

Design Patterns

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Patterns: background and use

Idea comes from architecture (Christopher Alexander): e.g.

Window Place: observe that people need comfortable places to sit, and like being near windows, so make a comfortable seating place at a window.

Similarly, there are many commonly arising technical problems in software design.

Pattern catalogues: for easy reference, and to let designers talk shorthand. Pattern *languages* are a bit more...

Patterns also used in: reengineering; project management; configuration management; etc.

Design Patterns

“Reuse of good ideas”

A pattern is a named, well understood good solution to a common problem in context.

Experienced designers recognise variants on recurring problems and understand how to solve them. Without patterns, novices have to find solutions from first principles.

Patterns help novices to learn by example to behave more like experts.

Elements of a pattern

A pattern catalogue entry normally includes roughly:

- ▶ Name (e.g. Publisher-Subscriber)
- ▶ Aliases (e.g. Observer, Dependants)
- ▶ Context (in what circumstances can the problem arise?)
- ▶ Problem (why won't a naive approach work?)
- ▶ Solution (normally a mixture of text and models)
- ▶ Consequences (good and bad things about what happens if you use the pattern.)

A very simple recurring problem

We often want to be able to model tree-like structures of objects: an object may be a thing without interesting structure – a leaf of the tree – or it may itself be composed of other objects which in turn might be leaves or might be composed of other objects...

We want other parts of the program to be able to interact with a single class, rather than having to understand about the structure of the tree.

Composite is a [design pattern](#) which describes a well-understood way of doing this.

Naive solution

Create a new class, say `Container`, which contains collection of `Graphics` elements.

Rewrite the clients so that instead of blindly sending a `draw()` message to a `Graphics` object, they

1. check whether they are dealing with a container;
2. if so, they get its collection of children and send the message to each child in turn.

Example situation

A graphics application has primitive graphic elements like lines, text strings, circles etc. A client of the application interacts with these objects in much the same way: for example, it might expect to be able to instruct such objects to draw themselves, move, change colour, etc. Probably there should be an interface or an abstract base class, say `Graphics`, which describes the common features of graphics elements, with subclasses `Text`, `Line`, etc.

Want to be able to group elements together to form pictures, which can then be treated as a whole: for example, users expect to be able to move a composite picture just as they move primitive elements.

Drawbacks of naive solution

Every client now has to be aware of the `Container` class and to do extra work to handle the fact that they might be dealing with a `Container`.

And can a `Container` contain other `Containers`? Not if we implement `Container` and `Graphics` as unrelated classes with the `Container` having a collection of `Graphics` objects.

Familiar (?) way to do this kind of task in Haskell

```
data graphicsElement =  
    Line  
  | Text  
  | Circle  
  | Picture [graphicsElement]  
  
draw Line = -- whatever  
draw Text = -- whatever  
draw Circle = -- whatever  
draw (Picture l) = (let x = map draw l in ())
```

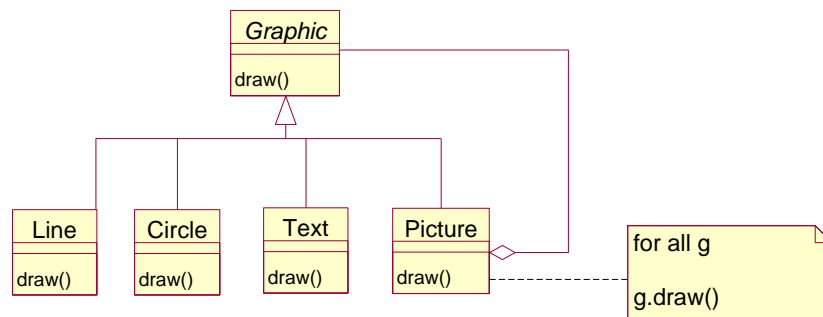
Drawbacks of the Haskell way

Clients must write recursive functions which pattern-match on the structure of the `graphicsElement` they have, *so all clients do in fact have to be aware of how elements of the datatype are built up.*

But this is just an example of how this mechanism does not support abstraction as well as we'd like: you can't (straightforwardly) wrap up the functions that should operate on a `graphicsElement` along with the datatype itself.

(Or can you? This example adapted from ML, and I don't speak Haskell...)

Composite pattern: best of both worlds



Benefits of Composite

- ▶ can automatically have trees of any depth: don't need to do anything special to let containers (`Pictures`) contain other containers
- ▶ clients can be kept simple: they only have to know about one class, and they don't have to recurse down the tree structure themselves
- ▶ it's easy to add new kinds of `Graphics` subclasses, including different kinds of pictures, because clients don't have to be altered

Drawbacks of Composite

- ▶ It's not easy to write clients which don't want to deal with composite pictures: the type system doesn't know the difference.
(A Picture is no more different from a Line than a Circle is, from the point of view of the type checker.)

(What could you do about this?)

MCQ (from 05/06 exam)

Which of the following best describes a *design pattern*?

1. a particular arrangement of associations between classes
2. a generic solution to a common problem
3. a variant of use cases
4. a type of design attracting specific legal protection

Cautions on pattern use

Patterns are very useful *if you have the problem they're trying to solve*.

But they add complexity, and often e.g. performance penalties too. Exercise discretion.

You'll find the criticism that the GoF patterns in particular are "just" getting round the deficiencies of OOPLs. This is true, but misses the point.

Exercise: write a pattern language for Haskell!

Patterns: Reading

Required: Wikipedia entries on Observer and Template Method (or equivalent: what I want you to do is to know and understand those patterns to the extent that you could use them, describe them in UML class and sequence diagrams, and explain what they achieve and how).

Suggested: Read more on design patterns, e.g. starting at Stevens or Somerville, Ch18.2 (in both cases!!), or http://en.wikipedia.org/wiki/Design_Patterns.