F# Workshop

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Pre-requisites

- .Net Core SDK
- Visual Studio Code
- Ionide Package
- Mono
  (Mac or Linux only)

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

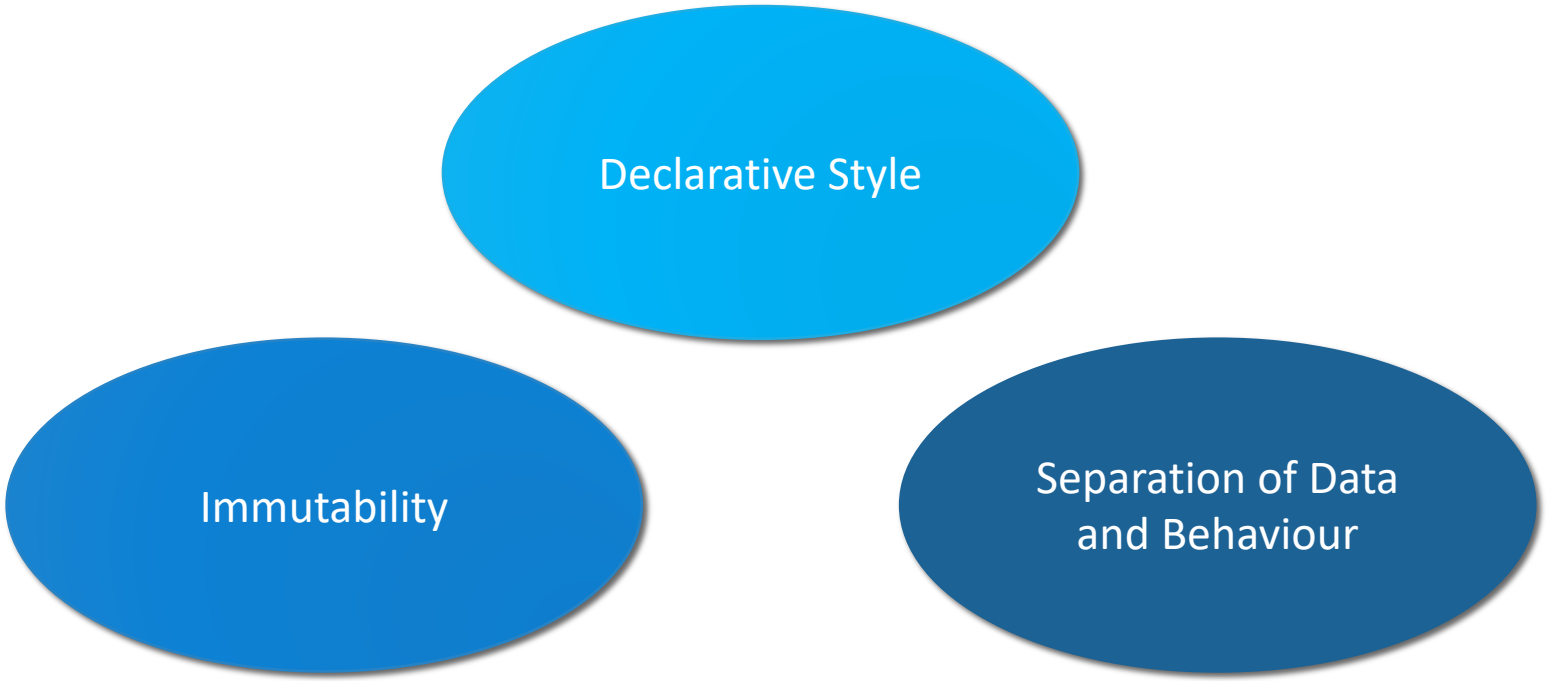
Objectives

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

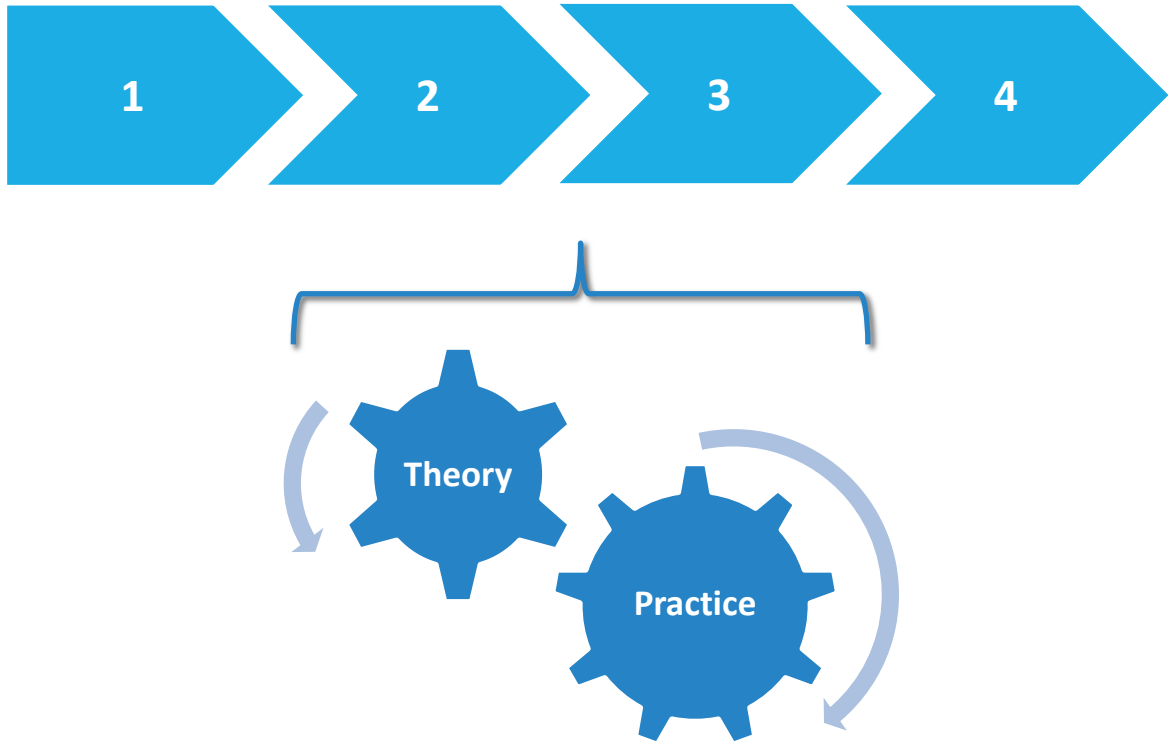
F# is a mature, open source, cross-platform, functional-first programming language.

Imperative vs Functional

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
```

```
let mutable x = 1
x <- 2
```

~~x = x + 1~~

```
let y = x + 1
```

Functions

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

Func<int,int,int>


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

let instead of

int -> int -> int

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 }
```

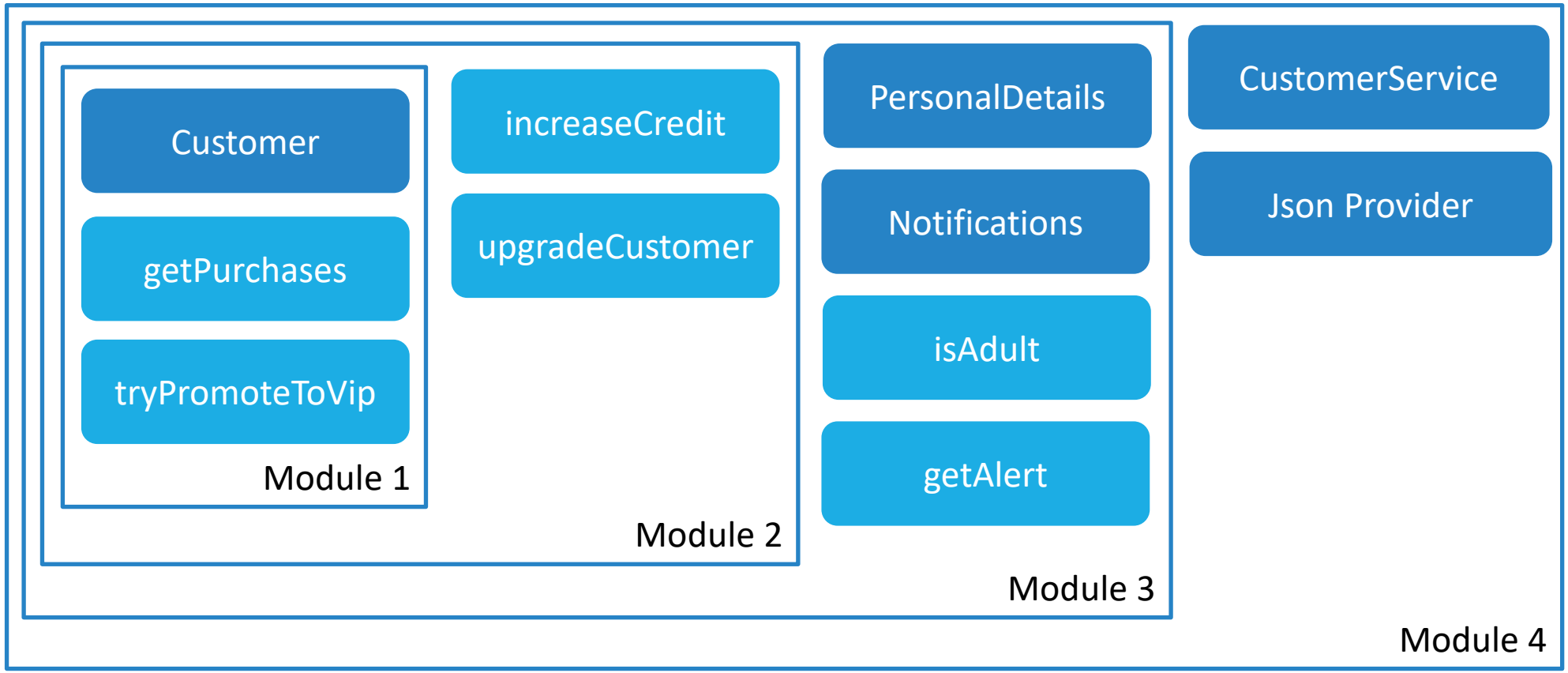
Structural Equality
Reference Types

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

Demo 1

BINDINGS | FUNCTIONS | TUPLES | RECORDS

Exercise


Customer
getPurchases
tryPromoteToVip
Module 1
increaseCredit
upgradeCustomer
Module 2
PersonalDetails
Notifications
isAdult
getAlert
Module 3
CustomerService
Json Provider
Module 4

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

High Order Function

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

```
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)
```

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

Partial Application

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

```
let result = sum 1 2
```
← Returns int = 3

```
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
```

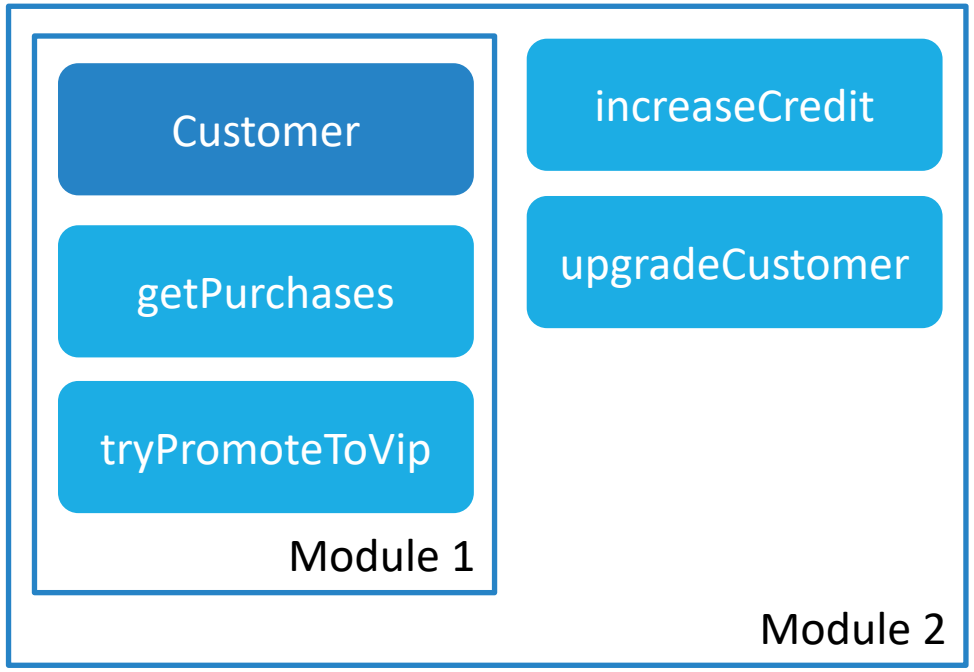
```
let result = addThree 1
```

Returns int = 4

Demo 2

HIGH ORDER FUNCTIONS | PIPELINING | PARTIAL APPLICATION | COMPOSITION

Exercise 2


Customer
getPurchases
tryPromoteToVip
Module 1
increaseCredit
upgradeCustomer
Module 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

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

Non Nullable Nullable

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

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

Hint: Possible Null

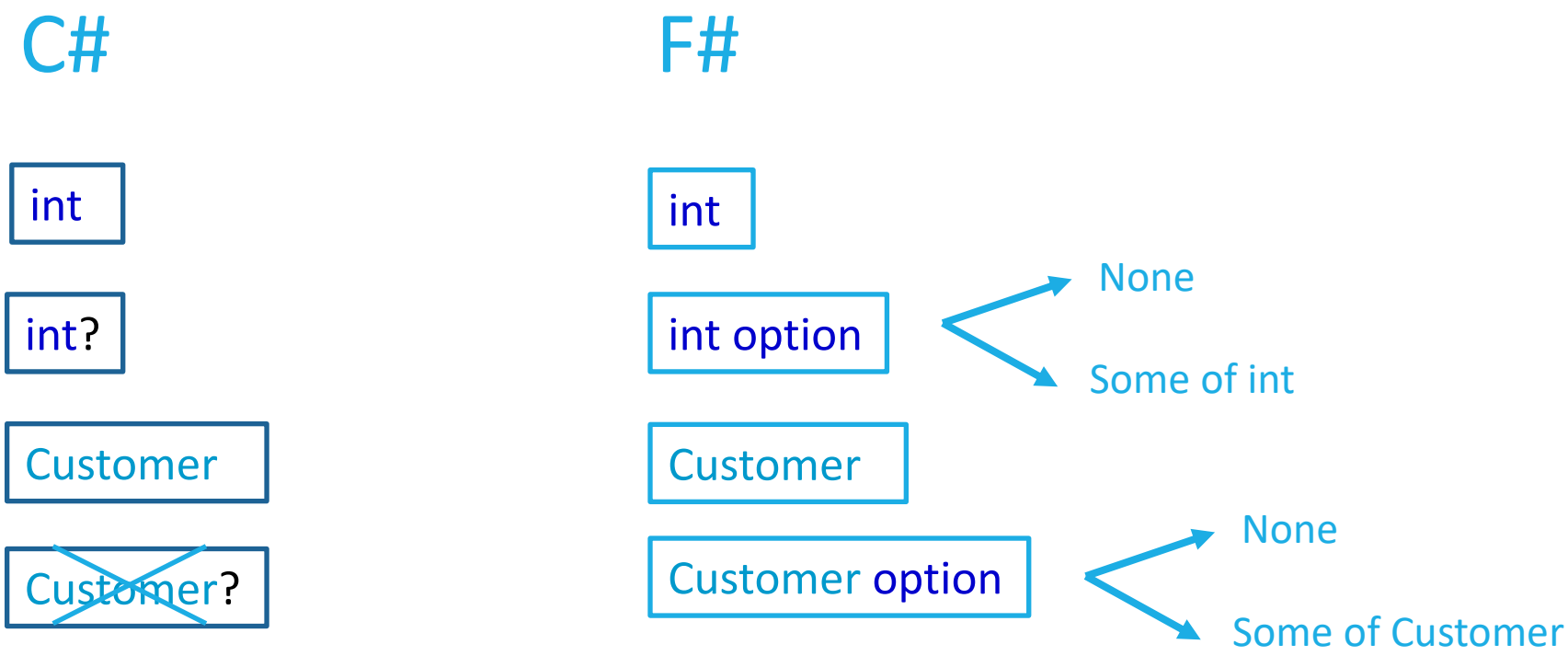
Non Nullable

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

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

Nullable

Options


C#
int
int?
Customer
Customer?
F#
int
int option
None
Some of int
Customer
Customer option
None
Some of Customer

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
```

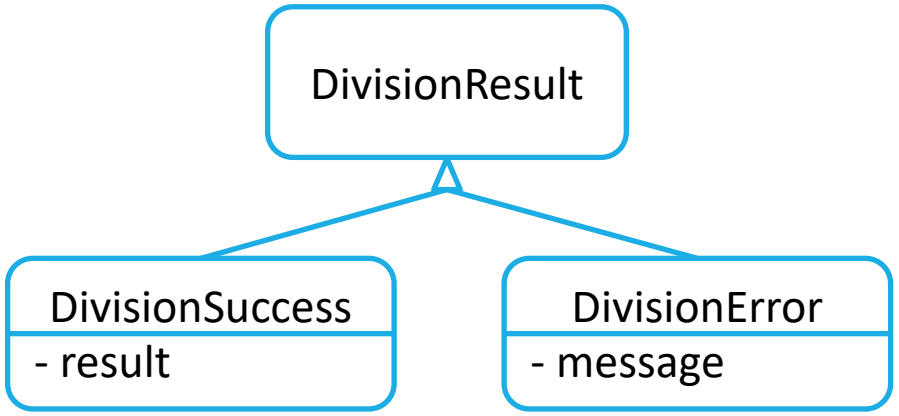

None

Pattern Matching

```
let result = divide 4 0
if result = None then
    printfn "No Result"
else
    printfn "Result: %i" result.Value
```

```
let result = divide 4 0
match result with
| None -> printfn "No Result"
| 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>

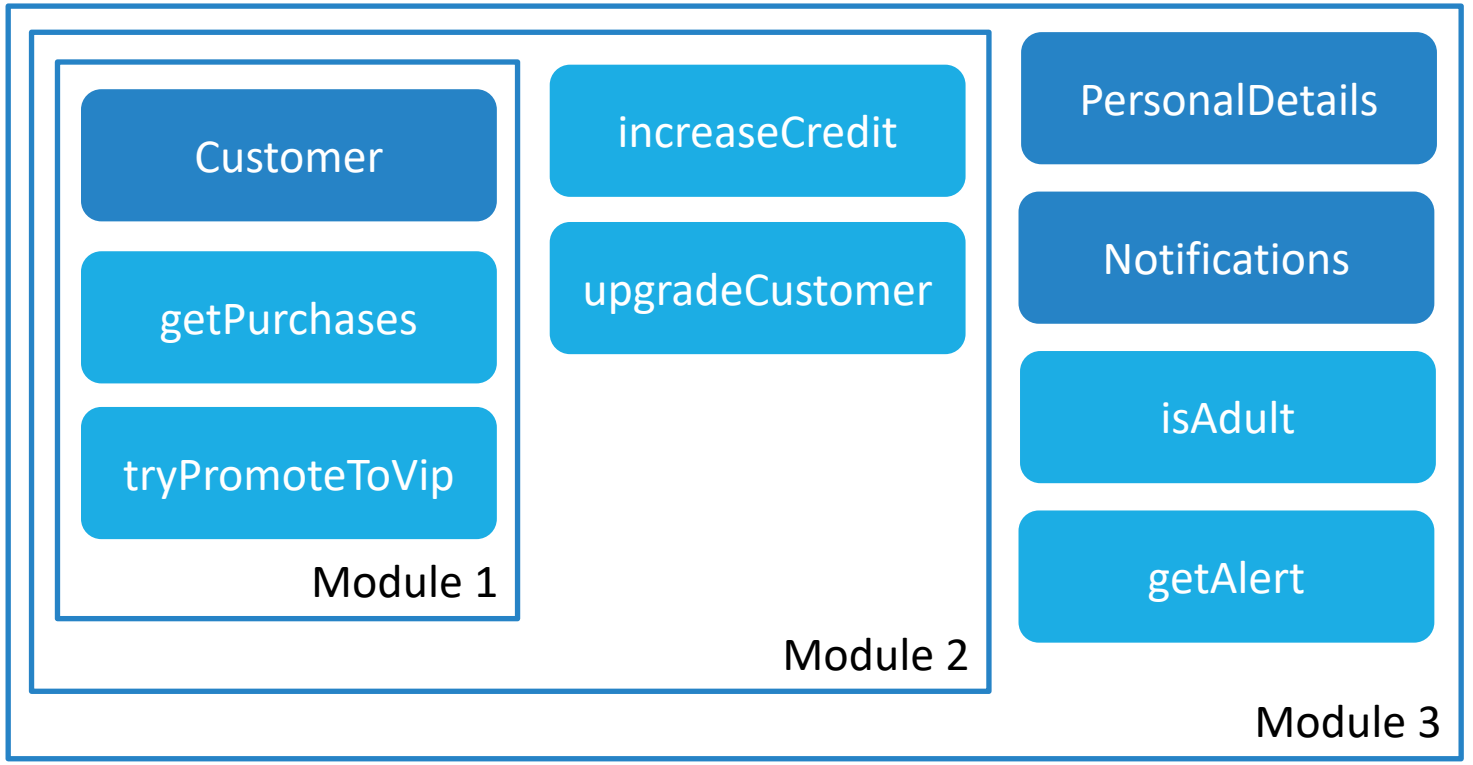
```
[<Measure>] type m

let width = 2<m>
let height = 3<m>
let surface = width * height
```

6<m^2>

Demo 3

OPTIONS | PATTERN MATCHING | DISCRIMINATED UNIONS | UNITS OF MEASURE

Exercise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Exercise 3

OPTIONS | PATTERN MATCHING | DISCRIMINATED UNIONS | UNITS OF MEASURE

Review

> What happens if you multiply the same unit of measure?

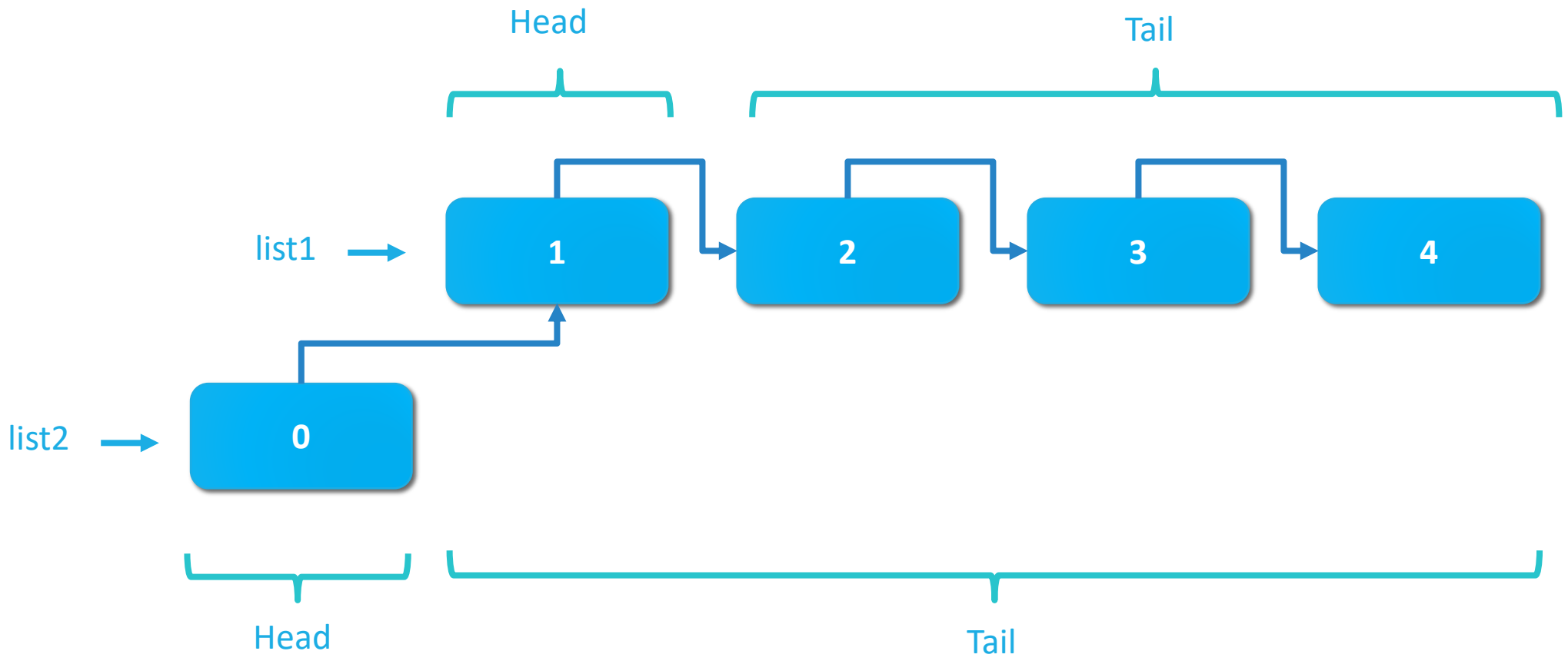
>When should we use “_”?

> 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#	C#
List.filter	.Where
List.map	.Select
List.fold	.Aggregate
List.find	.First
List.tryFind	.FirstOrDefault
List.forall	.All
List.exist	.Any
List.partition	-
List.zip	.Zip
List.rev	.Reverse
List.collect	.SelectMany
List.choose	-
List.pick	-
List.toSeq	.AsEnumerable
List.ofSeq	.ToList

Object Oriented Programming

Immutable Fields

```
type MyClass(myField: int) =

    member this.MyProperty = myField

    member this.MyMethod methodParam =
        myField + methodParam
```

Mutable Fields

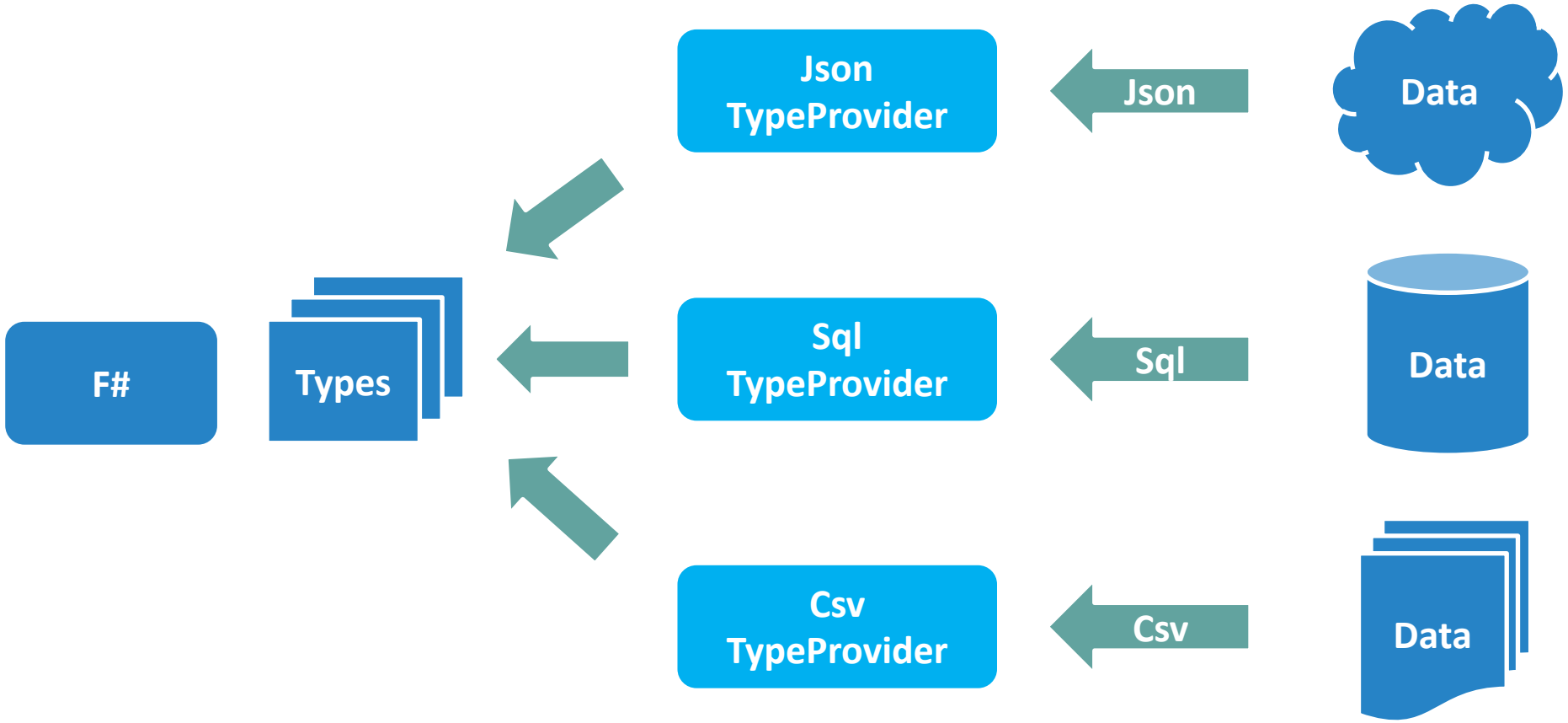
```
type MyClass(myField: int) =
    let mutable myMutableField = myField

    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
```

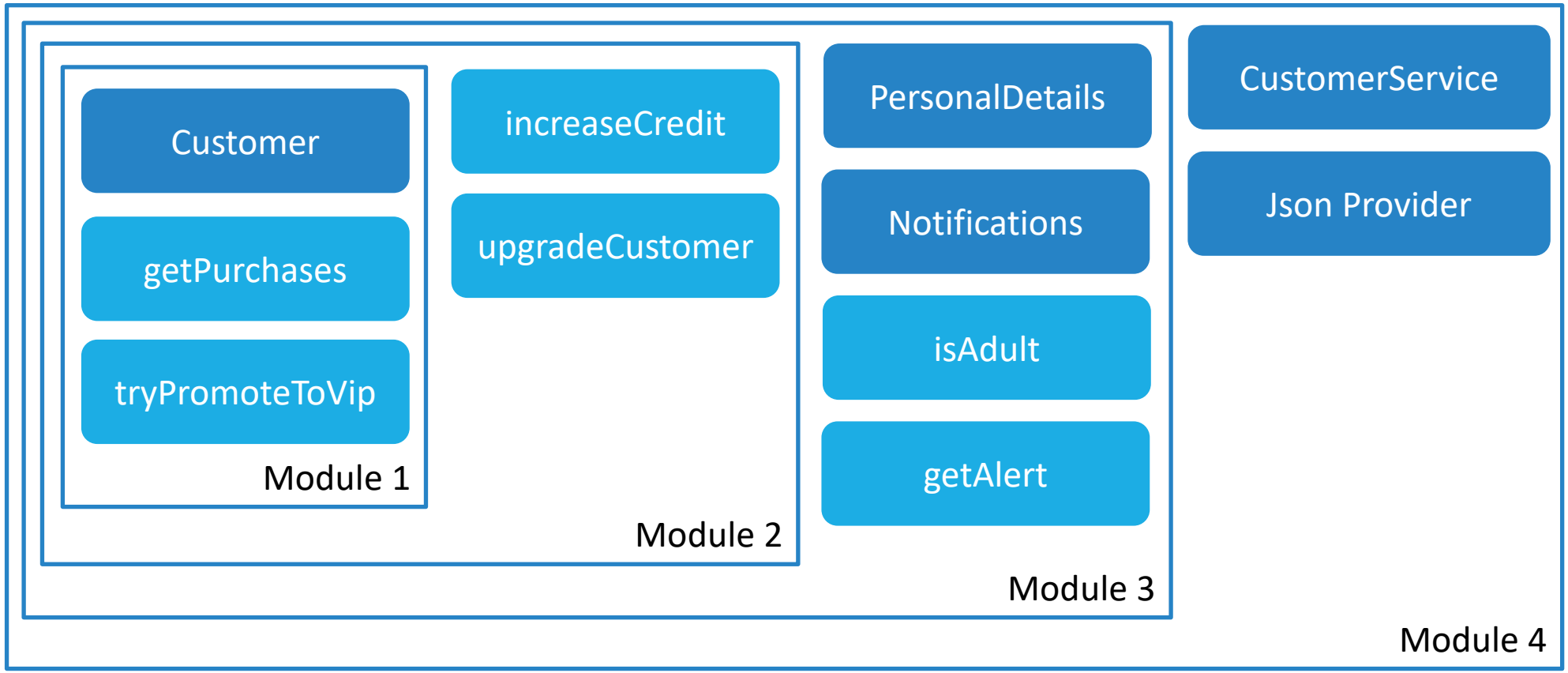
real.csv

```
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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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 fsharp.tv

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

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