

F# Workshop



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Pre-requisites

> Windows

- > Visual Studio 2015 Community or
- > Visual Studio Code + F# Compiler + Ionide package or
- > Atom + F# Compiler + Ionide package

> Linux

- > Visual Studio Code + Mono + Ionide package or
- > Atom + Mono + Ionide package

> Mac

- > Visual Studio for Mac + Mono or
- > Xamarin Studio 6.x + Mono or
- > Visual Studio Code + Mono + Ionide package or
- > Atom + Mono + Ionide package

Download links:

fsharpworkshop.com/#pre-requisites

See also the “Before we start” section on the Exercises Guide

Materials

- > Exercises Guide
- > Exercises Source Code

fsharpworkshop.com

github.com/jorgef/fsharpworkshop

Objectives

- > Understand the basic core principles behind FP
- > Understand the F# syntax and structures
- > Get motivation to practice and master F#



F# is a mature, open source, cross-platform,
functional-first programming language.

Imperative vs Functional

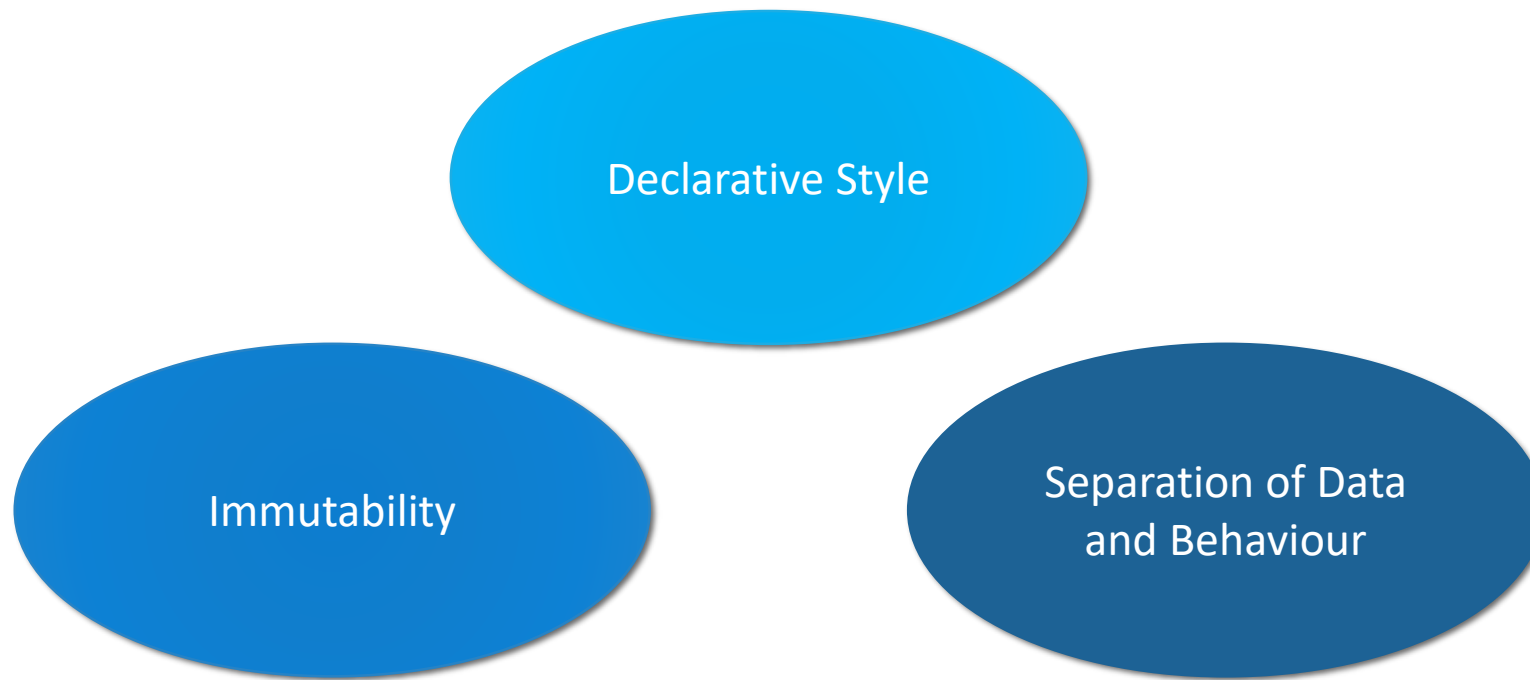
C#

F#

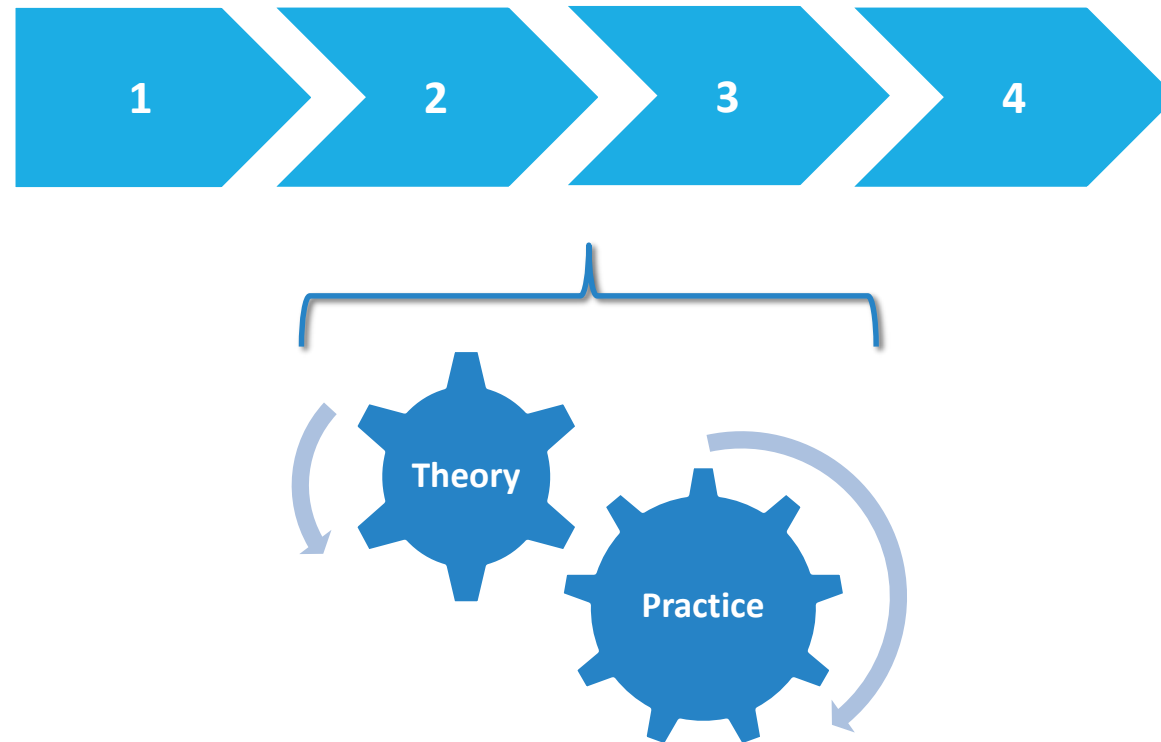
Imperative

Functional

Functional Core Concepts



Modules



Agenda

Module 1

Bindings | Functions | Tuples | Records

Module 2

High order functions | Pipelining | Partial application | Composition

Module 3

Options | Pattern matching | Discriminated unions | Units of measure

Module 4

Functional lists | Object-oriented programming | Type providers

Module 1

BINDINGS | FUNCTIONS | TUPLES | RECORDS

Bindings

let x = 1

~~x = x + 1~~

let y = x + 1

let mutable x = 1
x <- 2

Functions

```
int Add(int x, int y)
{
    return x + y;
}
```

Func<int,int,int>

↖ ↗
In Out

```
let add x y = x + y
```

int -> int -> int

↖ ↗ ↗
In Out

let instead of
no parens and
no return
concise

Tuples

```
let divide dividend divisor =  
  let quotient = dividend / divisor  
  let remainder = dividend % divisor  
  (quotient, remainder)
```

```
let quotient, remainder = divide 10 3
```

Records

```
type DivisionResult = {  
  Quotient: int  
  Remainder: int  
}
```

```
let result = { Quotient = 3; Remainder = 1 }
```

```
let result = { Quotient = 3; Remainder = 1 } : DivisionResult
```

```
let newResult = { Quotient = result.Quotient; Remainder = 0 }
```

```
let newResult = { result with Remainder = 0 }
```

```
let result1 = { Quotient = 3; Remainder = 1 }  
let result2 = { Quotient = 3; Remainder = 1 }  
result1 = result2 // true
```

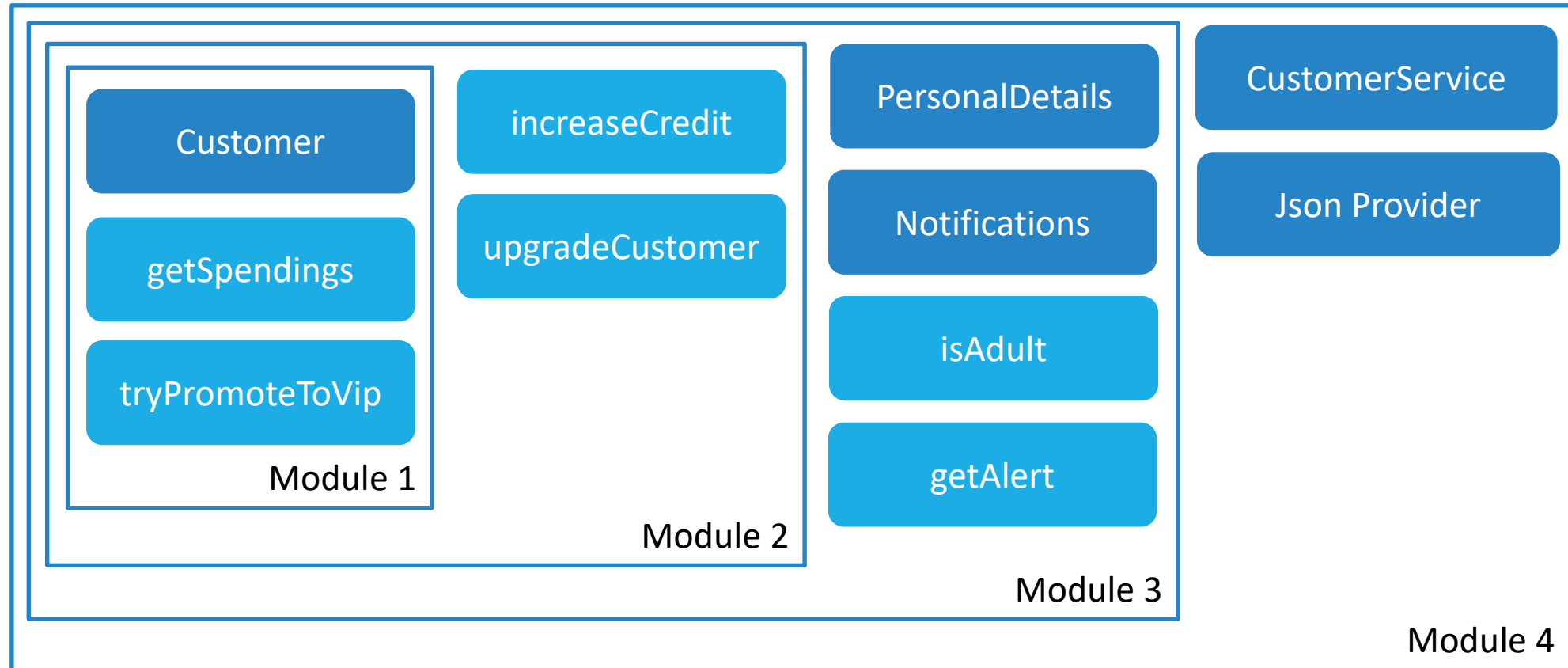
Structural Equality
Reference Types



Demo 1

BINDINGS | FUNCTIONS | TUPLES | RECORDS

Exercise



Exercise 1

BINDINGS | FUNCTIONS | TUPLES | RECORDS

Review

- > How do you return a value in a function?
- > Can you explain this type? `string -> int -> object`
- > How do you change a Record?

Module 2

HIGH ORDER FUNCTIONS | PIPELINING | PARTIAL APPLICATION | COMPOSITION

High Order Functions

High Order Function

```
let sum (a: int) (b: int) = a + b
```

High Order Function

```
let compute (a: int) (b: int) (operation: int -> int -> int) =  
  operation a b
```

```
let getOperation (type: OperationType) =  
  if type = OperationType.Sum then (fun a b -> a + b)  
  else (fun a b -> a * b)
```

```
let getOperation type =  
  if type = OperationType.Sum then (+)  
  else (*)
```

Pipelining Operator

```
let filter (condition: int -> bool) (items: int list) = ...
```

```
let filteredNumbers = filter (fun n -> n > 10) numbers
```

```
let filteredNumbers = numbers |> filter (fun n -> n > 10)
```



```
let filteredNumbers = numbers  
    |> filter (fun n -> n > 10)  
    |> filter (fun n -> n < 20)
```

Partial Application

```
let sum a b = a + b
```

```
let result = sum 1 2
```

← Returns int = 3

```
let result = sum 1
```

← Returns int -> int

```
let addOne = sum 1
```

← Returns int -> int

```
let result = addOne 2
```

← Returns int = 3

```
let result = addOne 3
```

← Returns int = 4

Composition

```
let addOne a = a + 1
```

```
let addTwo a = a + 2
```

```
let addThree = addOne >> addTwo
```

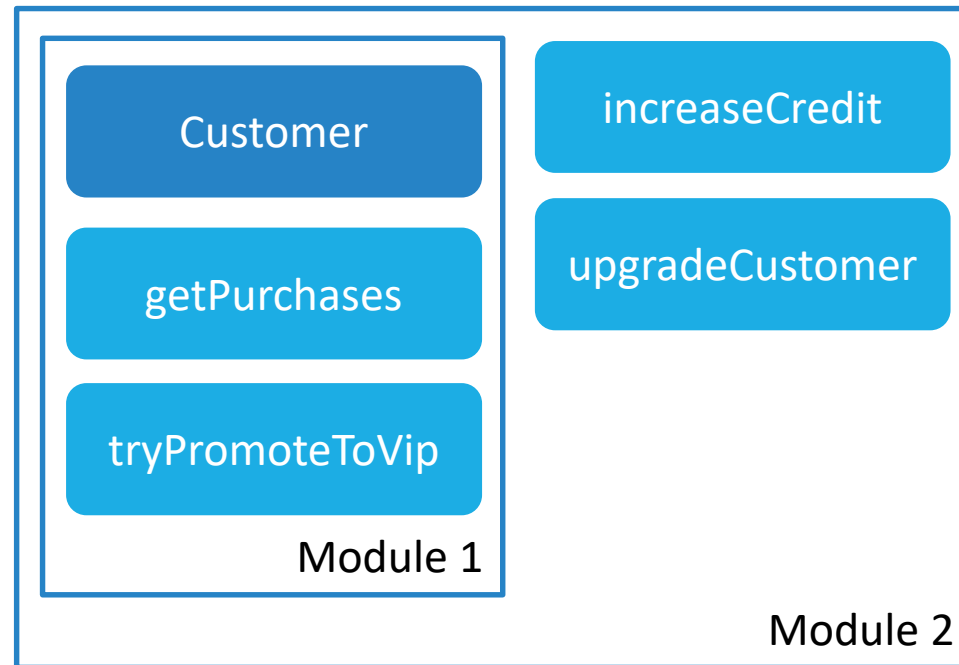
```
let result = addThree 1
```

← Returns int = 4

Demo 2

HIGH ORDER FUNCTIONS | PIPELINING | PARTIAL APPLICATION | COMPOSITION

Exercise 2



Exercise 2

HIGH ORDER FUNCTIONS | PIPELINING | PARTIAL APPLICATION | COMPOSITION

Review

- > What keyword do you use for lambda expressions?
- > What is the benefit of using the pipelining operator?
- > What happens when a function is called without its last parameter?

Module 3

OPTIONS | PATTERN MATCHING | DISCRIMINATED UNIONS | UNITS OF MEASURE

NullReferenceExceptions (C#)

```
var customer = GetCustomerById(42);
```

```
var age = customer.Age;
```

↑
NullReferenceException

```
var age = GetCustomerAgeById(42);
```

```
var result = GetCustomerAgeById(42);  
var age = result.Value;
```

↑
Hint: Possible Null

```
public Customer GetCustomerById(int id)
```

↙ ↘
Non Nullable Nullable

```
public int GetCustomerAgeById(int id)
```

↖
Non Nullable

```
public int? GetCustomerAgeById(int id)
```

↘
Nullable

Options

C#

int

int?

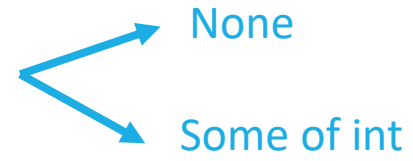
Customer

~~Customer?~~

F#

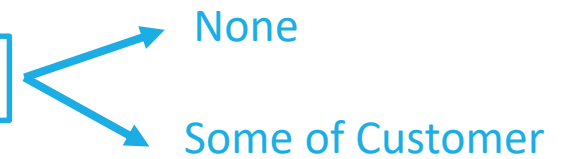
int

int option



Customer

Customer option



Options

```
let divide x y = x / y
```

← int -> int -> int

```
let divide x y =  
  if y = 0 then None  
  else Some(x / y)
```

← int -> int -> int option

```
let result = divide 4 2
```

← Some 2

```
let result = divide 4 0
```

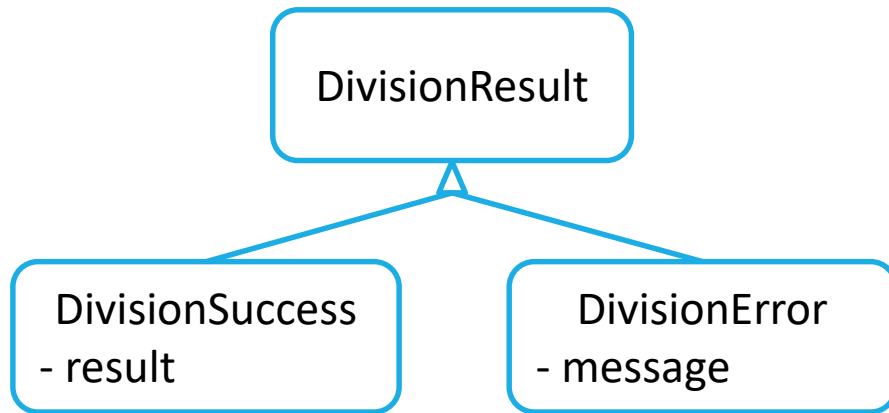
← None

Pattern Matching

```
let result = divide 4 0
if result = None then
    printfn "None"
else
    printfn "Result: %i" result.Value
```

```
let result = divide 4 0
match x with
| None -> printfn "None"
| Some n -> printfn "Result: %i" n
```


Discriminated Unions



```
type DivisionResult =  
  | DivisionSuccess of result : int  
  | DivisionError of message : string
```

Discriminated Unions

```
let divide x y =  
  match y with  
  | 0 -> DivisionError("Divide by zero")  
  | _ -> DivisionSuccess(x / y)
```

```
let result = divide 4 0  
match result with  
| DivisionSuccess result -> printfn "Result:%i" result  
| DivisionError message -> printfn "Error: %s" message
```

Units of Measure

```
let distanceInMts = 11580.0  
let distanceInKms = 87.34  
let totalDistance = distanceInMts + distanceInKms
```

← 11667.34

```
[<Measure>] type m  
[<Measure>] type km  
  
let distanceInMts = 11580.0<m>  
let distanceInKms = 87.34<km>  
let totalDistance = distanceInMts + distanceInKms
```

↑
Error: The unit of measure 'm' does not match the unit of measure 'km'

Units of Measure

[<Measure>] type km

[<Measure>] type h

let time = 2.4<h>

let distance = 87.34<km>

let speed = distance / time

← 36.39<km/h>

[<Measure>] type m

let width = 2<m>

let height = 3<m>

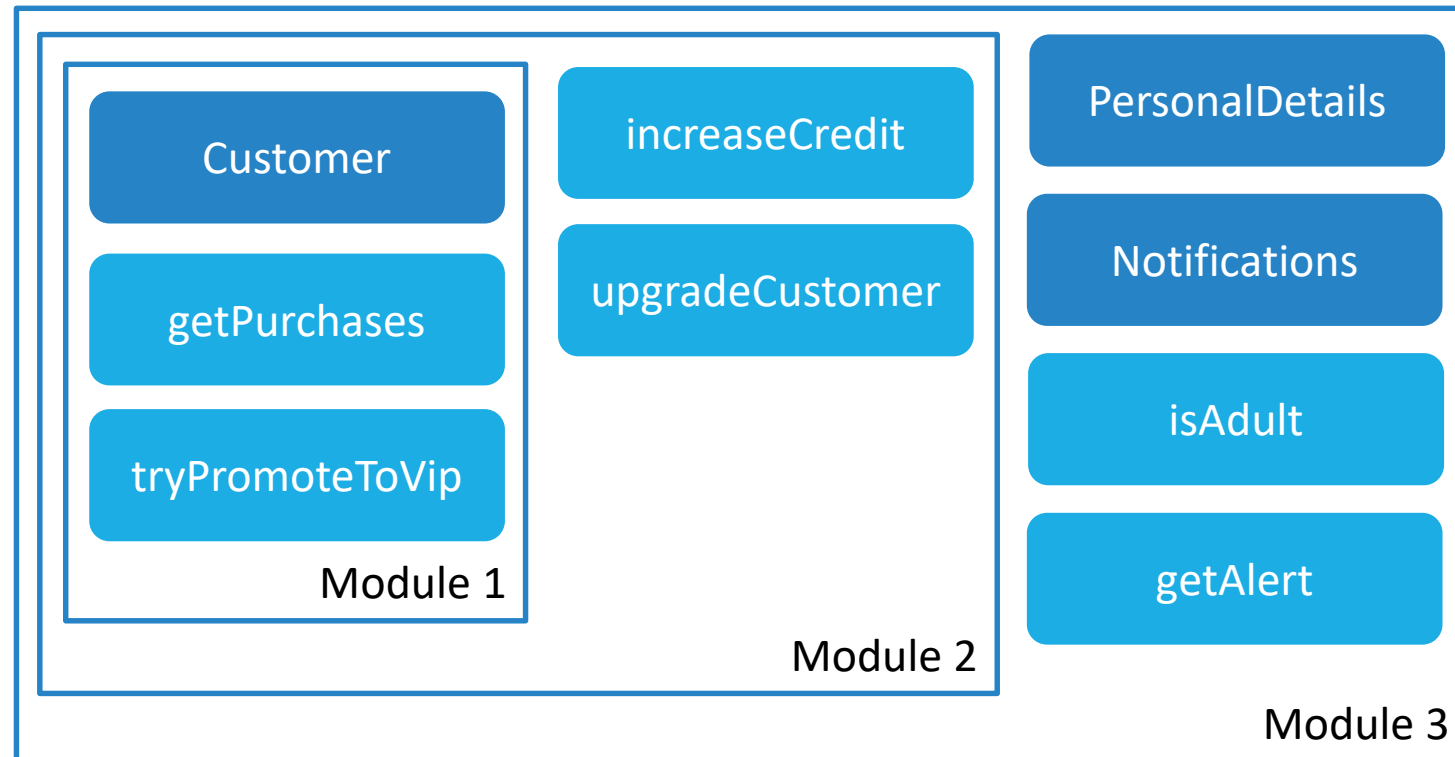
let surface = width * height

← 6<m²>

Demo 3

OPTIONS | PATTERN MATCHING | DISCRIMINATED UNIONS | UNITS OF MEASURE

Exercise



Exercise 3

OPTIONS | PATTERN MATCHING | DISCRIMINATED UNIONS | UNITS OF MEASURE

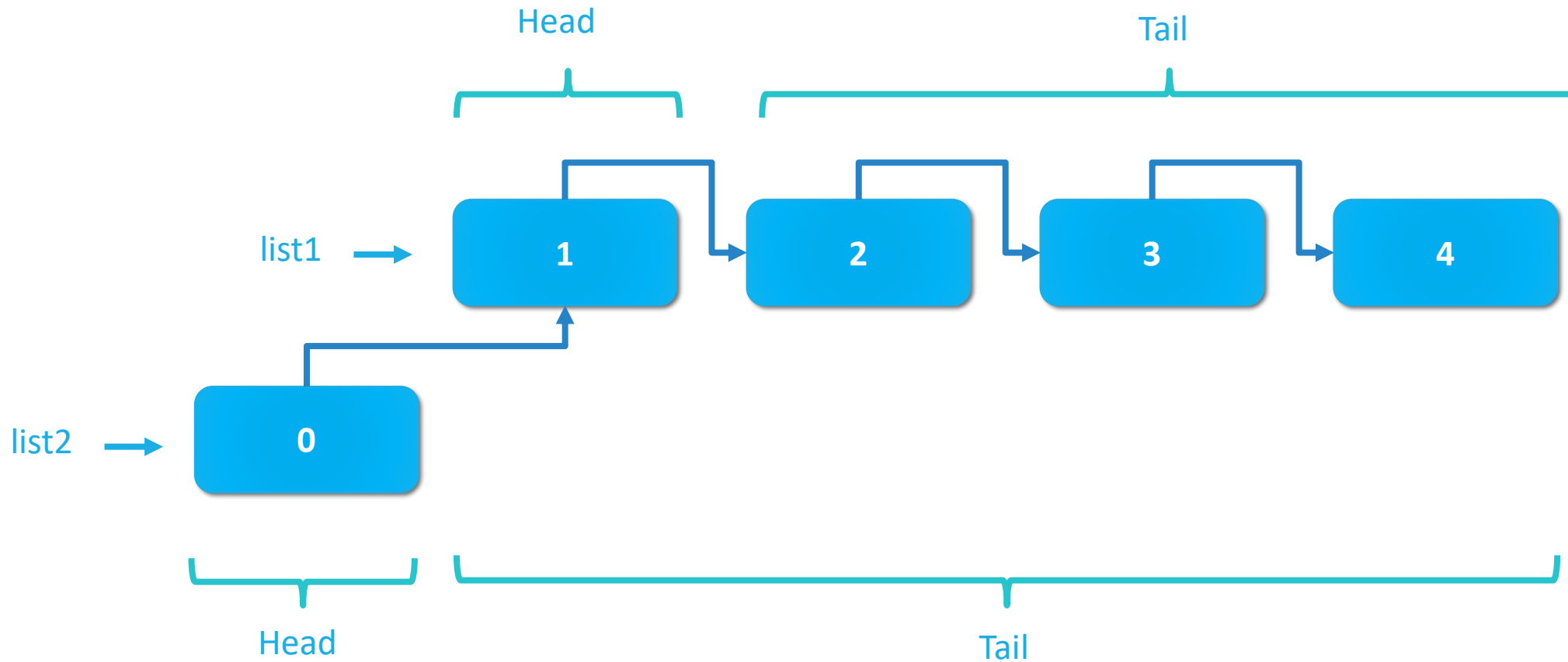
Review

- > What happens if you multiply the same unit of measure?
- > When should we use “_”?
- > What are the possible types of string option?

Module 4

FUNCTIONAL LISTS | OBJECT-ORIENTED PROGRAMMING | TYPE PROVIDERS

Functional Lists



Functional Lists

```
let numbers = [2; 3; 4]
```

```
let newNumbers = 1 :: numbers
```

```
let twoLists = numbers @ [5; 6]
```

```
let empty = []
```

```
let ns = [1 .. 1000]
```

```
let odds = [1 .. 2 .. 1000]
```

```
let oddsWithZero = [ yield 0  
                     yield! odds ]
```

```
let gen = [ for n in numbers do  
            if n%3 = 0 then  
            yield n * n ]
```

Lists vs Arrays vs Sequences

List

```
let myList = [1; 2]
```

Array

```
let myArray = [|1; 2|]
```

Seq

```
let mySeq = seq { yield 1; yield 2 }
```

List Module

```
let vipNames = customers
    |> List.filter (fun c -> c.IsVip)
    |> List.map (fun c -> c.Name)
```

```
let vipNames = customers
    |> Array.filter (fun c -> c.IsVip)
    |> Array.map (fun c -> c.Name)
```

```
let vipNames = customers
    |> Seq.filter (fun c -> c.IsVip)
    |> Seq.map (fun c -> c.Name)
```

Complete list:

<http://msdn.microsoft.com/en-us/library/ee353738.aspx>

F#

```
List.filter
List.map
List.fold
List.find
List.tryFind
List.forall
List.exist
List.partition
List.zip
List.rev
List.collect
List.choose
List.pick
List.toSeq
List.ofSeq
```

C#

```
.Where
.Select
.Aggregate
.First
.FirstOrDefault
.All
.Any
-
.Zip
.Reverse
.SelectMany
-
-
.AsEnumerable
.ToList
```

Object Oriented Programming

Immutable Fields

```
type MyClass(myField: int) =  
  
  member this.MyProperty = myField  
  
  member this.MyMethod methodParam =  
    myField + methodParam
```

Mutable Fields

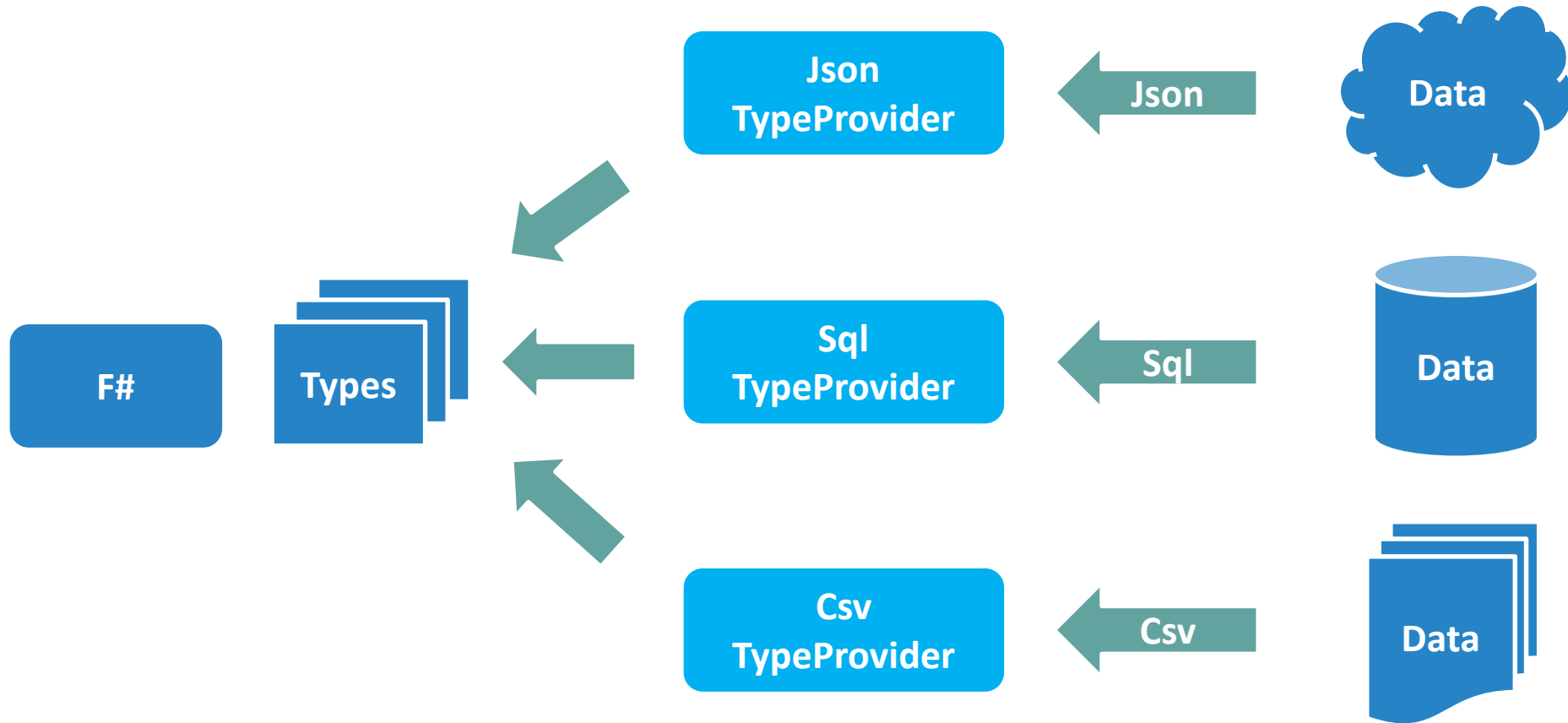
```
type MyClass(myField: int) =  
  let mutable myMutableField = myField  
  
  member this.MyProperty  
    with get () = myMutableField  
    and set(value) = myMutableField <- value  
  
  member this.MyMethod methodParam =  
    myField + methodParam
```

Object Expressions

```
type IMyInterface =  
  abstract member MyMethod: int -> int
```

```
let myInstance =  
  { new IMyInterface with  
    member this.MyMethod methodParam =  
      methodParam + 1 }
```

Type Providers



Type Providers

CSV

Json

XML

SQL

EF

Azure Storage

OData

Excel

R

Reflection

WMI

LINQ2SQL

Hadoop / Hive

Freebase

WSDL

And many more

CSV Type Provider

```
type Customer = CsvProvider<"sample.csv">  
let customers = Customer.Load "real.csv"  
  
customers.Rows  
|> Seq.iter (fun r -> printfn "%s: $%g" r.Name r.Credit)
```

sample.csv

```
Id,Name,IsVip,Credit  
1,Customer1,false,0.0
```

real.csv

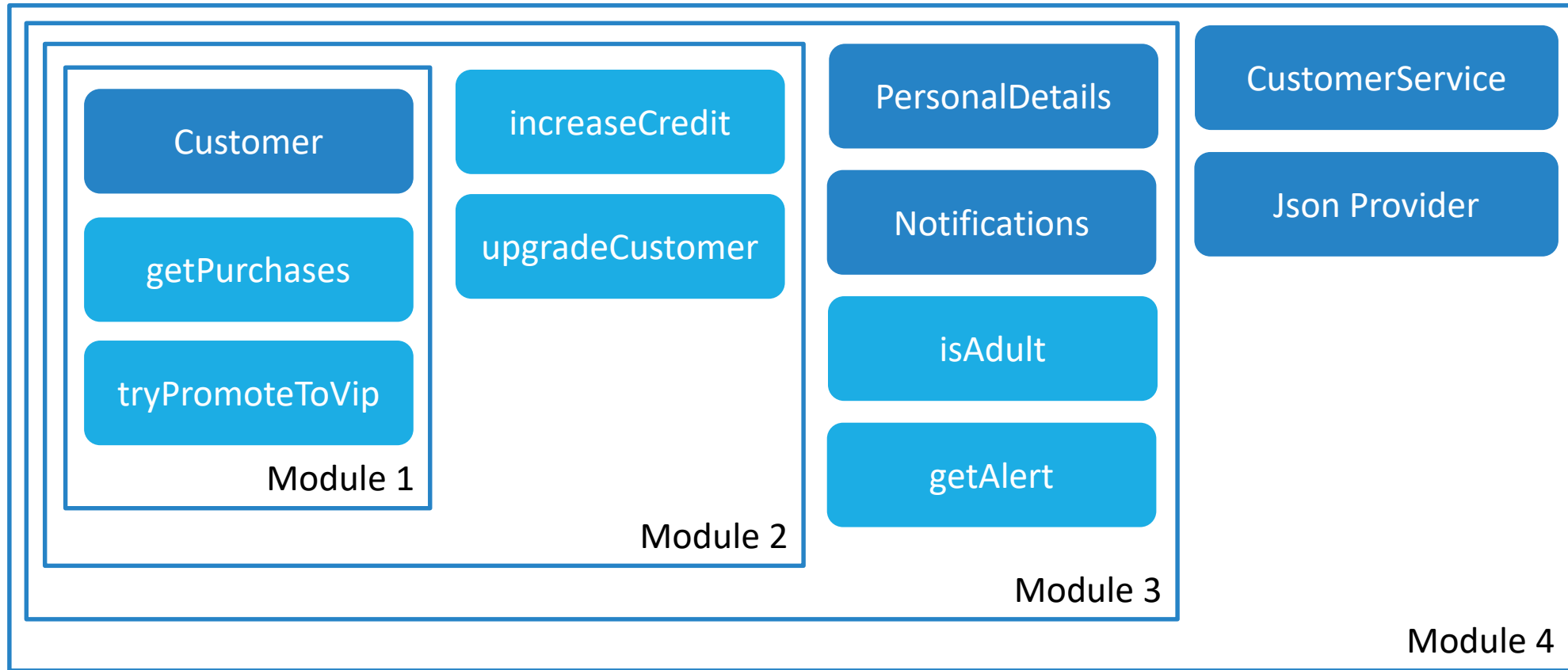
```
Id,Name,IsVip,Credit  
1,Customer1,false,0.0  
2,Customer2,false,10.0  
3,Customer3,false,30.0  
4,Customer4,true,50.0  
...
```

Demo 4

FUNCTIONAL LISTS | OBJECT-ORIENTED PROGRAMMING | TYPE PROVIDERS



Exercise 4



Exercise 4

FUNCTIONAL LISTS | OBJECT-ORIENTED PROGRAMMING | TYPE PROVIDERS

Review

- > Which keyword do we use to declare a class property or method?
- > Why do we refer to “Data.json” twice?
- > What happens if I change the name of a column in the sample.json file?

Thank you

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Resources



fsharp.org / c4fsharp.net



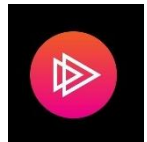
Real-World Functional Programming
By Tomas Petricek



Scott Wlaschin fsharpforfunandprofit.com
fpbridge.co.uk/why-fsharp.html



fsharp.tv



pluralsight.com/search?q=f%23&categories=all



Skills Matter: skillsmatter.com (tag: f#)