JS Notes

Comment Your JavaScript Code

Comments are lines of code that JavaScript will intentionally ignore. Comments are a great way to leave notes to yourself and to other people who will later need to figure out what that code does.

There are two ways to write comments in JavaScript:

Using `//` will tell JavaScript to ignore the remainder of the text on the current line. This is an in-line comment:

```
// This is an in-line comment.
```

You can make a multi-line comment beginning with `/*` and ending with `*/`. This is a multi-line comment:

```
/* This is a
multi-line comment */
```

NOTE: As you write code, you should regularly add comments to clarify the function of parts of your code. Good commenting can help communicate the intent of your code—both for others *and* for your future self.

Declare JavaScript Variables

In computer science, *data* is anything that is meaningful to the computer. JavaScript provides eight different *data types* which are `undefined`, `null`, `boolean`, `string`, `symbol`, `bigint`, `number`, and `object`.

For example, computers distinguish between numbers, such as the number `12`, and `strings`, such as `"12"`, `"dog"`, or `"123 cats"`, which are collections of characters. Computers can perform mathematical operations on a number, but not on a string.

Variables allow computers to store and manipulate data in a dynamic fashion. They do this by using a "label" to point to the data rather than using the data itself. Any of the eight data types may be stored in a variable.

Variables are similar to the x and y variables you use in mathematics, which means they're a simple name to represent the data we want to refer to. Computer variables differ from mathematical variables in that they can store different values at different times.

We tell JavaScript to create or *declare* a variable by putting the keyword `var` in front of it, like so:

```
var ourName;
```

creates a variable called `ourName`. In JavaScript we end statements with semicolons. Variable names can be made up of numbers, letters, and `$` or `_`, but may not contain spaces or start with a number.

Storing Values with the Assignment Operator

In JavaScript, you can store a value in a variable with the *assignment* operator (`=`).

```
myVariable = 5;
```

This assigns the `Number` value `5` to `myVariable`.

If there are any calculations to the right of the `=` operator, those are performed before the value is assigned to the variable on the left of the operator.

```
var myVar;
myVar = 5;
```

First, this code creates a variable named `myVar`. Then, the code assigns `5` to `myVar`. Now, if `myVar` appears again in the code, the program will treat it as if it is `5`.

Assigning the Value of One Variable to Another

After a value is assigned to a variable using the *assignment* operator, you can assign the value of that variable to another variable using the *assignment* operator.

```
var myVar;
myVar = 5;
var myNum;
myNum = myVar;
```

The above declares a `myVar` variable with no value, then assigns it the value `5`. Next, a variable named `myNum` is declared with no value. Then, the contents of `myVar` (which is `5`) is assigned to the variable `myNum`. Now, `myNum` also has the value of `5`.

Initializing Variables with the Assignment Operator

It is common to *initialize* a variable to an initial value in the same line as it is declared.

```
var myVar = 0;
```

Creates a new variable called `myVar` and assigns it an initial value of `0`.

Declare String Variables

Previously you used the following code to declare a variable:

```
var myName;
```

But you can also declare a string variable like this:

```
var myName = "your name";
```

`"your name"` is called a *string literal*. A string literal, or string, is a series of zero or more characters enclosed in single or double quotes.

Understanding Uninitialized Variables

When JavaScript variables are declared, they have an initial value of `undefined`. If you do a mathematical operation on an `undefined` variable your result will be `NaN` which means *"Not a Number"*. If you concatenate a string with an `undefined` variable, you will get a *string* of `undefined`.

Initialize the three variables `a`, `b`, and `c` with `5`, `10`, and `"I am a"` respectively so that they will not be `undefined`.

Understanding Case Sensitivity in Variables

In JavaScript all variables and function names are case sensitive. This means that capitalization matters.

`MYVAR` is not the same as `MyVar` nor `myvar`. It is possible to have multiple distinct variables with the same name but different casing. It is strongly recommended that for the sake of clarity, you *do not* use this language feature.

Best Practice

Write variable names in JavaScript in *camelCase*. In *camelCase*, multi-word variable names have the first word in lowercase and the first letter of each subsequent word is capitalized.

Examples:

```
var someVariable;
var anotherVariableName;
var thisVariableNameIsSoLong;
```

Explore Differences Between the var and let Keywords

One of the biggest problems with declaring variables with the `var` keyword is that you can easily overwrite variable declarations:

```
var camper = "James";
var camper = "David";
console.log(camper);
```

In the code above, the `camper` variable is originally declared as `James`, and is then overridden to be `David`. The console then displays the string `David`.

In a small application, you might not run into this type of problem. But as your codebase becomes larger, you might accidentally overwrite a variable that you did not intend to. Because this behavior does not throw an error, searching for and fixing bugs becomes more difficult.

A keyword called `let` was introduced in ES6, a major update to JavaScript, to solve this potential issue with the `var` keyword. You'll learn about other ES6 features in later challenges.

If you replace `var` with `let` in the code above, it results in an error:

```
let camper = "James";
let camper = "David";
```

The error can be seen in your browser console.

So unlike `var`, when you use `let`, a variable with the same name can only be declared once.

Declare a Read-Only Variable with the const Keyword

The keyword `let` is not the only new way to declare variables. In ES6, you can also declare variables using the `const` keyword.

`const` has all the awesome features that `let` has, with the added bonus that variables declared using `const` are read-only. They are a constant value, which means that once a variable is assigned with `const`, it cannot be reassigned:

```
const FAV_PET = "Cats";
FAV_PET = "Dogs";
```

The console will display an error due to reassigning the value of `FAV_PET`.

You should always name variables you don't want to reassign using the `const` keyword. This helps when you accidentally attempt to reassign a variable that is meant to stay constant.

Note: It is common for developers to use uppercase variable identifiers for immutable values and lowercase or camelCase for mutable values (objects and arrays). You will learn more about objects, arrays, and immutable and mutable values in later challenges. Also in later challenges, you will see examples of uppercase, lowercase, or camelCase variable identifiers.

Add Two Numbers with JavaScript

`Number` is a data type in JavaScript which represents numeric data.

Now let's try to add two numbers using JavaScript.

JavaScript uses the `+` symbol as an addition operator when placed between two numbers.

Example:

```
const myVar = 5 + 10;
```

`myVar` now has the value `15`.

Subtract One Number from Another with JavaScript

We can also subtract one number from another.

JavaScript uses the `-` symbol for subtraction.

Example

```
const myVar = 12 - 6;
```

`myVar` would have the value `6`.

Multiply Two Numbers with JavaScript

We can also multiply one number by another.

JavaScript uses the `*` symbol for multiplication of two numbers.

Example

```
const myVar = 13 * 13;
```

`myVar` would have the value `169`.

Divide One Number by Another with JavaScript

We can also divide one number by another.

JavaScript uses the `/` symbol for division.

Example

```
const myVar = 16 / 2;
```

`myVar` now has the value `8`.

Increment a Number with JavaScript

You can easily *increment* or add one to a variable with the `++` operator.

```
i++;
```

is the equivalent of

```
i = i + 1;
```

Note: The entire line becomes `i++;`, eliminating the need for the equal sign.

Decrement a Number with JavaScript

You can easily *decrement* or decrease a variable by one with the `--` operator.

```
i--;
```

is the equivalent of

```
i = i - 1;
```

Note: The entire line becomes `i--;`, eliminating the need for the equal sign.

Create Decimal Numbers with JavaScript

We can store decimal numbers in variables too. Decimal numbers are sometimes referred to as *floating point* numbers or *floats*.

Note: when you compute numbers, they are computed with finite precision. Operations using floating points may lead to different results than the desired outcome. If you are getting one of these results, open a topic on the freeCodeCamp forum.

Multiply Two Decimals with JavaScript

In JavaScript, you can also perform calculations with decimal numbers, just like whole numbers.

Let's multiply two decimals together to get their product.

Change the `0.0` so that product will equal `5.0`.

Divide One Decimal by Another with JavaScript

Now let's divide one decimal by another.

Change the `0.0` so that `quotient` will equal to `2.2`.

Finding a Remainder in JavaScript

The *remainder* operator `%` gives the remainder of the division of two numbers.

Example

```
5 % 2 = 1 because
Math.floor(5 / 2) = 2 (Quotient)
2 * 2 = 4
5 - 4 = 1 (Remainder)
```

Usage
In mathematics, a number can be checked to be even or odd by checking the remainder of the division of the number by `2`.

```
17 % 2 = 1 (17 is Odd)
48 % 2 = 0 (48 is Even)
```

Note: The *remainder* operator is sometimes incorrectly referred to as the modulus operator. It is very similar to modulus, but does not work properly with negative numbers.

Compound Assignment With Augmented Addition

In programming, it is common to use assignments to modify the contents of a variable. Remember that everything to the right of the equals sign is evaluated first, so we can say:

```
myVar = myVar + 5;
```

to add `5` to `myVar`. Since this is such a common pattern, there are operators which do both a mathematical operation and assignment in one step.

One such operator is the `+=` operator.

```
let myVar = 1;
```

```
myVar += 5;
console.log(myVar);
```

`6` would be displayed in the console.

Compound Assignment With Augmented Subtraction

Like the `+=` operator, `-=` subtracts a number from a variable.

```
myVar = myVar - 5;
```

will subtract `5` from `myVar`. This can be rewritten as:

```
myVar -= 5;
```

Compound Assignment With Augmented Multiplication

The `*=` operator multiplies a variable by a number.

```
myVar = myVar * 5;
```

will multiply `myVar` by `5`. This can be rewritten as:

```
myVar *= 5;
```

Compound Assignment With Augmented Division

The `/=` operator divides a variable by another number.

```
myVar = myVar / 5;
```

Will divide `myVar` by `5`. This can be rewritten as:

```
myVar /= 5;
```

Escaping Literal Quotes in Strings

When you are defining a string you must start and end with a single or double quote. What happens when you need a literal quote: `"` or `'` inside of your string?

In JavaScript, you can *escape* a quote from considering it as an end of string quote by placing a *backslash* (`\`) in front of the quote.

```
const sampleStr = "Alan said, \"Peter is learning
JavaScript\".";
```

This signals to JavaScript that the following quote is not the end of the string, but should instead appear inside the string. So if you were to print this to the console, you would get:

```
Alan said, "Peter is learning JavaScript".
```

Quoting Strings with Single Quotes

String values in JavaScript may be written with single or double quotes, as long as you start and end with the same type of quote. Unlike some other programming languages, single and double quotes work the same in JavaScript.

```
const doubleQuoteStr = "This is a string";
const singleQuoteStr = 'This is also a string';
```

The reason why you might want to use one type of quote over the other is if you want to use both in a string. This might happen if you want to save a conversation in a string and have the conversation in quotes. Another use for it would be saving an `<a>` tag with various attributes in quotes, all within a string.

```
const conversation = 'Finn exclaims to Jake, "Algebraic!"';
```

However, this becomes a problem if you need to use the outermost quotes within it. Remember, a string has the same kind of quote at the beginning and end. But if you have that same quote somewhere in the middle, the string will stop early and throw an error.

```
const goodStr = 'Jake asks Finn, "Hey, let\'s go on an adventure?"';
const badStr = 'Finn responds, "Let's go!"';
```

Here `badStr` will throw an error.

In the *goodStr* above, you can use both quotes safely by using the backslash `\` as an escape character.

Note: The backslash `\` should not be confused with the forward slash `/`. They do not do the same thing.

Escape Sequences in Strings

Quotes are not the only characters that can be *escaped* inside a string. There are two reasons to use escaping characters:

1. To allow you to use characters you may not otherwise be able to type out, such as a newline.
2. To allow you to represent multiple quotes in a string without JavaScript misinterpreting what you mean.

We learned this in the previous challenge.

Code	Output
`\'`	`single quote`

Code	Output
`\"`	double quote
`\\`	backslash
`\n`	newline
`\t`	tab
`\r`	carriage return
`\b`	word boundary
`\f`	form feed

Concatenating Strings with Plus Operator

In JavaScript, when the `+` operator is used with a `String` value, it is called the *concatenation* operator. You can build a new string out of other strings by *concatenating* them together.

Example

```
'My name is Alan,' + ' I concatenate.'
```

Note: Watch out for spaces. Concatenation does not add spaces between concatenated strings, so you'll need to add them yourself.

Example:

```
const ourStr = "I come first. " + "I come second.";
```

The string `I come first. I come second.` would be displayed in the console.

Concatenating Strings with the Plus Equals Operator

We can also use the `+=` operator to *concatenate* a string onto the end of an existing string variable. This can be very helpful to break a long string over several lines.

Note: Watch out for spaces. Concatenation does not add spaces between concatenated strings, so you'll need to add them yourself.

Example:

```
let ourStr = "I come first. ";
ourStr += "I come second.";
```

`ourStr` now has a value of the string `I come first. I come second.`.

Constructing Strings with Variables

Sometimes you will need to build a string. By using the concatenation operator (`+`), you can insert one or more variables into a string you're building.

Example:

```
const ourName = "freeCodeCamp";
const ourStr = "Hello, our name is " + ourName + ", how are
you?";
```

`ourStr` would have a value of the string `Hello, our name is freeCodeCamp, how are you?`.

Appending Variables to Strings

Just as we can build a string over multiple lines out of string *literals*, we can also append variables to a string using the plus equals (`+=`) operator.

Example:

```
const anAdjective = "awesome!";
let ourStr = "freeCodeCamp is ";
ourStr += anAdjective;
```

`ourStr` would have the value `freeCodeCamp is awesome!`.

Find the Length of a String

You can find the length of a `String` value by writing `.length` after the string variable or string literal.

```
console.log("Alan Peter".length);
```

The value `10` would be displayed in the console. Note that the space character between "Alan" and "Peter" is also counted.

For example, if we created a variable `const firstName = "Ada"`, we could find out how long the string `Ada` is by using the `firstName.length` property.

Use Bracket Notation to Find the First Character in a String

Bracket notation is a way to get a character at a specific index within a string.

Most modern programming languages, like JavaScript, don't start counting at 1 like humans do. They start at 0. This is referred to as *Zero-based* indexing.

For example, the character at index 0 in the word `Charles` is `C`. So if `const firstName = "Charles"`, you can get the value of the first letter of the string by using `firstName[0]`.

Example:

```
const firstName = "Charles";
const firstLetter = firstName[0];
```

`firstLetter` would have a value of the string `C`.

Understand String Immutability

In JavaScript, `String` values are *immutable*, which means that they cannot be altered once created.

For example, the following code will produce an error because the letter `B` in the string `Bob` cannot be changed to the letter `J`:

```
let myStr = "Bob";
myStr[0] = "J";
```

Note that this does *not* mean that `myStr` could not be re-assigned. The only way to change `myStr` would be to assign it with a new value, like this:

```
let myStr = "Bob";
myStr = "Job";
```

Use Bracket Notation to Find the Nth Character in a String

You can also use *bracket notation* to get the character at other positions within a string.

Remember that computers start counting at `0`, so the first character is actually the zeroth character.

Example:

```
const firstName = "Ada";
const secondLetterOfFirstName = firstName[1];
```

`secondLetterOfFirstName` would have a value of the string `d`.

Use Bracket Notation to Find the Last Character in a String

In order to get the last letter of a string, you can subtract one from the string's length.

For example, if `const firstName = "Ada"`, you can get the value of the last letter of the string by using `firstName[firstName.length - 1]`.

Example:

```
const firstName = "Ada";
const lastLetter = firstName[firstName.length - 1];
```

`lastLetter` would have a value of the string `a`.

Use Bracket Notation to Find the Nth-to-Last Character in a String

You can use the same principle we just used to retrieve the last character in a string to retrieve the Nth-to-last character.

For example, you can get the value of the third-to-last letter of the `const firstName = "Augusta"` string by using `firstName[firstName.length - 3]`

Example:

```
const firstName = "Augusta";
const thirdToLastLetter = firstName[firstName.length - 3];
```

`thirdToLastLetter` would have a value of the string `s`.

Word Blanks

You are provided sentences with some missing words, like nouns, verbs, adjectives and adverbs. You then fill in the missing pieces with words of your choice in a way that the completed sentence makes sense.

Consider this sentence - It was really ____, and we ____ ourselves ____. This sentence has three missing pieces- an adjective, a verb and an adverb, and we can add words of our choice to complete it. We can then assign the completed sentence to a variable as follows:

```
const sentence = "It was really " + "hot" + ", and we " +
"laughed" + " ourselves " + "silly" + ".";
```

Store Multiple Values in one Variable using JavaScript Arrays

With JavaScript `array` variables, we can store several pieces of data in one place.

You start an array declaration with an opening square bracket, end it with a closing square bracket, and put a comma between each entry, like this:

```
const sandwich = ["peanut butter", "jelly", "bread"];
```

Nest one Array within Another Array

You can also nest arrays within other arrays, like below:

```
const teams = [["Bulls", 23], ["White Sox", 45]];
```

Access Array Data with Indexes

We can access the data inside arrays using *indexes*.

Array indexes are written in the same bracket notation that strings use, except that instead of specifying a character, they are specifying an entry in the array. Like strings, arrays use *zero-based* indexing, so the first element in an array has an index of `0`.

Example

```
const array = [50, 60, 70];
console.log(array[0]);
const data = array[1];
```

The `console.log(array[0])` prints `50`, and `data` has the value `60`.

Modify Array Data With Indexes

Unlike strings, the entries of arrays are *mutable* and can be changed freely, even if the array was declared with `const`.

Example

```
const ourArray = [50, 40, 30];
ourArray[0] = 15;
```

`ourArray` now has the value `[15, 40, 30]`.

Note: There shouldn't be any spaces between the array name and the square brackets, like `array [0]`. Although JavaScript is able to process this correctly, this may confuse other programmers reading your code.

Access Multi-Dimensional Arrays With Indexes

One way to think of a *multi-dimensional* array, is as an *array of arrays*. When you use brackets to access your array, the first set of brackets refers to the entries in the outermost (the first level) array, and each additional pair of brackets refers to the next level of entries inside.

Example

```
const arr = [
  [1, 2, 3],
  [4, 5, 6],
  [7, 8, 9],
  [[10, 11, 12], 13, 14]
];

const subarray = arr[3];
const nestedSubarray = arr[3][0];
const element = arr[3][0][1];
```

In this example, `subarray` has the value `[[10, 11, 12], 13, 14]`, `nestedSubarray` has the value `[10, 11, 12]`, and `element` has the value `11` .

Note: There shouldn't be any spaces between the array name and the square brackets, like `array [0][0]` and even this `array [0] [0]` is not allowed. Although JavaScript is able to process this correctly, this may confuse other programmers reading your code.

Manipulate Arrays With push()

An easy way to append data to the end of an array is via the `push()` function.

`.push()` takes one or more *parameters* and "pushes" them onto the end of the array.

Examples:

```
const arr1 = [1, 2, 3];
arr1.push(4);

const arr2 = ["Stimpson", "J", "cat"];
arr2.push(["happy", "joy"]);
```

`arr1` now has the value `[1, 2, 3, 4]` and `arr2` has the value `["Stimpson", "J", "cat", ["happy", "joy"]]`.

Manipulate Arrays With pop()

Another way to change the data in an array is with the `.pop()` function.

`.pop()` is used to pop a value off of the end of an array. We can store this popped off value by assigning it to a variable. In other words, `.pop()` removes the last element from an array and returns that element.

Any type of entry can be popped off of an array - numbers, strings, even nested arrays.

```
const threeArr = [1, 4, 6];
const oneDown = threeArr.pop();
console.log(oneDown);
console.log(threeArr);
```

The first `console.log` will display the value `6`, and the second will display the value `[1, 4]`.

Manipulate Arrays With shift()

`pop()` always removes the last element of an array. What if you want to remove the first?

That's where `.shift()` comes in. It works just like `.pop()`, except it removes the first element instead of the last.

Example:

```
const ourArray = ["Stimpson", "J", ["cat"]];
const removedFromOurArray = ourArray.shift();
```

`removedFromOurArray` would have a value of the string `Stimpson`, and `ourArray` would have `["J", ["cat"]]`.

Manipulate Arrays With unshift()

Not only can you `shift` elements off of the beginning of an array, you can also `unshift` elements to the beginning of an array i.e. add elements in front of the array.

`.unshift()` works exactly like `.push()`, but instead of adding the element at the end of the array, `unshift()` adds the element at the beginning of the array.

Example:

```
const ourArray = ["Stimpson", "J", "cat"];
ourArray.shift();
ourArray.unshift("Happy");
```

After the `shift`, `ourArray` would have the value `["J", "cat"]`. After the `unshift`, `ourArray` would have the value `["Happy", "J", "cat"]`.

Shopping List

Create a shopping list in the variable `myList`. The list should be a multi-dimensional array containing several sub-arrays.

The first element in each sub-array should contain a string with the name of the item. The second element should be a number representing the quantity i.e.

```
["Chocolate Bar", 15]
```

There should be at least 5 sub-arrays in the list.

Write Reusable JavaScript with Functions

In JavaScript, we can divide up our code into reusable parts called *functions*.

Here's an example of a function:

```
function functionName() {
  console.log("Hello World");
}
```

You can call or *invoke* this function by using its name followed by parentheses, like this: `functionName();` Each time the function is called it will print out the message `Hello World` on the dev console. All of the code between the curly braces will be executed every time the function is called.

We can store function in a variable.
Everytime you declare a variable and equal to something weather a string, number, or a function that is known as an **Expression and in the end of expression we should have semicolon.**

Function Sequence

JavaScript functions are executed in the sequence they are called. Not in the sequence they are defined.

Parameter Rules

JavaScript function definitions do not specify data types for parameters.

JavaScript functions do not perform type checking on the passed arguments.

JavaScript functions do not check the number of arguments received.

Default Parameters

If a function is called with **missing arguments** (less than declared), the missing values are set to `undefined`.

Sometimes this is acceptable, but sometimes it is better to assign a default value to the parameter:

Passing Values to Functions with Arguments

Parameters are variables that act as placeholders for the values that are to be input to a function when it is called. When a function is defined, it is typically defined along with one or more parameters. The actual values that are input (or *"passed"*) into a function when it is called are known as *arguments.*

Here is a function with two parameters, `param1` and `param2`:

```
function testFun(param1, param2) {
  console.log(param1, param2);
}
```

Then we can call `testFun` like this: `testFun("Hello", "World");`. We have passed two string arguments, `Hello` and `World`. Inside the function, `param1` will equal the string `Hello` and `param2` will equal the string `World`. Note that you could call `testFun` again with different arguments and the parameters would take on the value of the new arguments.

Return a Value from a Function with Return

We can pass values into a function with *arguments*. You can use a `return` statement to send a value back out of a function.

Example

```
function plusThree(num) {
  return num + 3;
}

const answer = plusThree(5);
```

`answer` has the value `8`.

`plusThree` takes an *argument* for `num` and returns a value equal to `num + 3`.

Note: The `return` statement stops the execution of a function and returns a value.

Global Scope and Functions

In JavaScript, *scope* refers to the visibility of variables. Variables which are defined outside of a function block have *Global* scope. This means, they can be seen everywhere in your JavaScript code.

Variables which are declared without the `let` or `const` keywords are automatically created in the `global` scope. This can create unintended consequences elsewhere in your code or when running a function again. You should always declare your variables with `let` or `const`.

Local Scope and Functions

Variables which are declared within a function, as well as the function parameters, have *local* scope. That means they are only visible within that function.

Here is a function `myTest` with a local variable called `loc`.

```
function myTest() {
  const loc = "foo";
  console.log(loc);
}

myTest();
console.log(loc);
```

The `myTest()` function call will display the string `foo` in the console.
The `console.log(loc)` line (outside of the `myTest` function) will throw an error, as `loc` is not defined outside of the function.

Global vs. Local Scope in Functions

It is possible to have both *local* and *global* variables with the same name. When you do this, the local variable takes precedence over the global variable.

In this example:

```
const someVar = "Hat";

function myFun() {
  const someVar = "Head";
  return someVar;
}
```

The function `myFun` will return the string `Head` because the local version of the variable is present.

Understanding Undefined Value returned from a Function

A function can include the `return` statement but it does not have to. In the case that the function doesn't have a `return` statement, when you call it, the function processes the inner code but the returned value is `undefined`.

Example

```
let sum = 0;


function addSum(num) {
  sum = sum + num;
}


addSum(3);
```

`addSum` is a function without a `return` statement. The function will change the global `sum` variable but the returned value of the function is `undefined`.

Assignment with a Returned Value

If you'll recall from our discussion about [Storing Values with the Assignment Operator](), everything to the right of the equal sign is resolved before the value is assigned. This means we can take the return value of a function and assign it to a variable.

Assume we have pre-defined a function `sum` which adds two numbers together, then:

```
ourSum = sum(5, 12);
```

will call the `sum` function, which returns a value of `17` and assigns it to the `ourSum` variable.

Stand in Line

In Computer Science a *queue* is an abstract *Data Structure* where items are kept in order. New items can be added at the back of the queue and old items are taken off from the front of the queue.

Understanding Boolean Values

Another data type is the *Boolean*. Booleans may only be one of two values: `true` or `false`. They are basically little on-off switches, where `true` is on and `false` is off. These two states are mutually exclusive.

Note: Boolean values are never written with quotes. The strings `"true"` and `"false"` are not Boolean and have no special meaning in JavaScript.

Use Conditional Logic with If Statements

`if` statements are used to make decisions in code. The keyword `if` tells JavaScript to execute the code in the curly braces under certain conditions, defined in the parentheses. These conditions are known as `Boolean` conditions and they may only be `true` or `false`.

When the condition evaluates to `true`, the program executes the statement inside the curly braces. When the Boolean condition evaluates to `false`, the statement inside the curly braces will not execute.

Pseudocode

```
if (condition is true) {
  statement is executed
}
```

Example

```
function test (myCondition) {
  if (myCondition) {
    return "It was true";
  }
  return "It was false";
}

test(true);
test(false);
```

`test(true)` returns the string `It was true`, and `test(false)` returns the string `It was false`.

When `test` is called with a value of `true`, the `if` statement evaluates `myCondition` to see if it is `true` or not. Since it is `true`, the function returns `It was true`. When we call `test` with a value of `false`, `myCondition` is *not* `true` and the statement in the curly braces is not executed and the function returns `It was false`.

Comparison with the Equality Operator

There are many *comparison operators* in JavaScript. All of these operators return a boolean `true` or `false` value.

The most basic operator is the equality operator `==`. The equality operator compares two values and returns `true` if they're equivalent or `false` if they are not. Note that equality is different from assignment (`=`), which assigns the value on the right of the operator to a variable on the left.

```
function equalityTest(myVal) {
  if (myVal == 10) {
    return "Equal";
  }
  return "Not Equal";
}
```

If `myVal` is equal to `10`, the equality operator returns `true`, so the code in the curly braces will execute, and the function will return `Equal`. Otherwise, the function will return `Not Equal`. In order for JavaScript to compare two different *data types* (for example, `numbers` and `strings`), it must convert one type to another. This is known as Type Coercion. Once it does, however, it can compare terms as follows:

```
1   ==  1  // true
1   ==  2  // false
1   == '1' // true
"3" ==  3  // true
```

Note: There are many *comparison operators* in JavaScript. All of these operators return a boolean `true` or `false` value.

Comparison with the Strict Equality Operator

Strict equality (`===`) is the counterpart to the equality operator (`==`). However, unlike the equality operator, which attempts to convert both values being compared to a common type, the strict equality operator does not perform a type conversion.

If the values being compared have different types, they are considered unequal, and the strict equality operator will return false.

Examples

```
3 ===  3  // true
3 === '3' // false
```

In the second example, `3` is a `Number` type and `'3'` is a `String` type.

Practice comparing different values

In the last two challenges, we learned about the equality operator (`==`) and the strict equality operator (`===`). Let's do a quick review and practice using these operators some more.

If the values being compared are not of the same type, the equality operator will perform a type conversion, and then evaluate the values. However, the strict equality operator will compare both the data type and value as-is, without converting one type to the other.

Examples

`3 == '3'` returns `true` because JavaScript performs type conversion from string to number. `3 === '3'` returns `false` because the types are different and type conversion is not performed.

Note: In JavaScript, you can determine the type of a variable or a value with the `typeof` operator, as follows:

```
typeof 3
typeof '3'
```

`typeof 3` returns the string `number`, and `typeof '3'` returns the string `string`.

Comparison with the Inequality Operator

The inequality operator (`!=`) is the opposite of the equality operator. It means not equal and returns `false` where equality would return `true` and *vice versa*. Like the equality operator, the inequality operator will convert data types of values while comparing.

Examples

```
1 !=  2    // true
1 != "1"   // false
1 != '1'   // false
1 != true  // false
0 != false // false
```

Comparison with the Strict Inequality Operator

The strict inequality operator (`!==`) is the logical opposite of the strict equality operator. It means "Strictly Not Equal" and returns `false` where strict equality would return `true` and *vice versa*. The strict inequality operator will not convert data types.

Examples

```
3 !==  3  // false
3 !== '3' // true
4 !==  3  // true
```

Comparison with the Greater Than Operator

The greater than operator (`>`) compares the values of two numbers. If the number to the left is greater than the number to the right, it returns `true`. Otherwise, it returns `false`.

Like the equality operator, the greater than operator will convert data types of values while comparing.

Examples

```
5   >  3  // true
7   > '3' // true
2   >  3  // false
'1' >  9  // false
```

Comparison with the Greater Than Or Equal To Operator

The greater than or equal to operator (`>=`) compares the values of two numbers. If the number to the left is greater than or equal to the number to the right, it returns `true`. Otherwise, it returns `false`.

Like the equality operator, the greater than or equal to operator will convert data types while comparing.

Examples

```
6   >=  6  // true
7   >= '3' // true
2   >=  3  // false
'7' >=  9  // false
```

Comparison with the Less Than Operator

The less than operator (`<`) compares the values of two numbers. If the number to the left is less than the number to the right, it returns `true`. Otherwise, it returns `false`. Like the equality operator, the less than operator converts data types while comparing.

Examples

```
2   < 5 // true
'3' < 7 // true
```

```
5   < 5 // false
3   < 2 // false
'8' < 4 // false
```

Comparison with the Less Than Or Equal To Operator

The less than or equal to operator (`<=`) compares the values of two numbers. If the number to the left is less than or equal to the number to the right, it returns `true`. If the number on the left is greater than the number on the right, it returns `false`. Like the equality operator, the less than or equal to operator converts data types.

Examples

```
4   <= 5 // true
'7' <= 7 // true
5   <= 5 // true
3   <= 2 // false
'8' <= 4 // false
```

Add the less than or equal to operator to the indicated lines so that the return statements make sense.

Comparisons with the Logical And Operator

Sometimes you will need to test more than one thing at a time. The *logical and* operator (`&&`) returns `true` if and only if the *operands* to the left and right of it are true.

The same effect could be achieved by nesting an if statement inside another if:

```
if (num > 5) {
  if (num < 10) {
    return "Yes";
  }
}
return "No";
```

will only return `Yes` if `num` is greater than `5` and less than `10`. The same logic can be written as:

```
if (num > 5 && num < 10) {
  return "Yes";
}
return "No";
```

Comparisons with the Logical Or Operator

The *logical or* operator (`||`) returns `true` if either of the *operands* is `true`. Otherwise, it returns `false`.

The *logical or* operator is composed of two pipe symbols: (`||`). This can typically be found between your Backspace and Enter keys.

The pattern below should look familiar from prior waypoints:

```
if (num > 10) {
  return "No";
}
if (num < 5) {
  return "No";
}
return "Yes";
```

will return `Yes` only if `num` is between `5` and `10` (5 and 10 included). The same logic can be written as:

```
if (num > 10 || num < 5) {
  return "No";
}
return "Yes";
```

Introducing Else Statements

When a condition for an `if` statement is true, the block of code following it is executed. What about when that condition is false? Normally nothing would happen. With an `else` statement, an alternate block of code can be executed.

```
if (num > 10) {
  return "Bigger than 10";
} else {
  return "10 or Less";
}
```

Introducing Else If Statements

If you have multiple conditions that need to be addressed, you can chain `if` statements together with `else if` statements.

```
if (num > 15) {
  return "Bigger than 15";
} else if (num < 5) {
  return "Smaller than 5";
} else {
  return "Between 5 and 15";
}
```

Logical Order in If Else Statements

Order is important in `if`, `else if` statements.

The function is executed from top to bottom so you will want to be careful of what statement comes first.

Take these two functions as an example.

Here's the first:

```
function foo(x) {
  if (x < 1) {
    return "Less than one";
  } else if (x < 2) {
    return "Less than two";
  } else {
    return "Greater than or equal to two";
  }
}
```

And the second just switches the order of the statements:

```
function bar(x) {
  if (x < 2) {
    return "Less than two";
  } else if (x < 1) {
    return "Less than one";
  } else {
    return "Greater than or equal to two";
  }
}
```

While these two functions look nearly identical if we pass a number to both we get different outputs.

```
foo(0)
bar(0)
```

`foo(0)` will return the string `Less than one`, and `bar(0)` will return the string `Less than two`.

Chaining If Else Statements

`if/else` statements can be chained together for complex logic. Here is *pseudocode* of multiple chained `if` / `else if` statements:

```
if (condition1) {
  statement1
} else if (condition2) {
  statement2
} else if (condition3) {
  statement3
. . .
} else {
  statementN
}
```

Write chained `if`/`else if` statements to fulfill the following conditions:

`num < 5` - return `Tiny`
`num < 10` - return `Small`
`num < 15` - return `Medium`
`num < 20` - return `Large`
`num >= 20` - return `Huge`

Selecting from Many Options with Switch Statements

If you have many options to choose from, use a *switch* statement.
A `switch` statement tests a value and can have many *case* statements which define various possible values. Statements are executed from the first matched `case` value until a `break` is encountered.

Here is an example of a `switch` statement:

```
switch (lowercaseLetter) {
  case "a":
    console.log("A");
    break;
  case "b":
    console.log("B");
    break;
}
```

`case` values are tested with strict equality (`===`). The `break` tells JavaScript to stop executing statements. If the `break` is omitted, the next statement will be executed.

Write a switch statement which tests `val` and sets `answer` for the following conditions:

```
1 - alpha
2 - beta
3 - gamma
4 - delta
```

Solution:

```
function caseInSwitch(val) {
  let answer = "";
  // Only change code below this line
switch (val) {
  case 1:
  answer = "alpha";
  break;
  case 2:
  answer = "beta";
  break;
  case 3:
  answer = "gamma";
  break;
  case 4:
  answer = "delta";
  break;

}


  // Only change code above this line
  return answer;
}

caseInSwitch(1);
```

Adding a Default Option in Switch Statements

In a `switch` statement you may not be able to specify all possible values as `case` statements. Instead, you can add the `default` statement which will be executed if no matching `case` statements are found. Think of it like the final `else` statement in an `if/else` chain.

A `default` statement should be the last case.

```
switch (num) {
  case value1:
    statement1;
    break;
  case value2:
    statement2;
    break;
...
  default:
    defaultStatement;
    break;
}
```

Write a switch statement to set `answer` for the following conditions:

`a` - `apple`

`b` - `bird`

`c` - `cat`

`default` - `stuff`

Solution:

```
function switchOfStuff(val) {
  let answer = "";
  // Only change code below this line
switch (val) {
  case "a":
  answer = "apple";
  break;
  case "b":
  answer = "bird";
  break;
  case "c":
  answer = "cat";
  break;
  default:
  answer ="stuff";
  break;
}
  // Only change code above this line
  return answer;
}
console.log(switchOfStuff(""));
switchOfStuff(1)
```

Multiple Identical Options in Switch Statements

If the `break` statement is omitted from a `switch` statement's `case`, the following `case` statement(s) are executed until a `break` is encountered. If you have multiple inputs with the same output, you can represent them in a `switch` statement like this:

```
let result = "";
switch (val) {
  case 1:
  case 2:
  case 3:
    result = "1, 2, or 3";
    break;
  case 4:
    result = "4 alone";
}
```

Cases for 1, 2, and 3 will all produce the same result.

Write a switch statement to set `answer` for the following ranges:
`1-3` - `Low`
`4-6` - `Mid`
`7-9` - `High`

Note: You will need to have a `case` statement for each number in the range.

Solution:

```
function sequentialSizes(val) {
  let answer = "";
  // Only change code below this line
switch (val) {
  case 1:
  case 2:
  case 3:
  answer = "Low";
  break;
  case 4:
  case 5:
  case 6:
  answer = "Mid";
  break;
  case 7:
  case 8:
  case 9:
  answer = "High";
  break
}


  // Only change code above this line
  return answer;
}
console.log(sequentialSizes());
sequentialSizes();
```

Replacing If Else Chains with Switch

If you have many options to choose from, a `switch` statement can be easier to write than many chained `if`/`else if` statements. The following:

```
if (val === 1) {
  answer = "a";
} else if (val === 2) {
  answer = "b";
} else {
  answer = "c";
}
```

can be replaced with:

```
switch (val) {
  case 1:
    answer = "a";
    break;
  case 2:
    answer = "b";
    break;
  default:
    answer = "c";
}
```

Change the chained `if`/`else if` statements into a `switch` statement.

Solution:

```
function chainToSwitch(val) {
  let answer = "";
  // Only change code below this line
switch (val) {
  case "bob":
  answer = "Marley";
  break;
  case 42:
  answer = "The Answer";
  break;
  case 1:
  answer = "There is no #1";
  break;
  case 99:
  answer = "Missed me by this much!";
  break;
  case 7:
  answer = "Ate Nine";
  break;
}

  // Only change code above this line
  return answer;
}

console.log(chainToSwitch());
chainToSwitch(7);
```

Returning Boolean Values from Functions

You may recall from Comparison with the Equality Operator that all comparison operators return a boolean `true` or `false` value.

Sometimes people use an `if/else` statement to do a comparison, like this:

```
function isEqual(a, b) {
  if (a === b) {
    return true;
  } else {
    return false;
  }
}
```

But there's a better way to do this. Since `===` returns `true` or `false`, we can return the result of the comparison:

```
function isEqual(a, b) {
  return a === b;
}
```

Fix the function `isLess` to remove the `if/else` statements.

Solution:

```
function isLess(a, b) {
  // Only change code below this line
  return a < b;
  // Only change code above this line
}

isLess(10, 15);
```

Return Early Pattern for Functions

When a `return` statement is reached, the execution of the current function stops and control returns to the calling location.

Example

```
function myFun() {
  console.log("Hello");
  return "World";
  console.log("byebye")
}
myFun();
```

The above will display the string `Hello` in the console, and return the string `World`. The string `byebye` will never display in the console, because the function exits at the `return` statement.

Modify the function `abTest` so that if `a` or `b` are less than `0` the function will immediately exit with a value of `undefined`.

Hint
Remember that `undefined` is a keyword, not a string.

```
// Setup
function abTest(a, b) {
  // Only change code below this line
if (a < 0 || b < 0) {
  return;
}


  // Only change code above this line

  return Math.round(Math.pow(Math.sqrt(a) + Math.sqrt(b),
 2));
}

abTest(2,2);
```

Counting Cards

In the casino game Blackjack, a player can determine whether they have an advantage on the next hand over the house by keeping track of the relative number of high and low cards remaining in the deck. This is called Card Counting.

Having more high cards remaining in the deck favors the player. Each card is assigned a value according to the table below. When the count is positive, the player should bet high. When the count is zero or negative, the player should bet low.

Count Change	Cards
+1	2, 3, 4, 5, 6
0	7, 8, 9
-1	10, 'J', 'Q', 'K', 'A'

You will write a card counting function. It will receive a `card` parameter, which can be a number or a string, and increment or decrement the global `count` variable according to the card's value (see table). The function will then return a string with the current count and the string `Bet` if the count is positive, or `Hold` if the count is zero or negative. The current count and the player's decision (`Bet` or `Hold`) should be separated by a single space.

Example Outputs: `-3 Hold` or `5 Bet`

Hint
Do NOT reset `count` to 0 when value is 7, 8, or 9.
Do NOT return an array.
Do NOT include quotes (single or double) in the output.

```
let count = 0;

function cc(card) {
  // Only change code below this line
switch (card) {
    case 2:
    case 3:
    case 4:
    case 5:
    case 6:
      count++;
      break;
    case 10:
    case "J":
    case "Q":
    case "K":
    case "A":
      count--;
      break;
  }
  if (count > 0) {
    return count + " Bet";
  } else {
    return count + " Hold";
  }

  return "Change Me";
  // Only change code above this line
}

cc(2); cc(3); cc(7); cc('K'); cc('A');
```

Build JavaScript Objects

You may have heard the term `object` before.

Objects are similar to `arrays`, except that instead of using indexes to access and modify their data, you access the data in objects through what are called `properties`.

Objects are useful for storing data in a structured way, and can represent real world objects, like a cat.

Here's a sample cat object:

```
const cat = {
  "name": "Whiskers",
  "legs": 4,
  "tails": 1,
  "enemies": ["Water", "Dogs"]
};
```

In this example, all the properties are stored as strings, such as `name`, `legs`, and `tails`. However, you can also use numbers as properties. You can even omit the quotes for single-word string properties, as follows:

```
const anotherObject = {
  make: "Ford",
  5: "five",
  "model": "focus"
};
```

However, if your object has any non-string properties, JavaScript will automatically typecast them as strings.

Make an object that represents a dog called `myDog` which contains the properties `name` (a string), `legs`, `tails` and `friends`.

You can set these object properties to whatever values you want, as long as `name` is a string, `legs` and `tails` are numbers, and `friends` is an array.

```
const myDog = {
  // Only change code below this line
"name": "browny",
"legs": 4,
"tails": 1,
"friends": ["man", "women"]

  // Only change code above this line
};

console.log(myDog);
```

Accessing Object Properties with Dot Notation

There are two ways to access the properties of an object: dot notation (.) and bracket notation (`[]`), similar to an array.

Dot notation is what you use when you know the name of the property you're trying to access ahead of time.

Here is a sample of using dot notation (.) to read an object's property:

```
const myObj = {
  prop1: "val1",
  prop2: "val2"
};


const prop1val = myObj.prop1;
const prop2val = myObj.prop2;
```

`prop1val` would have a value of the string `val1`, and `prop2val` would have a value of the string `val2`.

Read in the property values of `testObj` using dot notation. Set the variable `hatValue` equal to the object's property `hat` and set the variable `shirtValue` equal to the object's property `shirt`.

Solution:

```
// Setup
const testObj = {
  "hat": "ballcap",
  "shirt": "jersey",
  "shoes": "cleats"
};

// Only change code below this line
const hatValue = testObj.hat;      // Change this line
const shirtValue = testObj.shirt;    // Change this line
```

Accessing Object Properties with Bracket Notation

The second way to access the properties of an object is bracket notation (`[]`). If the property of the object you are trying to access has a space in its name, you will need to use bracket notation.

However, you can still use bracket notation on object properties without spaces.

Here is a sample of using bracket notation to read an object's property:

```
const myObj = {
  "Space Name": "Kirk",
  "More Space": "Spock",
  "NoSpace": "USS Enterprise"
};
```

```
myObj["Space Name"];
myObj['More Space'];
myObj["NoSpace"];
```

`myObj["Space Name"]` would be the string `Kirk`, `myObj['More Space']` would be the string `Spock`, and `myObj["NoSpace"]` would be the string `USS Enterprise`.

Note that property names with spaces in them must be in quotes (single or double).

Read the values of the properties `an entree` and `the drink` of `testObj` using bracket notation and assign them to `entreeValue` and `drinkValue` respectively.

```
// Setup
const testObj = {
  "an entree": "hamburger",
  "my side": "veggies",
  "the drink": "water"
};

// Only change code below this line
const entreeValue = testObj["an entree"];   // Change this line
const drinkValue = testObj["the drink"];    // Change this line
```

Accessing Object Properties with Variables

Another use of bracket notation on objects is to access a property which is stored as the value of a variable. This can be very useful for iterating through an object's properties or when accessing a lookup table.

Here is an example of using a variable to access a property:

```
const dogs = {
  Fido: "Mutt",
  Hunter: "Doberman",
  Snoopie: "Beagle"
};

const myDog = "Hunter";
const myBreed = dogs[myDog];
console.log(myBreed);
```

The string `Doberman` would be displayed in the console.

Note that we do *not* use quotes around the variable name when using it to access the property because we are using the *value* of the variable, not the *name*.

Set the `playerNumber` variable to `16`. Then, use the variable to look up the player's name and assign it to `player`.

```
// Setup
const testObj = {
  12: "Namath",
  16: "Montana",
  19: "Unitas"
};

// Only change code below this line
const playerNumber = 16;  // Change this line
const player = testObj[playerNumber];   // Change this line
```

Updating Object Properties

After you've created a JavaScript object, you can update its properties at any time just like you would update any other variable. You can use either dot or bracket notation to update.

For example, let's look at `ourDog`:

```
const ourDog = {
  "name": "Camper",
  "legs": 4,
  "tails": 1,
  "friends": ["everything!"]
};
```

Since he's a particularly happy dog, let's change his name to the string `Happy Camper`. Here's how we update his object's name property: `ourDog.name = "Happy Camper";` or `ourDog["name"] = "Happy Camper";` Now when we evaluate `ourDog.name`, instead of getting `Camper`, we'll get his new name, `Happy Camper`.

Update the `myDog` object's name property. Let's change her name from `Coder` to `Happy Coder`. You can use either dot or bracket notation.

```
// Setup
const myDog = {
  "name": "Coder",
  "legs": 4,
  "tails": 1,
  "friends": ["freeCodeCamp Campers"]
};
myDog["name"] = "Happy Coder";

// Only change code below this line
```

Add New Properties to a JavaScript Object

You can add new properties to existing JavaScript objects the same way you would modify them.

Here's how we would add a `bark` property to `ourDog`:

```
ourDog.bark = "bow-wow";
```

or

```
ourDog["bark"] = "bow-wow";
```

Now when we evaluate `ourDog.bark`, we'll get his bark, `bow-wow`.

Example:

```
const ourDog = {
  "name": "Camper",
  "legs": 4,
  "tails": 1,
  "friends": ["everything!"]
};

ourDog.bark = "bow-wow";
```

Add a `bark` property to `myDog` and set it to a dog sound, such as "woof". You may use either dot or bracket notation.

```
const myDog = {
  "name": "Happy Coder",
  "legs": 4,
  "tails": 1,
  "friends": ["freeCodeCamp Campers"]
};

myDog.bark = "woof";
```

Delete Properties from a JavaScript Object

We can also delete properties from objects like this:

```
delete ourDog.bark;
```

Example:

```
const ourDog = {
  "name": "Camper",
  "legs": 4,
  "tails": 1,
  "friends": ["everything!"],
  "bark": "bow-wow"
};

delete ourDog.bark;
```

After the last line shown above, `ourDog` looks like:

```
{
  "name": "Camper",
  "legs": 4,
  "tails": 1,
  "friends": ["everything!"]
}
```

Delete the `tails` property from `myDog`. You may use either dot or bracket notation.

```
// Setup
const myDog = {
  "name": "Happy Coder",
  "legs": 4,
  "tails": 1,
  "friends": ["freeCodeCamp Campers"],
  "bark": "woof"
};
delete myDog["tails"];
```

Using Objects for Lookups

Objects can be thought of as a key/value storage, like a dictionary. If you have tabular data, you can use an object to lookup values rather than a `switch` statement or an `if/else` chain. This is most useful when you know that your input data is limited to a certain range.

Here is an example of an article object:

```
const article = {
  "title": "How to create objects in JavaScript",
  "link": "https://www.freecodecamp.org/news/a-complete-guide-
to-creating-objects-in-javascript-b0e2450655e8/",
  "author": "Kaashan Hussain",
  "language": "JavaScript",
  "tags": "TECHNOLOGY",
  "createdAt": "NOVEMBER 28, 2018"
};
```

```
const articleAuthor = article[author];
const articleLink = article[link];

const value = "title";
const valueLookup = article[value];
```

`articleAuthor` is the string `Kaashan Hussain`, `articleLink` is the string `https://www.freecodecamp.org/news/a-complete-guide-to-creating-objects-in-javascript-b0e2450655e8/`, and `valueLookup` is the string `How to create objects in JavaScript`.

Convert the switch statement into an object called `lookup`. Use it to look up `val` and assign the associated string to the `result` variable.

```
// Setup
function phoneticLookup(val) {
  let result = "";

  // Only change code below this line
  const lookup = {
  "alpha": "Adams",
  "bravo": "Boston",
  "charlie": "Chicago",
  "delta": "Denver",
  "echo": "Easy",
  "foxtrot": "Frank"
};
  result = lookup[val];


  // Only change code above this line
  return result;
}

phoneticLookup("charlie");
```

Testing Objects for Properties

Sometimes it is useful to check if the property of a given object exists or not. We can use the .ha(propname) method of objects to determine if that object has the given property name. .hasOwnProperty() returns true or false if the property is found or not.

Example

```
const myObj = {
  top: "hat",
  bottom: "pants"};

myObj.hasOwnProperty("top");
myObj.hasOwnProperty("middle");
```

The first hasOwnProperty returns true, while the second returns false.

Modify the function checkObj to test if an object passed to the function (obj) contains a specific property (checkProp). If the property is found, return that property's value. If not, return "Not Found".

Solution:

```
function checkObj(obj, checkProp) {
  // Only change code below this line
if (obj.hasOwnProperty(checkProp)) {
  return obj[checkProp];
}
else {
  return "Not Found";
}
```

```
  // Only change code above this line
}
```

Manipulating Complex Objects

Sometimes you may want to store data in a flexible *Data Structure*. A JavaScript object is one way to handle flexible data. They allow for arbitrary combinations of *strings*, *numbers*, *booleans*, *arrays*, *functions*, and *objects*.

Here's an example of a complex data structure:

```
const ourMusic = [
  {
    "artist": "Daft Punk",
    "title": "Homework",
    "release_year": 1997,
    "formats": [
      "CD",
      "Cassette",
      "LP"
    ],
    "gold": true
  }];
```

This is an array which contains one object inside. The object has various pieces of *metadata* about an album. It also has a nested formats array. If you want to add more album records, you can do this by adding records to the top level array. Objects hold data in a property, which has a key-value format. In the example above, "artist": "Daft Punk" is a property that has a key of artist and a value of Daft Punk.

Note: You will need to place a comma after every object in the array, unless it is the last object in the array.

Add a new album to the myMusic array.
Add artist and title strings, release_year number, and a formats array of strings.

Solution:

```
const myMusic = [
  {
    "artist": "Billy Joel",
    "title": "Piano Man",
    "release_year": 1973,
    "formats": [
      "CD",
      "8T",
      "LP"
    ],
    "gold": true
  },
  // addition of new album
  {
    "artist": "Billy Joel",
    "title": "Piano Man",
    "release_year": 1973,
    "formats": [
      "CD",
      "8T",
      "LP"
    ],
    "gold": true
  }

];
```

Accessing Nested Objects

The sub-properties of objects can be accessed by chaining together the dot or bracket notation.

Here is a nested object:

```
const ourStorage = {
  "desk": {
    "drawer": "stapler"
  },
  "cabinet": {
    "top drawer": {
      "folder1": "a file",
      "folder2": "secrets"
    },
    "bottom drawer": "soda"
  }};

ourStorage.cabinet["top drawer"].folder2;
ourStorage.desk.drawer;
```

ourStorage.cabinet["top drawer"].folder2 would be the string secrets, and ourStorage.desk.drawer would be the string stapler.

Access the myStorage object and assign the contents of the glove box property to the gloveBoxContents variable. Use dot notation for all properties where possible, otherwise use bracket notation.

Solution:

```
const myStorage = {
  "car": {
    "inside": {
      "glove box": "maps",
      "passenger seat": "crumbs"
     },
    "outside": {
      "trunk": "jack"
    }
  }
};

const gloveBoxContents = myStorage.car.inside["glove box"];
```

Accessing Nested Arrays

As we have seen in earlier examples, objects can contain both nested objects and nested arrays. Similar to accessing nested objects, array bracket notation can be chained to access nested arrays.

Here is an example of how to access a nested array:

```
const ourPets = [
  {
    animalType: "cat",
    names: [
      "Meowzer",
      "Fluffy",
      "Kit-Cat"
    ]
  },
  {
    animalType: "dog",
    names: [
      "Spot",
      "Bowser",
      "Frankie"
    ]
  }];

ourPets[0].names[1];
ourPets[1].names[0];
```

ourPets[0].names[1] would be the string Fluffy, and ourPets[1].names[0] would be the string Spot.

Using dot and bracket notation, set the variable secondTree to the second item in the trees list from the myPlants object.

Solution:

```
const myPlants = [
  {
    type: "flowers",
    list: [
      "rose",
      "tulip",
      "dandelion"
    ]
  },
  {
    type: "trees",
    list: [
      "fir",
      "pine",
      "birch"
    ]
  }
];

const secondTree = myPlants[1].list[1];
```

Record Collection

You are given an object literal representing a part of your musical album collection. Each album has a unique id number as its key and several other properties. Not all albums have complete information.

You start with an `updateRecords` function that takes an object literal, `records`, containing the musical album collection, an `id`, a `prop` (like `artist` or `tracks`), and a `value`. Complete the function using the rules below to modify the object passed to the function.

- Your function must always return the entire record collection object.
- If `prop` isn't `tracks` and `value` isn't an empty string, update or set that album's `prop` to `value`.
- If `prop` is `tracks` but the album doesn't have a `tracks` property, create an empty array and add `value` to it.
- If `prop` is `tracks` and `value` isn't an empty string, add `value` to the end of the album's existing `tracks` array.
- If `value` is an empty string, delete the given `prop` property from the album.

Note: A copy of the `recordCollection` object is used for the tests.

Solution:

```javascript
// Setup
const recordCollection = {
  2548: {
    albumTitle: 'Slippery When Wet',
    artist: 'Bon Jovi',
    tracks: ['Let It Rock', 'You Give Love a Bad Name']
  },
  2468: {
    albumTitle: '1999',
    artist: 'Prince',
    tracks: ['1999', 'Little Red Corvette']
  },
  1245: {
    artist: 'Robert Palmer',
    tracks: []
  },
  5439: {
    albumTitle: 'ABBA Gold'
  }
};

// Only change code below this line
function updateRecords(records, id, prop, value) {
  if (prop !== 'tracks' && value !== "") {
    records[id][prop] = value;
  } else if (prop === "tracks" && records[id].hasOwnProperty("tracks") === false) {
    records[id][prop] = [value];
  } else if (prop === "tracks" && value !== "") {
    records[id][prop].push(value);
  } else if (value === "") {
    delete records[id][prop];
  }
  return records;
}

updateRecords(recordCollection, 5439, 'artist', 'ABBA');
```

Iterate with JavaScript While Loops

You can run the same code multiple times by using a loop.

The first type of loop we will learn is called a `while` loop because it runs while a specified condition is true and stops once that condition is no longer true.

```
const ourArray = [];
let i = 0;

while (i < 5) {
  ourArray.push(i);
  i++;
}
```

In the code example above, the `while` loop will execute 5 times and append the numbers 0 through 4 to `ourArray`.

Let's try getting a while loop to work by pushing values to an array.

Add the numbers 5 through 0 (inclusive) in descending order to `myArray` using a `while` loop.

Solution:

```
// Setup
const myArray = [];

// Only change code below this line
```

```
let i = 5;
while (i >= 0) {
  myArray.push(i);
  i--;
}

console.log(myArray);
```

Iterate with JavaScript For Loops

You can run the same code multiple times by using a loop.

The most common type of JavaScript loop is called a `for` loop because it runs for a specific number of times.

For loops are declared with three optional expressions separated by semicolons:

`for (a; b; c)`, where `a` is the initialization statement, `b` is the condition statement, and `c` is the final expression.

The initialization statement is executed one time only before the loop starts. It is typically used to define and setup your loop variable.

The condition statement is evaluated at the beginning of every loop iteration and will continue as long as it evaluates to `true`. When the condition is `false` at the start of the iteration, the loop will stop executing. This means if the condition starts as false, your loop will never execute.

The final expression is executed at the end of each loop iteration, prior to the next condition check and is usually used to increment or decrement your loop counter.

In the following example we initialize with `i = 0` and iterate while our condition `i < 5` is true. We'll increment `i` by `1` in each loop iteration with `i++` as our final expression.

```
const ourArray = [];

for (let i = 0; i < 5; i++) {
  ourArray.push(i);
}
```

`ourArray` will now have the value `[0, 1, 2, 3, 4]`.

Use a `for` loop to push the values 1 through 5 onto `myArray`.

Solution:

```
// Setup
const myArray = [];

// Only change code below this line
for (let i = 1; i <= 5; i++) {
  myArray.push(i);
}
```

Iterate Odd Numbers With a For Loop

For loops don't have to iterate one at a time. By changing our `final-expression`, we can count by even numbers.

We'll start at `i = 0` and loop while `i < 10`. We'll increment `i` by 2 each loop with `i += 2`.

```
const ourArray = [];

for (let i = 0; i < 10; i += 2) {
  ourArray.push(i);
}
```

`ourArray` will now contain `[0, 2, 4, 6, 8]`. Let's change our `initialization` so we can count by odd numbers.

Push the odd numbers from 1 through 9 to `myArray` using a `for` loop.

Solution:

```
// Setup
const myArray = [];

// Only change code below this line
for (let i = 1; i < 10; i += 2) {
  myArray.push(i);
}
```

Count Backwards With a For Loop

A for loop can also count backwards, so long as we can define the right conditions.

In order to decrement by two each iteration, we'll need to change our initialization, condition, and final expression.

We'll start at `i = 10` and loop while `i > 0`. We'll decrement `i` by 2 each loop with `i -= 2`.

```
const ourArray = [];

for (let i = 10; i > 0; i -= 2) {
  ourArray.push(i);
}
```

`ourArray` will now contain `[10, 8, 6, 4, 2]`. Let's change our initialization and final expression so we can count backwards by twos to create an array of descending odd numbers.

Push the odd numbers from 9 through 1 to `myArray` using a `for` loop.

Solution:

```
// Setup
const myArray = [];

// Only change code below this line
for (let i = 9; i > 0; i -=2) {
  myArray.push(i);
}
```

Iterate Through an Array with a For Loop

A common task in JavaScript is to iterate through the contents of an array. One way to do that is with a `for` loop. This code will output each element of the array `arr` to the console:

```
const arr = [10, 9, 8, 7, 6];

for (let i = 0; i < arr.length; i++) {
   console.log(arr[i]);
}
```

Remember that arrays have zero-based indexing, which means the last index of the array is `length - 1`. Our condition for this loop is `i < arr.length`, which stops the loop when `i` is equal to `length`. In this case the last iteration is `i === 4` i.e. when `i` becomes equal to `arr.length - 1` and outputs `6` to the console. Then `i` increases to `5`, and the loop terminates because `i < arr.length` is `false`.

Declare and initialize a variable `total` to `0`. Use a `for` loop to add the value of each element of the `myArr` array to `total`.

Hints
Hint 1
Remember the structure of a for loop:
for ([initialization]; [condition]; [final-expression]) statement

The [initialization] part is executed only once (the first time).
The [condition] is checked on every iteration.
The [final-expression] is executed along the statement if [condition] resolves to true.
Hint 2
Remember how accumulators work:
let x += i

The variable x is going to act as the accumulator.
The variable i is the one which value will be stored (and accumulated) inside x
The expression += is an just abbreviation of x = x + i

Solution:

```
// Setup
const myArr = [2, 3, 4, 5, 6];

// Only change code below this line
let total = 0;
for (let i = 0; i < myArr.length; i++) {
  total += myArr[i];
}
```

Nesting For Loops

If you have a multi-dimensional array, you can use the same logic as the prior waypoint to loop through both the array and any sub-arrays. Here is an example:

```
const arr = [
  [1, 2], [3, 4], [5, 6]
];

for (let i = 0; i < arr.length; i++) {
  for (let j = 0; j < arr[i].length; j++) {
    console.log(arr[i][j]);
  }
}
```

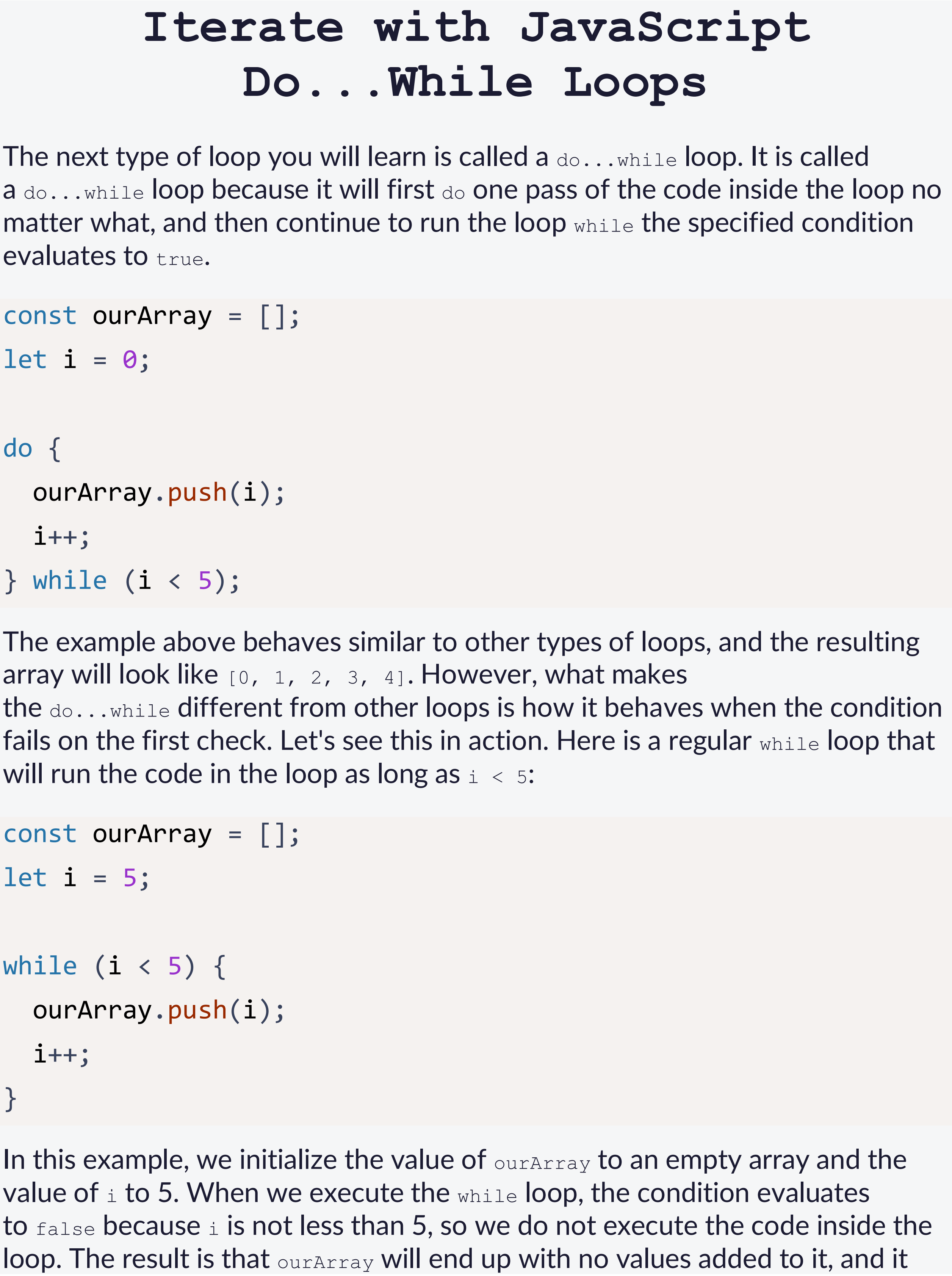
This outputs each sub-element in `arr` one at a time. Note that for the inner loop, we are checking the `.length` of `arr[i]`, since `arr[i]` is itself an array.

Modify function `multiplyAll` so that it returns the product of all the numbers in the sub-arrays of `arr`.

Solution:

```
function multiplyAll(arr) {
  let product = 1;
  // Only change code below this line
for (let i = 0; i < arr.length; i++) {
  for (let j = 0; j < arr[i].length; j++) {
    product *= arr[i][j];
  }
}
  // Only change code above this line
  return product;
}

multiplyAll([[1, 2], [3, 4], [5, 6, 7]]);
```



Iterate with JavaScript Do...While Loops

The next type of loop you will learn is called a `do...while` loop. It is called a `do...while` loop because it will first `do` one pass of the code inside the loop no matter what, and then continue to run the loop `while` the specified condition evaluates to `true`.

```
const ourArray = [];
let i = 0;

do {
  ourArray.push(i);
  i++;
} while (i < 5);
```

The example above behaves similar to other types of loops, and the resulting array will look like `[0, 1, 2, 3, 4]`. However, what makes the `do...while` different from other loops is how it behaves when the condition fails on the first check. Let's see this in action. Here is a regular `while` loop that will run the code in the loop as long as `i < 5`:

```
const ourArray = [];
let i = 5;

while (i < 5) {
  ourArray.push(i);
  i++;
}
```

In this example, we initialize the value of `ourArray` to an empty array and the value of `i` to 5. When we execute the `while` loop, the condition evaluates to `false` because `i` is not less than 5, so we do not execute the code inside the loop. The result is that `ourArray` will end up with no values added to it, and it will still look like `[]` when all of the code in the example above has completed running. Now, take a look at a `do...while` loop:

```
const ourArray = [];
let i = 5;

do {
  ourArray.push(i);
  i++;
} while (i < 5);
```

In this case, we initialize the value of `i` to 5, just like we did with the `while` loop. When we get to the next line, there is no condition to evaluate, so we go to the code inside the curly braces and execute it. We will add a single element to the array and then increment `i` before we get to the condition check. When we finally evaluate the condition `i < 5` on the last line, we see that `i` is now 6, which fails the conditional check, so we exit the loop and are done. At the end of the above example, the value of `ourArray` is `[5]`. Essentially, a `do...while` loop ensures that the code inside the loop will run at least once. Let's try getting a `do...while` loop to work by pushing values to an array.

Change the `while` loop in the code to a `do...while` loop so the loop will push only the number `10` to `myArray`, and `i` will be equal to `11` when your code has finished running.

Solution:

```
// Setup
const myArray = [];
let i = 10;

// Only change code below this line
do {
  myArray.push(i);
  i++;
} while (i < 5);
```

Replace Loops using Recursion

Recursion is the concept that a function can be expressed in terms of itself. To help understand this, start by thinking about the following task: multiply the first `n` elements of an array to create the product of those elements. Using a `for` loop, you could do this:

```
function multiply(arr, n) {
  let product = 1;
  for (let i = 0; i < n; i++) {
    product *= arr[i];
  }
  return product;
}
```

However, notice that `multiply(arr, n) == multiply(arr, n - 1) * arr[n - 1]`. That means you can rewrite `multiply` in terms of itself and never need to use a loop.

```
function multiply(arr, n) {
  if (n <= 0) {
    return 1;
  } else {
    return multiply(arr, n - 1) * arr[n - 1];
  }
}
```

The recursive version of `multiply` breaks down like this. In the *base case*, where `n <= 0`, it returns 1. For larger values of `n`, it calls itself, but with `n - 1`. That function call is evaluated in the same way, calling `multiply` again until `n <= 0`. At this point, all the functions can return and the original `multiply` returns the answer.

Note: Recursive functions must have a base case when they return without calling the function again (in this example, when `n <= 0`), otherwise they can never finish executing.

Write a recursive function, `sum(arr, n)`, that returns the sum of the first `n` elements of an array `arr`.

Hints

Hint 1:

When `n <= 0` `sum(arr, n)` returns `0`.

Hint 2:

When n is larger than 0 `sum(arr, n)` returns `sum(arr, n - 1) + arr[n - 1]`

Solution:

```
function sum(arr, n) {
  // Only change code below this line
  if(n <= 0) {
    return 0;
  } else {
    return sum(arr, n - 1) + arr[n - 1];
  }
  // Only change code above this line
  }
```

Profile Lookup

We have an array of objects representing different people in our contacts lists.

A `lookUpProfile` function that takes `name` and a property (`prop`) as arguments has been pre-written for you.

The function should check if `name` is an actual contact's `firstName` and the given property (`prop`) is a property of that contact.

If both are true, then return the "value" of that property.

If `name` does not correspond to any contacts then return the string `No such contact`.

If `prop` does not correspond to any valid properties of a contact found to match `name` then return the string `No such property`.

Solution:

```
// Setup
const contacts = [
  {
    firstName: "Akira",
    lastName: "Laine",
    number: "0543236543",
    likes: ["Pizza", "Coding", "Brownie Points"],
  },
  {
    firstName: "Harry",
    lastName: "Potter",
    number: "0994372684",
    likes: ["Hogwarts", "Magic", "Hagrid"],
  },
  {
    firstName: "Sherlock",
    lastName: "Holmes",
    number: "0487345643",
    likes: ["Intriguing Cases", "Violin"],
  },
  {
    firstName: "Kristian",
    lastName: "Vos",
    number: "unknown",
    likes: ["JavaScript", "Gaming", "Foxes"],
  },
];

function lookUpProfile(name, prop) {
  // Only change code below this line
for (let x = 0; x < contacts.length; x++) {
    if (contacts[x]["firstName"] === name) {
      if (contacts[x].hasOwnProperty(prop)) {
        return contacts[x][prop];
      } else {
        return "No such property";
      }
    }
  }
  return "No such contact";
  // Only change code above this line
}



lookUpProfile("Akira", "likes");
```

Generate Random Fractions with JavaScript

Random numbers are useful for creating random behavior.

JavaScript has a `Math.random()` function that generates a random decimal number between `0` (inclusive) and `1` (exclusive). Thus `Math.random()` can return a `0` but never return a `1`.

Note: Like Storing Values with the Assignment Operator, all function calls will be resolved before the `return` executes, so we can `return` the value of the `Math.random()` function.

Change `randomFraction` to return a random number instead of returning `0`.

Solution:

```
function randomFraction() {

  // Only change code below this line
var result = 0;
  while (result === 0) {
    result = Math.random();
  }
  return result
  // Only change code above this line
}
console.log(randomFraction())
```

Generate Random Whole Numbers with JavaScript

It's great that we can generate random decimal numbers, but it's even more useful if we use it to generate random whole numbers.

1. Use `Math.random()` to generate a random decimal.
2. Multiply that random decimal by `20`.
3. Use another function, `Math.floor()` to round the number down to its nearest whole number.

Remember that `Math.random()` can never quite return a `1` and, because we're rounding down, it's impossible to actually get `20`. This technique will give us a whole number between `0` and `19`.

Putting everything together, this is what our code looks like:

```
Math.floor(Math.random() * 20);
```

We are calling `Math.random()`, multiplying the result by 20, then passing the value to `Math.floor()` function to round the value down to the nearest whole number.

Use this technique to generate and return a random whole number between `0` and `9`.

Solution:

```
function randomWholeNum() {

  // Only change code below this line
  return Math.floor(Math.random() * 10);;
}
```

Generate Random Whole Numbers within a Range

Instead of generating a random whole number between zero and a given number like we did before, we can generate a random whole number that falls within a range of two specific numbers.

To do this, we'll define a minimum number min and a maximum number max.

Here's the formula we'll use. Take a moment to read it and try to understand what this code is doing:

```
Math.floor(Math.random() * (max - min + 1)) + min
```

Create a function called randomRange that takes a range myMin and myMax and returns a random whole number that's greater than or equal to myMin, and is less than or equal to myMax, inclusive.

Solution:

```
function randomRange(myMin, myMax) {
  // Only change code below this line
  let randomNumber = 0;
  randomNumber = Math.floor(Math.random() * (myMax - myMin + 1)
) + myMin;
  return randomNumber;
  // Only change code above this line
}

console.log(randomRange(10,100));
```

Use the parseInt Function

The parseInt() function parses a string and returns an integer. Here's an example:

```
const a = parseInt("007");
```

The above function converts the string 007 to the integer 7. If the first character in the string can't be converted into a number, then it returns NaN.

Use parseInt() in the convertToInteger function so it converts the input string str into an integer, and returns it.

Solution:

```
function convertToInteger(str) {
return parseInt(str);
}

convertToInteger("56");
```

Use the parseInt Function with a Radix

The parseInt() function parses a string and returns an integer. It takes a second argument for the radix, which specifies the base of the number in the string. The radix can be an integer between 2 and 36.

The function call looks like:

```
parseInt(string, radix);
```

And here's an example:

```
const a = parseInt("11", 2);
```

The radix variable says that 11 is in the binary system, or base 2. This example converts the string 11 to an integer 3.

Use parseInt() in the convertToInteger function so it converts a binary number to an integer and returns it.

Solution:

```
function convertToInteger(str) {
return parseInt(str, 2);
}

convertToInteger("10011");
```

Use the Conditional (Ternary) Operator

The *conditional operator*, also called the *ternary operator*, can be used as a one line if-else expression.

The syntax is a ? b : c, where a is the condition, b is the code to run when the condition returns true, and c is the code to run when the condition returns false.

The following function uses an if/else statement to check a condition:

```
function findGreater(a, b) {
  if(a > b) {
    return "a is greater";
  }
  else {
    return "b is greater or equal";
  }}
```

This can be re-written using the conditional operator:

```
function findGreater(a, b) {
  return a > b ? "a is greater" : "b is greater or equal";}
```

Use the conditional operator in the checkEqual function to check if two numbers are equal or not. The function should return either the string Equal or the string Not Equal.

Solution:

```
function checkEqual(a, b) {
let result
a === b ? result = "Equal" : result = "Not Equal";
return result
}

checkEqual(1, 2);
```

Use Multiple Conditional (Ternary) Operators

In the previous challenge, you used a single conditional operator. You can also chain them together to check for multiple conditions.

The following function uses if, else if, and else statements to check multiple conditions:

```
function findGreaterOrEqual(a, b) {
  if (a === b) {
    return "a and b are equal";
  }
  else if (a > b) {
    return "a is greater";
  }
  else {
    return "b is greater";
  }}
```

The above function can be re-written using multiple conditional operators:

```
function findGreaterOrEqual(a, b) {
  return (a === b) ? "a and b are equal"
    : (a > b) ? "a is greater"
    : "b is greater";}
```

It is considered best practice to format multiple conditional operators such that each condition is on a separate line, as shown above. Using multiple conditional operators without proper indentation may make your code hard to read. For example:

```
function findGreaterOrEqual(a, b) {
  return (a === b) ? "a and b are equal" : (a > b) ? "a is greater" : "b is greater";}
```

In the checkSign function, use multiple conditional operators - following the recommended format used in findGreaterOrEqual - to check if a number is positive, negative or zero. The function should return positive, negative or zero.

Solution:

```
function checkSign(num) {
let result
(num > 0) ? result = "positive"
: (num < 0) ? result = "negative"
: result = "zero";

return result;
}

console.log(checkSign(2));
```

Use Recursion to Create a Countdown

In a previous challenge, you learned how to use recursion to replace a for loop. Now, let's look at a more complex function that returns an array of consecutive integers starting with 1 through the number passed to the function.

As mentioned in the previous challenge, there will be a *base case*. The base case tells the recursive function when it no longer needs to call itself. It is a simple case where the return value is already known. There will also be a *recursive call* which executes the original function with different arguments. If the function is written correctly, eventually the base case will be reached.

For example, say you want to write a recursive function that returns an array containing the numbers 1 through n. This function will need to accept an argument, n, representing the final number. Then it will need to call itself with progressively smaller values of n until it reaches 1. You could write the function as follows:

```
function countup(n) {
  if (n < 1) {
    return [];
  } else {
    const countArray = countup(n - 1);
    countArray.push(n);
    return countArray;
  }}
console.log(countup(5));
```

The value [1, 2, 3, 4, 5] will be displayed in the console.

At first, this seems counterintuitive since the value of n decreases, but the values in the final array are increasing. This happens because the push happens last, after the recursive call has returned. At the point where n is pushed into the array, countup(n - 1) has already been evaluated and returned [1, 2, ..., n - 1].

We have defined a function called countdown with one parameter (n). The function should use recursion to return an array containing the integers n through 1 based on the n parameter. If the function is called with a number less than 1, the function should return an empty array. For example, calling this function with n = 5 should return the array [5, 4, 3, 2, 1]. Your function must use recursion by calling itself and must not use loops of any kind.

Solution:

```
function countdown(n){
  if (n < 1) {
    return [];
  } else {
    const countArray = countdown(n - 1);
    countArray.unshift(n);
    return countArray;
  }
}
```

Use Recursion to Create a Range of Numbers

Continuing from the previous challenge, we provide you another opportunity to create a recursive function to solve a problem.

We have defined a function named `rangeOfNumbers` with two parameters. The function should return an array of integers which begins with a number represented by the `startNum` parameter and ends with a number represented by the `endNum` parameter. The starting number will always be less than or equal to the ending number. Your function must use recursion by calling itself and not use loops of any kind. It should also work for cases where both `startNum` and `endNum` are the same.

Solution:

```
function rangeOfNumbers(startNum, endNum) {
  if (endNum < startNum) {
    return [];
  } else {
    const numberArr = rangeOfNumbers(startNum, endNum - 1
);
    numberArr.push(endNum);
    return numberArr;
  }
};

console.log(rangeOfNumbers(1, 10));
```