Asynchronous and Parallel Programming in C♯

Rasmus Lystrøm
External Associate Professor
ITU
rnie@itu.dk

Agenda

Multithreading

Concurrency

Threads

Task Parallel Library

Asynchronous Programming

Multithreading

Enables executing several pieces of code simultaneously

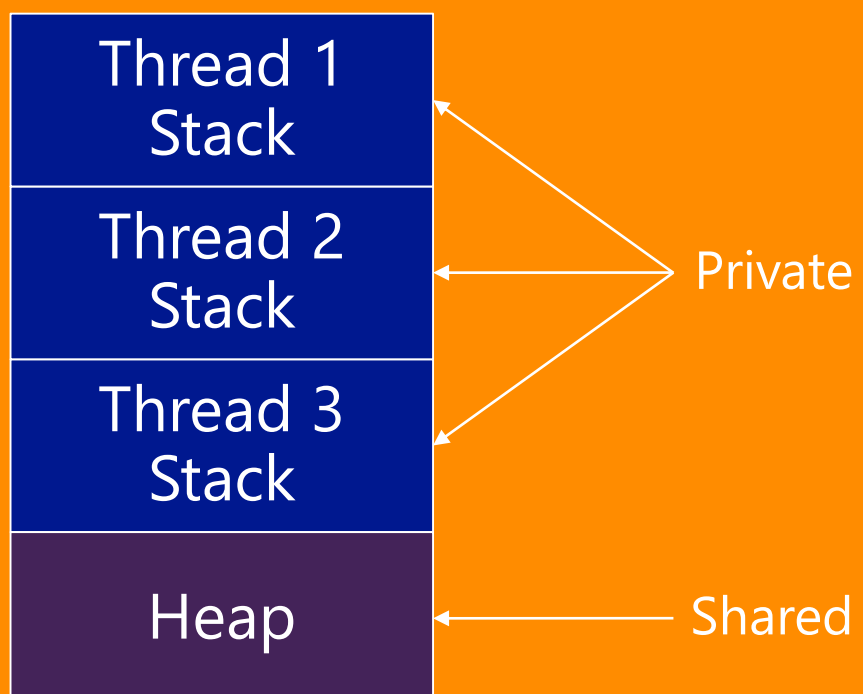
- Leverage multicore CPUs
- Speed

Concurrency

A property of systems in which several computations are executing **simultaneously**, and potentially interacting with each other. The computations may be executing on multiple cores in the same chip, preemptively time-shared threads on the same processor, or executed on physically separated processors.

Threads

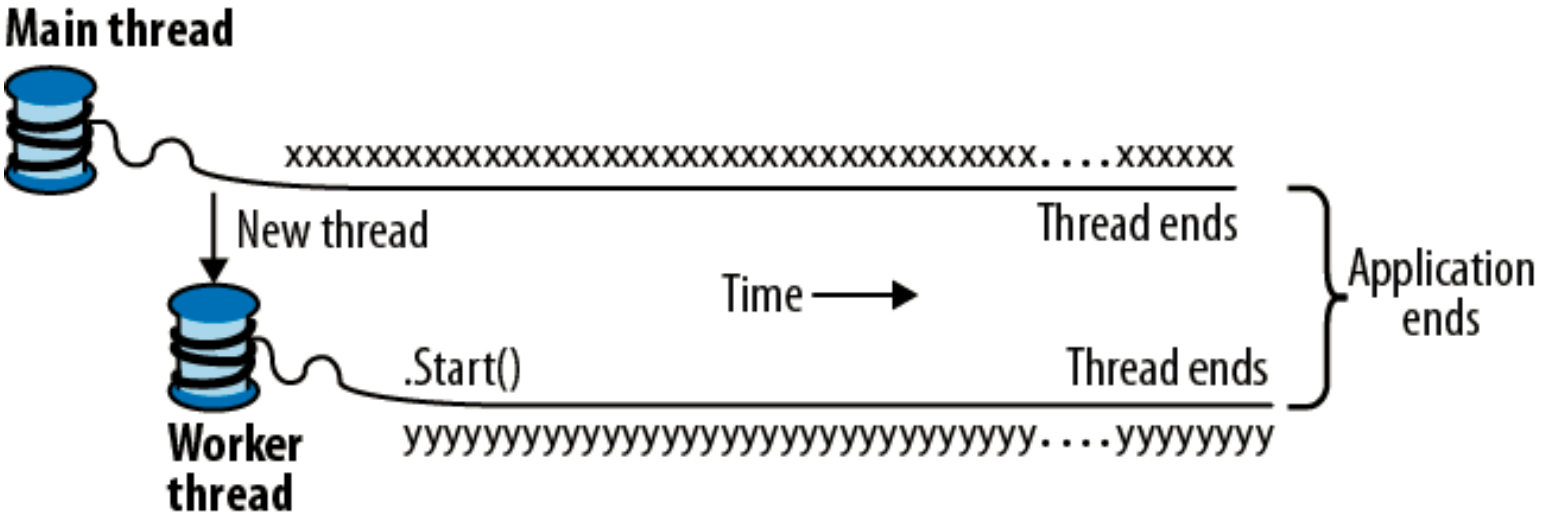
Single Threaded Program



Multithreaded Program

Threads Demo

Threads Example



Race Condition

Race Condition

Behavior of a program where the output is **dependent** on the **sequence** or **timing** of other **uncontrollable** events.

→ Bug, when events do not happen in the order the programmer intended.

Race Condition Demo

Deadlock

Deadlock

A situation in which two or more competing actions are each waiting for the other to finish, and thus neither ever does.

Deadlock demo

Task Parallel Library

Task.Run
Task.Factory…
Task.Delay
Parallel.For
Parallel.ForEach
Parallel.Invoke

Parallel Linq → .AsParallel()

Task Parallel Library demo

System.Collections.Concurrent

ConcurrentQueue<T>

ConcurrentStack<T>

BlockingCollection<T>

ConcurrentDictionary<TKey, TValue>

Asynchronous Programming

`async` →

Method must return **`void`**, **`Task`**, **`Task<T>`**, or a task-like type.
Specifically: a type, which satisfy the **`async`** pattern, meaning a **`GetAwaiter`** method must be accessible.

`await` → Await task(s)…

Note: Test methods must return **`Task`**

Async demo