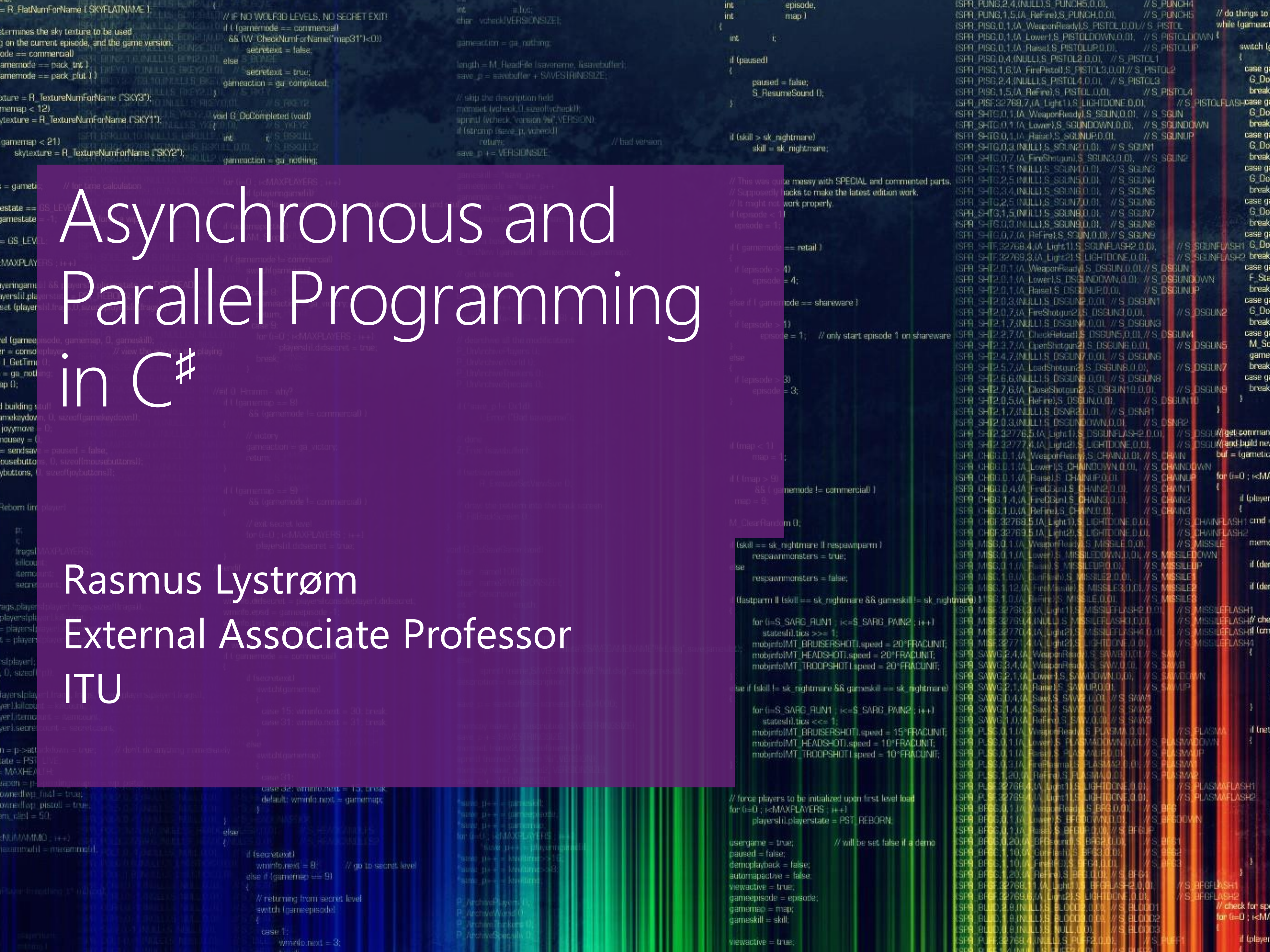

Asynchronous and Parallel Programming in C#

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Multithreading

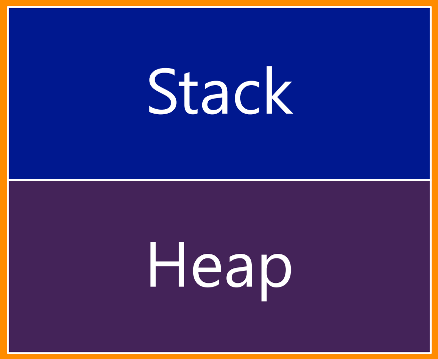
Enables executing several pieces of code simultaneously

- Leverage multicore CPUs
- Speed

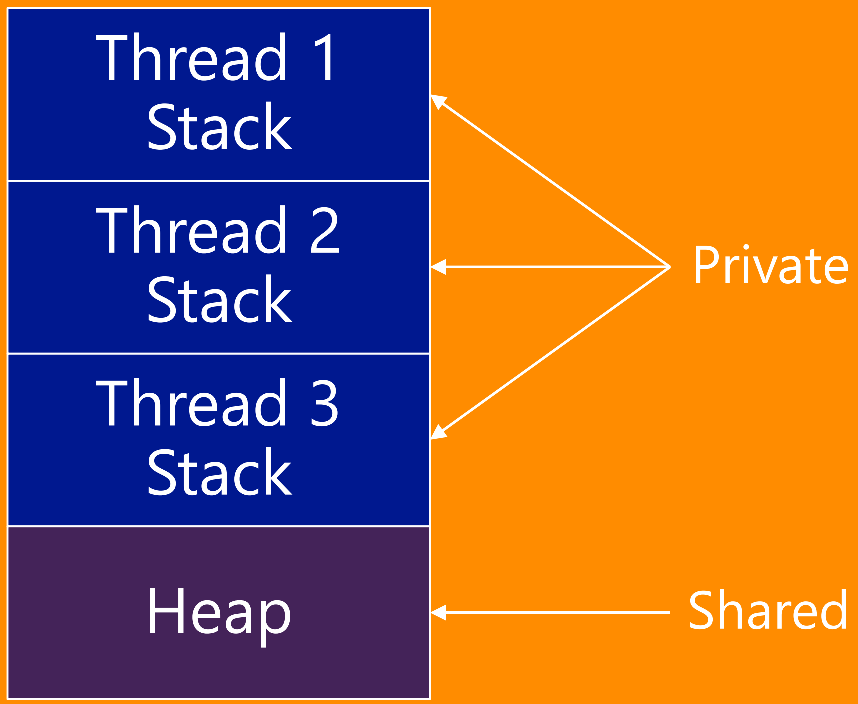
Concurrency

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



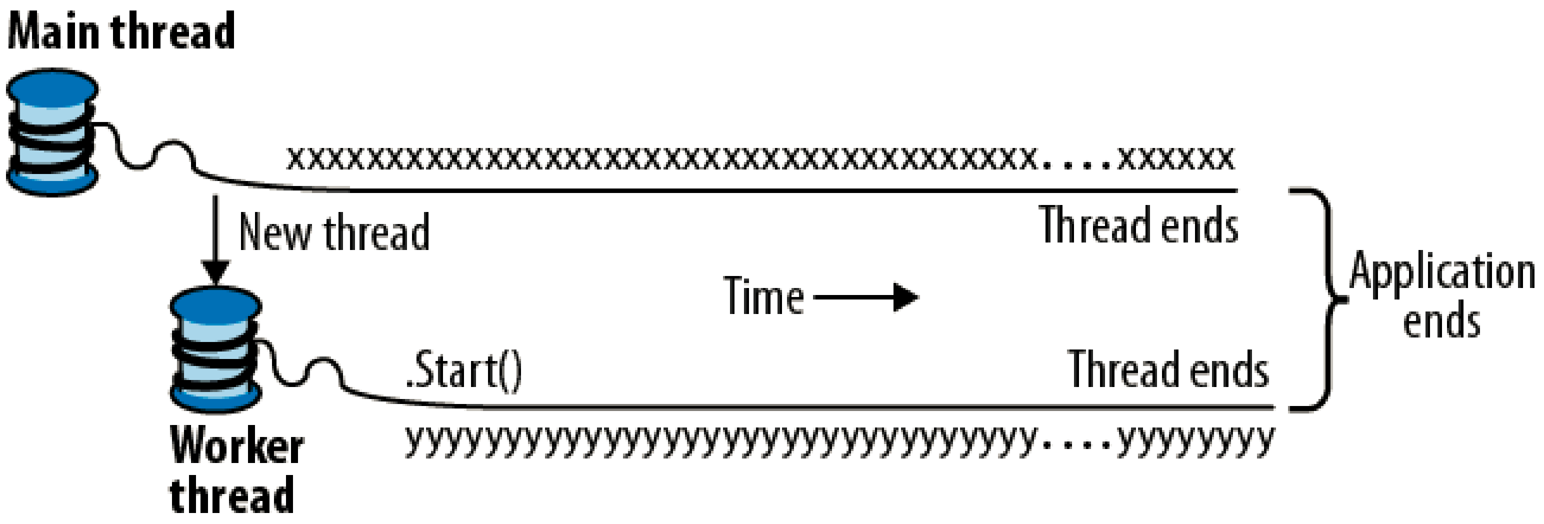
Single Threaded Program



Multithreaded Program

Threads Demo

Threads Example


Main thread
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx....xxxxxx
New thread
Thread ends
Time
Application ends
.Start()
Thread ends
Worker thread
yyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyyy....yyyyyyyy

© From C# 5.0 in a NUTSHELL

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, or Task<T>

await →

Await method or task…

Note: Test methods must return Task

Async demo