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Functional Techniques for C#

https://github.com/KathleenDollard/Slides

You are effective with the imperative, object-oriented core of Java or .NET but you look longingly at the winsome smile of functional languages.

If you play with your language’s functional features, you're never quite sure if you’re getting it right or taking full advantage of them. This talk is for you.

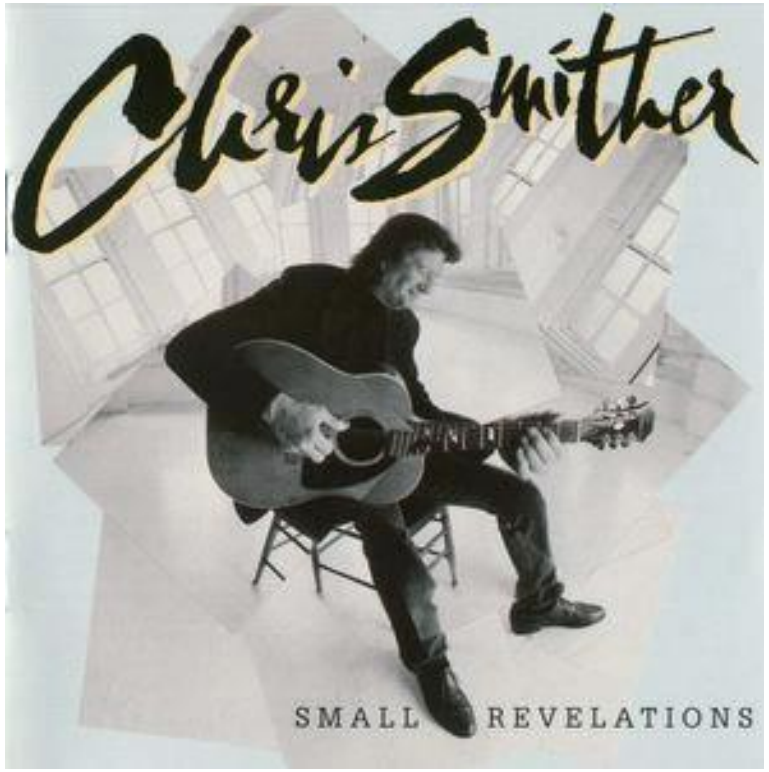
You'll learn which code to attack with functional ideas and how to do it. You’ll look at code similar to what you write every day, and see it transform from long, difficult-to-follow code to short code that's easy to understand, hard to mess up, and straightforward to debug. Better yet, functional approaches help you apply patterns in a clear and consistent way.

Apply these techniques while leveraging delegates, lambda expressions, base classes and generics.

Winsome Smile

Chris Smither

Small Revelations album



Winsome –

“attractive or appealing in appearance or character.”

- *Defined by Google*

What is a Functional Language?

Functional Language

- Central construct is a function
- Functions are first class citizens

Object Oriented Language

- Central concept is a class

C#

- Central construct is a objects
- Functions are first class citizens

What is a Functional Language?

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C# 2.0+

- Central construct is a objects
- Functions are first class citizens

Bigger distinctions than functional/not

- Dynamic vs Strong/static typing
  - JavaScript vs Haskell and C#
- Compiler intensity (policing)
  - JavaScript vs Haskell and C#
- Compiled vs. interpreted
  - C# vs Visual Basic for Applications (VBA)
- Support for REPL
  - PowerShell or F# (C# Interactive)

Why functional in C#?

• Testability	➢ Purity
• Parallelism	➢ Immutability
• Reuse	➢ Inheritance, helper classes
• Expressiveness	➢ Less smelly
• Reasonableness	➢ Craftsmanship (naming, SRP, etc)

Functional techniques
allow us to up the game in all these areas

Why C# with Functional

- Lots of usage (your team might be using it)
- Best of strong typing to reduce accidents
  - If you think that's noise, use inference and implicit operators
- Generics to reuse types
- Extension methods to extend types
- Functions as first class citizens (strongly typed delegates)
- Expressions trees: a structure to describe delegate contents
- Keep the best of this, add more…

Purity

- No surprises!
  - Should indicate all possible input/output
  - Same input should ***always*** result in same output

Demo!

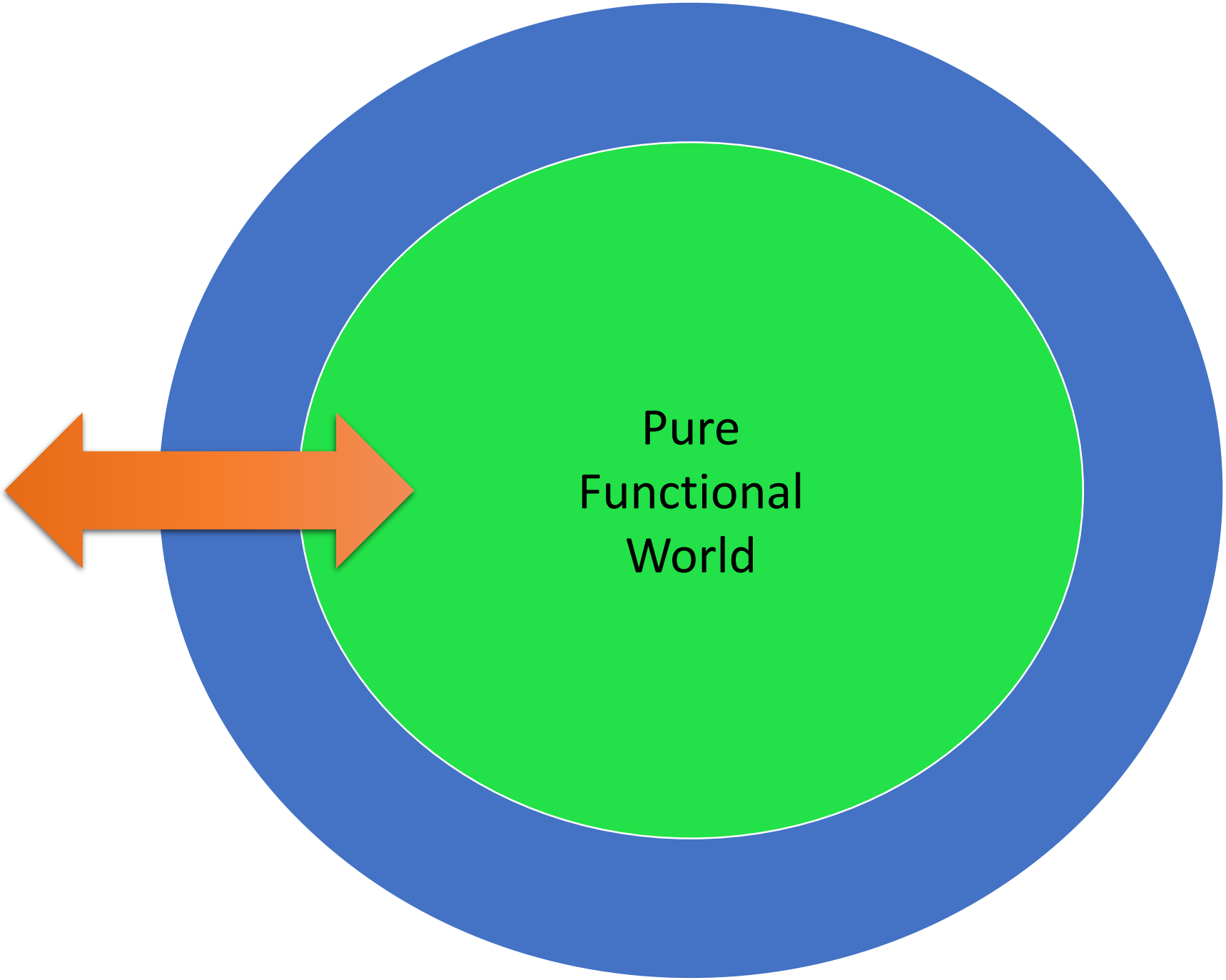
Purity

Purity

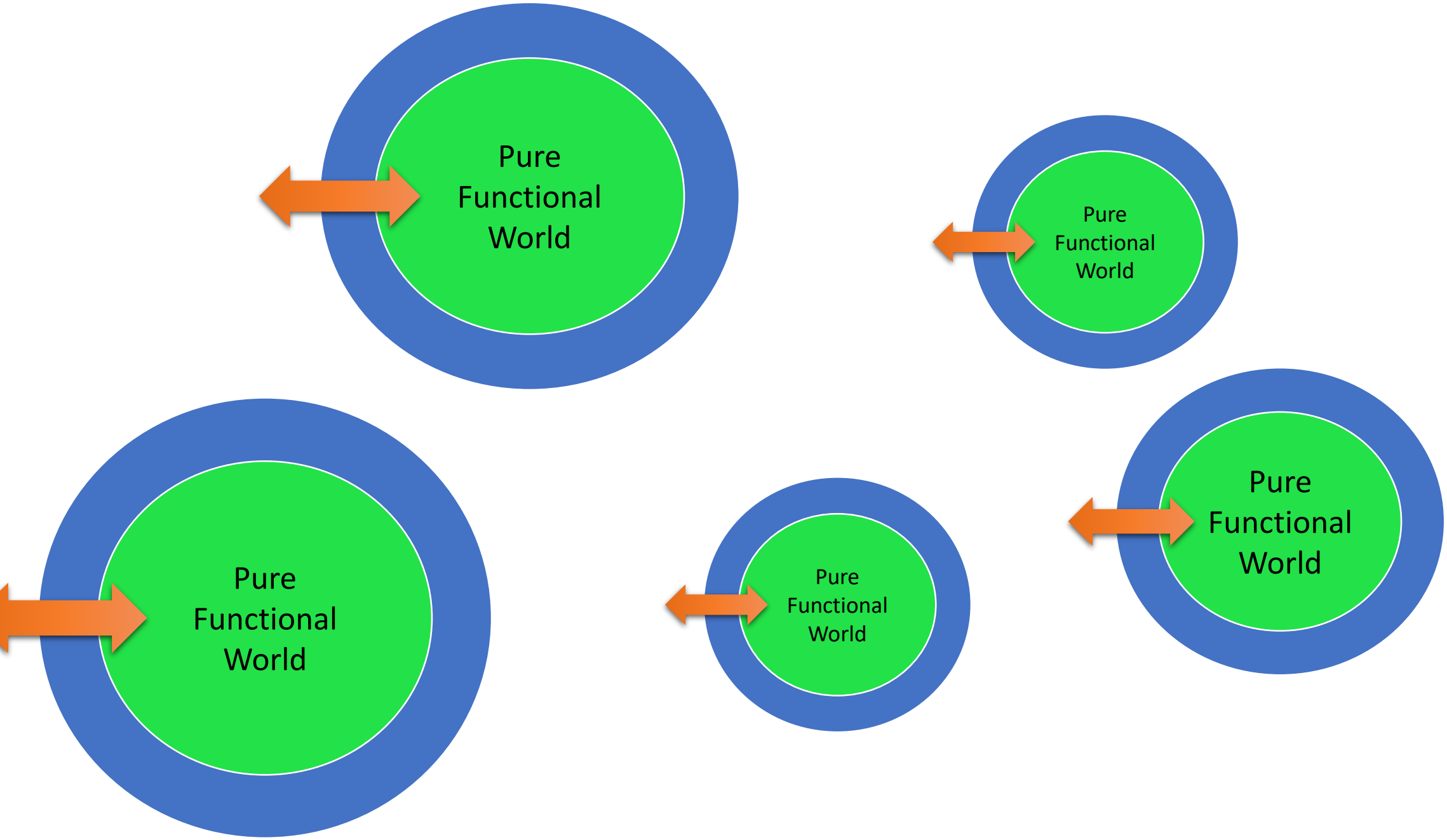
- No surprises!
  - Should indicate all possible input/output
  - Same input should ***always*** result in same output
  - Control flow should be entirely predictable
    - Careful planning for exception
  - Void methods (except those doing absolutely nothing) are not pure
- Pure code is easy to test
  - Be clear within your project what “the world can’t change” means

Purity is rather boring

Your app might look like...


Pure
Functional
World

Separate pure and not pure code


Pure
Functional
World
Pure
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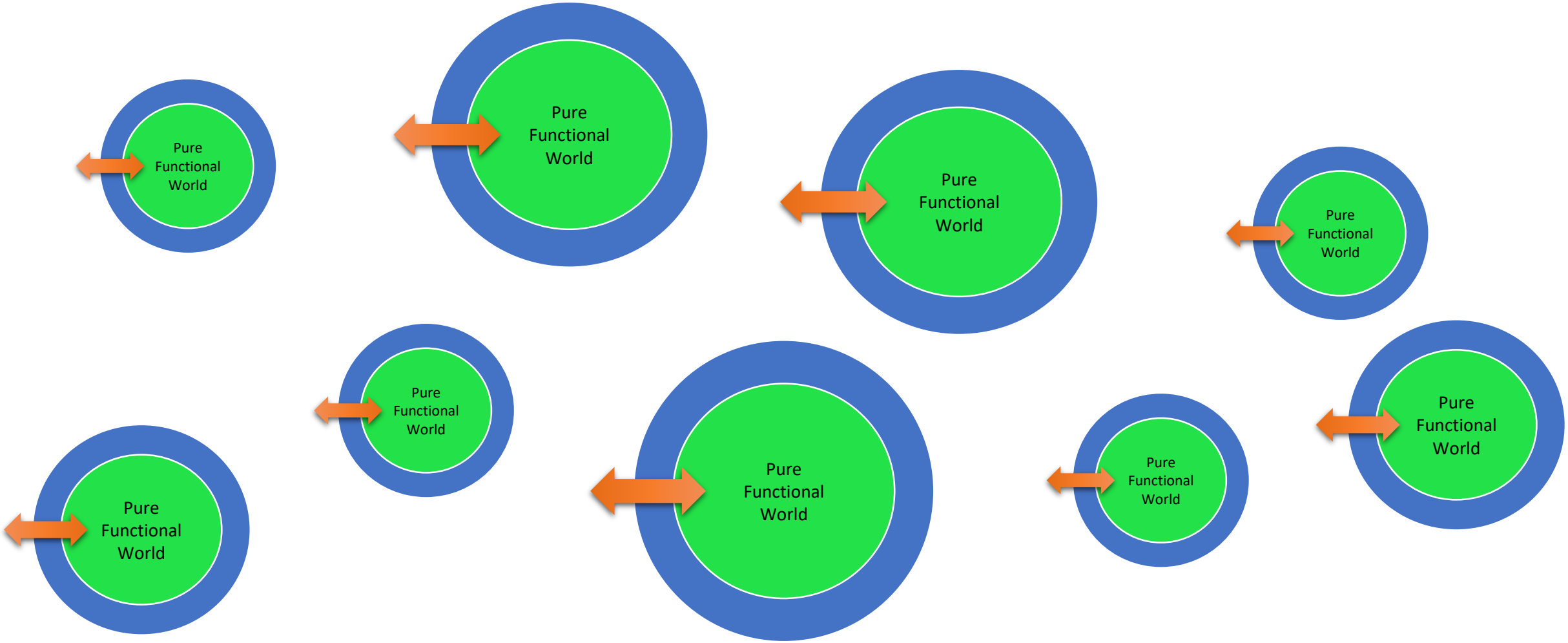
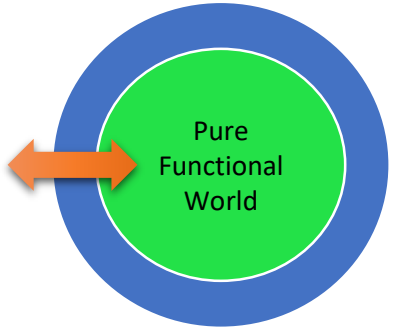
Functional
World

C#  Functional techniques

C# is statically typed and allows multiple internal functional islands



The ability to test is a measure of architectural sanity



- Unit tests within pure units
- Automated functional tests between units

- Don’t mingle pure and impure code
- Don’t mingle unit and functional tests

Confusing, since we refer to our automated test tools as unit test tools

Separate pure and not pure code

C# 7 and functional constructs (opinion)

First class functions		
Purity		
Immutability		
OOP		
Strong typing		
Generics		
Pattern matching		
Expression Trees		
Duck typing		
Records		

C# 7 and functional constructs (opinion)

First class functions		A-
Purity		D
Immutability		B-
OOP		A
Strong typing		A
Generics		A
Pattern matching		B
Expression Trees		A
Duck typing		F
Records		F

Functions as first-class citizens

- Define functions (like data)
- Pass functions around (like data)
- Support higher order functions
  - Functions with delegate parameters or return delegates
- In C# (and Visual Basic) this means Delegates

Delegates – functions as data

- Generic delegate types (Action, Func)
- Type safe function pointers
  - System.Delegate and inherited types
    - “Named” in docs
  - Anonymous methods
    - delegate()
  - Reference to a method (name without parens)
    - Can be a local method
  - Lambdas

Delegates – functions as data

- Generic delegate types (Action, Func)
- Type safe function pointers
  - ~~System.Delegate and inherited types~~
    - ~~"Named" in docs~~
  - ~~Anonymous methods~~
    - ~~delegate()~~
  - Reference to a method (name without parens)
    - Can be a local method
  - Lambdas

f
Delegate
Lambda
func

Are the same in today’s context

- Delegates are code fragments that can be stored to execute later
- **Func<T>**
  - **Func<T<T1<T2>>>**
- **Func<T1, T2>**
  - **Func<TParam, T<T1<T2>>>**
  - **Func<int, Task<DataResult<List<Student>>>>**
- **=>**
  - **Func<int, int> f1 = x => x + 2;**
  - **Func<int> f2 = () => 42;**
  - **Func<int, int, int> f3 = (x, y) => x + y;**
- **...Where<T>(Func<T, bool> predicate)**
  - **var y = list.Where(z => z.Id == x);**

- Action: Delegates that don't return a value
- **`Action<T>`**
  - **`Action<T<T1<T2>>>`**
- Not pure (unless trivial)
- Doesn't interchange with Func (not polymorphic)
  - **`...RecordTime<T>(Func<T> op)`**
  - **`...RecordTime<T>(Func<T, T2> op)`**
  - …
  - **`...RecordTime<T>(Action<T> op)`**
  - **`...RecordTime<T>(Action<T, T2> op)`**

Arity

Can convert delegate types to each other

```
public static class ActionExt
{
    public static Func<VoidType> ToFunc(this Action action)
        => () => { action(); return VoidData; };

    public static Func<T, VoidType> ToFunc<T>(this Action<T> action)
        => x => { action(x); return VoidData; };

    public static Func<T1, T2, VoidType> ToFunc<T1, T2>(
           this Action<T1, T2> action)
        => (T1 x, T2 y) => { action(x, y); return VoidData; };
}
```

- Action: Delegates that don’t return a value
- **`Action<T>`**
  - **`Action<T<T1<T2>>>`**
- Not pure (unless trivial)
- Doesn’t interchange with Func (not polym
  - **`...RecordTime<T>(Fu`**
  - **`...Rec`**

Or just generally avoid Action

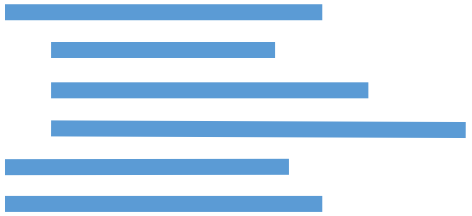
```
...RecordTime<T>(Action<T> op)
...RecordTime<T>(Action<T, T2> op)
```

Refactoring to Functional

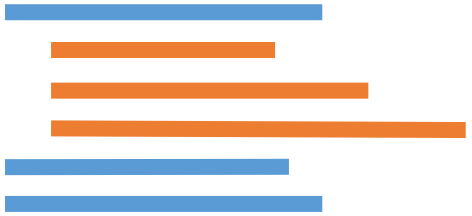
Imperative (normal) Refactoring

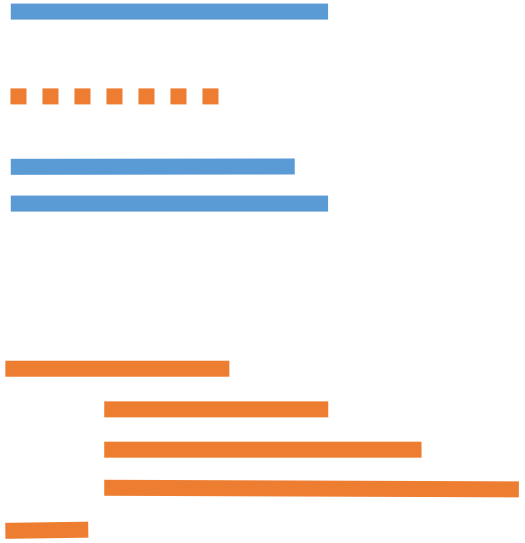
- Inside out refactoring

Imperative Refactoring



Imperative Refactoring



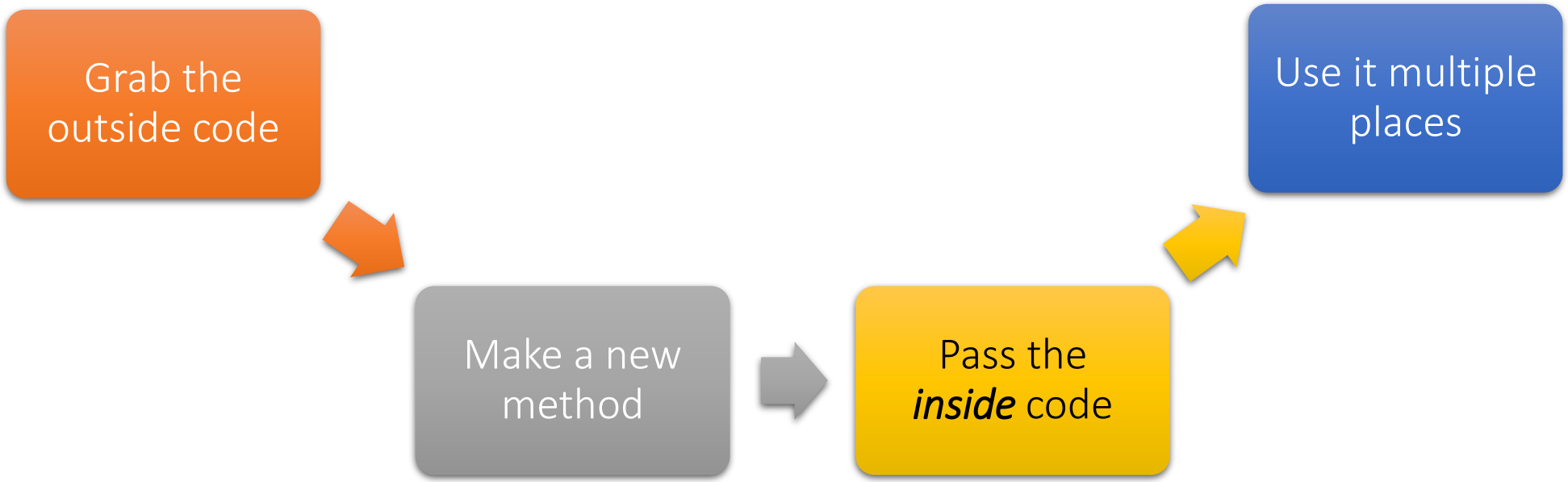


Demo!

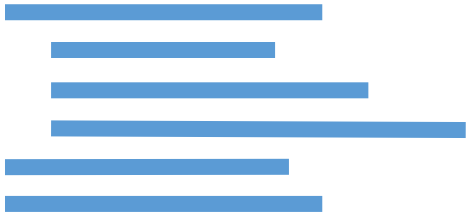
Inside out refactoring (normal)

Functional Refactoring

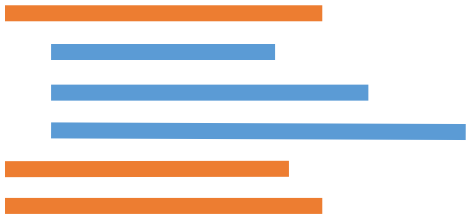
- Outside in refactoring

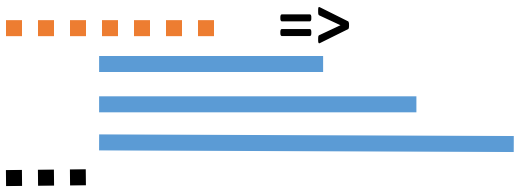


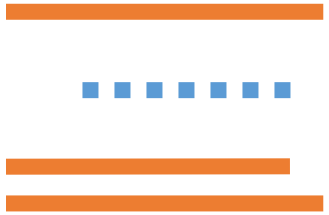
Functional Refactoring



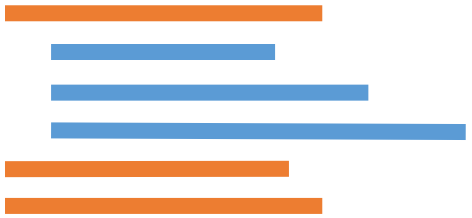
Functional Refactoring

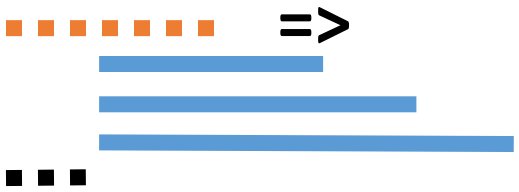


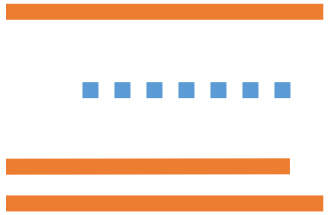




Functional Refactoring



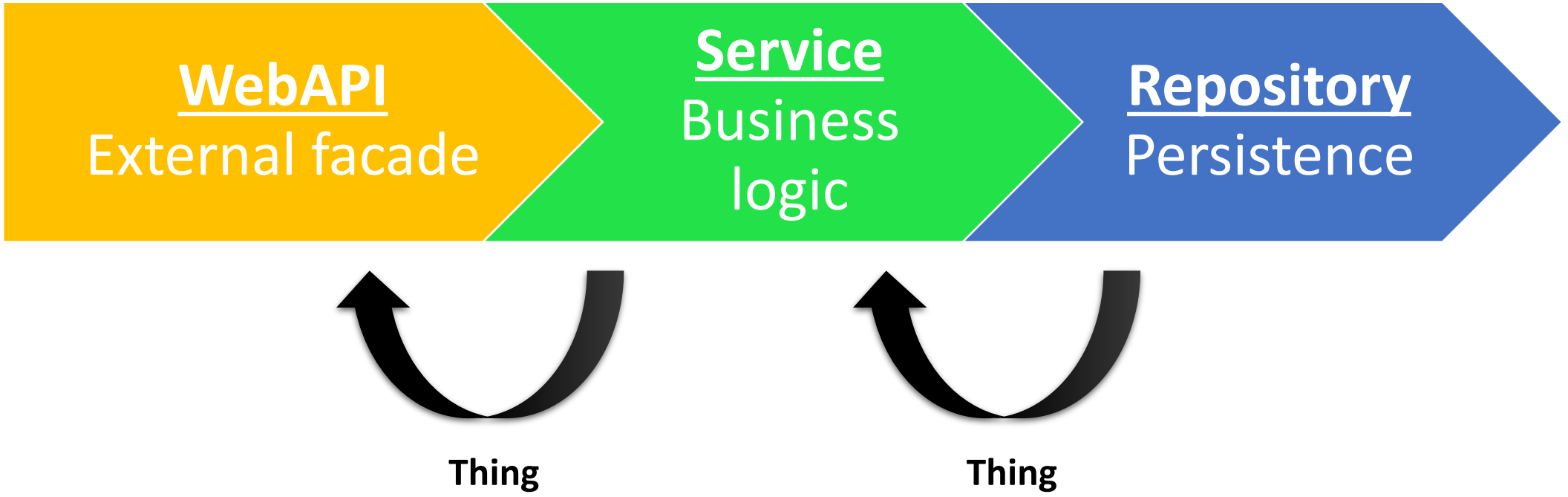


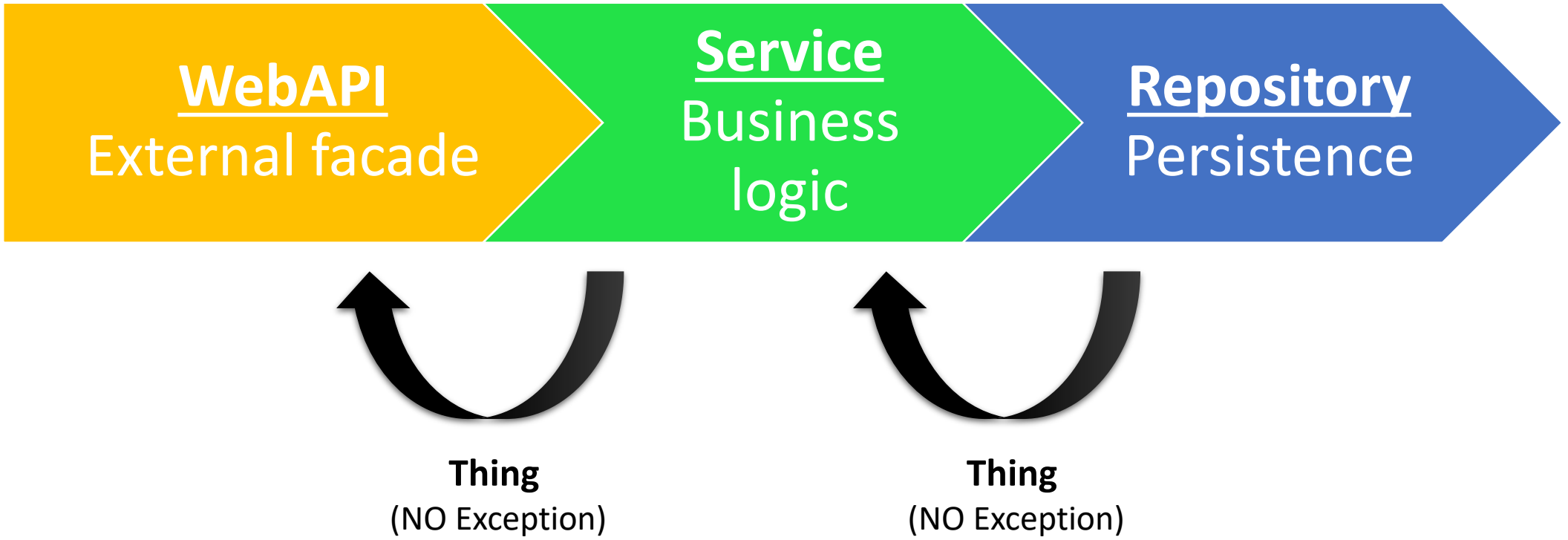


Demo!

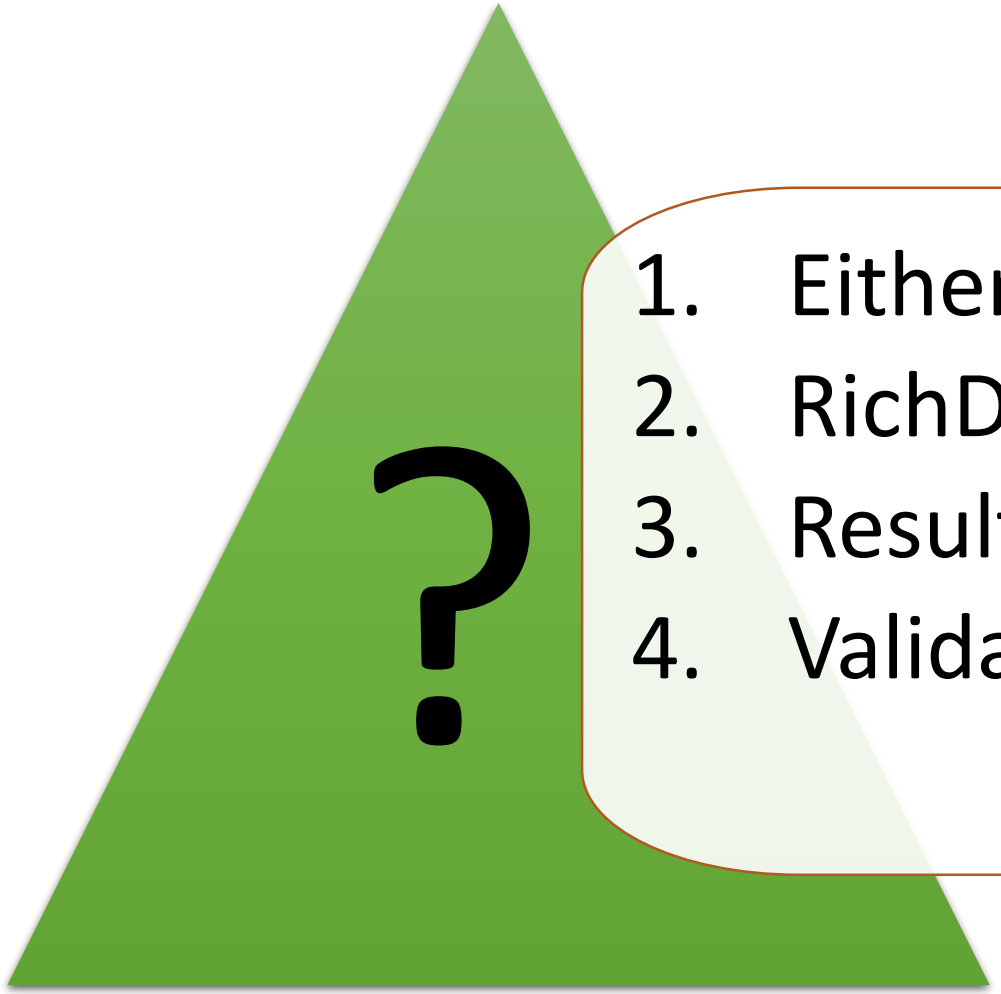
Outside in refactoring

Basic App Data Flow


WebAPI
External facade
Service
Business
logic
Repository
Persistence
Thing
Thing


WebAPI
External facade
Service
Business logic
Repository
Persistence
Thing
(NO Exception)
Thing
(NO Exception)

Naming is hard



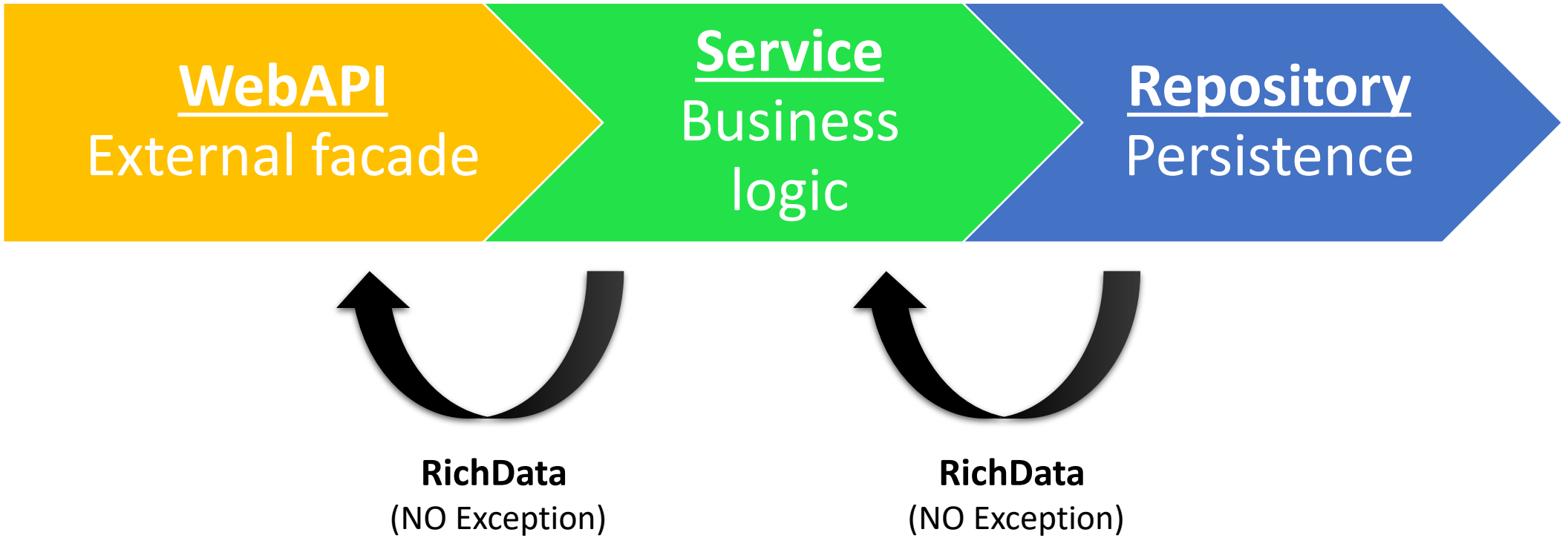
1. Either
2. RichData/RichValue
3. Result
4. Validation<Exception<T>>

1) Core FP concept, 2 & 3) Kathleen 4) Enrico Buonanna

Naming is hard

1. Either
2. **RichData/RichValue**
3. Result
4. Validation<Exception<T>>

1) Core FP concept, 2 & 3) Kathleen 4) Enrico Buonanna


WebAPI
External facade
Service
Business logic
Repository
Persistence
RichData
(NO Exception)
RichData
(NO Exception)

Your app might look like...

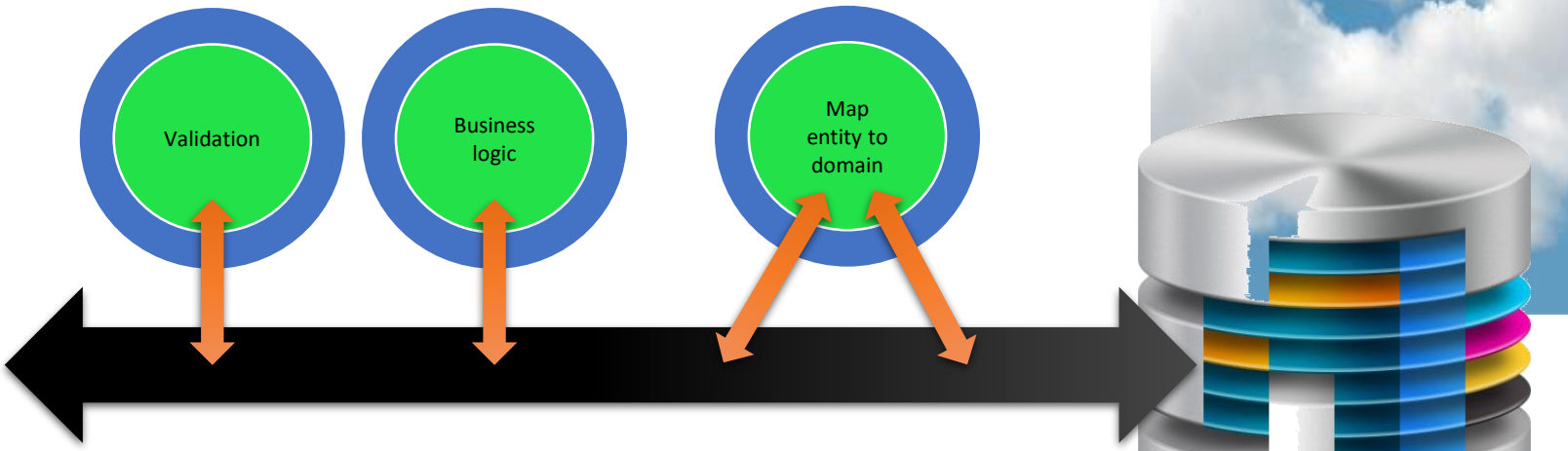
Your app might look like...

This talk seems to be lacking something

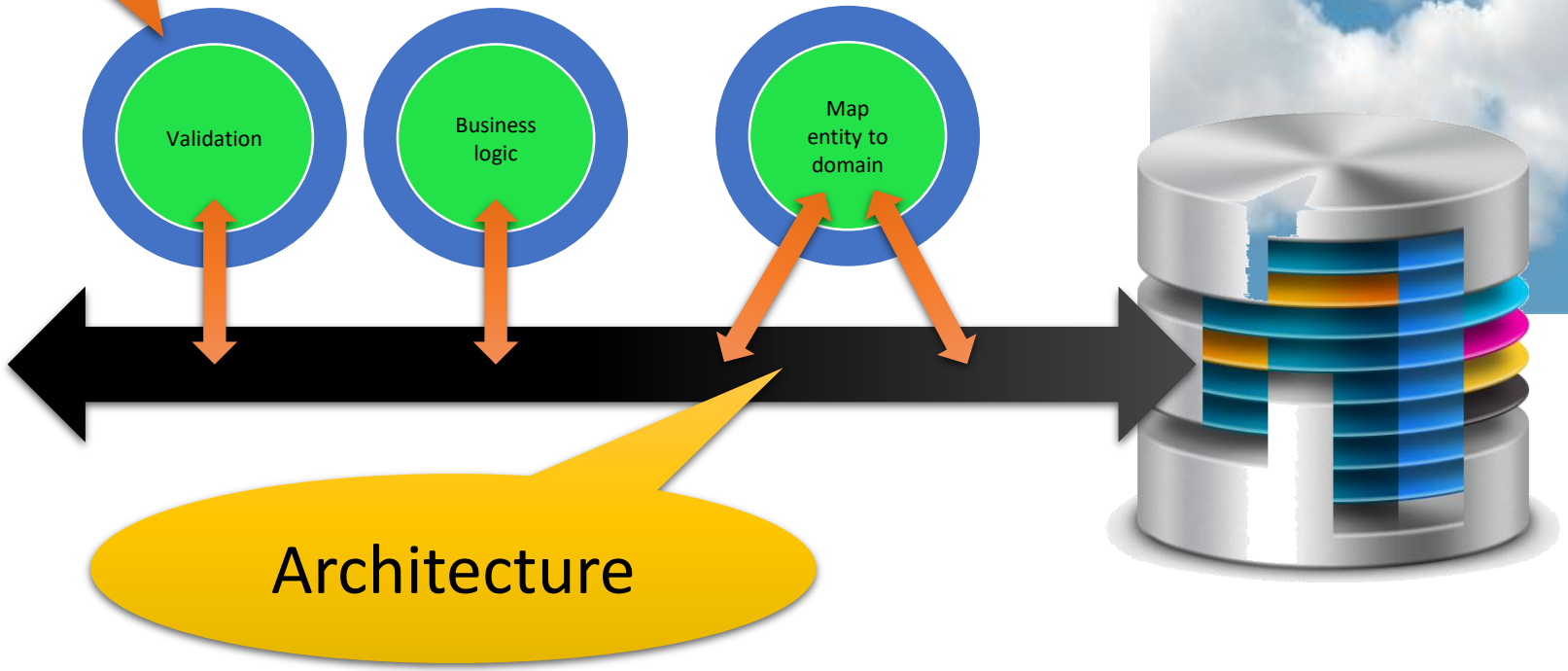
What?
Cats?
Cloud?
GIFs?

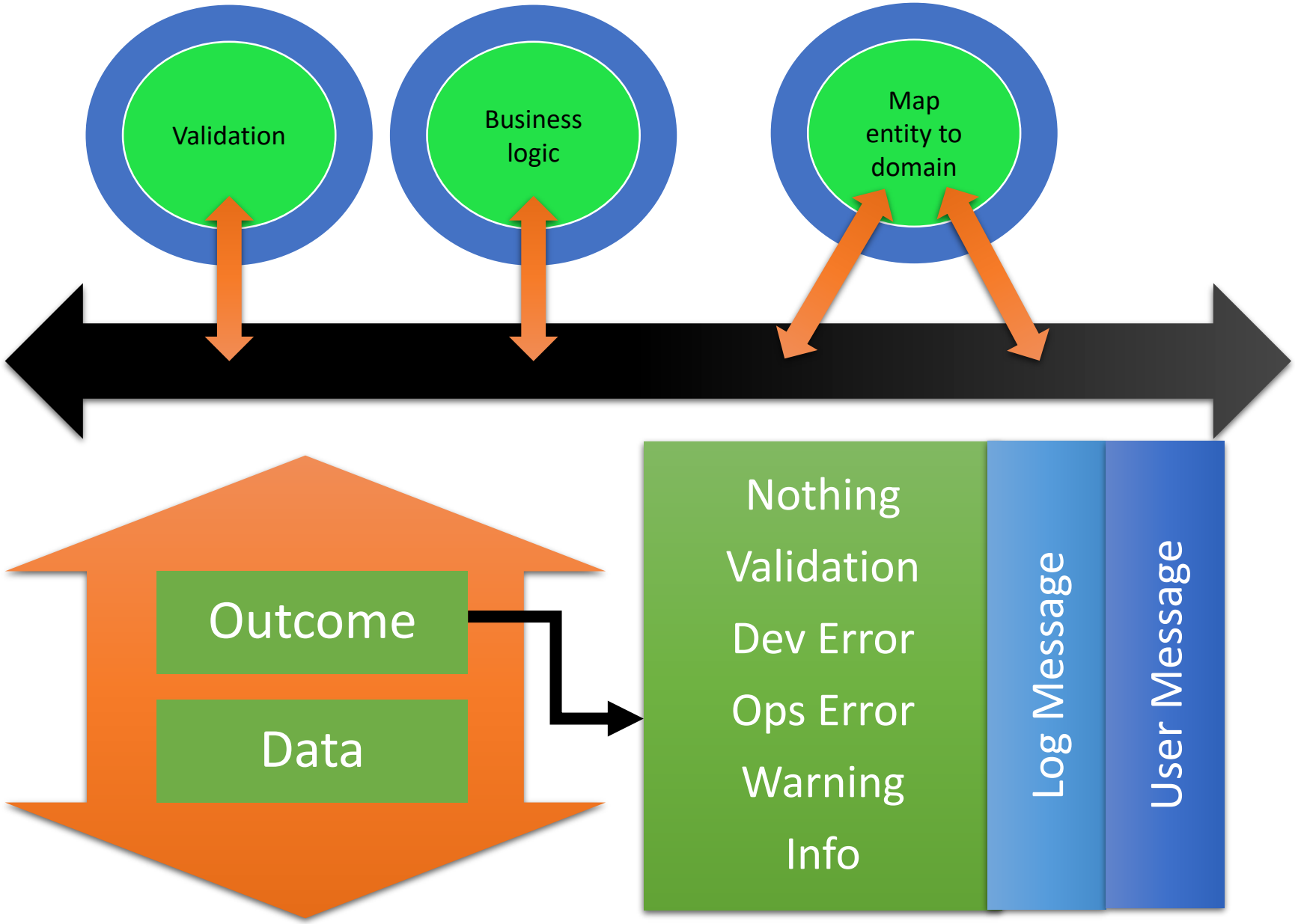
Your app might look like...

Your app might look like...



Your app might look like...




Validation
Business logic
Map entity to domain
Outcome
Data
Nothing
Validation
Dev Error
Ops Error
Warning
Info
Log Message
User Message

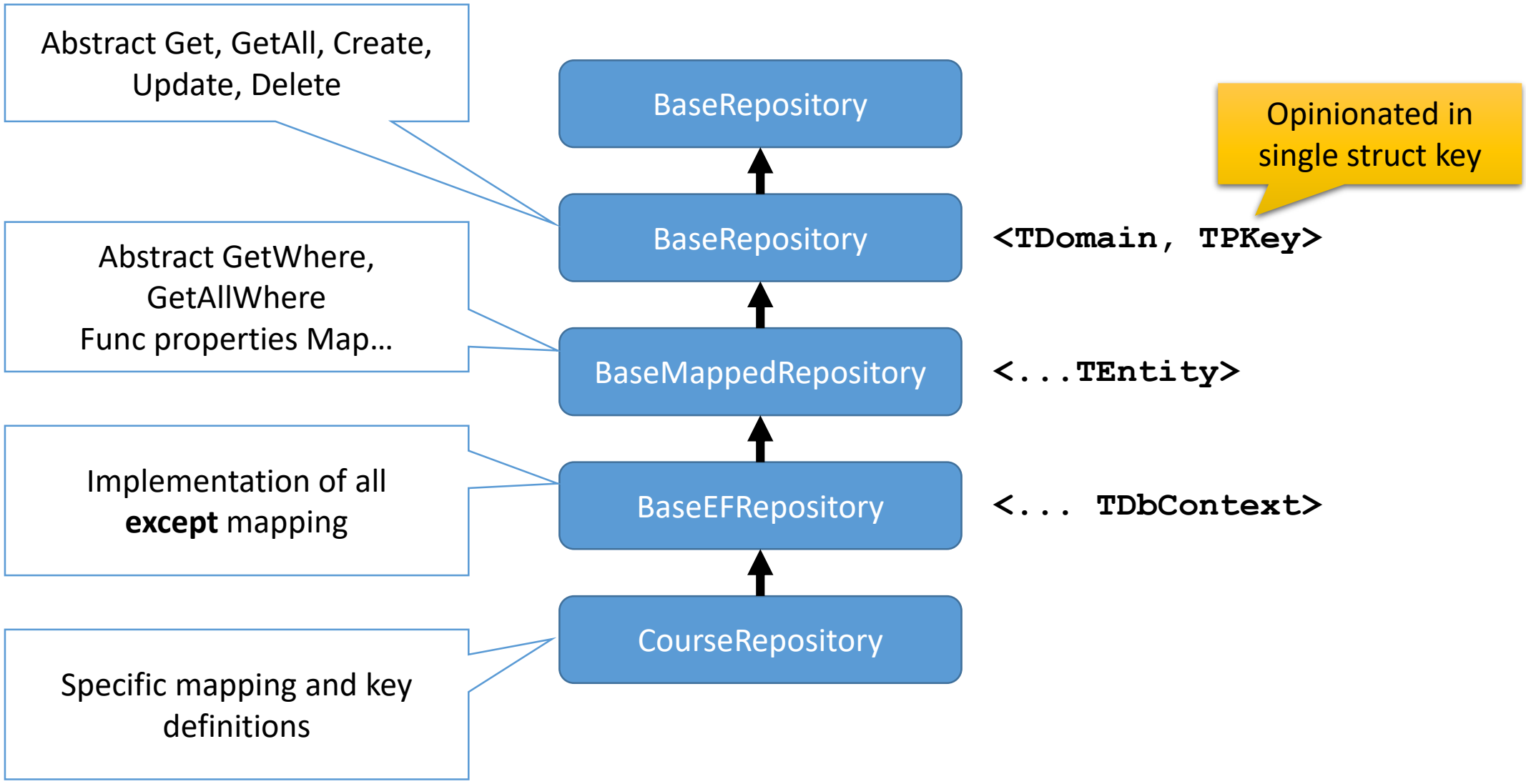
Demo!

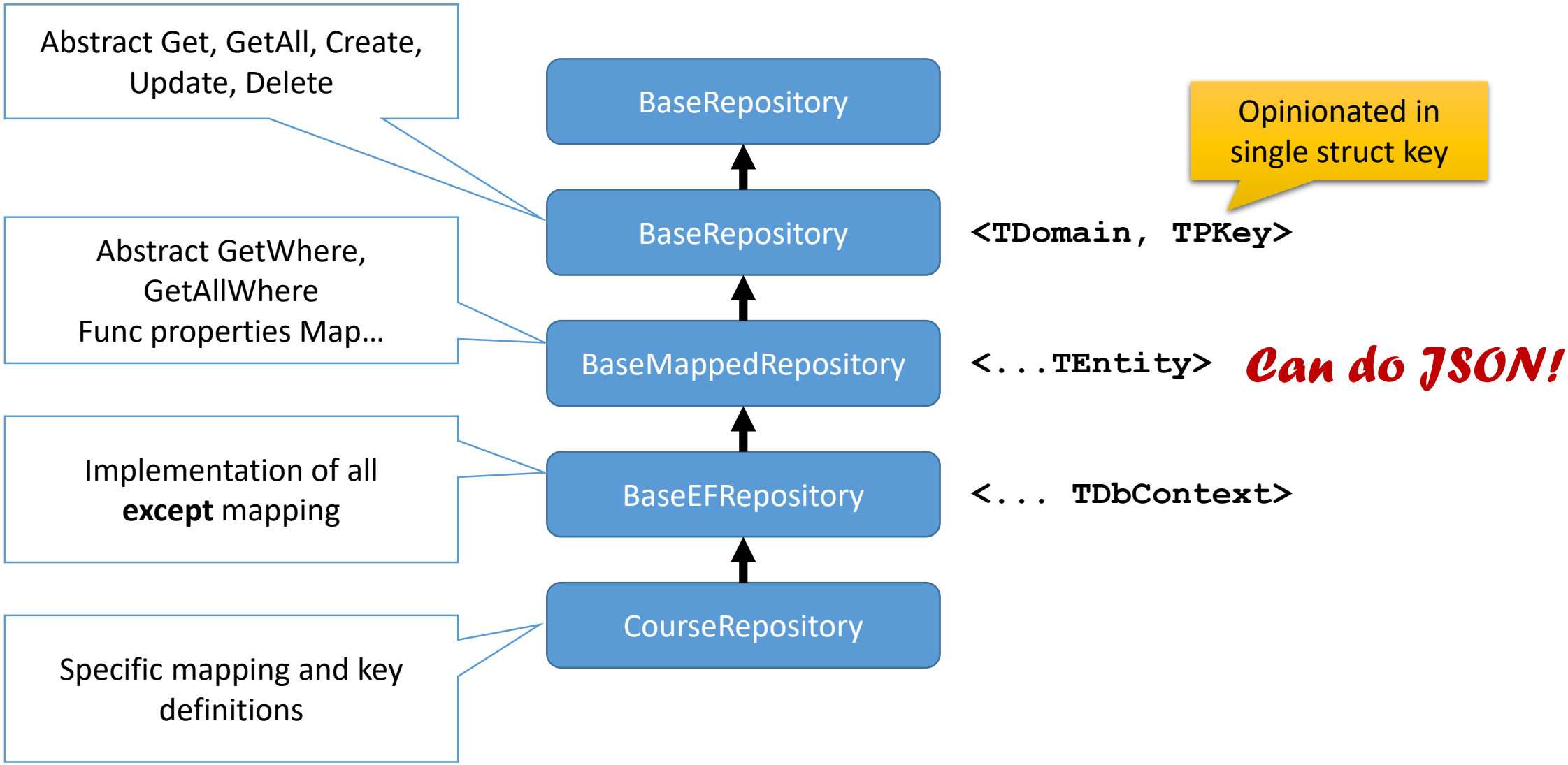
Outcome

RichData<TData>

Generic inheritance hierarchies from a *partial application* perspective

- Base class has no generic type
- Leaf class has all types
- Each intervening class has a purpose and adds generic types


Abstract Get, GetAll, Create, Update, Delete
Abstract GetWhere, GetAllWhere Func properties Map…
Implementation of all **except** mapping
Specific mapping and key definitions
BaseRepository
BaseRepository
BaseMappedRepository
BaseEFRepository
CourseRepository
Opinionated in single struct key
<TDomain, TPKey>
<...TEntity>
<... TDbContext>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BaseRepository
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BaseMappedRepository
BaseEFRepository
CourseRepository
Opinionated in single struct key
<TDomain, TPKey>
<...TEntity>
Can do JSON!
<... TDbContext>

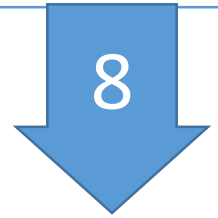
Demo!

Functions in Generic Hierarchy

Useful things in C#

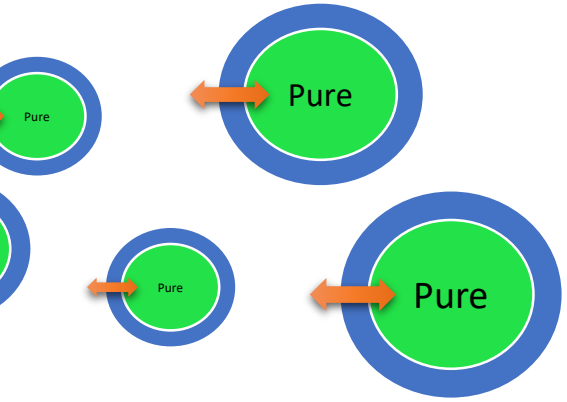
- Expression-body members
- Generic inheritance hierarchies
- Expression trees
- Local functions
- Pattern matching (enhanced switch statement)
- Tuples
- Throw expression

- Pattern matching (switch expression)
- Default interface implementation (rich interfaces)



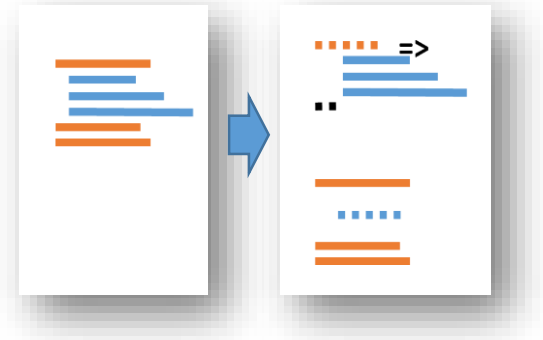
Recap

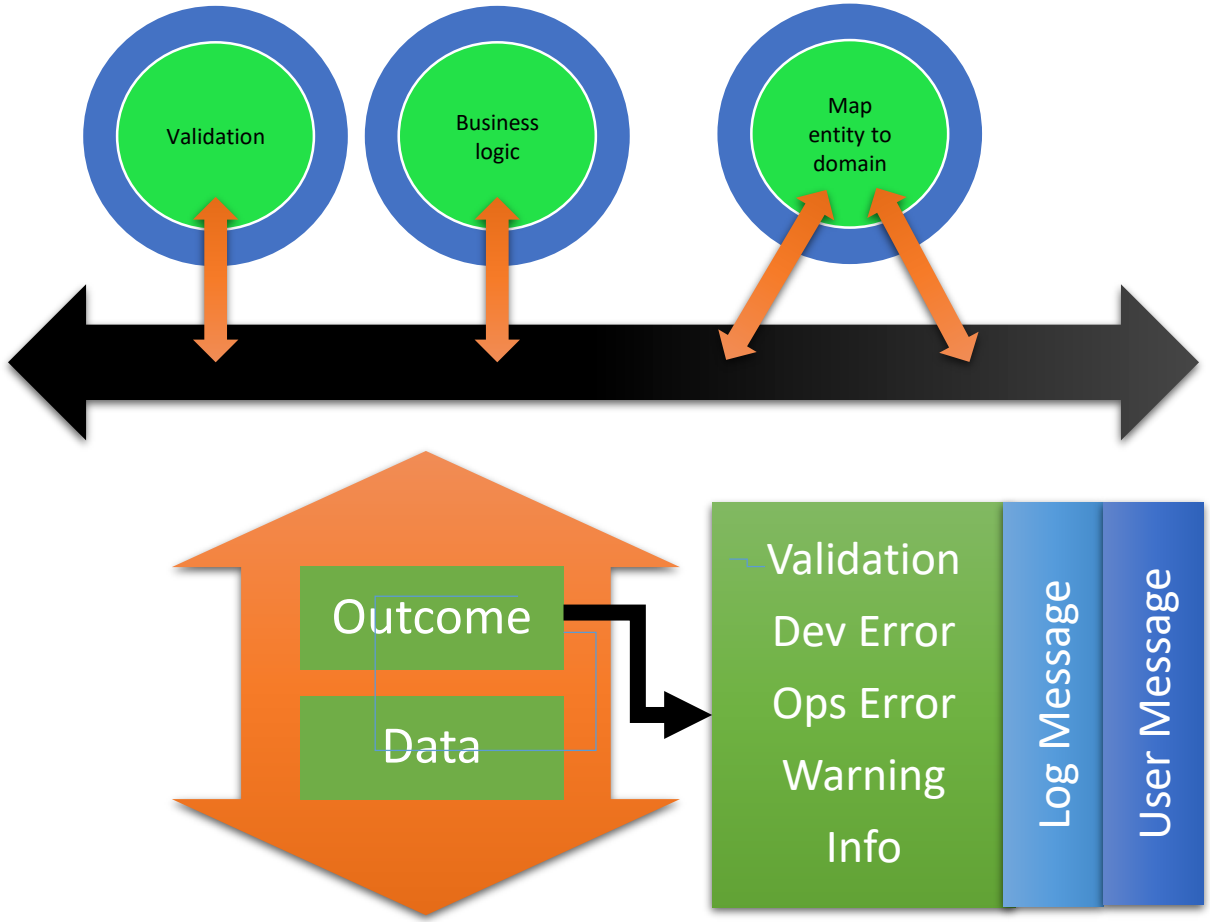
C#



Functional techniques

- Pattern matching
- Generic hierarchies
- And much more





Questions?

Functional Techniques for C#

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kdollard@microsoft.com

References

- Today's code: https://github.com/KathleenDollard/Slides
- Functional Programming in C#: How to write better C# code
  - Enrico Buonanna, Manning, 2017
- Pluralsight : *Applying Functional Principles in C#,* Vladimir Khorikov
- Pluralsight : *Functional Programming with C#,* Dave Fancher