The Expression Problem

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Why the Visitor Pattern?

The visitor pattern exists mainly because some languages don't support *pattern matching.*

Pattern matching is a mechanism for checking a value against a pattern. A successful match can also deconstruct a value into its constituent parts. It is a more powerful version of the switch statement and it can likewise be used in place of a series of if/else statements.

Pattern matching is a concept that goes "against" OOP, and is a feature used in the FP paradigm.

Pattern Matching: Syntax

```
e match {
   case … => …
   case … => …
   case … => …
   …
}
```

Matching Literals and Variables

```
import scala.util.Random

val x: Int = Random.nextInt(10)

x match {
  case 0 => "zero"
  case 1 => "one"
  case 2 => "two"
  case _ => "other"
}
```

"Any other case"

Pattern Matching on classes

Case classes are especially useful for pattern matching.

```
sealed trait Notification

case class Email(sender: String, title: String, body: String) extends Notification

case class SMS(caller: String, message: String) extends Notification

case class VoiceRecording(contactName: String, link: String) extends Notification
```

```
def showNotification(notification: Notification): String = {
  notification match {
    case Email(sender, title, _) =>
      s"You got an email from $sender with title: $title"
    case SMS(number, message) =>
      s"You got an SMS from $number! Message: $message"
    case VoiceRecording(name, link) =>
      s"You received a Voice Recording from $name! Click the $link"
  }
}

showNotification(SMS("12345", "Are you there?"))
```

You got an SMS from 12345! Message: Are you there?

Pattern Matching: Pattern guards

Case classes are especially useful for pattern matching.

```
def showImportantNotification(
                notification: Notification,
                impPple: Seq[String]): String = {
  notification match {
    case Email(sender, _, _) if impPple.contains(sender) =>
      "You got an email from special someone!"
    case SMS(number, _) if impPple.contains(number) =>
      "You got an SMS from special someone!"
    case other =>
      //nothing special, delegate to our
      //original showNotification function
      showNotification(other)
  }
}
val importantPeopleInfo = Seq("867-5309", "jenny@gmail.com")
val someSms = SMS("867-5309", "Are you there?")
showImportantNotification(someSms, importantPeopleInfo)
```

You got an SMS from special someone!

Matching on lists

```
def sum(l: List[Int]): Int = {
  l match{
    case Nil => 0
    case head :: tail => head + sum(tail)
  }
}

println(sum(List(1,2,3,4,5)))
```

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Pattern Matching on types

```
sealed trait Device

case class Phone(model: String) extends Device {
  def screenOff = "Turning screen off"
}

case class Computer(model: String) extends Device {
  def screenSaverOn = "Turning screen saver on..."
}

def goIdle(device: Device): String = device match {
  case p: Phone => p.screenOff
  case c: Computer => c.screenSaverOn
}
```

Pattern Matching: Extractor objects

```scala
import scala.util.Random

object CustomerID {

  def apply(name: String) = s"$name--${Random.nextLong()}"

  def unapply(customerID: String): Option[String] = {
    val stringArray: Array[String] = customerID.split("--")
    if (stringArray.tail.nonEmpty) Some(stringArray.head)
    else None
  }
}

val customer1ID = CustomerID("Sukyoung") // Sukyoung--23098234908
customer1ID match {
  case CustomerID(name) => println(name) // prints Sukyoung
  case _ => println("Could not extract a CustomerID")
}
```

Revisiting the FileSystem problem with Pattern Matching

```
class FileSystem() {
  …
  def getNumberOfFiles(): Int = {
    NumberOfFile(root)
  }

  def getNumberOfDirectory(): Int = {
    NumberOfDirectory(root)
  }

  def listing(): String = {
    Listing(root)
  }
}
```

Revisiting the FileSystem problem with Pattern Matching

```
object NumberOfFile {
  def apply(item: Item): Int = {
    item match{
      case d: Directory =>
        d.getItems().map(apply).sum
      case _ => 1
    }
  }
}
```

Revisiting the FileSystem problem with Pattern Matching

```
object NumberOfDirectory {
  def apply(item: Item): Int = {
    item match{
      case d: Directory =>
        1+d.getItems().map(apply).sum
      case _ => 0
    }
  }
}
```

Revisiting the FileSystem problem with Pattern Matching

```
object Listing {
  def apply(item: Item): String = {
    item match{
      case d: Directory => {
        /*d.getItems().foldLeft(d.getName()+"\n"){
          (acc, item) => acc + apply(item)
        }*/
        var tmp = d.getName()+"\n"
        for(item <- d.getItems()){
          tmp += apply(item)
        }
        tmp
      }
      case _ => item.getName()+"\n"
    }
  }
}
```

The Expression Problem

What happen if we want to **add a new operation** such as **SizeOf**?.

Easy and **low cost**:

```
object SizeOf{
  def apply(item: Item): Int = {
    item match {
      case d: Directory =>
        d.getItems().map(apply).sum
      case _ => item.getSize()
    }
  }
}
```

The Expression Problem

What happen if we want to **add a new variant** such as **SymbolicLink**?.

This might be **expensive**, as we may have to modify all of our operations and add an extra case.

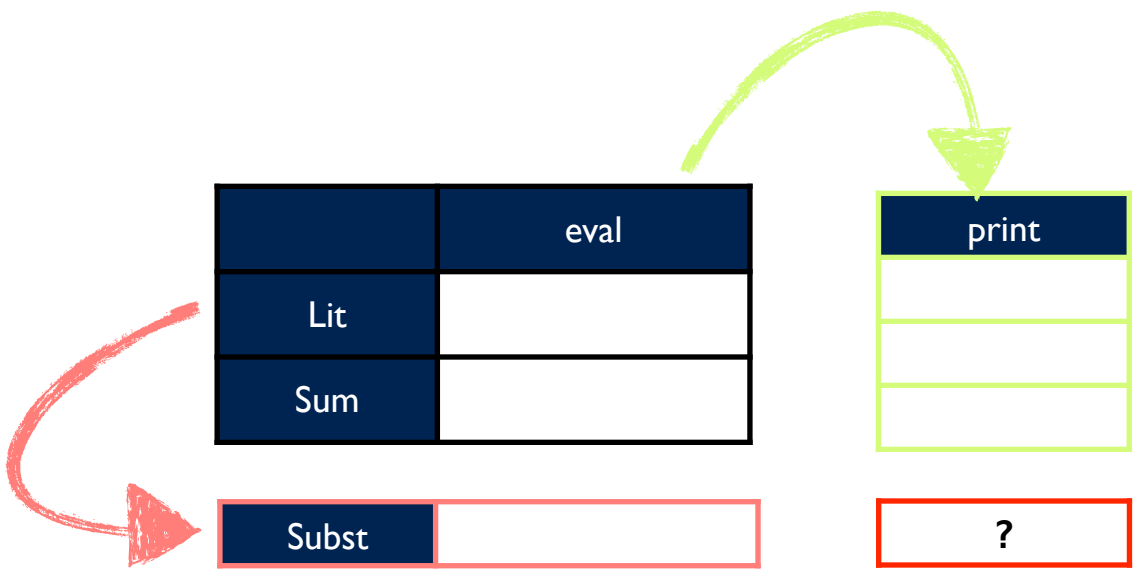
```
object SizeOf{
  def apply(item: Item): Int = {
    item match {
      case d: Directory =>
        d.getItems().map(apply).sum
      case i: SymbolicLink => ...
      case _ => item.getSize()
    }
  }
}
```

The Expression Problem

This extensibility problem is usually presented as follows: Given a language for arithmetic expressions, we want to extend it with two possible evolutions:

New variant: a new type of expression, e.g. **subtraction**

New operation: a new method, e.g., **pretty printing**



Expression Problem: OOP approach

Given a language for arithmetic expressions, we want to extend it with two possible evolutions:

New variant: a new type of expression, e.g. **subtraction**

New operation: a new method, e.g., **pretty printing**

```
trait Exp {
  def eval(): Int
}

class Lit(x: Int) extends Exp {
  def eval() = x
}

class Add(e1: Exp, e2: Exp) extends Exp {
  def eval() = e1.eval + e2.eval
}
```

Expression Problem: OOP approach.

Adding a **new variant** to the domain.

```
…
class Subs(e1: Exp, e2: Exp) extends Exp {
  def eval() = e1.eval - e2.eval
}
```

Low cost!

Expression Problem: OOP approach.

Adding a **new operation**.

```
trait Exp {
  def eval(): Int
  def print(): String
}

class Lit(x: Int) extends Exp {
  def eval() = x
  def print() = ""+x
}

class Add(e1: Exp, e2: Exp) extends Exp {
  def eval() = e1.eval + e2.eval
  def print() = "("+ e1.print + "+" + e2.print +")"
}
```

Expensive!

Expression Problem: FP approach

Given a language for arithmetic expressions, we want to extend it with two possible evolutions:

New variant: a new type of expression, e.g. **subtraction**

New operation: a new method, e.g., **pretty printing**

```
trait Exp {
}
case class Lit(x: Int) extends Exp
case class Add(e1: Exp, e2: Exp) extends Exp

def eval(e: Exp) = e match{
  case Lit(x) => x
  case Add(e1, e2) => eval(e1)+eval(e2)
}
```

Expression Problem: FP approach.

Adding a **new operation**.

```
…
def print(e: Exp) = e match{
   case Lit(x) => ""+x
   case Add(e1, e2) =>
        “(“+println(e1) + "+" + println(e2)+”)”
}
```

Low cost!

Expression Problem: FP approach.

Adding a **new variant** to the domain.

```
def eval(e: Exp) = e match{
  case Lit(x) => x
  case Add(e1, e2) => eval(e1)+eval(e2)
  case Subs(e1, e2) => println(e1)-println(e2))
}
def print(e: Exp) = e match{
  case Lit(x) => ""+x
  case Add(e1, e2) =>
    "("+print(e1) + "+" + print(e2)+")"
  case Subs(e1, e2) =>
    "("+print(e1) + "-" + print(e2)+")"
}
```

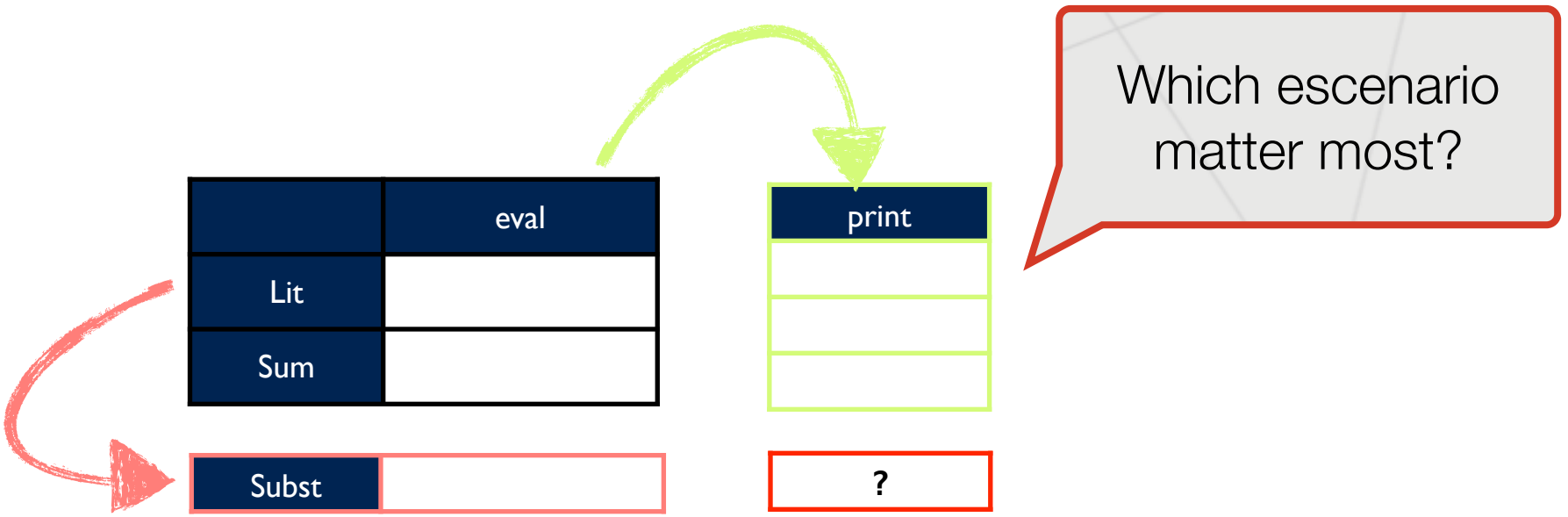
Expensive!

Expression Problem

Given a language for arithmetic expressions, we want to extend it with two possible evolutions:

New variant: a new type of expression, e.g. **subtraction**

New operation: a new method, e.g., **pretty printing**



Solutions to the Expression Problem

There are multiple solutions on the internet to this problem.

We are going to describe live, one fairly simple approach for Scala

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