Asynchronous Programming and Promises

Promises. Async / Await.

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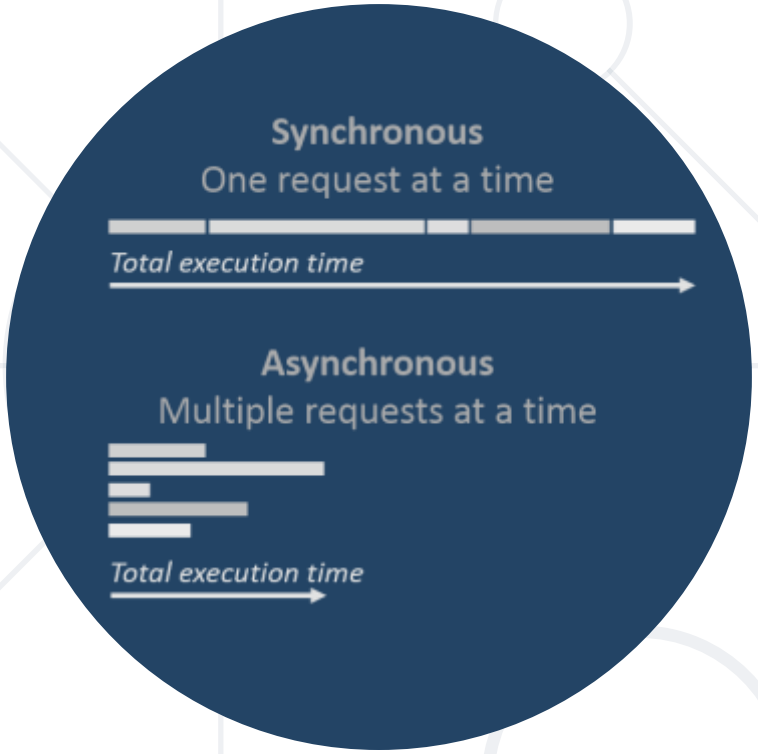
#JS-CORE



Asynchronous Programming

Synchronous vs Asynchronous

Asynchronous Programming

- Deals with the needs to run several tasks in **parallel**
- Asynchronous Programming is based on callbacks
- There can be **asynchronous code**, but it is **generally single-threaded**
- Handled with:
  - **Promises**
  - **Async** / **Await** pattern

Asynchronous Programming

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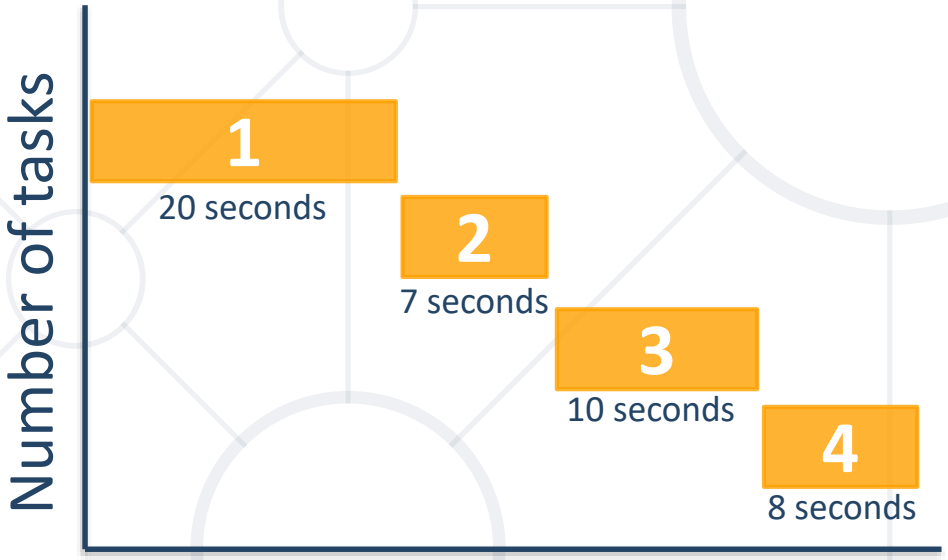
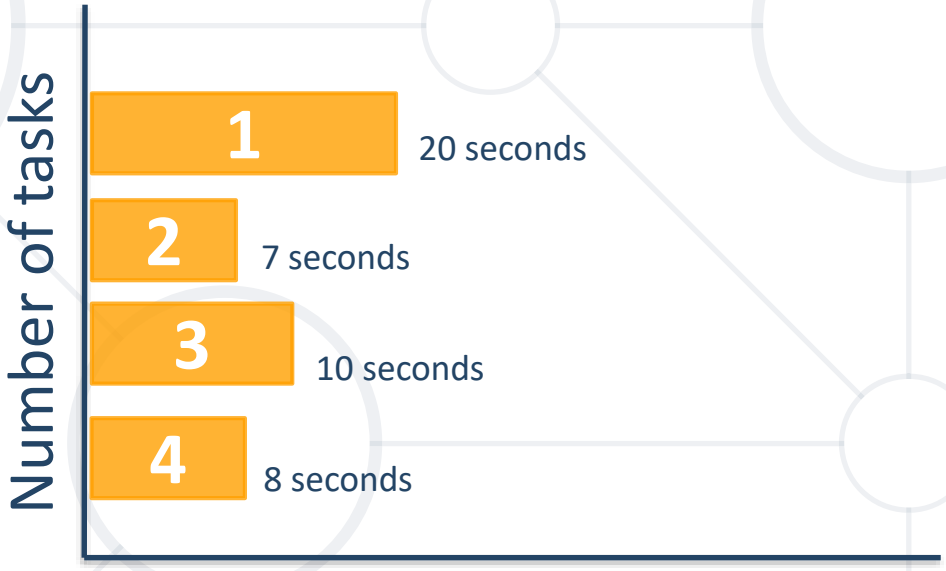
Synchronous



Total time taken by the tasks:
45 seconds

Asynchronous



Total time taken by the tasks:
20 seconds

Asynchronous Programming - Example

The following commands will be executed as follows:

```
console.log("Hello.");
```

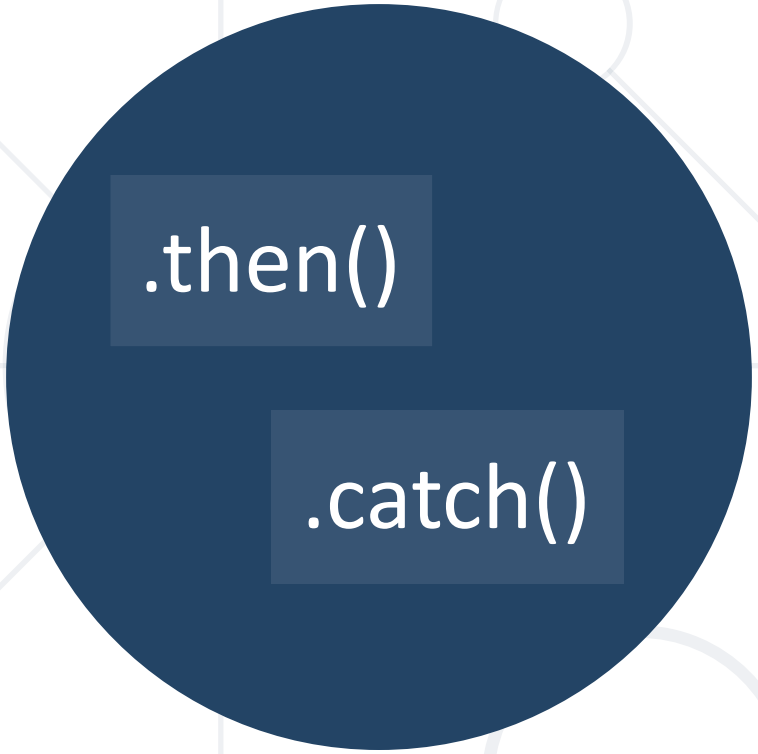
```
setTimeout(function() {
  console.log("Goodbye!");
}, 2000);
```

```
console.log("Hello again!");
```

```
// Hello.
```

```
// Hello again!
```

```
// Goodbye!
```



Promises

Objects Holding Asynchronous Operations

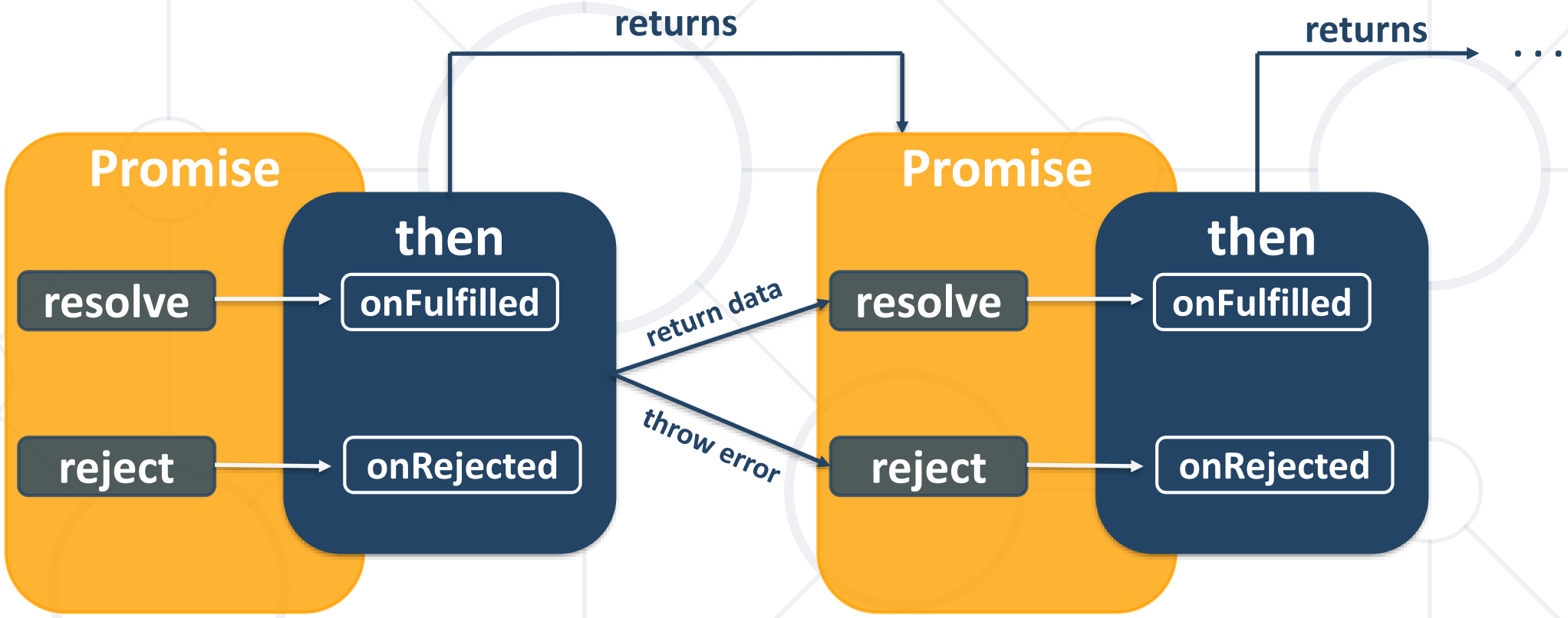
What is a Promise?

An object holding an asynchronous operation

- States:
  - **Pending** - operation still running (unfinished)
  - **Fulfilled** - operation finished (and the result is available)
  - **Failed** - operation is failed (and an error is available)
- Promises use the **Promise** object

```
new Promise(executor);
```

What is a Promise?



Promise Methods

- `Promise.reject(reason)`
  - Returns an object that is rejected with the given reason
- `Promise.resolve(value)`
  - Returns an object that is resolved with the given value
- `Promise.all(iterable)`
  - Returns a promise that either fulfills when **all** of the promises **have fulfilled** or rejects as soon as **one** of them **rejects**

Promise.then() - Example

```
console.log('Before promise');
```

```
new Promise(function(resolve, reject) {
  setTimeout(function() {
    resolve('done');
  }, 500);
})
.then(function(result) {
  console.log('Then returned: ' + result);
});
```

Resolved after 500 ms

```
console.log('After promise');
```

```
// Before promise
```

```
// After promise
```

```
// Then returned: done
```

Promise.catch() - Example

```
console.log('Before promise');
```

```
new Promise(function(resolve, reject) {
  setTimeout(function() {
    reject('fail');
  }, 500);
})
.then(function(result) { console.log(result); });
.catch(function(error) { console.log(error); });
```

Rejected after 500 ms

```
console.log('After promise');
```

```
// Before promise
```

```
// After promise
```

```
// fail
```

Promises with jQuery AJAX

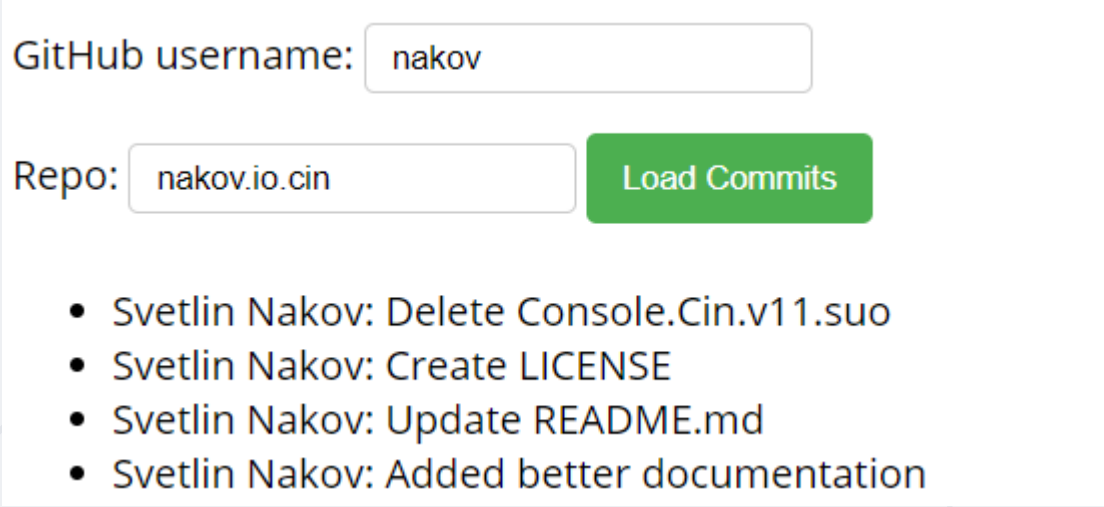
jQuery Promise

The **Deferred object** is a **chainable** utility object.

- Can register **multiple callbacks** into callback queues
- Invoke **callback queues** and relay the success or failure state of a function
- Is **thenable** - can be casted to **native Promise**
- Some of the arguments passed to **then()** method will be **discarded**

Problem: Load GitHub Commits with AJAX

```
GitHub username:
<input type="text" id="username" value="nakov" /> <br>
Repo: <input type="text" id="repo" value="nakov.io.cin" />
<button onclick="loadCommits()">Load Commits</button>
<ul id="commits"></ul>
<script>
  function loadCommits() {
     // AJAX call …
  }
</script>
```



Solution: Load GitHub Commits with AJAX

```
function loadCommits() {
  $("#commits").empty();
  let url = "https://api.github.com/repos/" +
    $("#username").val() + "/" +
    $("#repo").val() + "/commits";
  $.get(url)
    .then(displayCommits)
    .catch(displayError);
  function displayCommits(commits) { … }
  function displayError(err) { … }
}
```

jQuery AJAX methods return promises

Solution: Load GitHub Commits with AJAX (2)

```
function displayCommits(commits) {
  for (let commit of commits)
    $("#commits").append($("<li>").text(
      commit.commit.author.name + ": " +
      commit.commit.message
    ));
}
function displayError(err) {
  $("#commits").append($("<li>").text("Error: " +
    err.status + ' (' + err.statusText + ')'));
}
```

Check your solution here: https://judge.softuni.bg/Contests/1570

Problem: Blog

Create a **Kinvey app** and then add **user** "peter" with **password** "p"

- Create **comments** "Com1a" and "Com1b" for "Post1
- Create **comments** "Com2a", "Com2b" and "Com2c" for "Post2“
- Display **all posts** and view the **selected** post along with its **comments**

Solution: Blog - Create First Post

Insert your Kinvey App ID here

```
POST /appdata/kid_S1htVfcmm/posts/ HTTP/1.1
Host: baas.kinvey.com
Authorization: Basic cGV0ZXI6cA==
Content-Type: application/json

{ "title":"Post1", "body":"Post #1 body" }
```

Base64(user:pass)

```
{ "title": "Post3", "body": "Post #3 body", …,
  "_id": "5c9a3e3b13ebac4e57c0451e" }
```

Remember the post _id

Solution: Blog - Create Comments

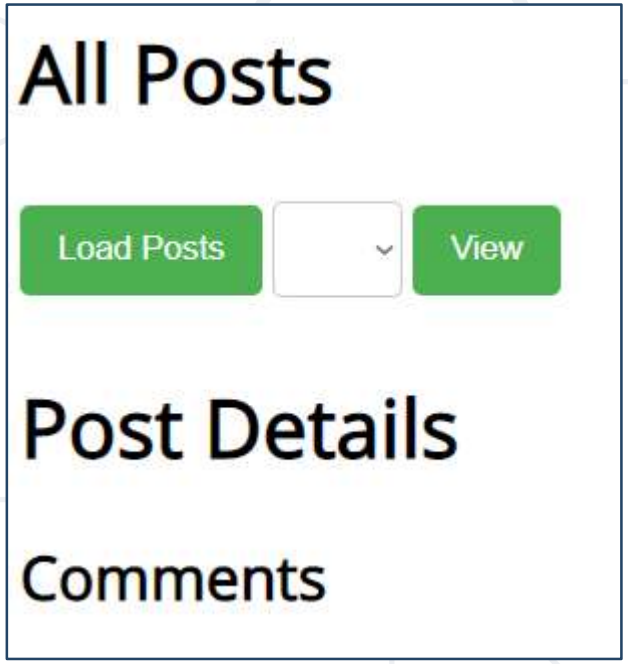
```
POST /appdata/kid_S1htVfcmm/comments/ HTTP/1.1
Host: baas.kinvey.com
Authorization: Basic cGV0ZXI6cA==
Content-Type: application/json

{ "text":"Com1a", "post_id":"5c9a3e3b13ebac4e57c0451e" }
```

Use post _id from the previous request

```
POST /appdata/kid_S1htVfcmm/comments/ HTTP/1.1
Host: baas.kinvey.com
Authorization: Basic cGV0ZXI6cA==
Content-Type: application/json

{ "text":"Com2a", "post_id":"5c9a3e3b13ebac4e57c0451e" }
```

Solution: Blog - HTML Code

```html
<script src="jquery-3.1.1.min.js"></script>
<script src="blog.js"></script>

<h1>All Posts</h1>
<button id="btnLoadPosts">Load</button>
<select id="posts"></select>
<button id="btnViewPost">View</button>

<h1 id="post-title">Post Details</h1>
<ul id="post-body"></ul>
<h2>Comments</h2>
<ul id="post-comments"></ul>
```



Solution: Blog - JS Code

```
$(document).ready(function() {
  const kinveyAppId = "kid_S1htVfcmm";
  const serviceUrl = "https://baas.kinvey.com/appdata/" +
    kinveyAppId;
  const kinveyUsername = "peter";
  const kinveyPassword = "p";
  const base64auth = btoa(kinveyUsername + ":" +
    kinveyPassword);
  const authHeaders = { "Authorization": "Basic " + base64auth
};
  $("#btnLoadPosts").click(loadPostsClick);
  $("#btnViewPost").click(viewPostClick);
  function loadPostsClick() { … }
  function viewPostClick() { … }
  …
});
```

Solution: Blog - Load Posts

```
function loadPostsClick() {
  let loadPostsRequest = {
    url: serviceUrl + "/posts",
    headers: authHeaders,
  };
  $.ajax(loadPostsRequest)
    .then(displayPosts)
    .catch(displayError);
}
```

Solution: Blog - Display Posts as Options

```
function displayPosts(posts) {
  $("#posts").empty();
  for (let post of posts) {
    let option = $("<option>")
      .text(post.title)
      .val(post._id);
    $("#posts").append(option);
  }
}
```

```
▼<select id="posts">
    <option value="5c9a3e3b13ebac4e57c0451e">Post 1</option>
    <option value="5c9a3e4aa698481aa90621e6">Post 2</option>
  </select>
```

Solution: Blog - Handle AJAX Errors

```
function displayError(err) {
  let errorDiv = $("<div>").text("Error: " +
    err.status + ' (' + err.statusText + ')');
  $(document.body).prepend(errorDiv);
  setTimeout(function() {
    $(errorDiv).fadeOut(function() {
      $(errorDiv).remove();
    });
  }, 3000);
}
```

Solution: Blog - Load Post Comments Query

Kinvey allows querying collections:

```
https://baas.kinvey.com/appdata/kid_S1htVfcmm/comments
?query={"post_id":"5c9a3e3b13ebac4e57c0451e"}
```

GET https://baas.kinvey.com/appdata/kid_S1htVfcmm/comments?query={"post_id":"5c9a3e3b13ebac4e57c0451e"}...

☑	Authorization	Basic cGV0ZXI6cA==
☑	Content-Type	application/json
	Key	Value

Body Cookies Headers (9) Test Results

Pretty Raw Preview JSON


```
1 [
2     {
3         "_id": "5c9a3f97fa20820788c0b299",
4         "text": "Com1a",
5         "post_id": "5c9a3e3b13ebac4e57c0451e",
```

Solution: Blog - [View Post] Button Click

```
function viewPostClick() {
  let selectedPostId = $("#posts").val();
  if (!selectedPostId) return;
  let requestPosts = $.ajax({
    url: serviceUrl + "/posts/" + selectedPostId,
    headers: authHeaders });
  let requestComments = $.ajax({ url: serviceUrl +
`/comments/?query={"post_id":"${selectedPostId}"}`,
    headers: authHeaders });
  Promise.all([requestPosts, requestComments])
    .then(displayPostWithComments)
    .catch(displayError);
}
```

Solution: Blog - Display Post with its Comments

```
function displayPostWithComments([post, comments]) {
  $("#post-title").text(post.title);
  $("#post-body").text(post.body);
  $("#post-comments").empty();
  for (let comment of comments) {
    let commentItem = $("<li>")
      .text(comment.text);
    $("#post-comments")
      .append(commentItem);
  }
}
```

Check your solution here: https://judge.softuni.bg/Contests/1570

Async / Await

Simplified Promises

Async Functions

Operate asynchronously via the **event loop**

Contain an **await** expression that:

- Is only valid inside **async functions**
- **Pauses** the execution
- **Waits** for the **Promise's resolution**

Async / **Await** is similar to combining **generators and promises**

Async Functions (2)

```
function resolveAfter2Seconds() {
  return new Promise(resolve => {
    setTimeout(() => {
      resolve('resolved');
    }, 2000);
  });
}
```

```
Expected output:
// calling
// resolved
```

```
async function asyncCall() {
  console.log('calling');
  var result = await resolveAfter2Seconds();
  console.log(result);
}
```

Async Functions (3)

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Do not confuse **await** with **Promise.then()**

- To **await two or more** promises in **parallel**, use **Promise.then()**

If a promise resolves normally, then **await** promise **returns the result**

- In case of a rejection, it **throws an error**

```
async function f() {
  try {
    let response = await fetch();
    let user = await response.json();
  } catch (err) {
    // catches errors both in fetch and
    response.json
    alert(err);
  }
}
```

```
async function f() {
  let response = await fetch();
}

// f() becomes a rejected promise
f().catch(alert);
```

Sequential Execution

To execute different promise methods **one by one**, use Async /Await

```
function doJob(x,sec) {
  return new Promise(resolve => {
  console.log('Start: ' + x);
    setTimeout(() => {
        console.log('End: ' + x);
      resolve(x);
    }, sec *1000);
  });
}
```

```
async function SerialFlow() {
 let result1 = await doJob(1,1);
 let result2 = await doJob(2,2);
 let result3 = await doJob(3,3);
 let finalResult = result1 + result2 + result3;
 console.log(finalResult);
}
```

```
// Start: 1
// End: 1
// Start: 2
// End: 2
// Start: 3
// End: 3
// 6
```

Concurrent Execution

```
async function ParallelFlow() {
 let result1 = doJob(1,1);
 let result2 = doJob(2,2);
 let result3 = doJob(3,3);
 let finalResult = await result1 + await result2 + await result3;
 console.log(finalResult);
}
```

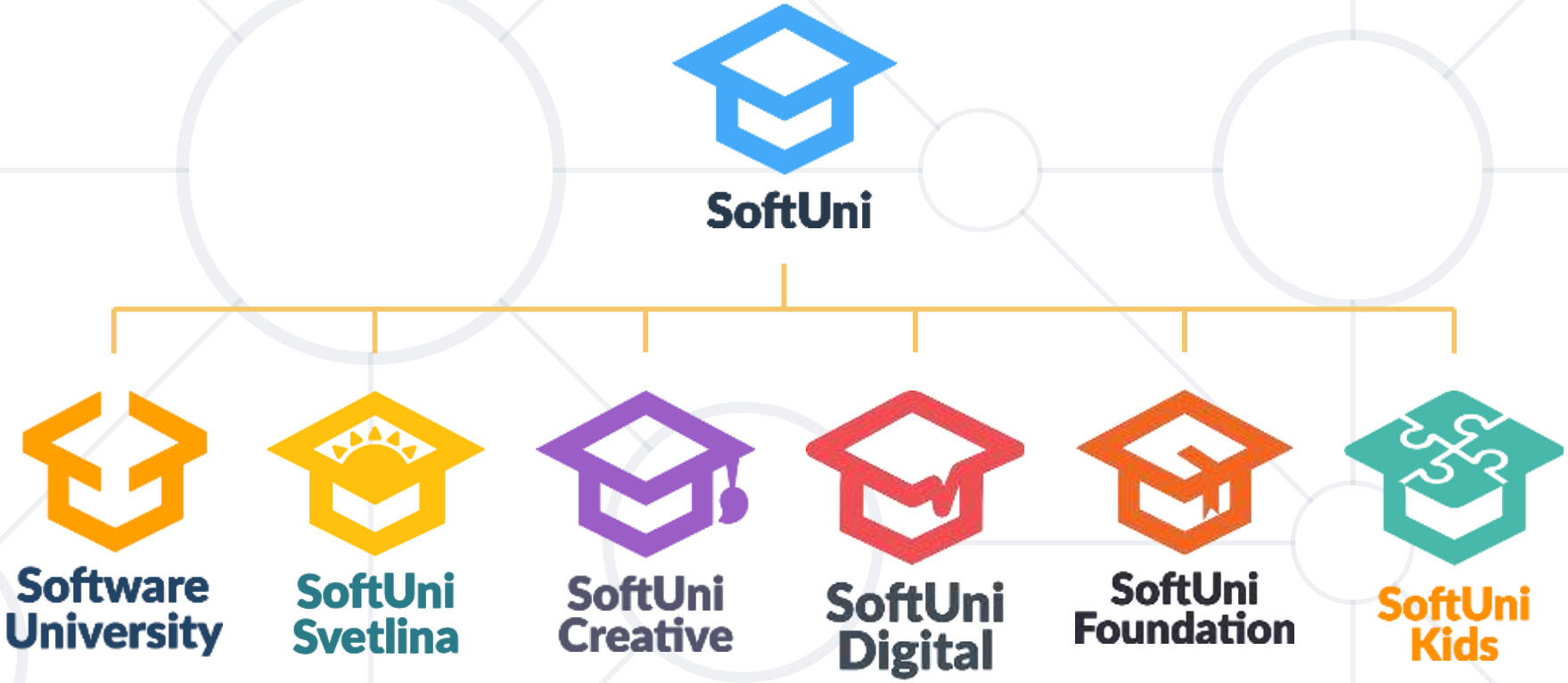
```
// Expected output:
Start: 1
Start: 2
Start: 3
End: 1
End: 2
End: 3
6
```

Live Exercises

Summary

- Promises hold **operations**
  - Can be **resolved** or **rejected**
- jQuery **AJAX** works with **promises**
- **Async** functions contain an **await** expression
  - It **pauses** the **execution**
  - **Waits** for the **Promise's resolution**

Questions?



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