Design patterns

Admin

- Final exam time
- Milestone 2 deadline tomorrow!

Design Patterns

Elements of Reusable Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides

Foreword by Grady Booch

ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

What are design patterns

- Solutions to specific problems in OO software design
- 23 patterns in 3 categories
  - Creational
  - Structural
    - Composite
    - …
  - Behavorial
    - Observer
    - Interpreter
    - …

Observer

- One to many relationship
  - The many need to know changes in “one” immediately

- Example
  - Facebook feed
  - Lines & rectangles
  - …

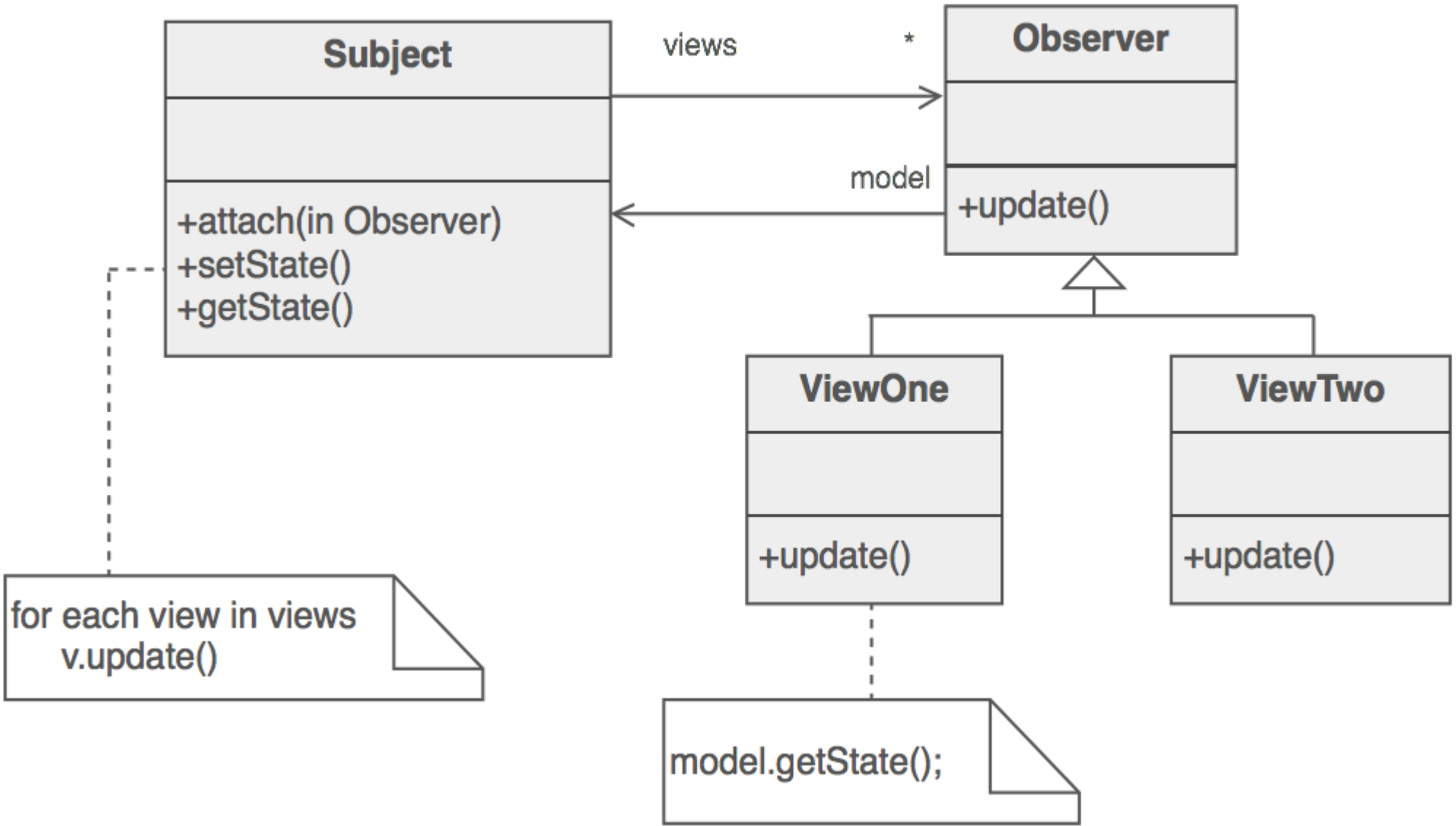
Example

- If a person changes its status, how to let all his “subscriber” knows?

Example

- What if there are different types of subscribers?

Class diagram



Can you think of some examples?

Composite pattern

- Tree hierarchy

How to build a tree and traverse it?

```
struct node{
   struct node* left;
   struct node* right;
   int val;
   int sum(){
        …
   }
}
```

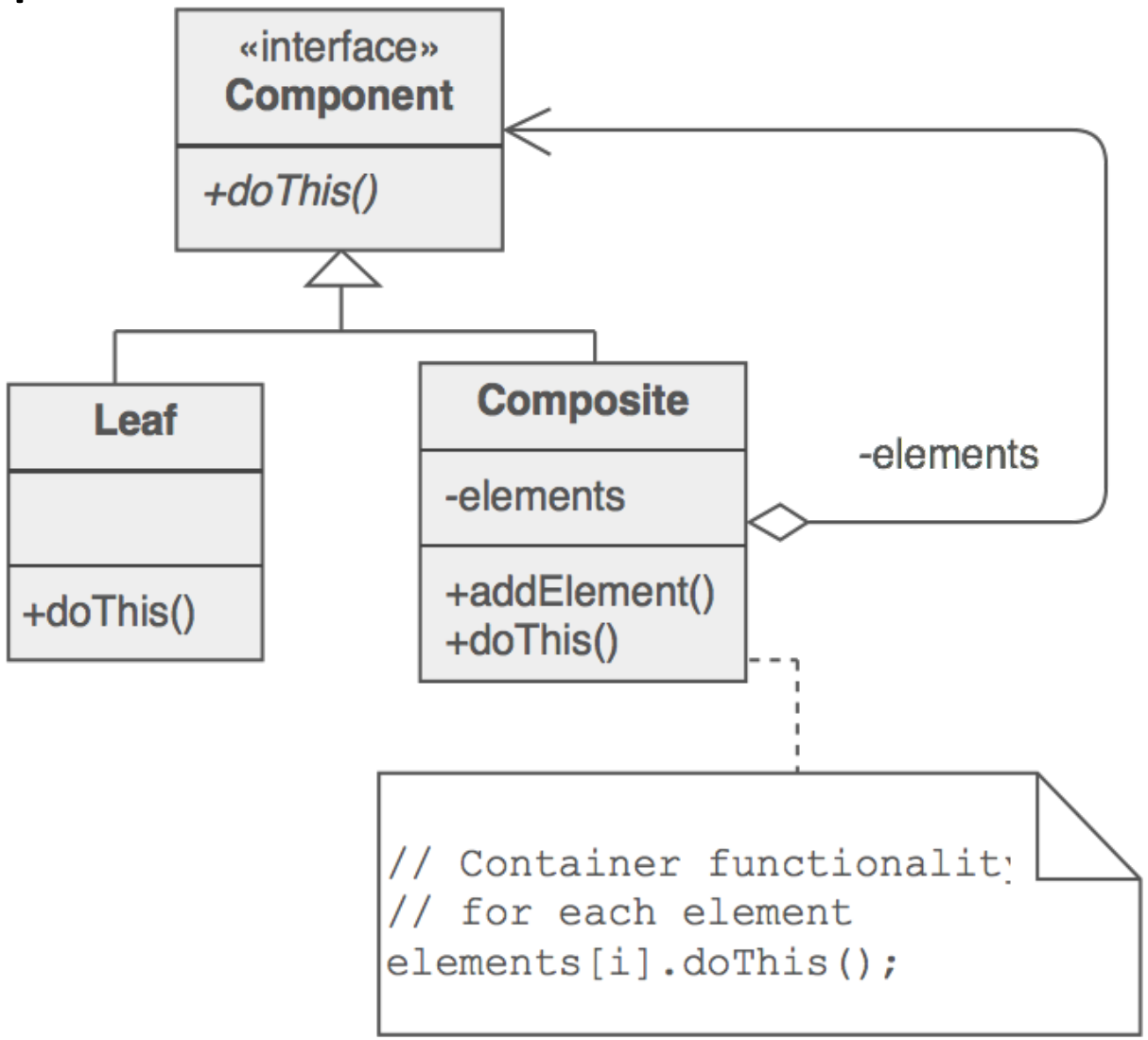
How to differentiate leaves and others?

```
struct leaf{
   int val;
   int sum(){ return val;}
}
```

How to accommodate different types of internal nodes?

- Examples
  - struct node or struct leaf?
  - Book
  - Graphics

Class diagram



Can you think of some examples?

Interpreter

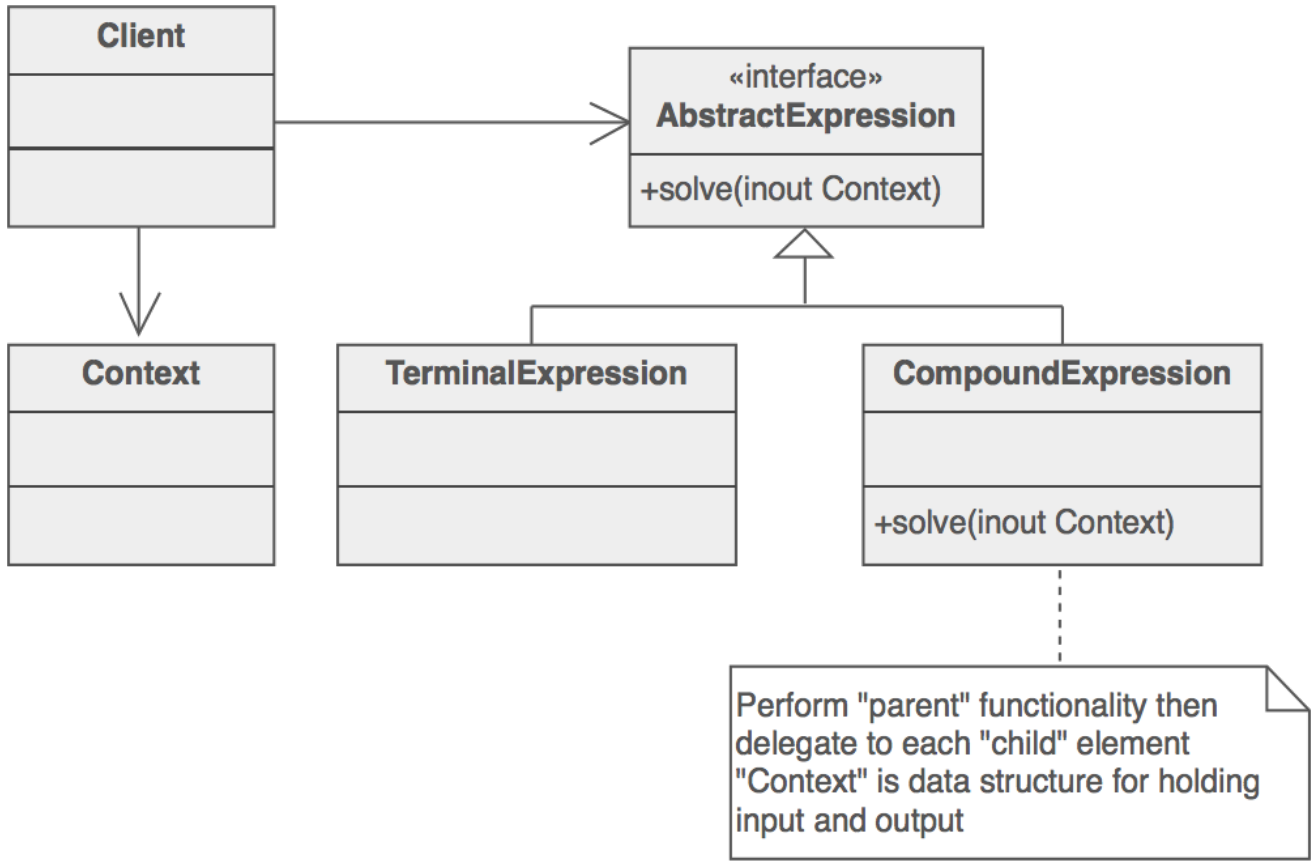
- What is an interpreter
  - Language, compiler

- Example
  - Boolean expression
    - Abstract syntax tree

    a && b || !c

    a parser will turn this into an abstract syntax tree, and then an interpreter will evaluate the tree. How to write a program to do the tree-based evaluation?

Class diagram

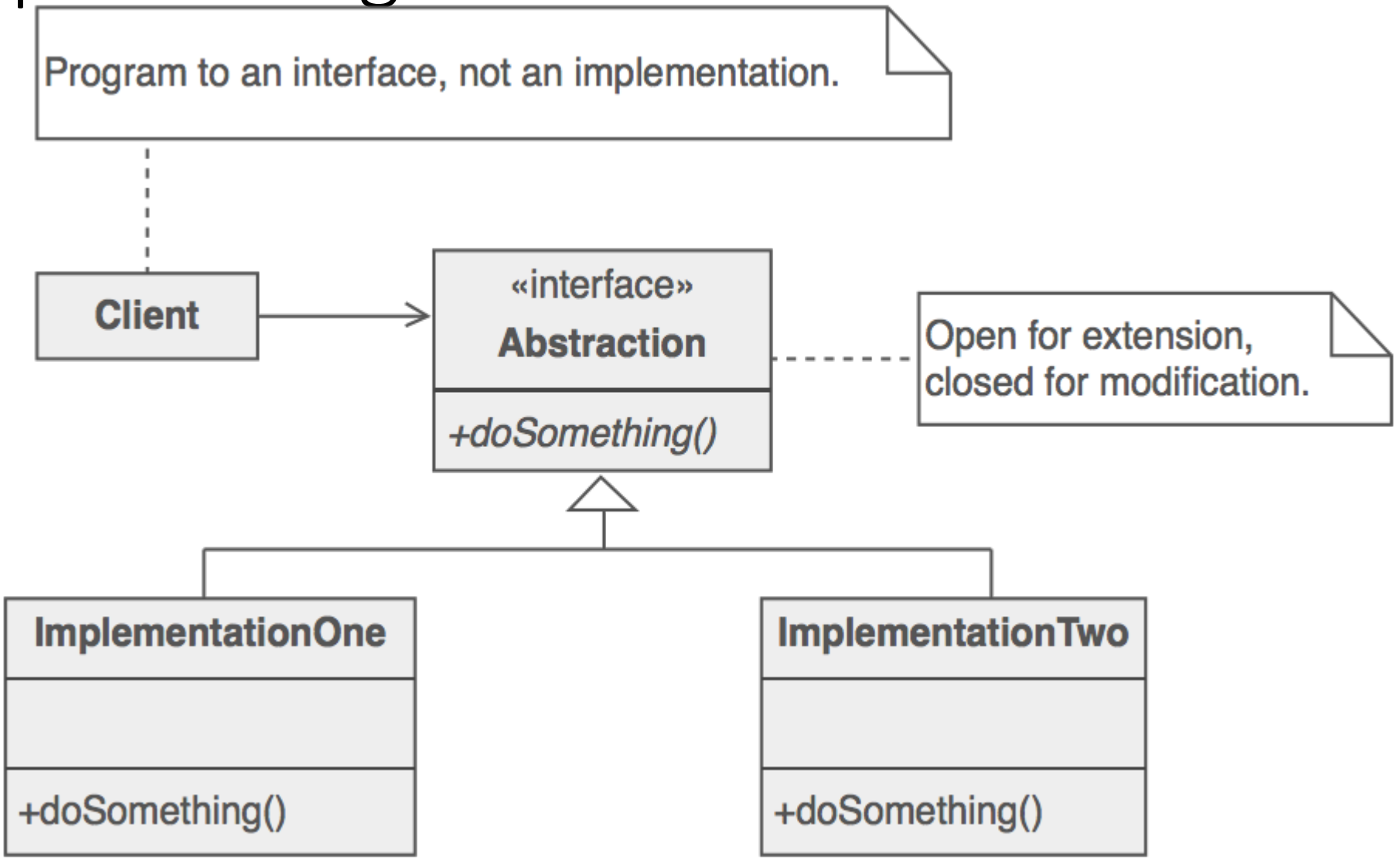


Strategy

- Multiple variants of one algorithm
- Different types of objects only differing in behavior

- Example
  - Different type of printing for an expression

Class diagram
-- encapsulate algorithms into class



Alternative solutions

- If in C
- Super-class on the data side
- Template in C++

Other examples

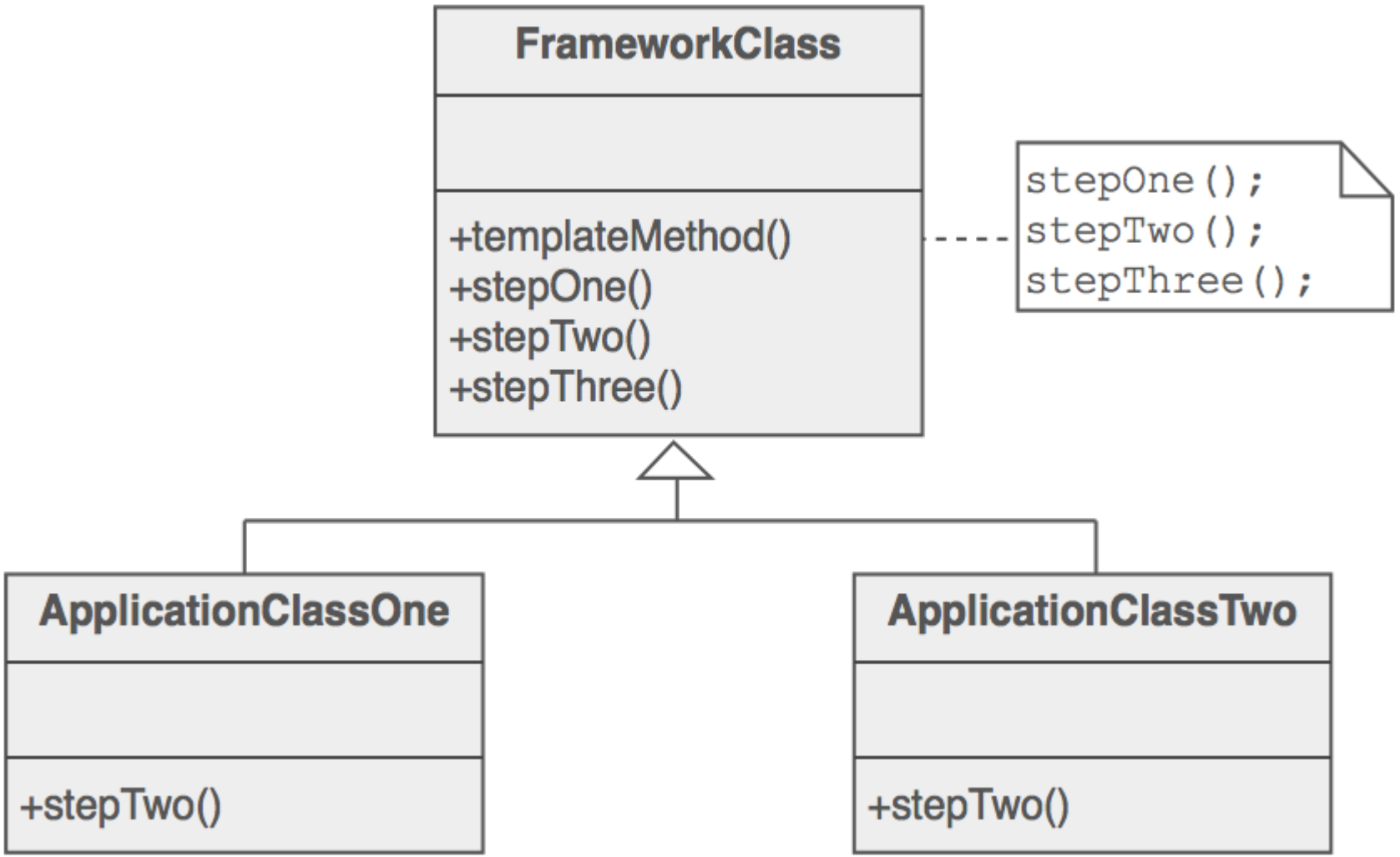
- Different sorting
- Different rendering
- What else?

Template

- Provide a skeleton for similar algorithms

- Example

Class diagram

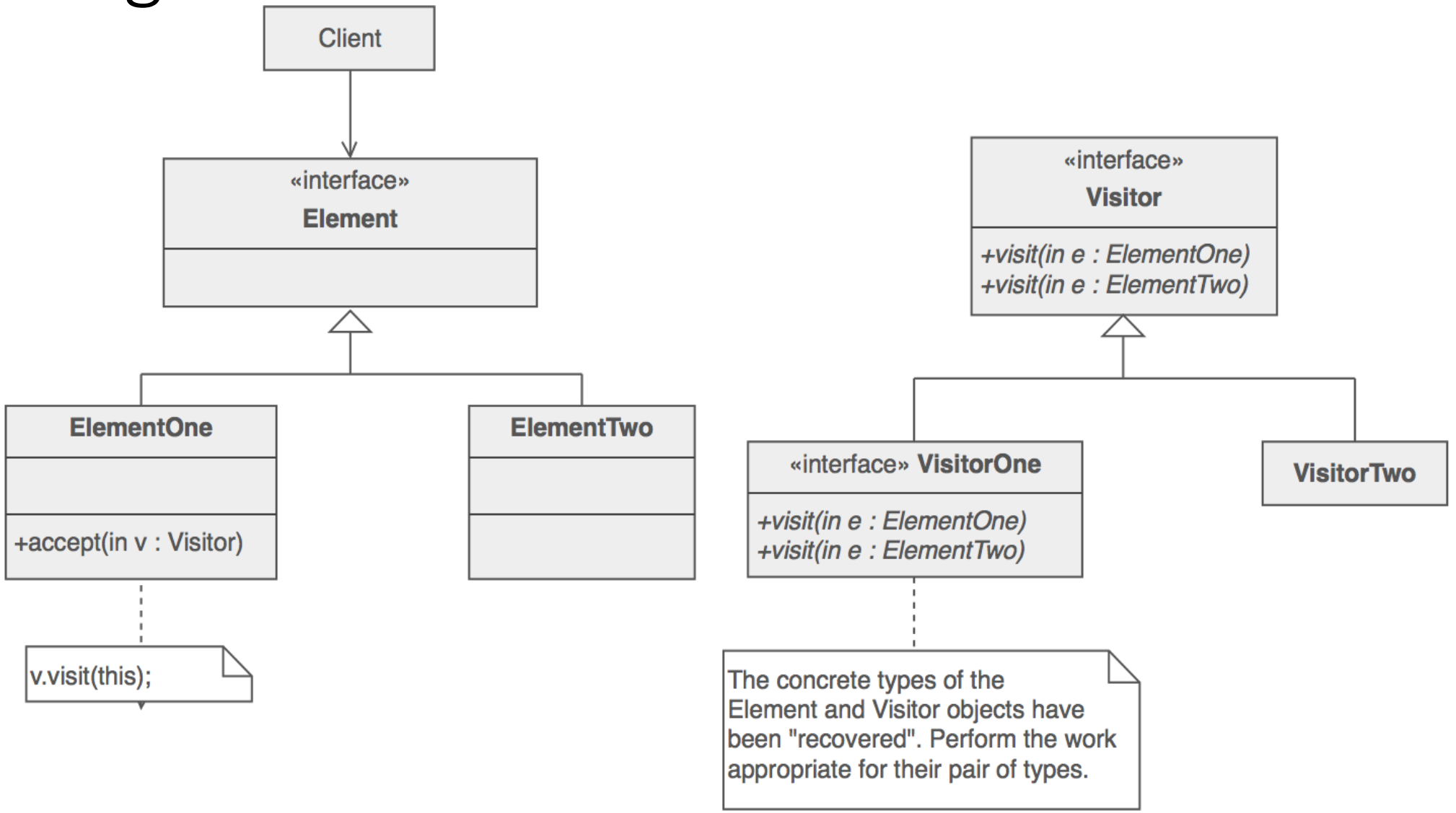


Visitor

- How to add a class of operations for a variety of data classes?

- Example
  - Different operations for AST nodes
  - Different operations for Person (Female, Male)

Class diagram



Visitor

- What is it good at?
  - If you add operations (Visitor classes), the interface of the Element classes remains unchanged
- What is it bad at?
  - If you add new Element sub-class, significant changes are needed for the Visitor side
- Double-dispatch
  - Imagine two dimensions of a function call
    - The exact algorithm
    - The type of data this algorithm works on
  - You will get chance to make choice along both dimensions dynamically, using visitor pattern

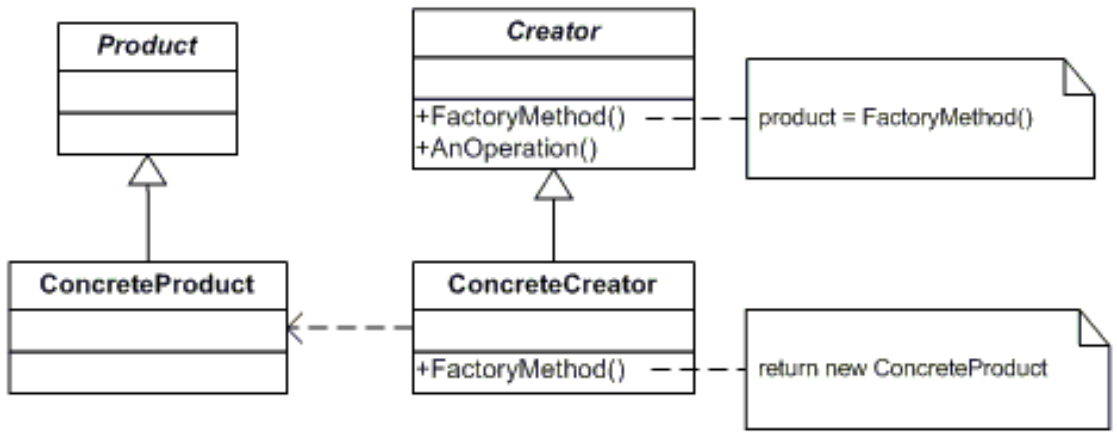
Creational design patterns

Factory Method

- Lets a class defer instantiation to subclasses
  - No need to decide which subclass I want to use statically

- Example
  - Date (US style, Europe style, Chinese style, …)
  - Window

Class diagram



Abstract Factory

- For creating families of related or dependent objects without specifying their concrete classes

- Examples
  - Date, currency, data
  - Window, mouse, scroll bar, …

Class diagram