Design Patterns as Language Constructs

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What is good code?

Washing Behind Your Ears: Principles of Software Hygiene

David M. Tilbrook: contributor of `QED` to unix, `vi` ancestor. And John McMullen

> *Like personal hygiene, **software hygiene** is most conspicuous in its absence.*

Often, quality considers only the development phase; the real picture is wider. The side of profession not usually highlighted in programming courses, is maintenance. It is widely **estimated that 70% of the cost of software is devoted to maintenance.** No discussion of software quality can be satisfactory if it neglects this aspect.

How can we?

1. know when it's high quality
2. actually make it high quality

What is good code?

criteria for judging *quality*

1. **Extendibility** ease the modification of existing source and the addition or removal of source
2. **Reusability** promote and facilitate the sharing (i.e., reusability) of software components
3. **Compatibility** integrate diverse components in large systems
4. **Portability** operate agnostic to the specific system
5. **Testability** verify correctness before changes reach the product

which all relate to **maintainability**

when the codebase gets large in a language like Java,

The problem with design patterns

The problem with design patterns

Design patterns have proven to be very useful,

~ for the design of object-oriented systems. The power of design patterns stems from their ability to provide generic solutions to reappearing problems that can be specialised for particular situations

but,

The problem with design patterns

1. The traceability of a design pattern in the implementation is often insufficient; often the design pattern is "lost".
2. Since several patterns require an object to forward messages to other objects to increase flexibility, the self problem often occurs.
3. The pattern implementation is mixed with the domain class, the reusability of pattern implementations is often limited.
4. Implementing design patterns can present significant implementation overhead for the software engineer.

The problem with design patterns

1. The traceability of a design pattern in the implementation is often insufficient; often the design pattern is "lost".

   hurts: maintainability, readability, testability

2. Since several patterns require an object to forward messages to other objects to increase flexibility, the self problem often occurs.

   hurts: predictability, reliability

3. The pattern implementation is mixed with the domain class, the reusability of pattern implementations is often limited.

   hurts: reusabiliity, maintainability

4. Implementing design patterns can present significant implementation overhead for the software engineer.

   hurts: productivity, maintainability

Can we make them more explicit?

Design patterns as language constructs

Jan Bosch

LayOM's (Layered Object Model) approach

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~~Class~~ → LayOM Object

(which transpiles into C++)

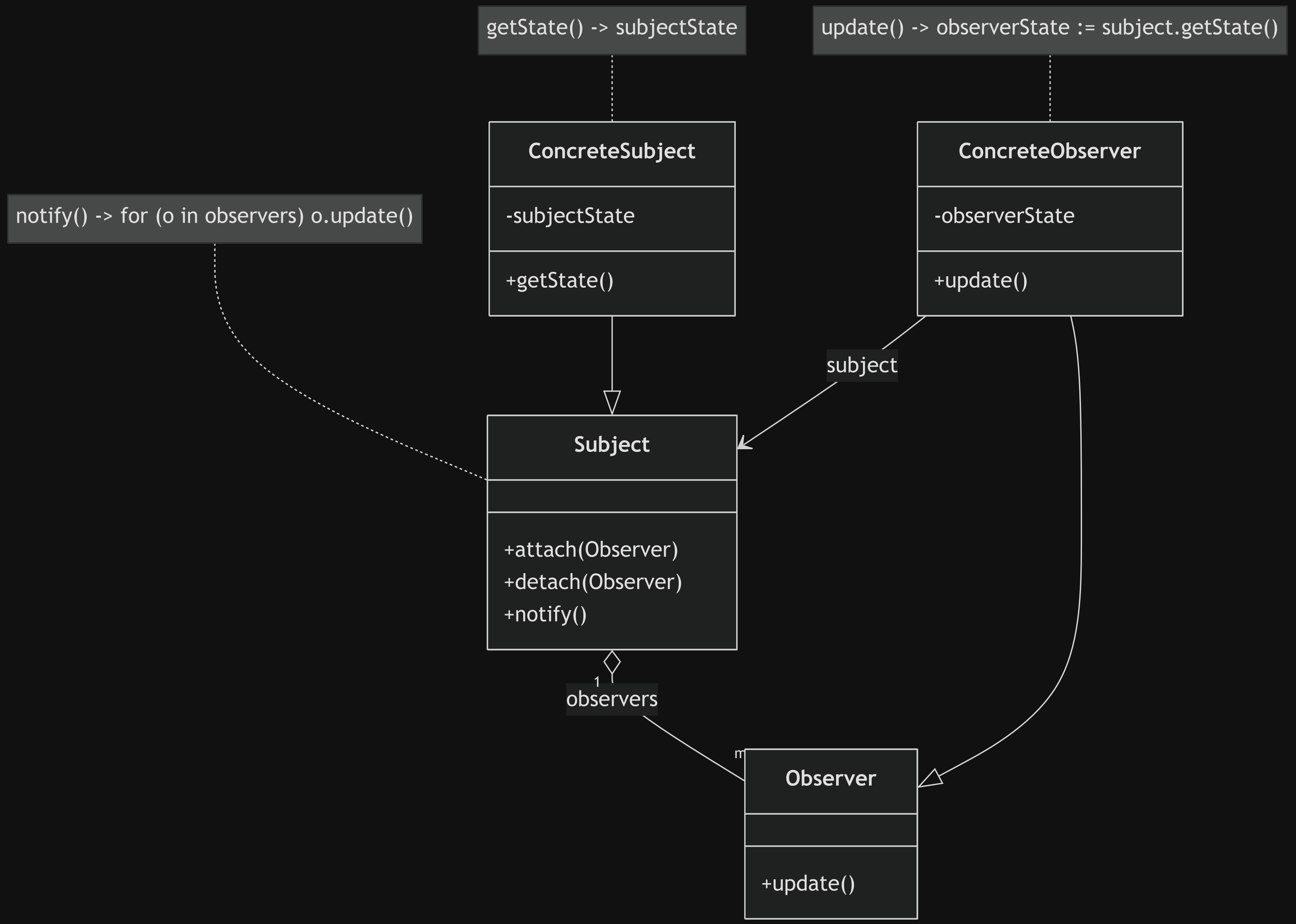
Components of a LayOM Object

in addition to traditional instance variables and methods:

- **States:** An abstraction of the object's internal, or "concrete," state. This allows for a simplified, externally visible representation of the object's state.
- **Categories:** An expression that defines a specific group of client objects. This allows the object to treat a subset of its possible clients in a particular way.
- **Layers:** These encapsulate the object, intercepting all incoming and outgoing messages. Layers are organized into classes, with each layer class representing a specific concept, such as a design pattern.

LayOM's (Layered Object Model) approach

Observer Pattern



metaprogramming the

Observer Pattern

new Layer:

```
<id> : Observer( notify [before|after] on <mess-sel>+ [on aspect <aspect>], ... );
```

Example:

```
class ObservablePoint
    layers // customer layer faciliates the observer pattern
        st : Observer(notify after on setX on aspect “X-axis”, notify after on setY
                   on aspect “Y-axis”, notify after on moveTo on aspect “Location”);
    ...

    methods
        setX(newX : Location) returns Location
            begin ... end;
        setY(newY : Location) returns Location
            begin ... end;
        moveTo(move : Location2D) returns Location2D
            begin ... end;
    ...
end; // class ObservablePoint
```

Observer Pattern

```
<id> : Observer( notify [before|after] on <mess-sel>+ [on aspect <aspect>], ... );
```

Why this works

...

LayOM's approach

1. Powerful.
   An **extensible** paradigm.

- <id> Adapter (accept <mess-sel>+ as <new-mess-sel>, ...);
- <id> Bridge(implement <mess-sel>+ as [<object>.]<method>,..);
- <id> Composite ([add is <mess-sel> and] ... multicast <mess-sel>+);
- <id> Facade (forward <mess-sel>+ to <object>, ...);
- <id> State(if <state-expr> forward <mess-sel>+ to [<mess-sel> <object>], ...);
- <id> Observer(notify [before|after] on <mess-sel>+ [on aspect <aspect>], ...);
- <id> Strategy(delegate [<mess-sel>+ to <class> [set by <mess-sel>]);
- <id> Mediator(forward <mess-sel>+ from <client> to <object>, ...);

(to show a few)

2. Compatible with existing C++
3. Relatively concise

we could stop here

But can we make it simpler?

Functional Programming

Stepping back, "can we make the *design* a part of the *language*?"
... perhaps the problem is OOP itself.

FP is concerned with "pure" code — no side-effects

In **Design by Contract (DbC)**

- preconditions
- postconditions
- invariants

Immutability — the ultimate invariant.
Functions are ironclad contracts.

In FP,

Patterns are not special techniques, they are the default, idiomatic way of writing code

Functional Programming

Patterns are not special techniques, they are the default, idiomatic way of writing code

Pattern or Principle	Functional Programming
Single Responsibility Principle	Functions
Open/Closed Principle	Functions
Dependency Inversion Principle	Functions, also
Interface Segregation Principle	Functions
Factory Pattern	Yes, functions
Strategy Pattern	Oh my, functions again!
Decorator Pattern	Functions
Visitor Pattern	Functions[]

Functional programming is well suited to the problem of representing design as language because all the challenges that OO design patterns address are related to state management

When systems have no state to protect, high quality design is easy

FP is not without weakness, but it does make some things much simpler

Patterns are not special techniques, they are the default, idiomatic way of writing code

Object Oriented

```
// The contract for the strategy
interface ICalculationStrategy {
    int execute(int a, int b);
}

// Concrete implementations
class AddStrategy implements ICalculationStrategy {
    public int execute(int a, int b) { return a + b; }
}

class SubtractStrategy implements ICalculationStrategy {
    public int execute(int a, int b) { return a - b; }
}

// The context that uses the strategy
class Calculator {
```

Functional

```
// The "context" is just a higher-order function
function calculator(strategy_function, a, b) {
    return strategy_function(a, b);
}

// The "strategies" are just functions
const add = (a, b) => a + b;
const subtract = (a, b) => a + b;

// Usage
let result1 = calculator(add, 5, 3); // 8
let result2 = calculator(subtract, 5, 3); // 2
```

// TODO: will improve this codeblock rendering in the next version of my slides

Thanks!

References

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5. Scott Wlaschin, Functional Programming Design Patterns, 2014
6. Meyer Bertrand, Design by Contract, 1986