Design Patterns and Refactoring

CSE 403

Outline

- Design Patterns
- Refactoring
- Refactoring patterns

Resources

- CSE 503 Sp ’04 lecture, CSE 403 Sp ’05
- Gamma, Helm, Johnson, Vlissides (“Gang of four”): *Design Patterns: Elements of reusable object-oriented software*
- Shalloway and Trott: Design Patterns Explained
- Martin: Agile Software Development

Design Patterns

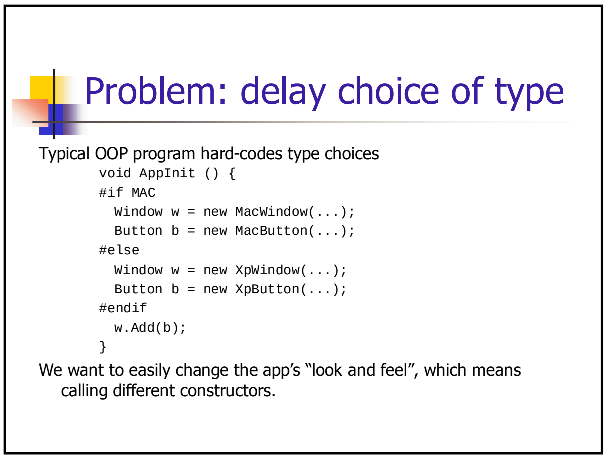
- Is design mostly *routine* or *innovative*?
- Design Patterns are a way of recording design knowledge
- Christopher Alexander first described patterns in architecture

What is a pattern

- Pattern name
- Problem
- Solution
- Consequences

Gang of Four patterns

			Purpose	
		creational	**structural**	**behavioral**
Scope	**class**	factory method	adapter (class)	interpreter template method
	object	abstract factory builder prototype singleton	adapter (object) bridge composite decorator facade flyweight proxy	chain of responsibility command iterator mediator memento observer state strategy visitor

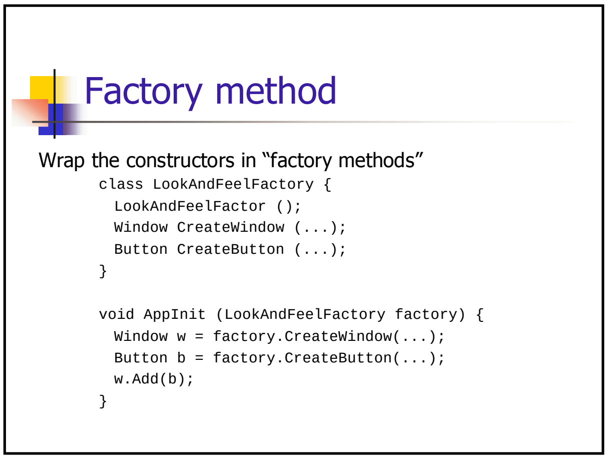


Problem: delay choice of type

Typical OOP program hard-codes type choices

```
void AppInit () {
#if MAC
  Window w = new MacWindow(...);
  Button b = new MacButton(...);
#else
  Window w = new XpWindow(...);
  Button b = new XpButton(...);
#endif
  w.Add(b);
}
```

We want to easily change the app's "look and feel", which means calling different constructors.

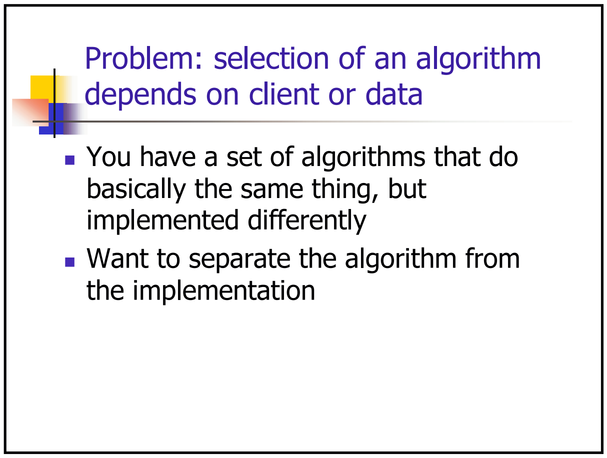


Factory method

Wrap the constructors in "factory methods"

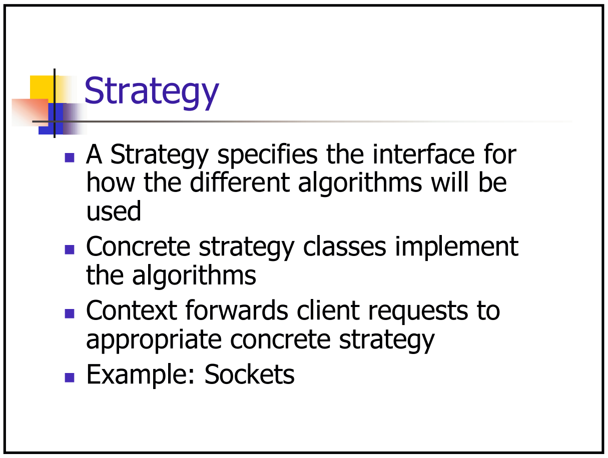
```
class LookAndFeelFactory {
  LookAndFeelFactor ();
  Window CreateWindow (...);
  Button CreateButton (...);
}

void AppInit (LookAndFeelFactory factory) {
  Window w = factory.CreateWindow(...);
  Button b = factory.CreateButton(...);
  w.Add(b);
}
```



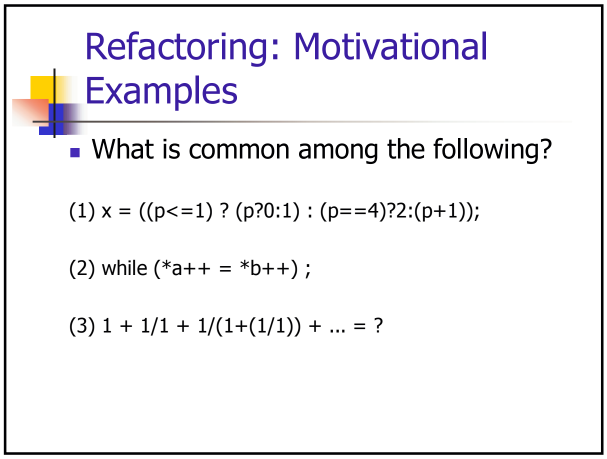
Problem: selection of an algorithm depends on client or data

- You have a set of algorithms that do basically the same thing, but implemented differently
- Want to separate the algorithm from the implementation



Strategy

- A Strategy specifies the interface for how the different algorithms will be used
- Concrete strategy classes implement the algorithms
- Context forwards client requests to appropriate concrete strategy
- Example: Sockets



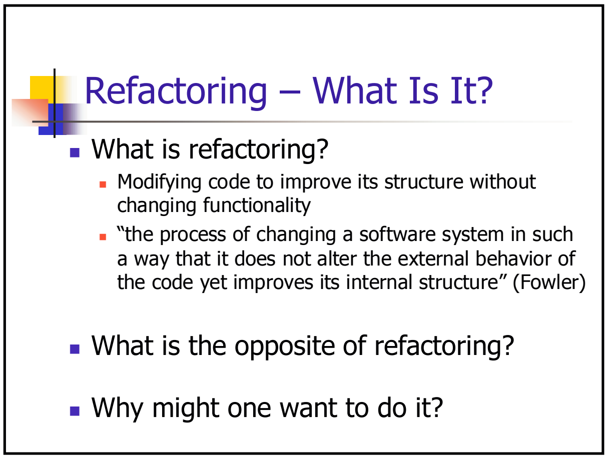
Refactoring: Motivational Examples

- What is common among the following?

(1) x = ((p<=1) ? (p?0:1) : (p==4)?2:(p+1));

(2) while (*a++ = *b++) ;

(3) 1 + 1/1 + 1/(1+(1/1)) + ... = ?



Refactoring – What Is It?

- What is refactoring?
  - Modifying code to improve its structure without changing functionality
  - "the process of changing a software system in such a way that it does not alter the external behavior of the code yet improves its internal structure" (Fowler)
- What is the opposite of refactoring?
- Why might one want to do it?

Refactoring – Why Do It?

- **Why is it necessary?**
  - A long-term investment in the quality of the code and its structure
    - Without proper maintenance, code tends to "rot" as its structure deteriorates when quick last-minute fixes are made and unplanned features are added
  - Doing no refactoring may save on costs in the short term but pays huge interest in the long run
    - "Don't be penny-wise but hour-foolish!"
- **Why fix it if it ain't broken? Every module has three functions:**
  - (a) to execute according to its purpose;
  - (b) to afford change;
  - (c) to communicate to its readers.

It it doesn't do one or more of these, it's broken.

Refactoring – When to Do It?

- **Refactoring is necessary from a business standpoint too**
  - Helps with predictable schedules and high output at lower cost
  - ROI for improved software practices is 500% (!) or better
  - By doing refactoring a team saves on unplanned defect-correction work
- **When is refactoring necessary?**
  - Best done continuously, along with coding and testing
  - Very hard to do late, much like testing
  - Often done before plunging into version 2

Types of Refactoring

- Renaming (methods, variables)
- Naming (extracting) "magic" constants
- Extracting common functionality into a service / module / class / method
- Extracting code into a method
- Changing method signatures
- Splitting one method into several to improve cohesion and readability (by reducing its size)
- Putting statements that semantically belong together near each other
- Exchanging risky language idioms with safer alternatives
- Clarifying a statement (that has evolved over time or that is hard to "decipher")
- Performance optimization
- http://www.refactoring.com/catalog/index.html

Refactoring patterns

- From http://industriallogic.com/xp/refactoring/catalog.html
- E.g., Chain Constructors, Extract Adapter, Introduce Null Object, Replace Conditional Logic with Strategy

Chain constructors

- Problem: You have constructors that contain duplicate code.
- Chain the constructors together to obtain the least duplicate code.

```
public class Loan {
  public Loan(float notional, float outstanding, int rating,
       Date expiry) {
     this(new TermROC(), notional, outstanding, rating,
       expiry, null);
   }
   public Loan(float notional, float outstanding, int rating,
       Date expiry, Date maturity) {
     this(new RevolvingTermROC(), notional, outstanding,
       rating, expiry, maturity);
   }
   public Loan(CapitalStrategy strategy, float notional,
       float outstanding, int rating, Date expiry, Date
       maturity) {
     ...
   }
}
```

Summary: Top Reasons for Refactoring

- Improving readability (and hence productivity)
- Responding to a change in the spec/design by improving cohesion
  - Or anticipating such a change
- *"If bug rates are to be reduced, each function needs to have one well-defined purpose, to have explicit single-purpose inputs and outputs, to be readable at the point where it is called, and ideally never return an error condition."* Steve Maguire -- "Writing Solid Code"

Language Support for Refactoring

- **Modern development environments (e.g., Eclipse) support:**
  - variable/method/class renaming
  - method or constant extraction
  - extraction of redundant code snippets
  - method signature change
  - extraction of an interface from a type
  - method inlining
  - providing warnings about method invocations with inconsistent parameters
  - help with self-documenting code through auto-completion
- **Older development environments (e.g., vi, Emacs, etc.) have little or no automated support**
  - Discourages programmers from refactoring their code