Understanding Synchronous and Asynchronous in JavaScript – Part 2

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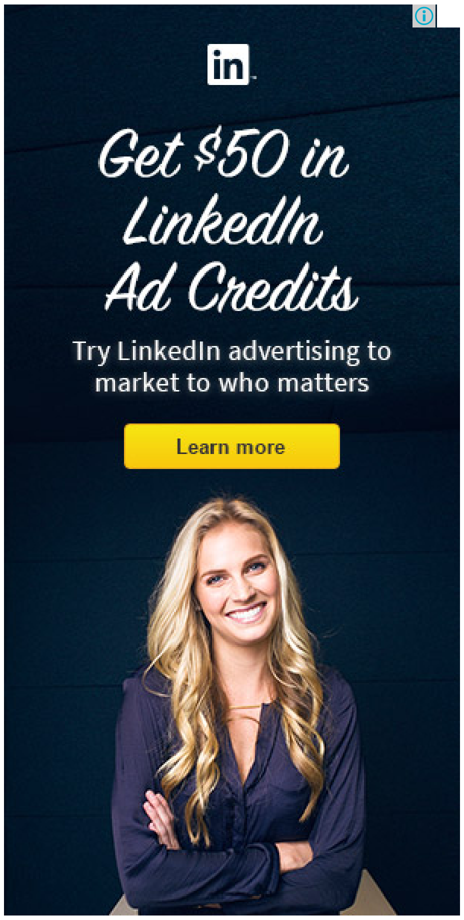
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In the first part of this post, we saw how the **concepts of synchronous and asynchronous** are perceived **in JavaScript**. In this second part, Mr X appears again to help us understand **how the setTimeout and AJAX APIs work**.

Understanding Synchronous and Asynchronous JavaScript – Part 1

Synchronous and asynchronous are confusing concepts in JavaScript, especially for beginners. Two or more things are synchronous when…

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Let's rewind back to the story of Mr X and the movie you want to leave for. Say you leave a task for Mr X before the outing, and tell him that he can only begin to work on this task **five hours *after* he got your message**.

He isn't happy about it, remember, he doesn't take a new message until he is done with the current one, and if he takes yours, he **has to wait for *five* hours** to even start on the task. So, to not be wasteful of time, he **brings in a helper**, Mr H.

Instead of waiting, he asks Mr H to **leave a new message for the task in the queue** after the given hours had passed, and moves on to the next message.

Five hours past; Mr H **updates the queue** with a new message. After he's done processing all the accrued messages prior to Mr H's, Mr X **carries out your requested task**. So, this way, you can leave a request to be **complied upon at a later time**, and not wait until it's fulfilled.

But why does Mr H leave a message in the queue instead of directly contacting Mr X? Because as I mentioned in the first part, the *only* way to contact Mr X is **by leaving a message to him** via phone call — no exceptions.

1. The `setTimeout()` method

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Suppose you have a set of code that you want to **execute after a certain time**. In order to do that, you just **wrap it in a function**, and **add it to a `setTimeout()` method** along with the delay time. The syntax of `setTimeout()` is as follows:

```
setTimeout(function, delay-time, arg...)
```

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The `arg...` parameter stands for any argument the function takes, and `delay-time` is to be added in milliseconds. Below you can see a simple code example, that outputs “hey” in the console after 3 seconds.

```
setTimeout( function() { console.log('hey') }, 3000 );
```

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Once `setTimeout()` starts running, **instead of blocking the call stack** until the indicated delay time is over, a **timer is triggered**, and the call stack is gradually emptied for the next message (similarly to the correspondence between Mr X and Mr H).

When the timer expires, a new message **joins the queue**, and the event loop picks it up when the call stack is free after processing all the messages before it — thus the code runs asynchronously.

2. AJAX

AJAX (Asynchronous JavaScript and XML) is a concept that uses the `XMLHttpRequest` (XHR) API to **make server requests** and **handle the responses**.

When browsers make server requests without using XMLHttpRequest, the **page refreshes** and **reloads its UI**. When the processing of requests and responses are handled by the XHR API, and **UI remains unaffected**.

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So, basically the goal is to **make requests without page reloads**. Now, where is the "asynchronous" in this? Just using XHR code (which we'll see in a moment) doesn't mean it's AJAX, because the XHR API can **work in both synchronous and asynchronous ways**.

XHR **by default** is set to **work asynchronously**; when a function makes a request using XHR, it **returns without waiting for the response**.

If XHR is configured to **be synchronous**, then the function waits until the **response is received and processed** before returning.

Code Example 1

This example presents an `XMLHttpRequest` **object creation**. The `open()` method, validates the request URL, and the `send()` method sends the request.

```
Asynchronous XHR
var xhr = new XMLHttpRequest();
xhr.open("GET", url);
xhr.send();
```

Any direct access to the response data after `send()` will be in vain, because `send()` **doesn't wait** until the request is completed. Remember, XMLHTTPRequest is set to work asynchronously by default.

Code Example 2

The `hello.txt` file in this example is a simple text file containing the text 'hello'. The `response` property of XHR is invalid, since it didn't output the text 'hello'.

```
Asynchronous XHR
var xhr = new XMLHttpRequest();
xhr.open("GET", "he
```

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```
xhr.send();
document.write(xhr.response);
// empty string
```

XHR implements a micro-routine that **keeps checking for response** in every millisecond, and **triggers complimentary events** for the different states a request goes through. When the response is loaded, **a load event is triggered by XHR**, which can deliver a valid response.

```
Asynchronous XHR
var xhr = new XMLHttpRequest();
xhr.open("GET", "hello.txt");
xhr.send();
xhr.onload = function(){ document.write(this.response) }
// writes 'hello' to the document
```

The response inside the load event **outputs 'hello'**, the correct text.

Going the asynchronous way is preferred, as it doesn't block other scripts until the request is completed.

If the response has to be processed synchronously, we pass `false` as the last argument of `open`, which **flags the XHR API** saying it **has to be synchronous** (by default the last argument of `open` is `true`, which you needn't explicitly specify).

```
Synchronous XHR
var xhr = new XMLHttpRequest();
xhr.open("GET", "hello.txt", false);
xhr.send();
document.write(xhr.response);
// writes 'hello' to document
```

Why learn all this?

Almost all beginners make some mistakes with asynchronous concepts such as `setTimeout()` and AJAX, for example by assuming `setTimeout()` executes code after the delay time, or by processing response directly inside a function making an AJAX request.

If you know how the puzzle fits, you can **avoid such confusion**. You know that the delay time in `setTimeout()` does not indicate the time **when the code execution starts**, but the time **when the timer expires** and a new message is queued, which will only be processed when the call stack is free to do so.

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