

The Visitor Design Pattern

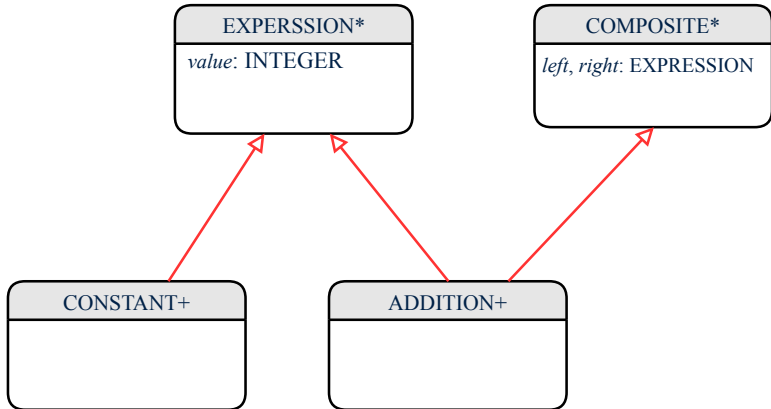


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CHEN-WEI WANG

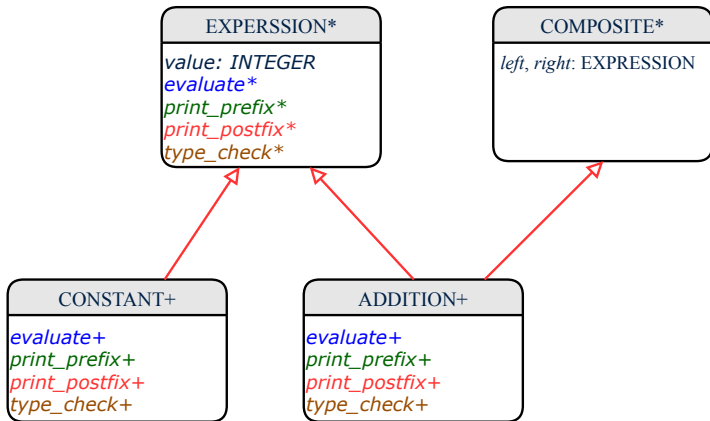
Motivating Problem (1)

Based on the **composite pattern** you learned, design classes to model **structures** of arithmetic expressions (e.g., 341 , 2 , $341 + 2$).



Motivating Problem (2)

Extend the **composite pattern** to support **operations** such as evaluate, pretty printing (`print_prefix`, `print_postfix`), and `type_check`.



Problems of Extended Composite Pattern

- Distributing the various **unrelated operations** across nodes of the **abstract syntax tree** violates the **single-choice principle**:
 - To add/delete/modify an operation
 - ⇒ Change of all descendants of `EXPRESSION`
- Each node class lacks in **cohesion**:
 - A **class** is supposed to group **relevant** concepts in a **single** place.
 - ⇒ Confusing to mix codes for evaluation, pretty printing, and type checking.
 - ⇒ We want to avoid “polluting” the classes with these various unrelated operations.

Open/Closed Principle

Software entities (classes, features, etc.) should be *open* for *extension*, but *closed* for *modification*.

⇒ When *extending* the behaviour of a system, we:

- May add/modify the *open* (unstable) part of system.
- May not add/modify the *closed* (stable) part of system.

e.g., In designing the application of an expression language:

- **Alternative 1:**
Syntactic constructs of the language may be *closed*, whereas operations on the language may be *open*.
- **Alternative 2:**
Syntactic constructs of the language may be *open*, whereas operations on the language may be *closed*.

Visitor Pattern

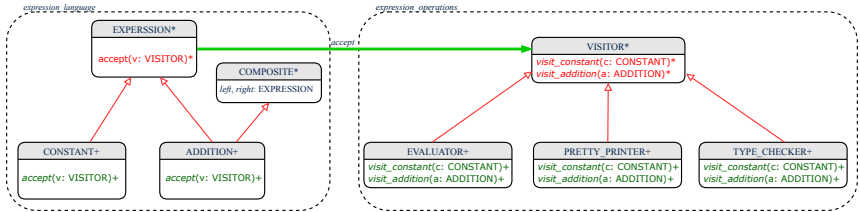
- *Separation of concerns* :
 - Set of language constructs
 - Set of operations

⇒ Classes from these two sets are *decoupled* and organized into two separate clusters.
- *Open-Closed Principle (OCP)* :
 - *Closed*, staple part of system: set of language constructs
 - *Open*, unstable part of system: set of operations

⇒ *OCP* helps us determine if Visitor Pattern is *applicable* .

⇒ If it was decided that language constructs are *open* and operations are *closed*, then do **not** use Visitor Pattern.

Visitor Pattern: Architecture



Visitor Pattern Implementation: Structures

Cluster *expression_language*

- Declare *deferred* feature `accept(v: VISITOR)` in `EXPRESSION`.
- Implement `accept` feature in each of the descendant classes.

```
class CONSTANT inherit EXPRESSION
...
  accept(v: VISITOR)
  do
    v.visit_constant(Current)
  end
end
```

```
class ADDITION
inherit EXPRESSION COMPOSITE
...
  accept(v: VISITOR)
  do
    v.visit_addition(Current)
  end
end
```


Visitor Pattern Implementation: Operations

Cluster *expression_operations*

- For each descendant class *C* of *EXPRESSION*, declare a *deferred* feature `visit_c (e: C)` in the *deferred* class *VISITOR*.

```
deferred class VISITOR
  visit_constant(c: CONSTANT) deferred end
  visit_addition(a: ADDITION) deferred end
end
```

- Each descendant of *VISITOR* denotes a kind of operation.

```
class EVALUATOR inherit VISITOR
  value: INTEGER
  visit_constant(c: CONSTANT) do value := c.value end
  visit_addition(a: ADDITION)
    local eval_left, eval_right: EVALUATOR
    do a.left.accept(eval_left)
       a.right.accept(eval_right)
       value := eval_left.value + eval_right.value
    end
end
```

Testing the Visitor Pattern

```

1 test_expression_evaluation: BOOLEAN
2   local add, c1, c2: EXPRESSION ; v: VISITOR
3   do
4     create {CONSTANT} c1.make (1) ; create {CONSTANT} c2.make (2)
5     create {ADDITION} add.make (c1, c2)
6     create {EVALUATOR} v.make
7     add.accept (v)
8     check attached {EVALUATOR} v as eval then
9       Result := eval.value = 3
10    end
11  end
  
```

Double Dispatch in **Line 7:**

1. **DT** of add is **ADDITION** \Rightarrow Call accept in **ADDITION**

v.visit_ **addition** (add)

2. **DT** of v is **EVALUATOR** \Rightarrow Call visit_addition in **EVALUATOR**

visiting result of add.left + visiting result of add.right

To Use or Not to Use the Visitor Pattern

- In the architecture of visitor pattern, what kind of **extensions** is easy and hard? Language structure? Language Operation?
 - Adding a new kind of **operation** element is easy.

To introduce a new operation for generating C code, we only need to introduce a new descendant class `C_CODE_GENERATOR` of `VISITOR`, then implement how to handle each language element in that class.

⇒ **Single Choice Principle** is *obeyed*.
 - Adding a new kind of **structure** element is hard.

After adding a descendant class `MULTIPLICATION` of `EXPRESSION`, every concrete visitor (i.e., descendant of `VISITOR`) must be amended to provide a new `visit_multiplication` operation.

⇒ **Single Choice Principle** is *violated*.
- The applicability of the visitor pattern depends on to what extent the **structure** will change.
 - ⇒ Use visitor if **operations** applied to **structure** change often.
 - ⇒ Do not use visitor if the **structure** change often.

Beyond this Lecture...

Learn about implementing the Composite and Visitor Patterns, from scratch, in this tutorial series:

https://www.youtube.com/playlist?list=PL5dxAmCmjv_4z5eXGW-ZBgsS2WZTyBHY2

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