Async/Await in C# Unity

Preface

The original content is from the author Santosh Parihar from Medium.com. It has been modified and updated for use in this wiki.

> This is an **advanced** topic! You should have an understanding of Object Oriented Programming in C# as well as an understanding behind C# Delegates.

Getting Started

Lets understand Synchronous Operations first:

In software development, synchronous operations refer to tasks that are executed in a sequential, blocking manner. This means that one task is completed before the next one begins, and each operation waits for the previous one to finish. In synchronous execution, the program's flow is linear, and tasks are processed one after the other. It's like standing in a queue: each person must wait for the one in front to finish before proceeding.

Unity's Main Thread :

Unity operates primarily on a single thread known as the "main thread" or "game loop". This main thread is responsible for several critical tasks, including:

- Input Handling, Game Logic Update,Physics Simulation, Rendering and Repeat.
- The loop continues these steps continuously, maintaining the real-time nature of the game.

Unity often requires asynchronous operations due to the following key reasons:

1. Preventing Main Thread Blocking:

- In synchronous operations, if a task takes a long time to complete (like loading a large file or making a network request), it can cause the main thread to become unresponsive. This results in the game freezing or stuttering, leading to a poor user experience.

- Asynchronous operations allow you to perform these time-consuming tasks in the background, ensuring that the main thread remains free to handle other critical tasks like rendering, input processing, and game logic.

2. *Handling Concurrent Tasks:*

- Games often need to perform multiple tasks simultaneously, like loading assets, processing AI behavior, and handling network communication. Asynchronous operations enable you to manage these tasks concurrently without one task blocking the others.

3. *Network Communication:*

- When making network requests, especially over the internet, the response time can vary. Asynchronous operations allow the game to continue functioning while waiting for data from the network, preventing the game from feeling sluggish.

4. *Error Handling:*

- Asynchronous operations often offer better error handling. If something goes wrong during a synchronous operation, it can disrupt the entire process and may not be easy to recover from. With asynchronous operations, errors can be caught and handled more gracefully, allowing the game to continue running without catastrophic failures.

```
async Task HandleAsyncOperation()
{
   try
   {
      // Asynchronous operation
      await SomeAsyncTask();
   }
   catch (Exception e)
   {
      Debug.Log($"error : {e.Message}");
   }
}
```

Here’s a simplified explanation and different examples of async/await for beginners :

To use async/await, you first need to declare your method as `async`. This tells the compiler that the method can return an `async Task` object. You can then use the `await` keyword to wait for an asynchronous operation to complete.

```
using System.Threading.Tasks;
using UnityEngine;

public class AsyncExample : MonoBehaviour
{
    async void Start()
    {
        Debug.Log("Start of the method");

        await SomeAsyncOperation();

        Debug.Log("After the async operation");
    }

    async Task SomeAsyncOperation()
    {
        await Task.Delay(2000); // Simulating a time-consuming operation
    }
}
```

Example 1

The following code loads an asset, creates a new object with the asset, and then moves the object to a specific location:

```
 void Start()
 {
   SpawnPlayer();
 }

async void SpawnPlayer()
{

 GameObject player = await AssetDatabase.LoadAssetAsync("Assets/Player.asset");
 GameObject playerBody= new GameObject(playerBody);
 await playerBody.transform.position = new Vector3(1, 5, 4);

}
```

Example 2

Imagine you’re a magician performing a series of magic tricks. Each trick requires some setup time, and you want to perform them one after another without making the audience wait too long between tricks.

Using async/await, you can perform multiple tricks concurrently and ensure a smooth flow of your performance. Let’s see how it works:

```
using System;
using UnityEngine;
using System.Threading.Tasks;

public class Magician : MonoBehaviour
{
    public async Task PerformMagicShow()
    {
        Debug.Log("Preparing for the magic show...");

        Task trick1Task = PerformTrick("Card Trick");
        Task trick2Task = PerformTrick("Coin Trick");

        // While the tricks are being prepared, you can engage the audience
        Debug.Log("Engaging the audience with some jokes...");

        // Await the completion of each trick
        await trick1Task;
        Debug.Log("Card Trick performed!");

        await trick2Task;
        Debug.Log("Coin Trick performed!");

        Debug.Log("Magic show completed!");
    }

    private async Task PerformTrick(string trickName)
    {
        Debug.Log($"Preparing for {trickName}...");

        // Simulate the time it takes to set up the trick
        await Task.Delay(3000); // 3 seconds

        Debug.Log($"Performing {trickName}!");
```

```
    }

    public async Task StartMagic( )
    {
       await PerformMagicShow();
    }

    public void Start()
    {
        StartMagic();
    }

}
```

In this example, the `Magician` class represents a magician performing a magic show. Each trick is represented by the `PerformTrick` method, which is called with the name of the trick.

Inside the `PerformMagicShow` method, two tricks (`Card Trick` and `Coin Trick`) are initiated concurrently using `PerformTrick` and stored in separate `Task` objects (`trick1Task` and `trick2Task`).

While the tricks are being prepared, you engage the audience with jokes, giving them an entertaining experience during the setup phase.

By assigning `PerformTrick("Card Trick")` to the `trick1Task` variable, you are creating a `Task` object that represents the asynchronous operation of performing card trick. However, at this point, the `PerformTrick("Card Trick")` method will start executing, and the program will proceed to the next line without waiting for the 3-second delay to complete.

The execution will continue to the line `Task trick2Task = PerformTrick("Coin Trick");`, which starts the `PerformTrick("Coin Trick")` method. Similarly, this method contains an asynchronous operation simulated by `Task.Delay(3000)`. Here again, the program will start executing this method, but it won't wait for the 3-second delay to finish.

The line await `trick1Task;` will pause the execution of the PerformMagicShow`()` method and wait until the `trick1Task` is completed before moving on to the next line of code.

When you use the `await` keyword, it essentially tells the program to pause at that point and allow other tasks to continue executing while it waits for the awaited task to complete. In this case, it will wait for the `trick1Task` to finish.

Once the `trick1Task` is completed, the program will resume execution at the next line after the `await` statement. In this code example, it will print "Card Trick performed!" to the console.

So, the `await` keyword ensures that the subsequent code is not executed until the awaited task (in this case, `trick1Task`) has finished its execution.

Then, using `await`, the program waits for each trick to complete before moving on to the next line. Once a trick is completed, a corresponding message is printed to the console.

Finally, when all the tricks are finished, the program prints a completion message, indicating that the magic show is complete.

This playful example demonstrates how async/await can be used to perform multiple tasks concurrently, allowing you to keep the audience engaged while seamlessly transitioning between different tricks during a magic show.

> Unity is single threaded. Coroutines are useful for executing methods over a number of frames.
> Async methods are useful for executing methods after a given task has finished.

Unity's main thread is single-threaded, meaning that all Unity-related operations, such as rendering and updating the game, are handled on that thread. However, async/await can still be beneficial in Unity for handling certain types of tasks, even if they don't run on separate threads.

The key idea is that while the async operations themselves may not run on separate threads, they still allow the Unity main thread to continue processing other tasks and remain responsive.

In summary, while Unity's main thread is single-threaded, async/await can still be utilized in Unity to handle async operations in a non-blocking manner, allowing the main thread to continue processing other tasks while waiting for the completion of the async operations.

> When utilizing coroutines, a feature in Unity, they will automatically stop running as soon as you stop the Unity editor or the game ends. However, when using threads, they can continue running in the background even after stopping the Unity editor. To ensure proper handling, it becomes necessary to manually stop the thread when stopping the Unity editor to prevent any unintended background execution.

To solve the problem we will use Task Cancellation feature of c#, you can read more about it here :

https://learn.microsoft.com/en-us/dotnet/standard/parallel-programming/task-cancellation

```
public class TestAsync : MonoBehaviour
{

    private CancellationTokenSource token;

    private void OnEnable()
```

```
{
    token = new CancellationTokenSource();
    Debug.Log(" task , on enable");

    // Start the work in a separate task
    Task.Run(DoWork);
}

private void OnDisable()
{
    Debug.Log(" task , on disable , task cancel");

    // Cancel the task when the script is disabled
    token.Cancel();
}

private async void DoWork()
{
    Debug.Log(" task , do work");
    await Task.Run(() =>
    {
        for (int i = 0; i < 5; i++)
        {
            Debug.Log("Hello");
            if (token.IsCancellationRequested)
            {
                return;
            }
        }
    }, token.Token);

    if (token.IsCancellationRequested)
    {
        Debug.Log("task was cancelled.");
        return; // further code will not be executed
    }

    // Code to be executed after the task completes successfully
    Debug.Log("task completed successfully.");
}
```

```
}
```

Hope you understood the concept.

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