Asynchronous in JavaScript

Callbacks

- A callback is a funtion passed as an argument to another function
- This technique allows a function to call another function
- A callback function call run after another function has finished
- Normal function -

```
const display = (sum) => {
  console.log(`The result is : ${sum}`);
};

const calculate = (value1, value2) => {
  const sum = value1 + value2;
  return sum;
};

const result = calculate(4, 5);
display(result); // Output: The result is : 9
```

- Using callback function as anonymous function

```
const display = (sum) => {
  console.log(`The result is : ${sum}`);
};

const calculate = (value1, value2, callback) => {
  const sum = value1 + value2;

  // Use callback function
  if (callback) callback(sum);
};

calculate(4, 5, display); // Output: The result is : 9
```

- Using callback function as anonymous function differently

```
const calculate = (value1, value2, callback) => {
  const sum = value1 + value2;

  // Calling anonymous callback function
  if (callback) callback(sum);
};
```

```
calculate(4, 5, function (sum) {
  console.log(`The result is : ${sum}`);
}); // Output: The result is : 9
```

- So, `callback` argument is pointing the following anonymous function

```
function (sum) {
  console.log(`The result is : ${sum}`)
}
```

- Using callback function as arrow function

```
const calculate = (value1, value2, callback) => {
  const sum = value1 + value2;

  // Calling arrow function
  if (callback) callback(sum);
};

calculate(4, 5, (sum) => {
  console.log(`The result is : ${sum}`);
}); // Output: The result is : 9
```

- So, `callback` argument is pointing the following arrow function

```
(sum) => {
  console.log(`The result is : ${sum}`);
};
```

- Callback example -

```
const paymentStatus = true;
const mark = 80;

const enroll = (callback) => {
  console.log('Enrollment is processing...');

  setTimeout(() => {
    if (paymentStatus) callback();
    else console.log('Enrollment process is failed');
  }, 2000);
};

const progress = (callback) => {
  console.log('Course on progress...');
  setTimeout(() => {
    if (mark >= 80) callback();
    else
      console.log(
        'You could not achieve enough marks for getting the certificate'
      );
  }, 3000);
};

const getCertificate = () => {
  console.log('Preparing your certificate...');

  setTimeout(() => {
    console.log('Congratulation!!! You earn the certificate');
  }, 2000);
};

enroll(() => {
  progress(getCertificate);
});
```

- Outcome -

```
Enrollment is processing...

(--- 2 seconds pause ---)

Course on progress...

(--- 3 seconds pause ---)

Preparing your certificate...

(--- 2 seconds pause ---)

Congratulation!!! You earn the certificate
```

- Tips:
- Inside `enroll` function I need to point `progress` function which takes a parameter, so use arrow function and inside that function call another function

```
() => {
  progress(getCertificate);
};
```

- But `getCertificate` function doesn't take any parameter, so pass direct function name as callback function -

```
progress(getCertificate);
```

Promise

- The previous example creates callback hell
- To get rid of it, need to use `Promise` feature of JavaScript
- `Promise` is a constructor function

```
new Promise();
```

- Takes a function inside the constructor function

```
// Using normal function
new Promise(function () {});

// Or using arrow function
new Promise(() => {});
```

- That function takes two functions as a parameter named `resolve` & `reject` (convention)

```
// Using normal function
// Takes 'resolve' & 'reject' functions
new Promise(function (resolve, reject) {});

// Or using arrow function
// Takes 'resolve' & 'reject' functions
new Promise((resolve, reject) => {});
```

- The concept is -
- If `Promise` is completed or success, the `Promise` has been resolved or `resolve` function calls
- Else the `Promise` has been rejected or `reject` function calls
- `Promise` definition -

```
const promise = new Promise((resolve, reject) => {
  setTimeout(() => {
    if (status) resolve('Task 1');
    else reject(new Error('Error message'));
  });
});
```

- `Promise` calls -

```
promise
  .then((res) => {
    console.log(res);
  })
  .catch((err) => {
    console.log(err.message);
  });
```

- Outcome if `resolve` -

```
Task 1
```

- Outcome if `reject` -

```
Error message
```

- Important notes:
- If I use `Promise`, then it's an asynchronous function
- If use `Promise`, either `resolve` or `reject`.
- Don't use `console.log` instead of `resolve` or `reject`
- See the above mentioned `Promise` definition
- Use `console.log` inside the function of `then` or `catch`
- See the above mentioned `Promise` call
- Same mentioned callback example using `Promise`

```
const paymentStatus = true;
const mark = 90;

// Use 'Promise' so it's an asynchronous function
const enroll = () => {
  console.log('Enrollment is processing...');

  // Either 'resolve' nor 'reject'. No console.log use in 'Promise'
  return new Promise((resolve, reject) => {
    setTimeout(() => {
      if (paymentStatus) resolve();
      else reject(new Error('Enrollment process is failed'));
    }, 2000);
  });
};

const progress = () => {
  console.log('Course on progress...');

  return new Promise((resolve, reject) => {
    setTimeout(() => {
      if (mark >= 80) resolve();
      else
        reject(
          new Error(
            'You could not achieve enough marks for getting the
certificate'
          )
        );
    }, 3000);
  });
};

const getCertificate = () => {
  console.log('Preparing your certificate...');

  return new Promise((resolve) => {
    setTimeout(() => {
      resolve('Congratulation!!! You earn the certificate');
    }, 2000);
  });
};

enroll()
  .then(progress)
  .then(getCertificate)
  .then((res) => {
    console.log(res);
  })
  .catch((err) => {
    console.log(err.message);
  });
```

- Outcome -

```
Enrollment is processing...

(--- 2 seconds pause ---)

Course on progress...

(--- 3 seconds pause ---)

Preparing your certificate...

(--- 2 seconds pause ---)

Congratulation!!! You earn the certificate
```

- Tips:

- From root `Promise`, start use `then` and `catch`
- For others only use `then`
- Inside a `Promise`, if `resolve` doesn't take any parameter then call like -

```
enroll().then(progress);
```

- Basically pass next `Promise` in `then`
- Inside a `Promise`, if `resolve` use any parameter then call like -

```
enroll().then((res) => {
  console.log(res);
});
```

- Basically receive the parameter sent from `resolve`
- Only one `catch` will catch all the `reject`'s from all `Promise`

```
enroll()
  .then(progress)
  .then(getCertificate)
  .then((res) => {
    console.log(res);
  })
  .catch((err) => {
    console.log(err.message);
  });
```

- Look at the next `Promise` example -

```
const promise1 = Promise.resolve('Promise 1 resolved');

const promise2 = new Promise((resolve, reject) => {
  setTimeout(() => {
    resolve('Promise 2 resolved');
  }, 2000);
});

promise1.then((res) => console.log(res));
promise2.then((res) => console.log(res));
```

- Output -

```
Promise 1 resolved
Promise 2 resolved
```

- Instead of one by one call, I can use `Promise.all`
- Pass all the `Promise`'s in the form of an array
- Receive all the resolved data in the form of an array too

```
Promise.all([promise1, promise2]).then((res) => console.log(res));
```

- Outcome will be the same
- If I want to process all the `Promise`s but want to show output who resolved first, then use `Promise.race`

```
Promise.race([promise1, promise2]).then((res) => console.log(res));
```

- Outcome -

```
Promise 1 resolved
```

Async-Await

- Use `async` so it's an asynchronous function
- Asynchronous function returns by default `Promise`

```
// Normal asynchronous function
async function myFunction() {}

// Asynchronous arrow function
const myFunction = async () => {};
```

- I can only use `await` inside `async` function
- Same mentioned callback example using `async`

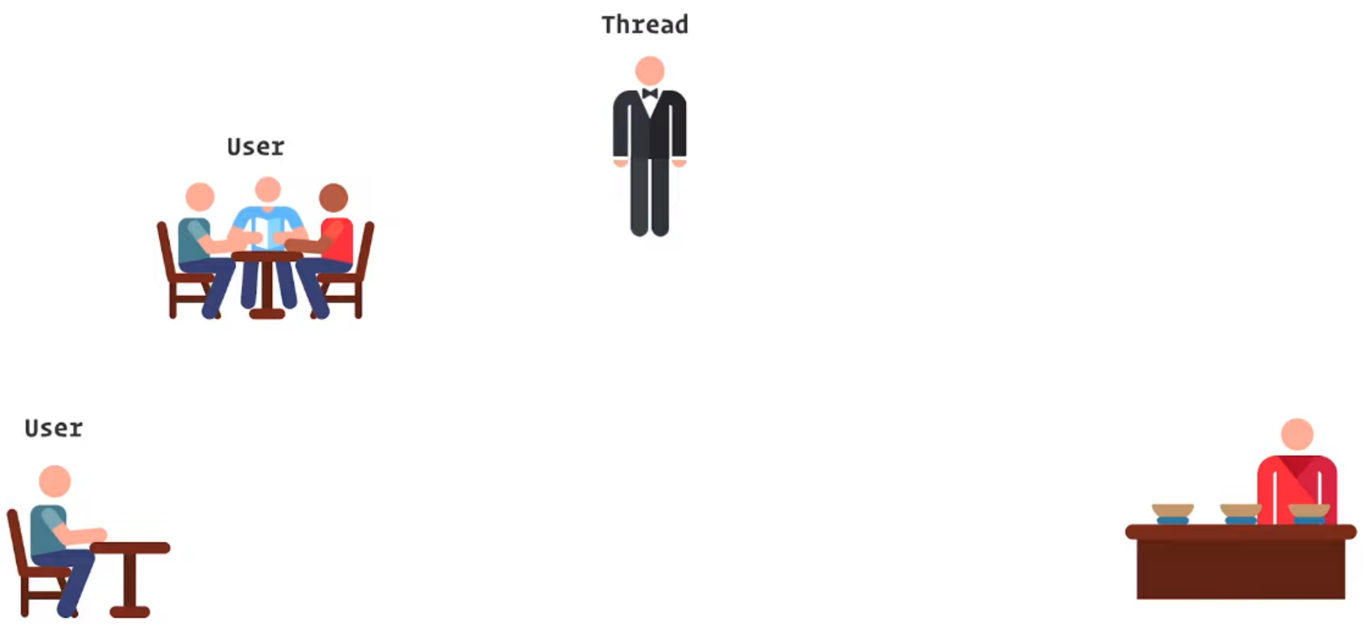
```
const paymentStatus = true;
const mark = 90;

// Use 'Promise' so it's an asynchronous function
const enroll = () => {
  console.log('Enrollment is processing...');

  // Either 'resolve' nor 'reject'. No console.log use
  return new Promise((resolve, reject) => {
    setTimeout(() => {
      if (paymentStatus) resolve();
      else reject(new Error('Enrollment process is failed'));
    }, 2000);
  });
};

const progress = () => {
  console.log('Course on progress...');

  return new Promise((resolve, reject) => {
    setTimeout(() => {
      if (mark >= 80) resolve();
      else
        reject(
          new Error(
            'You could not achieve enough marks for getting the
certificate'
          )
        );
    }, 3000);
  });
};

const getCertificate = () => {
  console.log('Preparing your certificate...');

  return new Promise((resolve) => {
    setTimeout(() => {
      resolve('Congratulation!!! You earn the certificate');
    }, 2000);
  });
};

const course = async () => {
  try {
    await enroll();
    await progress();
    const message = await getCertificate();

    console.log(message);
  } catch (err) {
    console.log(err.message);
  }
};

course();
```

- Outcome will be the same
- Before use `await`, always use `try-catch` block for error handling

Synchronous Behavior

- JavaScript works synchronously
- Doing a lot of work at the same time

- So, JavaScript is a single-thread language
- For example:
- In a restaurent scenario, one waiter and two customers are present
- So, I can indicate the waiter as **Thread** and the customers as **User**



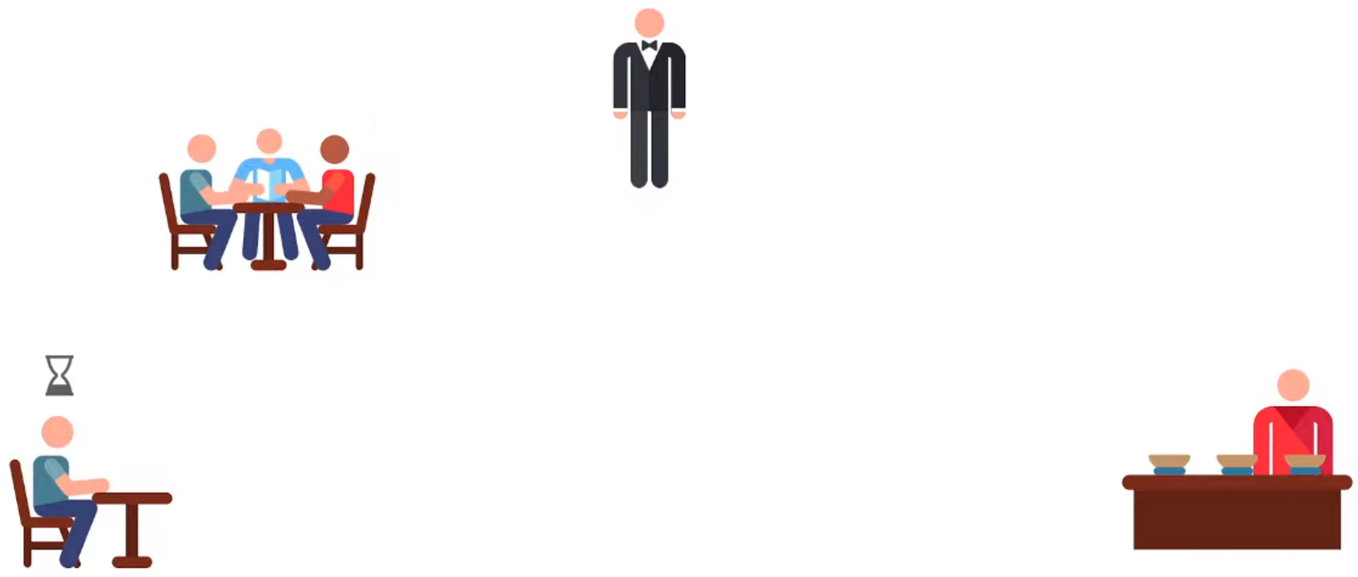
- Takes order from customer 1

- Move to the kitchen and wait until the food is ready to serve

processOrder('customer1')

- When the food become ready, serve the food to the customer

- Now, he becomes free

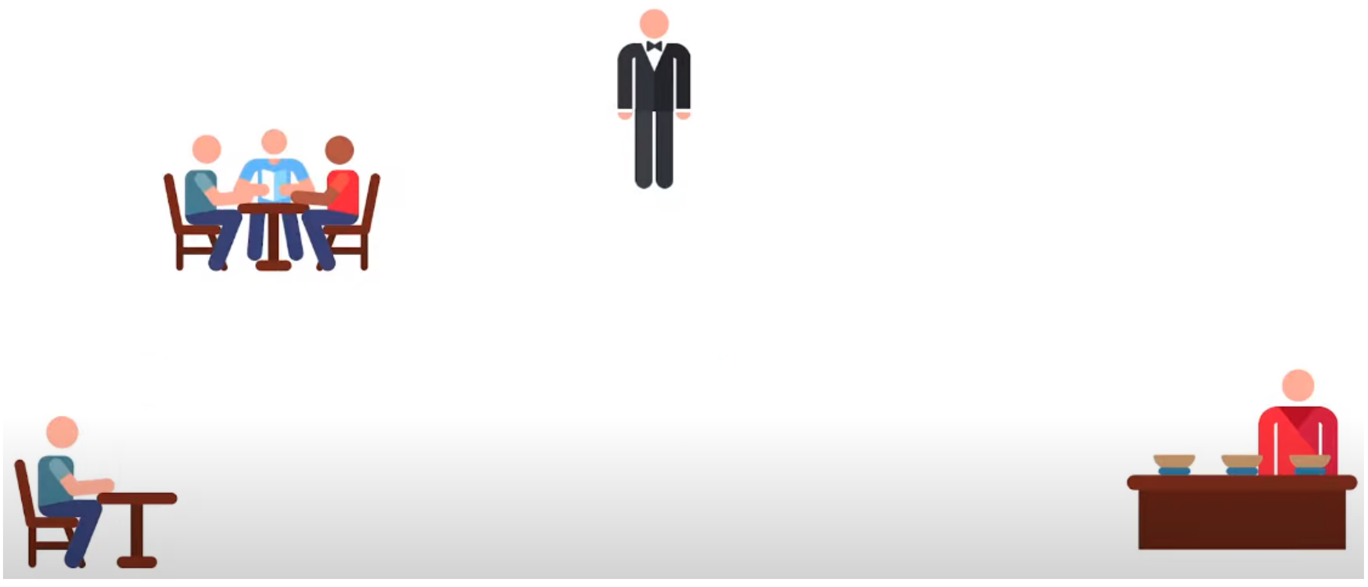


- After that, moves to customer 2

- Take the order and move to kitchen and wait until the food is ready

- Serve the food to customer 2

- After that, he become free



- This behavior is called **Synchronous Blocking Behavior**
- In JavaScript implementation of Synchronous Blocking Behavior -

```
// Printing the log
const log = (anything) => {
  console.log(anything);
};

let customer = 'Customer 1';

const processOrder = (customer) => {
  log(`Move to kitchen and wait until the food is ready for ${customer}`);

  let currentTime = new Date().getTime();
  while (currentTime + 3000 >= new Date().getTime()) {}

  log(`The food is ready and served to the ${customer}`);
};

log(`Take order from ${customer}`);
processOrder(customer);
log(`Complete the order for ${customer}`);

customer = 'customer 2';

log(`Take order from ${customer}`);
processOrder(customer);
log(`Complete the order for ${customer}`);
```

- Outcome -

```
Take order from Customer 1
Move to kitchen and wait until the food is ready for Customer 1

(--- 3 seconds pause ---)

The food is ready and served to the Customer 1
Complete the order for Customer 1
Take order from customer 2
Move to kitchen and wait until the food is ready for customer 2

(--- 3 seconds pause ---)

The food is ready and served to the customer 2
Complete the order for customer 2
```

Asynchronous Behavior

- Same functionality in JavaScript implementation of Asynchronous Behavior

```
// Printing the log
const log = (anything) => {
  console.log(anything);
};
```

```
let customer = 'Customer 1';

const processOrder = (customer, orderTime) => {
  log(`Move to kitchen and describe the order to chief for ${customer}`);

  // Asynchronous function
  setTimeout(() => {
    log(`The food is ready and served to the ${customer}`);
  }, orderTime);

  log(
    `Complete the order for ${customer} and ${customer} needs to wait
${orderTime} seconds`
  );
};

log(`Take order from ${customer}`);
processOrder(customer, 5000);
log(`Waiter is free for taking next order from any customer`);

customer = 'customer 2';

log(`Take order from ${customer}`);
processOrder(customer, 3000);
log(`Waiter is free for taking next order from any customer`);
```

- Outcome -

```
Take order from Customer 1
Move to kitchen and describe the order to chief for Customer 1
Complete the order for Customer 1 and Customer 1 needs to wait 5000 seconds
Waiter is free for taking next order from any customer
Take order from customer 2
Move to kitchen and describe the order to chief for customer 2
Complete the order for customer 2 and customer 2 needs to wait 3000 seconds
Waiter is free for taking next order from any customer

(--- 3 seconds pause ---)

The food is ready and served to the customer 2

(--- 2 seconds pause ---)

The food is ready and served to the Customer 1
```

- Now, Asynchronous Behavior implementation using JavaScript callback feature

```
// Printing the log
const log = (anything) => {
  console.log(anything);
};

const processOrder = (customer, orderTime, callback) => {
  log(`Move to kitchen and describe the order to chief for ${customer}`);

  // Asynchronous function
  setTimeout(() => {
    log(`The food is ready and served to the ${customer}`);
  }, orderTime);

  log(
    `Complete the order for ${customer} and ${customer} needs to wait
${orderTime} seconds`
  );

  callback();
};

const takeOrder = (customer, callback) => {
  log(`Take order from ${customer}`);
  callback();
};

const waiterFree = () => {
  log(`Waiter is free for taking next order from any customer`);
};

// First callback pattern
let customer = 'Customer 1';
takeOrder(customer, () => {
  processOrder(customer, 5000, () => {
    waiterFree();
  });
});

// Second callback pattern
customer = 'customer 2';
takeOrder(customer, () => {
  processOrder(customer, 3000, () => {
    waiterFree();
  });
});
```

- Outcome -

```
Take order from Customer 1
Move to kitchen and describe the order to chief for Customer 1
Complete the order for Customer 1 and Customer 1 needs to wait 5000 seconds
Waiter is free for taking next order from any customer
Take order from customer 2
Move to kitchen and describe the order to chief for customer 2
```

```
Complete the order for customer 2 and customer 2 needs to wait 3000 seconds
Waiter is free for taking next order from any customer

(--- 3 seconds pause ---)

The food is ready and served to the customer 2

(--- 2 seconds pause ---)

The food is ready and served to the Customer 1
```

- Another way to use callback pattern

```
let customer = 'Customer 1';
takeOrder(customer, () => {
  processOrder(customer, 5000, () => {
    waiterFree();

    customer = 'customer 2';
    takeOrder(customer, () => {
      processOrder(customer, 3000, () => {
        waiterFree();
      });
    });
  });
});
```

- Output will be the same
- Problem is the above example is creating callback hell

Promise

- The syntax of `Promise` -

```
const meeting = new Promise((resolve, reject) => {
  if (!hasMeeting) {
    const meetingDetails = {
      name: 'An JavaScript Interview Session',
      duration: '2 hours',
      time: '10:30 PM',
    };

    resolve(meetingDetails);
  } else {
    reject(new Error('A meeting has already scheduled'));
  }
});
```

- If only `resolve` is present in a `Promise`, then write like -

```
const promise = Promise.resolve(123);

promise.then((res) => {
  console.log(res); // Output: 123
});
```

- Or -

```
Promise.resolve(123).then((res) => {
  console.log(res); // Output: 123
});
```

- If only `reject` is present in a `Promise`, then write like -

```
const promise = Promise.reject(new Error('fail'));

promise.catch((err) => {
  console.log(err.message); // Output: fail
});
```

- Or -

```
Promise.reject(new Error('fail')).catch((err) => {
  console.log(err.message); // Output: fail
});
```

- Creating a `Promise` -

```
const hasMeeting = false;

const meeting = new Promise((resolve, reject) => {
  if (!hasMeeting) {
    const meetingDetails = {
      name: 'An JavaScript Interview Session',
      duration: '2 hours',
      time: '10:30 PM',
    };

    resolve(meetingDetails);
  } else {
    reject(new Error('A meeting has already scheduled'));
  }
});

meeting
  .then((res) => {
    console.log(JSON.stringify(res));
  })
  .catch((err) => {
    console.log(err.message);
  });
```

- If `Promise` is completed, the `Promise` has been `Resolved`

```
{"name":"An JavaScript Interview session","duration":"2
hours","time":"10:30 PM"}
```

- Else the `Promise` has been `Rejected`

```
A meeting has already scheduled
```

- Multiple `then` use -

```
const hasMeeting = false;

const meeting = new Promise((resolve, reject) => {
  if (!hasMeeting) {
    const meetingDetails = {
      name: 'An JavaScript Interview Session',
      duration: '2 hours',
      time: '10:30 PM',
    };

    resolve(meetingDetails);
  } else {
    reject(new Error('A meeting has already scheduled'));
  }
});

const addToCalender = (meeting) => {
  const calender = `I have a meeting titled ${meeting.name} at
${meeting.time}`;

  // No need to 'reject' a 'Promise'. So, use direct 'resolve'
  return Promise.resolve(calender);
};

meeting
  .then(addToCalender)
  .then((res) => {
    console.log(res);
  })
  .catch((err) => {
    console.log(err.message);
  });
```

- If `Promise` is completed, the `Promise` has been `Resolved`

```
I have a meeting titled An JavaScript Interview Session at 10:30 PM
```

- Else the `Promise` has been `Rejected`

```
A meeting has already scheduled
```

- I can receive any error messages using `catch` block
- Run all the `Promise`'s at a time and receive result at last in the same time

Async Await

Example-01

- Same `Promise` example completed using `async` function

```
const hasMeeting = false;

const meeting = new Promise((resolve, reject) => {
  if (!hasMeeting) {
    const meetingDetails = {
      name: 'An JavaScript Interview Session',
      duration: '2 hours',
      time: '10:30 PM',
    };

    resolve(meetingDetails);
  } else {
    reject(new Error('A meeting has already scheduled'));
  }
});

const addToCalender = (meeting) => {
  const calender = `I have a meeting titled ${meeting.name} at
${meeting.time}`;

  // No need to 'reject' a 'Promise'. So, use direct 'resolve'
  return Promise.resolve(calender);
};
```

```
const meetingSchecule = async () => {
  try {
    const meetingDetails = await meeting;
    const calender = await addToCalender(meetingDetails);
    console.log(calender);
  } catch (err) {
    console.log(err.message);
  }
};

meetingSchecule();
```

- Outcome will be the same
- So, to make sure best performance, I need to use asynchronous approach
- To ignore blocking behavior, I need to use asynchronous approach as much as possible

Example-02

- Reshape your code using `async` & `await`

```
const delay = (duration) =>
  new Promise((resolve) => setTimeout(resolve, duration));

const log = (anything) => {
  console.log(anything);
};

const processOrder = async (customer, orderTime) => {
  log(`Move to kitchen and describe the order to chief for ${customer}`);

  // Asynchronous function
  await delay(orderTime);

  log(`The food is ready and served to the ${customer}`);

  log(
    `Complete the order for ${customer} and ${customer} needs to wait
${orderTime} seconds`
  );
};

const takeOrder = async (customer) => {
  log(`Take order from ${customer}`);
  return customer;
};

const waiterFree = () => {
  log(`Waiter is free for taking next order from any customer`);
};
```

```
// Async-await model
const serveCustomer = async (customer, orderTime) => {
  await takeOrder(customer);
  await processOrder(customer, orderTime);
  waiterFree();
};

// Serve Customer 1
serveCustomer('Customer 1', 5000);

// Serve Customer 2
serveCustomer('Customer 2', 3000);
```

- Output:

```
Take order from Customer 1
Take order from Customer 2
Move to kitchen and describe the order to chief for Customer 1
Move to kitchen and describe the order to chief for Customer 2

( --- pause for 3 seconds --- )

The food is ready and served to the Customer 2
Complete the order for Customer 2 and Customer 2 needs to wait 3000 seconds
Waiter is free for taking next order from any customer

( --- pause for 2 seconds --- )

The food is ready and served to the Customer 1
Complete the order for Customer 1 and Customer 1 needs to wait 5000 seconds
Waiter is free for taking next order from any customer
```