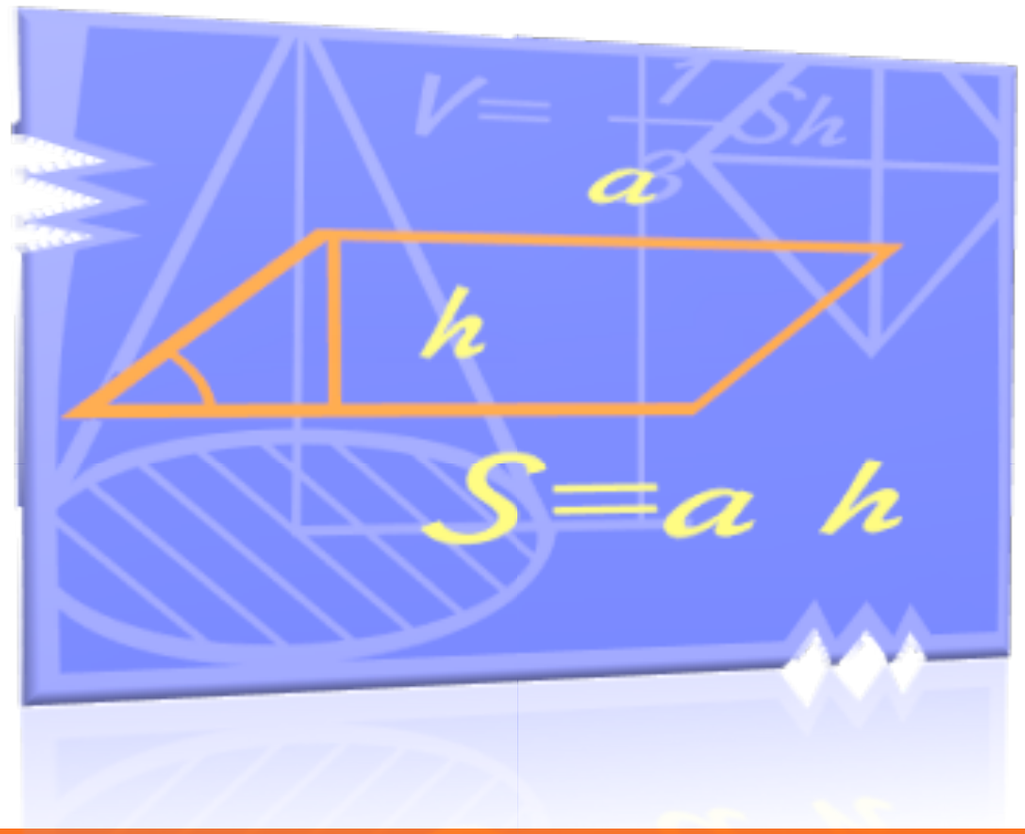
Functional Programming in C#



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Agenda

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Focus: What C# can do with regard to FP and how it works

- What is Functional Programming?
- FP Features introduced in C# 3.0 and .NET 3.5
- Map, Filter and Reduce
- Currying, Partial Application and Composition
- How does a C# programmer benefit from FP?

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What is Functional Programming?

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- A programming paradigm
- Focus on the application of functions
- Avoids state and mutable data
- Well-known languages include Lisp, Scheme, Haskell, ML and (recently) F#
- FP languages tend to have features that support Higher Order Functions, currying, recursion, list comprehensions, ...
- Many imperative and OO languages have FP features today

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Why is Functional Programming interesting?

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- Promotes modularization
- Lazy evaluation → greater efficiency
- Avoid and/or manage side-effects
- The target of avoiding side effects has several advantages: scalability, optimization, debugging, testing
- C# >= 3.0 supports many important FP techniques

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What's in the box

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Interlude — Map, Filter, Reduce

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- **Map/Select** does something with each element in a list
- **Filter/Where** extracts elements from a list based on some condition
- **Reduce/Fold/Aggregate** summarizes elements in a list according to some calculation
- Select, Where and Aggregate are .NET 3.5 implementations of these functions

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What's in the box ... continued

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Map, Filter, Reduce

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- **Map** does something with each element in a list
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Demo

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Map, Filter, Reduce

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Currying and Partial Application

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- Currying: Convert a function that takes multiple parameters into a chain of functions that each take one parameter and return the next function, until the deepest nested function performs the calculation with all the values and returns the result.
- Partial Application: Fixing one or more parameters of a function in curried form, creating a new function with a more specific purpose.

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Manual and Automatic Currying

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Demo

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Composition

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Function Construction

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- The idea of creating new functions from existing ones
- Promotes modularization on a function level
- Partial Application is one way to do it
- Composition is another way:

Assuming `B = f1(A), C = f2(B)`

→ `f2(f1(A))`

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Combining approaches

- Aim: create function `int sumOfOddNumbers(int)`, based on Reduce
- Using Partial Application to define accumulation strategy for Reduce, as well as algorithm for sequence creation
- Using Composition to allow for easier usage, simplify parameters

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Demo

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Function Construction

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FP in C# — what are the benefits?

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- Functional modularization is not easy to get used to, but very rewarding
- Unit testing can benefit from a no-side-effects philosophy
- Programming for scalability is easier, whether you use your own threads, thread pools or toolkits like ParallelFX
- It's easier to get things done – try it yourself!
- BUT: Make sure your team members understand it, too!

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Summary

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- C# has good support for important Functional Programming ideas
- Some “manual” work is required
- Syntax is sometimes a bit weird
- FP provides Glueing techniques (Currying, Partial Application, Composition) on a function level, introduces an additional level of modularization

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Thank you

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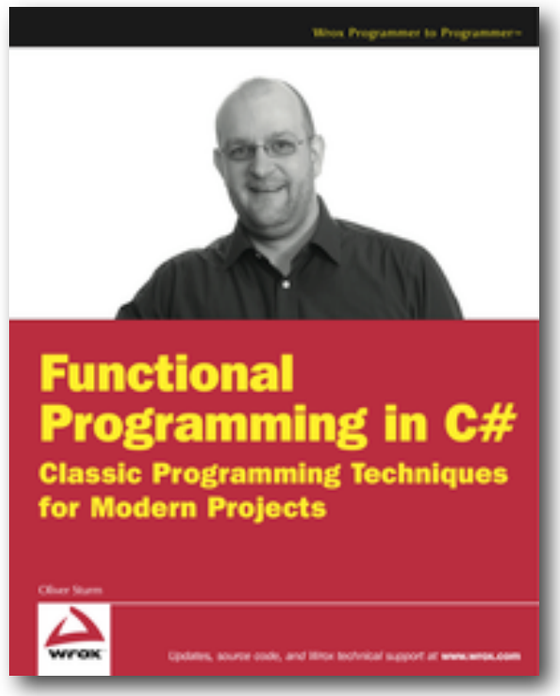

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