Asynchronous Programming in C# 10

Getting Started with Asynchronous Programming in C# using Async and Await

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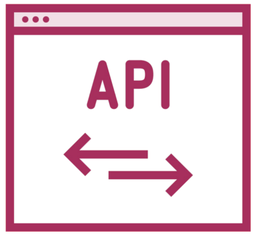
Works in Any .NET Application

WPF, WinForms, .NET MAUI

Console



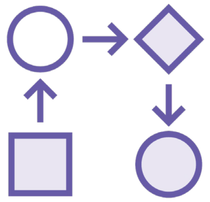
ASP.NET

Asynchronous Programming in .NET

Threading
(Low-level)

Background worker
(Event-based asynchronous pattern)

Task Parallel Library



Async and await

Synchronous vs Asynchronous

Synchronous

```
private void Search_Click(...)
{
    var client = new WebClient();

    var content =
             client.DownloadString(URL);


}
```

Asynchronous

```
private async void Search_Click(...)
{
    var client = new HttpClient();

    var response = await
              client.GetAsync(URL);

    var content = await response.
              Content.ReadAsStringAsync();
}
```

Asynchronous Web Request

```
private async void Search_Click(...)
{
    var client = new HttpClient();

    var response = await
            client.GetAsync(URL);

    var content = await response.
            Content.ReadAsStringAsync();
}
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Asynchronous Web Request

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Asynchronous Web Request

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            Content.ReadAsStringAsync();
}
```

An **asynchronous operation** occurs in parallel and **relieves the calling thread** of the work

Version Check

This version was created by using:

- C# 10
- .NET 6
- Visual Studio 2022

Relevant Notes

A note on frameworks, libraries and tools:

- Free community version of Visual Studio 2022
- Many features, libraries and concepts work in older versions of C# & .NET
- Applicable to all types of .NET applications

Setting up the Exercise Files

Ask questions on the discussion board

Introducing **Async** and **Await** in C#

Suited for I/O Operations

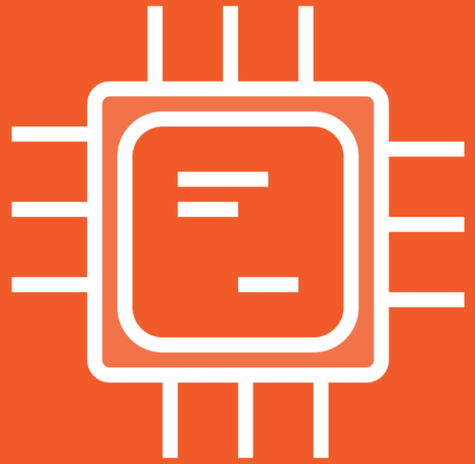
Disk

Memory

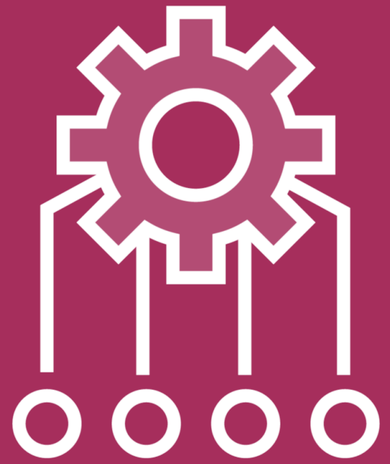
Database

Web/API

When to Use Parallel Programming



CPU bound operations



Independent chunks of data

An **asynchronous** operation
occurs in parallel

Task Parallel Library

```
await Task.Run(() => {
    // I'm an asynchronous operation that is awaited
});

Parallel.Invoke(
    () => { /* Parallel Thread 1 */ },
    () => { /* Parallel Thread 2 */ },
    () => { /* Parallel Thread 3 */ },
    () => { /* Parallel Thread 4 */ },
);
```

Calling **Result** or **Wait() may cause** a **deadlock**

Using **async** and **await** in **ASP.NET** means the **web server** can **handle other requests**

Obtaining the Result

```
Task<string> asynchronousOperation = GetStringAsync();

string result = await asynchronousOperation;
```

Using async and await

```
private async void Search_Click(...)
{
    var store = new DataStore();

    var responseTask = store.GetStockPrices("MSFT");

    var data = await responseTask;
    // Code below will run
    // when responseTask has completed
    Stocks.ItemsSource = data;
}
```

Always use **async** and **await** together

Understanding a Continuation

Using async and await

```
private async void Search_Click(...)
{
    var store = new DataStore();

    var responseTask = store.GetStockPrices("MSFT");

    var data = await responseTask;
    // Code below will run
    // when responseTask has completed
    Stocks.ItemsSource = data;
}
```

The Await Keyword

Gives you a potential result

Validates the success of the operation

Continuation is back on calling thread

The **await** keyword introduces a **continuation**, **allowing** you to **get back to** the **original context** (thread)

Asynchronous Web Request

```
var response = await client.GetAsync(URL);
```

Continuation executed when GetAsync completes

```
var content =  await response.Content.ReadAsStringAsync();
```

Continuation executed when ReadAsStringAsync completes

```
var data = JsonConvert.DeserializeObject(...)
```

Creating Your Own Asynchronous Method

Implementing `GetStocks()`

Option 1:

Retrieve, process and return the stock data

Option 2:

Retrieve and process the stock data, then update the UI

Implementing `GetStocks()`

Option 1:

Retrieve, process and return the stock data

Option 2:

Retrieve and process the stock data, then update the UI

Only use **async void** for
event handlers

Handling an Exception

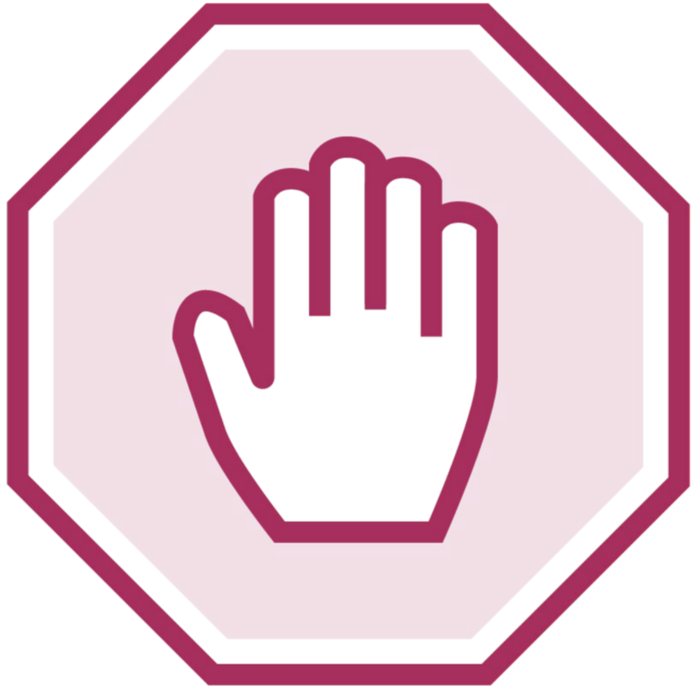
Introducing **asynchronous principles** can **improve** the **user experience**

Exceptions occurring
in an **async void** method
cannot be caught

Always use **await**
to **validate** your
asynchronous operations

Key Takeaways

Always **await** asynchronous operations



Avoid using **async void**

Best Practices

Using async & await

```
async Task Download()
{
    var client = new HttpClient();

    var response = await client.GetAsync(URL);

    var content = await response.
                Content.ReadAsStringAsync();
}
```

Using async & await

Task<HttpResponseMessage>

```
async Task Download()
{
    var client = new HttpClient();

    var response = await client.GetAsync(URL);

    HttpResponseMessage
}
```

Using async & await

```
async Task Download()
{
    var client = new HttpClient();

    var response = await client.GetAsync(URL);

}
```

Validates the Task<HttpResponseMessage>
any exceptions will be re-thrown

Using async & await

```
async Task Download()
{
    var client = new HttpClient();

    var response = await client.GetAsync(URL);

    var content = await response.
                Content.ReadAsStringAsync();
}
```

Avoid using async void

```
async Task Good()
{
    throw new Exception("Find me on the Task");
}

async void Bad()
{
    throw new Exception("No one can catch me");
}
```

Unable to await

```
async Task Good()
{
    Bad(); // Can’t await...

   // No way to run this line in a continuation
}
async void Bad()
{
    throw new Exception("No one can catch me");
}
```

Don’t call
Result or **Wait()**

Deadlocking

```
private async void Search_Click(...)
{
    GetStocks().Wait();
}
private async Task GetStocks()
{
    ...
}
```

Causes a deadlock!

Using the result after await

```
private async void Search_Click(...)
{
    var store = new DataStore();

    var responseTask = store.GetStockPrices("MSFT");

    await responseTask;

    // In the continuation you may use Result
    var data = responseTask.Result;
}
```

Best Practices

- Always use async and await together
- Always return a Task from an asynchronous method
- Always await an asynchronous method to validate the operation
- Use async and await all the way up the chain
- Never use async void unless it's an event handler or delegate
- Never block an asynchronous operation by calling Result or Wait()

Different types of continuations

```
var response = await client.GetAsync(URL);
```

Very different continuations!

```
client.GetAsync(URL).ContinueWith((response) => {

});
```