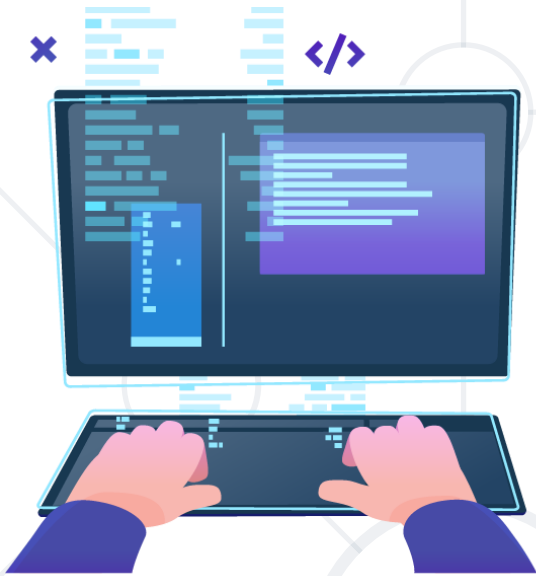


Syntax, Functions and Statements

Operators, Parameters, Return Value, Arrow Functions



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Technical Trainers



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#js-advanced

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Introduction to JavaScript

Definition, Execution, IDE Setup

What is JavaScript?



- JavaScript (**JS**) is a **high-level** programming language
 - One of the **core technologies** of the World Wide Web
 - Enables **interactive** web pages and applications
 - Can be **executed** on the **server** and on the **client**
- Features:
 - C-like **syntax** (curly-brackets, identifiers, operator)
 - **Multi-paradigm** (imperative, functional, OOP)
 - Dynamic **typing**

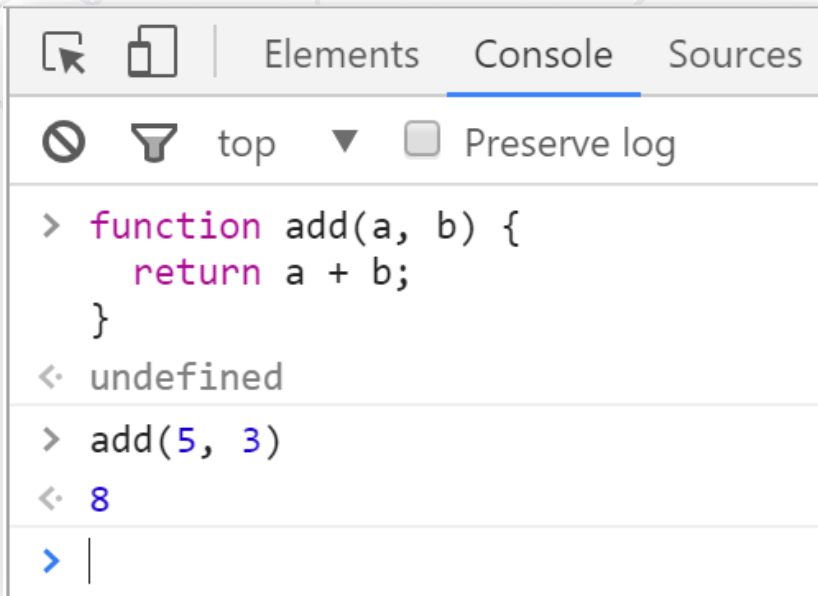
- JavaScript is a **dynamic programming language**
 - Operations otherwise done at **compile-time** can be done at **run-time**
- It is **possible** to change the **type** of a variable or add new properties or methods to an object **while** the program is **running**
- In **static programming languages**, such changes are normally **not possible**



Live Demonstration

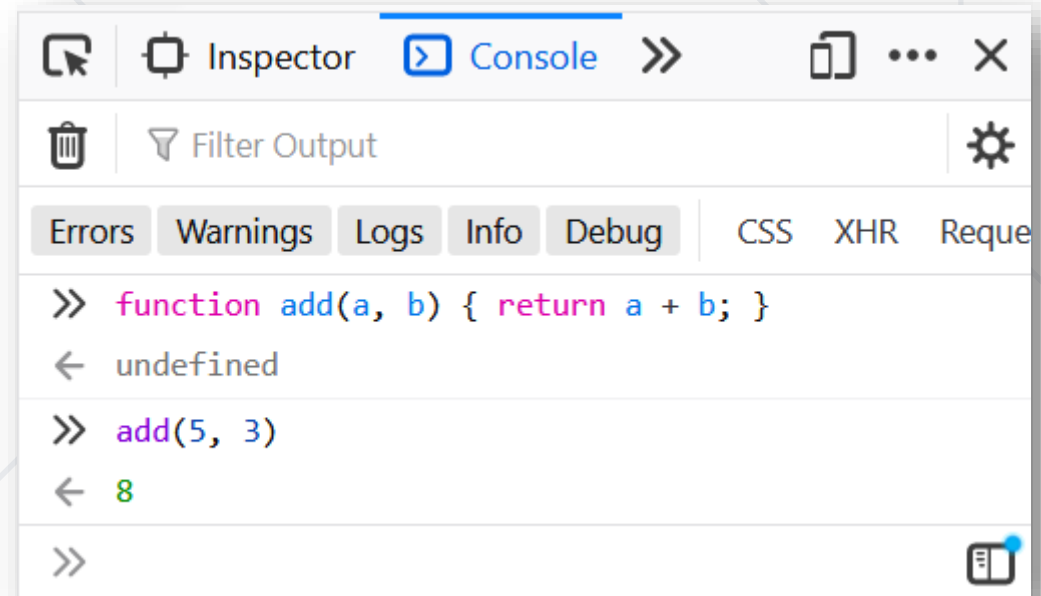
Setting up Node.js + VS Code

Developer Console: **[F12]**



The Chrome Developer Console interface is shown with the 'Console' tab selected. It includes a toolbar with a close button, a filter icon, a dropdown menu set to 'top', and a 'Preserve log' checkbox. The console contains the following code and output:

```
> function add(a, b) {  
    return a + b;  
}  
← undefined  
> add(5, 3)  
← 8  
> |
```

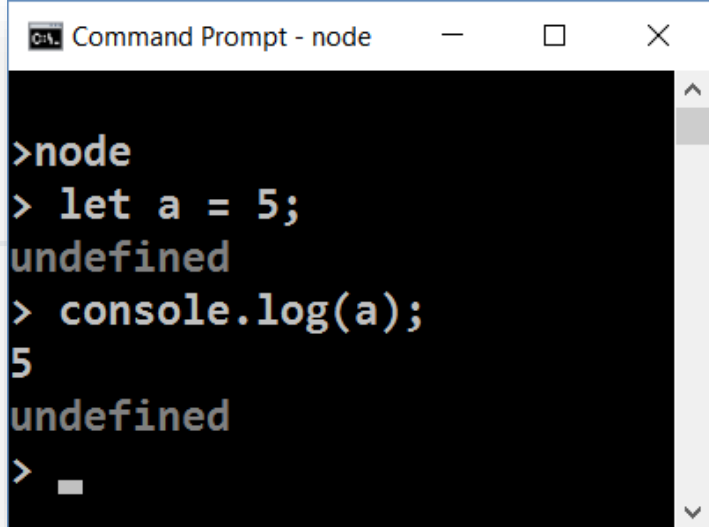


The Firefox Developer Console interface is shown with the 'Console' tab selected. It includes a toolbar with a close button, a filter icon, and a 'Filter Output' dropdown. Below the toolbar are tabs for 'Errors', 'Warnings', 'Logs', 'Info', 'Debug', 'CSS', 'XHR', and 'Reque'. The console contains the following code and output:

```
>> function add(a, b) { return a + b; }  
← undefined  
>> add(5, 3)  
← 8  
>>
```


Node.js

- What is **Node.js**?
 - **Server-side** JavaScript runtime
 - Chrome V8 JavaScript engine
 - NPM **package manager**
 - Install node packages



```
>node
> let a = 5;
undefined
> console.log(a);
5
undefined
>
```


Install the Latest Node.js


Latest LTS Version: 18.12.1 (includes npm 8.19.2)


Download the Node.js source code or a pre-built installer for your platform, and start developing today.

LTS
Recommended For Most Users

Current
Latest Features


Windows Installer
node-v18.12.1-x64.msi

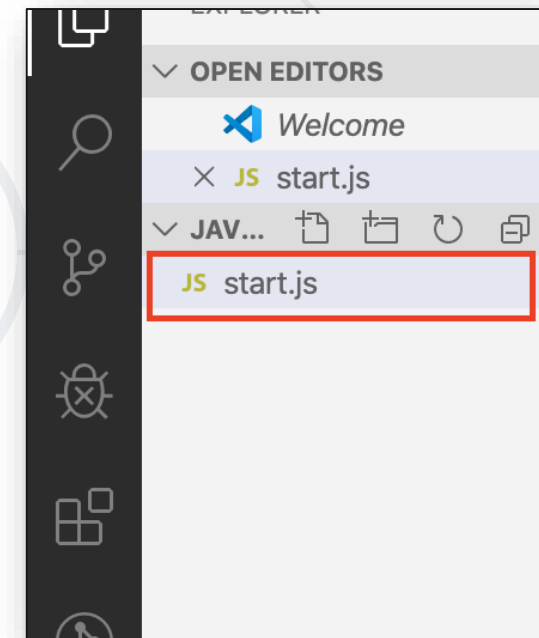
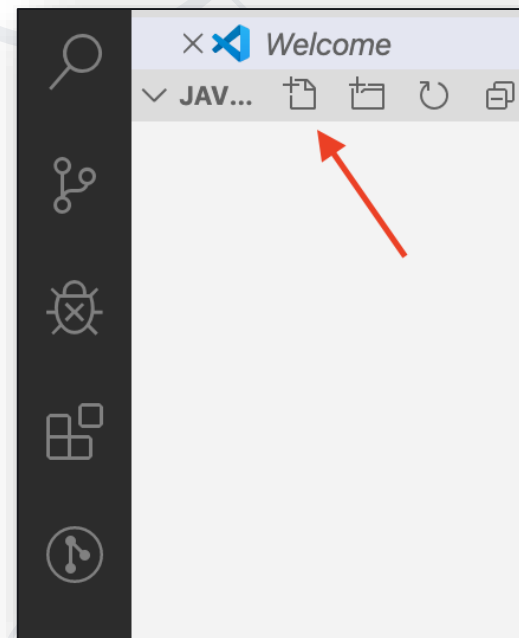
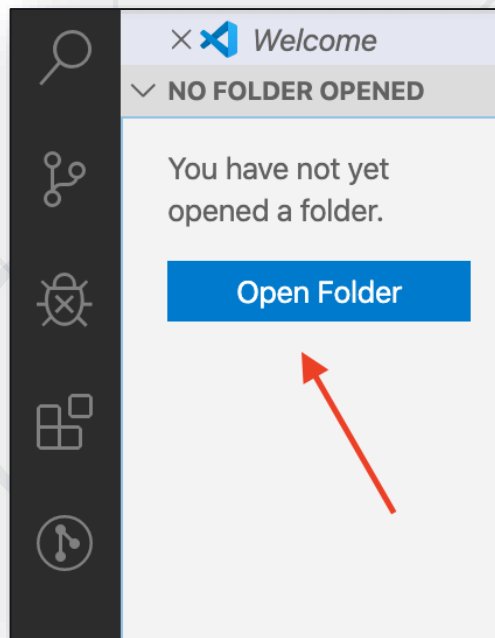

macOS Installer
node-v18.12.1.pkg


Source Code
node-v18.12.1.tar.gz

Windows Installer (.msi)	32-bit	64-bit
Windows Binary (.zip)	32-bit	64-bit
macOS Installer (.pkg)	64-bit / ARM64	
macOS Binary (.tar.gz)	64-bit	ARM64
Linux Binaries (x64)	64-bit	
Linux Binaries (ARM)	ARMv7	ARMv8
Source Code	node-v18.12.1.tar.gz	

Using Visual Studio Code

- **Visual Studio Code** is powerful text editor for JavaScript and other projects
- In order to create your **first project**:





Data Types & Variables

Identifiers, Declaring Variables, Variable Scope

- Seven **data types** that are **primitives**
 - **String** - used to represent textual data
 - **Number** - a numeric data type
 - **Boolean** - a logical data type
 - **Undefined** - automatically assigned to variables
 - **Null** - represents the **intentional absence** of any object value
 - **BigInt** - represent integers with **arbitrary precision**
 - **Symbol** - **unique** and **immutable** primitive value
- **Reference types – Object**


- An **identifier** is a sequence of characters in the code that identifies a **variable**, **function**, or **property**
- In JavaScript, identifiers are **case-sensitive** and can contain Unicode **letters**, **\$**, **_**, and **digits** (0-9), but may **not** start with a digit

```
let _name = "John";
```

```
function $sum(x, y) {  
    return x + y;  
}
```

```
let 9 = 'nine'; //SyntaxError: Unexpected number
```

Variable Values

- 
- Used to **store** data values
 - Variables that are assigned a **non-primitive** value are given a **reference** to that value
 - **Undefined** - a variable that has been declared with a keyword, but not given a value

```
let a;  
console.log(a) //undefined
```

- **Undeclared** - a **variable** that hasn't been declared at all

```
console.log(undeclaredVariable);  
//ReferenceError: undeclaredVariable is not defined
```

Variable Values

- **let**, **const** and **var** are used to declare variables
 - **let** - allows **reassignment**

```
let name = "George";  
name = "Maria";
```

- **const** - once assigned it **cannot** be modified

```
const name = "George";  
name = "Maria"; // TypeError
```

- **var** - defines a variable in the function scope **regardless** of block scope

```
var name = "George";  
name = "Maria";
```



Legacy Variable Declaration

- You will see **var** used in old examples
- Using **var** to declare variables is a **legacy** technique
- Since **ES2015** keywords **let** and **const** are available
- **var** introduces function scope **hoisting**
 - Will be discussed later in the lesson
- There is no good reason to **ever** use **var**!




Variable Scopes

- **Global scope** – Any variable that's **NOT** inside any **function** or **block** (a pair of curly braces);
- **Functional scope** – Variable declared **inside a function** is inside the local scope;
- **Block scope** – **let** and **const** declares **block** scoped variables



Dynamic Typing

- 
- Variables in JavaScript are **not** directly **associated** with any particular **value type**
 - Any variable **can** be assigned (and re-assigned) values of all types

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


- **NOTE: The use of dynamic typing is considered a bad practice!**



Functions

Declaring and Invoking

Functions

- 
- **Function** - named list of instructions (statements and expressions)
 - Can take **parameters** and return **result**
 - Function names and parameters use **camel case**
 - The **{** stays at the same line

```
function printStars(count) {  
    console.log("*".repeat(count));  
}
```

- **Invoke** the function

```
printStars(10);
```

Declaring Functions

- Function declaration

```
function walk() {  
  console.log("walking");  
}
```

- Function expression

```
const walk = function () {  
  console.log("walking");  
}
```


- Arrow functions

```
const walk = () => {  
  console.log("walking");  
}
```



Parameters and Returned Value

- You can receive parameters with **no value**
- The **unused parameters** are ignored



```
function foo(a,b,c){  
  console.log(a);  
  console.log(b);  
  console.log(c); //undefined  
}  
foo(1,2)
```

```
function foo(a,b,c){  
  console.log(a);  
  console.log(b);  
  console.log(c);  
}  
foo(1,2,3,6,7)
```

- Functions can yield a value with the **return** operator

```
function identity(param){  
  return param;  
}  
console.log(identity(5)) // 5
```

Object Methods and Standard Library

- Any object may have **methods**
 - **Functions** that operate from the **context** of the object
 - Accessed as a **property** using the **dot-notation**

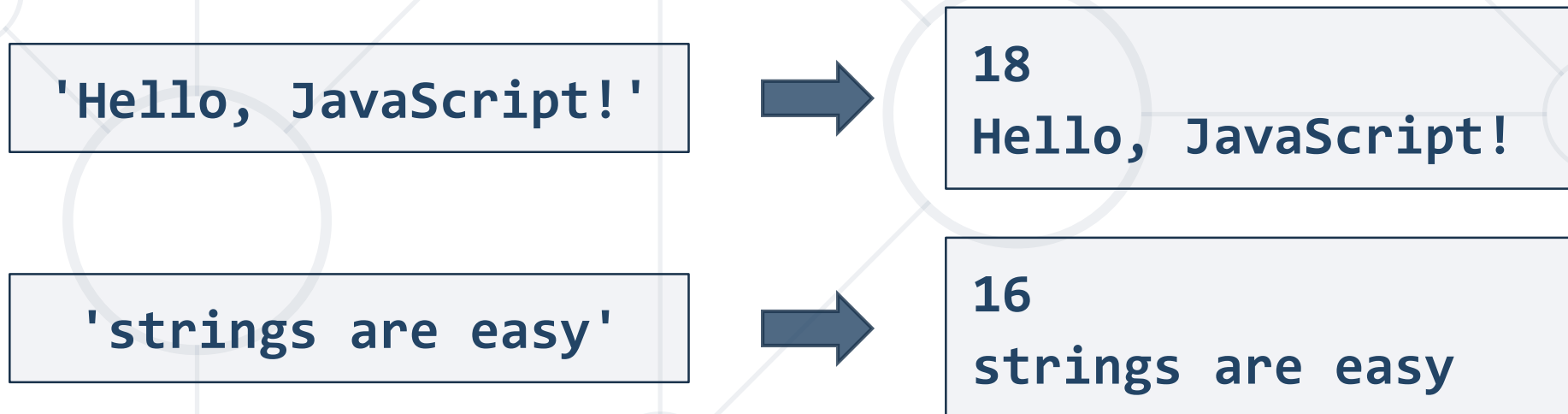
```
let myString = 'Hello, JavaScript!';  
console.log(myString.toLowerCase());  
// hello, javascript!
```

- JavaScript has a large **standard library**
 - **Math, Number, Date, RegExp, JSON** and more
 - For more information, [visit MDN](#)



Problem: Echo Function

- A **string argument** is passed to your function
- **Print** on separate lines:
 - The **length** of the input parameter (number of characters)
 - The **unchanged parameter** itself



Solution: Echo Function

```
function echo(inputAsString) {  
  let stringLength = inputAsString.length;  
  console.log(stringLength);  
  console.log(inputAsString);  
}
```

```
echo('Hello, JavaScript!');  
// 18  
// Hello, JavaScript!
```

Default Function Parameter Values

- Functions can have **default parameter** values

```
function printStars(count = 5) {  
    console.log("*".repeat(count));  
}
```

```
printStars(); // *****
```

```
printStars(2); // **
```

```
printStars(3, 5, 8); // ***
```





Operators and Statements

Assignment, Arithmetic, Comparison, Logical

Arithmetic Operators


- **Arithmetic operators** - take numerical values (either literals or variables) as their operands
 - Return a single numerical value
 - Addition (+)
 - Subtraction (-)
 - Multiplication (*)
 - Division (/)
 - Remainder (%)
 - Exponentiation (**)

```
let a = 15;
let b = 5;
let c;
c = a + b; // 20
c = a - b; // 10
c = a * b; // 75
c = a / b; // 3
c = a % b; // 0
c = a ** b; // 155 = 759375
```



Assignment Operators

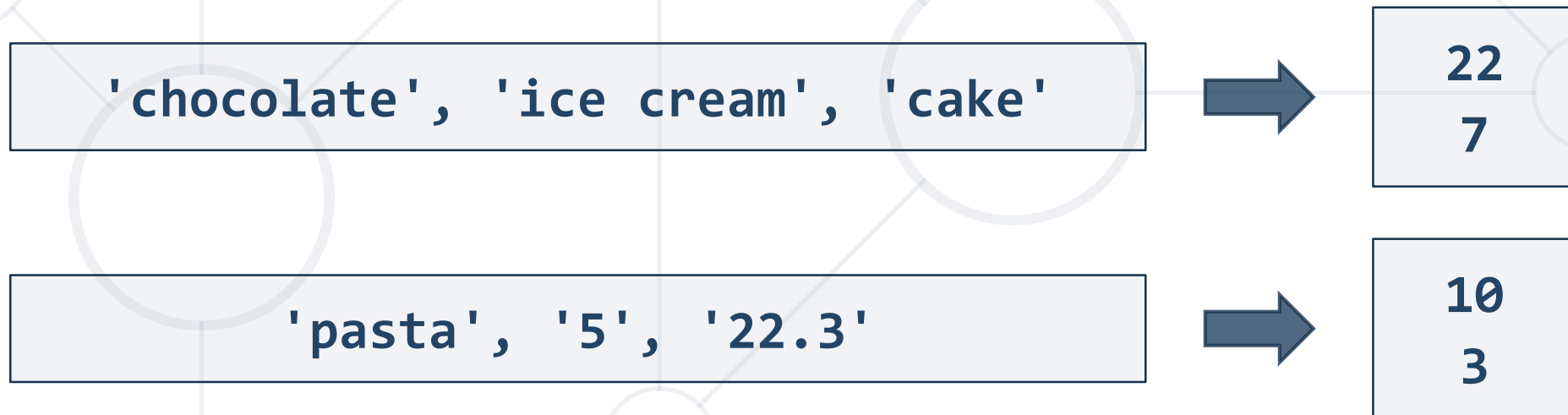
- **Assignment operators** - **assign** a value to its left operand based on the value of the right operand



Name	Shorthand operator	Basic usage
Assignment	$x = y$	$x = y$
Addition assignment	$x += y$	$x = x + y$
Subtraction assignment	$x -= y$	$x = x - y$
Multiplication assignment	$x *= y$	$x = x * y$
Division assignment	$x /= y$	$x = x / y$
Remainder assignment	$x \% = y$	$x = x \% y$
Exponentiation assignment	$x ** = y$	$x = x ** y$

Problem: String Length

- Receive **three string arguments** as input
- Calculate the **total length** of all strings
- Calculate the **average length, rounded down**
- **Print** the result on the console



Solution: String Length

```
function solve(str1, str2, str3) {  
  let len1 = str1.length;  
  let len2 = str2.length;  
  let len3 = str3.length;  
  
  let sumLength = len1 + len2 + len3;  
  let averageLength = Math.floor(sumLength / 3);  
  
  console.log(sumLength);  
  console.log(averageLength);  
}
```


Comparison Operators



Operator	Notation in JS
EQUAL value	<code>==</code>
EQUAL value and type	<code>===</code>
NOT EQUAL value	<code>!=</code>
NOT EQUAL value or type	<code>!==</code>
GREATER than	<code>></code>
GREATER than OR EQUAL	<code>>=</code>
LESS than	<code><</code>
LESS than OR EQUAL	<code><=</code>

Comparison Operators

```
console.log(1 == '1'); // true
console.log(1 === '1'); // false
console.log(3 != '3'); // false
console.log(3 !== '3'); // true
console.log(5 < 5.5); // true
console.log(5 <= 4); // false
console.log(2 > 1.5); // true
console.log(2 >= 2); // true
console.log((5 > 7) ? 4 : 10); // 10
```



Ternary operator

Conditional Statements

- The **if-else** statement:
 - Do action depending on condition

```
let a = 5;  
if (a >= 5) {  
  console.log(a);  
}
```

If the condition **is met**,
the code will execute

- You can chain conditions

```
else {  
  console.log('no');  
}
```

Continue on the **next condition**,
if the first is **not met**



Truthy and Falsy Values

- **"truthy"** - a value that **coerces** to **true** when **evaluated** in a boolean context
- The following values are **"falsy"** - **false, null, undefined, NaN, 0, 0n** and **""**

```
function logTruthiness (val) {  
  if (val) {  
    console.log("Truthy!");  
  } else {  
    console.log("Falsy.");  
  }  
}
```

```
logTruthiness (3.14);           //Truthy!  
logTruthiness ({});             //Truthy!  
logTruthiness (NaN);            //Falsy.  
logTruthiness ("NaN");          //Truthy!  
logTruthiness ([]);             //Truthy!  
logTruthiness (null);           //Falsy.  
logTruthiness ("");             //Falsy.  
logTruthiness (undefined);      //Falsy.  
logTruthiness (0);              //Falsy.
```

Logical Operators

- **&& (logical AND)** - returns the leftmost **"false"** value or the **last truthy** value, if all are true

```
const val = 'yes' && null && false
console.log(val); // null
const val1 = true && 5 && 'yes';
console.log(val1); // 'yes'
```

- **|| (logical OR)** - returns the leftmost **"true"** value or the **last falsy** value, if all are false

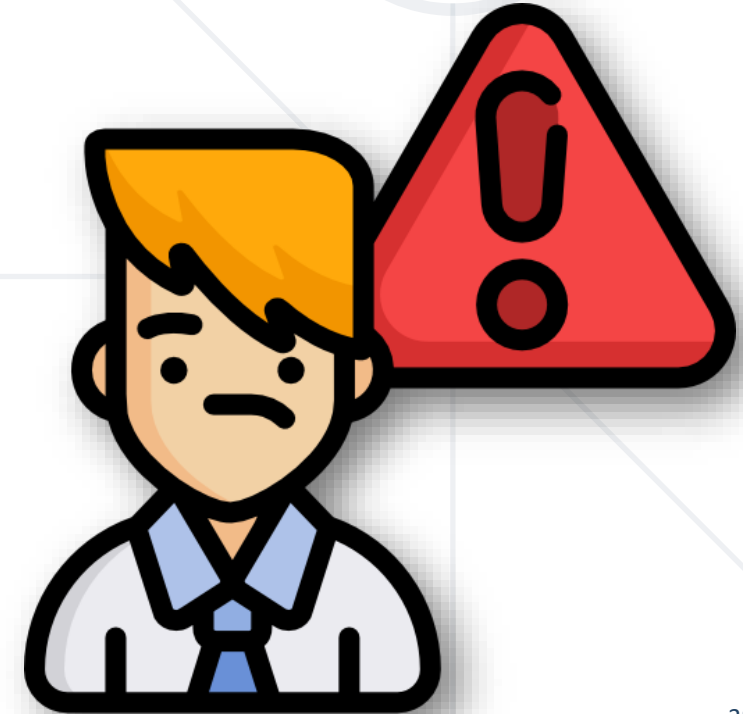
```
const val = false || '' || 5;
console.log(val); // 5
const val1 = null || NaN || undefined;
console.log(val1); // undefined
```



Logical Operators

- **!** (**logical NOT**) - Returns **false** if its single operand can be converted to **true**; otherwise, returns **true**

```
const val = !true  
console.log(val); // false  
const val = !false;  
console.log(val); // true
```



Problem: Largest Number

- **Three number arguments** passed to your function as an input
- Find the **largest** of them
- **Print** the result on the **console**

3, 4, 5



The largest number is 5.

7, 11, 2



The largest number is 11.

- **Tip:** Use **interpolated strings** to format the result

```
`3 + 5 = ${3 + 5}` // 3 + 5 = 8
```

Solution: Largest Number

```
function firstSolution(x, y, z) {  
  let result;  
  if (x >= y && x >= z) {  
    result = x;  
  } else if (y >= x && y >= z) {  
    result = y;  
  } else {  
    result = z;  
  }  
  console.log(`The largest number is ${result}.`);  
}
```

```
function secondSolution(...params) {  
  console.log(`The largest number is ${Math.max(...params)}.`);  
}
```


Typeof Operator

- The **typeof** operator returns a string indicating the type of an operand



```
const val = 5;  
console.log(typeof val);    // number
```

```
const str = 'hello';  
console.log(typeof str);    // string
```

```
const obj = {name: 'Maria', age:18};  
console.log(typeof obj);    // object
```

Problem: Circle Area

- Write a function that takes a **single parameter** as an input
- Calculate the **area of a circle**, with the parameter as **radius**
 - If the parameter is **not a number**, print an **error** message
 - Include the **type** of parameter in the message
- **Print** the result on the console, **rounded** to the second decimal

5



78.54

'name'



We can not calculate the circle area, because we receive a **string**.

Solution: Circle Area

```
function solve(radius) {  
  let inputType = typeof(radius);  
  
  if (inputType === 'number') {  
    let area = Math.pow(radius, 2) * Math.PI;  
    console.log(area.toFixed(2));  
  } else {  
    console.log(`We can not calculate the circle  
    area, because we receive a ${inputType}.`);  
  }  
}
```

Some Interesting Examples

■ Data Types

```
console.log(typeof NaN);           //number
console.log(NaN === NaN);          //false
console.log(typeof null);          //object(legacy reasons)
console.log(new Array() == false); //true
console.log(0.1 + 0.2);             //0.30000000000000004
console.log((0.2 * 10 + 0.1 * 10) / 10); //0.3
```

■ Truthy and Falsy values

```
const variable = [];               //empty array
console.log(variable == false);    //evaluates true
if (variable) { console.log('True!') }; //True!
```

Loops

- The **for** / **while** loops work as in C++, C# and Java
- Classical **for**-loop

```
for (let i = 0; i <= 5; i++) { console.log(i); }  
// 0 1 2 3 4 5
```

- JavaScript supports two more variants of the **for**-loop:
 - **for-of** – used with arrays and iterators
 - **for-in** – used with objects and associative arrays
 - Both will be reviewed in **upcoming lessons**

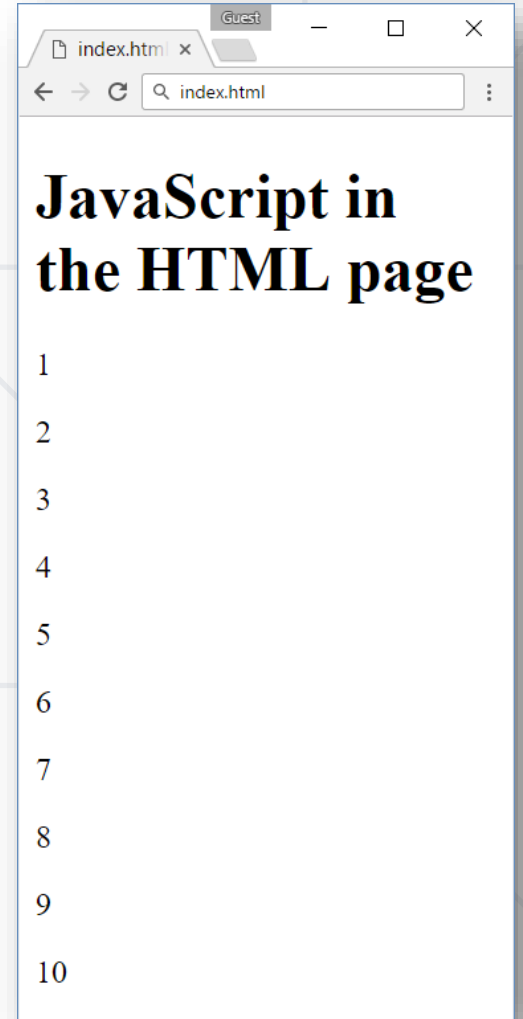




Mix HTML and JavaScript

Mixing HTML + JavaScript

```
<!DOCTYPE html>
<html>
<body>
  <h1>JavaScript in the HTML page</h1>
  <script>
    for (let i=1; i<=10; i++) {
      document.write(`<p>${i}</p>`);
    }
  </script>
</body>
</html>
```



Sum Numbers with HTML Form

```
<form>
  num1: <input type="text" name="num1" /> <br>
  num2: <input type="text" name="num2" /> <br>
  sum: <input type="text" name="sum" /> <br>
  <input type="button" value="Sum" onclick="calcSum()" />
</form>
```

```
function calcSum() {
  let num1 = document.getElementsByName('num1')[0].value;
  let num2 = document.getElementsByName('num2')[0].value;
  let sum = Number(num1) + Number(num2);
  document.getElementsByName('sum')[0].value = sum;
}
```

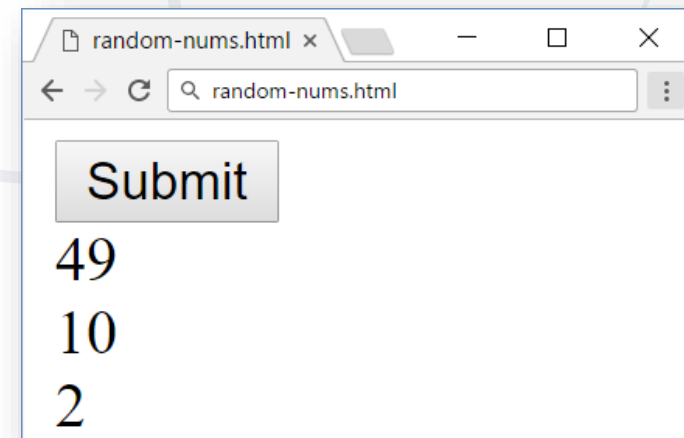

Load JavaScript File from HTML Document

random-nums.html

```
<!DOCTYPE html>
<html>
<head>
  <script src="numbers.js">
  </script>
</head>
<body>
  <input type="submit"
onclick="printRandNum()" />
</body>
</html>
```

numbers.js

```
function printRandNum() {
  let num = Math.round(
    Math.random() * 100);
  document.body.innerHTML +=
    `<div>${num}</div>`;
}
```





Debugging Techniques

Strict Mode, IDE Debugging Tools

Strict Mode

- **Strict mode** limits certain "sloppy" language features
 - Silent errors will **throw Exception** instead



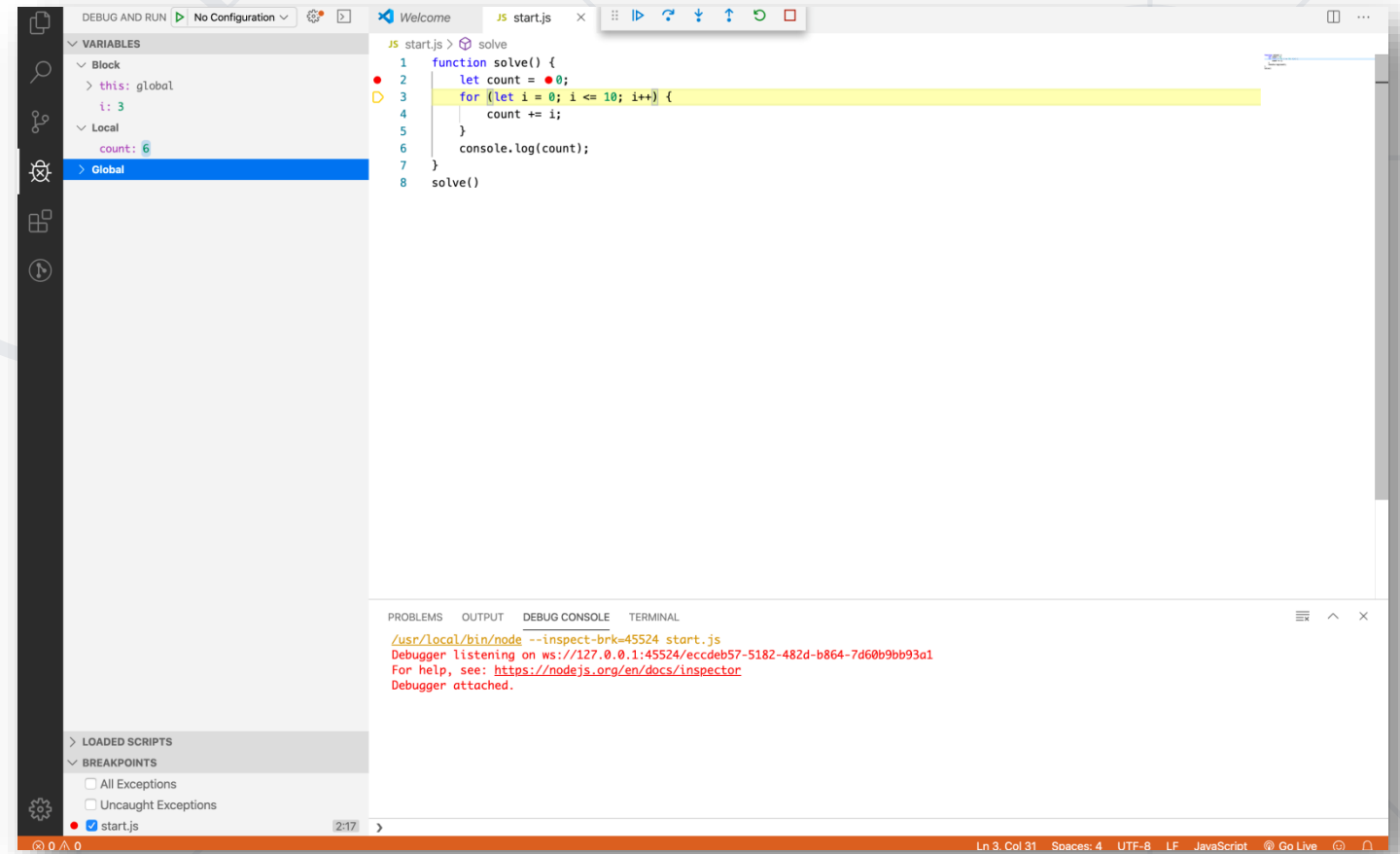
```
'use strict';           // File-level  
mistypeVariable = 17;    // ReferenceError
```

```
function strict() {  
    'use strict';        // Function-level  
    mistypeVariable = 17;  
}
```

- Enabled by default in **modules**

Debugging in Visual Studio Code

- Visual Studio Code has a built-in **debugger**
- It provides:
 - **Breakpoints**
 - Ability to **trace** the code execution
 - Ability to **inspect** variables at runtime



Using the Debugger in Visual Studio Code

- Start without Debugger: **[Ctrl+F5]**
- Start with Debugger: **[F5]**
- Toggle a breakpoint: **[F9]**
- Trace step by step: **[F10]**
- Force step into: **[F11]**



Language Specifics

Type Coercion, Functions and Scope

First-class Functions

- First-class functions – a function can be passed as an **argument** to other functions
- Can be **returned** by another function and can be **assigned** as a value to a variable




```
function running() {  
    return "Running";  
}  
function category(run, type) {  
    console.log(run() + " " + type);  
}  
category(running, "sprint"); //Running sprint
```

Callback function

Nested Functions

- Functions can be **nested** - hold other functions
 - Inner functions have **access** to **variables** from **their parent**



```
function hypotenuse(m, n) { // outer function
  function square(num) { // inner function
    return num * num;
  }
  return Math.sqrt(square(m) + square(n));
}
```

3, 4



5

Hoisting



- Variable and function declarations are **put into memory** during the **compile** phase, but stay exactly where you **typed** them in your code
- **Only declarations are hoisted**

Hoisting Variables



```
console.log(num); // Returns undefined  
var num;  
num = 6;
```

```
num = 6;  
console.log(num); // returns 6  
var num;
```

```
num = 6;  
console.log(num); // ReferenceError: num is not defined  
let num;
```

```
console.log(num); // ReferenceError: num is not defined  
num = 6;
```

Hoisting Functions



```
run(); // running  
function run() {  
    console.log("running");  
};
```

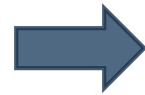
```
walk(); // ReferenceError: walk is not defined  
let walk = function () {  
    console.log("walking");  
};
```

```
console.log(walk); //undefined  
walk(); // TypeError: walk is not a function  
var walk = function () {  
    console.log("walking");  
};
```

Problem: Aggregate Elements

- Create function that applies **sum**, **inverse sum** and **concatenation**
 - Try to use a **nested aggregating function**
- Input will be an **array** of numbers
- **Print** the result on **separate lines** on the console

[1, 2, 4]



```
7 // sum: 1 + 2 + 4
3.5 // inverse: 1/1 + 1/2 + 1/4
124 // concat: '1' + '2' + '4'
```

Solution: Aggregate Elements

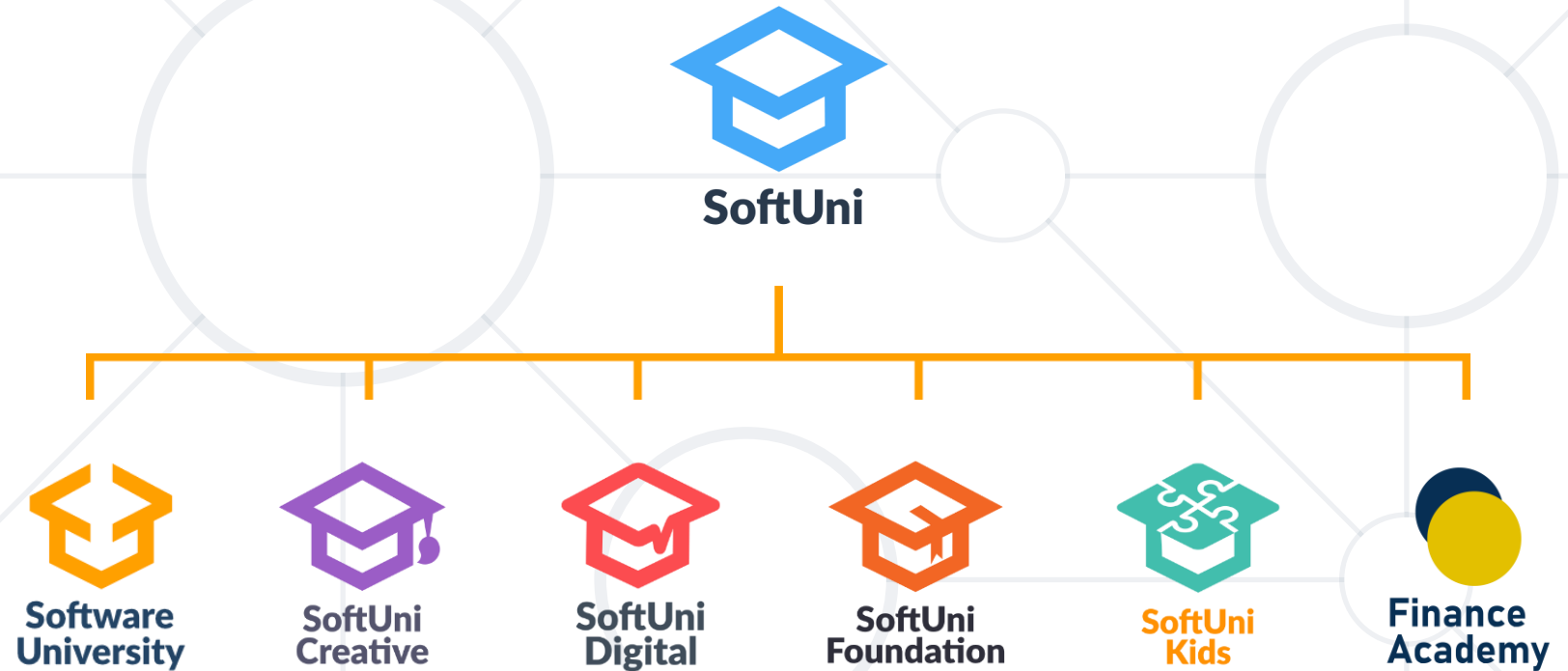
```
function aggregateElements(elements) {  
    aggregate(elements, 0, (a, b) => a + b);  
    aggregate(elements, 0, (a, b) => a + 1 / b);  
    aggregate(elements, '', (a, b) => a + b);  
  
    function aggregate(arr, initVal, func) {  
        let val = initVal;  
        for (let i = 0; i < arr.length; i++)  
            val = func(val, arr[i]);  
        console.log(val);  
    }  
}
```



- JavaScript is a **multi-paradigm** language
- Variables are used to **store** data **references**
 - **let**, **const** and **var** are used to **declare variables**
- Arithmetic operators take **numerical values** as their operands
- Functions can:
 - **Take parameters** and **return result**
 - **Hold other functions** inside them



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