement, ...tags);
  });
}
```

The scope of the TagComponent object...

...is not the same as...

...the scope of the anonymous function

Returns undefined

```
let tagComponent = new TagComponent(targetDiv, "/topics/17/tags");
tagComponent.render();
```

Using Arrow Functions to Preserve Scope

ES2015

Arrow functions bind to the scope of where they are **defined**, not where they are called.

(also known as **lexical binding**)

```
function TagComponent(target, urlPath){
  this.targetElement = target;
  this.urlPath       = urlPath;
}

TagComponent.prototype.render = function(){

  getRequest(this.urlPath, (data) => {
    let tags = data.tags;
    displayTags(this.targetElement, ...tags);
  });
}
```

Arrow functions bind to the lexical scope

this now properly refers to the TagComponent object

```
let tagComponent = new TagComponent(targetDiv, "/topics/17/tags");
tagComponent.render();
```

Objects and Strings

Level 3 – Section 1

Removing Repetition From Creating Objects

The *buildUser* function **returns an object** with the *first*, *last*, and *fullName* properties.

```
function buildUser(first, last){
  let fullName = first + " " + last;

  return { first: first, last: last, fullName: fullName }
}
```

Returning objects with keys and variables with the same name looks repetitive

Calling the *buildUser* function:

```
let user = buildUser("Sam", "Williams");

console.log( user.first );
console.log( user.last );
console.log( user.fullName );
```

```
> Sam
> Williams
> Sam Williams
```

The Object Initializer Shorthand

ES2015

We can remove **duplicate** variable names from object properties when those properties have the **same name** as the variables being assigned to them.

```
function buildUser(first, last){
  let fullName = first + " " + last;

  return { first, last, fullName };
}
```

Way cleaner!

Yields the same result:

```
let user = buildUser("Sam", "Williams");

console.log( user.first );
console.log( user.last );
console.log( user.fullName );
```

```
> Sam
> Williams
> Sam Williams
```

Assigning With Object Initializer Shorthand

The object initializer shorthand works **anywhere** a new object is returned, not just from functions.

```
let name = "Sam";
let age = 45;
let friends = ["Brook","Tyler"];

let user = { name, age, friends };

console.log( user.name );
console.log( user.age );
console.log( user.friends );
```

```
> Sam
> 45
> ["Brook", "Tyler"]
```

Same thing

```
let user = { name: name, age: age, friends: friends };
```

Object Destructuring

ES2015

We can use shorthand to assign **properties** from objects to **local variables** with the **same name**.

```
let user = buildUser("Sam", "Williams");

let first = user.first;
let last  = user.last;
let fullName = user.fullName;
```

Unnecessary repetition

This function returns `{ first, last, fullName }`

Same names as properties from return object

```
let { first, last, fullName } = buildUser("Sam", "Williams");

console.log( first );
console.log( last );
console.log( fullName );
```

```
> Sam
> Williams
> Sam Williams
```

Destructuring Selected Elements

Not **all** properties have to be destructured all the time. We can **explicitly select** the ones we want.

```
let { fullName } = buildUser("Sam", "Williams");

console.log( fullName );
```

```
> Sam Williams
```

Only grabbing fullName from the return object

```
let { last, fullName } = buildUser("Sam", "Williams");

console.log( last );
console.log( fullName );
```

```
> Williams
> Sam Williams
```

Grabbing last and fullName from the return object

Recap Object Initializer vs. Destructuring

Object Initializer Shorthand Syntax

```
let name = "Sam";
let age = 45;

let user = { name, age };

console.log(user.name);
console.log(user.age);
```

From variables
to object properties

Object Destructuring

From object properties
to variables

```
let { first, last, fullName } = buildUser("Sam", "Williams");

console.log(first);
console.log(last);
console.log(fullName);
```

Returns `{ first, last, fullName }`

Adding a Function to an Object

In previous versions of JavaScript, adding a function to an object required specifying the **property name** and then the **full function definition** (including the *function* keyword).

```
function buildUser(first, last, postCount){

  let fullName = first + " " + last;
  const ACTIVE_POST_COUNT = 10;

  return {
    first,
    last,
    fullName,
    isActive: function(){
      return postCount >= ACTIVE_POST_COUNT;
    }
  }
}
```

An anonymous function is assigned to an object property

Using the Method Initializer Shorthand

A new shorthand notation is available for adding a method to an object where the keyword *function* is no longer necessary.

```
function buildUser(first, last, postCount){

  let fullName = first + " " + last;
  const ACTIVE_POST_COUNT = 10;

  return {
    first,
    last,
    fullName,
    isActive(){
      return postCount >= ACTIVE_POST_COUNT;
    }
  }
}
```

Less characters and easier to read!

Template Strings

Template strings are **string literals** allowing embedded expressions. This allows for a much better way to do **string interpolation.**

```
function buildUser(first, last, postCount){

  let fullName = first + " " + last;
  const ACTIVE_POST_COUNT = 10;
  //...

}
```

```
function buildUser(first, last, postCount){

  let fullName = `${first} ${last}`;
  const ACTIVE_POST_COUNT = 10;
  //...

}
```

Enclosed by back-ticks, NOT single quotes, and code is wrapped inside dollar sign and curly braces

Writing Multi-line Strings

Template strings offer a new — and much better — way to write **multi-line strings**.

```
let userName = "Sam";
let admin = { fullName: "Alex Williams" };

let veryLongText = `Hi ${userName},

this is a very
very

veeeery
long text.

Regards,
  ${admin.fullName}
`;

console.log(veryLongText);
```

Newline characters are part of the template string

Newline characters are preserved

```
> Hi Sam,

  this is a very
  very

  veeeery
  long text.

  Regards,
    Alex Williams
```

Object.assign

Level 3 – Section 2

Adding a Countdown Timer to Our Forum

The **countdown timer** displays the time left for users to undo their posts after they've been created. Once the time is up, they cannot undo it anymore.

Let's write a countdown timer function!

Time remaining to undo post

Writing More Flexible Functions

In order to cater to different applications and domains, our *countdownTimer* function needs to be called in **many different ways.**

As simple as this...

Two arguments only

```
countdownTimer($('.btn-undo'), 60);
```

...and as complicated as this

```
countdownTimer($('.btn-undo'), 60,  {  container: '.new-post-options' });

countdownTimer($('.btn-undo'), 3,   {  container: '.new-post-options',
                                       timeUnit:  'minutes',
                                       timeoutClass: '.time-is-up' });
```

Custom options will vary according to each application

Using Too Many Arguments Is Bad

For functions that need to be used across different applications, it's okay to accept an **options object** instead of using named parameters

```
function countdownTimer(target, timeLeft,
  { container, timeUnit, clonedDataAttribute,
    timeoutClass, timeoutSoonClass, timeoutSoonSeconds
  } = {}){

  //...
}
```

Too many named arguments make this function harder to read

(Named arguments are okay, but for a different purpose)

```
function countdownTimer(target, timeLeft, options = {}){
  //...
}
```

Easier to customize to different applications

Using Local Values and || Is Bad for Defaults

Some options might not be specified by the caller, so we need to have **default values**.

```
function countdownTimer(target, timeLeft, options = {}){

  let container = options.container || ".timer-display";
  let timeUnit = options.timeUnit || "seconds";
  let clonedDataAttribute = options.clonedDataAttribute || "cloned";
  let timeoutClass = options.timeoutClass || ".is-timeout";
  let timeoutSoonClass = options.timeoutSoonClass || ".is-timeout-soon";
  let timeoutSoonTime = options.timeoutSoonSeconds || 10;

  //...
}
```

Default strings and numbers are all over the place... Yikes!

Using a Local Object to Group Defaults

Using a local object to group **default** values for user options is a common practice and can help write more **idiomatic JavaScript**.

```
function countdownTimer(target, timeLeft, options = {}){

  let defaults = {
    container:              ".timer-display",
    timeUnit:               "seconds",
    clonedDataAttribute:    "cloned",
    timeoutClass:           ".is-timeout",
    timeoutSoonClass:       ".is-timeout-soon",
    timeoutSoonTime:        10
  };

  //...
}
```

Looks much better

Merging Values Into a Combined Variable

We want to merge *options* and *defaults*. Upon duplicate properties, those from *options* **must override properties** from *defaults*.

3. ....and the result stored here.

```
let settings
{
  container: ...,
  timeUnit: ...,
  clonedDataAttribute: ...,
  timeoutClass: ...,
  ...
}
```

=

1. Default properties declared here...

```
let defaults
{
  container: ...,
  timeUnit: ...,
  clonedDataAttribute: ...,
  timeoutClass: ...,
  ...
}
```

+

2. ...will be merged with these...

```
options
{
  timeUnit: ...,
  timeoutClass: ...,
}
```

Values passed for timeUnit and timeoutClass will override properties on defaults object

Merging Values With Object.assign

ES2015

The *Object.assign* method copies properties from one or more **source objects** to a **target object** specified as the very first argument.

```
function countdownTimer(target, timeLeft, options = {}){

  let defaults = {
    //...
  };

  let settings = Object.assign({}, defaults, options);
  //...
}
```

Merged properties from defaults and options

Target object is modified and used as return value

Source objects remain unchanged

Merging Objects With Duplicate Properties

In case of **duplicate properties** on source objects, the value from the **last object** on the chain always prevails.

```
function countdownTimer(target, timeLeft, options = {}){

  let defaults = {
    //...
  };

  let settings = Object.assign({}, defaults, options);options2, options3);
  //...
}
```

Duplicate properties from options3 override those on options2, which override those on options, etc.

Using Object.assign

There are a couple incorrect ways we might see *Object.assign* being used.

```
Object.assign(defaults, options);
```

defaults is mutated, so we can't go back and access original default values after the merge

```
let settings = Object.assign({}, defaults, options);
```

Can access original default values and looks functional

```
let settings = {};
Object.assign(settings, defaults, options);
console.log(settings.user);
```

Not reading return value

Default values are not changed, but settings is passed as a reference

Reading Initial Default Values

Preserving the original default values gives us the ability to compare them with the options passed and act accordingly when necessary.

```
function countdownTimer(target, timeLeft, options = {}){

  let defaults = {
    //...
  };

  let settings = Object.assign({}, defaults, options);

  if(settings.timeUnit !== defaults.timeUnit){
    _conversionFunction(timeLeft, settings.timeUnit)
  }
}
```

Runs when value passed as argument for timeUnit is different than the original value

Object.assign in Practice

Let's run *countdownTimer()* passing the value for *container* as argument...

```
countdownTimer($('.btn-undo'), 60, { container: '.new-post-options' });
```

...and using the default value for everything else.

```
function countdownTimer(target, timeLeft, options = {}){
  let defaults = {
    container: ".timer-display",
    timeUnit:  "seconds",
    //...
  };

  let settings = Object.assign({}, defaults, options);

  console.log(settings.container);
  console.log(settings.timeUnit);
}
```

```
> .new-post-options
> seconds
```

C

Arrays

Level 4 – Section 1

Assigning From Array to Local Variables

We typically access array elements by their index, but doing so for more than just a couple of elements can quickly turn into a **repetitive task.**

```
let users = ["Sam", "Tyler", "Brook"];

let a = users[0];
let b = users[1];
let c = users[2];

console.log( a, b, c );
```

```
> Sam Tyler Brook
```

This will keep getting longer as we need to extract more elements

Reading Values With Array Destructuring

We can use destructuring to assign **multiple values** from an array to local variables.

```
let users = ["Sam", "Tyler", "Brook"];
let [a, b, c] = users;
console.log( a, b, c );
```

```
> Sam Tyler Brook
```

Still easy to understand AND less code

Values can be **discarded**

```
let [a, , b] = users;
console.log( a, b );
```

```
> Sam Brook
```

Notice the blank space between the commas

Combining Destructuring With Rest Params

We can **combine** destructuring with rest parameters to **group values** into other arrays.

```
let users = ["Sam", "Tyler", "Brook"];
let [ first, ...rest ] = users;
console.log( first, rest );
```

```
> Sam ["Tyler", "Brook"]
```

Groups remaining arguments in an array

Destructuring Arrays From Return Values

When returning arrays from **functions**, we can assign to **multiple variables** at once.

```
function activeUsers(){
  let users = ["Sam", "Alex", "Brook"];
  return users;
}
```

Returns an array, as expected...

```
let active = activeUsers();
console.log( active );
```

```
> ["Sam", "Alex", "Brook"]
```

...or assigns to **individual variables**. Handy!

```
let [a, b, c] = activeUsers();
console.log( a, b, c );
```

```
> Sam Alex Brook
```

Using *for...of* to Loop Over Arrays

The *for...of* statement iterates over **property values**, and it's a better way to loop over arrays and other **iterable objects.**

```
let names = ["Sam", "Tyler", "Brook"];
```

```
for(let index in names){
  console.log( names[index] );
}
```

Uses index to read actual element

```
> Sam Tyler Brook
```

```
for(let name of names){
  console.log( name );
}
```

Reads element directly and with less code involved

```
> Sam Tyler Brook
```

Limitations of *for...of* and Objects

The *for...of* statement **cannot** be used to iterate over properties in plain JavaScript objects out-of-the-box.

```
let post = {
  title: "New Features in JS",
  replies: 19,
  lastReplyFrom: "Sam"
};

for(let property of post){
  console.log( "Value: ", property );
}
```

```
> TypeError: post[Symbol.iterator]
  is not a function
```

How do we know when it's okay to use *for...of*?

Objects That Work With *for...of*

In order to work with *for...of*, objects need a special function assigned to the *Symbol.iterator* property. The presence of this property allows us to know whether an object is **iterable.**

Symbols are a new data type guaranteed to be unique

```
let names = ["Sam", "Tyler", "Brook"];

console.log( typeof names[Symbol.iterator] );

for(let name of names){
  console.log( name );
}
```

```
> function
```

Since there's a function assigned, then the names array will work just fine with for...of

```
> Sam
> Tyler
> Brook
```

Objects That Don't Work With *for...of*

No function assigned to the *Symbol.iterator* property means the object is **not iterable.**

```
let post = {
  title: "New Features in JS",
  replies: 19,
  lastReplyFrom: "Sam"
};

console.log( typeof post[Symbol.iterator] );

for(let property of post){
  console.log( property );
}
```

```
> undefined
```

Nothing assigned to Symbol.iterator, so the post object will not work with for...of

```
> TypeError: post[Symbol.iterator]
  is not a function
```

Finding an Element in an Array

Array.find returns the **first element** in the array that satisfies a provided testing function.

```
let users = [
  { login: "Sam",     admin: false },
  { login: "Brook",   admin: true  },
  { login: "Tyler",   admin: true  }
];

let admin = users.find( (user) => {
  return user.admin;
});

console.log( admin );
```

How can we find an admin in this array of users?

Returns first object for which user.admin is true

```
> { "login" : "Brook", "admin" : true }
```

One-liner arrow function

```
let admin = users.find( user => user.admin );
console.log( admin );
```

```
> { "login" : "Brook", "admin" : true }
```

Maps

Level 4 – Section 2

The Map Data Structure

Maps are a **data structure** composed of a collection of **key/value** pairs. They are very useful to store simple data, such as property values.

Issues With Using Objects as Maps

When using **Objects** as maps, its *keys* are **always converted to strings.**

Two different objects

```
let user1 = { name: "Sam" };
let user2 = { name: "Tyler" };

let totalReplies = {};
totalReplies[user1] = 5;
totalReplies[user2] = 42;

console.log( totalReplies[user1] );
console.log( totalReplies[user2] );

console.log( Object.keys(totalReplies) );
```

Both objects are converted to the string "[object Object]"

```
> 42
> 42
```

```
> ["[object Object]"]
```

Storing Key/Values With Map

The *Map* object is a simple **key/value** data structure. **Any value** may be used as either a key or a value, and objects are **not converted** to strings.

```
let user1 = { name: "Sam" };
let user2 = { name: "Tyler" };

let totalReplies = new Map();
totalReplies.set( user1, 5 );
totalReplies.set( user2, 42 );

console.log( totalReplies.get(user1) );
console.log( totalReplies.get(user2) );
```

Values assigned to different object keys, as expected

```
> 5
> 42
```

We use the get() and set() methods to access values in Maps

Use Maps When Keys Are Unknown Until Runtime

Map

```
let recentPosts = new Map();

createPost(newPost, (data) => {
  recentPosts.set( data.author, data.message );
});
```

Keys unknown until runtime, so... Map!

Object

```
const POSTS_PER_PAGE = 15;

let userSettings = {
  perPage:  POSTS_PER_PAGE,
  showRead: true,
};
```

Keys are previously defined, so... Object!

Use Maps When Types Are the Same

Map

```
let recentPosts = new Map();

createPost(newPost, (data) => {
  recentPosts.set( data.author, data.message );
});

// ...somewhere else in the code
socket.on('new post', function(data){
  recentPosts.set( data.author, data.message );
});
```

All keys are the same type, and
all values are the same type, so Map!

Object

```
const POSTS_PER_PAGE = 15;

let userSettings = {
  perPage:  POSTS_PER_PAGE,
  showRead: true,
};
```

Some values are numeric,
others are boolean, so Object!

Iterating Maps With for...of

Maps are iterable, so they can be used in a *for...of* loop. Each run of the loop returns a **[key, value]** pair for an entry in the *Map.*

```
let mapSettings = new Map();

mapSettings.set( "user", "Sam" );
mapSettings.set( "topic", "ES2015" );
mapSettings.set( "replies", ["Can't wait!", "So Cool"] );

for(let [key, value] of mapSettings){
  console.log(`${key} = ${value}`);
}
```

Remember array destructuring ?

```
> user = Sam
> topic = ES2015
> replies = Can't wait!,So Cool
```

WeakMap

The *WeakMap* is a type of *Map* where **only objects** can be passed as keys. Primitive data types — such as strings, numbers, booleans, etc. — are **not allowed.**

```
let user = {};
let comment = {};

let mapSettings = new WeakMap();
mapSettings.set( user, "user" );
mapSettings.set( comment, "comment" );

console.log( mapSettings.get(user) );
console.log( mapSettings.get(comment) );

mapSettings.set("title", "ES2015");
```

```
> user
> comment
```

```
> Invalid value used as weak map key
```

Primitive data types are not allowed

Working With WeakMaps

All available methods on a *WeakMap* require access to an **object used as a key**.

```
let user = {};

let mapSettings = new WeakMap();
mapSettings.set( user, "ES2015" );

console.log( mapSettings.get(user) );
console.log( mapSettings.has(user) );
console.log( mapSettings.delete(user) );
```

```
> ES2015
> true
> true
```

WeakMaps are **not iterable,** therefore they can't be used with *for...of*

```
for(let [key,value] of mapSettings){
  console.log(`${key} = ${value}`);
}
```

```
> mapSettings[Symbol.iterator] is not a function
```

WeakMaps Are Better With Memory

Individual entries in a *WeakMap* can be **garbage collected** while the *WeakMap* itself still exists.

```
let user = {};

let userStatus = new WeakMap();
userStatus.set( user, "logged" );

//...
someOtherFunction( user );
```

All objects occupy memory space

Object reference passed as key to the WeakMap

Once it returns, user can be garbage collected

WeakMaps don't prevent the garbage collector from collecting objects currently used as keys, but that are no longer referenced anywhere else in the system

Sets

Level 4 – Section 3

Limitations With Arrays

Arrays don’t enforce uniqueness of items. Duplicate entries are allowed.

```
let tags = [];

tags.push( "JavaScript" );
tags.push( "Programming" );
tags.push( "Web" );
tags.push( "Web" );

console.log( "Total items ", tags.length );
```

Duplicate entry

> Total items 4

Using Set

ES2015

The *Set* object stores **unique** values of **any type**, whether primitive values or object references.

```
let tags = new Set();

tags.add("JavaScript");
tags.add("Programming");
tags.add({ version: "2015" });
tags.add("Web");
tags.add("Web");

console.log("Total items ", tags.size);
```

Both primitive values and objects are allowed

Duplicate entries are ignored

```
> Total items 4
```

We use the add() method to add elements to a Set

Using Set as Enumerable Object

Set objects are **iterable,** which means they can be used with *for...of* and destructuring.

```
let tags = new Set();

tags.add("JavaScript");
tags.add("Programming");
tags.add({ version: "2015" });
tags.add("Web");

for(let tag of tags){
  console.log(tag);
}

let [a,b,c,d] = tags;
console.log(a, b, c, d);
```

```
> JavaScript
> Programming
> { version: '2015' }
> Web
```

```
> JavaScript Programming { version: '2015' } Web
```

Effectively extracting elements via destructuring

WeakSet

The *WeakSet* is a type of *Set* where **only objects** are allowed to be stored.

```
let weakTags = new WeakSet();

weakTags.add("JavaScript");
weakTags.add({ name: "JavaScript" });
let iOS = { name: "iOS" };
weakTags.add(iOS);

weakTags.has(iOS);
weakTags.delete(iOS);
```

```
> TypeError: Invalid value used in weak set
```

Only objects can be added

```
> true
> true
```

WeakSets don't prevent the garbage collector from collecting entries that are no longer used in other parts of the system

Can’t Read From a WeakSet

WeakSets **cannot** be used with *for...of* and they offer **no** methods for reading values from it.

```
let weakTags = new WeakSet();

weakTags.add({ name: "JavaScript" });
let iOS = { name: "iOS" };
weakTags.add(iOS);

for(let wt of weakTags){
  console.log(wt);
}
```

Not iterable!

```
> TypeError weakTags[Symbol.iterator]
  is not a function
```

If we can’t read values from a WeakSet,

when should we use them ?

Using WeakSets to Show Unread Posts

We want to add a different background color to posts that **have not yet been read.**

Unread posts should have a different background color

Using WeakSets to Show Unread Posts

One way to “tag” unread posts is to **change** a property on each post object once they are read.

```
let post = { //... };

//...when post is clicked on
postList.addEventListener('click', (event) => {
  //....
  post.isRead = true;
});

// ...rendering list of posts
for(let post of postArray){
  if(!post.isRead){
    _addNewPostClass(post.element);
  }
}
```

Mutates post object in order to indicate it’s been read

Checks a property on each post object

Showing Unread Posts With WeakSets

We can use *WeakSets* to create special groups from existing objects **without mutating them.** Favoring **immutable** objects allows for much **simpler** code with **no unexpected side effects.**

```
let readPosts = new WeakSet();

//...when post is clicked on
postList.addEventListener('click', (event) => {
  //....
  readPosts.add(post);
});

// ...rendering posts
for(let post of postArray){
  if(!readPosts.has(post)){
    _addNewPostClass(post.element);
  }
}
```

Adds object to a group of read posts

The has() method checks whether an object is present in the WeakSet

Classes

Level 5 – Section 1

Adding a Sponsor to the Sidebar

We want to add a sponsor widget to the sidebar.

Sponsor widget

Using a Function Approach

A common approach to encapsulation in JavaScript is using a **constructor function**.

```
function SponsorWidget(name, description, url){
  this.name          = name;
  this.description   = description;
  this.url           = url;
}
```

Constructor functions are invoked with the new operator

```
SponsorWidget.prototype.render = function(){
  //...
};
```

Too verbose!

Invoking the *SponsorWidget* function looks like this:

```
let sponsorWidget = new SponsorWidget(name, description, url);
sponsorWidget.render();
```

Using the New Class Syntax

ES2015

To define a class, we use the *class* keyword followed by the name of the class. The body of a class is the part between curly braces.

```
class SponsorWidget {

  render(){
    //...
  }
}
```

instance method definitions in classes look just like the method initializer shorthand in objects!

Initializing Values in the Constructor Function

The *constructor* method is a special method for **creating and initializing** an object.

```
class SponsorWidget {

  constructor(name, description, url){
    this.name        = name;
    this.description = description;
    this.url         = url;
  }

  render(){
    //...
  }
}
```

Runs every time a new instance is created with the new operator

Assigning to instance variables makes them accessible by other instance methods

Still use it just like before

```
let sponsorWidget = new SponsorWidget(name, description, url);
sponsorWidget.render();
```

Accessing Class Instance Variables

Instance variables set on the *constructor* method can be accessed from all other instance methods in the class.

```
class SponsorWidget {

  constructor(name, description, url){
    //...
    this.url = url;
  }

  render(){
    let link = this._buildLink(this.url);
    //...
  }

  _buildLink(url){
    //...
  }
}
```

Don't forget to use this to access instance properties and methods

Can access previously assigned instance variables

Prefixing a method with an underscore is a convention for indicating that it should not be invoked from the public API

Creating an Instance From a Class

The class syntax is not introducing a new object model to JavaScript. It's just **syntactical sugar** over the existing **prototype-based** inheritance.

Syntactic Sugar

```
class SponsorWidget {
  //...
}
```

Prototype Object Model

```
function SponsorWidget(name, description, url){
  //...
}
```

Instances are created the same way

```
let sponsorWidget = new SponsorWidget(name, description, url);
sponsorWidget.render();
```

Class Inheritance

We can use class inheritance to reduce code repetition. Child classes **inherit** and **specialize** behavior defined in parent classes.

Widget

Base class defines common behavior

```
constructor(){
  this.baseCSS = ... ;
}

parse(value){ ... }
```

Child classes inherit behavior from base class

SponsorWidget

```
this.baseCSS
...
this.parse(value)
```

PromoWidget

```
this.baseCSS
...
this.parse(value)
```

NewsWidget

```
this.baseCSS
...
this.parse(value)
```

Using extends to Inherit From Base Class

The *extends* keyword is used to create a class that **inherits methods and properties** from another class. The *super* method runs the constructor function from the parent class.

Parent Class

```
class Widget {

  constructor(){
    this.baseCSS = "site-widget";
  }

  parse(value){
    //...
  }
}
```

runs parent's setup code

Child Class

```
class SponsorWidget extends Widget {

  constructor(name, description, url){
    super();

    //...
  }

  render(){
    let parsedName = this.parse(this.name);
    let css = this._buildCSS(this.baseCSS);
    //...
  }
}
```

inherits methods

inherits properties

Overriding Inherited Methods

Child classes can invoke methods from their **parent** classes via the *super* object.

Parent Class

```
class Widget {

  constructor(){
    this.baseCSS = "site-widget";
  }

  parse(value){
    //...
  }
}
```

Child Class

```
class SponsorWidget extends Widget {

  constructor(name, description, url){
    super();

    //...
  }

  parse(){
    let parsedName = super.parse(this.name);
    return `Sponsor: ${parsedName}`;
  }

  render(){
    //...
  }
}
```

Calls the parent version of the parse() method