

F#: шаблоны, типы. Базовые паттерны ФП.

Юрий Литвинов

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Сопоставление шаблонов

F#

```
let urlFilter url agent =  
    match (url, agent) with  
    | "http://www.google.com", 99 -> true  
    | "http://www.yandex.ru" , _ -> false  
    | _, 86 -> true  
    | _ -> false
```

F#

```
let sign x =  
    match x with  
    | _ when x < 0 -> -1  
    | _ when x > 0 -> 1  
    | _ -> 0
```

F# — не Prolog

Не получится писать так:

F#

```
let isSame pair =  
    match pair with  
    | (a, a) -> true  
    | _ -> false
```

Нужно так:

F#

```
let isSame pair =  
    match pair with  
    | (a, b) when a = b -> true  
    | _ -> false
```

Какие шаблоны бывают

Синтаксис	Описание	Пример
(pat, \dots, pat)	Кортеж	$(1, 2, ("3", x))$
$[pat; \dots; pat]$	Список	$[x; y; 3]$
$pat :: pat$	cons	$h :: t$
$pat \mid pat$	"Или"	$[x] \mid ["X" \mid x]$
$pat \& pat$	"И"	$[p] \& [(x, y)]$
$pat \text{ as } id$	Именованный шаблон	$[x] \text{ as } inp$
id	Переменная	x
$_$	Wildcard (что угодно)	$_$
литерал	Константа	239, <i>DayOfWeek.Monday</i>
$:? type$	Проверка на тип	$:? string$

Последовательности

Ленивый тип данных

F#

```
seq {0 .. 2}  
seq {1 | .. 10000000000000 | }
```

F#

```
open System.IO  
let rec allFiles dir =  
    Seq.append  
        (dir |> Directory.GetFiles)  
        (dir |> Directory.GetDirectories  
            |> Seq.map allFiles  
            |> Seq.concat)
```

Типичные операции с последовательностями

Операция	Тип
Seq.append	$\#seq <' a > \rightarrow \#seq <' a > \rightarrow seq <' a >$
Seq.concat	$\#seq < \#seq <' a > > \rightarrow seq <' a >$
Seq.choose	$('a \rightarrow ' b option) \rightarrow \#seq <' a > \rightarrow seq <' b >$
Seq.empty	$seq <' a >$
Seq.map	$('a \rightarrow ' b) \rightarrow \#seq <' a > \rightarrow \#seq <' b >$
Seq.filter	$('a \rightarrow bool) \rightarrow \#seq <' a > \rightarrow seq <' a >$
Seq.fold	$('s \rightarrow ' a \rightarrow ' s) \rightarrow ' s \rightarrow seq <' a > \rightarrow ' s$
Seq.initInfinite	$(int \rightarrow ' a) \rightarrow seq <' a >$

Задание последовательностей

F#

```
let squares = seq { for i in 0 .. 10 -> (i, i * i) }  
seq { for (i, isquared) in squares ->  
      (i, isquared, i * isquared) }
```

F#

```
let checkerboardCoordinates n =  
    seq { for row in 1 .. n do  
          for col in 1 .. n do  
              if (row + col) % 2 = 0 then  
                  yield (row, col) }
```

Ленивое чтение из файла

F#

```
let rec allFiles dir =  
    seq { for file in Directory.GetFiles(dir) -> file  
          for subdir in Directory.GetDirectories dir ->>  
            (allFiles subdir) }
```

F#

```
let reader =  
    seq {  
        use reader = new StreamReader(  
            File.OpenRead("test.txt")  
        )  
        while not reader.EndOfStream do  
            yield reader.ReadLine() }
```


Записи

F#

```
type Person =  
    { Name: string;  
      DateOfBirth: System.DateTime; }
```

F#

```
{ Name = "Bill";  
  DateOfBirth = new System.DateTime(1962, 09, 02) }  
  
{ new Person  
  with Name = "Anna"  
  and DateOfBirth = new System.DateTime(1968, 07, 23) }
```

Клонирование записей

F#

```
type Car =  
    {  
        Make : string  
        Model : string  
        Year : int  
    }
```

F#

```
let thisYear's = { Make = "SomeCar";  
                  Model = "Luxury Sedan";  
                  Year = 2010 }  
let nextYear's = { thisYear's with Year = 2011 }
```

Размеченные объединения

Discriminated unions

F#

```
type Route = int
type Make = string
type Model = string

type Transport =
    | Car of Make * Model
    | Bicycle
    | Bus of Route
```

Известные примеры

F#

```
type 'a option =  
    | None  
    | Some of 'a
```

F#

```
type 'a list =  
    | ([])  
    | (::) of 'a * 'a list
```

Использование размеченных объединений

F#

```
type IntOrBool = I of int | B of bool
let i = I 99
let b = B true
```

F#

```
type C = Circle of int | Rectangle of int * int

[1..10]
|> List.map Circle

[1..10]
|> List.zip [21..30]
|> List.map Rectangle
```

Использование в match

F#

```
type Tree<'a> =  
    | Tree of 'a * Tree<'a> * Tree<'a>  
    | Tip of 'a  
  
let rec size tree =  
    match tree with  
    | Tree(_, l, r) -> 1 + size l + size r  
    | Tip _ -> 1
```

Пример

Дерево разбора логического выражения

F#

```
type Proposition =  
    | True  
    | And of Proposition * Proposition  
    | Or  of Proposition * Proposition  
    | Not of Proposition  
  
let rec eval (p: Proposition) =  
    match p with  
    | True -> true  
    | And(p1, p2) -> eval p1 && eval p2  
    | Or (p1, p2) -> eval p1 || eval p2  
    | Not(p1) -> not (eval p1)  
  
printfn "%A" <| eval (Or(True, And(True, Not True)))
```

Взаимосвязанные типы

F#

```
type node =  
    { Name : string;  
      Links : link list }  
and link =  
    | Dangling  
    | Link of node
```


Замена цикла рекурсией

Императивное разложение на множители

F#

```
let factorizeImperative n =  
    let mutable primefactor1 = 1  
    let mutable primefactor2 = n  
    let mutable i = 2  
    let mutable fin = false  
    while (i < n && not fin) do  
        if (n % i = 0) then  
            primefactor1 <- i  
            primefactor2 <- n / i  
            fin <- true  
        i <- i + 1  
    if (primefactor1 = 1) then None  
    else Some (primefactor1, primefactor2)
```

Замена цикла рекурсией

Рекурсивное разложение на множители

F#

```
let factorizeRecursive n =  
    let rec find i =  
        if i >= n then None  
        elif (n % i = 0) then Some(i, n / i)  
        else find (i + 1)  
    find 2
```

Хвостовая рекурсия, проблема

Императивный вариант

F#

```
open System.Collections.Generic
```

```
let createMutableList() =  
    let l = new List<int>()  
    for i = 0 to 100000 do  
        l.Add(i)  
    l
```

Хвостовая рекурсия, проблема

Рекурсивный вариант, казалось бы

F#

```
let createImmutableList() =  
    let rec createList i max =  
        if i = max then  
            []  
        else  
            i :: createList (i + 1) max  
    createList 0 100000
```

Факториал без хвостовой рекурсии

F#

```
let rec factorial x =  
    if x <= 1  
    then 1  
    else x * factorial (x - 1)
```

F#

```
let rec factorial x =  
    if x <= 1  
    then  
        1  
    else  
        let resultOfRecursion = factorial (x - 1)  
        let result = x * resultOfRecursion  
        result
```

Факториал с хвостовой рекурсией

F#

```
let factorial x =  
    let rec tailRecursiveFactorial x acc =  
        if x <= 1 then  
            acc  
        else  
            tailRecursiveFactorial (x - 1) (acc * x)  
    tailRecursiveFactorial x 1
```

После декомпиляции в C#

C#

```
public static int tailRecursiveFactorial(int x, int acc)
{
    while (true)
    {
        if (x <= 1)
        {
            return acc;
        }
        acc *= x;
        x--;
    }
}
```

Паттерн “Аккумулятор”

F#

```
let rec map f list =  
    match list with  
    | [] -> []  
    | hd :: tl -> (f hd) :: (map f tl)
```

```
let map f list =  
    let rec mapTR f list acc =  
        match list with  
        | [] -> acc  
        | hd :: tl -> mapTR f tl (f hd :: acc)  
    mapTR f (List.rev list) []
```


Аккумулятор — функция

F#

```
let printListRev list =  
    let rec printListRevTR list cont =  
        match list with  
        | [] -> cont ()  
        | hd :: tl ->  
            printListRevTR tl (fun () ->  
                printf "%d " hd; cont () )  
    printListRevTR list (fun () -> printfn "Done!")
```

Когда всё не так просто

F#

```
type ContinuationStep <'a> =  
    | Finished  
    | Step of 'a * (unit -> ContinuationStep <'a>)  
  
let rec linearize binTree cont =  
    match binTree with  
    | Empty -> cont()  
    | Node(x, l, r) ->  
        Step(x, (fun () -> linearize l (fun () ->  
            linearize r cont)))
```

Собственно, обход

F#

```
let iter f binTree =  
    let steps = linearize binTree (fun () -> Finished)  
  
    let rec processSteps step =  
        match step with  
        | Finished -> ()  
        | Step(x, getNext) -> f x  
            processSteps (getNext())  
  
    processSteps steps
```