Lesson 5-6

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[What we learnt last time?]

- What is loop?
- Types of loops in Javascript
- Breaking the loop
- Jumping to the next loop iteration

[Our targets for today]

- Functions in Javascript
- Passing functions as arguments
- Scope of various types of variables
- Debugging Javascript code

[Functions]

→ Quite often we need to perform a similar action in many places of the script
  → For example, we need to show a nice-looking message when a visitor logs in, logs out and maybe somewhere else

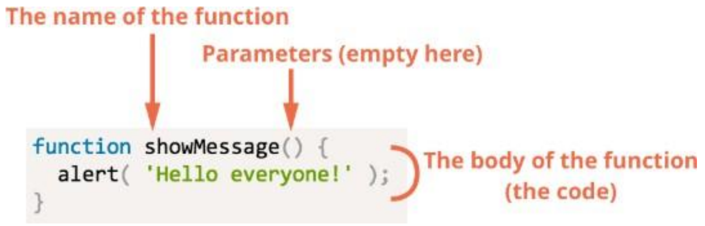
→ Functions are the main “building blocks” of the program

→ They allow the code to be called many times without repetition

→ We’ve already seen examples of built-in functions, like alert(message) and prompt(message, default), but we can create functions of our own as well

[Function Declaration]

→ To create a function we can use a *function declaration*:



```
function showMessage() {
  alert( 'Hello everyone!' );
}
```

→ Our new function can be called by its name: showMessage()

```
function showMessage() {
        alert('Hello everyone!');
}
showMessage();
showMessage();
```

→ The call showMessage() executes the code of the function

→ This example clearly demonstrates one of the main purposes of functions: avoid code duplication

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[Local Variables]

→ A variable declared inside a function is only visible inside that function.

→ For example:

```
function showMessage() {
    let message = 'Hello, I'm JavaScript!'; // local variable
    alert(message);
}
showMessage(); // Hello, I'm JavaScript!
alert(message); // <-- Error! The variable is local to the function
```

Global Variables

→ Variables declared outside of any function, are called *global*

→ Global variables are visible from any function

```
let userName = 'John';
function showMessage() {
    let message = 'Hello, ' + userName;
    alert(message);
}
showMessage(); // Hello, John
```

→ If a same-named variable is declared inside the function, it *shadows* the outer one:

```
let userName = 'John';
function showMessage() {
    let userName = 'Bob'; // declare a local variable
    let message = 'Hello,' + userName; // Bob
    alert(message);
}
// the function will create and use its own userName
showMessage();
alert(userName); // John, unchanged, the function did not access the outer variable
```

[DAN.IT] EDUCATION

Global Variables

→ Usually, a function declares all variables specific to its task

→ Global variables only store project-level data, so when it’s important that these

→ variables are accessible from anywhere

→ Modern code has few or no globals

→ Most variables reside in their functions

[Parameters]

→ We can pass arbitrary data to functions using parameters (also called *function arguments*)

→ In the example below, the function has two parameters: from and text

```
function showMessage(from, text) { // arguments: from, text
    alert(from + ': ' + text);
}

showMessage('Ann', 'Hello!'); // Ann: Hello!
showMessage('Ann', "What's up?"); // Ann: What's up?
```

→ When the function is called, the given values are copied to local variables from and text, i.e. the arguments are passed **by-value**

[DAN.IT] EDUCATION

Pass By Value

→ If a function changes one of its parameters, the change is not seen outside, because a function always gets a copy of the value:

```
function showMessage(from, text) {
    from = '*' + from + '*'; // make "from" look nicer
    alert(from + ': ' + text);
}

let from = 'Ann';
showMessage(from, 'Hello'); // *Ann*: Hello

// the value of "from" is the same, the function modified a local copy
alert(from); // Ann
```

[Default Values]

→ If a parameter is not provided, then its value becomes undefined

→ For instance, the function showMessage(from, text) can be called with a single argument:

```
showMessage('Ann');
```

→ That’s not an error. Such a call would output "Ann: undefined"

→ There’s no text, so it’s assumed that text === undefined

→ If we want to use a “default” text in this case, then we can specify it after =:

```
function showMessage(from, text = 'no text given') {
    alert(from + ": " + text);
}

showMessage('Ann'); // Ann: no text given
```

→ Now if the text parameter is not passed, it will get the value "no text given"

[Default Parameters Old-Style]

- → Old editions of JavaScript (before ES6) did not support default parameters
- → There are alternative ways to support them, that you can find mostly in older scripts
- → For instance, an explicit check for being undefined:

```
function showMessage(from, text) {
  if (text === undefined) {
      text = 'no text given';
  }

   alert(from + ": " + text);
}
```

- → Or the || operator:

```
function showMessage(from, text) {
    // if text is falsy then text gets the "default"
    value  text = text || 'no text given';
    ...
}
```

[Returning a Value]

→ A function can return a value back into the calling code as the result

→ The simplest example would be a function that sums two values:

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

let result = sum(1, 2);
alert(result); //3
```

→ The directive **return** can be in any place of the function

→ When the execution reaches it, the function stops, and the value is returned to the calling code

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[Returning a Value]

→ It is possible to use return without a value - that causes the function to exit immediately. For example:

```
function showMovie(age) {
    if (age < 18)
        return;

    alert('Showing you the movie');
}
```

→ If a function does not return a value, it is the same as if it returns undefined:

```
function doNothing() { /* empty */ }

alert(doNothing() === undefined); // true
```

Naming Functions

- → A function name should clearly describe what the function does
- → When we see a function call in the code, a good name instantly gives us an understanding what it does and returns
- → A function is an action, thus it is a widespread practice to start a function with a verbal prefix which vaguely describes the action
- → For instance, functions starting with…
  - → "show…" – usually show something.
  - → "get…" – return a value
  - → "calc…" – calculate something
  - → "create…" – create something
  - → "check…" – check something and return a boolean

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One Function – One Action

→ Functions should be short and do exactly one thing

→ Two independent actions usually deserve two functions, even if they are usually

→ called together (in that case we can make a 3rd function that calls those two)

→ A separate function is not only easier to test and debug – its very existence is a great comment!

→ A few examples of breaking this rule:

  → getAge – would be bad if it shows an alert with the age (should only get)

  → createForm – would be bad if it modifies the document, adding a form to it (should only create it and return)

  → checkPermission – would be bad if displays the access granted/denied message (should only perform the check and return the result)

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Exercise (1)

→ Write a function pow(x,n) that returns x in power n, or in other words, multiplies x by itself n times and returns the result
  → e.g., pow(3, 4) = 3 * 3 * 3 * 3 = 81

→ The function should support only natural values of n (i.e., integer from 1 up)

→ Create a web page that prompts for x and n, and then shows the result of pow(x,n)

Exercise (2)

- → Write a function **isPrime**(n) that gets a natural value of n and returns a boolean indicating is n is a prime number or not
- → A prime number is a natural number that divides only by 1 and itself
  - → e.g., 7, 11 and 13 are prime numbers while 8, 12 and 15 are not primes
- → Write another function **showPrimes**(n) that outputs all the prime numbers up to n
  - → This function should use isPrime(n) to test for primality
- → Create a web page that prompts for n, and then shows all the prime numbers up to n

[Function Expressions]

→ The **function** keyword can be used to define a function inside an expression

```
let getRectArea = function (width, height) {
    return width * height;
}

console.log(getRectArea(3, 4)); // 12
```

→ The function name can be omitted in function expression, in which case the function is **anonymous**

→ Function expressions in JavaScript are not hoisted, unlike function declarations, i.e., you can't use function expressions before you define them:

```
notHoisted(); // ReferenceError: notHoisted is not a function

let notHoisted = function () {
    console.log('test');
};
```

[Functions as Values]

→ In JavaScript, a function is a value, so we can work with it like with other kinds of values

→ For example, we can copy a function to another variable:

```
function sayHi() {      // (1) create
    alert('Hello');
}

let func =  sayHi;      // (2) copy

func(); // Hello     // (3) run the copy (it works)!
sayHi(); // Hello    // this still works too (why wouldn't it)
```

Callback Functions

→ You can also pass functions as arguments to other functions

→ For example, we will write a function ask(question, yes, no) with 3 parameters:

  → question – text of the question

  → yes - Function to run if the answer is “Yes”

  → no - Function to run if the answer is “No”

→ The function asks the question and depending on the user’s answer calls yes() or no():

```
function ask(question, yes, no) {
     if (confirm(question)) yes()
     else no();
}
function showOk() {
     alert('You agreed.');
}
function showCancel() {
     alert('You  canceled  the execution.');
}
// usage: functions showOk, showCancel are passed as arguments to ask
ask('Do you agree?', showOk, showCancel);
```

[Callback Functions]

→ The arguments of ask are called ***callback functions*** or just ***callbacks***

→ The idea is that we pass a function and expect it to be “called back” later if necessary

→ In our case, showOk becomes the callback for the “yes” answer, and showCancel for the “no”

→ We can use Function Expressions to write the same function much shorter:

```
function ask(question, yes, no) {
    if (confirm(question)) yes()
    else no();
}

ask(
    'Do you agree?',
    function() { alert('You agreed.'); },
    function() { alert('You canceled the execution.'); }
);
```

→ Here, functions are declared right inside the ask(...) call. They have no name, and so are called *anonymous*. Such functions are not accessible outside of ask, but that’s just what we want here.

Arrow Functions

→ There’s one more very simple and concise syntax for creating functions, that’s often better than Function Expressions

→ It’s called “arrow functions”, because it looks like this:

```
let func = (arg1, arg2, ...argN) => expression
```

→ This creates a function func that has arguments arg1…argN, evaluates the expression on the right side with their use and returns its result

→ It’s roughly the same as:

```
let func = function(arg1, arg2, ...argN) {
    return expression;
}
```

Arrow Functions

→ Example:

```
let sum = (a, b) => a + b;
/* The arrow function is a shorter form of:

let sum = function(a, b)
    {  return a + b;
};
*/

alert(sum(1, 2)); // 3
```

→ If we have only one argument, then parentheses can be omitted:

```
let double = n => n * 2;
    // same as
// let double = function(n) { return n * 2 }

alert(double(3)); // 6
```

Arrow Functions

→ If there are no arguments, parentheses should be empty:

```
let sayHi = () => alert("Hello!");

sayHi();
```

→ Arrow functions can also be used as callback functions:

```
function ask(question, yes, no) {
    if (confirm(question)) yes()
    else no();
}

ask(
    'Do you agree?',
    () => alert('You agreed.'),
    () => alert('You canceled the execution.')
);
```

Multiline Arrow Functions

→ Sometimes arrow functions need to be a little bit more complex, like having multiple expressions or statements

→ It is also possible, but we should enclose them in curly braces, and then use a normal return within them

```
let sum   =  (a, b)  =>  {   // the curly brace opens a multiline function
    let result = a + b;
    return result; // if we use curly braces, use return to get results
};

alert(sum(1, 2)); // 3
```

[Summary]

- ➔ Functions are values. They can be assigned, copied or declared in any place of the code.
- ➔ If the function is declared as a separate statement in the main code flow, that’s called a “Function Declaration”.
- ➔ If the function is created as a part of an expression, it’s called a “Function Expression”.
- ➔ Function Declarations are processed before the code block is executed. They are visible everywhere in the block.
- ➔ Function Expressions are created when the execution flow reaches them.
- ➔ We should use a Function Expression only when a Function Declaration is not fit for the task.
- ➔ Arrow functions are handy for one-liners. They come in two flavors:
  - ➔ Without curly braces: (...args) => expression – the right side is an expression: the function evaluates it and returns the result.
  - ➔ With curly braces: (...args) => { body } – brackets allow us to write multiple statements inside the function, but we need an explicit return to return something.

[Exercise (3)]

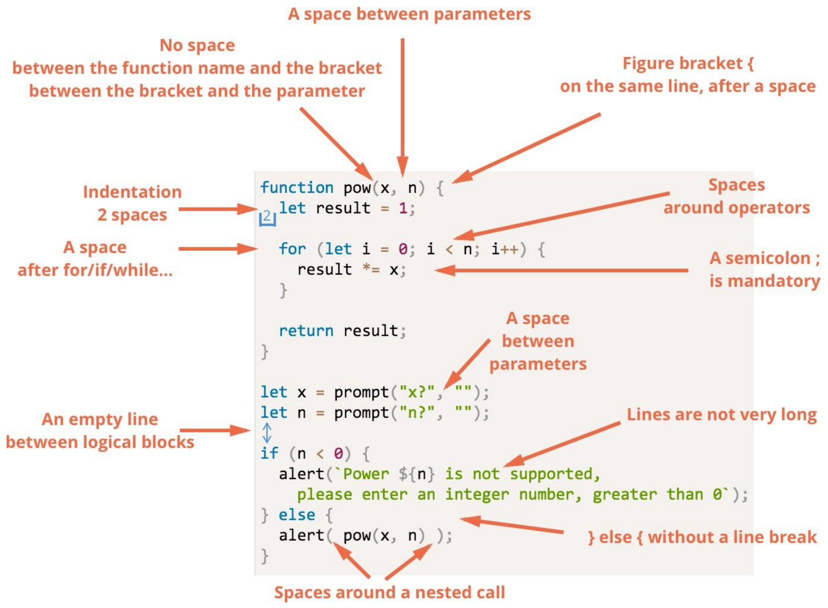
→ Replace the functions grantAccess() and denyAccess() below with arrow functions:

```
function checkAge(age, granted, denied) {
     if (age < 18) denied();
     else granted();
}

let age = prompt('What is your age?', 18);

function grantAccess() {
     alert('Access granted');
}

function denyAccess() {
     alert('Access denied');
}

checkAge(age, grantAccess, denyAccess);
```

Coding Style

→ Our code must be as clean and easy to read as possible

→ You should follow the following coding style rules:


A space between parameters
No space between the function name and the bracket between the bracket and the parameter
Figure bracket { on the same line, after a space
Indentation 2 spaces
Spaces around operators
A space after for/if/while…
A semicolon ; is mandatory
A space between parameters
An empty line between logical blocks
Lines are not very long
} else { without a line break
Spaces around a nested call

```
function pow(x, n) {
  let result = 1;

  for (let i = 0; i < n; i++) {
    result *= x;
  }

  return result;
}

let x = prompt("x?", "");
let n = prompt("n?", "");

if (n < 0) {
  alert(`Power ${n} is not supported,
    please enter an integer number, greater than 0`);
} else {
  alert( pow(x, n) );
}
```

Debugging in Chrome

→ All modern browsers support “debugging” – a special UI in developer tools that makes finding and fixing errors much easier

→ We’ll be using Chrome here, because it’s probably the most feature-rich in this aspect

→ Create the following example page and open it in Chrome:

```
function ask(question, yes, no) {
    if (confirm(question)) yes()
    else no();
}
function showOk() {
    alert('You agreed.');
}
function showCancel() {
    alert('You canceled the execution.');
}
// usage: functions showOk, showCancel are passed as arguments to ask
ask('Do you agree?', showOk, showCancel);
```

[Debugging in Chrome]

→ All modern browsers support “debugging” – a special UI in developer tools that makes finding and fixing errors much easier

→ We’ll be using Chrome here, because it’s probably the most feature-rich in this aspect

→ Create the following index.html page and hello.js script:

```html
<!DOCTYPE html>
<html>
<head>
    <title></title>
</head>
<body>
    <script src="hello.js"></script>

    An example for debugging.

    <script>
        hello("John");
    </script>
</body>
</html>
```

```javascript
// hello.js
function hello(name) {
    let phrase = `Hello, ${name}!`;
    say(phrase);
}

function say(phrase) {
    alert(`** ${phrase} **`);
}
```

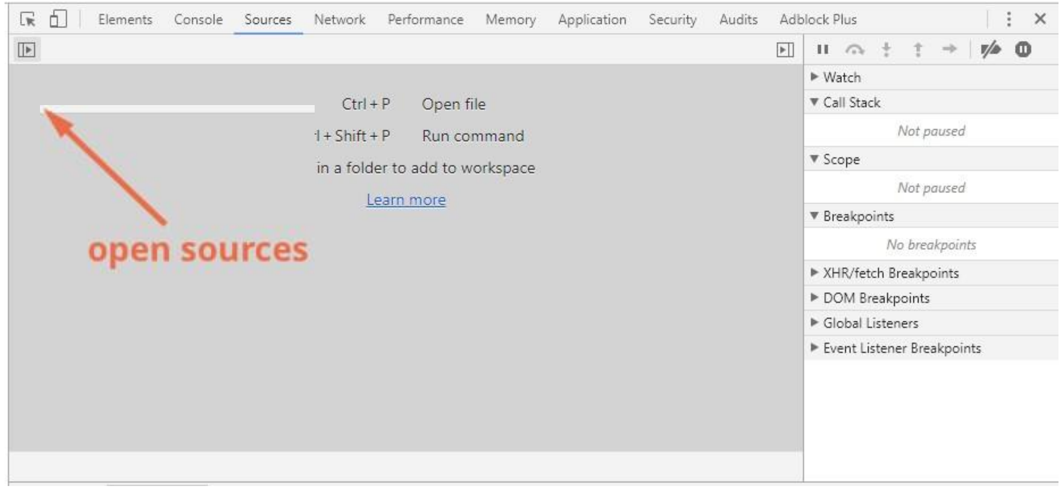
[Debugging in Chrome]

→ Open the HTML page in Chrome

→ Turn on developer tools with F12

→ Select the sources pane

→ Here's what you should see if you are doing it for the first time:



Debugging in Chrome

→ The toggler button opens the tab with files

→ Let's click it and select index.html and

→ then hello.js in the tree view

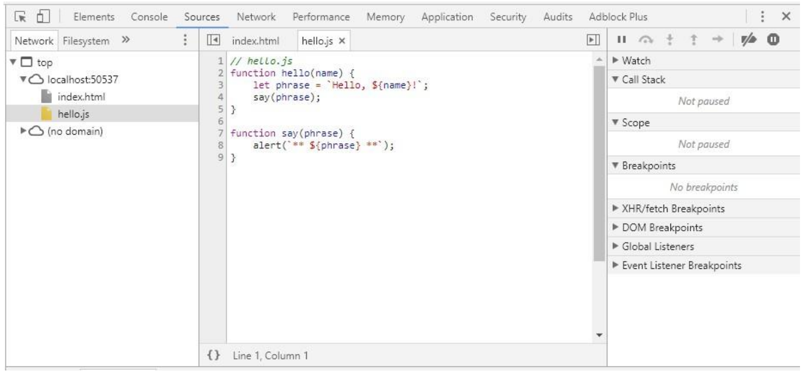
→ Here we can see three zones:

  → The **Resources zone** lists HTML, JavaScript, CSS and other files, including images that are attached to the page

  → The **Source zone** shows the source code

  → The **Information and control zone** is for debugging, we'll explore it soon

→ Now you could click the same toggler again to hide the resources list and give the code some space



```
// hello.js
function hello(name) {
    let phrase = `Hello, ${name}!`;
    say(phrase);
}

function say(phrase) {
    alert(`** ${phrase} **`);
}
```

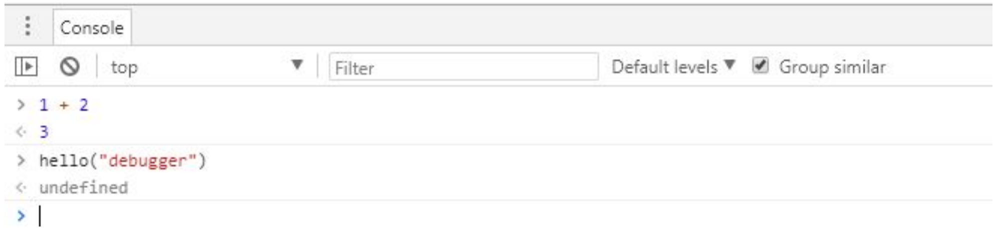
[Console]

→ If we press Esc, then a console opens below

→ We can type commands there and press Enter to execute

→ After a statement is executed, its result is shown below.

→ For example, here 1+2 results in 3, and hello("debugger") returns nothing, so the result is undefined:



```
> 1 + 2
< 3
> hello("debugger")
< undefined
> |
```

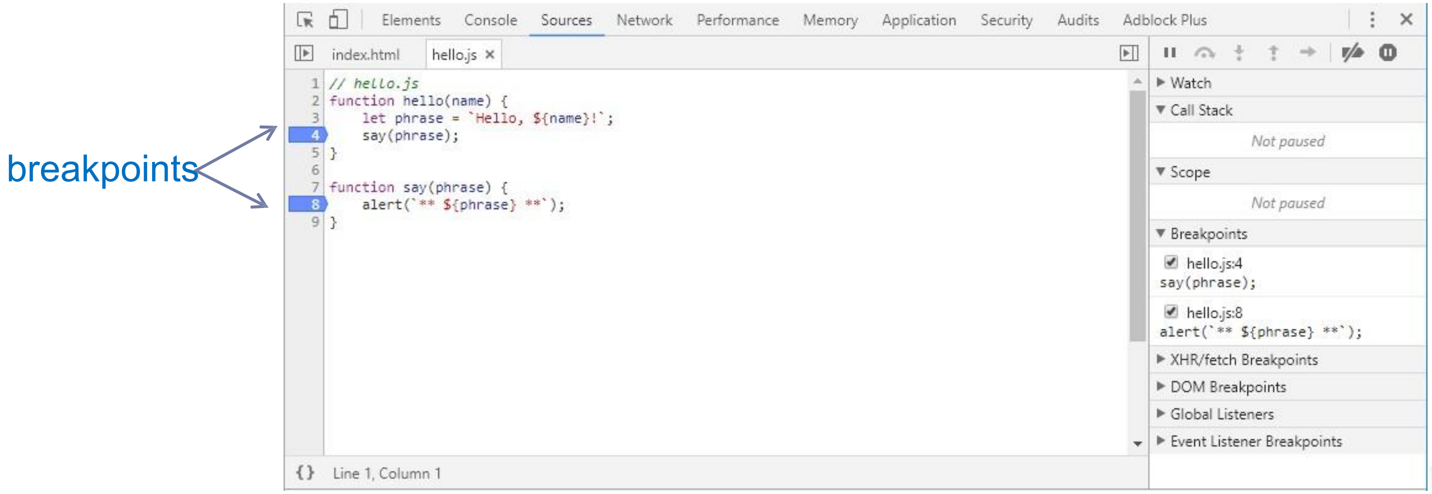
Breakpoints

→ Let's examine what's going on within the code of the example page

→ In hello.js, click at line number 4. Yes, right on the 4 digit, not on the code.

→ Congratulations! You've set a breakpoint. Please also click on the number for line 8.

→ It should look like this (blue is where you should click):



```
1 // hello.js
2 function hello(name) {
3     let phrase = `Hello, ${name}!`;
4     say(phrase);
5 }
6
7 function say(phrase) {
8     alert(`** ${phrase} **`);
9 }
```

☑ hello.js:4
```
say(phrase);
```

☑ hello.js:8
```
alert(`** ${phrase} **`);
```

Breakpoints

→ A **breakpoint** is a point of code where the debugger will automatically pause the JavaScript execution

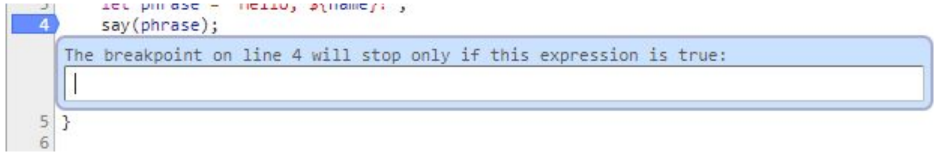
→ While the code is paused, we can examine current variables, execute commands in the console etc. In other words, we can debug it.

→ We can always find a list of breakpoints in the right pane

→ Right click on the line number allows to create a **conditional** breakpoint

  → It only triggers when the given expression is truthy

  → That's handy when we need to stop only for a certain variable value or for certain function parameters



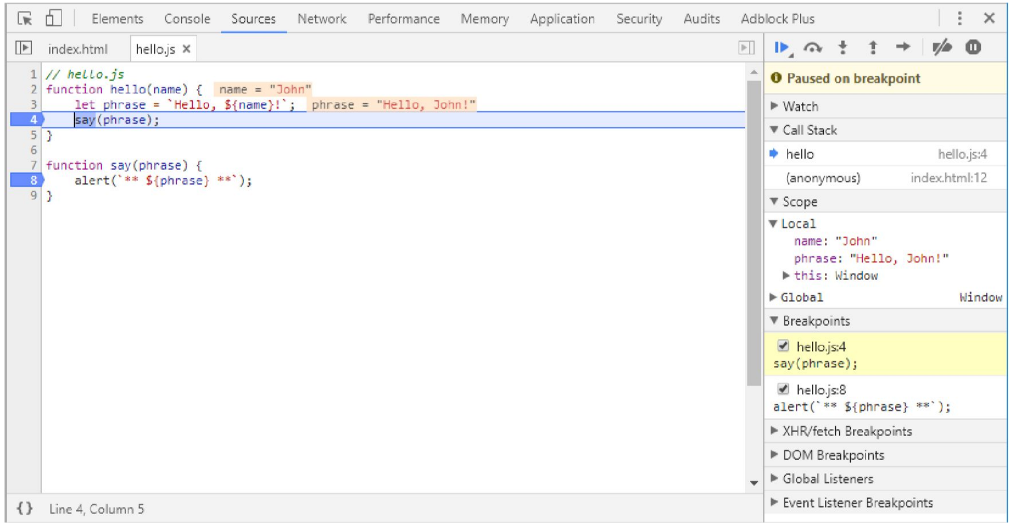
```
    let phrase = `Hello, ${name}!`;
4   say(phrase);
    The breakpoint on line 4 will stop only if this expression is true:

5   }
6
```

Pause and Look Around

→ In our example, hello() is called during the page load, so the easiest way to activate the debugger is to reload the page.

→ So let’s press F5 (Windows, Linux) or Cmd+R (Mac)

→ As the breakpoint is set, the execution pauses at the 4th line:



```
// hello.js
function hello(name) {   name = "John"
    let phrase = `Hello, ${name}!`;   phrase = "Hello, John!"
    say(phrase);
}

function say(phrase) {
    alert(`** ${phrase} **`);
}
```

```
name: "John"
phrase: "Hello, John!"
▶ this: Window
```

```
☑ hello.js:4
say(phrase);
☑ hello.js:8
alert(`** ${phrase} **`);
```

Pause and Look Around

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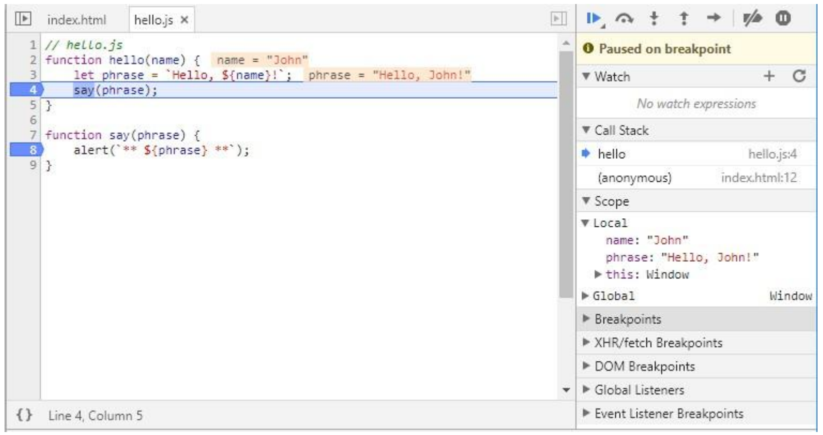


```
1  // hello.js
2  function hello(name) {   name = "John"
3      let phrase = `Hello, ${name}!`;   phrase = "Hello, John!"
4      say(phrase);
5  }
6
7  function say(phrase) {
8      alert(`** ${phrase} **`);
9  }
```

Line 4, Column 5

```
Paused on breakpoint
▼ Watch
    No watch expressions
▼ Call Stack
➡ hello                 hello.js:4
  (anonymous)           index.html:12
▼ Scope
▼ Local
    name: "John"
    phrase: "Hello, John!"
  ▶ this: Window
▶ Global                Window
▶ Breakpoints
▶ XHR/fetch Breakpoints
▶ DOM Breakpoints
▶ Global Listeners
▶ Event Listener Breakpoints
```

Watch – shows current values for any
expressions that you enter

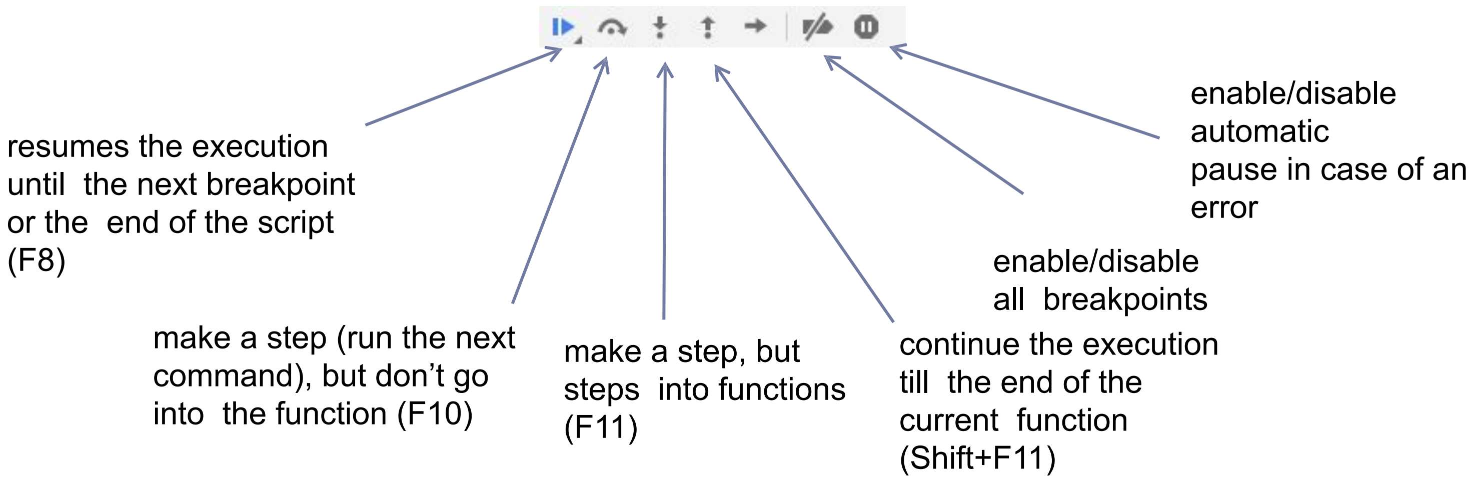
Call Stack – shows the nested calls chain. If you click on a stack item, the debugger jumps to the corresponding code

Scope – current variables.
Local shows local function variables. Global has global variables (out of any functions).

Tracing the Execution

→ Now it's time to *trace* the script

→ There are buttons for it at the top of the right pane



resumes the execution until the next breakpoint or the end of the script (F8)

make a step (run the next command), but don't go into the function (F10)

make a step, but steps into functions (F11)

continue the execution till the end of the current function (Shift+F11)

enable/disable all breakpoints

enable/disable automatic pause in case of an error

[Control questions]

1. What is function?
2. What are the ways to declare a function in Javascript?
3. What is a variable scope?
4. What is a global scope?
5. How type of variable influences it’s scope?
6. What is a callback?
7. What is arrow function?
8. How can you debug your code?