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JavaScript Async/Await Tutorial - Learn Callbacks, Promises, and Async/Await in JS by Making Ice Cream

by Joyshaw

Today we're going to build and run an **ice cream shop** and learn **asynchronous JavaScript** at the same time. Along the way, you'll learn how to use:

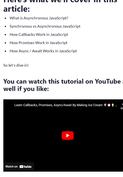
- Callbacks
- Promises
- Async / Await

Here's what we'll cover in this article:

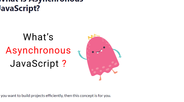
- What is Asynchronous JavaScript?
- Synchronous vs Asynchronous JavaScript
- How Callbacks Work in JavaScript
- How Promises Work in JavaScript
- How Async / Await Works in JavaScript

So let's dive in!

You can watch this tutorial on YouTube as well if you like:



What is Asynchronous JavaScript?



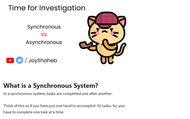
If you want to build projects efficiently, then this concept is for you.

The theory of async JavaScript helps you break down big complex projects into smaller tasks.

Then you can use any of these three techniques – **callbacks, promises or Async/Await** – to run those small tasks in a way that you get the best results.

Let's dive in!

Synchronous vs Asynchronous JavaScript



What is a Synchronous System?

In a synchronous system, tasks are completed one after another.

Think of this as if you have just one hand to accomplish 10 tasks. So, you have to complete one task at a time.

Take a look at the GIF 👇 – one thing is happening at a time here:

You'll see that until the first image is loaded completely, the second image doesn't start loading.

Well, JavaScript is by default synchronous [**single threaded**]. Think about it like this – one thread means one hand with which to do stuff.

What is an Asynchronous System?

In this system, tasks are a composed independently.

Here, imagine that for 10 tasks, you have 10 hands. So, each hand can do each task independently and at the same time.

Take a look at the GIF 👇 – you can see that each image loads at the same time.

Again, all the images are loading at their own pace. None of them is waiting for any of the others.

To Summarize Synchronous vs Asynchronous JS:

When three images are on a webpage, in a:

- **Synchronous** system, three images are in the same lane. One can't overtake the other. The race is finished one by one. If image number 2 stops, the following image stops.

- **Asynchronous system**, the three images are in different lanes. They'll finish the race on their own pace. Nobody stops for anybody.

Synchronous and Asynchronous Code Examples

Before starting our project, let's look at some examples and clear up any doubts.

Synchronous Code Example

To test a synchronous system, write this code in JavaScript:

```
console.log("A");
console.log("B");
console.log("Ice Cream");
```

Here's the result in the console 👇

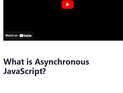
Asynchronous code example

Let's say it takes two seconds to eat some ice cream. Now, let's test out an asynchronous system. Write the below code in JavaScript.

Note: Don't worry, we'll discuss the `setTimeout()` function later in this article.

```
console.log("A");
// This will be done after 2 seconds.
setTimeout(() => {
  console.log("B");
},2000)
console.log("Ice Cream");
```

And here's the result in the console 👇



Now that you know the difference between synchronous and async operations, let's build our ice cream shop.

How to Setup our Project

For this project you can just open Codepen in and start coding. Or, you can do it in VS code or the editor of your choice.

Open the JavaScript section, and then open your developer console. We'll write our code and see the results in the console.

What are Callbacks in JavaScript?

When you need a function inside another function as an argument, that's called a callback.

Here's an illustration of a callback:

An example of a callback

Don't worry, we'll see some examples of callbacks in a minute.

Why do we use callbacks?

When doing a complex task, we break that task down into smaller steps. To help us establish a relationship between these steps according to time (optional) and order, we use callbacks.

Take a look at this example 👇

Chef contains steps to make ice cream

These are the small steps you need to take to make ice cream. Also note that in this example, the order of the steps and timing are crucial. You can't just chop the fruit and serve ice cream.

At the same time, if a previous step is not completed, we can't move on to the next step.

To explain that in more detail, let's start our ice cream shop business.

But Wait...

The shop will have two parts:

- The storeroom will have all the ingredients (Our Backend)
- We'll produce ice cream in our kitchen (The frontend)

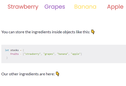
Let's store our data

Now, we're gonna store our ingredients inside an object. Let's start!

You can store the ingredients inside objects like this 👇

```
let stocks =
  fruits: ["strawberry", "grape", "banana", "apple"],
}
```

Our other ingredients are here: 👇



You can store these other ingredients in JavaScript objects like this 👇

```
let stocks =
  fruits: ["strawberry", "grape", "banana", "apple"],
  holder: ["cone", "cup", "stick"],
  toppings: ["chocolate", "sprinkles"],
}
```

The entire business depends on what a customer **orders**. Once we have an order, we start production and then we serve ice cream. So, we'll create two functions →

- order
- production

This is how it all works: 👇

Cut order from customer, fetch ingredients, start production, then serve.

Let's make our functions. We'll use arrow functions here:

```
let order = () =>{}

let production = () =>{}
```

Now, let's establish a relationship between these two functions using a callback, like this: 👇

```
let order = (call_production) =>{
  call_production();
}

let production = () =>{}
```

Let's do a small test

We'll use the `console.log()` function to conduct tests to clear up any doubts we might have regarding how we established the relationship between the two functions.

```
let order = (call_production) =>{
console.log("Order placed. Please call production");
// Calling the wrong order
  call_production();
}

let production = () =>{
console.log("Production has started");
}
```

To run the test, we'll call the `order()` function. And we'll add the second function named `production()` as its argument.

```
// calls 👇 to start second function
order(production);
```

Here's the result in our console 👇

Take a break

So far so good - take a break!

Clear out the console.log

Keep this code and remove everything (don't delete our stocks variable). On our first function, pass another argument so that we can receive the order (Fruit name):

```
// function 1
let order = (fruit_name, call_production) =>{
  call_production();
}

// function 2
let production = () =>{}

// trigger 🔫
order("", production);
```

Here are our steps, and the time each step will take to execute.

Time(seconds)

#1 Place Order	— 2
#2 Cut The Fruit	— 2
#3 Add water and ice	— 1
#4 Start the machine	— 1
#5 Select Container	— 2
#6 Select Toppings	— 3
#7 Serve Ice Cream	— 2

Chart contains steps to make ice cream

In this chart, you can see that step 1 is to place the order, which takes 2 seconds. Then step 2 is cut the fruit (2 seconds), step 3 is add water and ice (1 second), step 4 is to start the machine (1 second), step 5 is to select the container (2 seconds), step 6 is to select the toppings (3 seconds) and step 7, the final step, is to serve the ice cream which takes 2 seconds.

To establish the timing the function `setTimeout()` is excellent as it is also uses a callback by taking a function as an argument.

setTimeout() Syntax

setting time
1000 milliseconds = 1 second

setTimeout (0+0,1000)

calling a function[callback]

Syntax of setTimeout() function

Now, let's select our fruit and use this function:

```
// 1st function
let order = (fruit_name, call_production) =>{
  setTimeout(function(){
    console.log("I choose fruitin fruit_name, "on stock");
  },2000);
  // then alerted call production to start
  call_production();
},1000)

// 2nd function
let production = () =>{
  // time to cut
},0)

// trigger 🔫
order("", production);
```

And here's the result in the console: 👇

Note that the result is displayed after 2 seconds.

If you're wondering how we picked strawberry from our stock variable, Here's the code with the format 👇

Format → variable.object[array]

Our Code → stocks.Fruits[0]

Don't delete anything. Now we'll start writing our production function with the following code 👇 We'll use arrow functions:

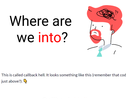
```
let production = () =>{

setTimeout(() =>{
  console.log("production has started");
},0)
}
```

And here's the result 👇

We'll nest another `setTimeout()` function in our existing `setTimeout` function to chop the fruit. Like this 👇

```
let production = () =>{

setTimeout(() =>{
  console.log("production has started");
},0)

setTimeout(() =>{
  console.log("The fruit has been chopped")
  },2000);
},0)
}
```

And here's the result 👇



If you remember, here are our steps:

Time(seconds)

#1 Place Order	— 2
#2 Cut The Fruit	— 2
#3 Add water and ice	— 1
#4 Start the machine	— 1
#5 Select Container	— 2
#6 Select Toppings	— 3
#7 Serve Ice Cream	— 2

Chart contains steps to make ice cream

Let's complete our ice cream production by nesting a function inside another function - this is also known as a callback, remember!

```
let production = () =>{

setTimeout(() =>{
  console.log("production has started");
  },0)

  setTimeout(() =>{
    console.log("The fruit has been chopped");
    setTimeout(fruit_name, call_toppings, time){
      console.log("Fruit has been",
      setTimeout(() =>{
        console.log("The cream placed on",fruit_name);
        setTimeout(() =>{
          console.log("Toppings",call_toppings,"on topping");
          setTimeout(() =>{
            console.log("Serve Ice cream");
            },0)
          },0)
        },0)
      },0)
    },2000);
  },0)
}
```

And here's the result in the console 👇

Feeling confused?

This is called callback hell. It looks something like this (remember that code just above): 👇

Callback Hell

```
let production = () =>{

setTimeout(() =>{
  console.log("production has started");
  },0)

  setTimeout(() =>{
    console.log("The fruit has been chopped");
    setTimeout(fruit_name, call_toppings, time){
      console.log("Fruit has been",
      setTimeout(() =>{
        console.log("The cream placed on",fruit_name);
        setTimeout(() =>{
          console.log("Toppings",call_toppings,"on topping");
          setTimeout(() =>{
            console.log("Serve Ice cream");
            },0)
          },0)
        },0)
      },0)
    },2000);
  },0)
}
```

Illustration of Callback hell

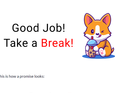
What's the solution to this?

How to Use Promises to Escape Callback Hell

Promises were invented to solve the problem of callback hell and to better handle our tasks.

Take a break

But first, take a break!



This is how a promise looks:

Illustration of a promise format

Let's dissect promises together.

An illustration of the life of a promise

As the above chart's show, a promise has three states:

- **Pending**: This is the initial state. Nothing happens here. Think of it like this, your customer is taking their time giving you an order. But they haven't ordered anything yet.
- **Resolved**: This means that your customer has received their food and is happy.
- **Rejected**: This means that your customer didn't receive their order and left the restaurant.

Let's adopt promises to our ice cream production case study.

But wait...

We need to understand four more things first →

- Relationship between time and work
- Promise chaining
- Error handling
- The `.finally()` handler

Let's start our ice cream shop and understand each of these concepts one by one by taking baby steps.

Relationship between time and work

If you remember, there are our steps and the time each takes to make ice cream*:

Time(seconds)

#1 Place Order — 2
#2 Cut The Fruit — 2
#3 Add water and ice — 1
#4 Start the machine — 1
#5 Select Container — 2
#6 Select Toppings — 3
#7 Serve Ice Cream — 2

Chart contains steps to make ice cream

For this to happen, let's create a variable in JavaScript 👇

```
let is_shop_open = true;
```

Now create a function named `order` and pass two arguments named `time` and `work`:

```
function order(time, work) {
}
```

Now, we're going make a promise to our customer, "We will serve you ice-cream! Like this →

```
function order(time, work) {
  return new Promise((resolve, reject) => {
    if (is_shop_open) {
      resolve()
    } else {
      reject()
    }
  });
}
```

Our promise has 2 parts:

- Resolve( ) ice-cream delivered]
- Reject( ) customer didn't get ice cream]

```
function order(time, work) {
  return new Promise((resolve, reject) =>
    if (is_shop_open) {
      resolve()
    } else {
      reject()
    }
  );
}

order(2000, () => console.log("ice-cream delivered"));
order(0, () => console.log("Sorry, we're closed"));
```

Let's add the time and work factors inside our promise using a `setTimeout()` function inside our `if{}` statement. Follow me 👇

Note: In real life, you can avoid the time factor as well. This is completely dependent on the nature of your work.

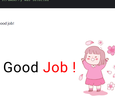
```
function order(time, work) {
  return new Promise((resolve, reject) =>
    if (is_shop_open) {
      setTimeout(() =>
      // work is starting here
      console.log(`${work} ...`)
      // serving 🍨 ice here for 2 work
      resolve(`${work} done`)
      }, time);
    } else {
      reject(new Error("our shop is closed"));
    }
  );
}
```

Now, we're gonna use our newly created function to start ice cream production:

```
order(2000, () => console.log("Cutting Fruits🍓"), "ice selected")
order(1000, () => console.log("Cutting Fruits🍓"), "production has started")
```

The result 👇 after 2 seconds looks like this:

Good job!



Promise chaining

In this method, we defining what we need to do when the first task is complete using the `.then()` handler. It looks something like this 👇

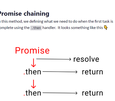


Illustration of promise chaining using then handler

The .then handler returns a promise when our original promise is resolved.

Here's an Example:

Let me make it simpler. It's similar to giving instructions to someone. You tell someone to "First do this, then do that, then this other thing, then... then..." and so on.

- The first task is our original promise.
- The rest of the tasks return our promise once one small bit of work is completed.

Let's implement this on our project. At the bottom of your code write the following lines. 👇

Note: don't forget to write the `.then()` word inside your `.then()` handler. Otherwise, it won't work properly. If you're curious, try removing the return once we finish the steps:

```
order(2000, () => console.log("Cutting Fruits🍓"), "ice selected")
.then(() =>
  return order(1000, () => console.log("production has started"));
)
```

And here's the result: 👇

Using the same system, let's finish our project 👇

```
order(2000, () => console.log("Cutting Fruits🍓"), "ice selected")
.then(() =>
  return order(1000, () => console.log("production has started"));
)
.then(() =>
  return order(2000, () => console.log("Fruit has been chopped"));
)
.then(() =>
  return order(1000, () => console.log("water and ice added"));
)
.then(() =>
  return order(1000, () => console.log("start the machine"));
)
.then(() =>
  return order(2000, () => console.log("ice cream placed on cone"));
)
.then(() =>
  return order(3000, () => console.log("chocolate or toppings"));
)
.then(() =>
  return order(2000, () => console.log("Serve Ice Cream"));
);
```

Here's the result 👇

Error handling

We need a way to handle errors when something goes wrong. But first, we need to understand the promise cycle:

An illustration of the life of a promise

To catch our errors, let's change our variable to false.

```
let is_shop_open = false;
```

Which means our shop is closed. We're not selling ice cream to our customers anymore.

To handle this, we use the `.catch()` handler. Just like `.then()`, it also returns a promise. but only when our original promise is rejected.

A small reminder here:

- `.then()` works when a promise is resolved
- `.catch()` works when a promise is rejected

Go down to the very bottom and write the following code 👇

Just remember that there should be nothing between your previous `.then()` handler and the `.catch` handler.

To handle this, we use the `.catch()` handler. Just like `.then()`, it also returns a promise. but only when our original promise is rejected.

A small reminder here:

- `.then()` works when a promise is resolved
- `.catch()` works when a promise is rejected

Go down to the very bottom and write the following code 👇

Just remember that there should be nothing between your previous `.then()` handler and the `.catch` handler.

```
console.log("customer left")
```

Here's the result 👇

A couple things to note about this code:

- The 1st message is coming from the `Promise()` part of our promise
- The 2nd message is coming from the `.catch()` handler

How to use the .finally() handler

There's something called the `.finally()` handler which works regardless of whether our promise was resolved or rejected.

For example: whether we serve no customers or 100 customers, our shop will close at the end of the day.

If you're curious to test this, come at very bottom and write this code 👇

```
finally(
console.log("end of day")
)
```

The result 👇

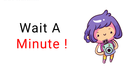
Everyone, please welcome Async / Await~

How Does Async / Await Work in JavaScript?

This is supposed to be the better way to write promises and it helps us keep our code simple and clean.

All you have to do is write the word `async` before any regular function and it becomes a promise.

But first, take a break



Let's have a look 👇

Promises vs Async/Await in JavaScript

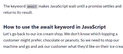
Before async/await, to make a promise we wrote this:

```
function order(){
  return new Promise(function(resolve, reject) {
    // write code here
  });
}
```

Now using async/await, we write one like this:

```
async function order(){
  // write code here
}
```

But wait.....



You need to understand →

- How to use the `try` and `catch` keywords
- How to use the await keyword

How to use the Try and Catch keywords

We use the `try` keyword to run our code while we use `catch` to catch our errors. It's the same concept we saw when we looked at promises.

Let's see a comparison. We'll see a small demo of the format, then we'll start coding.

Promises in JS -> resolve or reject

We used resolve and reject in promises like this:

```
function order(){
  return new Promise(function(resolve, reject){
    if (true){
      console.log("Order Received");
      resolve("Order Received");
    }
    else
      reject("error caught here")
  });
}

order().then(function(){
  console.log("2. Cut the vegs");
  console.log("3. Add water and ice");
  console.log("4. Place order");
  console.log("5. Serve the order");
});
// output: 1. Order Received
// 2. Cut the vegs
// 3. Add water and ice
// 4. Place order
// 5. Serve the order
```

Async / Await in JS -> try, catch

When we're using async/await, we use this format:

```
async function order(){
  console.log("1. Order Received");
  console.log("2. Cut the vegs");
  console.log("3. Add water and ice");
  console.log("4. Place order");
  console.log("5. Serve the order");
}

order();
// output: 1. Order Received
// 2. Cut the vegs
// 3. Add water and ice
// 4. Place order
// 5. Serve the order
```

Don't panic, we'll discuss the `order()` keyword next.

Now hopefully you understand the difference between promises and Async / Await.

How to Use JavaScript's Await Keyword

The keyword `await` makes JavaScript wait until a promise settles and returns its result.

How to use the await keyword in JavaScript

Let's go back to our ice cream shop. We don't know which topping a customer might prefer, chocolate or peanuts. So we need to stop our machine and go and ask our customer what they'd like on their ice cream.

Notice here that only our kitchen is stopped, but our staff outside the kitchen will still do things like:

- doing the dishes
- cleaning the tables
- taking orders, and so on.

An Await Keyword Code Example

Let's create a small promise to ask which topping to use. The process takes three seconds.

```
function toppings_choice(){
  return new Promise(function(resolve, reject){
    setTimeout(function(){
      console.log("which topping would you like?")
    },3000)
  });
}
```

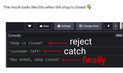
Now, let's create our kitchen function with the async keyword first.

```
async function kitchen(){
  console.log("A");
  console.log("B");
  console.log("C");

  await toppings_choice()

  console.log("D");
  console.log("E");

// Trigger the function
kitchen();
```

Let's add other tasks below the `kitchen()` call.

```
console.log("doing the dishes");
console.log("cleaning the tables");
console.log("taking orders");
```

And here's the result:



We are literally going outside our kitchen to ask our customer, "what is your topping choice?" In the mean time, other things still get done.

Once, we get their topping choice, we enter the kitchen and finish the job.

Small note

When using Async / Awaiting, you can also use the `.then()`, `.catch()`, and `.finally()` handlers as well which are a core part of promises.

Let's open our ice cream shop again

We're gonna create two functions →

- `kitchen()` to make ice cream
- `time()` to assign the amount of time each small task will take.

Let's start! First, create the time function:

```
let is_one_sec = true;
function time(){
  return new Promise(function(resolve, reject) {
    if (is_one_sec){
      setTimeout(function(){
        console.log("Step to closed");
      },1000)
    }
    else{
      setTimeout(function(){
        console.log("Step to closed");
      },2000)
    }
  });
}
```

Now, let's create our kitchen:

```
async function kitchen(){
  console.log("A");
  console.log("B");
  console.log("C");
  console.log("D");
  console.log("E");
  console.log("customer left");
  console.log("Shop closed");
}

// Trigger
kitchen();
```

Let's give small instructions and test if our kitchen function is working or not:

```
async function kitchen(){
  console.log("A");
  console.log("B");
  console.log("C");
  console.log("D");
  console.log("E");
  console.log("customer left");
  console.log("Shop closed");
}

// Trigger
kitchen();
```

The result looks like this when the shop is open 👇

The result looks like this when the shop is closed 👇

So far so good.

Let's complete our project.

Here's the list of our tasks again 👇

```
#4 Start Microwave  → 1
#5 Select Container → 2
#6 Select Toppings  → 3
#7 Serve Ice Cream  → 2
```

Chart contains steps to make ice cream

First, open our shop

```
let is_shop_open = true;
```

Now write the steps inside our `SUCCESSFUL` function 👇

```
async function successful() {
  await time(1000)
  console.log("[status.finding_ice_cream]");

  await time(1000)
  console.log("[status.ice_cream_found]");

  await time(1000)
  console.log("Full has been changed");

  await time(1000)
  console.log("[status.flavorful] - in [flavor.flavor]");

  await time(1000)
  console.log("[cart.ice_machine]");

  await time(1000)
  console.log("[cart.item_placed in [flavor.bucket]]");

  await time(1000)
  console.log("[cart.item.toppings]] - on toppings");

  await time(1000)
  console.log("Serve Ice Cream");

  ice_cream++;
  console.log("[customer.left]");
}
```

And here's the result 👇

```
Output                                    Clear
"Strawberry was selected"
"Production has started"
"Fruit has been chopped"
"Water and ice added"
"Can't find machine"
"Ice cream placed on cup"
"Serve Ice Cream"
"Serve Ice Cream"
```

Conclusion

Congratulations for reading until the end! In this article you've learned:

- The difference between synchronous and asynchronous systems
- Mechanisms of asynchronous JavaScript using 3 techniques (callbacks, promises, and Async/Await)

Here's your medal for reading until the end 🏅

Suggestions and criticisms are highly appreciated ❤️

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Joy Shaheb
Senior Software Engineer, Frontend Developer and a mentor based in Dhaka, Bangladesh. He is highly enthusiastic about javascript & he is a mission to create the best web dev tutorial online

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