Module 06:
"Data Parallelism in TPL"

TEKNOLOGISK
INSTITUT

Agenda

- Introducing the Task Parallel Library
- The Parallel Class
- Parallel LINQ

Task Parallel Library

- Task Parallel Library (TPL)
  - Was introduced in .NET 4.0
  - Enhanced in .NET 4.5
    - Special keywords are included in C# 5.0, C# 8.0
- Features
  - Task Parallelism
  - **Data Parallelism**
  - **Parallel LINQ**
  - Thread-safe collections
- Emerging trends leverage parallelism! Also .NET!

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The Parallel Class

- The `Parallel` class leverages data parallelism
- Provides a high-level API to data parallelism
  - Essentially abstracting thread pool coordination
  - A perfect fit for similar computations where data varies
- Note: No direct C# language support!

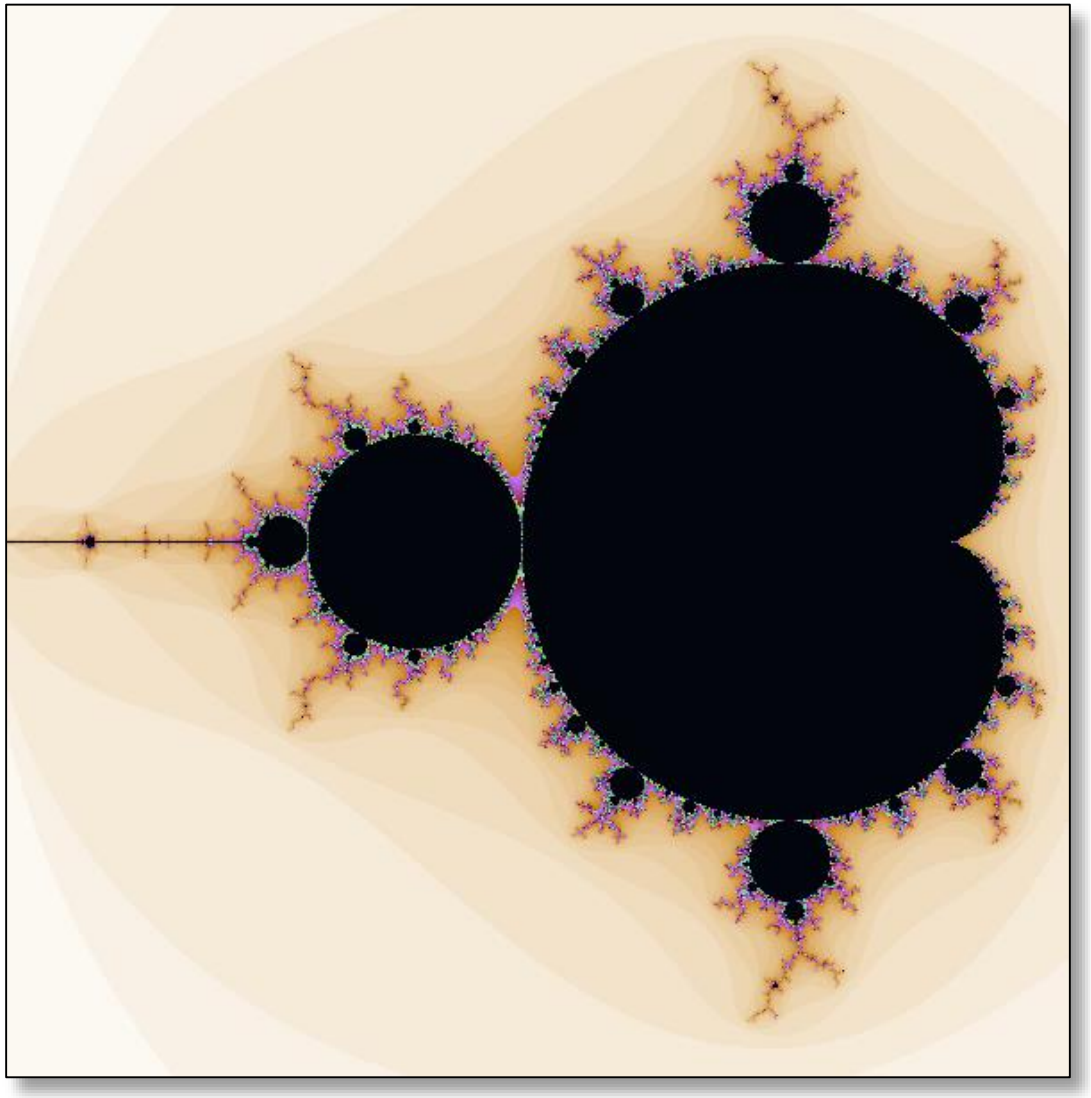
The `Parallel` Class

- `Parallel.`
  - `Invoke()` invokes actions in parallel
  - `For()` is a parallel `for`-loop
  - `ForEach()` is a parallel `foreach`-loop

```
Parallel.For( 0, 1000, i =>
   Console.WriteLine( $"Executing number {i,4}..." )
);
```

- Developer's responsibility that iterations are in fact independent

Example: The Mandelbrot Set



Additional Parallel Options

- Options and refinements are provided through various overloads
  - The `ParallelLoopState` and `ParallelLoopResult` classes

```
ParallelLoopResult result = Parallel.For( 0, 1000, ( i, state ) =>
{
   if( i == 87 )
   {
      state.Break();
   }
   ...
}
```

  - The `ParallelOptions` class
    - `MaxDegreeOfParallelism`
    - `CancellationToken`

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Introducing Parallel LINQ

- Parallel LINQ
  - Implements the well-know API of LINQ
  - Use thread pool to (potentially) evaluate queries in parallel
- (Almost) all operations have parallel implementations
  - Filtering
  - Sorting
  - Grouping
  - Aggregation (*)
  - …

Using Parallel LINQ

- Parallel LINQ = Parallel LINQ
  - **`ParallelEnumerable`** class is defined in **`System.Linq`** namespace

- `ParallelEnumerable`
  - `AsParallel<T>()`
  - `AsSequential<T>()`
  - `WithCancellation<T>()`
  - `WithDegreeOfParallelism<T>()`

```
var even = from i in numbers.AsParallel()
                            .WithCancellation( token )
                            .WithDegreeOfParallelism( 2 )
           where i % 2 == 0
           select i;
```

Best Practices for Using PLINQ

- Do…
  - Use for low-hanging, inherently parallelizable CPU-bound computations
  - Remember that UI updates from Parallel need dispatching
- Don't…
  - Automatically always use PLINQ (due to potential overhead)
  - Use for out-of-process or IO-bound tasks
    - SQL access
    - Entity Framework

Summary

- Introducing the Task Parallel Library
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- Parallel LINQ


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