

# Visitor

Modular and extensible first class actions

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# Goals

- Studying examples
- Understanding the Visitor design pattern
- Discussions on pros and cons



# Example: basic arithmetic expressions

Imagine a simple mathematical system

Plus

left: (Number value: 1)

right: (Times left: (Number value: 3) right: (Number value: 2))

Remarks:

- In this example, we reify everything
- In Pharo, no need to wrap numbers with our own Number because can extend the Pharo core Number

Plus

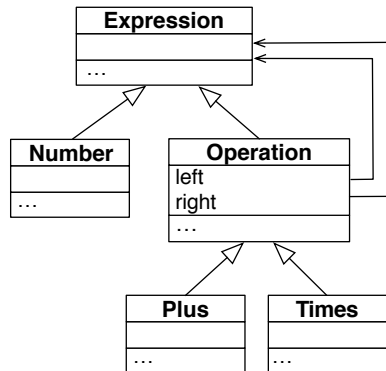
left: 1

right: (Times left: 3 right: 2)



# Basic arithmetic expressions as Composite

An expression is represented by a Composite with numbers and operations (see Lecture on Composite)



# Some expressions

1

Number value: 1

$(3 * 2)$

Times left: (Number value: 3) right: (Number value: 2)

$1 + (3 * 2)$

Plus

left: (Number value: 1)

right: (Times left: (Number value: 3) right: (Number value: 2))



# Operations on the expressions

We want two operations on expressions:

- Evaluate

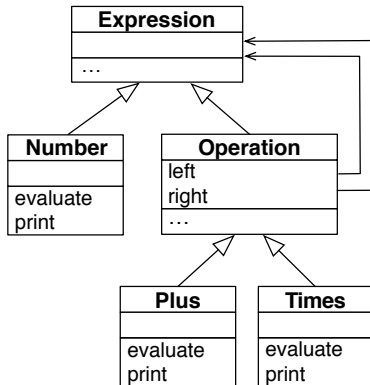
$1 + (3 * 2)$   
 $> 7$

- Print (in Polish notation)

$1 + (3 * 2)$   
 $> +1*32$



# First design: behavior defined in the domain



# First design: behavior defined in the domain

Number >> evaluate  
^ value

Plus >> evaluate  
^ left evaluate + right evaluate

Number >> print  
stream nextPutAll: value asString

Plus >> print  
...



# First design: analysis

- Some operations require some state
  - e.g. a stack is needed to print expressions in infix notation
- Where should we define such state?
  - **in** the expression classes?
  - even if this is **only** related to print?

Should we **mix** the state of operations on items with the items themselves?



# Overview of a real system

The Pillar Pharo library:

- a core hierarchy of 50 classes (document model)
- export to LaTeX (two versions)
- export to HTML
- export to Beamer
- export to ASCIIDoc, Markdown, Microdown
- transform trees for expansion
- code checkers
- ...



# First design: conclusion

Putting all the behavior inside domain objects:

- **Blows up** the class API / state / methods
- **Mixes** concerns
- Is **not modular**: we cannot have **one** operation only
- **Prevents extension**: adding a new behavior requires changing the domain



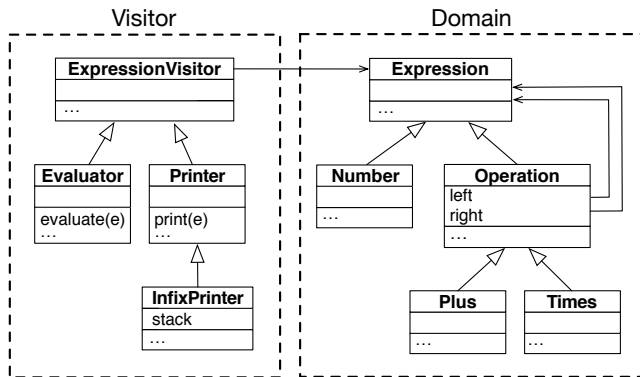
# Essence of the Visitor design pattern

A Visitor:

- **Represents** an operation
- **Decouples** this operation from the domain objects it applies to (separate class)
- Supports **modularity** (separate package)
- Supports **extension**
  - We define **once** a set of messages (e.g., visitX) in domain objects
  - Then, new visitors (operations) are easy to define **without changing domain objects** it operates on



# Overview of a Visitor-based design

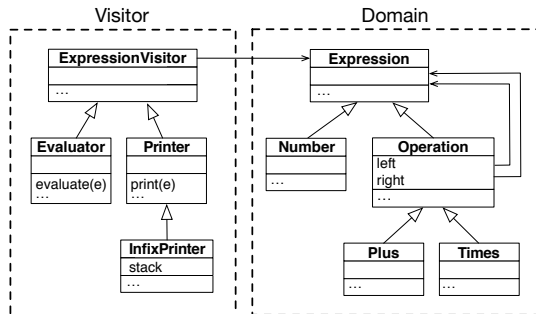


# Visitor: key points

A Visitor:

- requires a structure to operate on
- performs different actions based on the kind of the elements
  - **knows** what operation to do for a Number, a Plus, and a Times
- manages its **own specific** state
- is **independent** of other ones

Visitor + Composite: a **perfect** match



# Using Visitors

```
"1+(3*2)"
```

```
expr := (Plus  
  left: (Number value: 1)  
  right: (Times  
    left: (Number value: 3)  
    right: (Number value: 2)))
```

```
Evaluator new evaluate: expr.  
> 7
```

```
Printer new print: expr.  
> +1*32
```

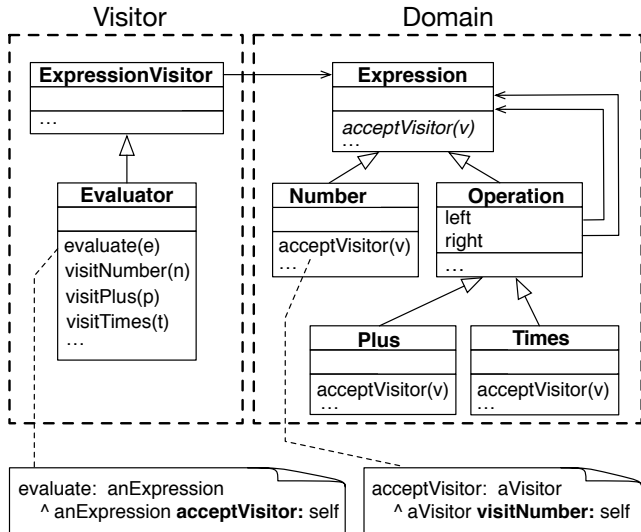
```
InfixPrinter new print: expr.  
> 1+(3*2)
```

# Visitor implementation: Domain instrumentation

Prepare the domain to accept Visitors:

- add `acceptVisitor`: on each composite element
- tells the visitor passed in parameter how to visit it

**only once for all Visitors**





# Visitor implementation: Domain instrumentation

Number >> acceptVisitor: aVisitor  
^ aVisitor visitNumber: **self**

Plus >> acceptVisitor: aVisitor  
^ aVisitor visitPlus: **self**

Times >> acceptVisitor: aVisitor  
^ aVisitor visitTimes: **self**

- **only once for all Visitors**
- Domain objects tell to the Visitor how they want to be visited
  - visitNumber:, visitPlus:, visitTimes:, visitXXX:



# Visitor implementation

A Visitor:

- executes the right operation for an element
- propagates recursively on composite elements
  - acceptVisitor:

```
Evaluator >> visitNumber: aNumber  
  ^ aNumber value
```

```
Evaluator >> visitPlus: anExpression  
  | l r |  
  l := anExpression left acceptVisitor: self.  
  r := anExpression right acceptVisitor: self.  
  ^ l + r
```

```
Evaluator >> visitTimes: anExpression  
  | l r |  
  l := anExpression left acceptVisitor: self.  
  r := anExpression right acceptVisitor: self.  
  ^ l * r
```



# Visitor: an extensible design

Supporting a new operation is simple:

- Define a new Visitor class
  - e.g, Printer
- Implement the expected API
  - i.e., visitNumber, visitPlus **and** visitTimes
- Use it

```
anExpression acceptVisitor: Printer new
```

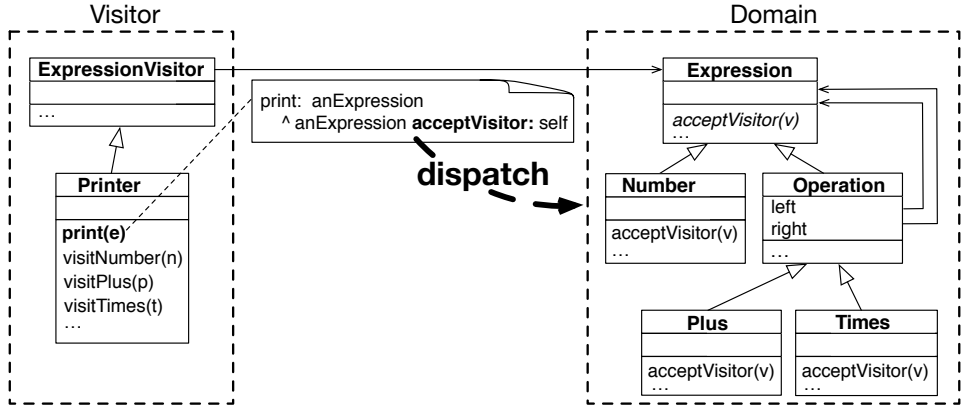
```
Printer new print: anExpression
```

# Visitor: step back

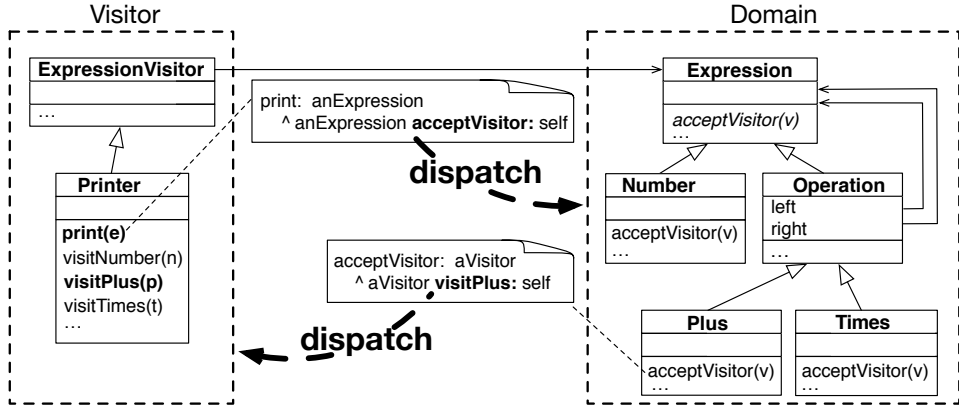
Did you really understand the subtle interaction  
between `acceptVisitor` and `visitXXX` methods?



# Double dispatch



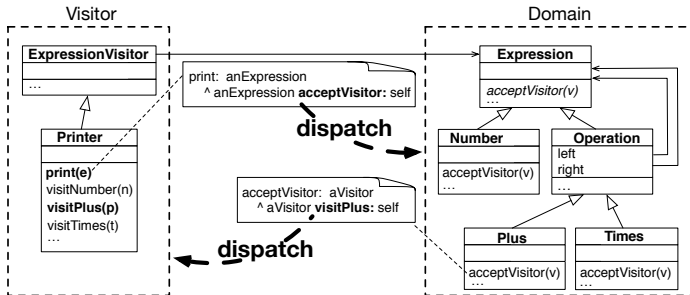
# Double dispatch



# Visitor core: Double dispatch

Double dispatch:

- Core mechanism of Visitor
- No conditional checks
- Provides decoupling between:
  - Visitors and domain objects
  - Different visitors



# When to use a Visitor

Whenever you have to perform multiple operations on structured object graphs  
Examples:

- Parse tree (ProgramNode) uses a Visitor for
  - the compilation (emitting code on CodeStream),
  - pretty printing, syntax highlighting
  - different analysis pass, rotten green test analysis
- Rendering documents (Document) in different formats
  - nodes expansion, HTML, LaTeX, ...





# When using a Visitor is challenging

- If the elements of the composite **change**
  - It requires to change **all** Visitors
- Related to the *expression problem* in statically-typed languages



# Conclusion

## Pros:

- Visitor is a very nice pattern
- It provides a modular and extensible design
- Double dispatch makes it plug and play

## Cons:

- Can look complex
- Not well adapted to changing structures



Produced as part of the course on <http://www.fun-mooc.fr>

# Advanced Object-Oriented Design and Development with Pharo

A course by

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