Object-Oriented Patterns & Frameworks

Assignment 4b Patterns

Dr. Douglas C. Schmidt

d.schmidt@vanderbilt.edu

www.dre.vanderbilt.edu/~schmidt

Professor of EECS
Vanderbilt University
Nashville, Tennessee

Managing Global Objects Effectively

Goals:

- Centralize access to objects that should be visible globally, e.g.:
  - command-line options that parameterize the behavior of the program
  - The object (Reactor) that drives the main event loop

Constraints/forces:

- Only need one instance of the command-line options & Reactor
- Global variables are problematic in C++

Verbose mode

```
% tree-traversal -v
format [in-order]
expr [expression]
print [in-order|pre-order|post-order|level-order]
eval [post-order]
quit
> format in-order
> expr 1+4*3/2
> eval post-order
7
> quit
```

Succinct mode

```
% tree-traversal
> 1+4*3/2
7
```

Solution: Centralize Access to Global Instances

Rather than using global variables, create a central access point to global instances, e.g.:

```
int main (int argc, char *argv[])
{
  // Parse the command-line options.
  if (!Options::instance ()->parse_args (argc, argv))
    return 0;

  // Dynamically allocate the appropriate event handler
  // based on the command-line options.
  Expression_Tree_Event_Handler *tree_event_handler =
    Expression_Tree_Event_Handler::make_handler
      (Options::instance ()->verbose ());

  // Register event handler with the reactor.
  Reactor::instance ()->register_input_handler
    (tree_event_handler);
  // ...
```

Singleton — object creational

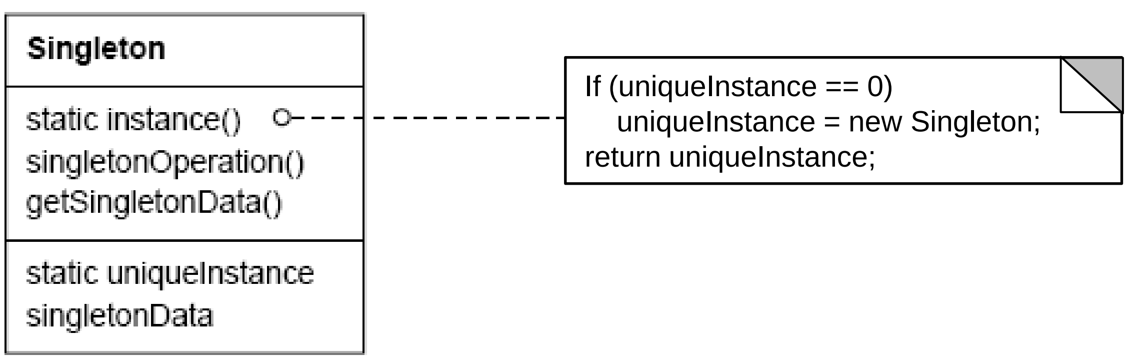
Intent

ensure a class only ever has one instance & provide a global point of access

Applicability

- when there must be exactly one instance of a class, & it must be accessible from a well-known access point
- when the sole instance should be extensible by subclassing, & clients should be able to use an extended instance without modifying their code

Structure



Singleton object creational

Consequences

+ reduces namespace pollution
+ makes it easy to change your mind & allow more than one instance
+ allow extension by subclassing

– same drawbacks of a global if misused
– implementation may be less efficient than a global
– concurrency pitfalls strategy creation & communication overhead

Implementation

– static instance operation
– registering the singleton instance
– deleting singletons

Known Uses

– Unidraw's Unidraw object
– Smalltalk-80 ChangeSet, the set of changes to code
– InterViews Session object

See Also

– Double-Checked Locking Optimization pattern from POSA2
– “To Kill a Singleton” www.research.ibm.com/designpatterns/pubs/ph-jun96.txt

Strategy   object behavioral

Consequences

+ greater flexibility, reuse
+ can change algorithms dynamically
– strategy creation & communication overhead
– inflexible Strategy interface
– semantic incompatibility of multiple strategies used together

Implementation

– exchanging information between a Strategy & its context
– static strategy selection via parameterized types

Known Uses

– InterViews text formatting
– RTL register allocation & scheduling strategies
– ET++SwapsManager calculation engines
– The ACE ORB (TAO) Real-time CORBA middleware

See Also

– Bridge pattern (object structural)

Strategy object behavioral

Intent

define a family of algorithms, encapsulate each one, & make them interchangeable to let clients & algorithms vary independently

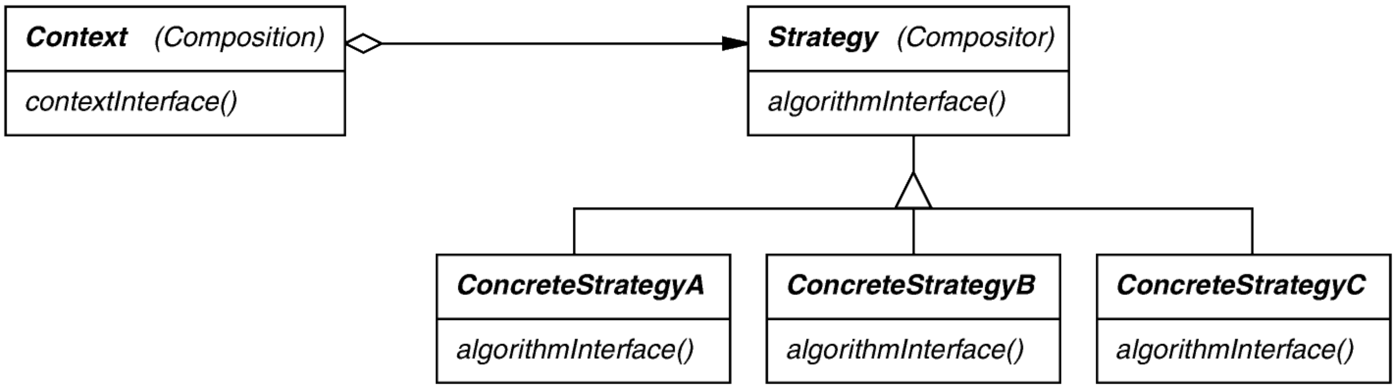
Applicability

– when an object should be configurable with one of many algorithms,

– *and* all algorithms can be encapsulated,

– *and* one interface covers all encapsulations

Structure



Factory Method class creational

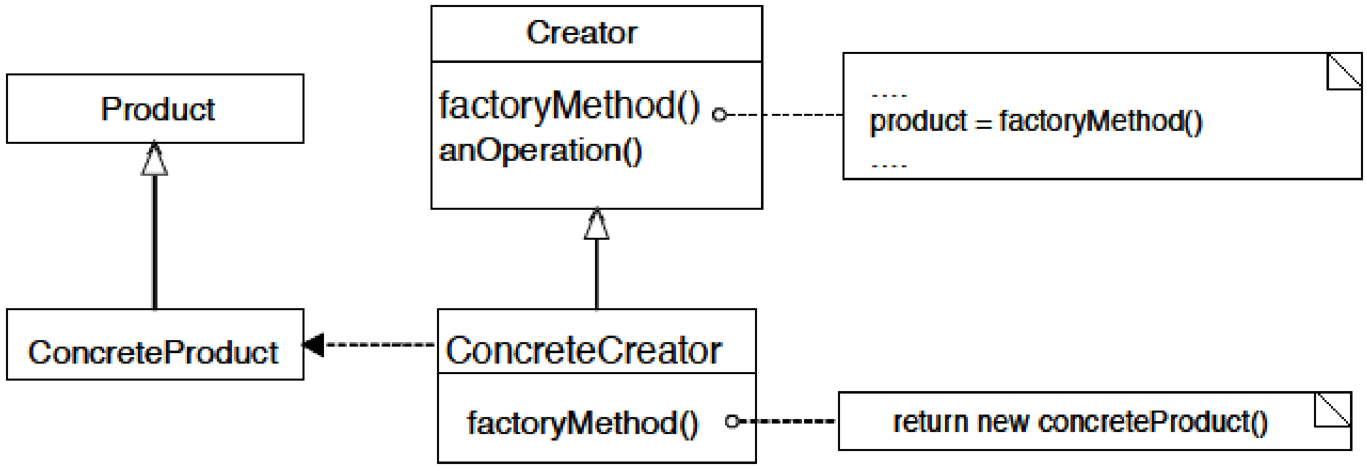
Intent

Provide an interface for creating an object, but leave choice of object's concrete type to a subclass

Applicability

when a class cannot anticipate the objects it must create or a class wants its subclasses to specify the objects it creates

Structure



Factory Method class creational

Consequences

+By avoiding to specify the class name of the concrete class &the details of its creation the client code has become more flexible

+The client is only dependent on the interface

- Construction of objects requires one additional class in some cases

Implementation

- There are two choices here
  - The creator class is abstract & does not implement creation methods (then it *must be subclassed)*
  - The creator class is concrete & provides a default implementation (then it *can be subclassed)*
- Should a factory method be able to create different variants? If so the method must be equipped with a parameter

Known Uses

- InterViews Kits
- ET++ WindowSystem
- AWT Toolkit
- The ACE ORB (TAO)
- BREW
- UNIX open() syscall

Abstract Factory object creational

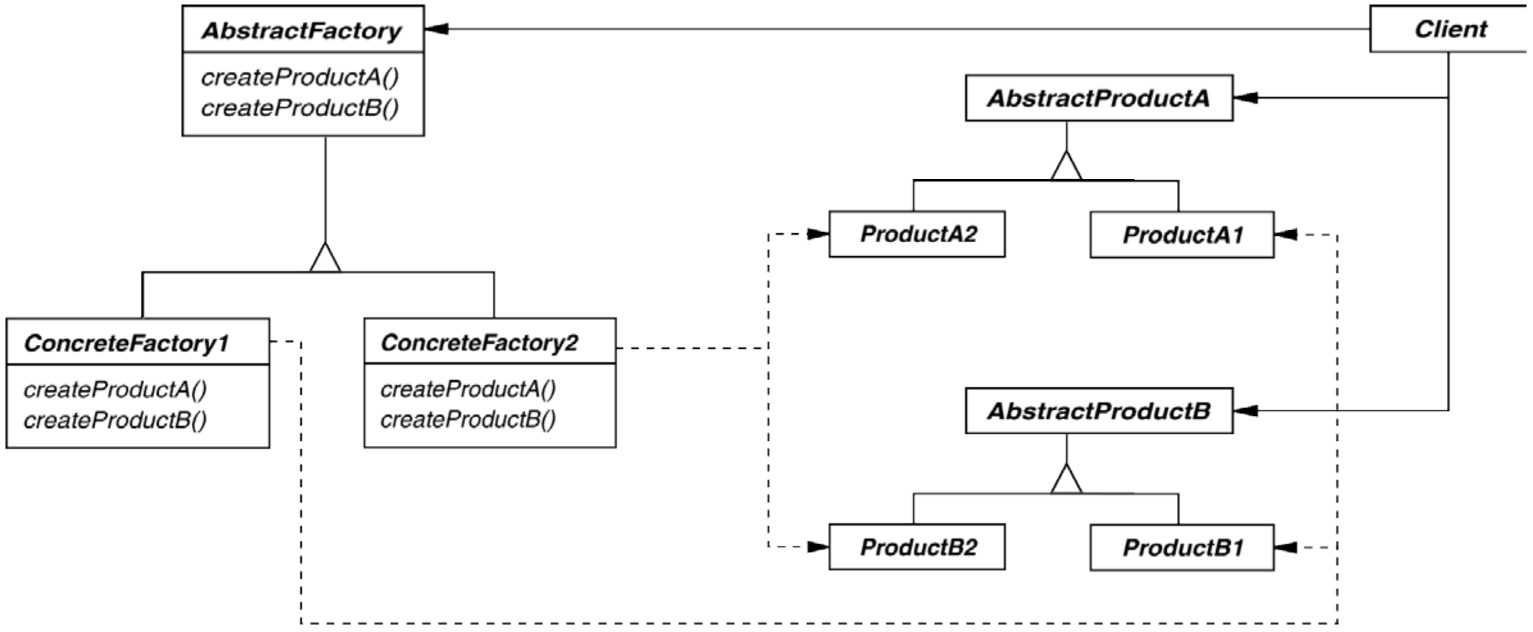
Intent

create families of related objects without specifying subclass names

Applicability

when clients cannot anticipate groups of classes to instantiate

Structure



Abstract Factory object creational

Consequences

+ flexibility: removes type (i.e., subclass) dependencies from clients
+ abstraction & semantic checking: hides product's composition
– hard to extend factory interface to create new products

Known Uses

– InterViews Kits
– ET++ WindowSystem
– AWT Toolkit
– The ACE ORB (TAO)

Implementation

– parameterization as a way of controlling interface size
– configuration with Prototypes, i.e., determines who creates the factories
– abstract factories are essentially groups of factory methods

Bridge object structural

Intent

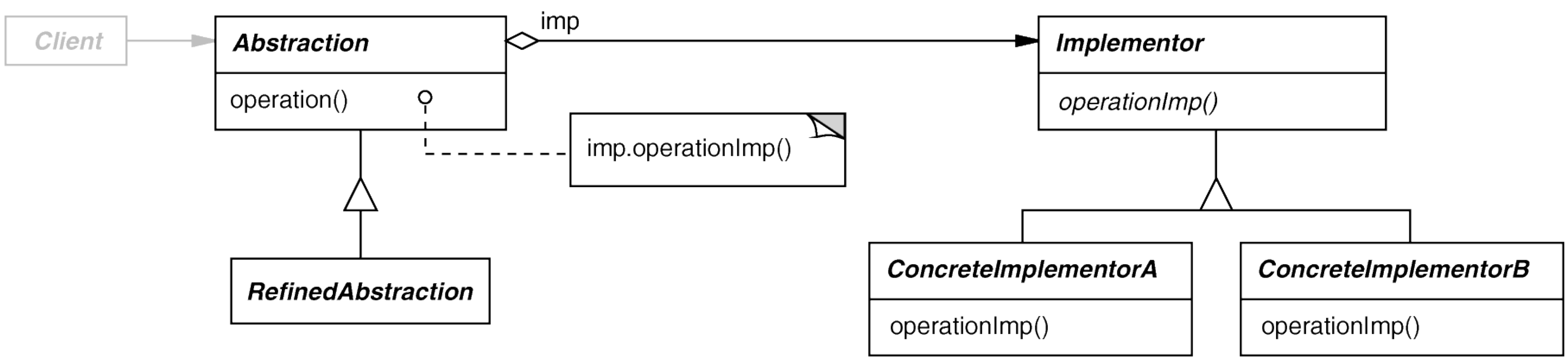
Separate a (logical) abstraction interface from its (physical) implementation(s)

Applicability

– When interface & implementation should vary independently

– Require a uniform interface to interchangeable class hierarchies

Structure



Bridge object structural

Consequences

+ abstraction interface & implementation are independent
+ implementations can vary dynamically
+ Can be used transparently with STL algorithms & containers

– one-size-fits-all Abstraction & Implementor interfaces

Implementation

– sharing Implementors & reference counting
  – See reusable `Refcounter` template class (based on STL/boost `shared_pointer`)

– creating the right Implementor (often use factories)

Known Uses

– ET++ Window/WindowPort

– libg++ Set/{LinkedList, HashTable}

– AWT Component/ComponentPeer