JavaScript

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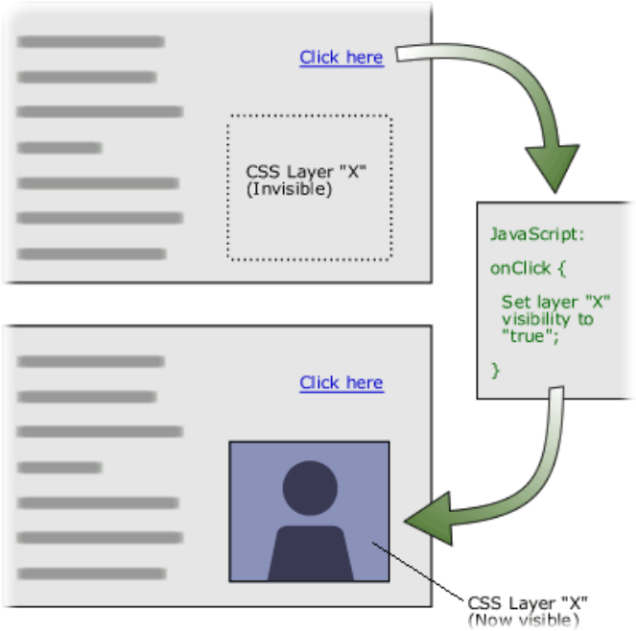
Introduction to JavaScript

Dynamic Behavior at the **Client Side**

Or Server-Side Web applications



Back

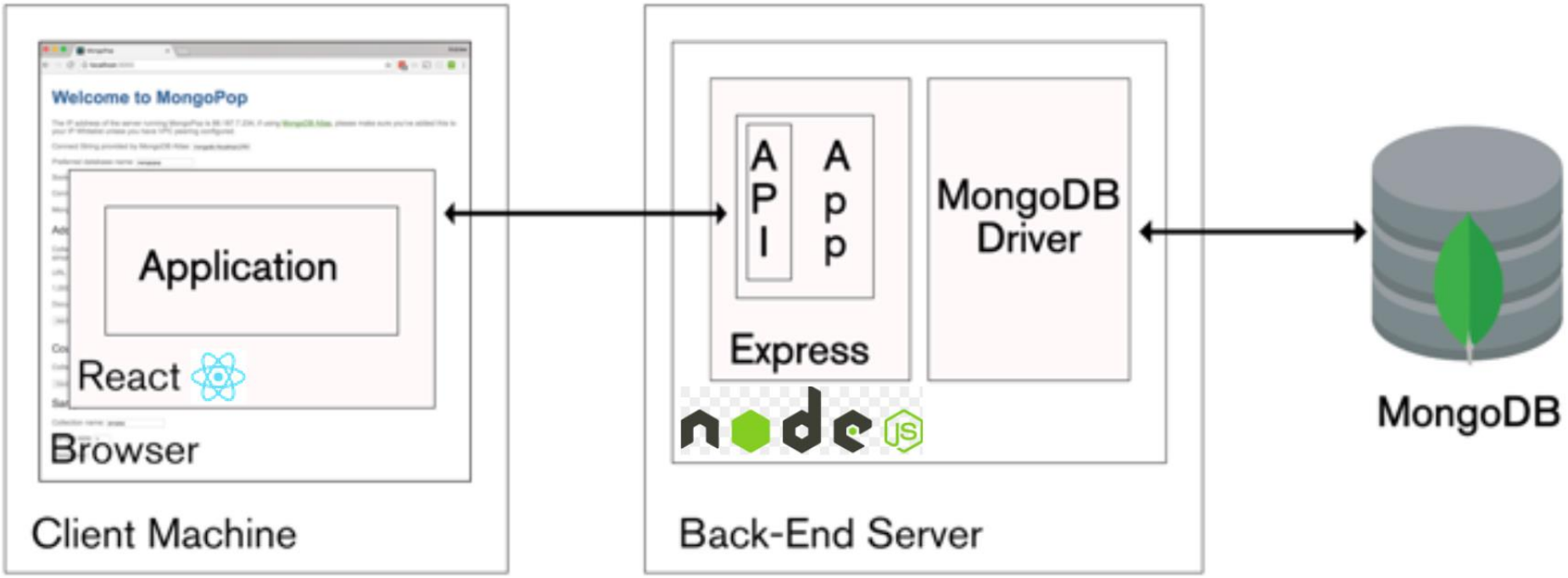
JavaScript

- JavaScript is a platform independent **scripting** language
  - Lightweight but a powerful **interpreted** language
  - Supports both **functional** and **object-oriented** programming style
  - Current Version ES 2021 (ECMAScript 2021)
  - Can be used for:
    - **Client-side scripting**: embedded in HTML pages and interpreted by the Web browser
    - **Server-side programming** using **Node.js**
    - **Desktop app development** (e.g., https://electronjs.org)
    - **Mobile app development** (e.g., https://reactnative.dev/)

What Can JavaScript Do?

- **Web Client-side Dynamic Behavior**
  - Handle client-side events such as button clicked event
    - e.g., Changing an image on moving mouse over it
  - Manipulate the Document Object Model (DOM) of the page: read, modify, add, delete HTML elements
  - Validate form input values before being submitted to the server
  - Perform computations, sorting and animation
  - Perform asynchronous server calls (AJAX) to load new page content or submit data to the server without reloading the page
- Server-side Web applications development using Node.js
- Other usage such as desktop apps, mobile apps and game development

MERN (MongoDB, Express, React, Node.js)



JS IS EVERYWHERE

JavaScript is the common language throughout the MERN stack, and **JSON is the common data format**

JavaScript Syntax

- JavaScript is syntactically a C family language
  - It differs from C mainly in its type system
- The JavaScript syntax is similar to Java and C#
  - Variables (by dynamically typed in JavaScript)
  - Operators (+, *, =, !=, &&, ++, …)
  - Conditional statements (`if`, `else`, `switch`)
  - Loops (`for`, `while`)
  - Arrays (`myArray[]`) and associative arrays (`myArray['abc']`)
  - Functions
  - Classes
- Although there are **strong outward similarities** between JavaScript and Java, the two are **distinct languages and differ greatly in their design**.

Data Types in JavaScript

Declaring Variables

- Names in JavaScript are case-sensitive
- The syntax is the following:

```
let <identifier> [= <initialization>];
```

- Example:

```
let height = 200;
```

- **let** – creates a block scope variable (accessible only in its scope)

```
for(let number of [1, 2, 3, 4]){
  console.log(number);
}
//accessing number here throws exception
```

Declaring Variables using var

- **var** – creates a variable accessible outside its scope (**avoid using var and use let**)

```
for(var number of [1, 2, 3, 4]){
  console.log(number);
}
console.log(number); //accessing number here is OK
```

Declaring a Constant

- **const** – creates a constant variable. Its value is read-only and cannot be changed

```
const MAX_VALUE = 16;
MAX_VALUE = 15; // throws exception
```

JavaScript Data Types

- JavaScript is a **Loosely Typed** and **Dynamic** language
  - All variables are declared with the keyword `let`
  - The variable datatype is derived from the assigned value

```
let count = 5; // variable holds a number
let name = 'Ali Dahak'; // variable holds a string
let grade = 5.25 // grade holds a number
```

Primitive types

- There are 6 data types in JavaScript:
  - number
  - string
  - boolean
  - undefined
  - function
  - object (Everything else is an object)
- A string is a sequence of characters enclosed in single (' ') or double quotes (" ")

```
let str1 = "Some text saved in a string variable";
let str2 = 'text enclosed in single quotes';
```

String Methods

- `str.length` returns the number of characters
- Indexer (`str[index]`) or `str.charAt(index)`
  - Gets a single-character string at location `index`
  - If index is outside the range of string characters, the indexer returns `undefined`
    - e.g., `string[-1]` or `string[string.length]`
- str3 = str1.concat(str2) or str3 = str1 + str2;
  - Returns a new string containing the concatenation of the two strings
- Other String methods

http://www.w3schools.com/jsref/jsref_obj_string.asp

Convert a number to a string

- Use number's method (**`toString`**)

```
str = num.toString()
```

- Use **`String`** function

```
str = String(num)
```

Convert a string to a number

- Use the **parseInt** function

```
num = parseInt(str)
```

- Use the Number function

```
num = Number(str)
```

- Use the + prefix operator

```
num = +str
```

Template Literals

- Template Literals allow creating dynamic templated string with placeholders
  - Replaces long string concatenation!

```
let person = {fname: 'Samir',  lname:'Mujtahid'};

console.log(`Full name: ${person.fname} ${person.lname}`);
```

undefined vs. null Values

- In JavaScript, undefined means a variable has been declared but **has not been assigned a value**, e.g.,:

```
let testVar; console.log(testVar); //shows undefined
console.log(typeof testVar); //shows undefined
```

- null is an assignment value. It can be assigned to a variable as a representation of no value:

```
let testVar = null;
console.log(testVar); //shows null
console.log(typeof testVar); //shows object
```

=> undefined and null are two distinct types: **undefined** is a value of type “undefined” while null is an **object**

NaN

- NaN (Not a Number) is an illegal number
- Result of undefined or erroneous operations such **'A' * 2** will return a **NaN**
- Toxic: any arithmetic operation with **NaN** as an input will have **NaN** as a result
- Use **isNaN()** function determines whether a value is an illegal number (Not-a-Number).
  - **NaN** is not equal to anything, including **NaN**

    NaN === NaN is **false**

    NaN !== NaN is **true**

Checking a Variable Type

- The variable type can be checked at runtime:

```
let x = 5;
console.log(typeof(x)); // number
console.log(x); // 5

let person = {fname: 'Samir',  lname:'Mujtahid'};
console.log(typeof(person)); // object
console.log(person); //{fname: 'Samir',  lname:'Saghir'}

x = null;
console.log(typeof(x)); // object

x = undefined;
console.log(typeof(x)); // undefined
```

Comments

```
// slash slash line comment

/*
    slash star
    block
    comment
*/
```

Operators in JavaScript

Arithmetic, Logical, Comparison, Assignment, Etc.

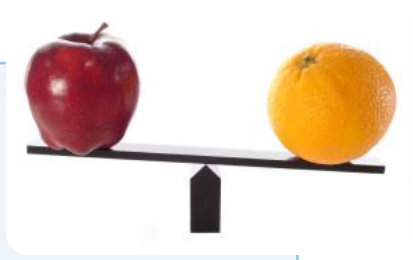
Categories of Operators in JS

Category	Operators
Arithmetic	+ - * / % ++ --
Logical	&& || ^ !
Binary	& | ^ ~ << >>
Comparison	== != < > <= >= === !==
Assignment	= += -= *= /= %= &= |= ^= <<= >>=
String concatenation	+
Other	. [] () ?: new

http://www.w3schools.com/js/js_operators.asp

Comparison Operators

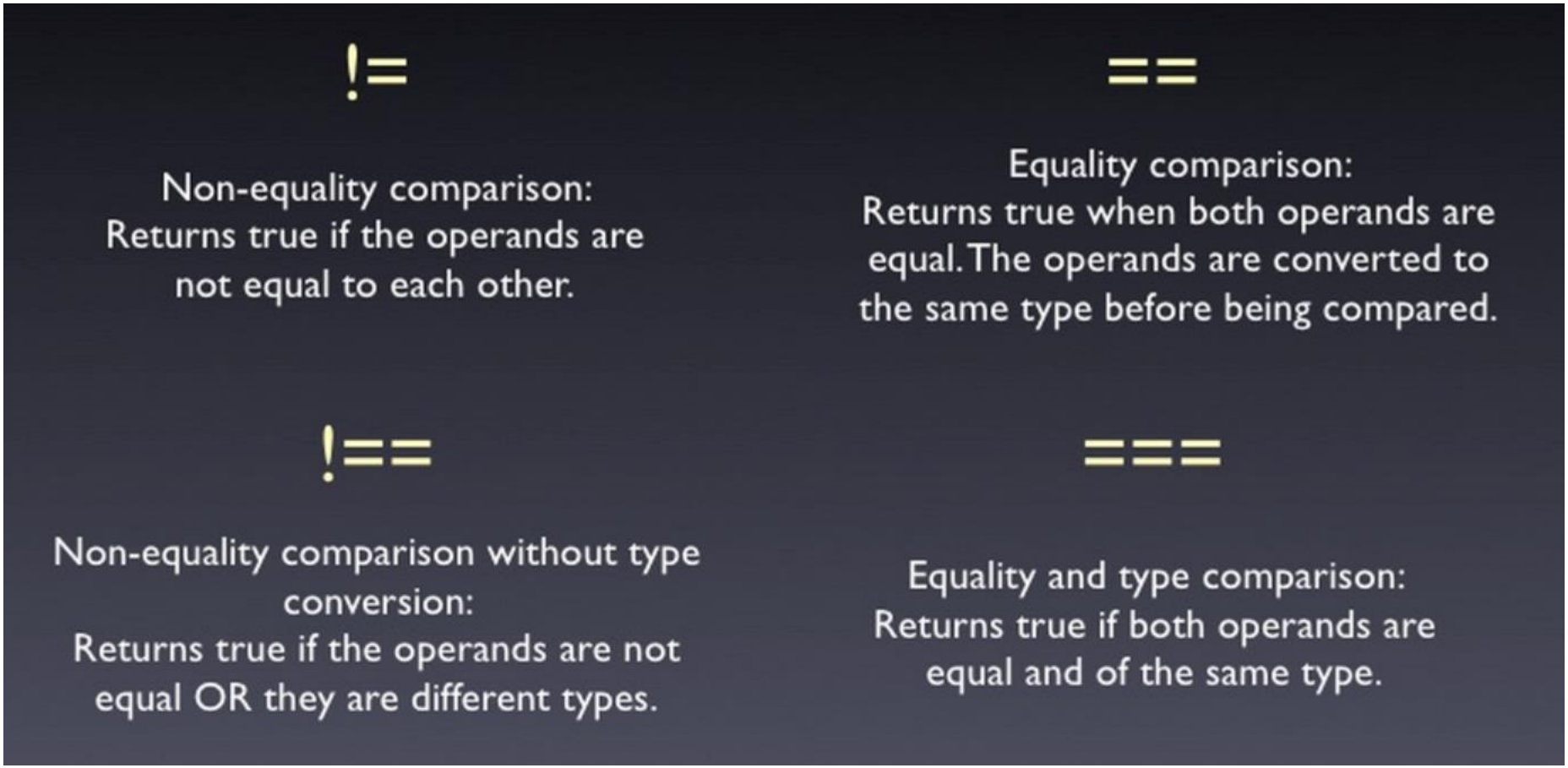
- Comparison operators are used to compare variables
  - ==, <, >, >=, <=, !=, ===, !==
- Comparison operators example:



```
let a = 5;
let b = 4;
console.log(a >= b); // True
console.log(a != b); // True
console.log(a == b); // False

console.log(0 == ""); // True
console.log(0 === ""); //False
```

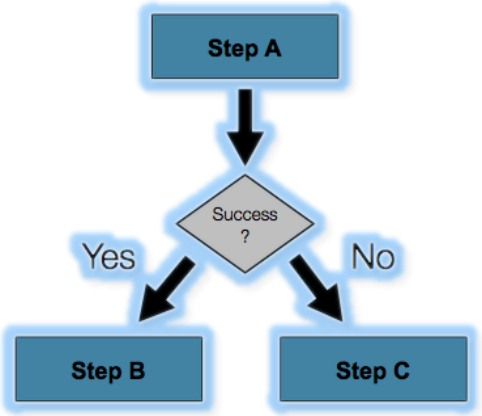
== vs. ===



- See Examples

http://www.w3schools.com/js/js_comparisons.asp

Conditional Statements



`if-else` Statement – Example

- Checking a number if it is odd or even

```
let number = 10;

if (number % 2 === 0)
{
    console.log('This number is even');
}
else
{
    console.log('This number is odd');
}
```

`switch-case` Statement

- Selects for execution a statement from a list depending on the value of the **`switch`** expression

```
switch (day)
{
   case 1: console.log('Monday'); break;
   case 2: console.log('Tuesday'); break;
   case 3: console.log('Wednesday'); break;
   case 4: console.log('Thursday'); break;
   case 5: console.log('Friday'); break;
   case 6: console.log('Saturday'); break;
   case 7: console.log('Sunday'); break;
   default: console.log('Error!'); break;
}
```

False-like conditions

- These values are always false (when used in a condition)
  - false
  - `0` (zero)
  - "" (empty string)
  - null
  - Undefined
  - NaN

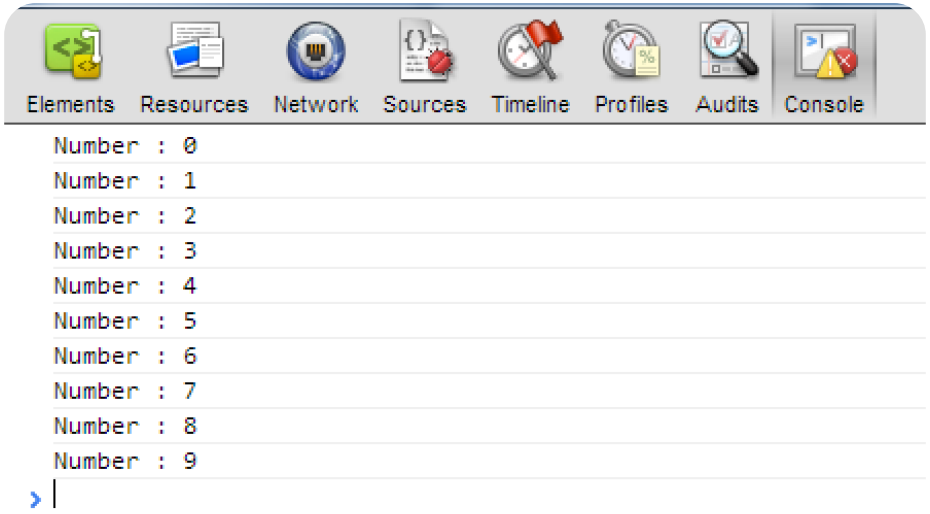
- All other values are true

while (…)
do { … }
for { … }
Loops

Execute Blocks of Code Multiple Times

While Loop – Example

```
let counter = 0;
while (counter < 10){
    console.log(`Number : ${counter}`);
    counter++;
}
```



Other loop structures

- Do-While Loop:

```
do {
    statements;
}
while (condition);
```

- **For** loop:

```
for (initialization; test; update) {
    statements;
}
```

Simple for Loop – Example

- A simple for-loop to print the numbers 0…9:

```
for (let number = 0; number < 10; number++){
    console.log(number + " ");
}
```

- A simple for-loop to calculate **n!**:

```
let factorial = 1;
for (let i = 1; i <= n; i++){
    factorial *= i;
}
```

For-of loop

- For-of loop iterates over a list of values

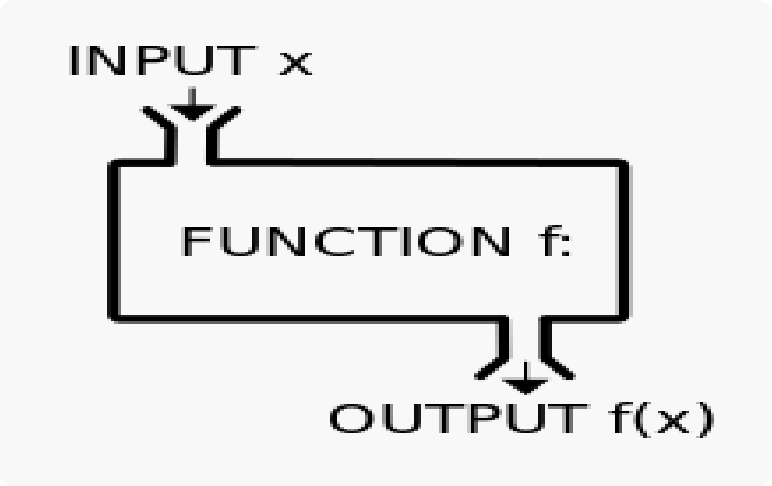
```
let sum = 0;
for(let number of [1, 2, 3])
   sum += number;
console.log(sum);
```

For-in loop

- For-in loop iterates over the properties of an object

```
let obj = { fName: "Ali", lName: "Mujtahid" };
for (let prop in obj) {
     console.log(prop , ':' , obj[prop]);
}
```

Functions



```
function (parameter) {
    return expression;
}
```

```
function double (number) { return number * 2; }
double(212); // call function
```

```
let average = function (a, b) {
    return (a + b) / 2;
}
average(10, 20); // call function
```

OR

```
let average = (a, b) => (a + b) / 2;
average(10, 20);  // call function
```

Arrow Function
Also called LAMBDA expressions

Sum Even Numbers – Example

- Calculate the sum of all even numbers in an array

```
function sum(numbers){
  let sum = 0;
  for (let num of numbers) {
    if( num % 2 === 0 ){
      sum += num;
    }
  }
  return sum;
}
```

Function Scope

- Every variable has its scope of usage
  - A scope defines where the variable is accessible
  - Generally there are local and global scope

```
let arr = [1, 2, 3, 4, 5, 6, 7];
function countOccurences (value){
  let count = 0;
  for (let num of arr){
    if (num == value){
      count++;
    }
  }
  return count;
}
```

arr is in the global scope (it is accessible from anywhere)

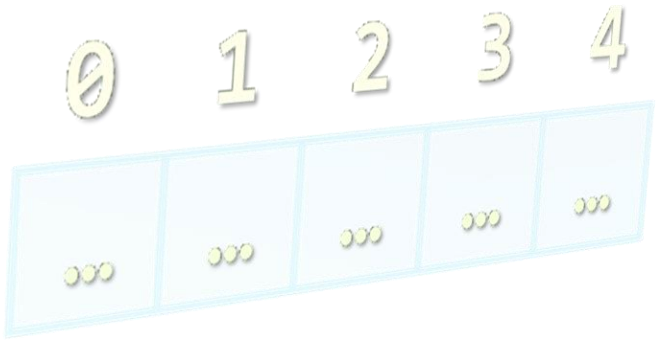
count is declared inside countOccurences and it can be used only inside it

num is declared inside the for loop and it can be used only inside it

Arrays

Processing Sequences of Elements

https://sdras.github.io/array-explorer/



Declaring Arrays

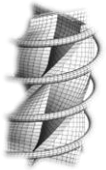
- Declaring an array in JavaScript

```
// Array holding integers
let numbers = [1, 2, 3, 4, 5];

// Array holding strings
let weekDays = ["Monday", "Tuesday", "Wednesday",
  "Thursday", "Friday", "Saturday", "Sunday"]

// Array of different types
let mixedArr = [1, new Date(), "hello"];

// Array of arrays (matrix)
let matrix = [
               [1,2],
               [3,4],
               [5,6]
             ];
```



Processing Arrays Using for Loop

- The for-of loop iterates over a list of values

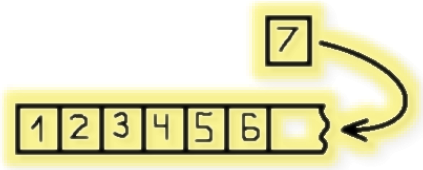
```
let sum = 0;
for(let number of [1, 2, 3])
  sum+= number;
```


- Printing array of integers in reversed order:

```
let array = [1, 2, 3, 4, 5];
for (let i = array.length-1; i >= 0; i--) {
    console.log(array[i]);
} // Result: 5 4 3 2 1
```

- Initialize an array:

```
for (let index = 0; index < array.length; index++) {
    array[index] = index;
}
```



Dynamic Arrays

- All arrays in JavaScript are dynamic
  - Their size can be changed at runtime
  - New elements can be inserted to the array
  - Elements can be removed from the array
- Methods for array manipulation:
  - `array.push(element)`
    - Inserts a new element at the tail of the array
  - `array.pop()`
    - Removes the element at the tail
    - Returns the removed element

Insert/Remove at the head of the array

- `array.unshift(element)`
  - Inserts a new element at the head of the array
- `array.shift()`
  - Removes and returns the element at the head

```
let numbers = [1, 2, 3, 4, 5];
console.log(numbers.join("|")); // result: 1|2|3|4|5

let tail = numbers.pop();         // tail = 5;
console.log(numbers.join("|")); // result: 1|2|3|4

numbers.unshift(0);
console.log(numbers.join("|")); // result: 0|1|2|3|4

let head = numbers.shift();       // head = 0;
console.log(numbers.join("|")); // result: 1|2|3|4
```

Deleting Elements

- Splice removes item(s) from an array and returns the removed item(s)
- This method changes the original array
- Syntax:

array.splice(index,howmany)

```
let myArray = ['a', 'b', 'c', 'd'];
let removed = myArray.splice(1, 1);
// myArray after splice ['a', 'c', 'd']
```

Destructuring assignment

- The destructuring assignment makes it easier to **extract** data from arrays or objects into distinct variables

```
let colors = ["red", "green", "blue", "yellow"];

//Extracting array elements and assigning them to variables
let [primaryColor, secondaryColor, ...otherColors] = colors;
primaryColor  = 'red' , secondaryColor = 'green' and
otherColors = [ 'blue', 'yellow' ]
```

3 dots ... is called the rest operator

Spread Operator

- **Spread Operator (3 dots ...)** allows converting an array into consecutive arguments in a function call

```
let nums = [5, 4, 23, 2];
//Spead could be used to convert the array
//into multiple arguments
let max = Math.max(...nums);
console.log("max:", max);
```

- **Spread Operator can also be used to concatenate arrays**

```
let cold = ['autumn', 'winter'];
let warm = ['spring', 'summer'];
// construct an array
let seasons = [...cold, ...warm];
// => ['autumn', 'winter', 'spring', 'summer']
```

Sets

- A collection of values **without duplicates**
  - Sets do not allow duplicate values to be added

```
let names = new Set();
names.add('Samir');
names.add('Fatima');
names.add('Mariam');
names.add('Ahmed');
names.add('Samir'); // won't be added

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

Maps

- Map is a **collection** of key-value pairs

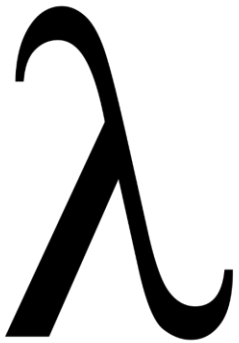
```
let map = new Map();
map.set(1, 'One');
map.set(2, 'Two');

for(let pair of map) {
    console.log(pair);
}

for(let key of map.keys()) {
    console.log( key, numbersMap.get(key) );
}

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

Arrow Function (aka Lambda)



Imperative vs. Declarative

Imperative Programming

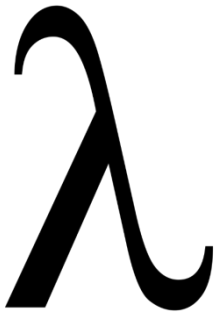
- You tell the computer **how** to perform a task.

Declarative Programming

- You tell the computer **what you want**, and you let the compiler (or runtime) figure out the best way to do it. This makes the code simpler and more concise
- **Declarative programming using Functional Programming & Lambdas helps us to achieve KISS**

KEEP IT SHORT & SIMPLE

What is a Lambda?



- Lambda is *anonymous function*. It has:
  - Parameters
  - A body
  - A return type
- Also known as **Arrow Function**
- It **don't have a name** (anonymous method)
- It can be assigned to a variable
- It **can be passed as a parameter** to other function:
  - As *code* to be executed by the receiving function
- Concise syntax:

```
Parameters => Body
```

Passing Lambda as a Parameter

- Lambda expression can be passed as a parameter to methods such as ***forEach***, ***filter*** and ***map*** methods :

```
let numbers = [1, 2, 3, 4, 5, 6, 7, 8, 9];
numbers.forEach ( e => console.log(e) );
```

forEach - Calls a Lambda on Each Element of the list

- Left side of **=>** operator is a parameter variable
- Right side is the code to operate on the parameter and compute a result
- Allows working with arrays in a **functional style**

Common operations on arrays

`.map` 

- Applies a function to each array element

`.filter(condition)` 

- Returns a new array with the elements that satisfy the condition

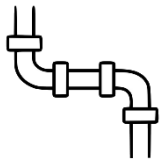
`.find(condition)` / `findIndex(condition)` 

- Returns the first array element that satisfy the condition

`.reduce` 

- Applies an accumulator function to each array element to reduce them to a single value

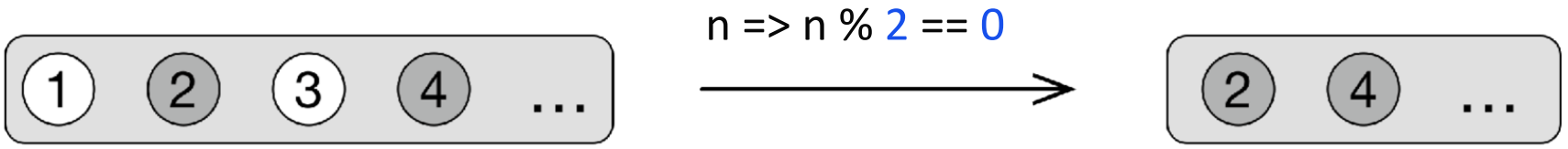
Operations Pipeline



- **A pipeline of operations:** a sequence of operations where the output of each operation becomes the input into the next
  - e.g., .filter -> .map -> .reduce
- Operations are either **Intermediate** or **Terminal**
- **Intermediate operations** produce a new array as output (e.g., map, filter, …)
- **Terminal operations** are the final operation in the pipeline (e.g., reduce, join …)
  - Once a terminal operation is invoked then no further operations can be performed

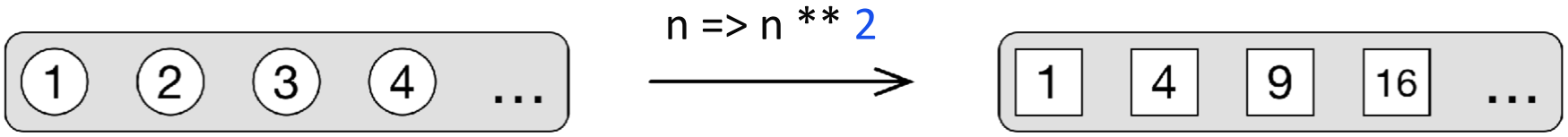
Filter

Return elements that satisfy a condition



Map

Transform elements by applying a Lambda to each element



Reduce

Apply an accumulator function to each element of the array to reduce them to a single value

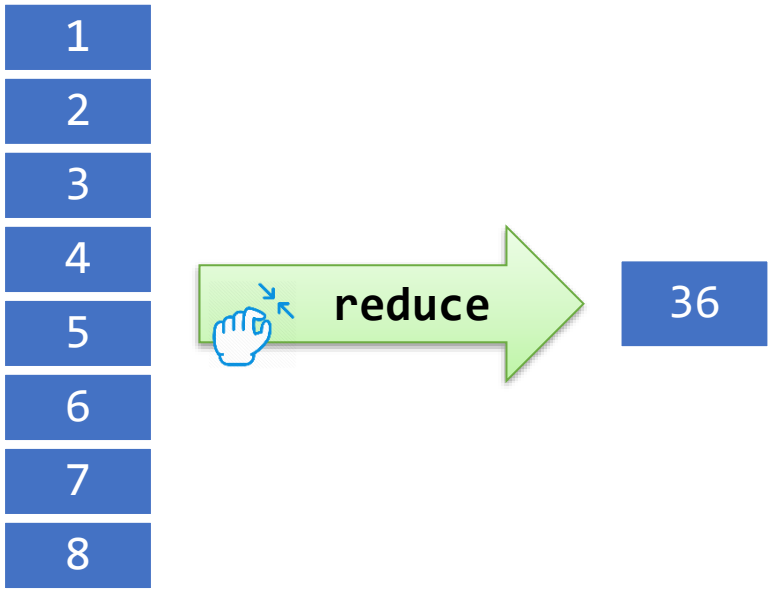
```
// Imperative
let sum = 0
for(let n of numbers)
    sum += n
```

```
//Declarative
let total = numbers.reduce ( (sum, n) => sum + n )
```

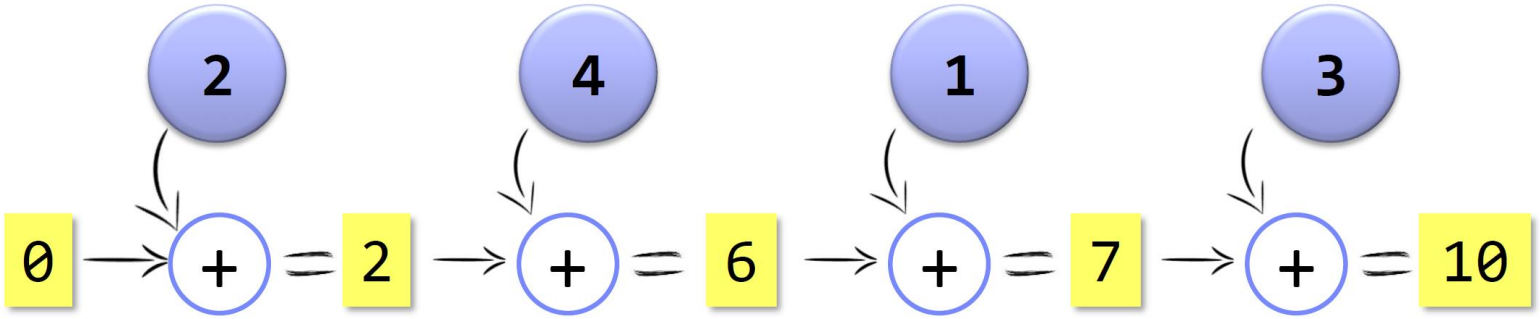
Accumulation Variable

Accumulation Lambda

Collapse the multiple elements of an array into a single element



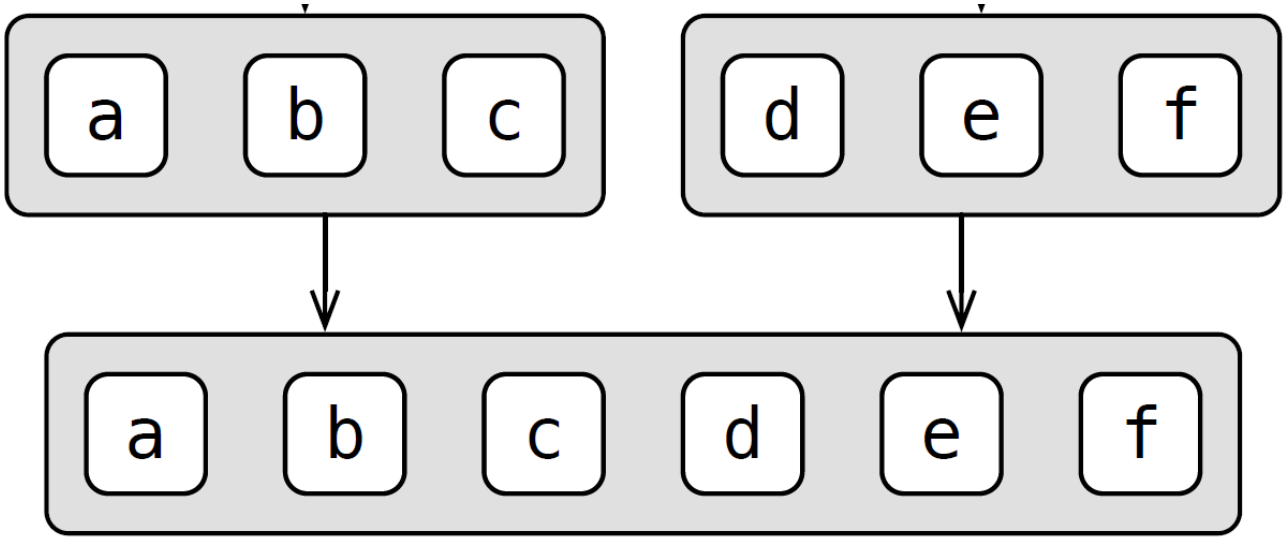
Reduce




```
.reduce ( (sum, n) => sum + n )
```

Reduce is **terminal** operation that yields a single value

Flat




```
flattened = [['a', 'b', 'c'], ['d', 'e']].flat()
//flattened array: [ 'a', 'b', 'c', 'd', 'e' ]
console.log("flattened array:", flattened);
```

flatMap

Do a map and flatten the results into 1 list

Each book has a list of authors. **flatMap** combines them to produce a single list of **all** authors

```
let books = [
   {title: "Head First JavaScript", authors: ["Dawn Griffiths", "David Griffiths"]},
   {title: "JavaScript in Action", authors: ["Dmitry Jemerov", "Svetlana Isakova"]}
]

let authors = books.flatMap(b => b.authors);
console.log(authors);
```

Other Array Functions

- `nums.sort((a, b) => a - b)`
  - Sorts the elements of the nums array in ascending order
- `nums.sort((a, b) => b - a)`
  - Sorts the elements of the nums array in descending order
- `array.reverse()`
  - Returns a new array with elements in reversed order
- `array.concat(elements)`
  - Inserts the elements at the end of the array and returns a new array
- `array.join(separator)`
  - Concatenates the elements of the array

Summary

- To start thinking in the functional style ***avoid loops*** and instead use Lambdas
  - Widely used for array processing and UI events handling
- An array can be processed in a pipeline
  - Typical pipeline operations are filter, map and reduce

JavaScript Resources

- Mozilla JavaScript learning links
  - https://developer.mozilla.org/en-US/learn/javascript
- JavaScript features
  - https://github.com/mbeaudru/modern-js-cheatsheet & https://zellwk.com/blog/es6/
  - https://exploringjs.com/
- Modern JavaScript Tutorial
  - https://javascript.info/
- Node.js School
  - https://nodeschool.io/