

Объектно-ориентированное программирование в F#

Юрий Литвинов

02.04.2019г

“За” и “против” ООП в функциональных языках

За:

- ▶ Портирование существующего кода
- ▶ Интеграция с другими языками
- ▶ Использование в основном для ООП с возможностью писать красивый код

Против:

- ▶ Не очень дружит с системой вывода типов
- ▶ Нет встроенной поддержки печати, сравнения и т.д.

Методы у типов

```
type Vector = {x : float; y : float} with  
  member v.Length = sqrt(v.x * v.x + v.y * v.y)
```

```
let vector = {x = 1.0; y = 1.0}  
let length = vector.Length
```

```
type Vector with  
  member v.Scale k = {x = v.x * k; y = v.y * k}
```

```
let scaled = vector.Scale 2.0
```

Методы у Discriminated Union-ов

```
type Tree<'a> =  
    | Tree of 'a * Tree<'a> * Tree<'a>  
    | Tip of 'a  
with  
    member t.Size =  
        match t with  
        | Tree(_, l, r) -> 1 + l.Size + r.Size  
        | Tip _ -> 1
```

Расширения

```
type System.Int32 with
  member i.IsPrime =
    let limit = i |> float |> sqrt |> int
    let rec check j =
      j > limit or (i % j <> 0 && check (j + 1))
    check 2
```

```
printfn "%b" (5).IsPrime
printfn "%b" (8).IsPrime
```

Статические методы

```
type Vector = {x : float; y : float} with  
    static member Create x y = {x = x; y = y}
```

```
let vector = Vector.Create 1.0 1.0
```

```
type System.Int32 with  
    static member IsEven x = x % 2 = 0
```

```
printfn "%b" <| System.Int32.IsEven 10
```

Методы и существующие функции

```
type Vector = {x : float; y : float} with  
    static member Create x y = {x = x; y = y}
```

```
let length (v : Vector) = sqrt(v.x * v.x + v.y * v.y)
```

```
type Vector with  
    member v.Length = length v
```

```
printfn "%f" <| (Vector.Create 1.0 1.0).Length  
printfn "%f" <| (length (Vector.Create 1.0 1.0))
```

Методы и каррирование

open Operators

```
type Vector = {x : float; y : float} with
    static member Create x y = {x = x; y = y}
```

```
let transform v rotate scale =
    let r = System.Math.PI * rotate / 180.0
    { x = scale * v.x * cos r - scale * v.y * sin r;
      y = scale * v.x * sin r + scale * v.y * cos r }
```

```
type Vector with
    member v.Transform = transform v
```

```
printfn "%A" <| (Vector.Create 1.0 1.0).Transform 45.0 2.0
```


Каррирование против кортежей

type **Vector** with

member v.TupledTransform (r, s) = transform v r s

member v.CurriedTransform r s = transform v r s

let v = **Vector**.Create 1.0 1.0

printfn "%A" <| v.TupledTransform (45.0, 2.0)

printfn "%A" <| v.CurriedTransform 45.0 2.0

Кортежи: именованные аргументы

```
type Vector with  
    member v.TupledTransform (r, s) =  
        transform v r s
```

```
let v = Vector.Create 1.0 1.0  
printfn "%A" <| v.TupledTransform (r = 45.0, s = 2.0)  
printfn "%A" <| v.TupledTransform (s = 2.0, r = 45.0)
```

Кортежи: опциональные параметры

```
type Vector with
    member v.TupledTransform (r, ?s) =
        match s with
        | Some scale -> transform v r scale
        | None -> transform v r 1.0

let v = Vector.Create 1.0 1.0
printfn "%A" <| v.TupledTransform (45.0, 2.0)
printfn "%A" <| v.TupledTransform (90.0)
```

defaultArg

type **Vector** with

member v.TupledTransform (r, ?s) =
transform v r <| defaultArg s 1.0

let v = **Vector**.Create 1.0 1.0

printfn "%A" <| v.TupledTransform (45.0, 2.0)

printfn "%A" <| v.TupledTransform (90.0)

Кортежи: перегрузка

type **Vector** with

member v.TupledTransform (r, s) =
transform v r s

member v.TupledTransform r =
transform v r 1.0

let v = **Vector**.Create 1.0 1.0

printfn "%A" <| v.TupledTransform (45.0, 2.0)

printfn "%A" <| v.TupledTransform (90.0)

Кортежи против каррирования

За:

- ▶ Можно вызывать из .NET-кода
- ▶ Опциональные и именованные аргументы, перегрузки

Против:

- ▶ Не поддерживают частичное применение
- ▶ Не дружат с функциями высших порядков

Методы против свободных функций

Вывод типов

```
type Vector = {x : float; y : float} with  
    member v.Length = v.x * v.x + v.y * v.y |> sqrt
```

```
let length v = v.x * v.x + v.y * v.y |> sqrt
```

```
let compareWrong v1 v2 =  
    v1.Length < v2.Length
```

```
let compareRight v1 v2 =  
    length v1 < length v2
```

Методы против свободных функций

Функции высших порядков

```
type Vector = {x : float; y : float} with  
  member v.Length = v.x * v.x + v.y * v.y |> sqrt
```

```
let length v = v.x * v.x + v.y * v.y |> sqrt
```

```
let lengths1 = [{x = 1.0; y = 1.0}; {x = 2.0; y = 2.0}]  
  |> List.map (fun x -> x.Length)
```

```
let lengths2 = [{x = 1.0; y = 1.0}; {x = 2.0; y = 2.0}]  
  |> List.map length
```


Классы, основной конструктор

```
type Vector(x, y) =  
    member v.Length = x * x + y * y |> sqrt
```

```
printfn "%A" <| Vector (1.0, 1.0)
```

F# Interactive

```
FSI_0003+Vector
```

```
type Vector =  
    class  
        new : x:float * y:float -> Vector  
        member Length : float  
    end  
val it : unit = ()
```

Методы и свойства

```
type Vector(x : float, y : float) =  
    member v.Scale s = Vector(x * s, y * s)  
    member v.X = x  
    member v.Y = y
```

F# Interactive

```
type Vector =  
    class  
        new : x:float * y:float -> Vector  
        member Scale : s:float -> Vector  
        member X : float  
        member Y : float  
    end
```

Private-поля и private-методы

```
type Vector(x : float, y : float) =  
  let mutable mX = x  
  let mutable mY = y  
  let lengthSqr = mX * mX + mY * mY  
  member v.Length = sqrt lengthSqr  
  member v.X = mX  
  member v.Y = mY  
  member v.SetX x = mX <- x  
  member v.SetY y = mY <- y
```

Мутабельные свойства

```
type Vector(x, y) =  
  let mutable mX = x  
  let mutable mY = y  
  member v.X  
    with get () = mX  
    and set x = mX <- x  
  member v.Y  
    with get () = mY  
    and set y = mY <- y
```

Автоматические свойства

```
type Vector(x, y) =  
    member val X = x with get, set  
    member val Y = y with get, set
```

```
let v = Vector(1.0, 1.0)  
v.X <- 2.0
```

Индексеры

open System.Collections.Generic

```
type SparseVector(items : seq<int * float>) =  
    let elems = new SortedDictionary<_, _>()  
    do items |> Seq.iter (fun (k, v) -> elems.Add(k, v))
```

```
member t.Item  
    with get(idx) =  
        if elems.ContainsKey(idx) then elems.[idx]  
        else 0.0
```

```
let v = SparseVector [(3, 547.0)]  
printfn "%f" v.[4]
```

Операторы

```
type Vector(x : float, y : float) =  
  member v.X = x  
  member v.Y = y
```

```
static member (+) (v1 : Vector, v2 : Vector) =  
  Vector(v1.X + v2.X, v1.Y + v2.Y)
```

```
static member (-) (v1 : Vector, v2 : Vector) =  
  Vector(v1.X - v2.X, v1.Y - v2.Y)
```

```
let v = Vector (1.0, 1.0) + Vector (2.0, 2.0)
```

Вернёмся к конструкторам

Дополнительное поведение

```
type Vector(x : float, y : float) =  
    let length () = x * x + y * y |> sqrt  
    do  
        printfn "Vector (%f, %f), length = %f"  
            x y <| length ()  
        printfn "Have a nice day"  
    let mutable x = x  
    let mutable y = y  
  
let v = Vector(1.0, 1.0)
```


let-функции и методы

```
type Vector(x : float, y : float) =  
    let length () = x * x + y * y |> sqrt  
    let normalize () = Vector(x / length(), y / length())  
    member this.Normalize = normalize  
    member this.X = x  
    member this.Y = y  
  
let v = Vector(2.0, 2.0)  
let v' = v.Normalize ()
```

Рекурсивные методы

```
type Math() =  
    member this.Fibonacci x =  
        match x with  
        | 0 | 1 -> 1  
        | _ -> this.Fibonacci (x - 1)  
            + this.Fibonacci (x - 2)  
  
let math = new Math()  
printfn "%i" <| math.Fibonacci 10
```

Много конструкторов

```
type Vector(x : float, y : float) =  
  member this.X = x  
  member this.Y = y  
  new () =  
    printfn "Constructor with no parameters"  
    Vector(0.0, 0.0)
```

```
let v = Vector(2.0, 2.0)  
let v' = Vector()
```

Модификаторы видимости

```
type Example() =  
    let mutable privateValue = 42  
  
    member this.PublicValue = 1  
    member private this.PrivateValue = 2  
    member internal this.InternalValue = 3  
  
    member this.PrivateSetProperty  
        with get () =  
            privateValue  
        and private set(value) =  
            privateValue <- value
```

Наследование

```
type Shape() =  
    class  
    end
```

```
type Circle(r) =  
    inherit Shape()  
    member this.R = r
```

Абстрактные классы

```
[<AbstractClass>]
```

```
type Shape() =  
    abstract member Draw : unit -> unit  
    abstract member Name : string
```

```
type Circle(r) =  
    inherit Shape()  
    member this.R = r  
    override this.Draw () =  
        printfn "Drawing circle"  
    override this.Name = "Circle"
```

Реализация по умолчанию

```
type Shape() =  
    abstract member Draw : unit -> unit  
    abstract member Name : string  
    default this.Draw () =  
        printfn "Drawing shape"  
    default this.Name =  
        "Shape"
```

Вызов метода родителя

```
type Shape() =  
    abstract member Draw : unit -> unit  
    abstract member Name : string  
    default this.Draw () = printfn "Drawing shape"  
    default this.Name = "Shape"
```

```
type Circle(r) =  
    inherit Shape()  
    member this.R = r  
    override this.Draw () =  
        base.Draw ()  
        printfn "Drawing circle"  
    override this.Name = "Circle"
```


Интерфейсы

```
type Shape =  
    abstract member Draw : unit -> unit  
    abstract member Name : string
```

```
type Circle(r) =  
    member this.R = r  
    interface Shape with  
        member this.Draw () =  
            printfn "Drawing circle"  
        member this.Name = "Circle"
```

Явное приведение типов

```
let c = Circle 10
```

```
c.Draw () // Ошибка
```

```
(c :> Shape).Draw () // Ок
```

```
let draw (s : Shape) = s.Draw ()
```

```
draw c // Ок
```

Наследование интерфейсов

```
type IEnumerable<'a> =  
    abstract GetEnumerator : unit -> IEnumerator<'a>
```

```
type ICollection<'a> =  
    inherit IEnumerable<'a>  
    abstract Count : int  
    abstract IsReadOnly : bool  
    abstract Add : 'a -> unit  
    abstract Clear : unit -> unit  
    abstract Contains : 'a -> bool  
    abstract CopyTo : 'a[] * int -> unit  
    abstract Remove : 'a -> unit
```

Объектные выражения

Реализация интерфейсов на лету

```
type Shape =  
  abstract member Draw : unit -> unit  
  abstract member Name : string  
  
let rect w h =  
  { new Shape with  
    member this.Draw () =  
      printfn "Drawing rect, w = %d, h = %d" w h  
    member this.Name = "Rectangle"  
  }  
  
(rect 10 10).Draw ()
```

Частичная реализация интерфейса

```
type Shape =  
  abstract member Draw : unit -> unit  
  abstract member Name : string
```

```
let simpleShape nameFunc =  
  { new Shape with  
    member this.Draw () =  
      printfn "Drawing %s" this.Name  
    member this.Name = nameFunc ()  
  }
```

```
(simpleShape (fun () -> "Star")).Draw ()
```

Делегация вложенному классу

```
type Printer =  
    abstract member WriteString : string -> unit  
  
type HtmlWriter() =  
    let mutable count = 0  
    let printer =  
        { new Printer with  
            member this.WriteString s =  
                count <- count + s.Length  
                System.Console.WriteLine(s) }  
    member x.CharCount = count  
    member x.Header () = printer.WriteString "<html>"  
    member x.Footer () = printer.WriteString "</html>"  
    member x.WriteString s = printer.WriteString s
```

Модули

```
type Vector =  
    { x : float; y : float }
```

```
module VectorOps =  
    let length v = sqrt(v.x * v.x + v.y * v.y)  
    let scale k v = { x = k * v.x; y = k * v.y }  
    let shiftX x v = { v with x = v.x + x }  
    let shiftY y v = { v with y = v.y + y }  
    let shiftXY (x, y) v = { x = v.x + x; y = v.y + y }  
    let zero = { x = 0.0; y = 0.0 }  
    let constX dx = { x = dx; y = 0.0 }  
    let constY dy = { x = 0.0; y = dy }
```

Расширения модулей

```
module List =  
  let rec pairwise l =  
    match l with  
    | [] | [_] -> []  
    | h1 :: (h2 :: _ as t) -> (h1, h2) :: pairwise t  
  
let x = List.pairwise [1; 2; 3; 4]
```


Дотнетовские структуры

```
[<Struct>]
```

```
type VectorStruct =
```

```
    val x : float
```

```
    val y : float
```

```
    new (x, y) = {x = x; y = y}
```

```
    member v.X = v.x
```

```
    member v.Y = v.y
```

```
    member v.Length = v.x * v.x + v.y * v.y |> sqrt
```

```
type VectorStruct' =
```

```
    struct
```

```
        val x: float
```

```
        val y: float
```

```
    end
```

Пространства имён

```
namespace Vectors
```

```
type Vector =  
    { x : float; y : float }
```

```
module VectorOps =  
    let length v = sqrt(v.x * v.x + v.y * v.y)
```