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JAVASCRIPT

Web Tech
SET08101

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TL/DR

JavaScript is how we add dynamism to our web pages…

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AIMS

- At the end of this (sub-section) of the topic you will be able to:
  - Understand the role that JavaScript plays amongst the other core web technologies
  - Gain an understanding of the core JavaScript syntax
  - How JavaScript interacts with HTML, CSS, & the Browser

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JAVASCRIPT

- The third part of our triumvirate of web technologies (alongside HTML & CSS)
- Separates functionality (or behaviour) from a web page's content & presentation
- A high-level, dynamic, weakly typed, prototype-based, multi-paradigm, interpreted programming language.
- Originally a project at Netscape which lead to the first Javascript implementation
- This was then formalised to produce the ECMAScript specification which anyone can implement to produce their own variation. NB. The name "Javascript" itself is a trademark of Oracle
- No single Javascript implementation - different engines in most web browsers - each implements ECMAScript specification to varying degrees (some feature might be missing & some engines have additional features)

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THE LANGUAGE

- Multi-paradigm - so can support different programming styles, e.g. event-driven, functional, imperative, OO,

- API for working with:
  - Text, arrays, dates, regular expressions, DOM manipulation

- No support for I/O, i.e. networking, storage, graphics - facilities which are generally provided by the host environment (browser API, server side libraries)

- Designed as a "*glue language*" - easy for web designers & part-time programmers to assemble components of web pages

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ASIDE: JAVA(SCRIPT)?

- Javascript & Java are two wholly separate languages
- For historical reasons there are some superficial similarities between the two:
  - Some syntax, standard libraries, & the name
- Brendan Eich was originally employed by Netscape to write a version of Scheme to run in the browser. Management made the decision that Javascript should "look like Java" (which was the *hot new thing* in the mid/late-90s)
- That all said, syntactically speaking Java isn't hugely different from its predecessors - *why might this be?*

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JS ENGINES

- Interpreted & VM based so requires an environment to live in: **JS Engine**
- Many engines, but some are more important than others
- V8 - the google chrome engine (also used in Node.js)
- Spidermonkey - Firefox engine
- JavaScriptCore - marketed as Nitro & used in Safari
- You can work with JS in the browser fairly easily.
- Can also install a standalone tool to run JS outside the browser (e.g. Node.js) - this enables Javascript to run server side

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WHAT'S JAVASCRIPT FOR?

- (slightly weird) General purpose programming language
- Web programming (it's raison d'être)
  - Primarily: Interacting with the DOM (for a given web page) and the user agent (via various Browser APIs)
  - Secondarily: Providing a server-side environment so that our core tools are (reasonably) cohesive - we'll get to this in a later topic (*for now we are staying client side*)

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WHAT DOES JS LOOK LIKE?

```
<!DOCTYPE html>
<html>
  <head>
    <title>Example</title>
  </head>
  <body>
    <button id="hellobutton">Hello</button>
    <script>
        document.getElementById('hellobutton').onclick = function() {
            alert('Hello world!');
            var myTextNode = document.createTextNode('Some new words.');
            document.body.appendChild(myTextNode);
        };
    </script>
  </body>
</html>
```

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USING JAVASCRIPT

- Similar to CSS, we have choices for how to integrate HTML with Javascript
- Inline, e.g.
  - <button id="hellobutton" onclick="alert('Hello World')">Click Me</button>
- Within a script block <script></script>, e.g.

```
<script>
    document.getElementById('hellobutton').onclick = function() {
        alert('Hello world');
    };
</script>
```

- Using an external script (placed within either <head> or <body>)
  - HTML 4:

    <script type="text/javascript" src="javascript.js"></script>

  - HTML 5:

    <script src="javascript.js"></script>

  - NB. Can use any number of scripts

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EVEN MORE SEPARATION

- Some JS developers want to go even further, i.e. if HTML describes document structure why do we have event handlers registered in HTML, e.g.

```
<input type="text" name="date" onchange="validateDate()" />
```

- Instead, give element an ID then use JS to add the handler to the element (identified by ID in the DOM), e.g. First remove onchange & add an ID:

```
<input type="text" name="date" id="date" />
```

- Now add an event listener to that element from JS:

```
window.addEventListener("DOMContentLoaded", function(event) {
    document.getElementById('date').addEventListener("change", validateDate);
});
```

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BROWSER CONSOLE JS

- Useful for learning JS & playing around without too much HTML & CSS (we'll quickly grow beyond this though)

- Gives us a little programming environment almost anywhere there is a (reasonably modern & not-locked-down) web browser.

- Let's look at some simple examples of how we can write JS directly in the browser console:

#1

HELLO NAPIER

New Tab

Search with DuckDuckGo or enter address

Inspector | Console | Debugger | Style Editor | Performance | Memory | Network

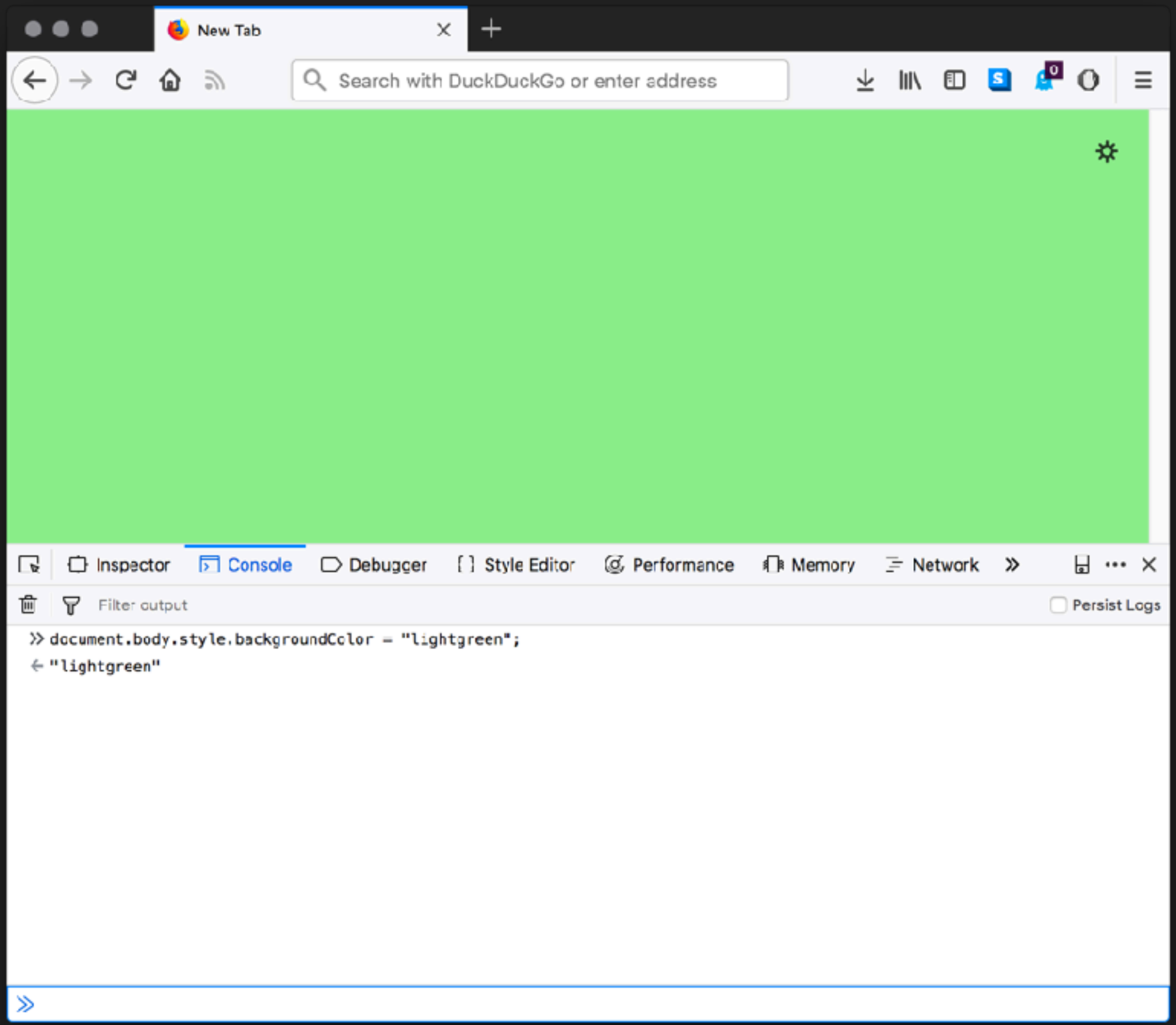
Filter output

Persist Logs

```
>> console.log('hello napier!!!')
   hello napier!!!                                   debugger eval code:1:1
<- undefined
```

#2

INTERACT WITH THE WEB PAGE/SCREEN


New Tab
Search with DuckDuckGo or enter address
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Debugger
Style Editor
Performance
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Network
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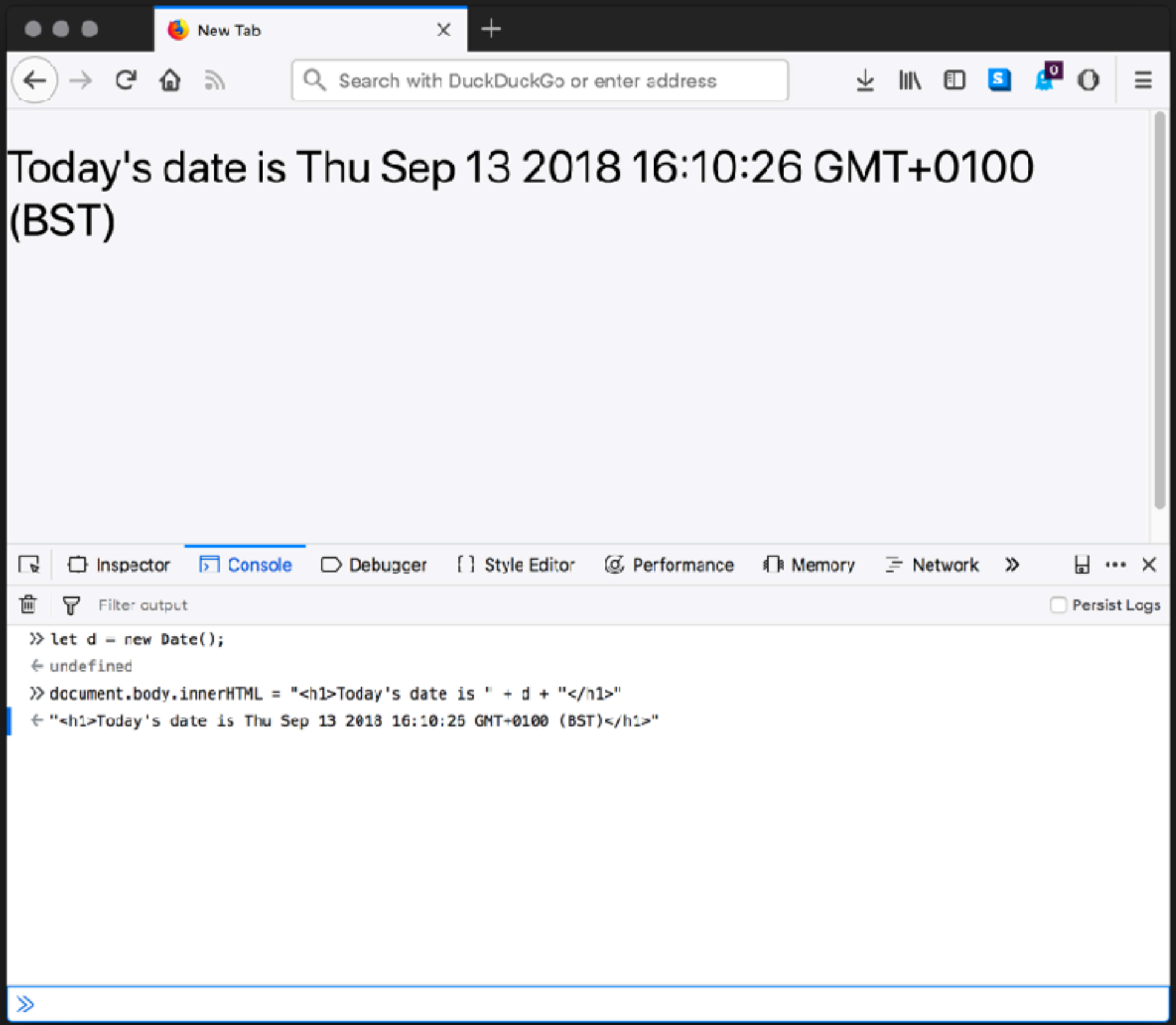
Persist Logs
document.body.style.backgroundCcolor = "lightgreen";
"lightgreen"

#3

USE STANDARD JAVASCRIPT FUNCTIONS


New Tab
Search with DuckDuckGo or enter address
Today's date is Thu Sep 13 2018 16:10:26 GMT+0100 (BST)
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Filter output
Persist Logs
let d = new Date();
undefined
document.body.innerHTML = "<h1>Today's date is " + d + "</h1>"
"<h1>Today's date is Thu Sep 13 2018 16:10:25 GMT+0100 (BST)</h1>"

#4

CONSTRUCT A WEB PAGE

New Tab

Search with DuckDuckGo or enter address

Hello Napier!!!

Inspector | Console | Debugger | Style Editor | Performance | Memory | Network

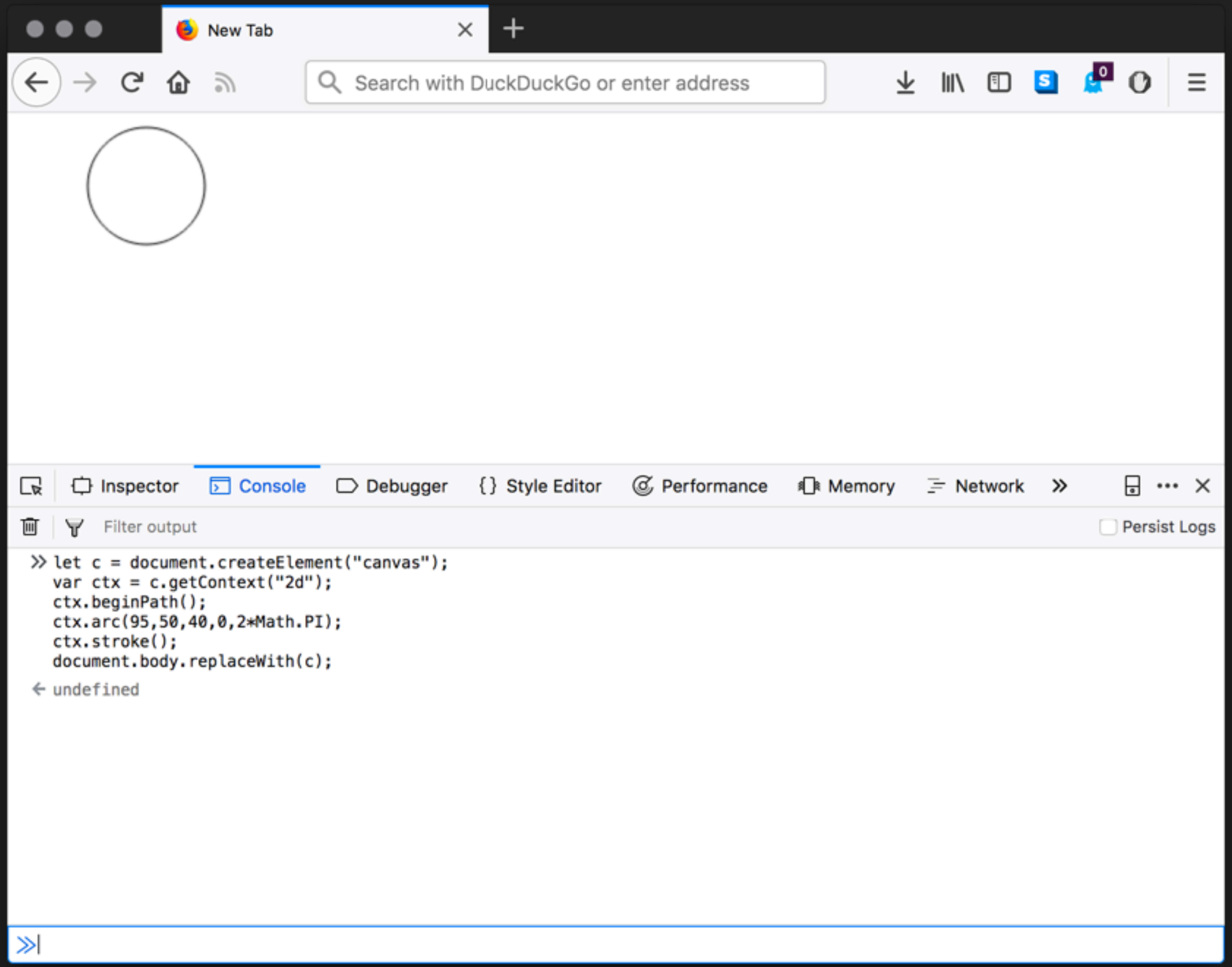
Filter output | Persist Logs

```
let p = document.createElement("P");
let t = document.createTextNode("Hello Napier!!!");
p.appendChild(t);
document.body.replaceWith(p);
```

undefined

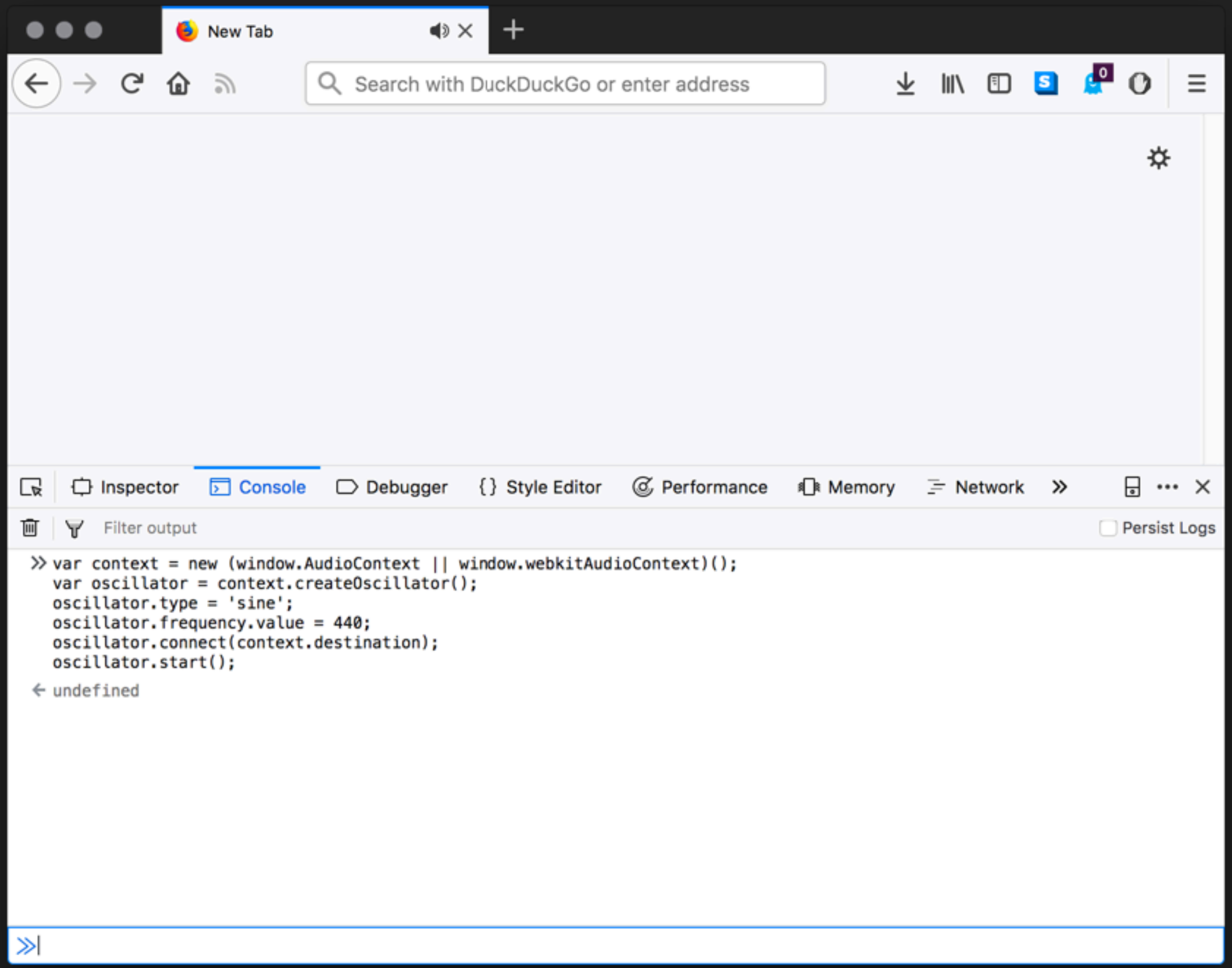
#5

GRAPHICS


New Tab
Search with DuckDuckGo or enter address
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Filter output
Persist Logs
let c = document.createElement("canvas");
var ctx = c.getContext("2d");
ctx.beginPath();
ctx.arc(95,50,40,0,2*Math.PI);
ctx.stroke();
document.body.replaceWith(c);
undefined

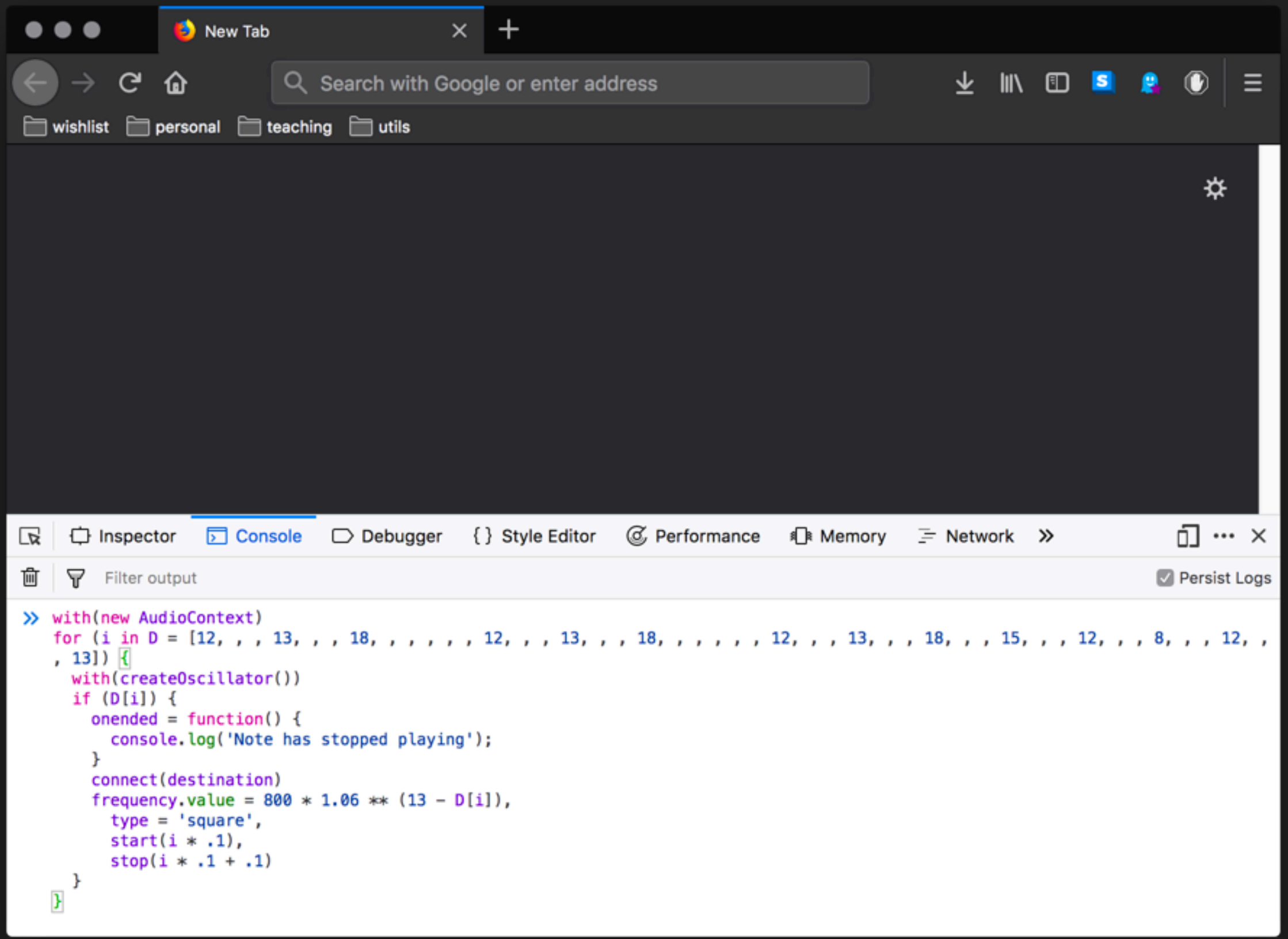
#6

SOUND - BEEPS


New Tab
Search with DuckDuckGo or enter address
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Filter output
Persist Logs
var context = new (window.AudioContext || window.webkitAudioContext)();
var oscillator = context.createOscillator();
oscillator.type = 'sine';
oscillator.frequency.value = 440;
oscillator.connect(context.destination);
oscillator.start();
undefined

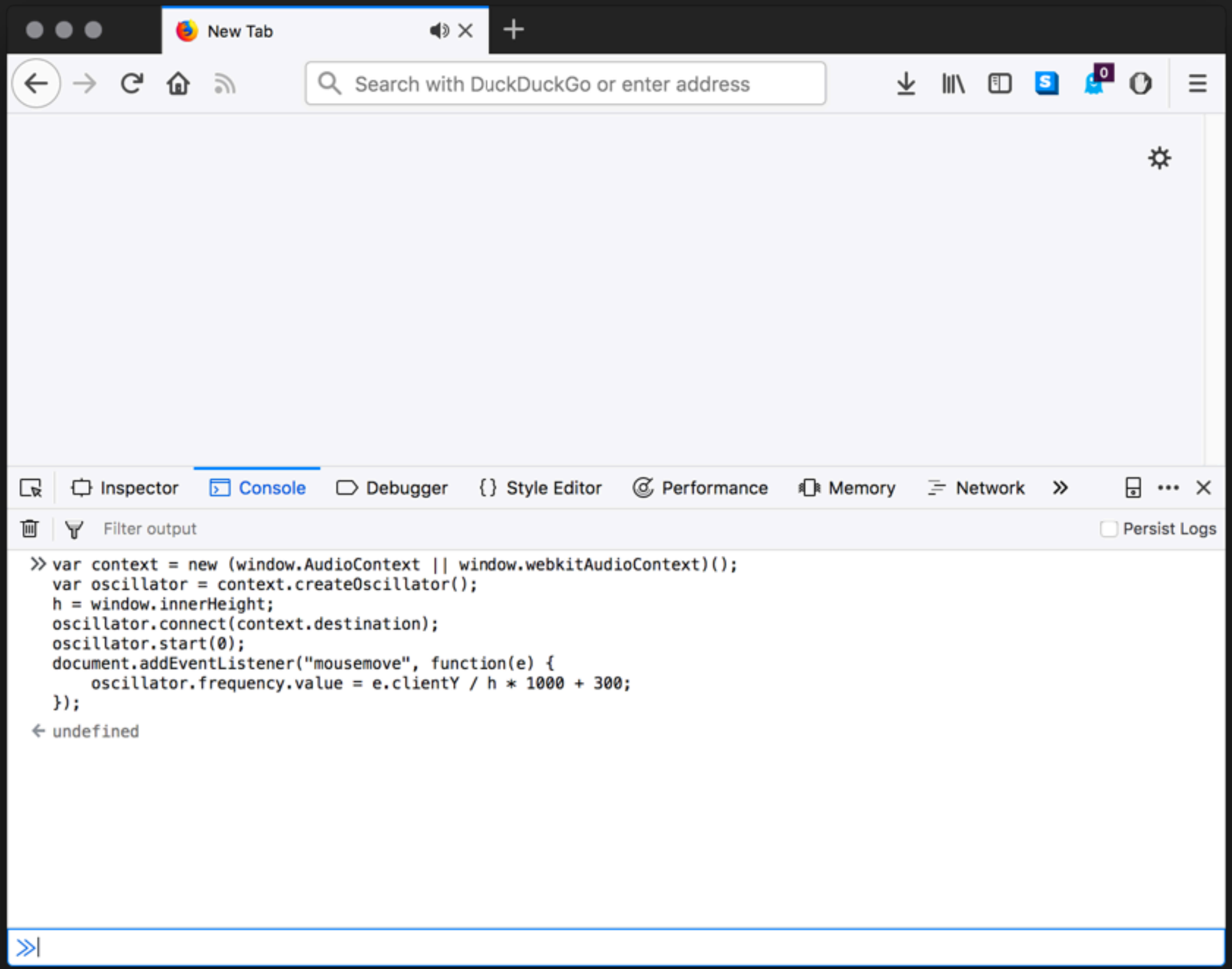
#7

SOUND - BIT TUNES


New Tab
Search with Google or enter address
wishlist
personal
teaching
utils
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Filter output
Persist Logs
» with(new AudioContext)
for (i in D = [12, , , 13, , , 18, , , , , , 12, , , 13, , , 18, , , , , , 12, , , 13, , , 18, , , 15, , , 12, , , 8, , , 12, ,
, 13]) {
with(createOscillator())
if (D[i]) {
onended = function() {
console.log('Note has stopped playing');
}
connect(destination)
frequency.value = 800 * 1.06 ** (13 - D[i]),
type = 'square',
start(i * .1),
stop(i * .1 + .1)
}
}

#8

SOUND - THEREMIN


New Tab
Search with DuckDuckGo or enter address
Inspector
Console
Debugger
Style Editor
Performance
Memory
Network
Filter output
Persist Logs
var context = new (window.AudioContext || window.webkitAudioContext)();
var oscillator = context.createOscillator();
h = window.innerHeight;
oscillator.connect(context.destination);
oscillator.start(0);
document.addEventListener("mousemove", function(e) {
oscillator.frequency.value = e.clientY / h * 1000 + 300;
});
undefined

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LANGUAGE FEATURES

- Case sensitive - Like all programming we have to be precise. Develop a habit for using case then stick to it
    - NB. I nearly always use lowercase (& snake_case rather than camelCase)
- Whitespace - spaces, tabs, newlines outside of strings are whitespaces. Generally not a problem. Choose a way to use whitespace then be consistent in laying out your code
- Semicolons are automatically inserted if you leave them out
    - This can interfere with the whitespace and cause valid code to be incorrectly parsed
    - So good practise to end statements with a semicolon

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KEYWORDS

- Avoid the following when naming variables, function names, or labels

- **JavaScript keywords:** abstract, arguments, await*, boolean, break, byte, case, catch, char, class*, const, continue, debugger, default, delete, do, double, else, enum*, eval, export*, extends*, false, final, finally, float, for, function, goto, if, implements, import*, in, instanceof, int, interface, let*, long, native, new, null, package, private, protected, public, return, short, static, super*, switch, synchronized, this, throw, throws, transient, true, try, typeof, var, void, volatile, while, with, yield

- **Built-in Objects, Properties, & Methods:** Array, Date, eval, function, hasOwnProperty, Infinity, isFinite, isNaN, isPrototypeOf, length, Math, NaN, name, Number, Object, prototype, String, toString, undefined, valueOf

- **HTML & Window objects & properties:** alert, all, anchor, anchors, area, assign, blur, button, checkbox, clearInterval, clearTimeout, clientInformation, close, closed, confirm, constructor, crypto, decodeURI, decodeURIComponent, defaultStatus, document, element, elements, embed, embeds, encodeURI, encodeURIComponent, escape, event, fileUpload, focus, form, forms, frame, innerHeight, innerWidth, layer, layers, link, location, mimeTypes, navigate, navigator, frames, frameRate, hidden, history, image, images, offscreenBuffering, open, opener, option, outerHeight, outerWidth, packages, pageXOffset, pageYOffset, parent, parseFloat, parseInt, password, pkcs11, plugin, prompt, propertyIsEnum, radio, reset, screenX, screenY, scroll, secure, select, self, setInterval, setTimeout, status, submit, taint, text, textarea, top, unescape, untaint, window

- **HTML Event Handlers:** onblur, onclick, onerror, onfocus, onkeydown, onkeypress, onkeyup, onmouseover, onload, onmouseup, onmousedown, onsubmit

COMMENTS

```
// A short, one line comment


/* a longer, multi-line
comment about something
that must be important */


/* Comments /* cannot be nested */ as this is a syntax error */
```

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VARIABLES

- Variables can be declared in three ways:
    - Block level using **let**
    - function level using **var** or **const**
- Don't have a type attached - any value can be stored in any variable
- Variable declared anywhere inside a function will resolve to that variable when it's named is used (within the function)
- Variable *value* is undefined until initialised, e.g. var a = 203
- Variables declared outside a function are *global*
- If a variable isn't found then a ReferenceError exception will happen

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PRIMITIVE DATATYPES

- Undefined, Null, Number, String, Boolean, Symbol
- Undefined - assigned to all uninitialised variables & returned where checking for object properties that don't exist
- Null - When something has been declared but the value is empty
- Numbers - IEEE754 doubles (floating point, use toFixed() to round) - accuracy to 16 significant digits
- Strings - sequence of characters enclosed in double quotes. Access individual letters using charAt(). Compare using ==
- Boolean - true & false. Useful for comparisons
- Symbol - New (ECMAScript 6). A unique & immutable identifier.

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NATIVE OBJECTS

- Arrays, Dates, Errors, Math, Regular Expressions, Functions
- Arrays - Objects representing lists of values indexed by keys. Keys are numeric & use zero based indexing. Can be multi-dimensional.
- Date - Object that stores a signed millisecond count from zero (representing 1970-01-01 00:00:00 UT). Various methods to access fields of data object
- Error - Object that can be used to create custom error messages
- Math - Object storing math-related constants, e.g. E, Natural Log, Pi, and functions, e.g. max, min, random
- Regular Expressions - Object used to store text patterns
- Function - Object constructed using the Function constructor & used to collect statements into reusable groups

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OPERATORS

- Arithmetic: +, -, *, /, %
- Unary: + (string to number), - (reverse sign), ++, —
- Assignment: =, +=, -+, *=, /=, %=
- Destructuring assignment: [a, b, c] = [3, 4, 5];
- Logical: !, ||, &&
- String: =, +, +=
- NB. Bitwise (operators & assignments), Ternary conditional

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CONTROL STRUCTURES

If...else

```
if (expr) {
  //statements;
} else if (expr2) {
  //statements;
} else {
  //statements;
}
```

Switch Statement

```
rswitch (expr) {
 case SOMEVALUE:
  // statements;
  break;
 case ANOTHERVALUE:
  // statements;
  break;
 default:
  // statements;
  break;
}
```

Conditional Operator

```
result = condition ? expression :
alternative;
```

LOOPING

For Loop

```
for (initial; condition; loop statement) {
  /*
   statements will be executed every time
   the for{} loop cycles, while the
   condition is satisfied
  */
 }
```

For In Loop

```
for (var property_name in some_object) {
  // statements using some_object[property_name];
}
```

While Loop

```
while (condition) {
  statement1;
  statement2;
  statement3;
  ...
}
```

Do… While Loop

```
do {
  statement1;
  statement2;
  statement3;
  ...
} while (condition);
```

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FUNCTIONS

Various ways to declare functions:

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

var add = function(x,y) { return x + y; };

var add = new Function('x','y','return x + y');
```

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OBJECTS

```
var cow = new Object();
cow.colour = 'brown';
cow.commonQuestion = 'What now?';
cow.moo = function(){
  console.log('moo');
}
cow.feet = 4;
cow.accordingToLarson = 'will take over the world';
```

```
var cow = {
  colour:'brown',
  commonQuestion:'What now?',
  moo:function(){
    console.log('moo);
  },
  feet:4,
  accordingToLarson:'will take over the world'
};
```

EXCEPTION HANDLING

- Handle run time errors by:
  - Trying to execute the statements
  - Catching any thrown exceptions
  - & Finally cleaning things up.

```
try {
  // Statements in which exceptions might be thrown
} catch(errorValue) {
  // Statements that execute in the event of an exception
} finally {
  // Statements that execute afterward either way
}
```

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ACCESSING THE DOM

```
<!DOCTYPE html> <html>

<head>
<title>SET08101 - Interacting with the DOM</title>

</head> <body >

<p><a href="#" onClick="addMessage();">Click Me</a></p> <h1>OUTPUT:</h1>
<p id="outputDemo"></p>

<script>
function addMessage() {

document.getElementById("outputDemo").innerHTML = "HELLO WORLD" }

</script> </body>

</html>
```

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JSON

- **J**ava**S**cript **O**bject **N**otation
  - Started as a way to serialise JavaScript Objects but now much more than that
- Has become a lightweight data interchange format
- Independent of language - we'll use it with JS but can be used directly with Python & many other languages have core/standard library support for it
- De facto way to send data between web servers & clients
- Text only. Easy to write. Easy to read, Easy to edit

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JSON SYNTAX

- Data stored in name:value pairs:

"name":"simon"

- Data is separated by commas

- Curly braces around objects

{"first_name":"simon","last_name":"wells"}

- Square brackets around arrays/lists:

```
"lecturers":[
  {"first_name":"simon","last_name":"wells"},
  {"first_name":"simon","last_name":"powers"}
]
```

- Might receive data & want to use it in our web interface (via JS):

- First create a string from the JSON:

```
var text = ‘ “lecturers”:[ ‘+
‘{“first_name”:”simon”,“last_name”:”wells”},‘ +
‘{“first_name”:”simon”,“last_name”:”powers”}] ‘;
```

- Parse a JS object from the string:

```
var obj = JSON.parse(text);
```

- Then use the object:

```
<p id=“lecturer”></p>
…
<script>
document.getElementById(“lecturer”).innerHTML =
  obj.lecturers[1].first_name + “ ” + obj.lecturers[1].last_name
</script>
```

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JAVASCRIPT BEST PRACTICES

- W3C: https://www.w3.org/wiki/JavaScript_best_practices
- Some are debatable but thinking about them **will** make you into a better web developer, e.g.
  - Call things by their name — easy, short and readable variable and function names
  - Avoid globals
  - Stick to a strict coding style
  - Comment as much as needed but not more
  - Avoid mixing with other technologies
  - Use shortcut notation when it makes sense
  - Modularise — one function per task
  - Enhance progressively
  - Allow for configuration and translation
  - Avoid heavy nesting
  - Optimize loops
  - Keep DOM access to a minimum
  - Don't yield to browser whims
  - Don't trust any data
  - Add functionality with JavaScript, don't create too much content
  - Build on the shoulders of giants
  - Development code is not live code

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SUMMARY

- The role that JavaScript plays amongst other web technologies
- Gain an understanding of the core JavaScript syntax
- How JavaScript interacts with HTML, CSS, & the Browser

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NEXT

- We'll take a look at Designing for the Web.

- Specifically the tools & techniques (& other miscellaneous stuff) the help us to put HTML, CSS, & JS to good use in producing robust, reliable, & well engineered web interfaces.