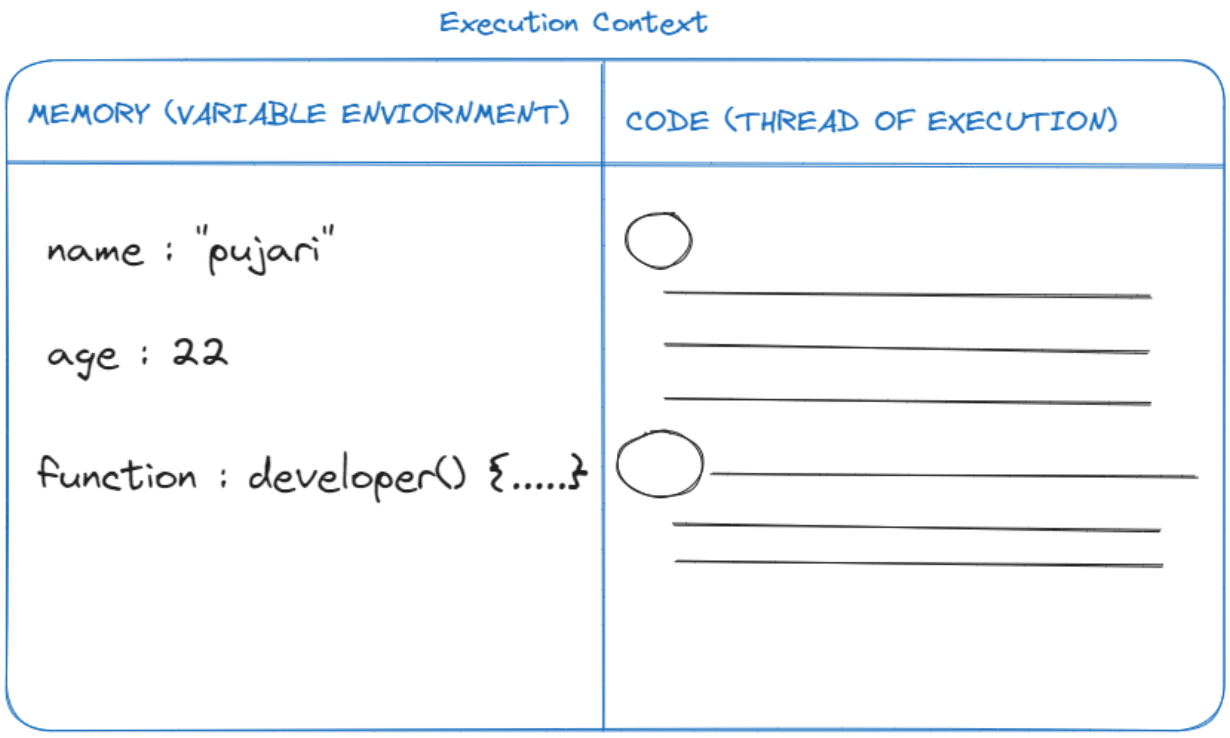
Namaste-JavaScript(Season-1)

– Episode-1(Season-1 -> Intro To how JS Works)

“Everything In JavaScript Happens Inside An Execution Context”

Assume Execution Context as Box OR Container



In Memory, everything is stored in (key : value) pair
Eg:- name: “pujari”
The place where Code is executed one line at a time.

“Javascript is the synchronous, single-threaded language”.

synchronous : It means it executes only one line/ comand that can run at a time.

Single-threaded: It means it can only execute only one command at a time.

“JS Can only execute one command at a time and in a specific order”

– Episode-2(Season-1 ->how JS Code is Executed)

As we all know in JS everything is executed in Execution Context.

Execution Context has 2 Phases

1. **Memory Creation Phase**
2. **Code Execution Phase**

Let’s take below code for better understanding

```
var name = "pujari";

function developer(designation) {
 const role = designation;
 return role;
}

var position = developer("frontend engineer");
```

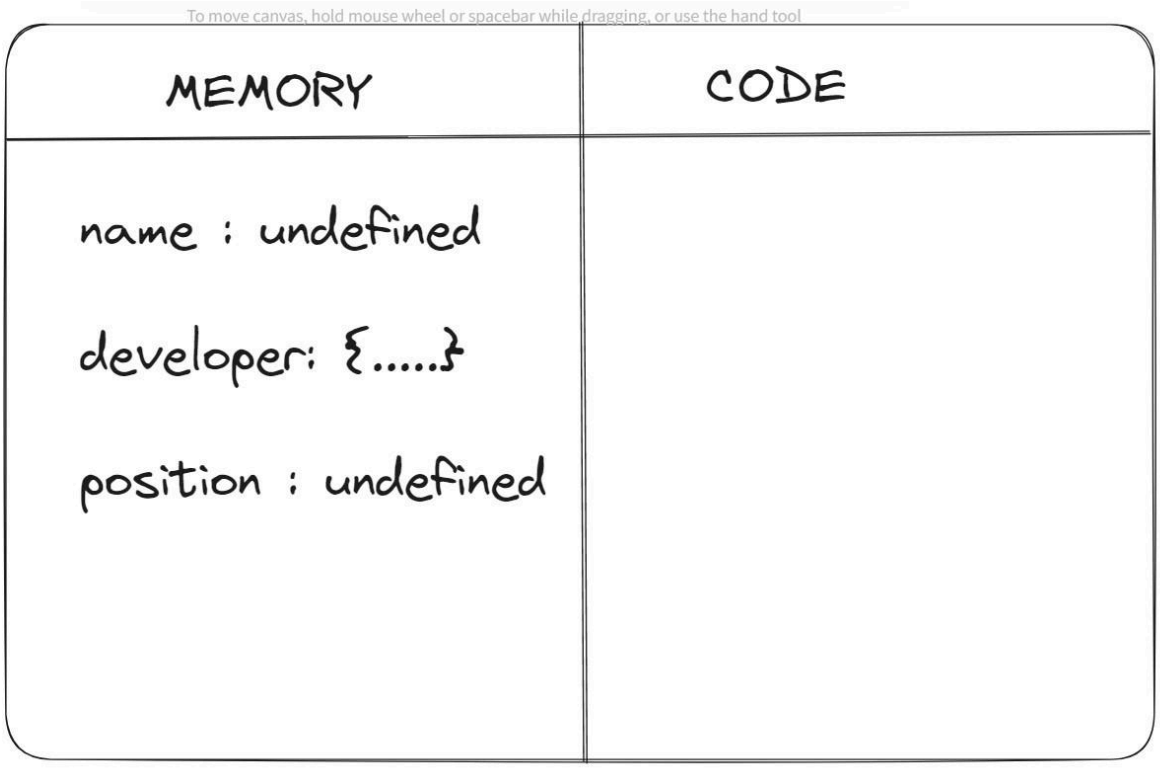
After running the code,

- In the memory creation phase(1), so it goes to line one of the above code snippets, and allocates memory space for

variable 'name' , after allocating memory to name it goes to the next line and allocates memory space for function { developer }.

- When allocating memory for 'name' it stores 'undefined', a special value for 'name' . For { developer }, it stores the whole code of the function inside its memory space.
- As position is also a variable it allocates memory & stores a space.

The memory allocation phase would look something like this



Now, in the 2nd phase i.e. code execution phase, it starts going through the whole code line by line.

- As it encounters var name = “pujari”, it assigns ‘pujari’ to 'name'. Until now, the value of 'name' was undefined. For

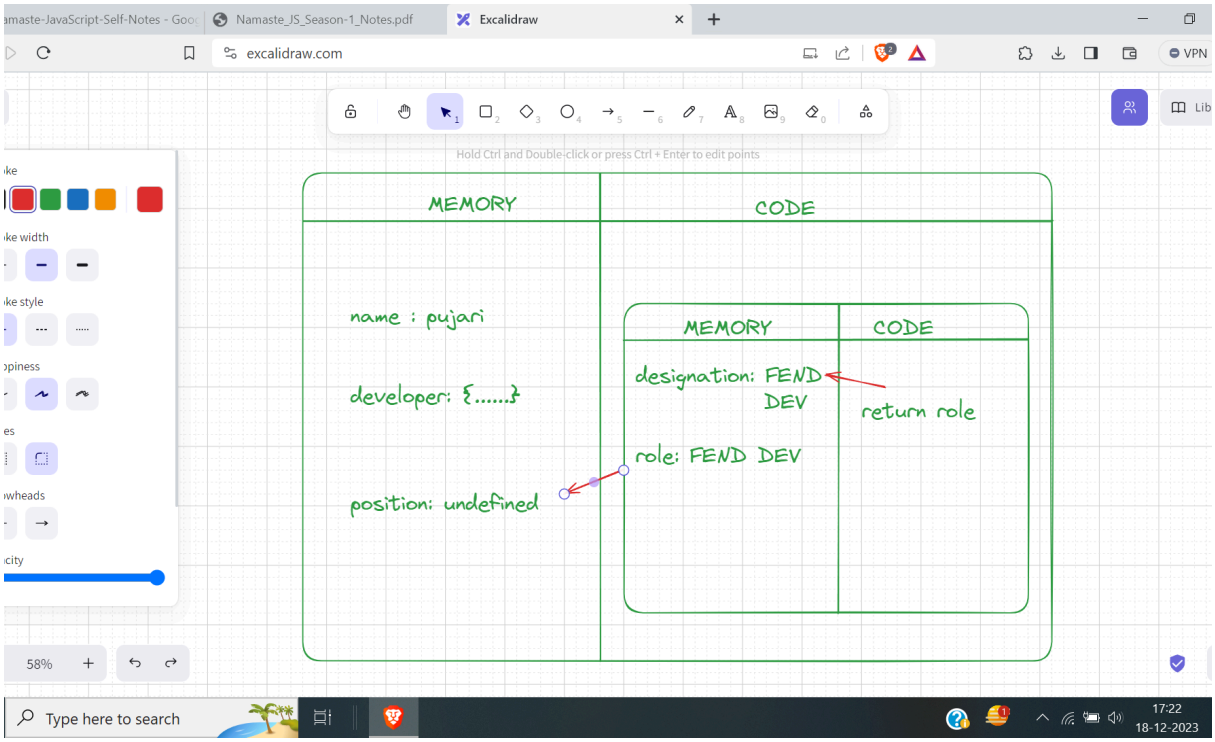
function, there is nothing to execute. As these lines were already dealt with in the memory creation phase.

- Coming to line 8 i.e. var position= developer(“frontend engineer”), here functions are a bit different than in any other language. A brand new execution context is created altogether.

- In this new execution context, in the memory creation phase, we allocate memory to the role. An undefined value is given to the role variable.

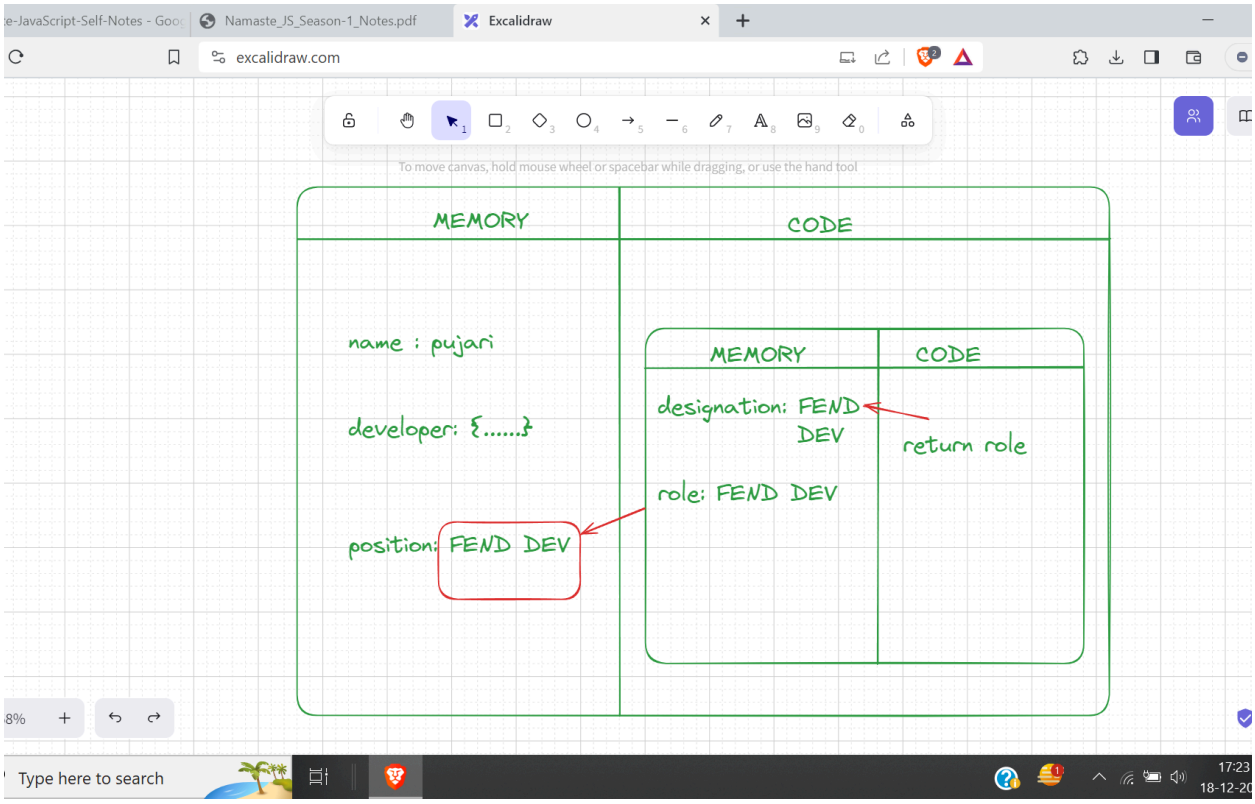
- Now, in the code execution phase of this execution context, the value (“frontend engineer”) is assigned to the role and stored it inside the role. After that, the role returns the control of the program back to where this function was invoked from.

The memory allocation & Code execution phase would look something like this



- When the return keyword is encountered, It returns the control to the called line and also the function execution

- final execution context diagram:



As we all have gone through JS engine runs the code BTS and it looks like a very tedious task right but that's the beauty of JS

To manage all these things we have a mechanism that is known as Call Stack

Call Stack maintains the order of execution of execution contexts.

It is also known as Program Stack, Control Stack, Runtime stack, Machine Stack, and Execution context stack.

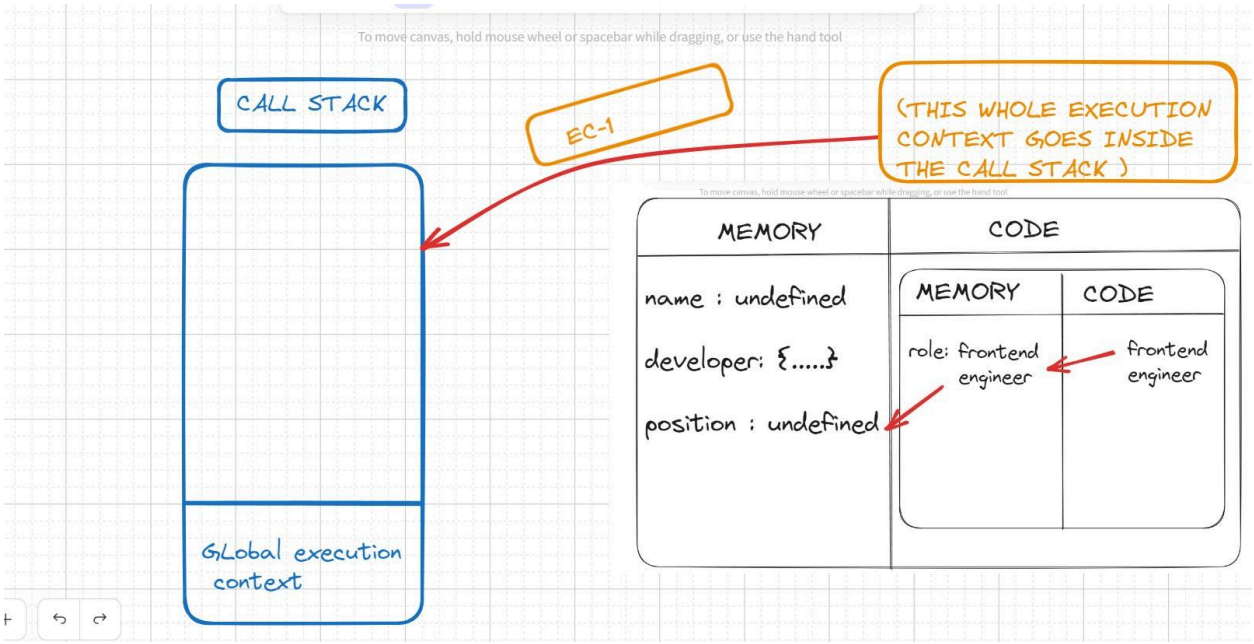
(global execution context is created when a JavaScript first starts to run, and it represents the global scope in JavaScript.)

More About Call Stack:

- JavaScript manages code execution context creation and deletion with the help of Call Stack.
- A Call Stack is a normal stack that follows the LIFO (Last in First Out) principle.
- When JS executes a program, it creates a Global Execution Context (GEC) and pushes it to the bottom of the call stack
- Within the code execution phase of GEC When a function is invoked a new/Function Execution Context is created which is again pushed inside the stack. And the process goes on.
- When the Function execution context is done with its two phases, it gets removed from the stack.
- Finally, when the program execution is finished, The GEC gets removed from the stack.
- Call Stack maintains the order of execution of execution contexts. It is also known as Program Stack, Control Stack, Runtime stack, Machine Stack, or Execution context stack.

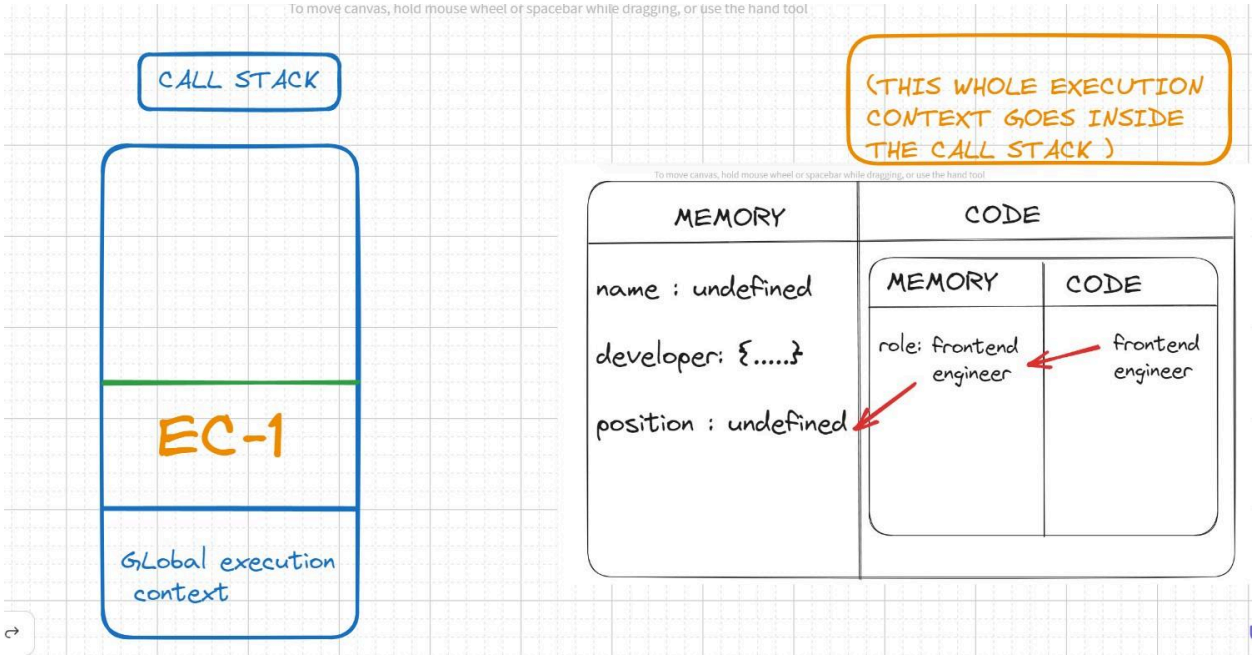
Let’s Take an Example Of how execution context gets stacked into a call stack

Before Running the program:



Before Running the program call stack is empty

After Running the program (execution context-1) is stacked inside the call stack above the global execution context.



– Episode-3(Season-1 ->Hoisting in JS)

Hoisting

★ Variable hoisting in JavaScript is a behavior where variable declarations are moved (or "hoisted") to the top of their containing scope during the compilation phase, regardless of where they are declared within the code. This means that even if you declare a variable later in your code, JavaScript will move the declaration to the top of its current scope, making it available for use throughout the entire scope.

In JS, even before the code starts execution the memory is allocated to variables & functions.

Let's take the example of below code and it's explanation

```
var num = 18;

function getName() {
    console.log("Namaste");
}

getName();
console.log(num);
console.log(getName);
```

1. It should have been an outright error in many other languages, as it is not possible to access something that is not even created (defined) yet But in JS, We know that in the memory creation phase, it assigns undefined and puts the content of function to function's memory.
2. And in execution, it then executes whatever is asked. Here, as execution goes line by line and not after compiling, it could only print undefined and nothing else. This phenomenon is not an error. However, if we remove var num = 18; then it gives an error. Uncaught ReferenceError: x is not defined

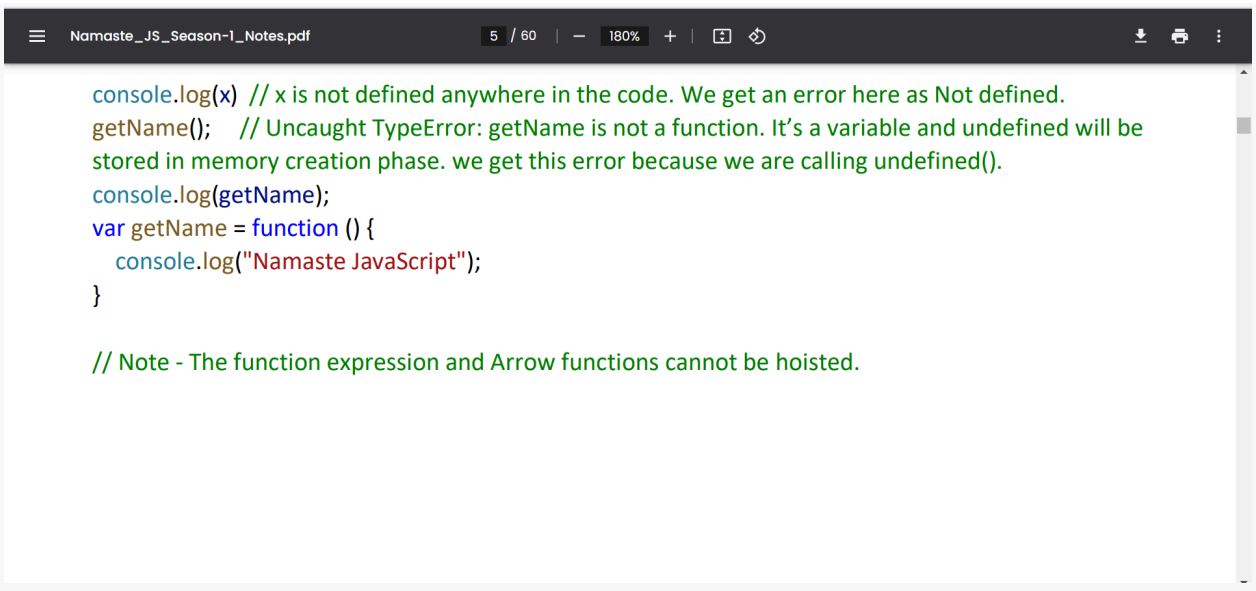
   Let's take another example

```
getName();
console.log(num);
console.log(getName);

var num = 18;

function getName() {
    console.log("Namaste");
}
```

Here when the variable and function are accessed before defining , the variable returns undefined and the function returns function has an object.

```
getName(); // Namaste
console.log(num); // Uncaught Reference: num is not defined.
console.log(getName); //function getName() {console.log("Namaste")}



function getName() {
    console.log("Namaste");
}
```

Another example:

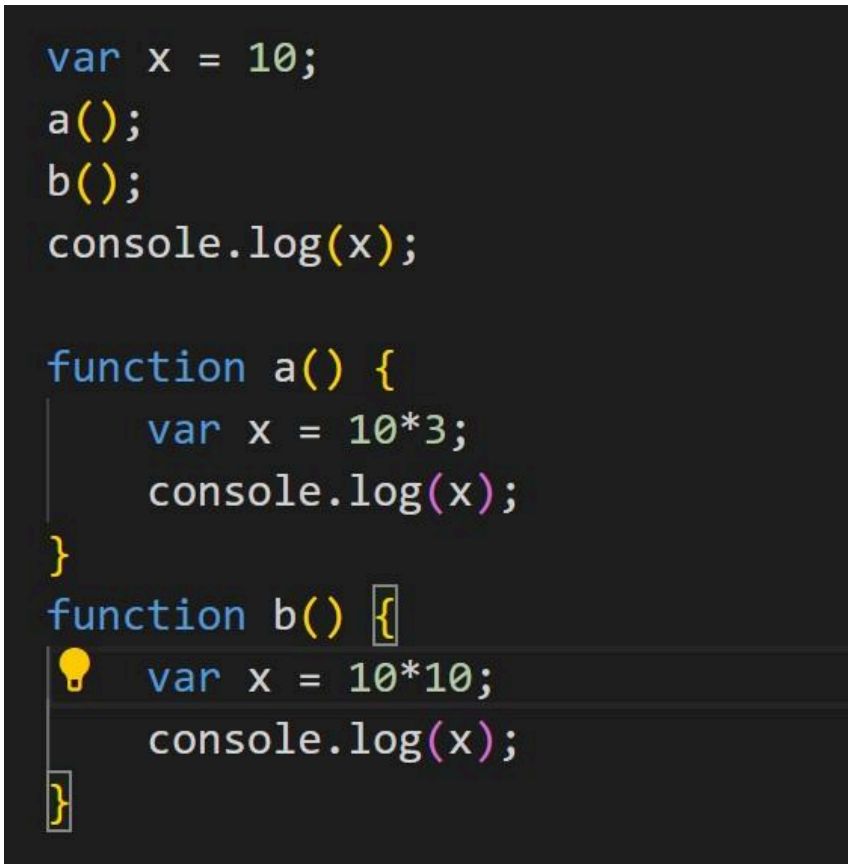


// Note - The function expression and Arrow functions cannot be hoisted.

– Episode-4(Season-1 -> how function works in JS)

Function —> A function in JavaScript is similar to a procedure—a set of statements that performs a task or calculates a value, but

for a procedure to qualify as a function, it should take some input and return an output where there is some obvious relationship between the input and the output.



```
var x = 10;
a();
b();
console.log(x);

function a() {
    var x = 10*3;
    console.log(x);
}
function b() {
    var x = 10*10;
    console.log(x);
}
```

The Output will be ➖
10
30
100

Code Flow in terms of Execution Context
*** The Global Execution Context (GEC) is created and pushed into the Call Stack.**

Call Stack: GEC

- In phase 1 of GEC, variable x is initialized with undefined, and a and b are initialized with their function definitions. In phase 2 of GEC, x is initialized with 1 and in subsequent lines, a and b functions are invoked.
- As soon as JS encounters function invocations inside GEC, it creates a local or function execution Context for each of the function invocations or function calls. At present function a's execution context is created and pushed into the call stack.

> Call Stack: [GEC, a()]

- In phase 1 of a's local EC, a totally different variable x is initialised with undefined and in phase 2 it is assigned with 10 and printed in the console. After printing, no more commands to run, so function a's local EC is removed from both GEC and from the Call stack.

> Call Stack: GEC

- In the next line, When JS encounters b function invocation, b's execution context is created. The same steps are for the b's Execution Context.

> Call Stack: [GEC, b()]

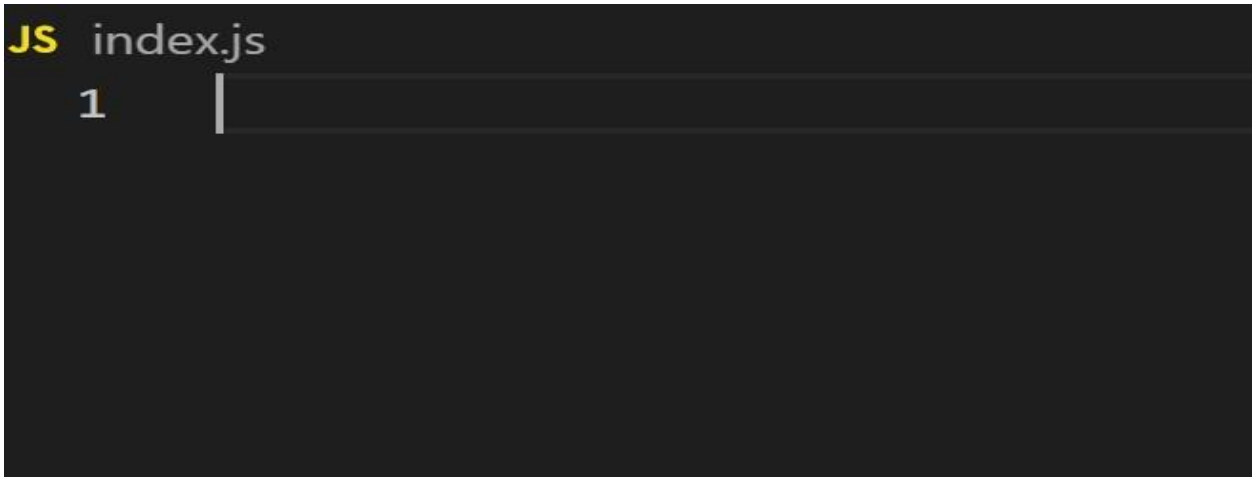
- when b's code execution phase is finished, there is no longer code exists for b to get executed and the local execution context for b is removed from the call stack. At this moment both functions execution contexts are removed from the stack.

> Call Stack: GEC

- In the next line JS encounters console log (x) which will print the value of x from the GEC into the console.JS cannot encounter further code after the current line execution, Thus GEC is removed from the call stack and JS program ends.

– Episode- 5(Season-1 -> Shortest JS Program, window & this keyword)

Have you ever thought what would be the shortest Program in JavaScript, If Not then have a look at what it looks like



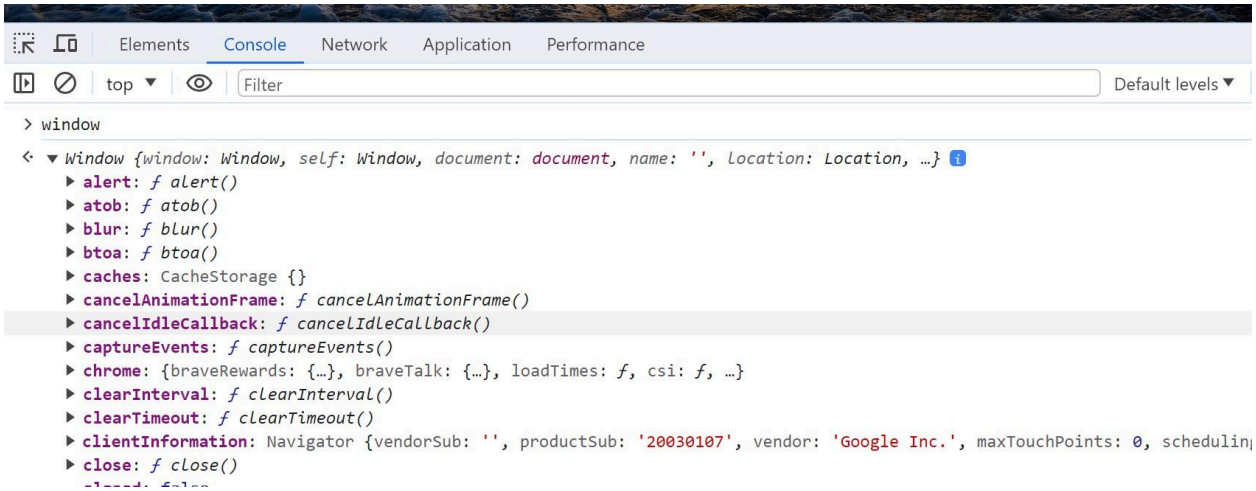
Many of them will say what rubbish but yes this is this shortest program you could ever write in js 🥵 I'm not kidding
Let's understand why this is the shortest program,

- ★ Behind The Scenes when the program is run, the JS engine does a lot of things. As always, even in this case, it creates the GEC (global execution context) which has memory space and the execution context.
- ★ The JS engine creates object something known as 'window'. It is an object, which is created in the global space. It contains lots of functions and variables. The functions and variables declared insider this scope can be accessed from anywhere in the program.
- ★ The JS engine also creates a "this" keyword, which points to the window object at the global level. So, in summary, along

with GEC, a global object (window) is created and a “this” variable is created.

★ In different engines, the name of the global object changes. Window in browsers, but in nodeJS it is called something else. At a global level, this === window If we create any variable in the global scope, then the variables get attached to the global object.

Window Object looks something like this



– Episode- 6(Season-1 -> undefined and not defined in JS)

The “undefined” is just a keyword given the variable or you can think it’s the placeholder kept for the variable in the execution context

If an object/variable is not even declared/found in memory allocation phase, and tried to access it then it is Not defined

Not Defined !== Undefined

When a variable is declared but not assigned value, its value will be undefined. But when the variable itself is not declared but called in code, then it is not defined.

```
//ep- 6

console.log(x); // undefined var x = 25;
console.log(x); // 25
console.log(a); // Uncaught ReferenceError: a is not defined
```

JS is a loosely typed / weakly typed language. It doesn't attach variables to any data type. Let's Example to understand it in a better manner if we declare a variable var a = 19, and then later we change the value of the variable to string,boolean,etc
This is the power of JS🔥.

But one should Never assign undefined as a value to any variable.

– Episode-7 (Season-1 -> Scope Chain, 🔥Scope & Lexical Environment)

Scope —> Scope in JavaScript refers to the current context of code, which determines the accessibility of variables to JavaScript.

JavaScript has three types of different scopes:

- Global scope: The default scope for all code running in script mode.
- Module scope: The scope for code running in module mode.

- Function scope: The variable created within a function is known as Function scope.

Global Scope —> Variables defined outside any function, block, or module scope have global scope. Variables in global scope can be accessed from everywhere in the application.

Example:

```
<script>
  let GLOBAL_DATA = { value : 1};
</script>

console.log(GLOBAL_DATA);
```

Module scope —> Before modules, a variable declared outside any function was a global variable. In modules, a variable declared outside any function is hidden and not available to other modules unless it is explicitly exported.

Exporting makes a function or object available to other modules. In the next example, I export a function from the sequence.js module file:

```
// in sequence.js
export { sequence, toList, take };
```

Importing makes a function or object, from other modules, available to the current module.

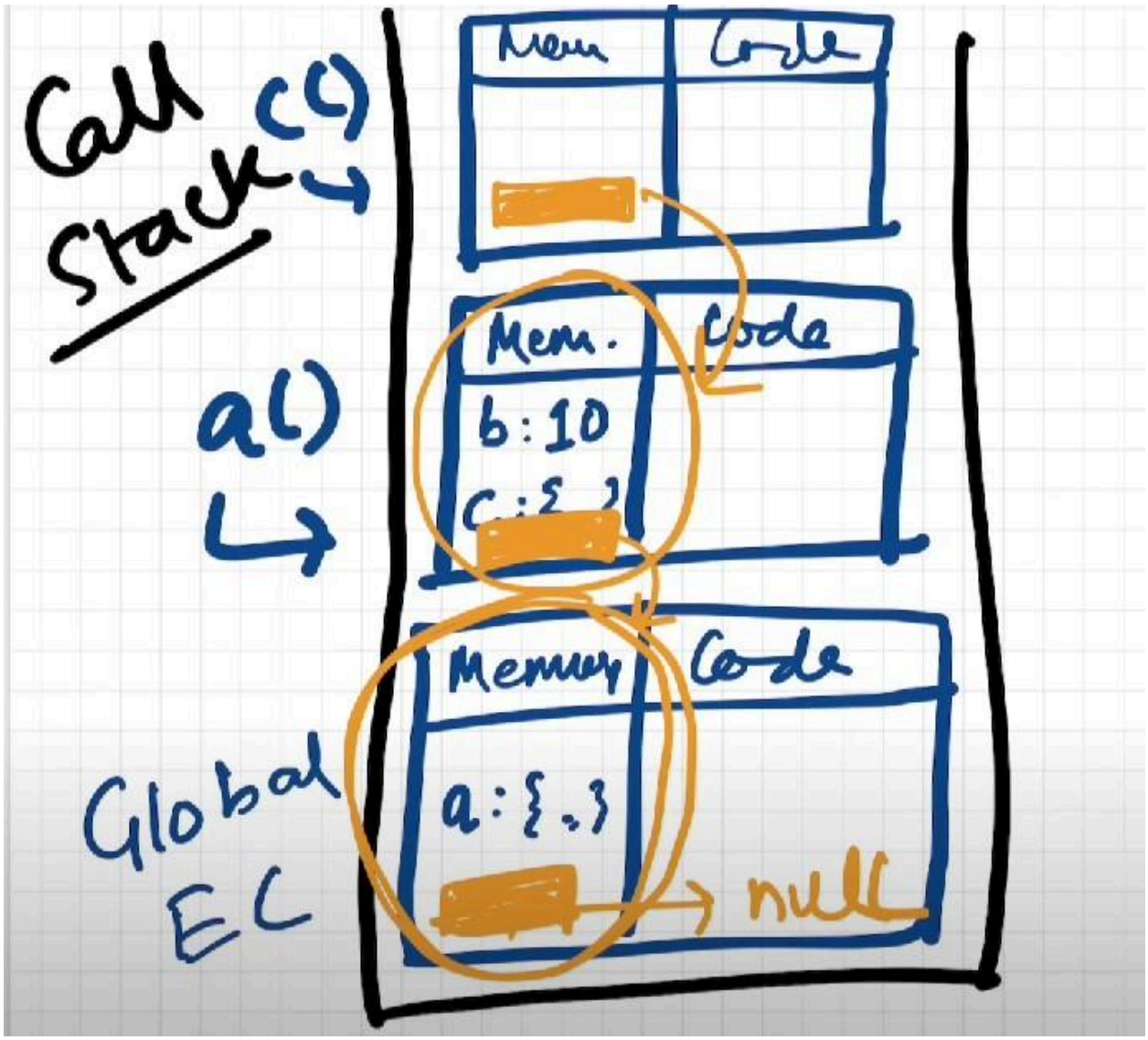
Function Scope —>Function scope means that parameters and variables defined in a function are visible everywhere within the function, but are not visible outside of the function.

```
function a() {
    var b = 19;
    console.log(b);
}
```

Let's take an example to understand lexical scope

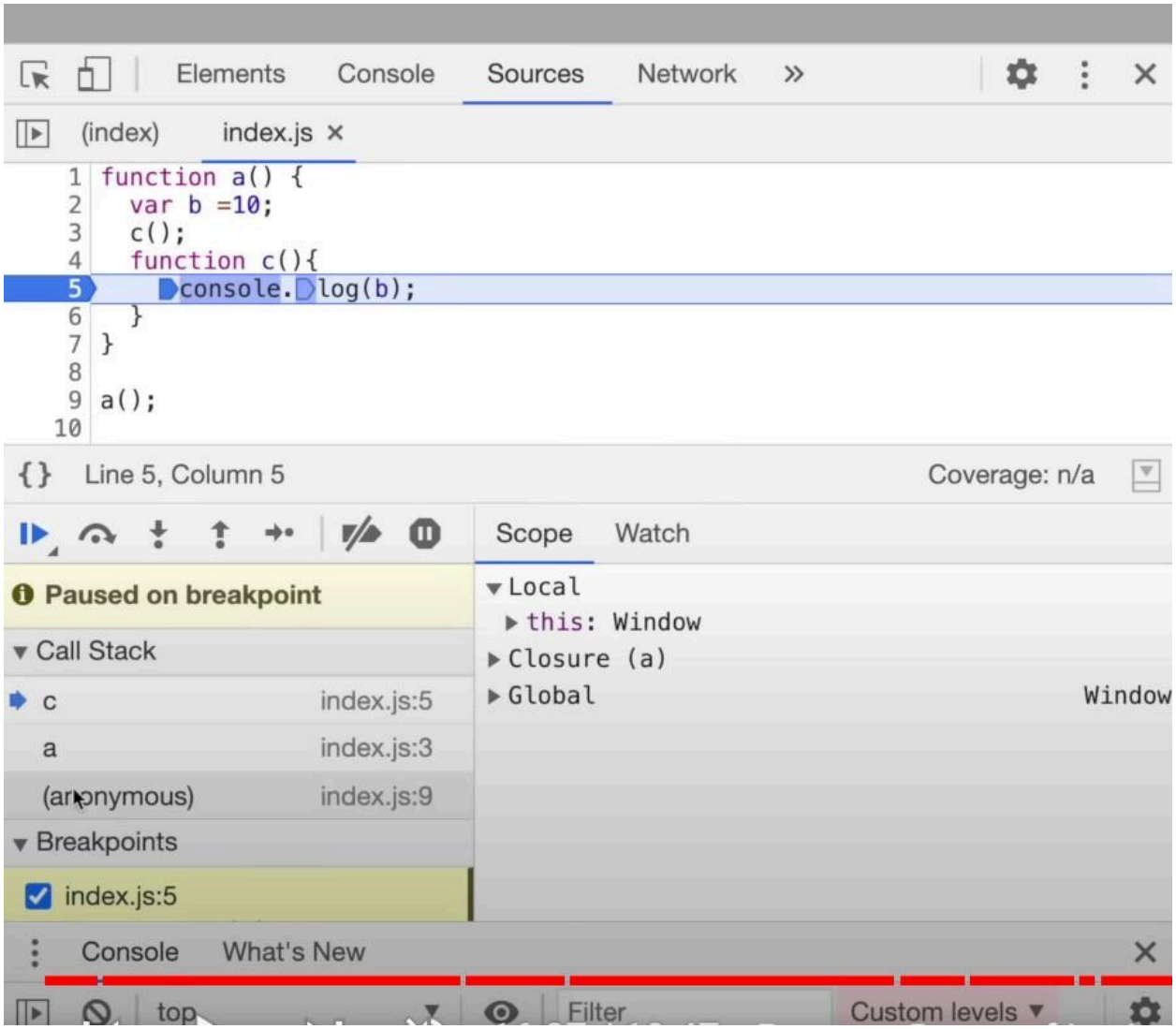
```
function a() {
    var number = 19;
    c();
    function c() {
        //
    }
}

a();
console.log(number);
```

The Call stack will be looking something like this,

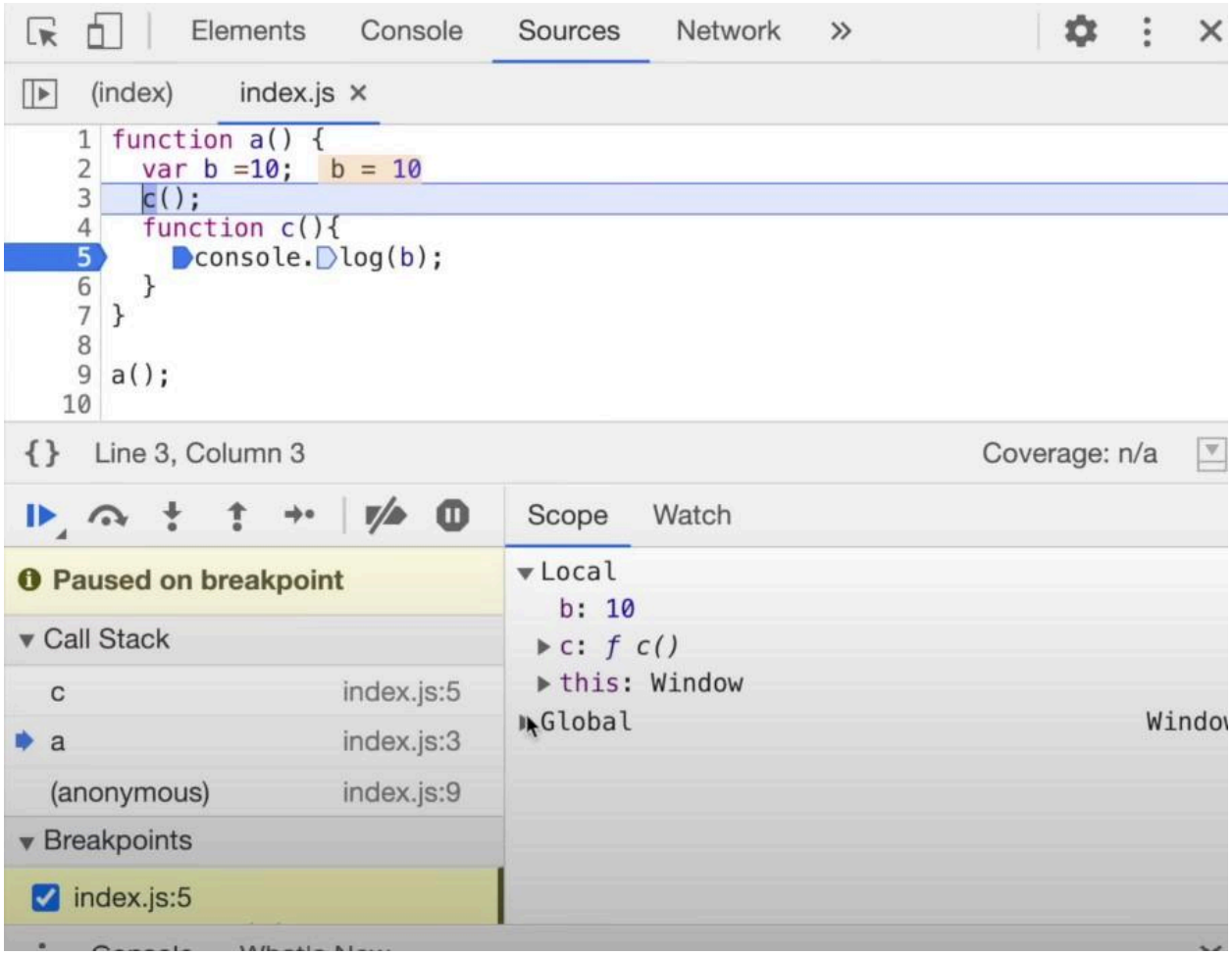


With The above Execution Context it shows that there is a chain of scopes that is dependent on each other, lexical scope of function c() is dependent on the local scope of function a() and lexical scope of function a() is dependent on the gec

This is how code works BTS



Function C () works like this



Function a () works like this

Lexical Scope —> Lexical scope is the ability of the inner function to access the variable defined inside the outer function.
(example)

– Episode-7 (Season-1 -> let & const in JS, Temporal Dead Zone)

Everyone while learning Js must have heard about **let** and **const** declarations are hoisted. But exactly what does it mean? The block of code is aware of the variable, but it cannot be used until it has been declared. Using a let variable before it is declared will result in a ReferenceError.

Let's take example of this

```
// ep-8
console.log(a); // ReferenceError: Cannot access 'a' before initialization
console.log(b); // prints undefined as expected
let a = 10;
console.log(a); // 10
var b = 15;
console.log(window.a); // undefined
console.log(window.b); // 15
```

Both 'a' and 'b' are actually initialized as **undefined** in the hoisting stage. But var b is inside the storage space of GLOBAL, and 'a' is in a separate memory object called script, where it can be accessed only after assigning some value to it first ie. One can access 'a' only if it is assigned. Thus, it throws an error.

Temporal Dead Zone: It's the Time since when the let variable was hoisted until it is initialized with some value.

- So any line before "let a = 10" is the TDZ for `**a**`
- Since a is not accessible on global, it's not accessible in window/this also.
window.b or this.b -> 15; But window.a or this.a ->undefined, just like window.x->undefined
(x isn't declared anywhere)

Now let’s have a look at the Types Of Errors we may encounter

Uncaught TypeError: Assignment to constant variable
This Error signifies that we are reassigning to a const variable.
SOME GOOD PRACTICES:
- Try using const wherever possible.
- If not, use let, Avoid var.
- Declare and initialize all variables with let to the top to avoid errors to shrink the temporal dead zone window to zero

Uncaught ReferenceError: cannot access 'a' before initialization
This Error signifies that 'a' cannot be accessed because it is declared as 'let' and since it is not assigned a value, its in Temporal Dead Zone. Thus, this error occurs.

Uncaught SyntaxError: Identifier 'a' has already been declared
This Error signifies that we are redeclaring a variable that is 'let' declared. No execution will take place (because js scans the whole code).

– Episode-9 (Season-1 -> BLOCK SCOPE & Shadowing in JS)

What is a **Block** ?
- Block aka compound statement is used to group JS statements together into a “1” group. We group them within {...}

```
{
    var a = 10;
    let b = 20;
    const c = 30;
    // Here let and const are hoisted in Block scope,
    // While, var is hoisted in Global scope.
}
```

Block scope and It’s accessibility example

```
{
    var a = 10; let b = 20;
    const c = 30;
}
console.log(a); // 10
console.log(b); // Uncaught ReferenceError: b is not defined
```

1. In the BLOCK SCOPE; we get b and c inside it initialized as “undefined” as a part of hoisting (in a separate memory space called **block**)
2. While, a is stored inside a GLOBAL scope.
3. Thus we say, *let* and *const* are BLOCK SCOPED. They are stored in a separate memory space which is reserved for this({...}) block. Also, they can't be accessed outside this ({...})block. But var a can be accessed anywhere as it is in global scope. Thus, we can't access them outside the Block.

What is **Shadowing** —> It occurs when a variable declared in a certain scope (e.g. a local variable) has the same name as a variable in an outer scope (e.g. a global variable)

```
 var a = 100;
{
   var a = 10; // same name as global var let b = 20;
   const c = 30;
   console.log(a); // 10
   console.log(b); // 20
   console.log(c); // 30
   }
   console.log(a); // 10, instead of the 100 we were expecting. So block "a"
modified val of global "a" as well. In console, only b and c are in block
space. a initially is in global space(a = 100), and when a = 10 line is run, a
is not created in block space, but replaces 100 with 10 in global space
itself.
```

In Simpler words, If one variable has the same name outside the block, the variable inside the block shadows the outside variable.

In the above example, first the value of variable a is “100” and in a block scope, its value is “10” but when we print its value it will display “10” because the value of a gets over-shadowed from “100” to “10”
But this happens only when a variable is declared with var keyword.

Let's observe the behavior in the case of let and const and understand its reason

```
let b = 100;

{
var a = 10; let b = 20;
const c = 30;
console.log(b); // 20
}
console.log(b);
// 100, Both b's are in separate spaces (one in Block(20) and one in
// Script(another arbitrary mem space)(100)). Same is also true for
*const* declarations.
```

And same applies for the function

```
const c = 100;
function x()
{
const c = 10;
console.log(c); // 10
}
x();
console.log(c); // 100
```

What is Illegal Shadowing ===> If we create a variable in a global scope with the **let** keyword and another variable with the **var** keyword in a **block** scope but with the **same** name, it will throw an error.

```
let a = 20;
{
var a = 20;
}
// Uncaught SyntaxError: Identifier 'a' has already been declared
```

– Episode-10(Season-1 -> Closures in JS 🔥)

Closures —> A closure is a function along with its lexical scope **bundled** together (enclosed) with **references** to its surrounding state (the lexical environment). In other words, a closure gives you access to an outer function's scope from an inner function. In JavaScript, closures are created every time a function is created, at function creation time.

JavaScript has a **lexical** scope environment. If a function needs to access a variable, it first goes to its local memory. When it does not find it there, it goes to the memory of its **lexical parent**. In Below code snippet, Over here function “y” along with its lexical scope i.e. (function x) would be called a **closure**.

```
function x()
{
  var a = 7;
  function y() {
    console.log(a);
  }
  return y;
}
var z = x();
console.log(z); // value of z is entire code of function y.
```

In the above code snippet, When “y” is returned, not only the function returned but the entire closure (function y + its lexical scope) is returned and put inside variable “z”. So when z is used anywhere else in the program, it still points to the value of a variable “a” inside x().

Let’s take another example

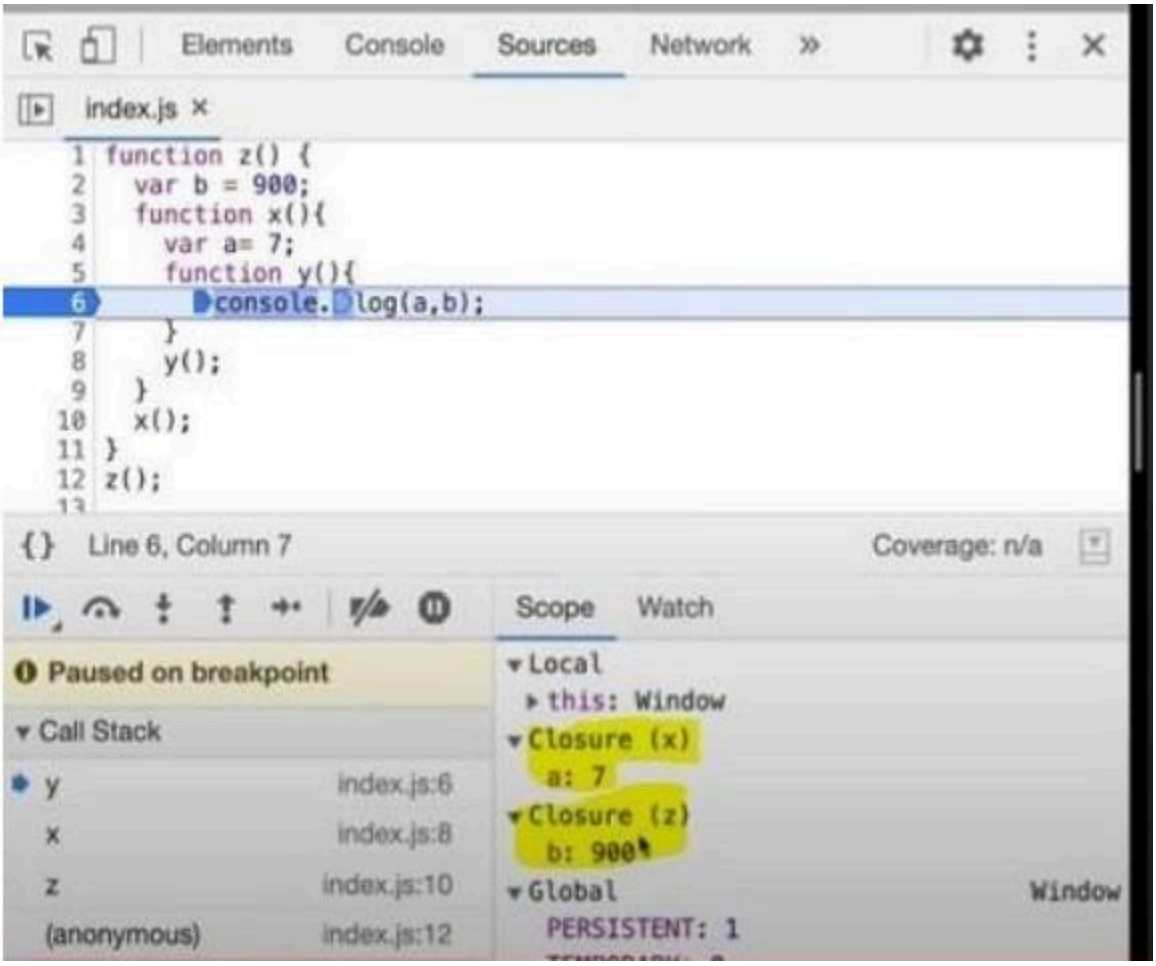
```
function z() {
  var b = 900;
  function x() {
    var a = 10;
    function y() {
      console.log(a, b);
    }
    y();
  }
  x();
}

z();
```

In the above code snippet, we have put the entire function “x” inside the new function “z”; this is also closure.
The output that we will get after running this code will be,

```
ƒ y() {
    console.log(a);
  }
```

```
10 900
```

In the above output, You might wondering how we're able to get the value of variable "b" inside function "y" which is enclosed inside the function "x".
This is all due to closure because **closure** is a function that has **access to its outer function** scope even after the function has **returned**. Meaning, A closure can remember and access variables and arguments referenced by its outer function even after the function has returned.*



If you look carefully in the scope tab there are two different scope defined ("x" & "z") that's the reason we can get values of a and b in function "y".

Advantages of Closure:

- Module Design Pattern
- Currying
- Memoize
- Data hiding and encapsulation
- setTimeouts etc.
- Iterators.

Disadvantages of Closure:

- Over consumption of memory
- Memory Leak

– Episode-11(Season-1 -> setTimeout + Closures Interview Question 🔥)

setTimeout function sets a timer which executes a function or specified piece of code once the timer expires.

```
function x() {
  var i = 1;
  setTimeout(function () {
    console.log(i);
}, 3000);
  console.log("Namaste Javascript");
}
x();
```

- We expect JS to wait 3 sec, print 1 and then go down and print the string. But JS prints
- string immediately, wait 3 sec and then print 1.
- The function inside setTimeout forms a closure (remembers reference to i). So wherever function goes it carries this reference along with it.
- setTimeout takes this callback function & attaches a timer of 3000ms and stores it. Goes to the next line without waiting and prints the string.
- After 3000ms runs out, JS takes a function, puts it into call stack and runs it.

Q: Print “1” after 1 sec,” 2” after 2 sec till 5 : Tricky interview question

We assume many developers will use this simple approach as below snippet:

```
function x() {
  for (var i = 1; i <= 5; i++) {
    setTimeout(function () {
      console.log(i);
    }, i * 1000);
  }
  console.log("Namaste Javascript");
}
x();
```

OUtput will be:
6
6
6
6
6

- We get above output because of closures. When setTimeout stores the function somewhere and attaches a timer to it, the function remembers its reference to i, not value of i.
- All 5 copies of the function point to the same reference of i. JS stores these 5 functions, prints string and then comes back to the functions. By then the timer had run fully.
- And due to looping, the i value became 6. And when the callback fun runs the variable i = 6. So same 6 is printed in each log

- To avoid this, we can use **let** instead of **var** as let has Block scope. For each iteration, the i is a new variable altogether (new copy of i). Everytime setTimeout is run, the inside function forms closure with a new variable i.

But what if we don't have option to use **"var"** , we can this snippet of code

```
function x() {
    for (var i = 1; i <= 5; i++) {
    function close(i) {
    setTimeout(function () {
    console.log(i);
    }, i * 1000);
    // put the setT function inside new function close()
    }
    close(i); // everytime you call close(i) it creates new copy of i. Only this
    time, it is with var itself!
    }
    console.log("Namaste Javascript");
    }
x();
```

Output will be:
Namaste Javascript
1
2
3
4
5

- When we're using "var" instead of "let" All 5 copies of the function were pointing to the same reference of "i" , But when we use "let" it points to 5 different reference of "i",
- And due to looping, the "i" value keeps getting incremented.

– Episode-11(Season-1 -> CRAZY JS INTERVIEW 🤯ft. Closures)

Q1. What is Closure in Javascript?
Ans-> A function along with reference to its outer environment together forms a closure. Or in other words, A Closure is a combination of a function and its lexical scope bundled together.

Example:

```
function outer() {
  var outervariable = 10;
  function inner() {
    console.log("outervariable value-> "+outervariable);
  }    // inner forms a closure with outer return inner;
  return inner;
}

outer()();  /* first we're calling outer function and then inner function  */
```

Q2: Will the below code snippet still form a closure?

```
function outer() {
  function inner() {
    console.log("outervariable value-> "+outervariable);
  }
  var outervariable = 10;
  return inner;
}

outer()();
```

Ans–> Yes, because inner function forms a closure with its outer environment so sequence of the code doesn't matter.

Q3: Changing var to let, will it make any difference?

```
function outer() {
  let outervariable = 10;
  function inner() {
    console.log("outervariable value-> "+outervariable);
  }    // inner forms a closure with outer return inner;
  return inner;
}

outer()();  /* first we're calling outer function and then inner function  */
```

Q4: Can we pass the parameter to the outer function?

```
function outer(outerparam) {
  let outervariable = 10;
  function inner() {
    console.log("outervariable value-> "+outervariable+"  params passed =>"+outerparam)
  }    // inner forms a closure with outer return inner;
  return inner;
}

outer("Cricket")();  /* first we're calling outer function and then inner function  */
```

Ans→ Yes, we can pass the parameter to a function when it's closure.

Q5. Can we nest an outer function inside another new function and If yes will it still form closure?

```
function outest() {
  var c = 20;
  function outer(b) {
    function inner() {
      console.log(a, b, c);
    }
    let a= 10;
    return inner;
  }
  return outer;
}

var close = (outest())("hellow");
close();
```

Ans-> Yes we can nest a new function to the outer function and it'll still form closure.

Q6. What if adding the same variable in the global scope will it work.

```
function outest() {
  var c = 20;
  function outer(b) {
    function inner() {
      console.log(a, b, c);
    }
    let a= 10;
    return inner;
  }
  return outer;
}

let a = 999;
var close = (outest())("hellow");
close();
```

Ans-> Yes, it will work as closures form reference to its outer environment, but if we don't define the variable in function "outer" it will take value of "a" from global scope i.e 999 (it searches more deeper hierarchy level and gets global value)

Q7: Advantages of Closure?

Ans->

- Module Design Pattern
- Currying
- Memoize
- Data hiding and encapsulation
- setTimeouts etc.

Q8. Discuss more on Data hiding and encapsulation?

```
function counter() {
  var count = 0;
  return function increment() {
    count++;
    console.log(count);
  };
}
var counter1 = counter(); //counter function has closure with count var.
counter1(); // increments counter
var counter2 = counter();
counter2(); // here counter2 is whole new copy of counter function and it wont impack the output of counter1
// ------------------------------------------------------------
```

```
// without closures
var count = 0;
function increment() {
  count++;
}
// in the above code, anyone can access count and change it.
// ------------------------------------------------------------
// (with closures) -> put everything into a function
function counter() {
  var count = 0;
  function increment() {
    count++;
  }
}
console.log(count); // this will give referenceError as count can't be accessed. So now we are able to achieve
hiding of data
// ------------------------------------------------------------
//(increment with function using closure) true function
```

```
,,
// Above code is not good and scalable for say, when you plan to implement decrement counter at a later stage.
// To address this issue, we use *constructors*
// -----------------------------------------------------------
// Adding decrement counter and refactoring code:
function Counter() {
  //constructor function. Good coding would be to capitalize first letter of constructor function.

  var count = 0;
  this.incrementCounter = function () {
    //anonymous function
    count++;
    console.log(count);
  };
  this.decrementCounter = function () {
    count--;
    console.log(count);
  };
}
var counter1 = new Counter(); // new keyword for constructor function
counter1.incrementCounter();
counter1.incrementCounter();
counter1.decrementCounter();
```

Q9: Disadvantages of closure ?
Ans-> Overconsumption of memory when using closure as every time as those closed over variables are not garbage collected till program expires. So when creating many closures, more memory is accumulated and this can create memory leaks if not handled.

Garbage collector : Program in JS engine or browser that frees up unused memory. In high level languages like C++ or JAVA, garbage collection is left to the programmer, but in JS engine it's done implicitly. Below is the example of Garbage collector

```
function a() {
  var x = 0;
  return function b() {
  console.log(x);
  };
  }
  var y = a(); // y is a copy of b() y();
  // Once a() is called, its variable "x" should be garbage collected ideally.
  // But function "b" has closure over variable x. So memmory of "x" cannot be freed.
  //Like this if more closures are formed, it becomes an issue. To tackle this issue,
  //JS engines like v8 and Chrome have smart garbage
  // collection mechanisms. Say we have var x = 0, z = 10 in code.
  // When we access "x" it's value is printed as 0 but z is removed automatically because it hasn't been used.
```

– Episode-13(Season-1 -> FIRST CLASS FUNCTIONS 🔥, Anonymous Functions)

Q: What is a Function statement (aka Function Declaration) ?
A function statement is a way to define a named function using the function keyword.

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

Q: What is Function Expression ?
 A function expression is a way to define a function as an expression within an assignment or another expression. Unlike function declarations (which use the function keyword), function expressions do not hoist the function to the top of their containing scope, and they can be defined inline as part of an expression.

```
var b = function () {
  console.log("Hello");
};
a();
```

Q: Difference between function statement and expression
The major difference between these two:
Function Statement:

- Hoisted to the top of their containing scope.
- Can be called before its declaration in the code.

Function Expression:

- Not hoisted.
- Must be defined before it can be called in the code.

```
a(); // "Hello A"
b(); // TypeError
function a() {
console.log("Hello A");
}
var b = function () {
console.log("Hello B");
};
// Why? During memory creation phase a is created in memory and function is assigned
to a.
// But b is created like a variable (b:undefined) and until code reaches the function
() part, it is still undefined. So it cannot find the value for "b" that's the reason
it results in error.
```

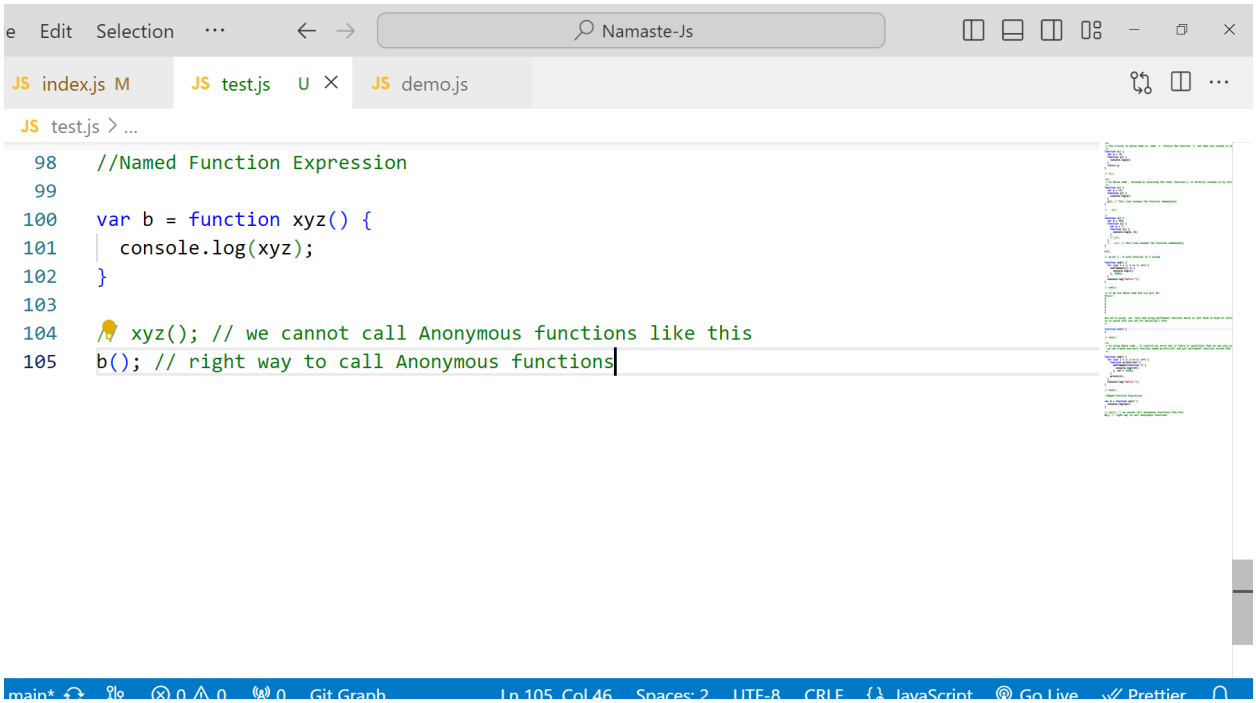
Q: What is Anonymous Function?
An anonymous function is a function that is defined without a name. Instead of having a name identifier like traditional named functions.

```
// function () {


// }
```

More About Anonymous functions:-

- They don't have their own identity. So an anonymous function without code inside it results in an error.
- Anonymous functions are often created as function expressions. These can be assigned to variables or passed as arguments to other functions.
- Anonymous functions are commonly used as callback functions.
- We cannot use directly Anonymous functions we have to store them in **some variable**.

Q: What is Named Function Expression?
A Named Function Expression in JavaScript is a type of function expression that has a name identifier within its definition. Unlike traditional function declarations, where the function name is automatically bound to the function.



Q: Parameters vs Arguments?

- Parameters are the placeholders or variables listed in the function declaration. They represent the values that a function **expects to receive** when it's called.

- Arguments are the actual values or expressions that are passed to a function when it's called. They correspond to the parameters defined in the function declaration. Arguments are **provided when invoking** the function.

```
var b = function (param1, param2) // labels/identifiers are parameters
{
console.log("b called");
}

b(arg1, arg2); // arguments - values passed inside function call
```

Q: What is First Class Function OR First Class Citizens?
When a function is passed inside another function as arguments and/or returns a function(HOF). These ability are altogether known as First-class functions.

```
var b = function (param1) {
  console.log(param1); // prints " f() {} "
};
b(function () {});

// Other way of doing the same thing:
var b = function (param1) {
  console.log(param1);
};
function xyz() {}
b(xyz); // same thing but with different code.

// we can return a function from a function:
var b = function (param1) {
  return function () {};
};
console.log(b()); //we log the entire fun within b
```

Q Function Invocation

It refers to the process of running or executing a function. When you invoke a function, you are telling the JavaScript engine to **execute** the code inside that function. This involves passing arguments (if any) to the function and performing the operations defined within the function's body.

```
// function invocation

function greet(name) {
  console.log("Hello, " + name + "!");
}

// Function invocation
greet("John");
```

In this example, greet("John") is a function invocation. It runs the greet function and passes the argument "John".

Q **Function Call:**
A function call, is the syntactic structure used to invoke a function. It includes the function name followed by parentheses, optionally containing arguments. Essentially, **every function invocation is a function call, but not every function call necessarily results in the function being invoked** (if the function doesn't exist or there's a syntax error, for example).

```
// Function call

function add(a, b) {
  return a + b;
}

// making a Function call
var result = add(3, 5);
console.log(result); // Output: 8
```

The main difference between function **invocation** and function **call** lies in their emphasis on different aspects of the process. "Function invocation" highlights the execution or running of the function, emphasizing what happens when a function is called and its code is executed. "Function call" is a more general term that refers to the syntax used to invoke a function, focusing on the act of calling a function with or without arguments.

– Episode-14(Season-1-> Callback Functions, ft. Event Listeners 🔥)

Callback Functions
Functions are first-class citizens ie. A callback function is a function that is passed as an argument to another function and is executed after the completion of a particular task. Callback functions are commonly used in asynchronous programming, where operations are non-blocking and may take some time to complete.
This callback function gives us access to the whole **Asynchronous** world in the **Synchronous** world.
(Eg:- setTimeout)

```
setTimeout(function () {
console.log("Timer");
}, 1000); // first argument is callback function and second is timer.
```

JS is a synchronous and single-threaded language. But due to callbacks, we can do asynchronous things in JS.

- In the call stack, first x and y are present. After code execution, they go away and the stack is empty. Then after 5 seconds (from the beginning) anonymous suddenly appears up in the stack ie. setTimeout

- All 3 functions are executed through the call stack. If any operation blocks the call stack, it's called blocking the main thread.
- Say if x() takes 30 sec to run, then JS has to wait for it to finish as it has only 1 call stack/1 main thread. Never block the main thread.
- Always use async for functions that take time eg. setTimeout

Event Listeners

We will create a button in html and attach event to it

```
    // index.html
    <button id="clickMe">Click Me!</button>;

    // in index.js
    document.getElementById("clickMe").addEventListener("click", function
xyz() {
    //when event click occurs, this callback function (xyz) is called into
callstack console.log("Button clicked");
    });
```

Let's implement an increment counter button.
- Using global variable (not good as anyone can change it) :

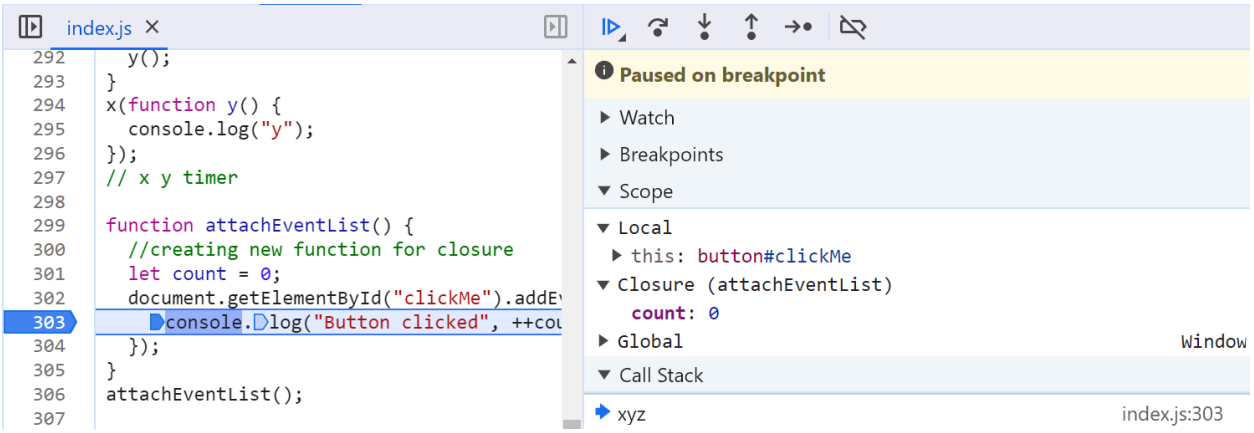
```
    let count = 0;
    document.getElementById("clickMe").addEventListener("click", function
xyz() {
    console.log("Button clicked", ++count);
    });
```

Use closures for data abstraction

```
function attachEventList() {
//creating new function for closure
  let count = 0;
  document.getElementById("clickMe").addEventListener("click", function xyz() {
    console.log("Button clicked", ++count); //now callback function forms closure
    with outer scope(count)
  });
}
attachEventList();
```

Garbage Collection and removeEventListeners

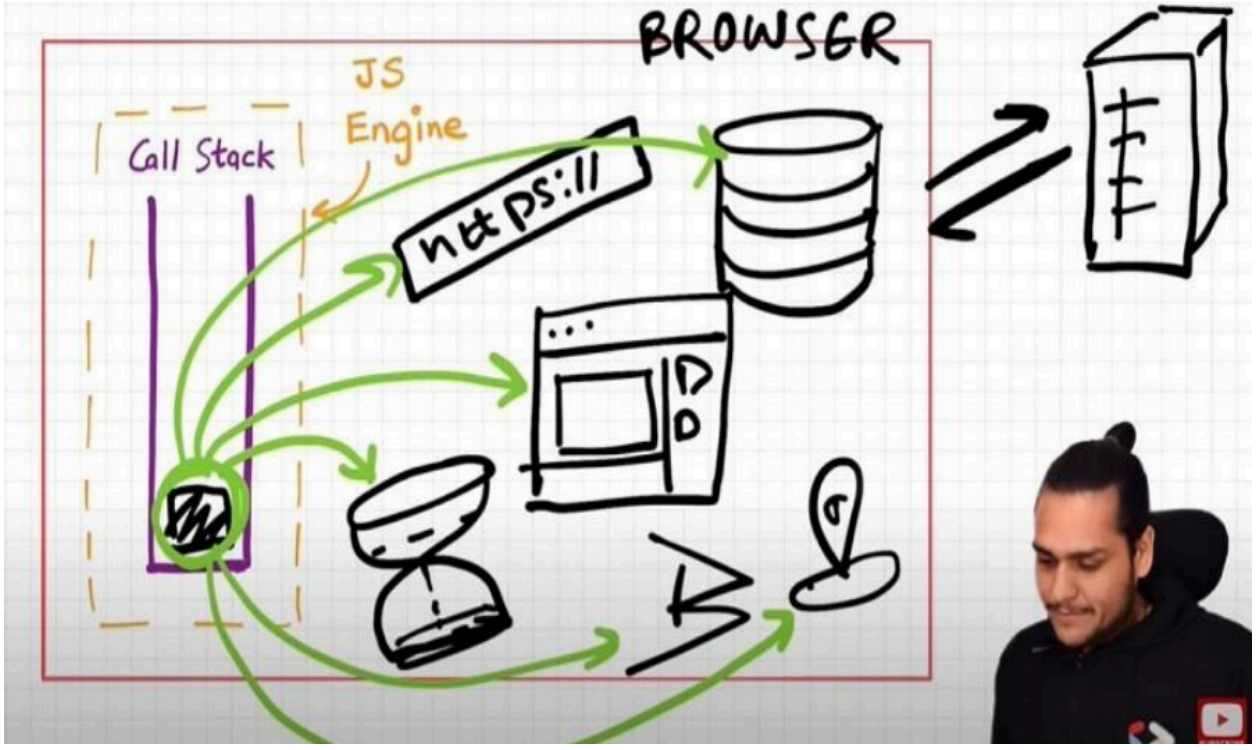
Event listeners are heavy as they form closures. So even when the call stack is empty, EventListener won't free up memory allocated to count as it doesn't know when it may need to count again. Sowe remove event listeners when we don't need them (garbage collected) onClick, onHover, and onScroll all in a page can slow it down heavily.



– Episode-15(Season-1 -> Asynchronous JavaScript & EVENT LOOP from scratch 🔥)

Note: Call stack will execute any execution context which enters in it. **Time, tide and JS waits for none**. TLDR; Callstack has no timer.

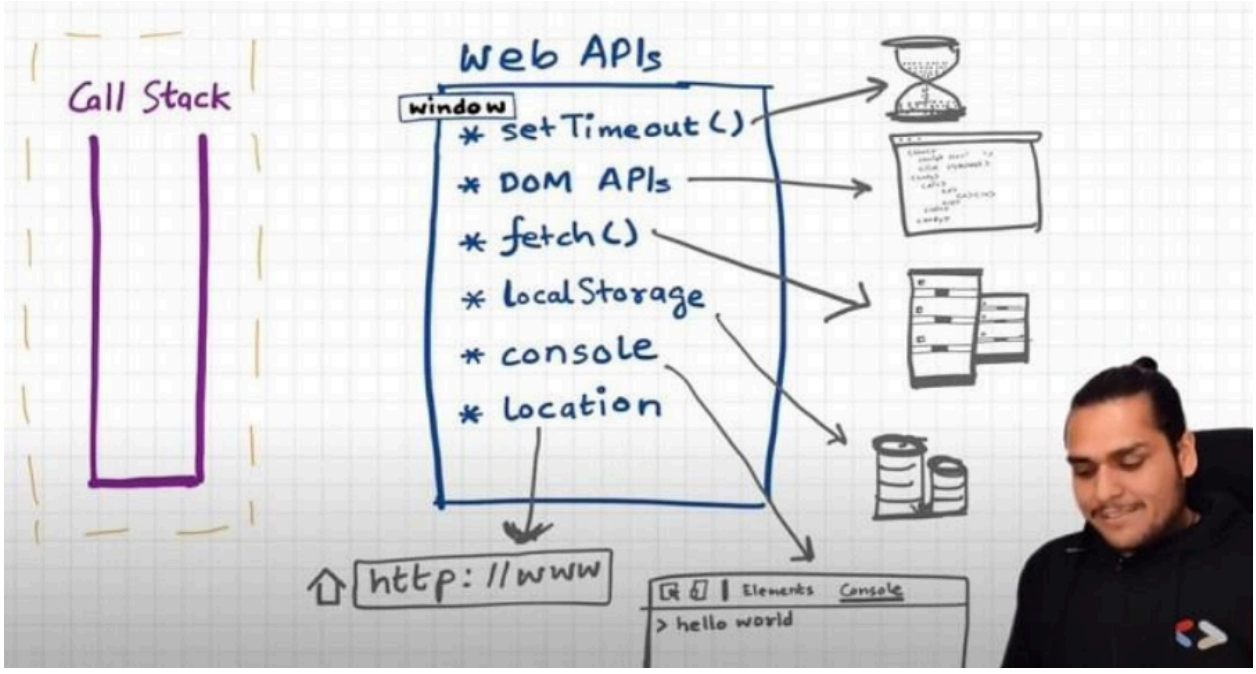
The browser has JS Engine which has Call Stack which has Global execution context, local execution
context, etc.
- But the browser has many other superpowers - Local storage space, Timer, a place to enter
URL, Bluetooth access, Geolocation access and so on.
- Now JS needs some way to connect the callstack with all these superpowers. This is done using Web APIs.



WebAPIs

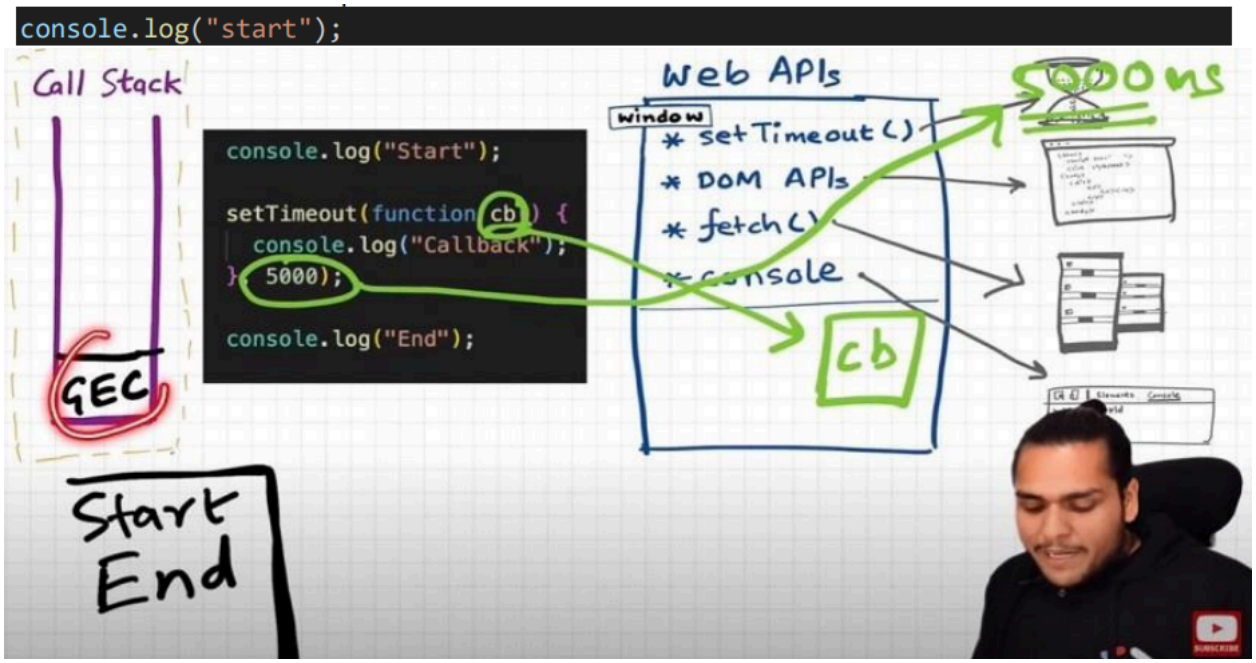
None of the below are part of Javascript! These are extra superpowers that browsers have.
The browser gives access to JS call stack to use these powers which are part of **Web API's**
setTimeout(), DOM APIs, fetch(), localstorage, console (yes, even console.log is not JS!!), location and so many more.
- setTimeout(): Timer function
- DOM APIs: eg.Document.get() , Used to access HTML DOM tree. (Document Object
- Manipulation) fetch(): Used to make API call with external servers eg. Netflix servers etc.

We get all these inside call stack through global object ie. window - Use window keywords like window.setTimeout(), window. localstorage, window.console.log() to log something inside the console. - As window is a global obj, and all the above functions are present in global object, we don't explicitly write window but it is implied.



Let's understand the below code image and its explanation:

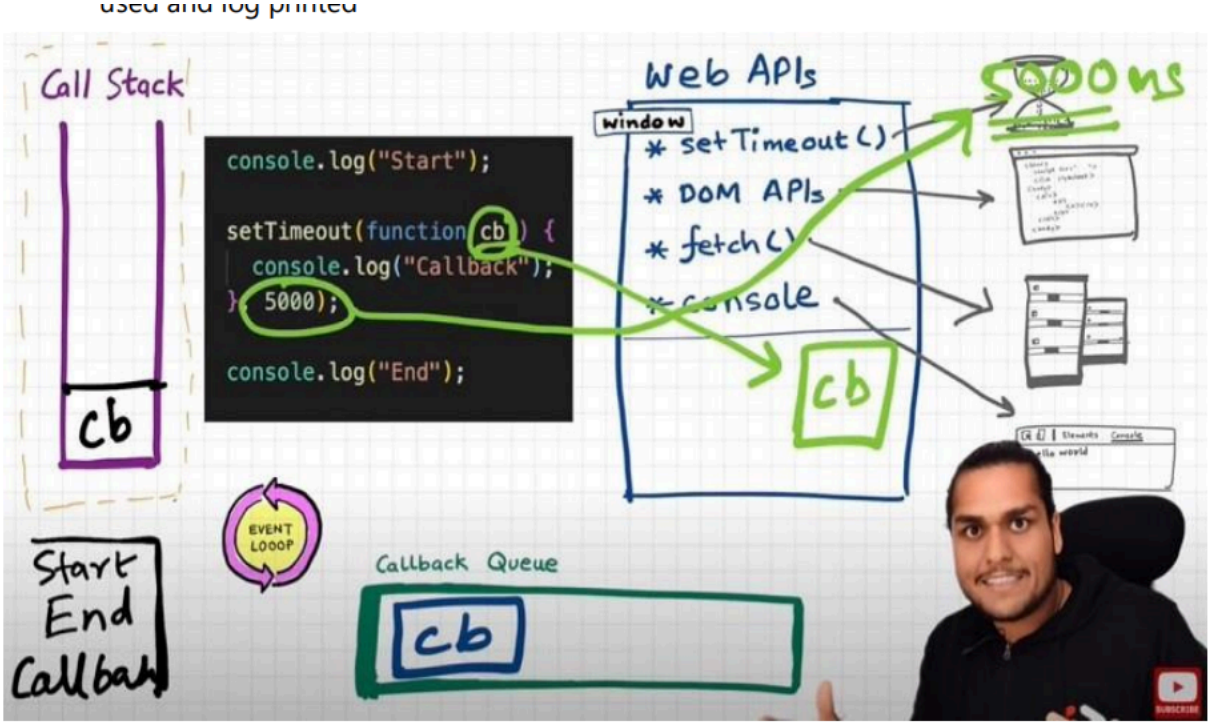
- First a GEC is created and put inside a call stack.
- console.log("Start"); // this calls the console web api (through the window) which in turn modifies values in the console.
- setTimeout(function cb() {
  //this calls the setTimeout **web API** which gives access to the timer feature. It stores the callback cb() and starts the timer.
  console.log("Callback");
  }, 5000);
- console.log("End"); // calls console API and logs in the console window. After this GEC pops out from call stack.
- While all this is happening, the timer is constantly ticking. After it becomes 0, the callback cb() has to run.
- Now we need this cb to go into the call stack. Only then will it be executed. For this we need an event loop and Callback queue



Event Loops and Callback Queue

Q: How after 5 secs timer is the console?

- cb() cannot simply directly go into the call stack to be executed. It goes through the callback queue when the timer expires.
- Event loop keeps checking the callback queue and seeing if it has any element to put into the call stack. It is like a gatekeeper(watchman).
- Once cb() is in the callback queue, the event loop pushes it to the call stack to run. Console API is used and log printed



Q: Need a callback queue?

Ans: Suppose the user clicks the button “n” several times. So “n” cb() is put inside the callback queue. The event loop sees if the call stack is empty/has space and whether the callback queue is not empty(“n” number of elements here).

Elements of the callback queue popped off, put in the call stack, executed, and then popped off from the call stack.

Behavior of fetch (Microtask Queue?)

Let's observe the code below and try to understand

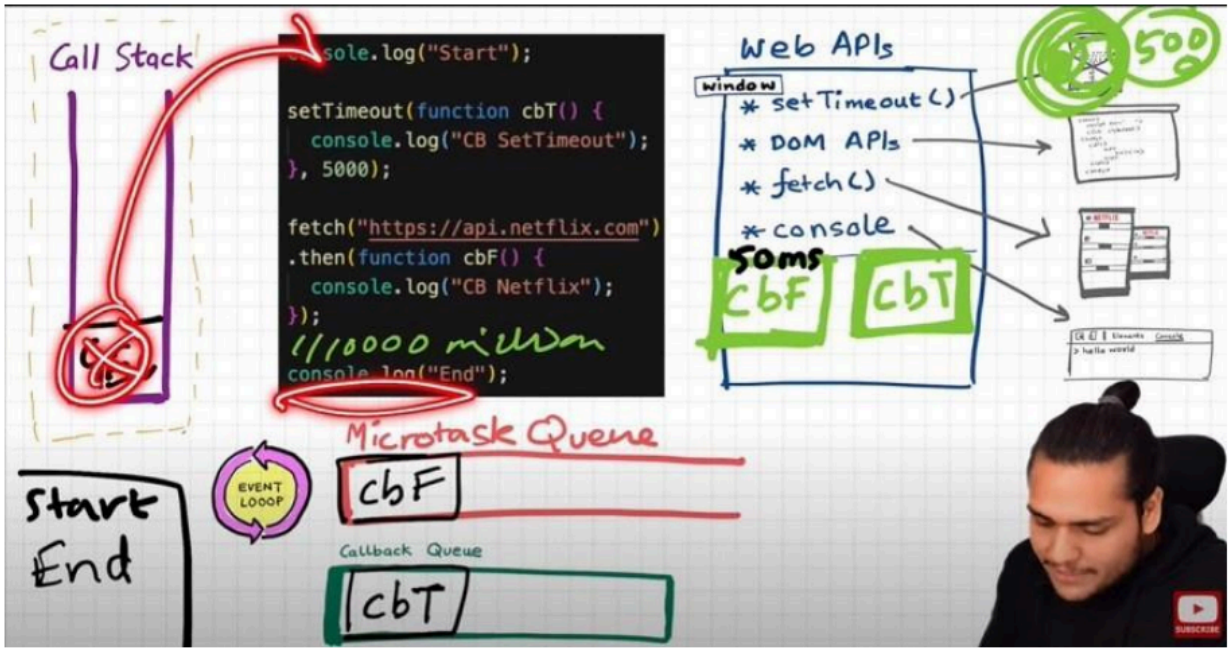
```
console.log("Start"); // this calls the console web api (through window) which
in turn actually modifies values in console.
setTimeout(function cbT() {
    console.log("CB Timeout");
}, 5000);
fetch("https://api.netflix.com").then(function cbF() { console.log("CB
Netflix");
}); // take 2 seconds to bring response
// millions lines of code console.log("End");
```

Code Explanation:

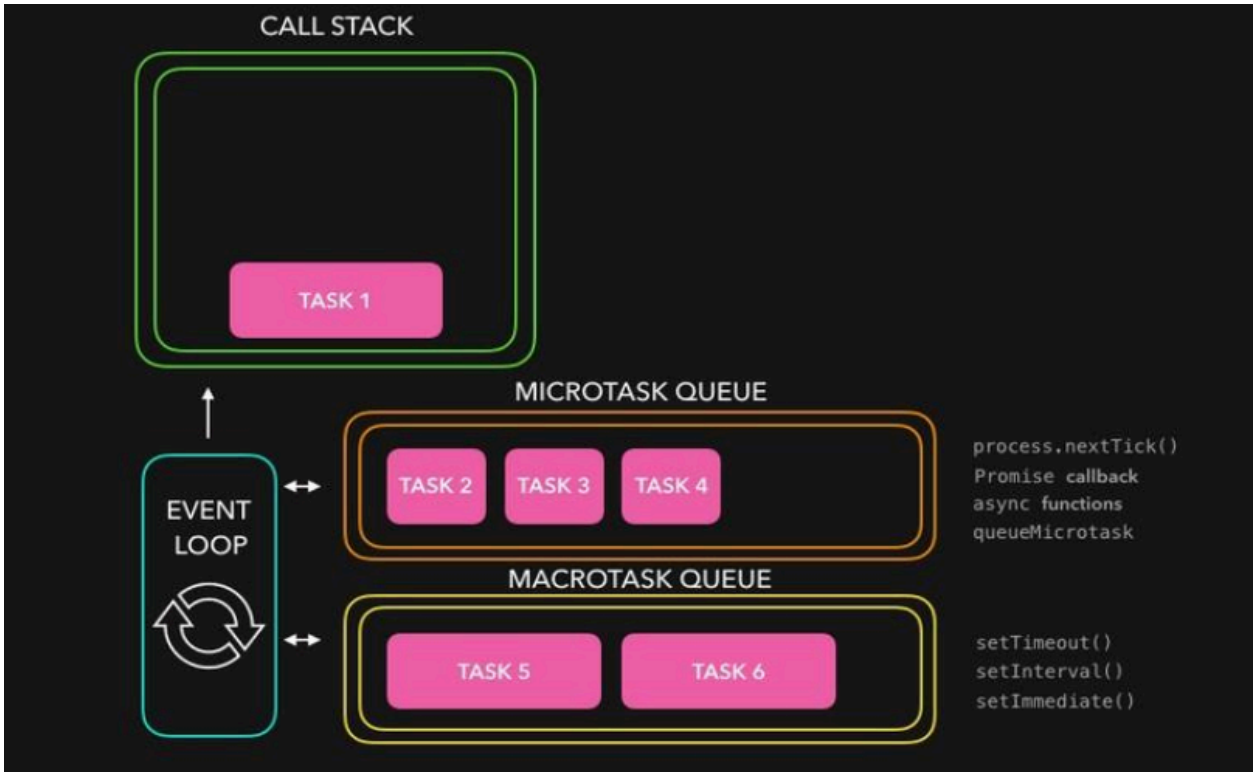
- Same steps for everything before fetch() in the above code.
- fetch registers cbF into the web API environment along with existing cbT.
- cbT is waiting for 5000ms to end so that it can be put inside the callback queue.
- cbF is waiting for data to be returned from Netflix servers, which will take 2 seconds.
- After this millions of lines of code are completed, by the time millions of lines of code will execute, 5 seconds has finished and now the timer has expired and the response from the Netflix (API) server is ready.
- Data back from cbF ready to be executed gets stored in something called a **Microtask** Queue.
- Also after the expiration of the timer, cbT is ready to execute in the **Callback** Queue.
- Microtask Queue is the same as Callback Queue, but it has higher priority. Functions in
- Microtask Queues execute the important task that has higher priority than the tasks inside the Callback Queues.
- In the console, the first Start and End are printed on the console. First, cbF goes in the call stack, and "CB Netflix"

- is printed. cbF popped from the call stack. Next cbT is removed from the callback Queue, put in the Call Stack, "CB Timeout '' is printed, and cbT is removed from call stack.

Have a look at image below, for a better understanding



Microtask Priority Visualization



What enters the Microtask Queue?

- All the callback functions that come through promises go inside the microtask Queue.
- **Mutation Observer**: Keeps on checking whether there is a mutation(change) in the DOM tree or not, and if there is, then it executes some callback function.
- Callback functions that come through promises and mutation observer go inside the Microtask Queue.
- All the rest goes inside the **Callback Queue aka. Task Queue**.
- If the task in the microtask Queue keeps creating new tasks in the queue, the element in the callback queue never gets a chance to be run. This is called **starvation**.

Some Important Questions

1. **When does the event loop start ?**

- Event loop, as the name suggests, is a single-thread loop that is almost infinite. It's always running and doing its job.

2. **Are only asynchronous web API callbacks registered in the web API environment?**
   - YES, the synchronous callback functions like what we pass inside map, filter, and reduce aren't registered in the Web API environment. It's just those async callback functions that go through all this.

3. **How does it matter if the delay for setTimeout is 0ms, Then the callback will move to the queue without any wait.**
   - No, there are trust issues with setTimeout() . The callback function needs to wait until the Call Stack is empty. So the 0 ms callback might have to wait for 100ms also if the stack is busy.

4. **Does the web API environment store only the callback function and push the same callback to the queue/microtask queue?**
   - Yes, the callback functions are stored, and a reference is scheduled in the queues. Moreover, in the case of event listeners(for example click handlers), the original callbacks stay in the web API environment, that's why it's advised to explicitly remove the listeners when not in use so that the garbage collector does its job.

– Episode-17(Season-1 -> Trust issues with setTimeout())

setTimeout with a timer of 5 seconds sometimes does not exactly guarantee that the callback function will execute exactly after 5 seconds.

Let's understand more with the code and its explanation:

```
console.log("Start");
setTimeout(function cb() {
  console.log("Callback");
}, 5000);
console.log("End");
// Millions of lines of code to execute
// o/p: Over here setTimeout exactly doesn't guarantee that the callback
function will be called exactly after 5s. Maybe 6,7 or even 10! It all depends
on callstack. Why?
```

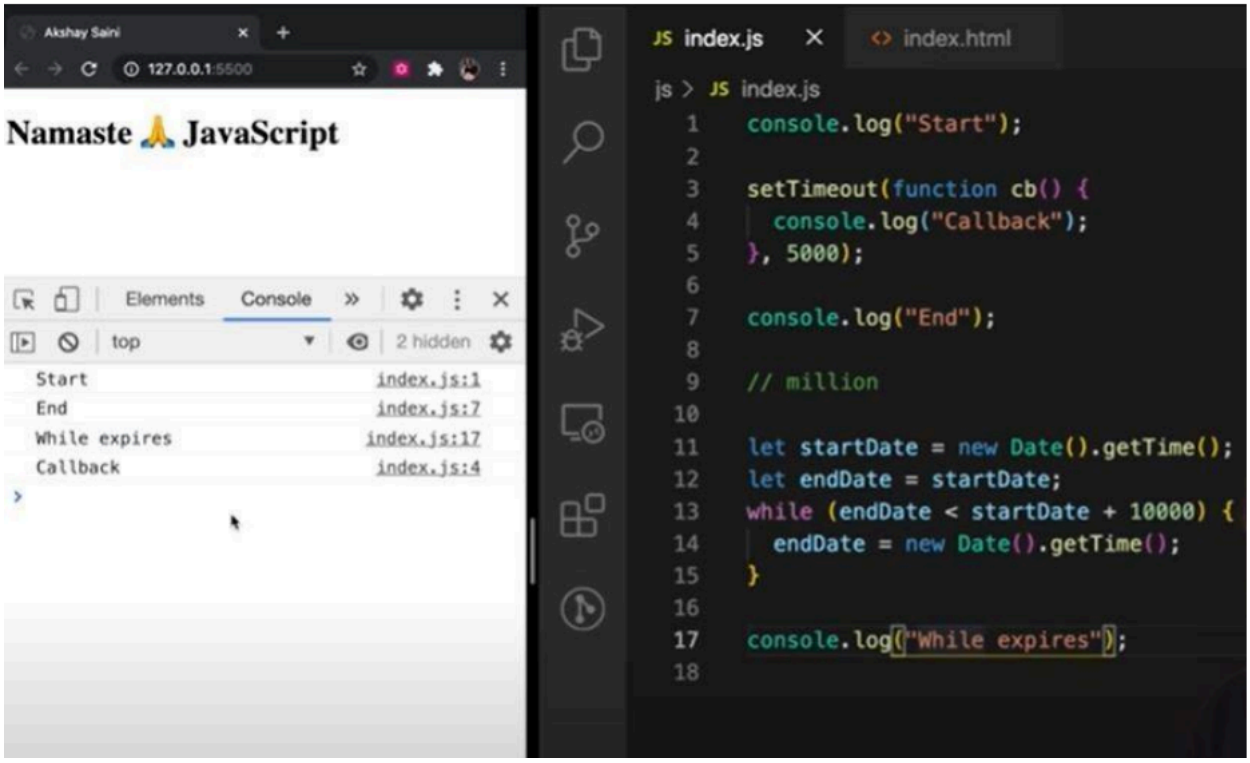
Reasons?

- First GEC is created and pushed in call stack.
- "Start" is printed in console
- When setTimeout is seen, the callback function is registered into Webapi's env. And timer is attached to it and started. Till that time callback waits for its turn to be executed once the timer expires. **But JS waits for none**.
- Now the Next line "End" is printed in the console.
- After "End", we have 1 million lines of code that take **10 sec(say)** to finish execution. So
- GEC won't pop out of the stack. It runs all the code for 10 sec.
- But in the background, the timer (of setTimeout) runs for 5s. While the call stack runs the 1M line of code,
- The timer of setTimeout has already expired and the callback function has been pushed to the **Callback** queue and waiting to push inside **GEC** to get executed.

- The event loop keeps checking if the call stack is empty or not. But here GEC is still inside the call stack so the **cb function** can't be popped from the callback Queue and pushed to CallStack.
- Though setTimeout is only for 5s, it waits for 10s until the call stack is empty before it can execute (**When GEC pops out after 10 sec, call stack () is pushed into the call stack and immediately executed (Whatever is pushed to call stack is executed instantly).**
- This is called the **Concurrency model of JS**. This is the logic behind setTimeout's trust issues.

The First rule of JavaScript: Do not block the main thread (as JS is a single-threaded (there is only 1 call stack) language). In the below example, we are blocking the main thread. Observe Questions and Output.

Q setTimeout guarantees that it will take at least the given timer to execute the code.
Ans- JS is a **synchronous** single-threaded language. With just 1 thread it runs all pieces of code.JS has a just-in-time interpreter language, and runs code very fast inside the browser (no need to wait for code to be compiled) (JIT - Just in time compilation). And there are still ways to do async operations as well.



What if timeout inside setTimeout is set to 0 sec?

```
console.log("Start");
setTimeout(function cb() {
  console.log("Callback");
}, 0);
console.log("End");

// Even though timer = 0s, the cb() has to go through the queue. Registers
calback in webapi's env , moves to callback queue, and execute once callstack
is empty.
// O/p - Start End Callback
// This method of putting timer = 0, can be used to defer a less imp function
by a little so the more important function(here printing "End") can take place
```

– Episode-18(Season-1 -> Higher-Order Functions ft. Functional Programming)

Q: What is a Higher Order Function?
Ans: Higher-order functions are regular functions that **take** other functions as **arguments** or **return** functions as their result.
Eg :

```
function x() {
console.log("Hi)";
};
function y(x) { x();
};
y();

// Hi
// y is a higher order function
// x is a callback function
```

Let's try to understand how we should approach a solution in an interview. I have an array of radius and I have to calculate the area using this radius and store it in an array.

FIrst Approach

```
const radius = [1, 2, 3, 4];

const calculateArea =
  function (radius) {
  const output = [];

  for (let i = 0; i < radius.length; i++) {

    output.push(Math.PI * radius[i] * radius[i]);

  }

  return output;

};

console.log(calculateArea(radius));
```

The above solution works perfectly fine but what if we have now a requirement to calculate an array of circumferences? Code now be like :

```
const radius = [1, 2, 3, 4];

const calculateCircumference =
  function (radius) {const
  output = [];

  for (let i = 0; i <
    radius.length; i++)
    {output.push(2 *
    Math.PI *
    radius[i]);

  }

  return output;

};

console.log(calculateCircumference(radius));
```

But over here we are violating the **DRY(Don’t Repeat Yourself)** Principle, now let's observe the better approach.

```
const radiusArr = [1, 2, 3, 4];
// logic to calculate area
const area = function (radius)
{
return Math.PI * radius * radius;
}

// logic to calculate circumference
const circumference = function (radius) { return 2 * Math.PI * radius;
}
const calculate = function(radiusArr, operation) { const output = [];

for (let i = 0; i < radiusArr.length; i++) {
output.push(operation(radiusArr[i]));
}
return output;
}
console.log(calculate(radiusArr, area));
console.log(calculate(radiusArr, circumference));
```

- Over here calculate is **HOF**
- We have extracted logic into separate functions. This is the beauty of functional programming.
- Polyfill of map Over here calculates nothing but polyfill of map function console.log(radiusArr.map(area))==console.log(calculate(radiusArr, area));
- Let's convert the above calculate function as a map function and try to use it.

```
Array.prototype.calculate = function(operation) { const output = [];
for (let i = 0; i < this.length; i++) { output.push(operation(this[i]));
}
return output;
}
console.log(radiusArr.calculate(area))
```

– Episode-19(Season-1 -> map, filter & reduce)

Map function :
It is basically used to transform an array. The map() method **creates a new array** with the results of calling a function for every array element.
const output = arr.map(function)
//This function tells the map what transformation I want on each element of the array

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

// Task 1: Double the array
element: [10, 2, 6, 4, 12]function
double(x) {

  return x * 2;

}

const doubleArr = arr.map(double); // Internally map will run
double function for eachelement of array and create a new array
and returns it.

console.log(doubleArr); // [10, 2, 6, 4, 12]
```

So basically the map function **maps each and every value** in the array and transforms it based on a given condition.

Filter function: Filter function is used to filter the value inside an array. The arr. filter() method is used to create a new array from a given array consisting of only those elements from the given array that satisfy the given condition.

```
const array = [5, 1, 3, 2, 6];
// filter odd values
function isOdd(x) {
  return x % 2;
}
const oddArr = array.filter(isOdd); // [5,1,3]

// Other way of writing the above:
const oddArr = arr.filter((x) => x % 2);
```

The filter function creates an array and stores only those values which evaluated as true.

Reduce function:
It is used to reduce the array to a **single** value and executes a provided function for each value of the array (from left to right) and the **return** value of the function is stored in an **accumulator**.

```
const array = [5, 1, 3, 2, 6];
// Calculate sum of elements of array - Non functional programming way

function findSum(arr) {
  let sum = 0;
  for (let i = 0; i < arr.length; i++) {
    sum = sum + arr[i];
  }
  return sum;
}
console.log(findSum(array)); // 17

// reduce function way
const sumOfElem = arr.reduce(function (accumulator, current) {
  // current represent the value of array
  // accumulator is used the result from element of array.
  // In comparison to previous code snippet, *sum* variable is *accumulator*
and *arr[i]* is *current*
  accumulator = accumulator + current;
  return accumulator;
}, 0); //In above example sum was initialized with 0, so over here accumulator
also needs to be initialized,
// so the second argument to reduce function represent the initialization
value.
console.log(sumOfElem); // 17
```

Function Chaining

```
const users = [
  { firstName: "Raj", lastName: "Pujari", age: 23 },
  { firstName: "Abhi", lastName: "Kumar", age: 27 },
  { firstName: "Ankit", lastName: "Pandey", age: 25 },
  { firstName: "Ravi", lastName: "Ashwin", age: 50 },
];

// function chaining
const output = users
  .filter((user) => user.age < 30)
  .map((user) => user.firstName);
console.log(output); // ["Raj", "Abhi", "Ankit"]
// Homework challenge: Implement the same logic using reduce
const outputs = users.reduce((acc, curr) => {
  if (curr.age < 30) {
    acc.push(curr.firstName);
  }
  return acc;
}, []);
console.log(outputs); // ["Raj", "Abhi", "Ankit"]
```

Shallow Copy & Deep Copy Of Array in JS

A shallow copy is a type of **object or array copy** that creates a new object or array, but the nested objects and arrays within the original object are still referenced. This means that although the top-level structure is copied, any changes made to the nested objects or arrays will be reflected in both the original and the copied object.

Eg:-

```
//shallow copy-eg

const originalObject = {
  name: "John",
  age: 30,
  hobbies: ["reading", "painting"],
};

// const copiedObject = Object.assign({}, originalObject);

const copiedObject = originalObject;
// console.log(originalObject);
// console.log(copiedObject);

originalObject.name = "Jane";

// console.log("AFTER-MODIFIYING-NAME");
// console.log(originalObject);
// console.log(copiedObject);
```

Deep-Copy

A deep copy in JavaScript creates an entirely **new object or array**, including all nested objects and arrays. In other words, a deep copy duplicates the entire data structure, ensuring that any modifications made to the original object or its nested objects do not affect the copied object.

Eg-

```
// deep-copy-eg

const OriginalObject = {
  name: "John",
  age: 30,
  hobbies: ["reading", "painting"],
};

const CopiedObject = JSON.parse(JSON.stringify(OriginalObject));

console.log(OriginalObject); // { name: 'John', age: 30, hobbies: ['reading', 'painting'] }
console.log(CopiedObject); // { name: 'John', age: 30, hobbies: ['reading', 'painting'] }

// Modifying a property in the original object
OriginalObject.name = "Jane";

console.log("AFTER-MODIFIYING-NAME");
console.log(OriginalObject); // { name: 'Jane', age: 30, hobbies: ['reading', 'painting'] }
console.log(CopiedObject); // { name: 'John', age: 30, hobbies: ['reading', 'painting'] }


// Modifying a nested array
OriginalObject.hobbies.push("cooking");

console.log("AFTER-MODIFIYING-NESTED-OBJECT");
console.log(OriginalObject); // { name: 'Jane', age: 30, hobbies: ['reading', 'painting',
'cooking'] }
console.log(CopiedObject); // { name: 'John', age: 30, hobbies: ['reading', 'painting'] }
```