Modern Asynchronous Programming with JavaScript (Goodbye Callbacks!)

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The Message Queue and Event Loop

Code is a Series of Instructions

- Computer reads your code one line at a time.
- Before one line can be executed, the line before it must finish executing.
- We call this “synchronous” programming.

```
const x = 42;
const answer = x;
console.log(`The answer to life is ${answer}`);
```

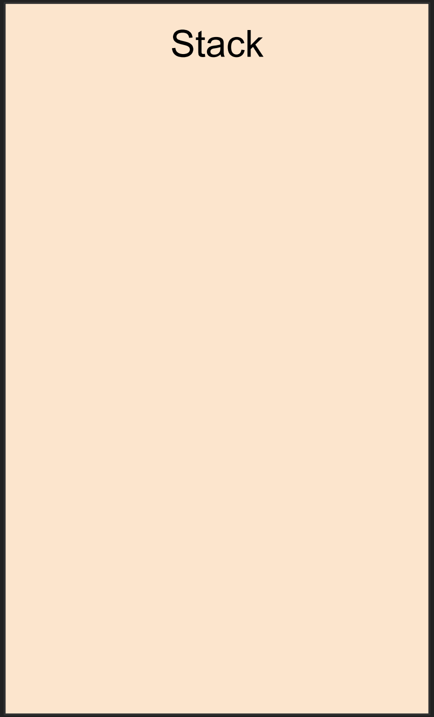
Code is a ~~Series of Instructions~~ Giant While Loop

- The CPU runs at a certain frequency.
- 2.2 GHz = 2,200,000,000 clock cycles per second.
- One clock cycle is used to perform a tiny operation.
- Those tiny operations add up to doing things like "make a new variable called x and put 42 into it".

What does this mean?

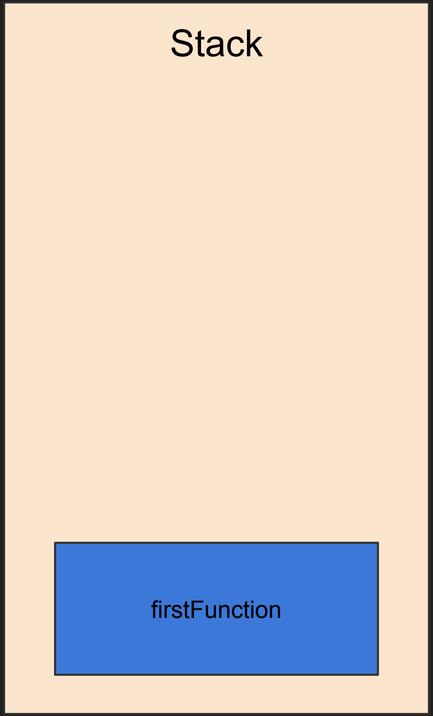
The Computer could potentially do billions of "things" per second.

Normal Programming



What is the stack?

Normal Programming



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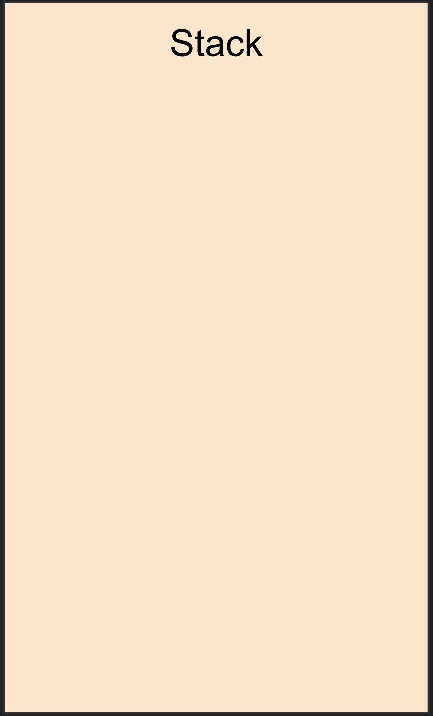

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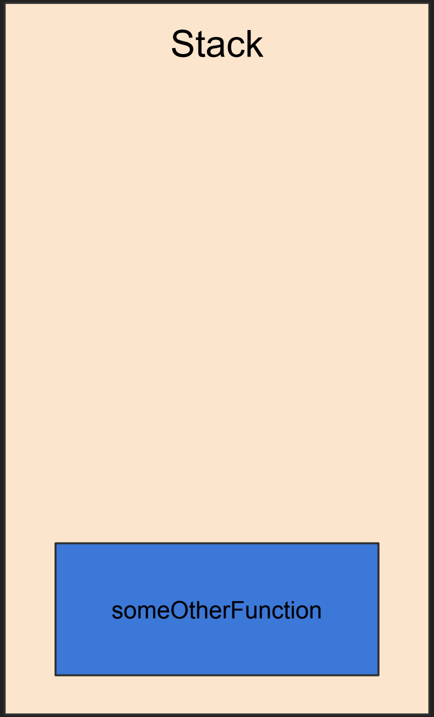

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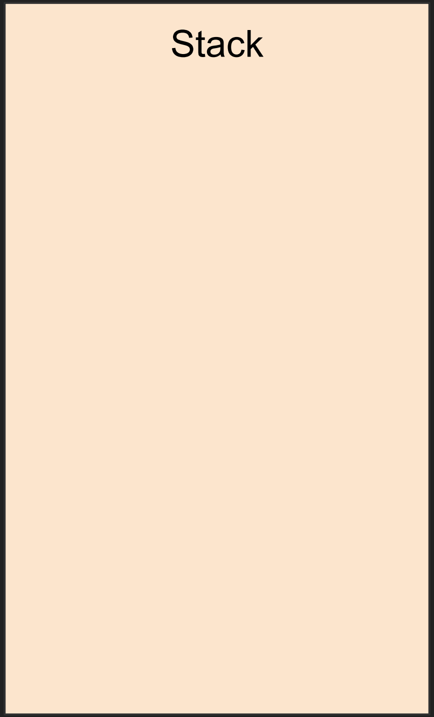
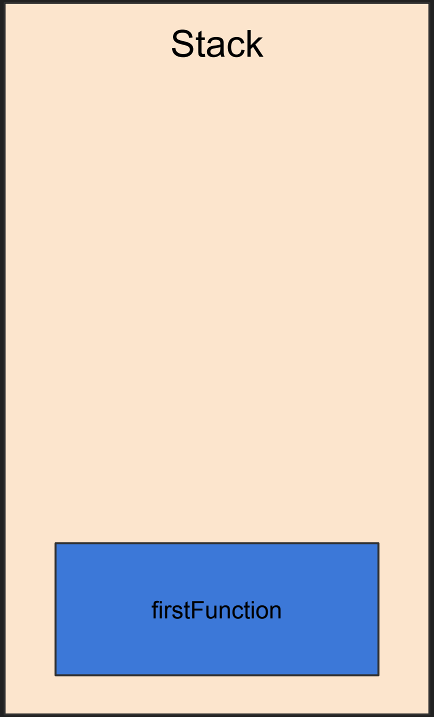


Stack

Normal Programming

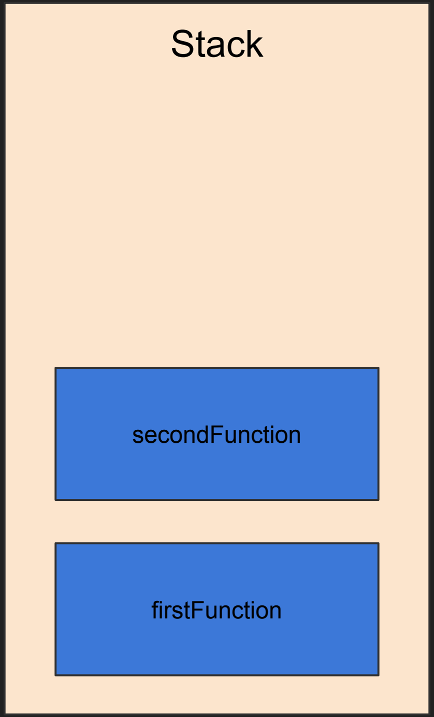


Stack

firstFunction

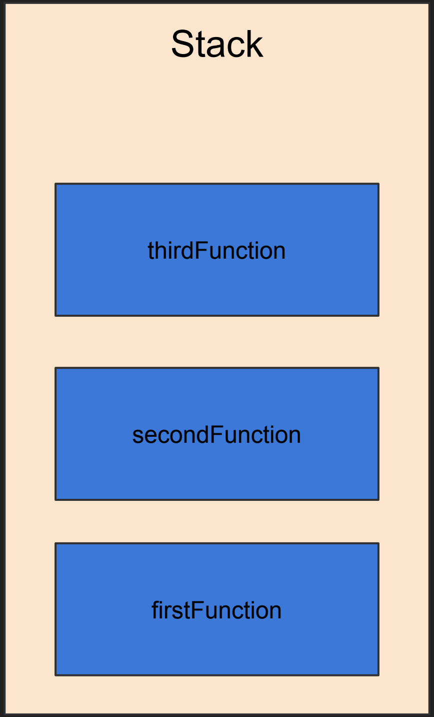
```
function firstFunction() {
  secondFunction();
}
```

Normal Programming



```
function firstFunction() {
  secondFunction();
}
```

Normal Programming



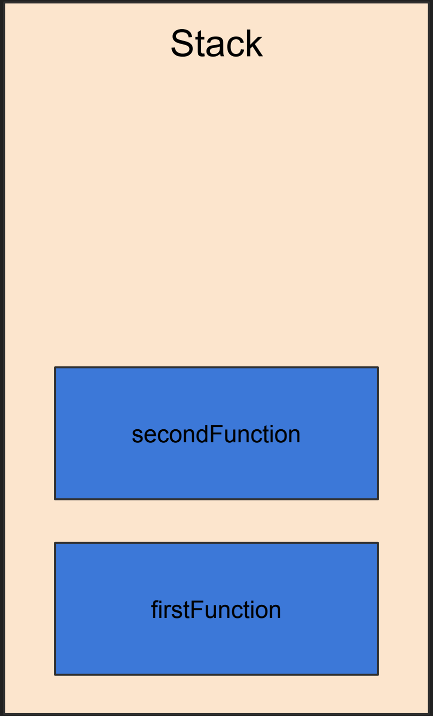
Stack

thirdFunction

secondFunction

firstFunction

Normal Programming



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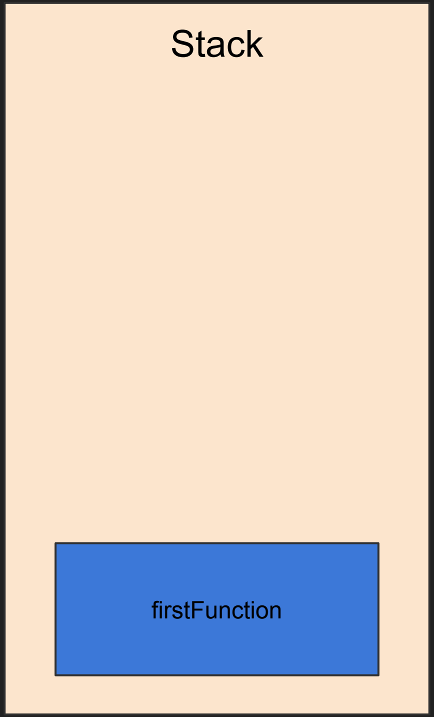
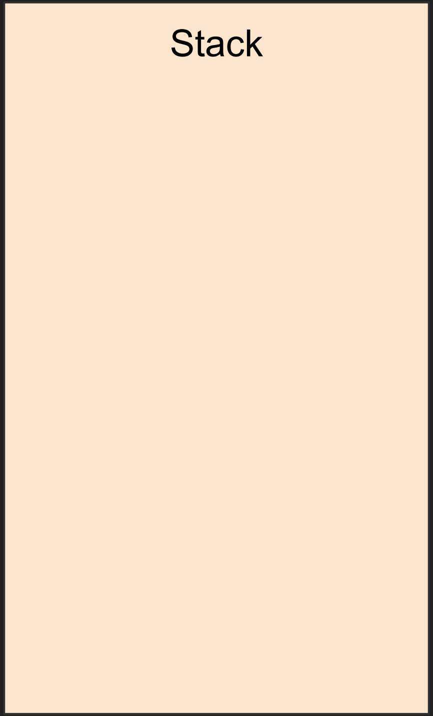


Stack

firstFunction

Normal Programming



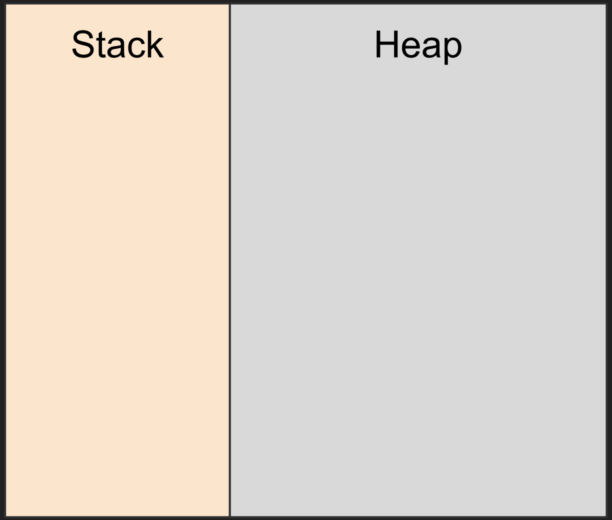
Stack

Normal Programming

```
function cleanKitchen() {
  console.log(‘Cleaned kitchen.’);
}

function cleanHome() {
  cleanKitchen();
  console.log(‘Cleaned home.’);
}

cleanHome();
```



Stack

Heap

Normal Programming

```
function cleanKitchen() {
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}

function cleanHome() {
  cleanKitchen();
  console.log(‘Cleaned home.’);
}

cleanHome();
```

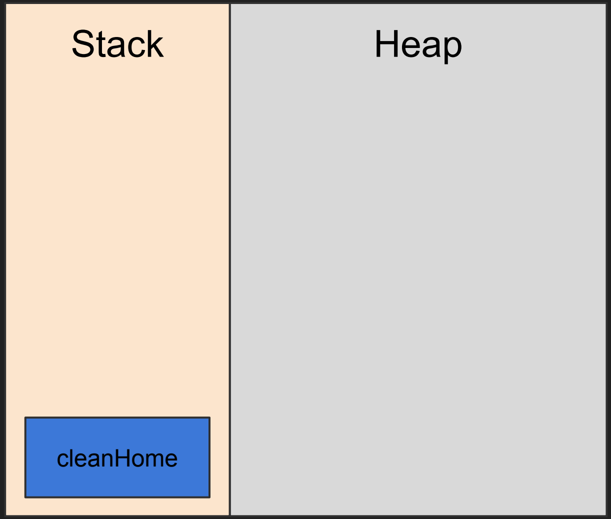

Stack

Heap

cleanHome

Normal Programming

```
function cleanKitchen() {
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}

function cleanHome() {
  cleanKitchen();
  console.log(‘Cleaned home.’);
}

cleanHome();
```

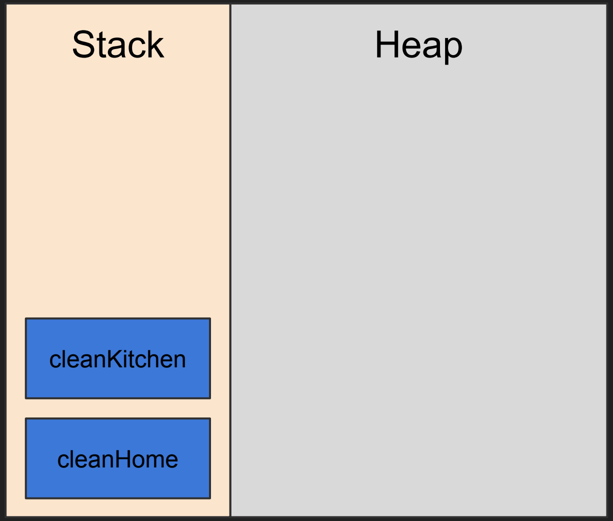

Normal Programming

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function cleanHome() {
  cleanKitchen();
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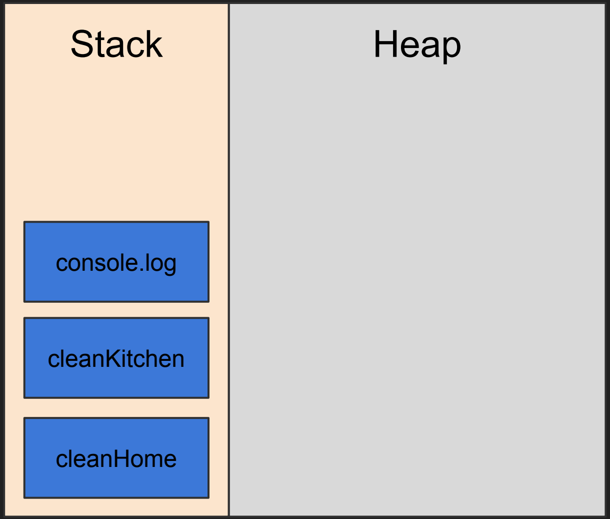
cleanHome();
```



Normal Programming

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cleanHome();
```
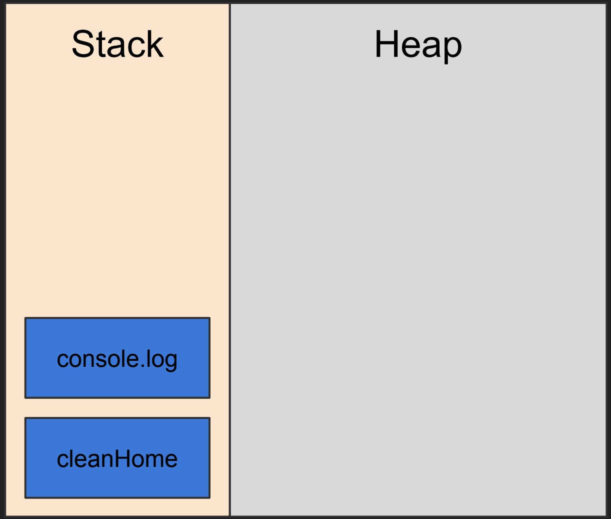



Stack

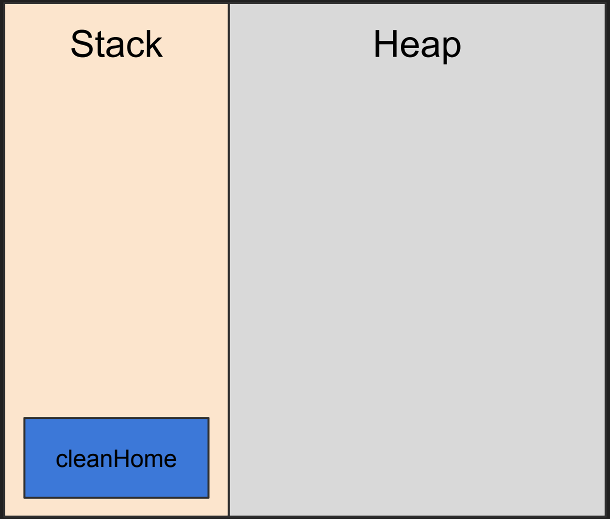
Heap

console.log

cleanHome

Normal Programming

```
  function cleanKitchen() {
    console.log(‘Cleaned kitchen.’);
  }

  function cleanHome() {
    cleanKitchen();
    console.log(‘Cleaned home.’);
  }

→ cleanHome();
```



Normal Programming

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cleanHome();
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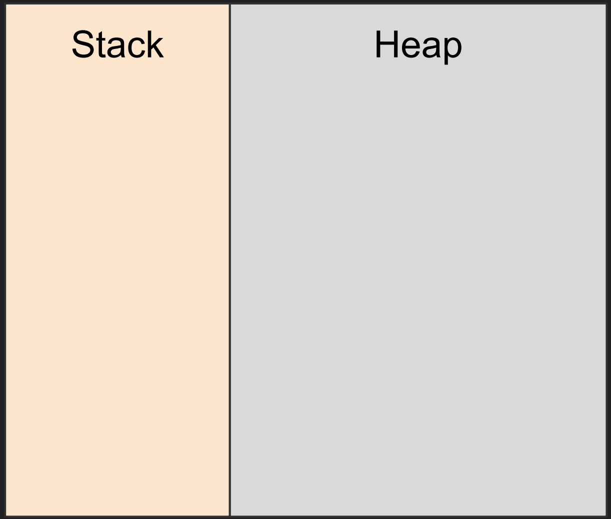


Stack

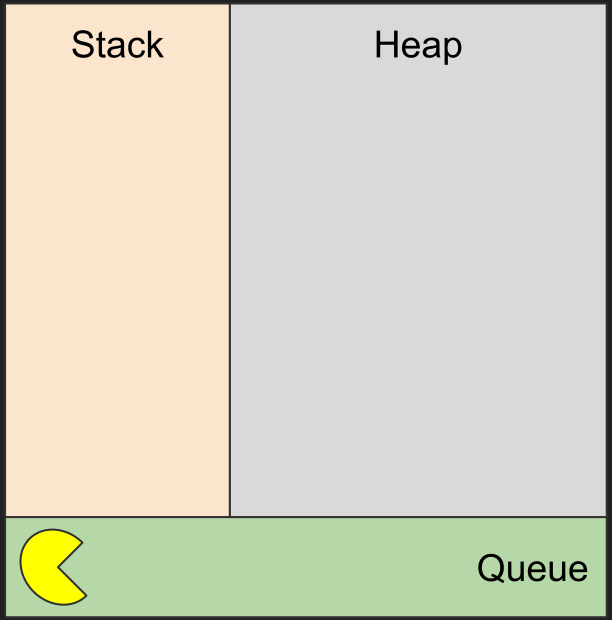
Heap

Asynchronous JavaScript Programming

```
function cleanKitchen() {
  console.log(‘Started dishwasher.’);
  setTimeout(function cb() {
    console.log(‘Dishwasher done. Cleaned kitchen.’);
    console.log(‘Cleaned home.’);
  }, 30000); // Add msg to queue in 30s
}

function cleanHome() {
  cleanKitchen();
}

cleanHome();
```



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cleanHome();
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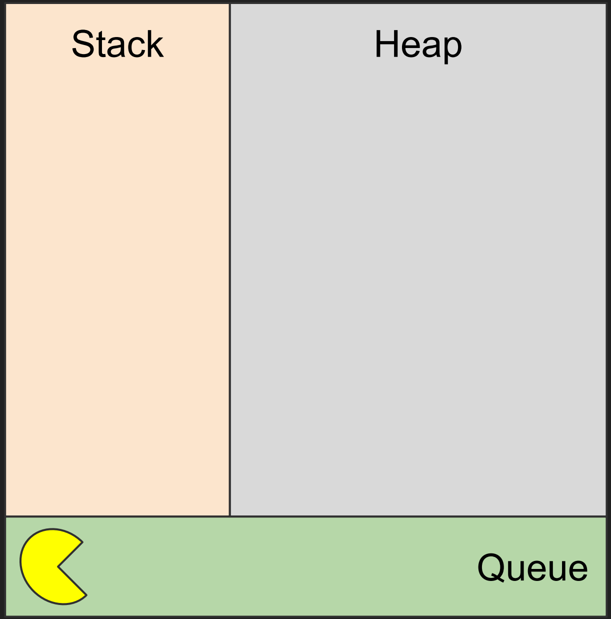

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cleanHome();
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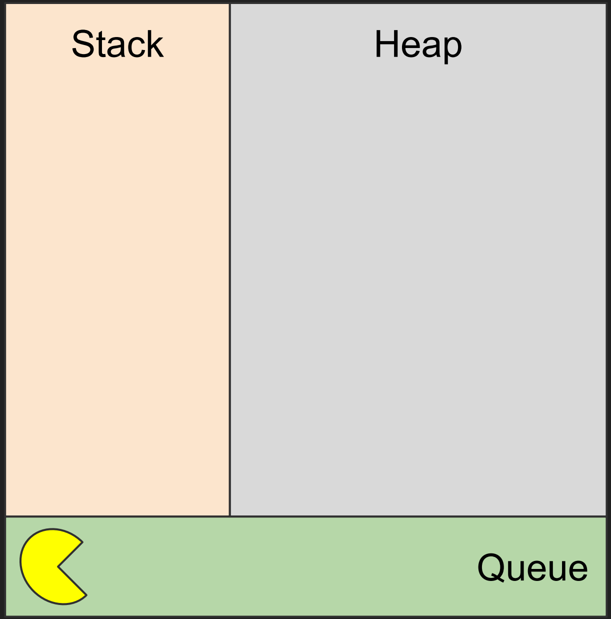

Stack

Heap

Queue

Asynchronous JavaScript Programming

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cleanHome();
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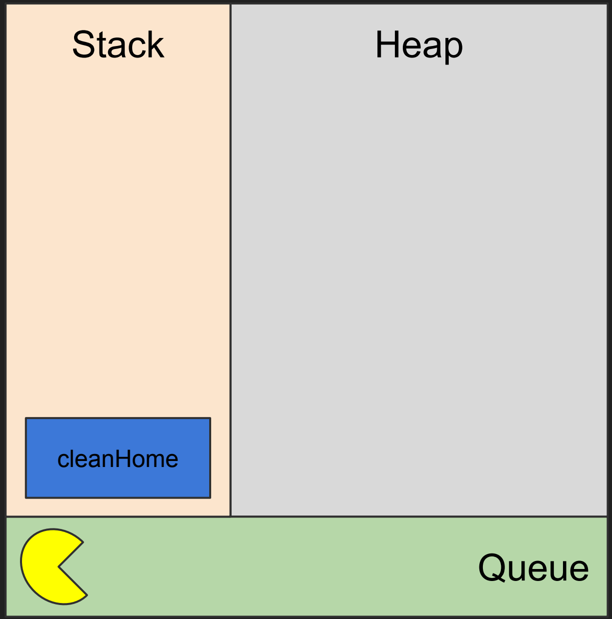

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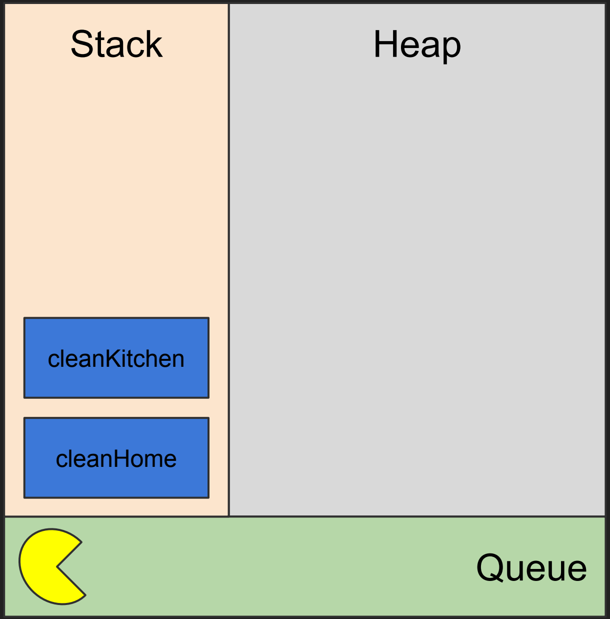

Stack

Heap

cleanKitchen

cleanHome

Queue

Asynchronous JavaScript Programming

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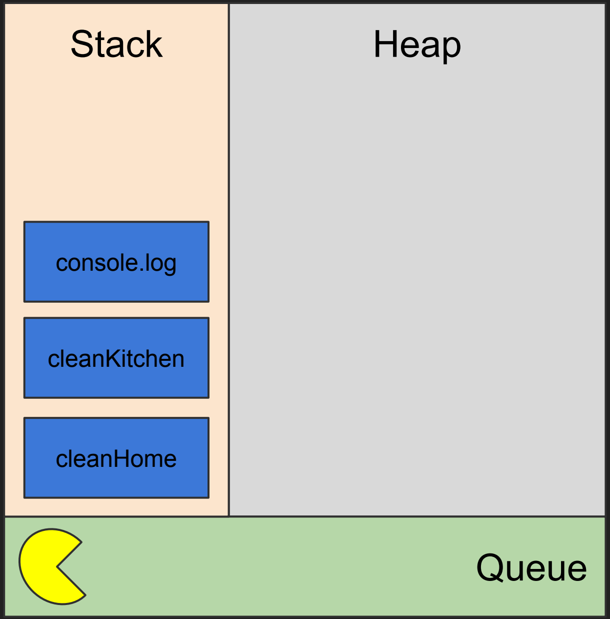

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function cleanHome() {
  cleanKitchen();
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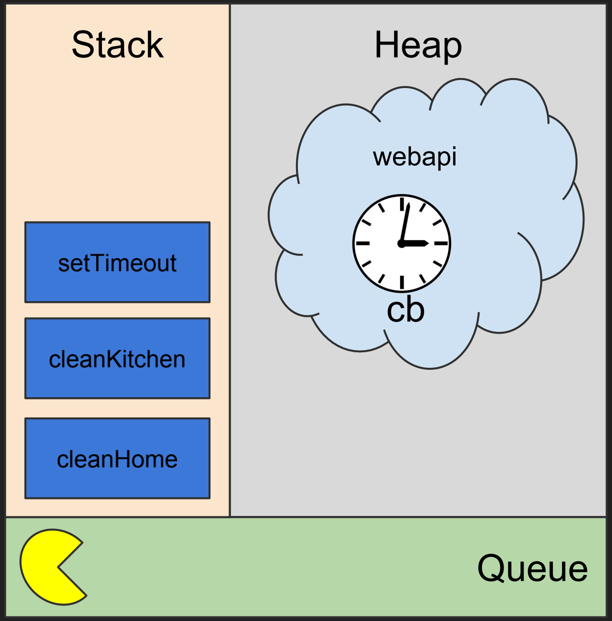
cleanHome();
```

- You wouldn’t just stand by the dishwasher and wait for it to finish.
- You’d start it and work on something else.



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function cleanHome() {
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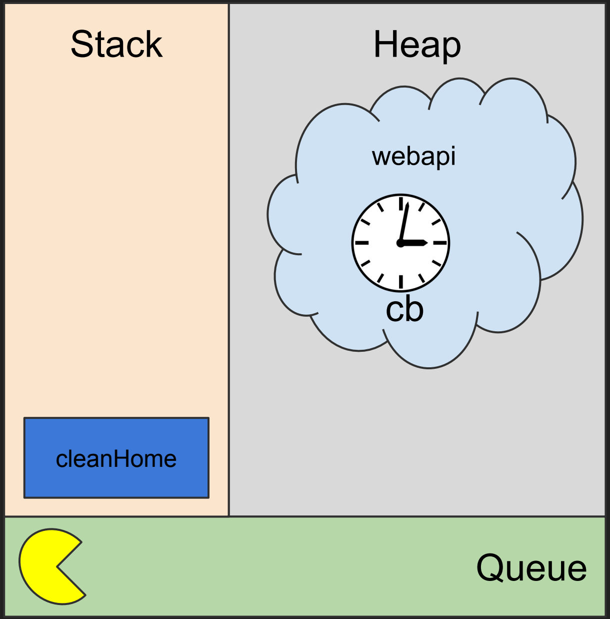

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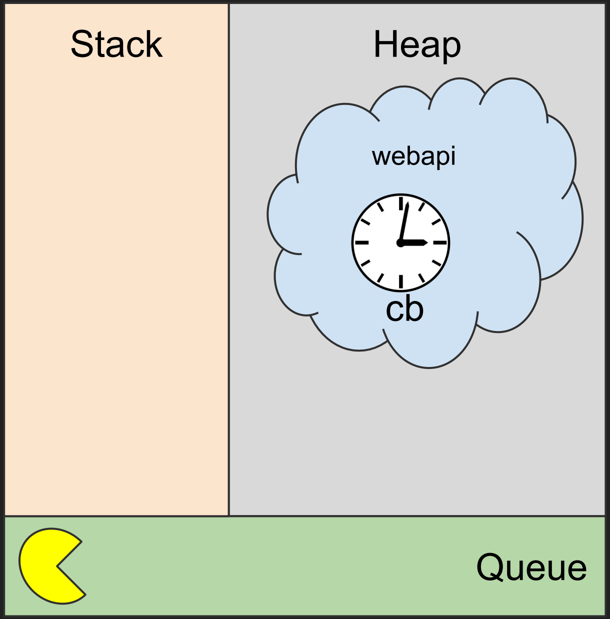

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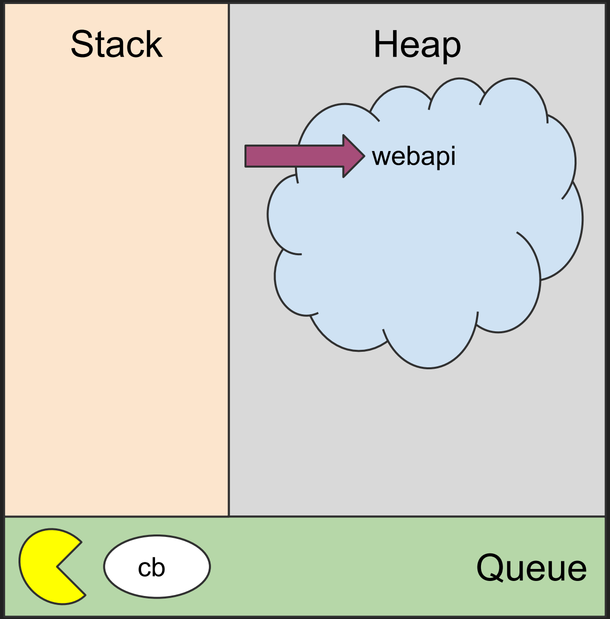

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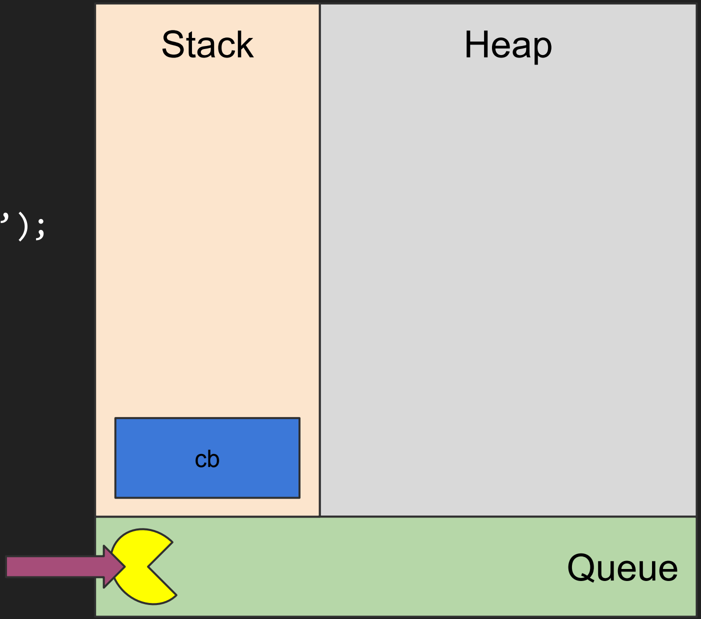

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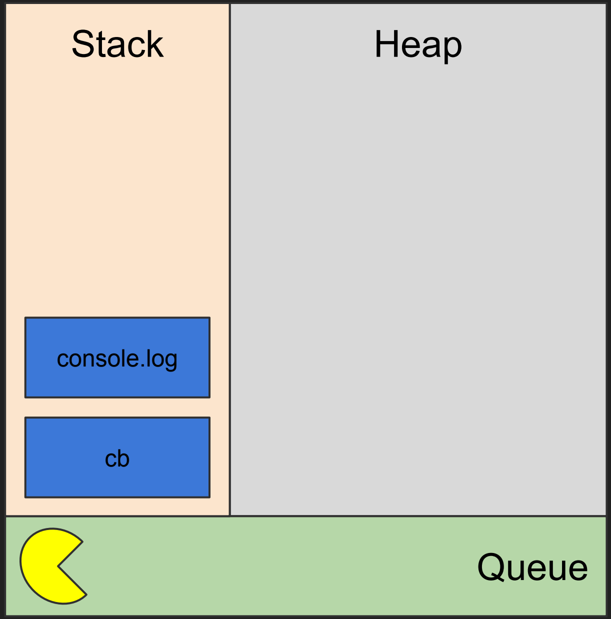

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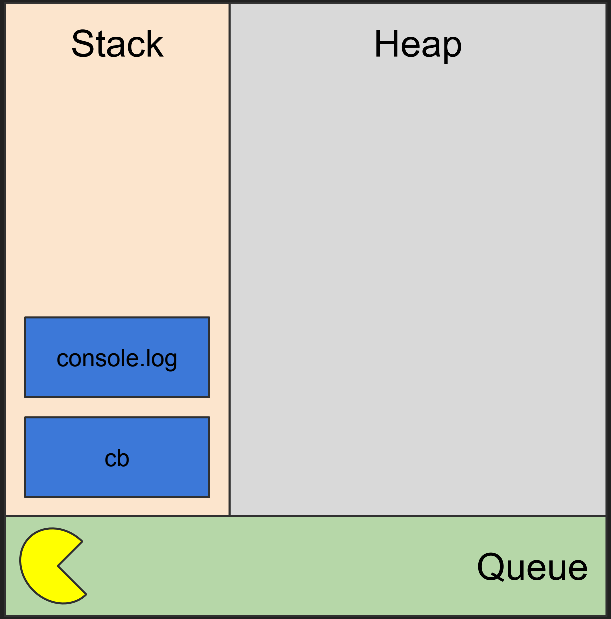

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cleanHome();
```
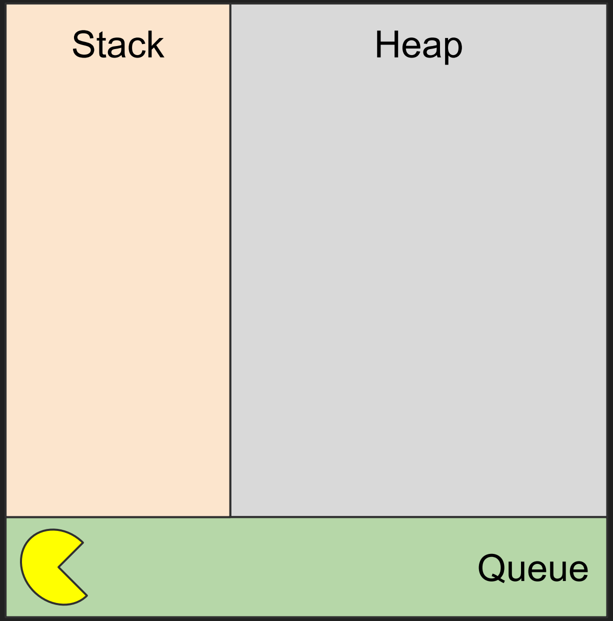



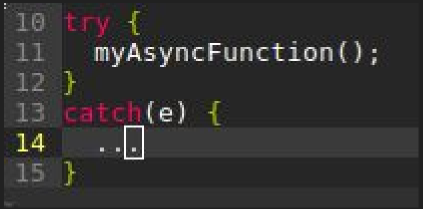
Some things have to be done in synchrony

> getInformationFromDatabase();

> buildHTMLTemplate();

> sendResponse();

No try/catch



```
try {
  myAsyncFunction();
}
catch(e) {
  ...
}
```

Does not work!

example 1.js

Methods of Asynchronous programming

1. Callbacks

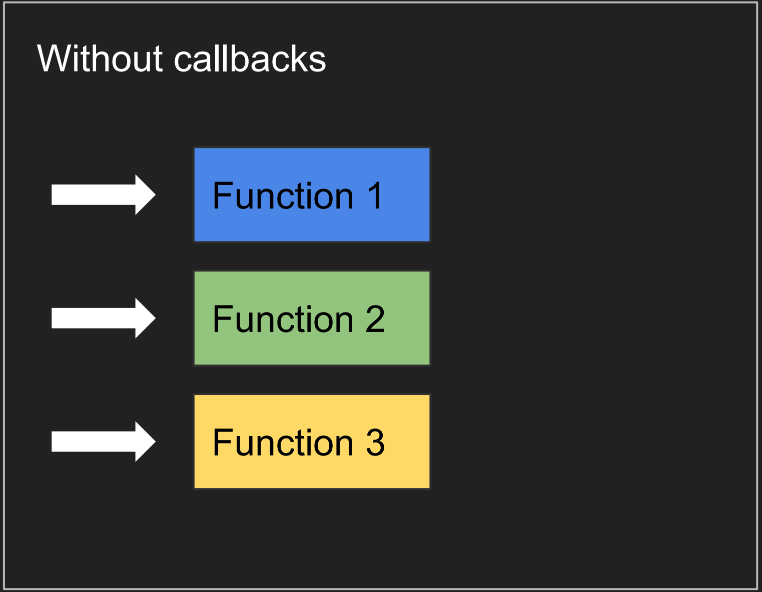
2. Promises (ES6)

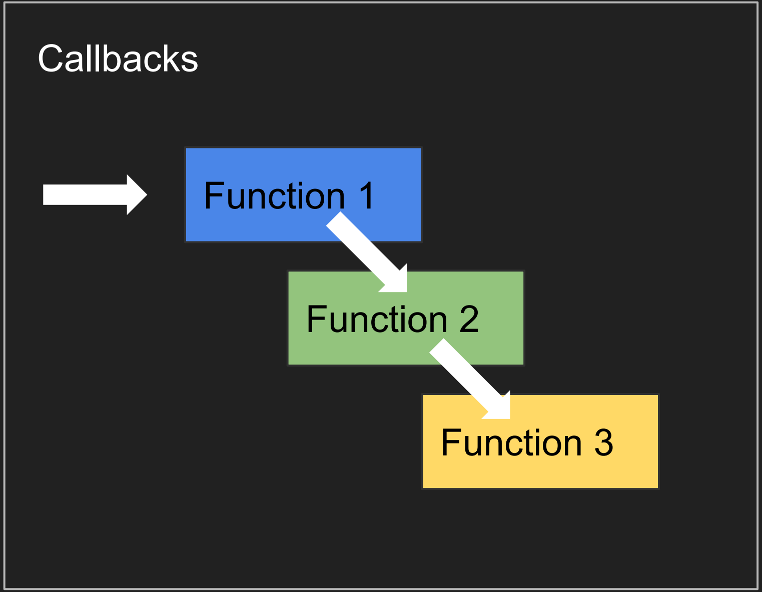
3. Generators (ES6)

4. Async functions (ES7)

Callbacks

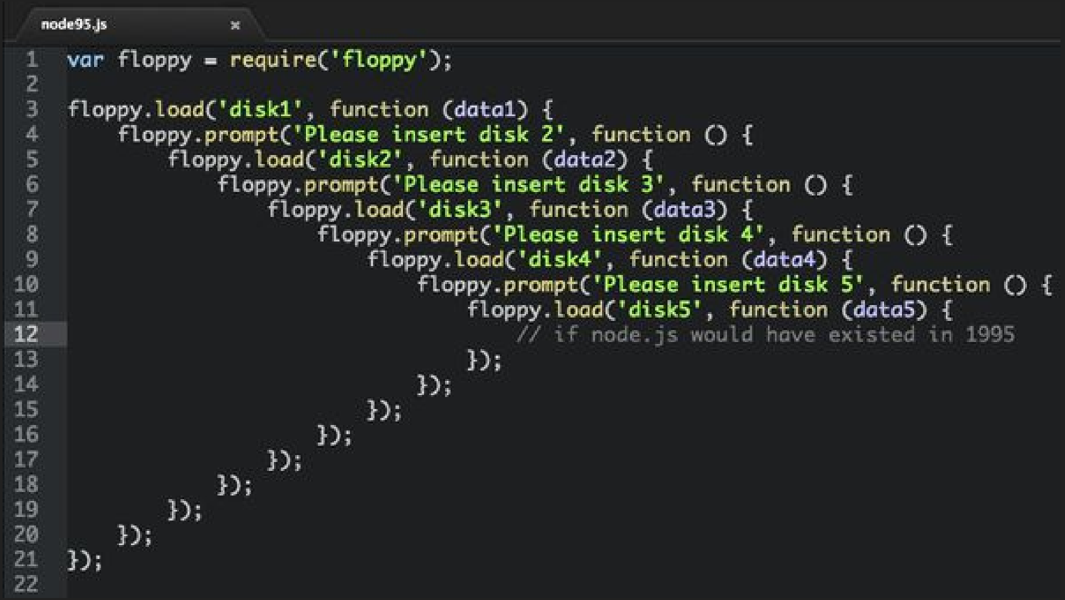
A chain of instructions. Pass what to do next when the function is done



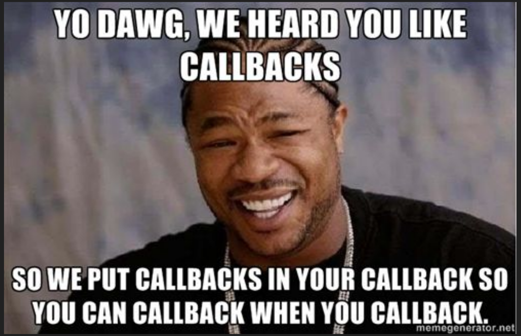


example callback1.js, callback2.js, callback3.js

Callback hell



```
var floppy = require('floppy');

floppy.load('disk1', function (data1) {
    floppy.prompt('Please insert disk 2', function () {
        floppy.load('disk2', function (data2) {
            floppy.prompt('Please insert disk 3', function () {
                floppy.load('disk3', function (data3) {
                    floppy.prompt('Please insert disk 4', function () {
                        floppy.load('disk4', function (data4) {
                            floppy.prompt('Please insert disk 5', function () {
                                floppy.load('disk5', function (data5) {
                                    // if node.js would have existed in 1995
                                });
                            });
                        });
                    });
                });
            });
        });
    });
});
```

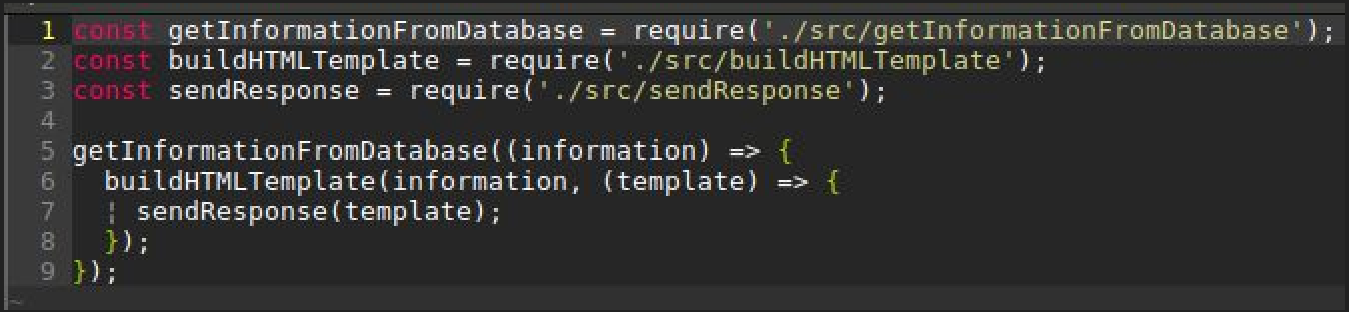


YO DAWG, WE HEARD YOU LIKE CALLBACKS
SO WE PUT CALLBACKS IN YOUR CALLBACK SO YOU CAN CALLBACK WHEN YOU CALLBACK.
memegenerator.net

example callback1.js

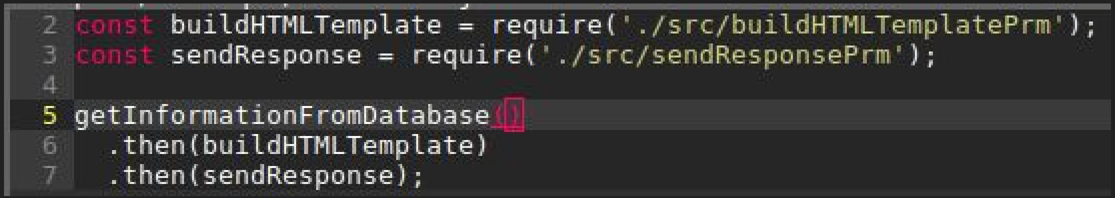
Promises

Callbacks



```
const getInformationFromDatabase = require('./src/getInformationFromDatabase');
const buildHTMLTemplate = require('./src/buildHTMLTemplate');
const sendResponse = require('./src/sendResponse');

getInformationFromDatabase((information) => {
  buildHTMLTemplate(information, (template) => {
    sendResponse(template);
  });
});
```

Promises



```
const buildHTMLTemplate = require('./src/buildHTMLTemplatePrm');
const sendResponse = require('./src/sendResponsePrm');

getInformationFromDatabase()
  .then(buildHTMLTemplate)
  .then(sendResponse);
```

example promise1.js, promise2.js

Promises

Other useful methods:

Promise.all([Promises]) - Succeeds as soon as one of the promises finish

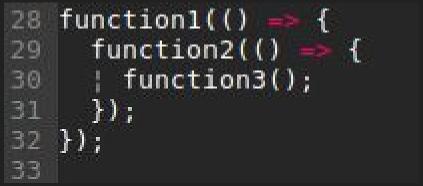
Promise.race([Promises]) - Succeeds when all the promises succeed

example promise3.js

Generators

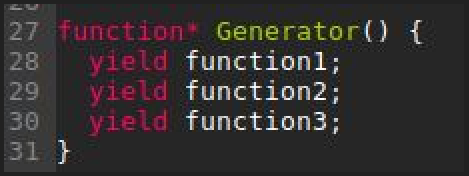
In simple terms, it is a factory for iterators

Iterators are collections that allow you to access its content one item at a time, normally with a .next() method



```
function1(() => {
  function2(() => {
    function3();
  });
});
```

→



```
function* Generator() {
  yield function1;
  yield function2;
  yield function3;
}
```

example generator1.js

Async Functions

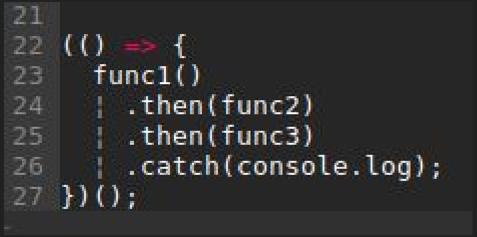
New in ES7

Functions that return promises (have the method .then())

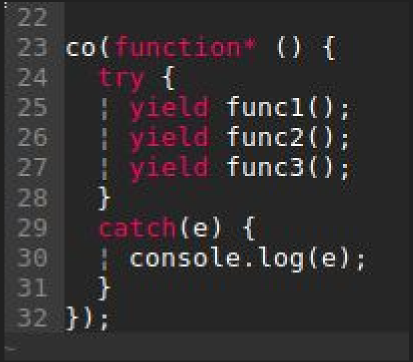
Provide the keyword await - it waits for promises to be completed (somehow similar to yield)

example async1.js, async2.js

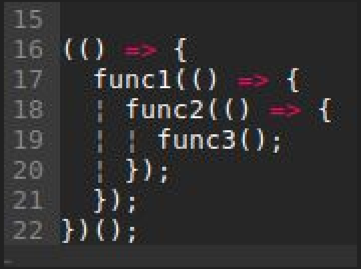
Conclusion



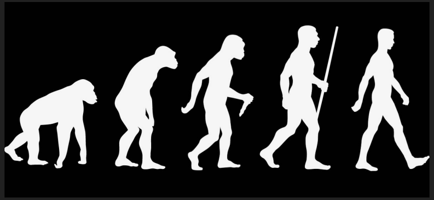
```
(() => {
  func1()
    .then(func2)
    .then(func3)
    .catch(console.log);
})();
```

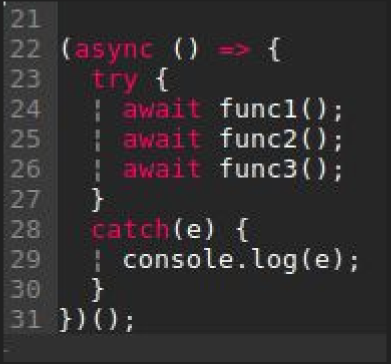


```

co(function* () {
  try {
    yield func1();
    yield func2();
    yield func3();
  }
  catch(e) {
    console.log(e);
  }
});
```



```

(() => {
  func1(() => {
    func2(() => {
      func3();
    });
  });
})();
```





```

(async () => {
  try {
    await func1();
    await func2();
    await func3();
  }
  catch(e) {
    console.log(e);
  }
})();
```