Chapter 3 Javascript Multiple Values: Arrays and Objects

Lesson Objectives

A multiple-value variable is a variable (or the object) that can store more than one value.

This chapter discusses two types of multiple-value variables in JavaScript: Arrays and Objects in fundamental.

The following topics are covered in this chapter:

- Arrays and their properties
- Array methods
- Multidimensional arrays
- Objects
- Working with objects and arrays

3.1 Arrays and their properties

An array is an object that saves a list of values in the memory.

- Values are stored in the contiguous memory locations
- The values are indexed; the index starts from 0

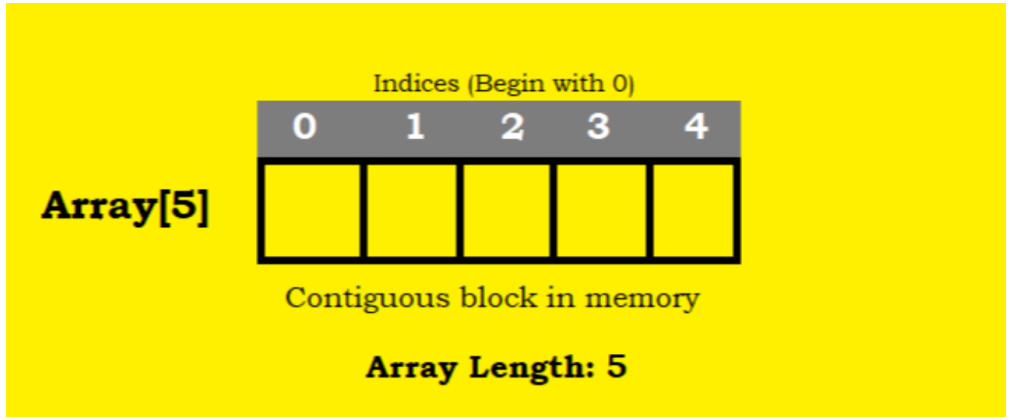


Figure 3.1: An array is a list of values.

Source: JavaScript Arrays: A Beginner's Guide – TecAdmin

Basic operations on arrays

Basic operations on arrays include:

- Creating an array
- Accessing array elements
- Modifying array elements (adding, deleting, and updating)
- Get the length of an array
- Iterating through an array

3.2 Creating an array

Array Literal, Array Constructor, Array.of(), Array.from()

Array Literal

Use the array literal `[]` to create an array.

- Often used when creating an empty array or an array with a list of values known in advance.

```
let colors = [];   // create an empty array
let colors = ['red', 'green', 'blue'];  // create an array with three elements
```

Add elements from an other array in the array literal: Spread Operator (ES6)

The spread operator `...` can spread the array of elements into a list of elements.

These elements can be used in the array literal to create a new array.

Example 1: Extend the `moreColors` array with the `basicColors` array.

```
let basicColors = ['red', 'green', 'blue'];

// Equivalent to let moreColors = ['yellow', 'purple', 'red', 'green', 'blue'];
let moreColors = ['yellow', 'purple', ...basicColors];

// ['yellow', 'purple', 'red', 'green', 'blue']
console.log(moreColors);
```

Characteristics of the spread operator `...`

- Copy: Copy the elements of the array when spreading.
  - Modifying the original array does not affect the new array, and vice versa.
- Shallow copy: Only copy scalar or reference values of the array elements.
  - That means the nested objects are shared between the original and the new array.

Example 2: Shallow copy of the `basicColors` array.

```
let basicColors = ['red', 'green', 'blue'];

// ...basicCopy shallowly copy of the basicColors array
let moreColors = ['yellow', 'purple', ...basicColors];

basicColors[0] = 'black';
console.log(basicColors);  // ['black', 'green', 'blue']
console.log(moreColors);  // ['yellow', 'purple', 'red', 'green', 'blue']
```

Array constructor

- Limitation of the Array literal
  - Be convenient to create an empty array or an array with a list of values.
- What if we want to create an array dynamically?
  - e.g. create an array of length n with all elements are `undefined`.
- Array constructor `Array(n)` is the right choice in this case.

Example 3: Create an array of length 5 with empty slots.

```
// let emptyArray = Array(5);  // the new keyword is optional
let emptyArray = new Array(5);
console.log(emptyArray);  // [ <5 undefined items> ]
```

Initialize an array with the array constructor

You can also pass a list of arguments to the array constructor to create an array with the elements.

```
let basicColors = new Array('red', 'green', 'blue');
console.log(basicColors);  // ['red', 'green', 'blue']
```

The `Array()` constructor accept variable-length arguments.
So, you can copy the elements of an array to a new array using the `Array()` constructor.

Example 4: Copy an array to create a new one:

```
let basicColors = ['red', 'green', 'blue'];
let moreColors = new Array(...basicColors);
console.log(moreColors);  // ['red', 'green', 'blue']
```

The trap of the array constructor

However, be careful about the trap of the array constructor:

- Cannot create an array containing a single integer value.
- If only one argument is passed and it is an integer, the array constructor creates an array of length `n` with empty slots.

For example, we want to create the array `[5]` and use the following code:

```
let numbers = new Array(5);  // create an array of length 5
console.log(numbers);  // [ <5 empty items> ]
```

The first statement creates an array of length 5 with empty slots, not `[5]`.

Array.of() method: Create an array from a list of values

If you want to avoid the trap of the array constructor, use the `Array.of()` method when creating an array with a list of values.

```
let numbers = Array.of(5);  // create an array with one element 5
console.log(numbers);  // [5]
let basicColors = Array.of('red', 'green', 'blue');
```

You can copy an array to create a new one using the `Array.of()` method.

```
let basicColors = ['red', 'green', 'blue'];
let moreColors = Array.of('orange', 'black', ...basicColors);
console.log(moreColors);  // ['orange', 'black', 'red', 'green', 'blue']
```

See more about the `Array.of()` method in the MDN web docs: Array.of() - JavaScript | MDN

Array.from() method: Convert an array-like object or an iterable object to an array

This method creates a new array by iterating an array-like object or an iterable object.

Example 5: Convert an array-like object to an array.

```
let arrayLike = {0: 'red', 1: 'green', 2: 'blue', length: 3};
let colors = Array.from(arrayLike);
console.log(colors);  // ['red', 'green', 'blue']
```

We will cover this method later.

See more about the `Array.from()` method in the MDN web docs: Array.from() - JavaScript | MDN

Concept: Array-like object

An array-like object is an object that has the **length property** and **indexed elements**.

- It behaves like an array but does not have all the array methods.

Example 6: An array-like object `arrayLike` with the `length` property and indexed elements.

```
let arrayLike = {
  0: 'red',
  1: 'green',
  2: 'blue',
  length: 3
};
```

Other examples of the array-like object:

- NodeList and HTMLCollection objects in DOM.
- The `arguments` object in a function.

See more in Array - JavaScript | MDN

Concept: Iterable Object

An iterable object in JavaScript is an object that can be iterated over using a `for...of` loop.

Common Iterable Objects:

- Arrays, Strings, Maps, Sets, NodeLists (from DOM queries)

Example 7: iterating over an array using the `for...of` loop.

```
let iterable = [10, 20, 30];

for (let value of iterable) {
  console.log(value);
}
```

3.3 Accessing array elements

Access by index: the square brackets `[]`

Use the square brackets `[n]` where `n` is the index of the element after the array name to access the elements of an array

- n is an integer starting from 0
- return undefined if the index is out of the range of the array

Example 8: Accessing the first element of the `basicColors` array.

```
let basicColors = ['red', 'green', 'blue'];
console.log(basicColors[0]);  // red
console.log(basicColors[-1]);  // undefined
console.log(basicColors[4]);  // undefined
```

No out-of-bound error

- When you try to query a nonexistent property of any object, you don’t get an error;
  - you simply get **undefined**

Indexes other than non-negative integers

- The index of an array must be a non-negative integer.
- The non-negative integer becomes the **property** of the array object.
  - the square brackets `[property_name]` is used to access the property of an object, the same case as assessing an array element.

Example 9: Accessing the property of an array object.

```
let basicColors = ['red', 'green', 'blue'];

// Access the property "-1" of the basicColors array.
// It returns undefined because the property "-1" does not exist.
console.log(basicColors[-1]);  // undefined

console.log(basicColors[1]);  // green.
```

Example 10: Trap of the `[non-negative integer]`

```
Console was cleared
undefined
> basicColors
▶ (3) ['red', 'green', 'blue']
> basicColors[-1] = 'Non-integer index'
'Non-integer index'
> basicColors
▶ (3) ['red', 'green', 'blue', -1: 'Non-integer index']
                                  Object Property
>
```

Quick summary for using the square brackets `[ ]`

- array[n]: access the n-th element of the array when n is a non-negative integer.
- array[property_name]: access the property of the array object when the property name is not a non-negative integer.
    - the non-negative integer will be converted to a number string.
    - It is equivalent to `array.property_name` when the property name is a valid identifier.

```
let basicColors = ['red', 'green', 'blue'];
basicColors[-1] = 'yellow';  // add the property "-1" to the basicColors array
console.log(basicColors[-1]);  // yellow
console.log(basicColors['-1']);  // the same as basicColors[-1]
```

3.4 Add, delete, and update array elements

Add elements

- Use the assignment operator `=` to add elements to an array with an index that is out of the range of the array.
- Javascript will automatically expand the array to accommodate the new element.
- Empty slots are created between the last element and the new element.

Example 11: Add an element

```
let basicColors = ['red', 'green', 'blue'];
basicColors[5] = 'yellow';   // auto expand the array to accommodate the new element
console.log(basicColors);  // ['red', 'green', 'blue', <2 empty items>, 'yellow']
```

Note: there are two empty slots between the last element `green` and the new element `yellow`.

Non-negative integer index becomes a property

Recall that using values other than non-negative integers as the index will add the property, not the element, to the array object.

Example 12: use index values other than non-negative integers.

```
let basicColors = ['red', 'green', 'blue'];
basicColors[-1] = 'yellow';
console.log(basicColors);  // ['red', 'green', 'blue', '-1': 'yellow']
```

Append elements to the end of the array

Example 13: Add an element to the end of the array

To append an element to the end of the array, we:

- first get the length of the array and
- then use the length value as the index to add the element.

```
let basicColors = ['red', 'green', 'blue'];
basicColors[basicColors.length] = 'yellow';  // append 'yellow' to the end of the array
console.log(basicColors);  // ['red', 'green', 'blue', 'yellow']
```

Use the `push()` method to append elements

A more concise way to is to use the `push()` method.

- don't need to know the length of the array.

The above code can be rewritten as follows:

```
let basicColors = ['red', 'green', 'blue'];
basicColors.push('yellow');  // append 'yellow' to the end of the array
console.log(basicColors);  // ['red', 'green', 'blue', 'yellow']
```

Delete elements

- Use the `delete` operator to delete an element from an array.
- The `delete` operator sets the element's value to `undefined`
    - does not change the length of the array.

Example 14: Delete the second element from the `basicColors` array.

```
let basicColors = ['red', 'green', 'blue'];
delete basicColors[1];  // delete the second element
console.log(basicColors);  // ['red', <1 empty item>, 'blue']
```

The side effect of the `delete` operator

The `delete` operator will make the array sparse because it does not alter its length.

If you want to remove an element, including its slot, use the `splice()` method.

- avoiding the array becoming sparse.

The `splice()` method is a general method to insert, update, and delete elements in an array.

- `splice` means joining or connecting.

See MDN web docs: Array.prototype.splice() - JavaScript | MDN

Update elements

Assign a new value to an existing element to update it.

Example 15: Update the second element of the `basicColors` array.

```
let basicColors = ['red', 'green', 'blue'];
basicColors[1] = 'yellow';  // update the second element
console.log(basicColors);  // ['red', 'yellow', 'blue']
```

3.5 Array methods

Some common methods for operating on arrays include:

- Add and replacing elements: `push()`, `unshift()`, `splice()`
- Remove elements: `pop()`, `shift()`, `splice()`
- Concatenate arrays: `concat()`
- Find elements: `indexOf()`, `find()`
- Sorting: `sort()`, `reverse()`

`push()` and `pop()` methods

- `push(val)` : append an element to the end of the array
- `pop()` : remove and return the last element from the array

```
[1,2,3,4,5].push(6);  // [1,2,3,4,5,6]
let val = [1,2,3,4,5].pop();  // [1,2,3,4]
console.log(val);  // 5
```

`shift()` and `unshift()` methods

- `shift()` : remove and return the first element from the array (shift all elements to the left).
- `unshift(val)` : insert an element to the beginning of the array (shift all elements to the right and put the new element at the beginning).

```
[1,2,3,4,5].unshift(0);  // [0,1,2,3,4,5]
const val = [1,2,3,4,5].shift();  // [2,3,4,5]
console.log(val);  // 1
```

`splice()` method

A general array method to add, remove, and replace elements in an array.

What the `splice()` method does on the array:

1. Remove `deleteCount` elements starting from the `start` index.
2. Insert the `item1, item2, ...` elements at the `start` index.
    - Original elements after the `start` index are shifted to the right.
3. Update the element at the `start` index with `deleteCount` = 1

The `splice()` method modifies the original array and returns the removed elements as a new array.

Function signature: `arrayObject.splice(start, deleteCount, item1, item2, ...)`

- `start`: the index at which to start changing the array (inclusive).
- `deleteCount`: the number of elements to remove from the array. Set it to 0 if you do not want to remove any elements.
- `item1, item2, ...`: the elements to add to the array.

Effect:

- Modify the original array.

Return:

- An array containing the deleted elements.

Insert and update elements:

```
// Insert Fet after Jan => Insert an element at index 1
let months = ['Jan', 'March', 'April', 'June'];
months.splice(1,0,'Feb');
console.log(months); // ['Jan', 'Feb', 'March', 'April', 'June']

// Update the second element to February
// Delete then insert
let delElements = months.splice(1, 1, 'February');
console.log(months); // ['Jan', 'February', 'March', 'April', 'June']
console.log(delElements); // ['Feb']
```

Delete and insert multiple elements:

```
// Delete the first two months
delElements = months.splice(0, 2);
console.log(months); // ['March', 'April', 'June']
console.log(delElements); // ['Jan', 'February']

// Insert Jan and Feb at the beginning
let newMonths = ['Jan', 'Feb'];
months.splice(0, 0, ...newMonths);
console.log(months);
```

See the full code in the ex_03_splice.js file.

Concatenate arrays: `concat()` method

Concatenate two or more arrays and return a new array.

```
const array1 = [1,2,3].concat([4,5,6]);
console.log(array1);  // [1,2,3,4,5,6]
array1.concat([7,8,9]);
```

Find elements: `find()` method

The `find()` method returns the first element in the provided array that satisfies the provided testing function.

- Pass a function returning a boolean value to the `find()` method.

Example 16: Find the values greater than 5 in the array.

```
const array1 = [5, 12, 8, 130, 44];
const firstFound = array1.find(element => element > 5);
console.log(found);  // 12
```

See more about the `find()` method in the MDN web docs: Array.prototype.find() - JavaScript | MDN

Sorting: `sort()` and `reverse()` methods

Leave it as the reading assignment.

See more about the `sort()` method in the MDN web docs: Array.prototype.sort() - JavaScript | MDN and the `reverse()` method in the MDN web docs: Array.prototype.reverse() - JavaScript | MDN

Cheat Sheet

Use the following cheat sheet to remember the usage of the array methods.

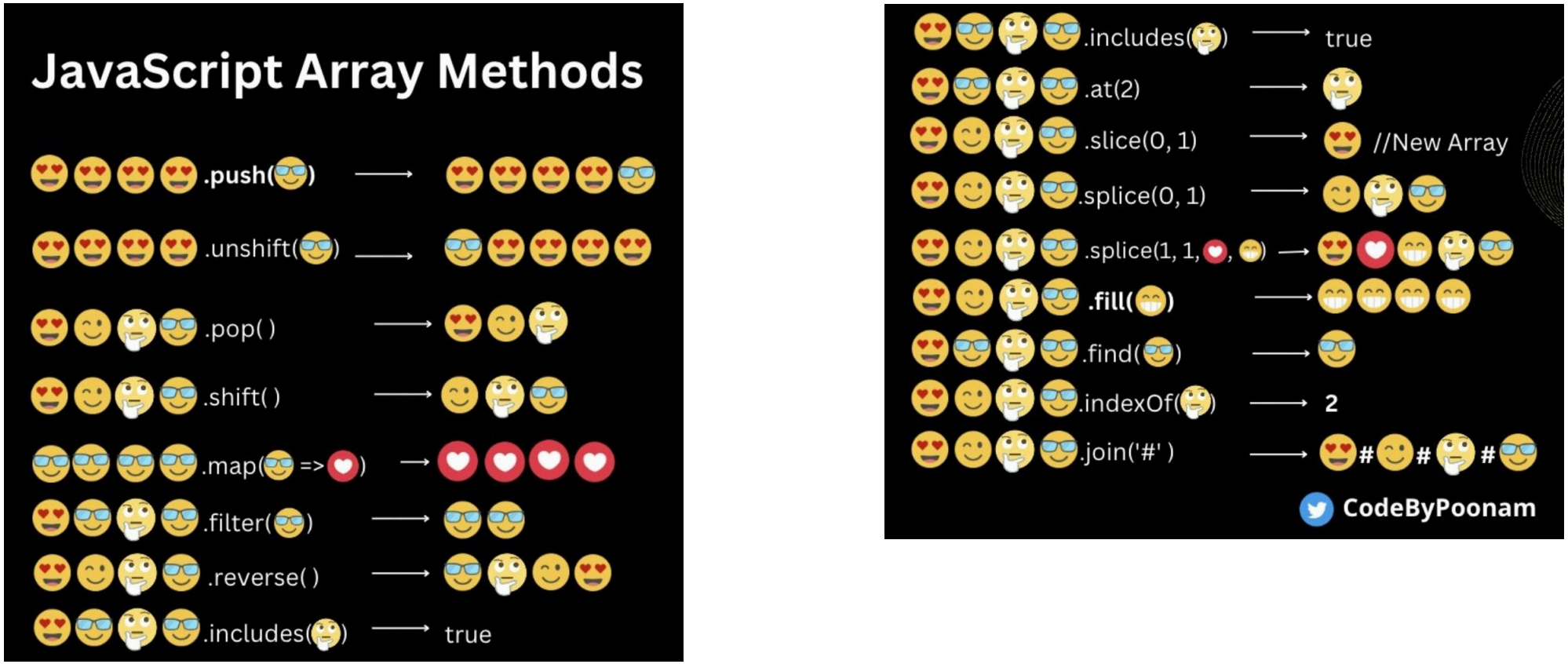


Figure 3.2: Array methods cheat sheet

Source: Poonam Soni@CodeByPoonam

Summary of the array methods

Add and replace elements:

- `push()` : append an element to the end of the array.
- `unshift()` : insert an element to the beginning of the array.
- `splice()` : add, remove, and replace elements in an array.

Remove elements:

- `pop()` : remove and return the last element from the array.
- `shift()` : remove and return the first element from the array.
- `splice()` : add, remove, and replace elements in an array.

Concatenate arrays:

- `concat()` : concatenate two or more arrays and return a new array.

Find elements:

- Find with the test function:
  - `find()`: find the first element in the array that satisfies the provided testing function.
  - `findIndex()`: find the index of the first element in the array that satisfies the provided testing function.
- Find the index:
  - `indexOf()`: find the index of the first occurrence of the element in the array.
  - `lastIndexOf()`: find the index of the last occurrence of the element in the array.
  - `findIndex()`
- Membership test:
  - `includes()`: check if the array contains the element.

Sorting:

- `sort()` : sort the elements of the array.
- `reverse()` : reverse the order of the elements in the array.

3.6 Iterating array

Ways to iterate an array

- `for` loop: the old way to iterate an array.
- `for/of` loop: a more concise way to iterate an array.
- `forEach()` method: a functional way to iterate an array.

for loop

Iterating an array means visiting each element of the array one by one.

- A common operation on an array.

The old way to iterate an array is to use the `for` loop with the index.

- Programmers are responsible for managing the index.
- The `for` loop is verbose and error-prone.

```
let colors = ['red', 'green', 'blue'];
for (let i = 0; i < colors.length; i++) {
    console.log(colors[i]);
}
```

for/of loop

The `for/of` loop (ES6) is a more concise way to iterate an array.

- JavaScript engine manages the iteration.
- The index is hidden and managed by the JavaScript engine.

Rewrite the above code using the `for/of` loop.

```
let colors = ['red', 'green', 'blue'];
for (let color of colors) {
    // Task to do with each element
    console.log(color);
}
```

the current index and value while iterating an array using the `for/of` loop

The variable before the `of` keyword is the returned value of each visit.

What if you want to use the index in the `for/of` loop?

- use the `entries()` method of the array object to return each element's index and value in an array.

```
let colors = ['red', 'green', 'blue'];
for( let [idx, color] of colors.entires()) {
    console.log(`${idx}: ${color}`);
}
```

Sample outputs:

```
0: red
1: green
2: blue
```

forEach() method of the array object

Using the view of functional programming can lead to a more concise way to iterate an array.

Think of the `for/of` loop body block as a function that processes each array element.

So, instead of the body block, we can pass a function that is applied to each visited element in the array.

```
let colors = ['red', 'green', 'blue'];

for( let [idx, color] of colors.entires())
{   // body block
    console.log(`${idx}: ${color}`);
}
```

```
let colors = ['red', 'green', 'blue'];

colors.forEach(
// Replace the for/of body block with a function:
(color, idx) => {
    console.log(`${idx}: ${color}`);
});
```

The `forEach()` method of an array object is a method that applies a function to each element of the array.

- It takes a function as an argument.
- The passed function can take three arguments: 1)the current element, 2)the index, and 3)the array itself.
- In most cases, we only need the current element

Example 17: Rewrite the above code using the `forEach()` method.

```
let colors = ['red', 'green', 'blue'];
colors.forEach((color, idx) => {
    console.log(`${idx}: ${color}`);
});
```

Review questions for the array iteration

1. When iterating an array, which way may require you to know the array's length?
2. If you already have a function and want to apply it to each array element, which way should you use it?

3.7 Objects

Objects are a data structure that comprises a collection of **properties** and **methods**.

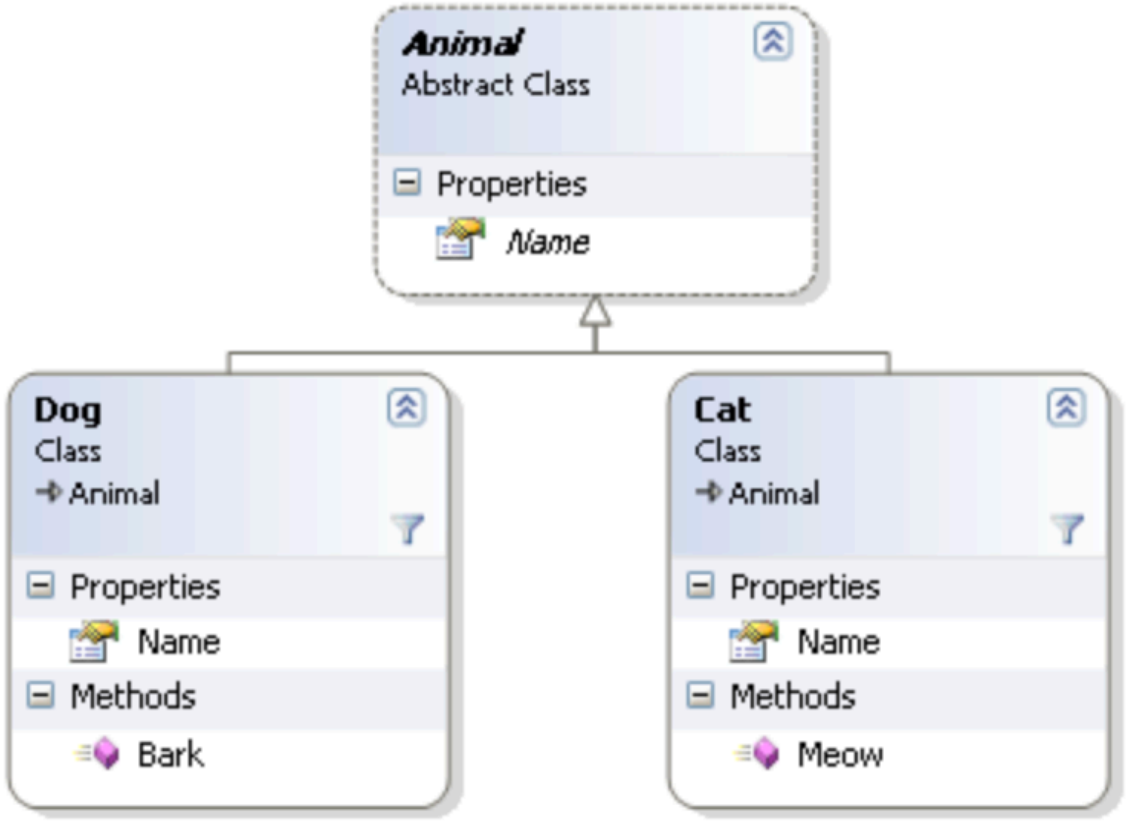
- A property is a key-value pair.
- A method is a function that can access the object's properties to perform a task.

Objects are the abstractions of real-world entities.

- Use them to model real-world entities in the program.

An object can inherit properties and methods from another object to extend its functionality.

- Be ease for developers to maintain and extend the code.



Example 18: The object hierarchy of Animal, Dog, and Cat.

- Dogs and Cats inherit the properties and methods from the Animal object.

Fig Source: Object-Oriented JavaScript Inheritance

See more about objects in the MDN web docs: JavaScript object basics - Learn web development | MDN

Creating an object

There are three ways to create an object in JavaScript:

- object literal,
- object constructor, and
- `Object.create()` method.

Object literal

Use the object literal `{}` to create an object when you want to create an object declaratively.

- shortcoming: Can only create one object at a time.

Example 19: Create the car FIAT-500

The FIAT 500 in the physical world:

Fig source: [1]

Abstracting the FIAT 500 as an object:

Fig source: [1]

Create the FIAT 500 object in the JavaScript "world".

The object literal of the FIAT 500:

```
let fiat500 = {
  // properties
  maker: 'Fiat', // key: value
  model: '500',
  year: 1957,
  color: 'Blue',
  passengers: 2,
  mileage: 88000,

// methods
  drive_forward: function(distance_miles) {
    console.log('Driving forward');
    // use the "this" keyword to refer to the object itself
    this.mileage += distance_miles;
  }, // key: function() { method body } or function object

  drive_backward: function() {
    console.log('Driving backward');
  }
}
```

In the above object literal:

- The properties are key-value pairs separated by a colon `:`.
- The methods are key-function pairs separated by a colon `:`.
- The `this` keyword is used to refer to the object itself to access the object's properties and methods.

Object constructor: the template to create multiple objects

Object literal is suitable for creating a single object.

- Error-prone when creating multiple objects with the same properties and methods.
  - Repeatedly write the same properties and methods for each object.

Use the object constructor to create **multiple objects** from an object template (class).

The object constructor is a function that initializes the object's properties.

Use the `class` keyword to define an object constructor in ES6.

Example 20: Define the FIAT500 class in ES6.

```
class FIAT500 {
    // constructor function
    constructor(maker, model, year, color, passengers, mileage) {
        this.maker = maker; // add a property to the object
        // this['marker'] = maker;  // the same meaning as the above line
        this.model = model;
        this.year = year;
        this.color = color;
        this.passengers = passengers;
        this.mileage = mileage;
        }
    // methods: named functions
    drive_forward(distance_miles) {
        console.log('Driving forward');
        this.mileage += distance_miles;
    }
    drive_backward() {
        console.log('Driving backward');
    }
}
```

In the above code:

- The `constructor` function initializes the object's properties.
- Pass arguments to the constructor function to initialize the object's properties.
- In the constructor function, use the `this` keyword to refer to the object itself.
- Use the dot operator `.` to access the object's properties and methods.

Steps to create a class: Summary

```
class FIAT500 {
    // constructor function
    constructor(maker, model, year, color, passengers, mileage) {
        this.maker = maker; // add a property to the object
        // this['marker'] = maker;  // the same meaning as the above line
        this.model = model;
        this.year = year;
        this.color = color;
        this.passengers = passengers;
        this.mileage = mileage;
        }
    // methods: named functions
    drive_forward(distance_miles) {
        console.log('Driving forward');
        this.mileage += distance_miles;
    }
    drive_backward() {
        console.log('Driving backward');
    }
}
```

1. Define the class using the `class` keyword.
2. Define the `constructor` function to initialize the object's properties.
    - All required properties are defined in the constructor function.
3. Define the methods as named functions in the class definition.

Create an object from the class

With the class definition, we can now create multiple objects of the same type using the `new` keyword.

Example 21: Create the myFiat500 and yourFIAT500 objects.

```
let myFiat = new FIAT500('Fiat', '500', 1957, 'Blue', 2, 6000);
let yourFiat = new FIAT500('Fiat', '500', 1957, 'Red', 2, 80000);
```

Note:

- There are other ways to create an object, such as the `Object.create()` method.
- We will cover these methods after discussing the `prototype` concepts in Chapter 7.
- See more about the class in Using classes - JavaScript | MDN

Accessing object properties

Use the dot operator `.` or the square brackets `[]` with the property name (or key name) to access the object's properties.

Example 22: Log the `myFiat` object's mileage property.

```
console.log(myFiat.mileage);  // 6000
// or
console.log(myFiat['mileage']);
```

Add or remove object's properties

JavaScript objects are dynamic.

- You can add, delete, and update properties (or even methods) of an object after the object is created.

When you specify a **new key-value pair** that does not exist in the object, JavaScript will add the new property to the object.

Example 23: Add the `fuel` property to the `myFiat` object.

```
myFiat.fuel = 'gasoline';   // Add a new property
console.log(myFiat.fuel);  // gasoline
```

To remove a property from an object, use the `delete` operator.

```
delete myFiat.fuel;  // remove the fuel property
console.log(myFiat);  // no fuel property in the object.
```

Output:

```
FIAT500 {
  maker: 'Fiat',
  model: '500',
  year: 1957,
  color: 'Blue',
  passengers: 2,
  mileage: 88100
}
```

3.8 Working with objects and arrays

Array of objects

Dealing with an array of objects is a common task in JavaScript programming.

- Scenario
  - Query a list of **HTML element objects** with the same class name and store them in an array of objects.
  - Have a list of **File objects** when reading files from the file input element.

Scenario: Create your array of objects

Example 24: Create the `cars` array that contains 2 FIAT500 objects.

Using the object literals:

```
let cars = [{
    maker: 'Fiat',
    model: '500',
    year: 1957,
    color: 'Blue',
    passengers: 2,
    mileage: 6000
  },
  {
    maker: 'Fiat',
    model: '500',
    year: 1957,
    color: 'Red',
    passengers: 2,
    mileage: 80000
  }
];
```

Or, using the FIAT500 constructor:

```
let cars = [new FIAT500('Fiat', '500', 1957, 'Blue', 2, 6000),
            new FIAT500('Fiat', '500', 1957, 'Red', 2, 80000)];
```

Scenario: Handling an array of HTML element object

Example 25: Add a click event listener to each radio button in the HTML document below.

Show the radio button's value when the radio button is clicked.

- the value is displayed in the `<p>` element with the `display` id.

```
<fieldset>
        <legend>Select a maintenance drone:</legend>

        <div>
          <input type="radio" id="huey" name="drone" value="huey" checked />
          <label for="huey">Huey</label>
        </div>

        <div>
          <input type="radio" id="dewey" name="drone" value="dewey" />
          <label for="dewey">Dewey</label>
        </div>

        <div>
          <input type="radio" id="louie" name="drone" value="louie" />
          <label for="louie">Louie</label>
        </div>
      </fieldset>
    <div>
       Your selection: <p id="display"></p>
    </div>
```

Select a maintenance drone:

- Huey
- Dewey
- Louie

Your selection:

huey

To do that, we need to add a click event listener to each radio button.

- First, we get all the radio button elements in an array.
- Then, we iterate the array and add a click event listener to each radio button.
    - The listener function gets the radio button's value and shows it in the `<p>` element.

Here is the code:

```
let drones = document.getElementsByName('drone');

// NodeList(3) [input#huey, input#dewey, input#louie], an array of input elements
console.log(drones);

// iterate the array
drones.forEach( drone => {
    // add a click event listener to each radio button
    drone.addEventListener('click', function(e){
        // get the radio button's value
        let value = e.target.value;
        // show the value in the <p> element
        document.getElementById('display').textContent = value;
    });
})
```

See full code in the ex_03_array_of_objects.html file.

Object having an array property

You can use an array as a property of an object.

Example 26: Create the `myFiat` object with the `gear` property as an array of values: 1, 2, 3, 4, 5, and R

```
let myFiat = {
    maker: 'Fiat',
    model: '500',
    year: 1957,
    color: 'Blue',
    passengers: 2,
    mileage: 6000,
    gear: [1, 2, 3, 4, 5, 'R']
}
```

To log the first gear value of the `myFiat` object:

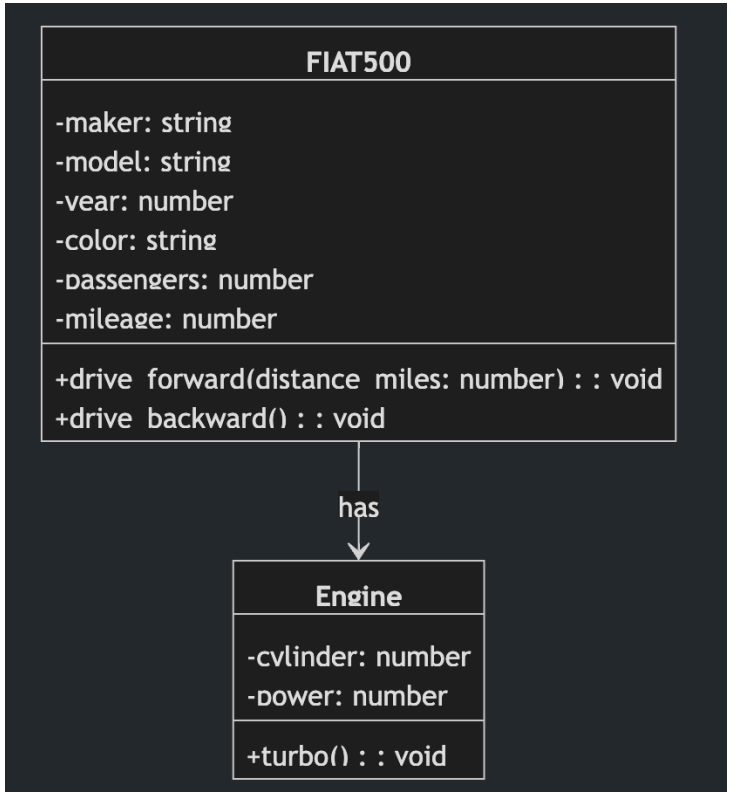
```
console.log(myFiat.gear[0]);  // 1
```

Nested objects

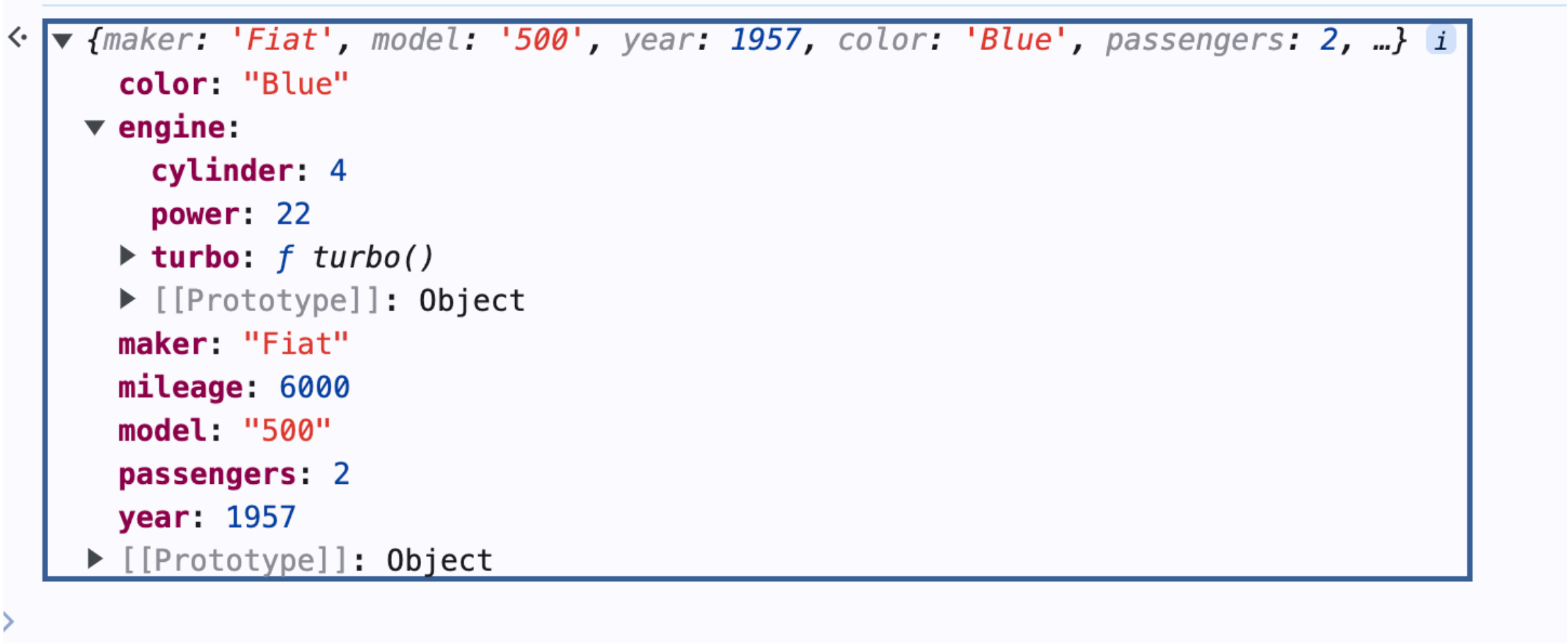
An object can have another object as a property.

Example 27: Create the `myFiat` object with the `engine` property as an object. The `engine` object has the `cylinder` and `power` properties.

```
let myFiat = {
    maker: 'Fiat',
    model: '500',
    year: 1957,
    color: 'Blue',
    passengers: 2,
    mileage: 6000,
    engine: {
        cylinder: 4,
        power: 22,
        // engine's method
        turbo(){
            console.log('Turbo is on' + this.power * 1.2);
        }
    }
}
```



Constructed object:



Summary

We have learned:

- Data types that can store multiple values: Arrays and Objects.
- Ways to create an array: array literal, array constructor, `Array.of()` method, and `Array.from()` method.
- Methods to operate on arrays: `push()`, `pop()`, `shift()`, `unshift()`, `splice()`, `concat()`, `find()`, `sort()`, and `reverse()`.
- Ways to iterate an array: `for/of` loop, `forEach()` method, and `entries()` method.
- Ways to create an object: object literal and object constructor.
- Working with arrays and objects: array of objects, object having an array property, and nested objects.

References

[1] Eric T. Freeman and Elisabeth Robson, 2014. Head First JavaScript Programming: A Brain-Friendly Guide, O'Reilly Media