

Chapter 2 JavaScript Essentials

Lesson Overview

- Primitive data types
- string template
- null and undefined
- Data type conversion
 - Type inference and `typeof` operator
 - Implicit and explicit type conversion
- Operators
- Practical Technique: Set the default value of a variable

2.1 Variables

- Use variables to store values temporarily for later use.
- JS is a loosely typed (weakly) language, so you don't need to specify the data type of a variable when you declare it.
- JS determines the data type of a variable at runtime.
- Uninitialized variables have the value `undefined`.

Declaring variables

Best practice for declaring variables:

- Use `let` to declare local variables in a block. (block scope).
- Use `const` to declare constants.
- Use `var` to declare variables of the function scope.
- Initialize variables when you declare them to avoid `undefined` values.
- Any variables that are declared outside of a function are global variables, no matter using `let`, `const`, or `var`.

Examples of declaring a global variable in a block:

```
let count = 0; // global variable
function aFunction(){
  for (let i = 0; i < 10; i++) {
    var sum = 10; // function-scoped variable
    var user; // undefined variable
  }
  console.log('sum(inside):', sum); // accessible from outside the block
  console.log('user: ', user); // undefined; accessible from outside the block.
  console.log('i:', i); // out of scope; ReferenceError: i is not defined. i is a block-scoped variable.
}
aFunction();
console.log('count:', count); // accessible from outside the block
console.log('sum(outside):', sum); // out of scope; ReferenceError: sum is not defined. sum is block-scoped variable.
```

See full example in [ex_02_01](#)

```
> for (let i = 0; i < 10; i++) {  
    var sum = 10;  
    var user; // undefined variable  
}  
console.log(sum);  
console.log(user); // undefined  
console.log(i); // out of scope; ReferenceError: i is not defined
```

10

undefined

✖ ▶ Uncaught
ReferenceError: i is not defined
at <anonymous>:7:13

>

See more: [Grammar and types - JavaScript | MDN](#)

Naming variables

Best practices:

- Use Intention-Revealing names for variables to show their purpose and make the code easier to read.

```
let d = 0; // bad  
let daysSinceCreation = 0; // good; self-explanatory
```

- Use camelCase for variable names, e.g., `ageOfBuyer` .
- Use Pronounceable names, e.g., `modificationTimestamp` instead of `modydhms` .

2.2 Primitive data types

The primitive data type is a data type that is not an object and has no methods.

Available primitive data types:

- string, number, bigint, boolean, undefined, symbol, null
 - See [Primitive - MDN Web Docs Glossary: Definitions of Web-related terms | MDN](#)
- they are all in lowercase
 - `string` is a primitive data type; `String` is an object.

Immutability of primitive data types

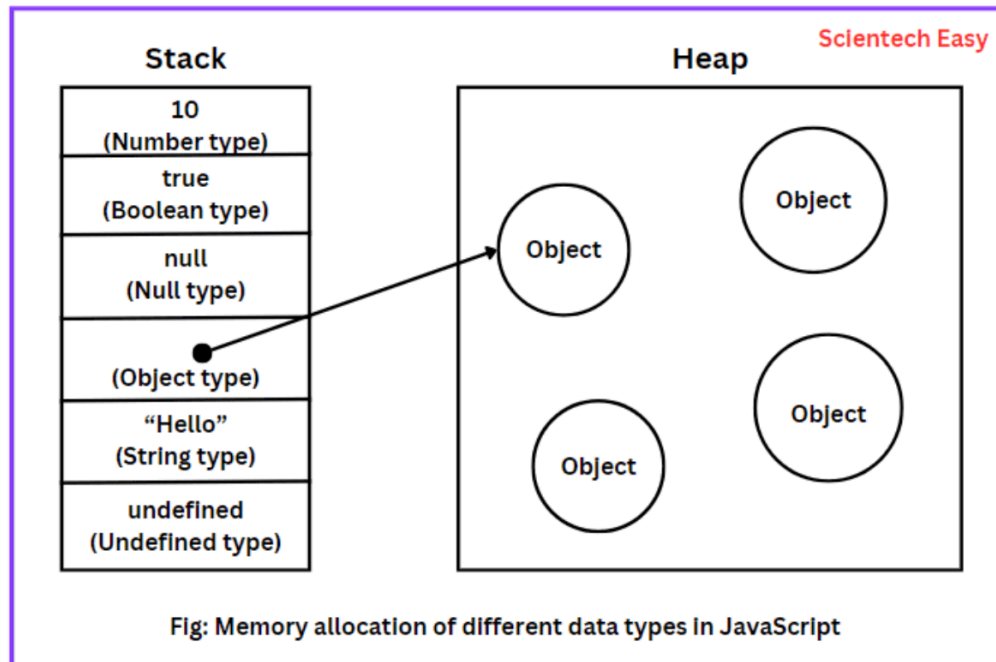
Primitive data types are **immutable**, meaning that their values cannot be changed. But you can assign a new value to it.

```
let x = 10;  
x.toFixed(2); // Auto-boxing: converts x to a Number object  
console.log(x); // 10. x is still a primitive value.  
x = 12;  
console.log(x); // 12. Although you cannot change the value of x, you can assign a new value to x.
```

Primitive data types vs reference data types

The another difference between primitive and reference data types is that

- primitive data types are stored in the **stack**,
- while reference data types are stored in the **heap**.



How JavaScript allocates memory location for different data types.

Source: <https://www.scientecheasy.com/2021/10/javascript-data-types.html/>

Auto-boxing of primitive data types to objects

Primitives have no methods but still behave as if they do. This is because JS automatically converts primitive values to objects when you call a method on them. This is called **auto-boxing**.

```
let userName = "Alice";  
// ALICE. A String wrapper object is created and then destroyed by auto-boxing.  
console.log(userName.toUpperCase());  
// Alice. The original value is not changed.  
console.log(userName);
```

See more: [Primitive - MDN Web Docs Glossary: Definitions of Web-related terms | MDN](#)

Comparing primitive data types by value

Primitives are also compared by value, not by reference.

Example of comparing by value:

```
let x = 10;  
let y = 10;  
console.log(x === y); // true. x and y have the same value but don't share the same memory location.
```

Example of comparing by reference:

```
let a = [1, 2, 3];  
let b = [1, 2, 3];  
console.log(a === b); // false. a and b don't share the same memory location, although they have the same value.  
let c = a;  
console.log(a === c); // true. a and c share the same memory location.
```

ex_02_02

2.3 `string` template

Use the string template to make your code:

- more readable
- allowing for multi-line strings
- embedding expressions in strings
- avoiding the `+` operator to concatenate strings.

- Use backticks to create a string template.
- You can embed expressions in a string template using `${}`.

```
let name = 'Alice';  
let age = 20;  
let message = `Hello, ${name}. You are ${age} years old.`;  
console.log(message); // Hello, Alice. You are 20 years old.
```

The string template is more readable than using the `+` operator to concatenate strings.

```
// Using the + operator to concatenate strings  
// not recommended  
let message = 'Hello, ' + name + '. You are ' + age + ' years old.';  
console.log(message); // Hello, Alice. You are 20 years old.
```

2.4 Symbol data type (Optional)

- A symbol is a unique and immutable data type
- It is often used as an object property key to avoid being overwritten by other programs.
- Be available after ES6.

Create public and private symbols

- Create a **private** symbol by using the `Symbol('optional_description')` function.
 - Each symbol is unique, even if they have the same description.
- Create a **public** symbol by using the `Symbol.for('key')` function.
 - If a symbol with the same key already exists, it returns the existing symbol.
 - Shareable symbols are stored in the **global symbol registry**.


```
//Create a private symbol
privateId = Symbol('id');

// create a public in the public symbol registry
sharedId = Symbol.for('id');

console.log(privateId === sharedId);

// Get the symbol by key from the public symbol registry
retrievedId = Symbol.for('id');
console.log(retrievedId === sharedId);
```

Ref: [Symbol - JavaScript | MDN](#)

Advanced Reading: Using the symbol data type to create private properties

Example of object properties that are overwritten by other programs:

```
// Define an object with a property
let user = {
  name: "John Doe"
};

console.log(user.name); // Output: John Doe
```

```
// Later in the code or in another script, the property is overridden  
user.name = "Jane Doe";
```

```
console.log(user.name); // Output: Jane Doe
```

```
// Another example, a third-party library might modify the object  
function updateUser(user) {  
    // A function from a library that modifies the user object  
    user.name = "Library User";  
}
```

```
updateUser(user);
```

```
console.log(user.name); // Output: Library User
```

Example of using a symbol to create a private property:

```
// Create a unique symbol
const uniqueName = Symbol('name');

// Define an object using the symbol as a property key
let user = {
  [uniqueName]: "John Doe"
};

console.log(user[uniqueName]); // Output: John Doe
```

```
// Even if another part of the code or a library tries to set 'name' property,  
//It won't affect the unique symbol property  
user.name = "Jane Doe";  
console.log(user.name); // Output: Jane Doe  
console.log(user[uniqueName]); // Output: John Doe  
  
// Another script or library using a symbol with the same description  
// will not override the original property, as each symbol is unique  
const anotherUniqueName = Symbol('name');  
user[anotherUniqueName] = "Library User";  
  
console.log(user[uniqueName]); // Output: John Doe  
console.log(user[anotherUniqueName]); // Output: Library User
```

2.5 null and undefined

- `null` and `undefined` both represent an absence of value.
- `undefined` is used by **JS** to indicate an **uninitialized state**.
 - e.g. a variable that has been declared but not assigned a value.
 - e.g. a function that does not return anything.
- `null` is used by **programmers** to explicitly indicate "**no value**" or "**empty**".

2.6 Data type conversion

Type inference and `typeof` operator

- JS infers the data type of a variable at runtime.

```
let foo = 42;    // foo is a number
let foo = 'bar'; // foo is a string
let foo = true;  // foo is a boolean
let foo;         // foo is undefined
```

- When you want to know the data type of a variable at the runtime, use the `typeof` operator.

```
let x = 10;
console.log(typeof x); // number
```


Conversion between data types

- Two different data types cannot be operated together.
- You explicitly convert a data type to another (explicit type conversion) or
- Let JS convert it automatically for you (implicit type conversion) according to the default rules.
- Example: What is the result of $1 + "1"$?

```
let result = 1 + "1"; // "11"  
console.log(typeof result); // string
```

- Example: What is the result of $1 - "1"$?

```
let result = 1 - "1"; // 0  
console.log(typeof result); // number
```

Explicit type conversion

- Use the explicit type conversion to avoid unexpected results (Also showing your intention clearly).
- Data type conversion functions:
 - Use the `Number()`, `String()`, `Boolean()`, `BigInt()`, `Symbol()` functions to convert a value to a specific data type.
 - These are standard built-in functions in JS.

```
let x = "1";  
// Explicitly convert the string "1" to a number 1  
let y = 1 + Number(x);  
console.log(y); // 2
```

Convert a string to a number

- `Number()` vs `parseInt()` and `parseFloat()`
 - `Number()` converts a value to a number in 10 radix.
 - Use `parseInt()` and `parseFloat()` to convert a string of a specific radix to an integer or a floating-point number.
 - binary, octal, decimal, or hexadecimal strings => integer

```
// parse the string "11" as a binary number and convert it to a decimal number
console.log(parseInt("11", 2)); // 3
// parse the string "11" as a hexadecimal number and convert it to a decimal number
console.log(parseInt("11", 16)); // 17
```

Convert a number to a string

- Apply `toString()` to convert a number to a string in a specific radix.
 - Use it when you want to convert a number to a string in a specific radix.
 - Example: Convert the number 10 to a string in binary.
 - JS auto-boxes the `number` to a `Number` object when you call the `toString()` method.

```
let x = 10;
```

```
// Wrap x in a Number object and convert it to a string in binary: "1010"  
console.log(x.toString(2));
```

Explicit conversion idioms

- You can use the **default conversion rules** of some operators to explicitly convert a value to a specific data type.
 - Save your time but make your code less readable.
- Convert to string:
 - `x + ""`: convert x to a string. `+` is a binary operator (with two operands).
- Convert to number:
 - `+x`: convert x to a number. `+` is the unary operator: unary plus
 - `x-0`: convert x to a number. `-` is a binary operator: subtraction.
- Convert to boolean:
 - `!!x`: convert x to a boolean. `!` is the unary operator: logical NOT.

Implicit type conversion

- JS can convert data types for you automatically when you operate with two different data types.
- The conversion rules depend on the operator or the context in which the conversion occurs.
- Introduce two most famous operators with special conversion rules: `+` and `==`.

Conversion rules of the `+` operator

- Operator `+` (addition operator):
 - The `+` operator can perform two operations: **string concatenation** and **number addition**.
 - This is called **operator overloading**.
 - If one of the operands is a string, JS converts the other to a string and concatenates them.
 - If both operands are numbers, JS adds them.

```
console.log(2 + 2); // Expected output: 4
console.log(2 + true); // Expected output: 3
console.log("2" + true); // Expected output: "2true"
```

Ref: [Addition \(+\) - JavaScript | MDN](#)

Conversion rules of the equal operator `==`

- Operator `==` : Equality operator with type coercion (Also called the **loosely** equality operator)
 - The `==` operator compares two values and returns `true` if they are equal.
 - If the two values have different data types, JS converts one to the other's data type.
 - This is called **type coercion**.
 - The `==` operator is not recommended because it can lead to unexpected results.
 - Use the `===` operator (strict equality operator) to compare two values **without** type coercion.

Examples of the `==` operator

```
// true; Type Coercion: convert the string "1" to a number 1
console.log("1" == 1);

// true; Type coercion occurs:
console.log(1 == "1");

// true; Type coercion occurs: convert the boolean false to a number 0
console.log(0 == false);

// not perform type coercion between null and any other value except undefined.
console.log(0 == null); // false

// not perform type coercion between null and any other value except undefined.
console.log(0 == undefined); // false
```

```
// Explicitly convert null to boolean false before comparison
// !! is a conversion idiom to convert a value to a boolean.
// true. !!null is false -> false converted to 0 -> 0 == 0 is true
console.log(0 == !!null);

// Explicitly convert undefined to boolean false before comparison
// !! is a conversion idiom to convert a value to a boolean.
// true. !!undefined is false -> false converted to 0 -> 0 == 0 is true
console.log(0 == !!undefined);

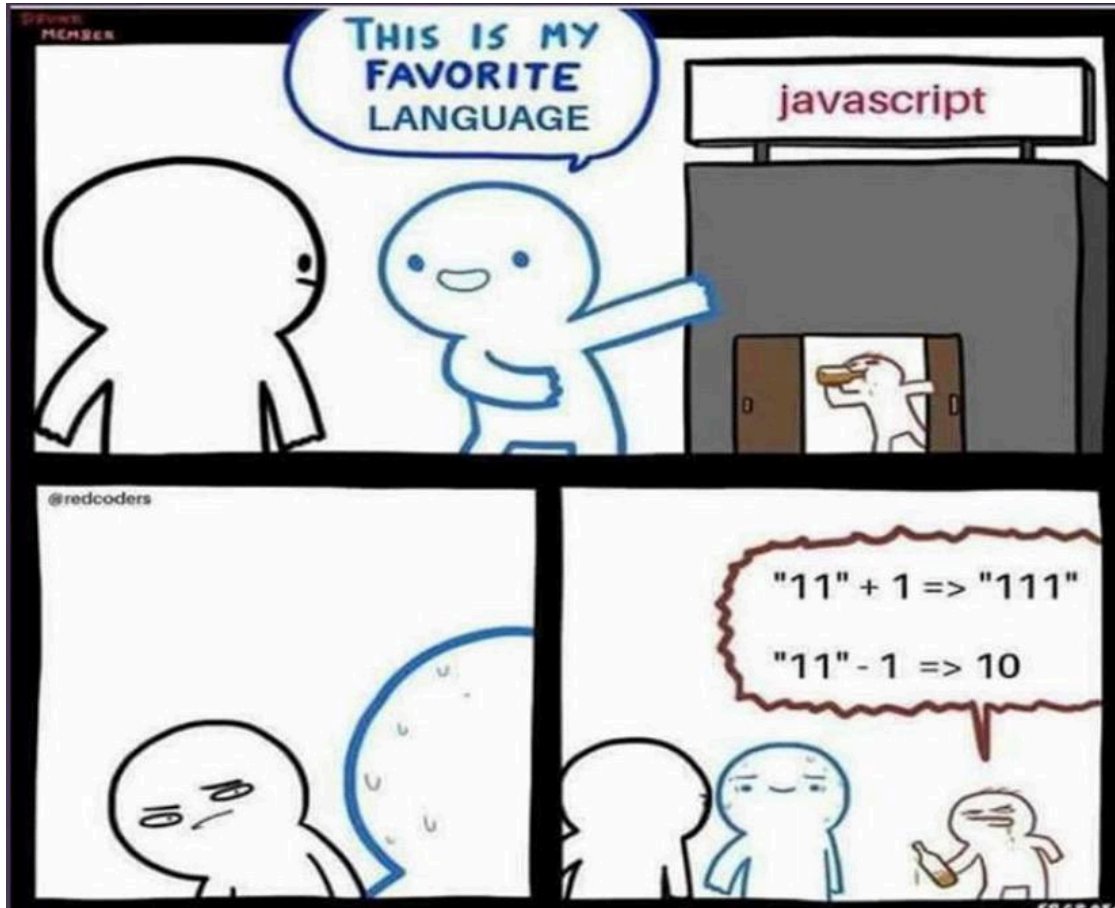
// According to the ECMAScript specification,
// null and undefined are only equal to themselves and each other.
console.log(null == undefined); // true
```

Ref: [Equality \(==\) - JavaScript | MDN](#)

Best Practice for comparing values

- Always use the strict equality operator `===` to compare two values without type coercion.
- **Do not rely on the default type coercion rules if you want to write clear and predictable code.**

Programming meme about the implicit type conversion in JS:



If you are really serious about these kinds of memes, please visit:

[Javascript vs memes](#)

Summary of the implicit conversion rules

Value	Converted to:			
	String	Number	Boolean	Object
undefined	"undefined"	NaN	false	throws <i>TypeError</i>
null	"null"	0	false	throws <i>TypeError</i>
true	"true"	1		new Boolean(true)
false	"false"	0		new Boolean(false)
"" (empty string)		0	false	new String("")
"1.2" (nonempty, numeric)		1.2	true	new String("1.2")
"one" (nonempty, non-numeric)		NaN	true	new String("one")
0	"0"		false	new Number(0)
-0	"0"		false	new Number(-0)
NaN	"NaN"		false	new Number(NaN)
Infinity	"Infinity"		true	new Number(Infinity)
-Infinity	"-Infinity"		true	new Number(-Infinity)
1 (finite, non-zero)	"1"		true	new Number(1)
{ } (any object)	see §3.8.3	see §3.8.3	true	
[] (empty array)	""	0	true	
[9] (1 numeric elt)	"9"	9	true	
['a'] (any other array)	use <i>join()</i> method	NaN	true	
function() { } (any function)	see §3.8.3	NaN	true	

Source: Flanagan, D. 2011, JavaScript: The Definitive Guide, 6th Edition, p46., O'Reilly

2.7 Operators

- Various kinds of operators in JS:
 - Arithmetic operators: `+`, `-`, `*`, `/`, `%` (modulus), `++` (increment), `--` (decrement), `**` (exponentiation)
 - Assignment operators: `=`, `+=` (Addition assignment), `-=`, `*=`, `/=`, `%=`, `**=`
 - Comparison operators: `==`, `===`, `!=`, `!==`, `>`, `<`, `>=`, `<=`
 - Logical operators: `&&` (AND), `||` (OR), `!` (NOT)

Please read the section on the operators in Chapter 2 of the textbook.

See more: [Expressions and operators - JavaScript | MDN](#)

2.8 Practical Technique: Set the default value of a variable when your source is `null` or `undefined`

- very often, you set a value to a variable according to the value of another variable.
- When the source variable is `null` or `undefined`, you want to set a default value to the target variable.
- Consider the following example:

```
function greet(name) {  
    // parameter name might be null or undefined  
    let userName = name;  
    console.log(`Hello, ${userName}`);  
}
```

Set default value using the `||` or `??` operators

- use the logical OR operator `||` to set a default value when the source value is falsy. (Default a value when the source value is `null`, `undefined`, `0`, `false`, `""`)
- use the `??` operator (nullish coalescing operator) to set a default value only when the source value is `null` or `undefined`. (Default a value when the source value is `null`)
- The above example can be rewritten as follows:

```
function greet(name) {  
  // parameter name might be null or undefined  
  // set the default value to "Guest" when name is null or undefined  
  let userName = name ?? "Guest";  
  console.log(`Hello, ${userName}`);  
}
```

Ref: [The Ultimate Guide to Default Values in JavaScript: || and ?? Operators Explained](#)

Summary

- Declaring and naming variables
- Primitive data types: string, number, bigint, boolean, undefined, symbol, null
- null vs undefined
- Data type conversion: explicit and implicit
- Operators: arithmetic, assignment, comparison, logical