Technology Group

Complexity

Simplified

Functional Programming

Authored & Presented By : **Amit Mulay**

Technical Evangelist

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Requirement

System to schedule tasks and meetings and we want to have several ways to specify the calendar

- For event that happen only once <-> (Datetime)
- Events that occur repeatedly <-> (Datetime, timeinterval)
- Events that don’t have time specified yet <-> ?

Object oriented way

Abstract Base class -> Schedule
(GetNextOccurance() : DateTime)

Child classes ->

Never

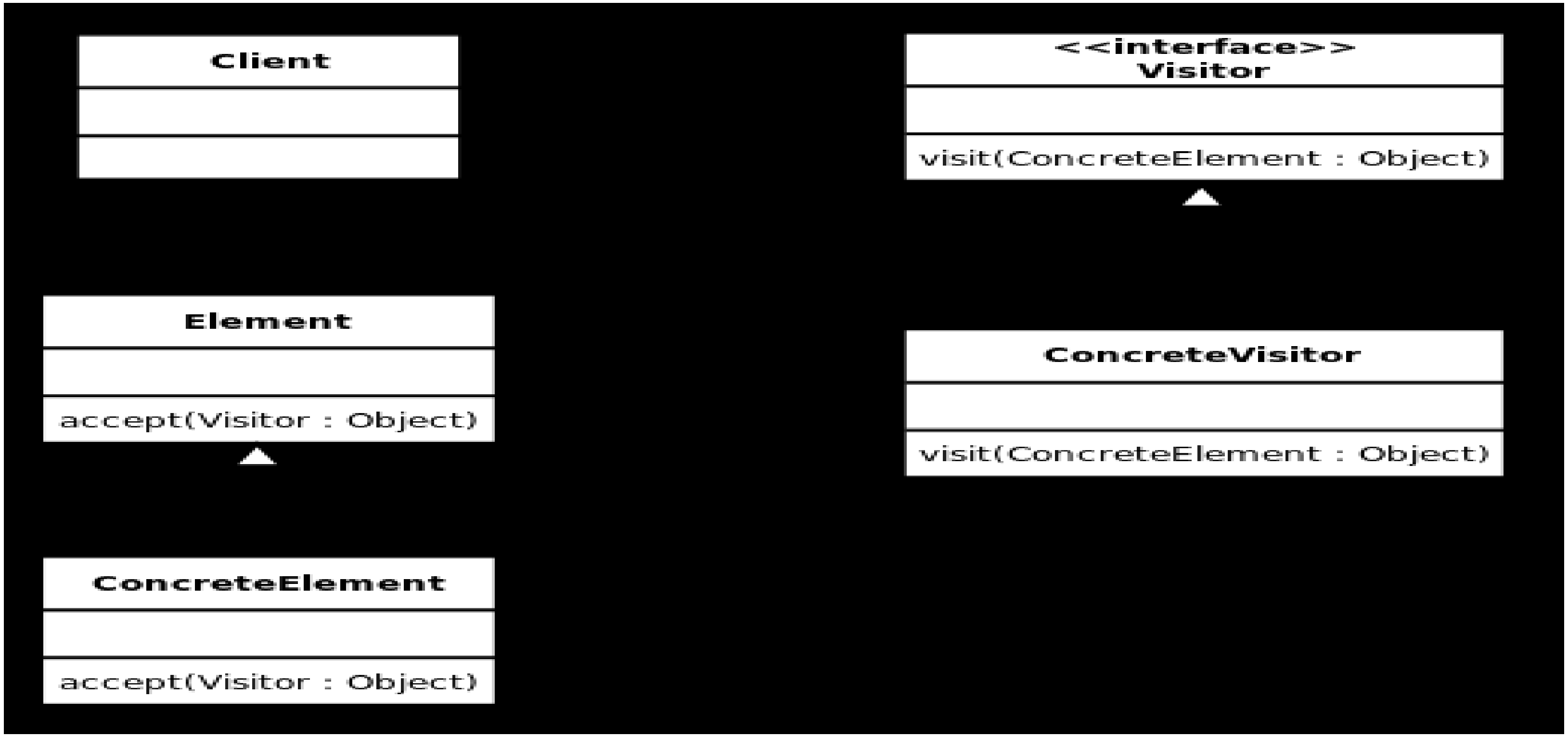
Once(eventdate : DateTime)

Recurring(StartDate : DateTime
TimeInterval : TimeSpan)

- Adding new type of schedule is easy.
- Adding new operation is difficult. (like GetPreviousOccurance() or GetOccuranceNumber())
- Code gets distributed in different files.
- Visitor pattern is used

Visitor pattern

The Gang of Four defines the Visitor as: "***Represent an operation to be performed on elements of an object structure. Visitor lets you define a new operation without changing the classes of the elements on which it operates.***"



FP way #1

```
type Schedule =
            | Never
            | Once of DateTime
            | Repeatedly of DateTime * TimeSpan
```

- Adding new operation is very easy. (like GetPreviousOccurance() or GetOccuranceNumber())
- Adding new type of schedule is difficult.
- We use pattern matching and hence all code for given operation is at same place.

FP way #2 - OOPS

```
type NextOccuranceF<'a> = 'a -> DateTime
type Schedule<'a> = 'a * NextOccuranceF<'a>
let GetNextOccurance<'a> (obj : Schedule<'a>) =
    (snd obj) (fst obj)

// first subclass
type Never = | Never
let NeverCons  =
    let neverf : NextOccuranceF<Never> = fun _ -> DateTime.Max
    fun () -> (Never, neverf) : Schedule<Never>

// second subclass
type Once = DateTime
let SonceCons  =
    let oncef : NextOccuranceF<Once> = fun d -> d.AddDays(1)
    fun (date : DateTime) -> (date, oncef) : Schedule<Once>
```

FP way #3 – WIN WIN SOLN

```
type Schedule<‘a,’f> =
            | Never
            | Once of DateTime
            | Repeatedly of DateTime * TimeSpan
            | FUTURETYPE of ‘a * ‘f

let GetNextOcurrance sch = match sch with
                                    | Never
                                    ..
                                    |  FUTURETYPE(a,f) -> f a
let r = GetNextOcurrance (Once(d))
let r1 = GetNextOcurrance (Never)

type k = {d : datetime; int a; int b}
let GetNextOcurranceK k = …
let r1 = GetNextOcurrance (FUTURETYPE({d,a,b},
GetNextOcurranceK ))
```

Generic functions

Function should perform operation on value obtained but since code needs to be generic, we don’t want to restrict type on value too much.

OOP’s way

- Interface
- actual value will have operations defined for given interface

```
interface ITestAndFormat
{
        bool Test();
        string Format();
}
void CondPrint(ITestAndFormat tf) {
        if (tf.Test())
                Console.WriteLine(tf.Format());

}
```

Generic functions

Function should perform operation on value obtained but since code needs to be generic, we don’t want to restrict type on value too much.

FP way

- Using type parameter (Generics)

```
void CondPrint<T>(T value, Func<T, bool> test, Func<T, string> format) {
        if (test(value))
                Console.WriteLine(format(value));
}
```

F#

```
let condPrint value test format =
        if (test(value)) then
                printfn "%s" (format(value))
        else ()
val condPrint : 'a -> ('a -> bool) -> ('a -> string) -> ()
```

High order functions - Tuple

- Map functions on Tuple
- You need two!
- MapFirst
- MapSecond

```
let mapFirst f (a, b) = f a, b
 let mapSecond f (a, b) = a, f b
(‘a -> ‘b) -> ‘a  * ‘c -> ‘b * ‘c
(‘a -> ‘b) -> ‘c * ‘a -> ‘c * ‘b
```

Map

- Structure remains unchanged
- Functions acts on component of structure

```
(‘a -> ‘b) -> List<‘a> -> List<‘b>
(‘a -> ‘b) -> Wrapper<‘a> -> Wrapper<‘b>
```

High order functions - Schedule

```
type Schedule =
        | Never
        | Once of DateTime
        | Repeatedly of DateTime * TimeSpan

let mapSchedule rescheduleFunc schedule =
        match schedule with
        | Never -> Never
        | Once(eventDate) > Once(rescheduleFunc(eventDate))
        | Repeatedly(startDate, interval) >
                Repeatedly(rescheduleFunc(startDate), interval)

val mapSchedule : (DateTime -> DateTime) -> Schedule
                        -> Schedule
```

High order functions - Schedule

```
let mapSchedule rescheduleFunc schedule =
          match schedule with
          | Never -> Never
          | Once(eventDate) > Once(rescheduleFunc(eventDate))
          | Repeatedly(startDate, interval) >
                    Repeatedly(rescheduleFunc(startDate), interval)
```

Reschedule by 7 days:

```
  schedule |> mapSchedule (fun x -> x.AddDays(7))
```

High order functions - Options

Req : Given ConsoleIntRead() which gives Some(n) if user enters valid number. Else gives None.

Get 2 inputs from user and return Some(addition of numbers) if both inputs are number else return None.

```
let readAndAdd1() =
        match (readInput()) with
        | None   -> None
        | Some(n) -> match (readInput()) with
                     | None   -> None
                     | Some(m) ->      Some(n + m)
```

High order functions - Options

```
let readAndAdd1() =
            match (readInput()) with
            | None   -> None
            | Some(n) -> match (readInput()) with
                             | None   -> None
                             | Some(m) ->      Some(n + m)
```

Lets check map signature for options

(‘a -> ‘b) -> ‘a option -> ‘b option

```
let optionmap f a =
            match a with
            | None -> None
            | Some a -> Some(f a)
```

High order functions - Options

```
let readAndAdd1() =
            match (readInput()) with
            | None   -> None
            | Some(n) -> match (readInput()) with
                             | None   -> None
                             | Some(m) ->      Some(n + m)
let optionmap f a =
            match a with
            | None -> None
            | Some a -> Some(f a)

let readAndAdd2() =
            match (readInput()) with
            | None       -> None
            | Some(first) > readInput()
                              |>  optionmap  (fun second -> first + second)
```

High order functions - Options

```
let readAndAdd2() =
            match (readInput()) with
            | None        -> None
            | Some(first) > readInput()
                                |> Option.map (fun second -> first + second)
```

With map we eliminated inner match!

Can we eliminate outer match?

(‘a -> ‘b option) -> ‘a option -> ‘b option

(‘a -> Wrapper of ‘b) -> Wrapper of ‘a -> Wrapper of ‘b

Well this is signature for High order function known as bind

High order functions - Options

(‘a -> ‘b option) -> ‘a option -> ‘b option

(‘a -> Wrapper of ‘b) -> Wrapper of ‘a -> Wrapper of ‘b

Well this is signature for High order function known as bind

```
let optionbind f a =
        match a with
        | None -> None
        | Some(a) -> f a
```

High order functions - Options

```
let readAndAdd2() =
          match (readInput()) with
          | None      -> None
          | Some(first) > readInput()
                          |> Option.map (fun second -> first + second)
```

Using optionbind

```
let readAndAdd3() =
          readInput() |> optionbind(fun first ->
                    readInput()
                    |> Option.map (fun second -> first + second)
          )
```

High order functions

```
// map operation
val mapFirst     : ('a -> 'b) -> 'a * 'c   -> 'b * 'c
val List.map     : ('a -> 'b) -> 'a list   -> 'b list
val Option.map   : ('a -> 'b) -> 'a option -> 'b option

// filter operation
val List.filter   : ('a -> bool) -> 'a list   -> 'a list
val Option.filter : ('a -> bool) -> 'a option -> 'a option

// fold operation
val List.fold    : ('a -> 'b -> 'a) -> 'a -> 'b list   -> 'a
val Option.fold  : ('a -> 'b -> 'a) -> 'a -> 'b option -> 'a

Option.bind :  ('a -> 'b option) -> 'a option -> 'b option
List.bind   :  ('a -> 'b list)   -> 'a list   -> 'b list  // Referred as List.collect
```

Any Questions?

Thank you!