Design Patterns

UNIT-3

By

G. Fayaz Hussain
Assistant Professor
Department of CSE

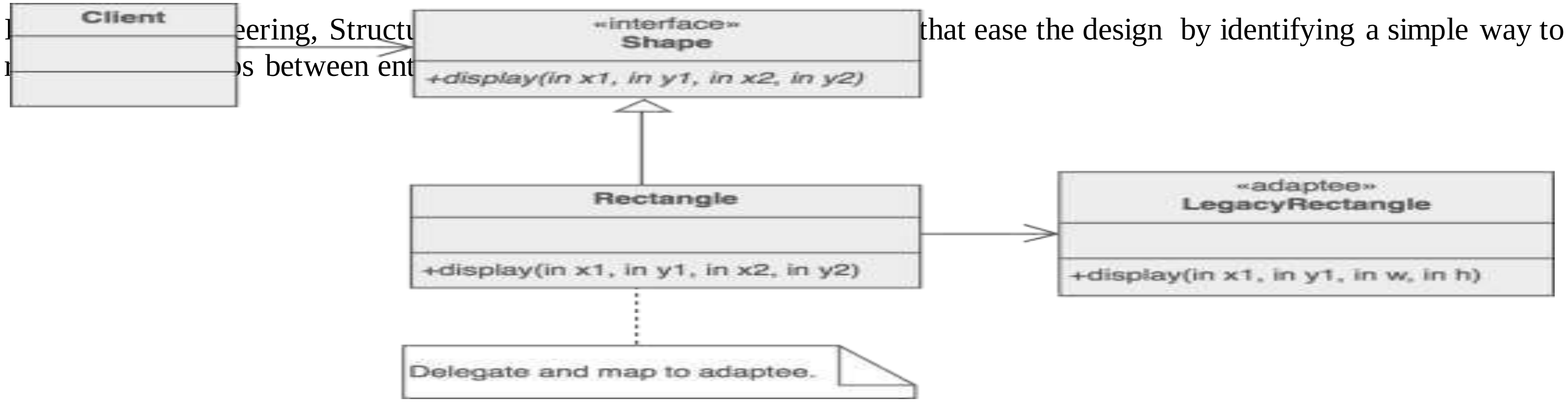
Ravindra College of Engineering for Women
Kurnool – 518452, Andhra Pradesh, India

UNIT-III

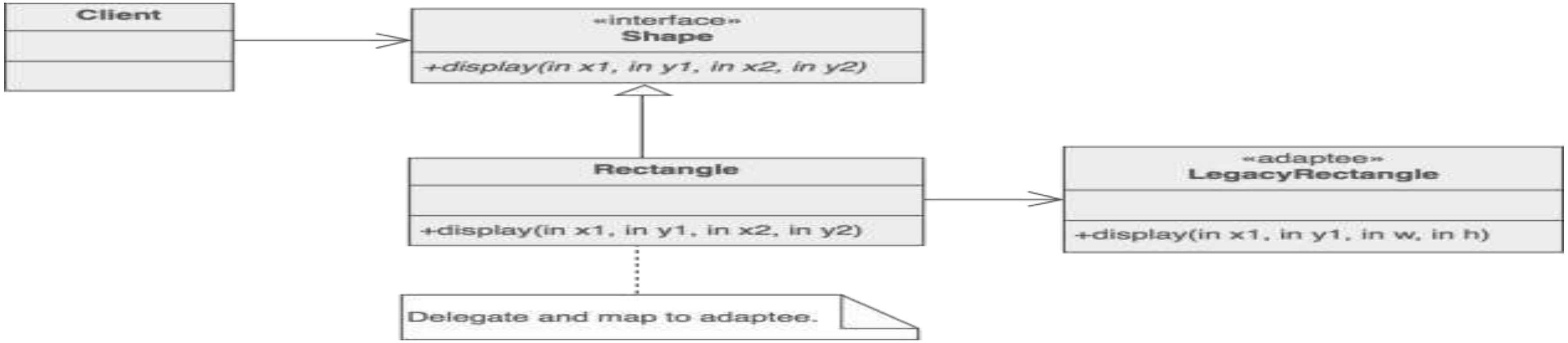
Structural Pattern Part-I

Structural patterns

I eering, Structu that ease the design by identifying a simple way to r s between ent



- Adapter
  Match interfaces of different classes
- Bridge
  Separates an object's interface from its implementation
- Composite
  A tree structure of simple and composite objects
- Decorator
  Add responsibilities to objects dynamically
- Facade
  A single class that represents an entire subsystem
- Flyweight
  A fine-grained instance used for efficient sharing



Private Class Data
Restricts accessor/mutator access

Proxy
An object representing another object

Rules of thumb

1. Adapter makes things work after they're designed; Bridge makes them work before they are.
2. Bridge is designed up-front to let the abstraction and the implementation vary independently. Adapter is retrofitted to make unrelated classes work together.
3. Adapter provides a different interface to its subject. Proxy provides the same interface. Decorator provides an enhanced interface.
4. Adapter changes an object's interface, Decorator enhances an object's responsibilities. Decorator is thus more transparent to the client. As a consequence, Decorator supports recursive composition, which isn't possible with pure Adapters.
5. Composite and Decorator have similar structure diagrams, reflecting the fact that both rely on recursive composition to organize an open-ended number of objects.
6. Composite can be traversed with Iterator. Visitor can apply an operation over a Composite. Composite could use Chain of responsibility to let components access global properties through their parent. It could also use Decorator to override these properties on parts of the composition. It could use Observer to tie one object structure to another and State to let a component change its behavior as its state changes.
7. Composite can let you compose a Mediator out of smaller pieces through recursive composition.
8. Decorator lets you change the skin of an object. Strategy lets you change the guts.

9. Decorator is designed to let you add responsibilities to objects without subclassing. Composite's focus is not on embellishment but on representation. These intents are distinct but complementary. Consequently, Composite and Decorator are often used in concert.
10. Decorator and Proxy have different purposes but similar structures. Both describe how to provide a level of indirection to another object, and the implementations keep a reference to the object to which they forward requests.
11. Facade defines a new interface, whereas Adapter reuses an old interface. Remember that Adapter makes two existing interfaces work together as opposed to defining an entirely new one.
12. Facade objects are often Singleton because only one Facade object is required.
13. Mediator is similar to Facade in that it abstracts functionality of existing classes. Mediator abstracts/centralizes arbitrary communication between colleague objects, it routinely "adds value", and it is known/referenced by the colleague objects. In contrast, Facade defines a simpler interface to a subsystem, it doesn't add new functionality, and it is not known by the subsystem classes.
14. Abstract Factory can be used as an alternative to Facade to hide platform-specific classes.
15. Whereas Flyweight shows how to make lots of little objects, Facade shows how to make a single object represent an entire subsystem.
16. Flyweight is often combined with Composite to implement shared leaf nodes.
17. Flyweight explains when and how State objects can be shared.

Adapter Design Patterns

Intent

- Convert the interface of a class into another interface clients expect. Adapter lets classes work together that couldn't otherwise because of incompatible interfaces.
- Wrap an existing class with a new interface.
- Impedance match an old component to a new system

Problem

An "off the shelf" component offers compelling functionality that you would like to reuse, but its "view of the world" is not compatible with the philosophy and architecture of the system currently being developed.

Discussion

Reuse has always been painful and elusive. One reason has been the tribulation of designing something new, while reusing something old. There is always something not quite right between the old and the new. It may be physical dimensions or misalignment. It may be timing or synchronization. It may be unfortunate assumptions or competing standards.

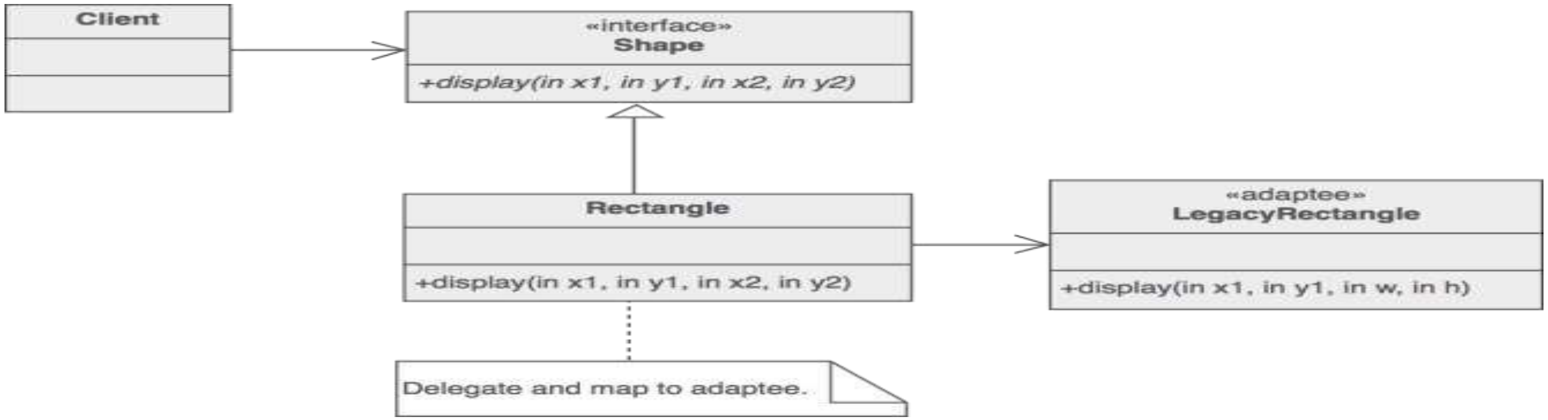
It is like the problem of inserting a new three-prong electrical plug in an old two-prong wall outlet – some kind of adapter or intermediary is necessary.

Adapter is about creating an intermediary abstraction that translates, or maps, the old component to the new system. Clients call methods on the Adapter object which redirects them into calls to the legacy component. This strategy can be implemented either with inheritance or with aggregation.

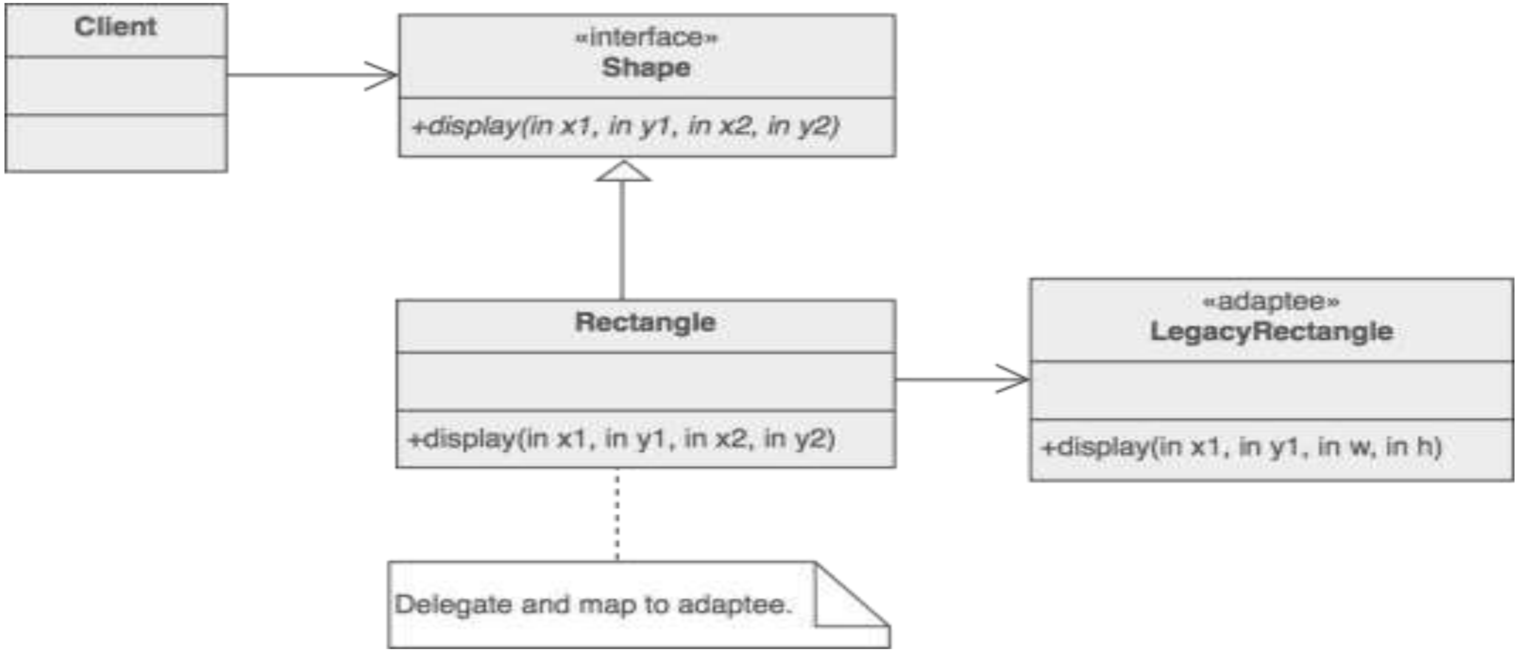
Adapter functions as a wrapper or modifier of an existing class. It provides a different or translated view of that class.

Structure

Below, a legacy Rectangle component's display() method expects to receive "x, y, w, h" parameters. But the client wants to pass "upper left x and y" and "lower right x and y". This incongruity can be reconciled by adding an additional level of indirection – i.e. an Adapter object.

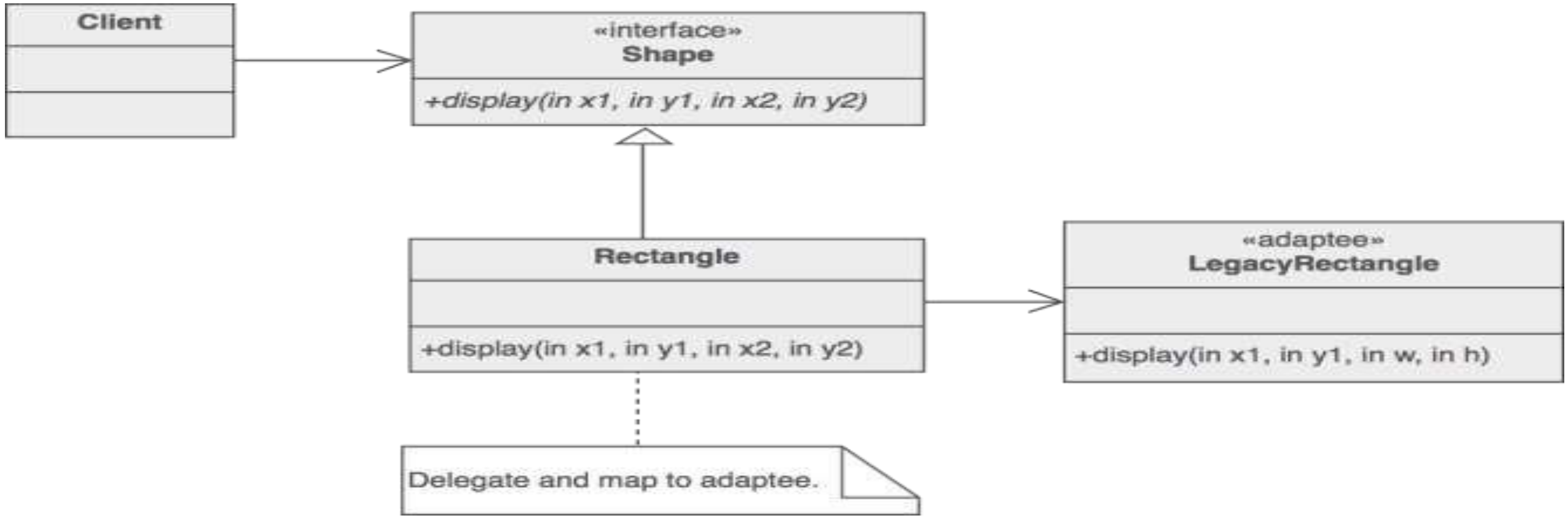


The Adapter could also be thought of as a "wrapper".



Example

The Adapter pattern allows otherwise incompatible classes to work together by converting the interface of one class into an interface expected by the clients. Socket wrenches provide an example of the Adapter. A socket attaches to a ratchet, provided that the size of the drive is the same. Typical drive sizes in the United States are 1/2" and 1/4". Obviously, a 1/2" drive ratchet will not fit into a 1/4" drive socket unless an adapter is used. A 1/2" to 1/4" adapter has a 1/2" female connection to fit on the 1/2" drive ratchet, and a 1/4" male connection to fit in the 1/4" drive socket.



Check list

1. Identify the players: the component(s) that want to be accommodated (i.e. the client), and the component that needs to adapt (i.e. the adaptee).
2. Identify the interface that the client requires.
3. Design a "wrapper" class that can "impedance match" the adaptee to the client.
4. The adapter/wrapper class "has a" instance of the adaptee class.
5. The adapter/wrapper class "maps" the client interface to the adaptee interface.
6. The client uses (is coupled to) the new interface

Rules of thumb

- Adapter makes things work after they're designed; Bridge makes them work before they are.
- Bridge is designed up-front to let the abstraction and the implementation vary independently. Adapter is retrofitted to make unrelated classes work together.
- Adapter provides a different interface to its subject. Proxy provides the same interface. Decorator provides an enhanced interface.
- Adapter is meant to change the interface of an existing object. Decorator enhances another object without changing its interface. Decorator is thus more transparent to the application than an adapter is. As a consequence, Decorator supports recursive composition, which isn't possible with pure Adapters.
- Facade defines a new interface, whereas Adapter reuses an old interface. Remember that Adapter makes two existing interfaces work together as opposed to defining an entirely new one.

Bridge Design Pattern

Intent

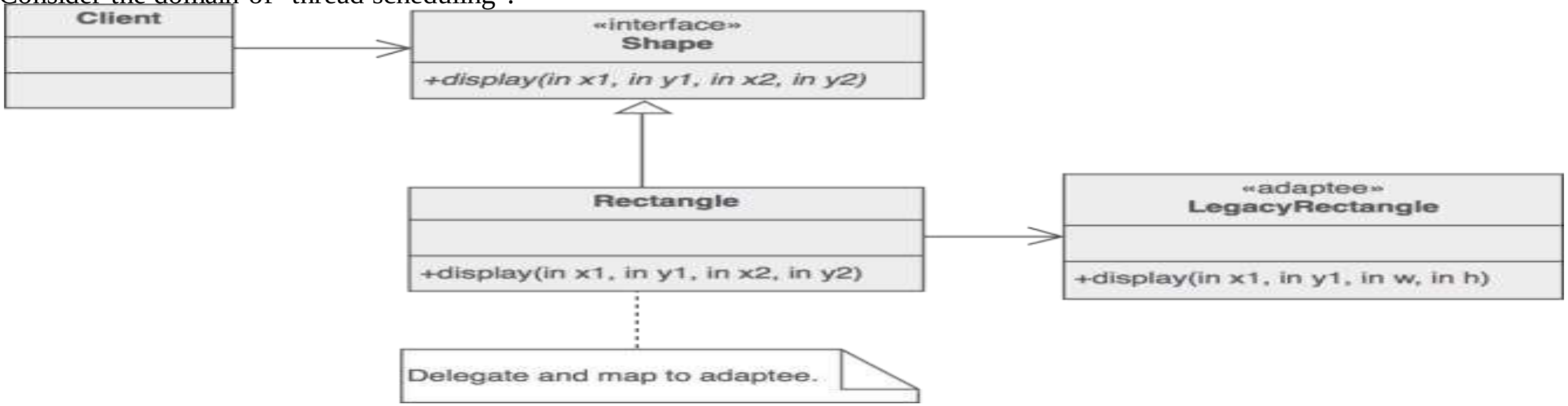
- Decouple an abstraction from its implementation so that the two can vary independently.
- Publish interface in an inheritance hierarchy, and bury implementation in its own inheritance hierarchy.
- Beyond encapsulation, to insulation

Problem

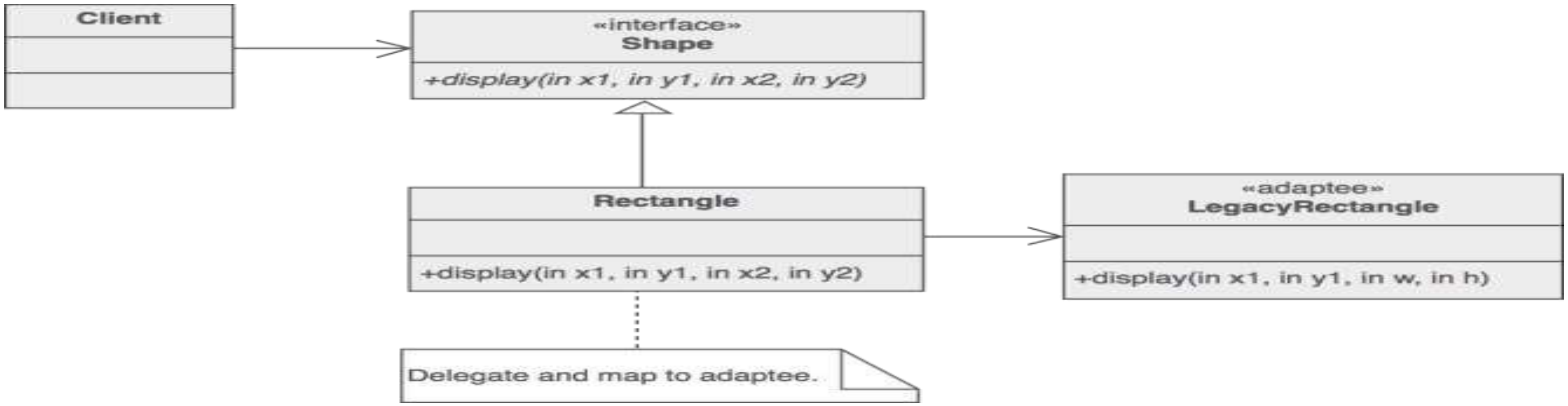
"Hardening of the software arteries" has occurred by using subclassing of an abstract base class to provide alternative implementations. This locks in compile-time binding between interface and implementation. The abstraction and implementation cannot be independently extended or composed.

Motivation

Consider the domain of "thread scheduling".

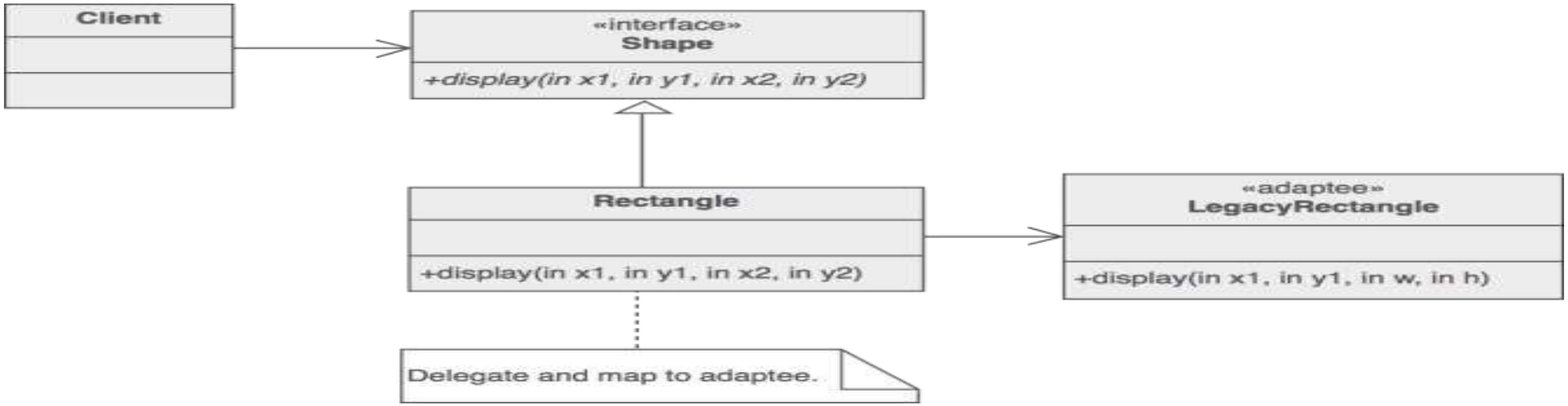


There are two types of thread schedulers, and two types of operating systems or "platforms". Given this approach to specialization, we have to define a class for each permutation of these two dimensions. If we add a new platform (say ... Java's Virtual Machine), what would our hierarchy look like?



What if we had three kinds of thread schedulers, and four kinds of platforms? What if we had five kinds of thread schedulers, and ten kinds of platforms? The number of classes we would have to define is the product of the number of scheduling schemes and the number of platforms.

The Bridge design pattern proposes refactoring this exponentially explosive inheritance hierarchy into two orthogonal hierarchies – one for platform-independent abstractions, and the other for platform-dependent implementations.



Discussion

Decompose the component's interface and implementation into orthogonal class hierarchies. The interface class contains a pointer to the abstract implementation class. This pointer is initialized with an instance of a concrete implementation class, but all subsequent interaction from the interface class to the implementation class is limited to the abstraction maintained in the implementation base class. The client interacts with the interface class, and it in turn "delegates" all requests to the implementation class.

The interface object is the "handle" known and used by the client; while the implementation object, or "body", is safely encapsulated to ensure that it may continue to evolve, or be entirely replaced (or shared at run-time.

Use the Bridge pattern when:

- you want run-time binding of the implementation,
- you have a proliferation of classes resulting from a coupled interface and numerous implementations,
- you want to share an implementation among multiple objects,
- you need to map orthogonal class hierarchies. Consequences include:

- decoupling the object's interface,
- improved extensibility (you can extend (i.e. subclass) the abstraction and implementation hierarchies independently),

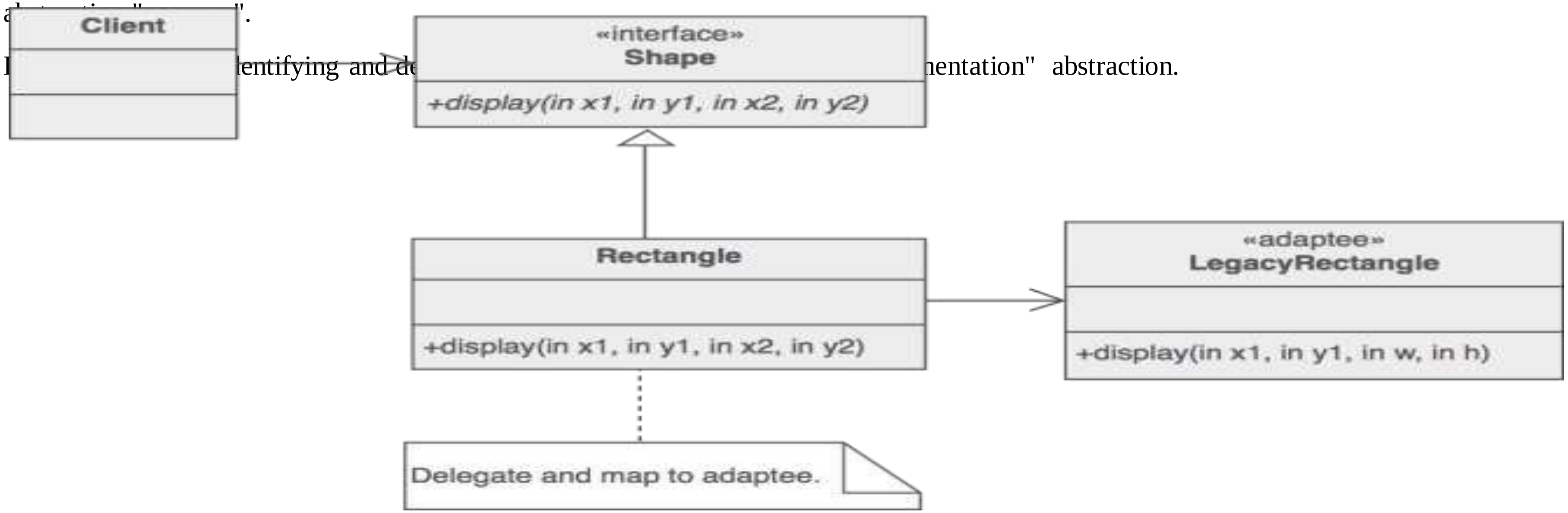
- hiding details from clients.

Bridge is a synonym for the "handle/body" idiom. This is a design mechanism that encapsulates an implementation class inside of an interface class. The former is the body, and the latter is the handle. The handle is viewed by the user as the actual class, but the work is done in the body. "The handle/body class idiom may be used to decompose a complex abstraction into smaller, more manageable classes. The idiom may reflect the sharing of a single resource by multiple classes that control access to it (e.g. reference counting)."

Structure

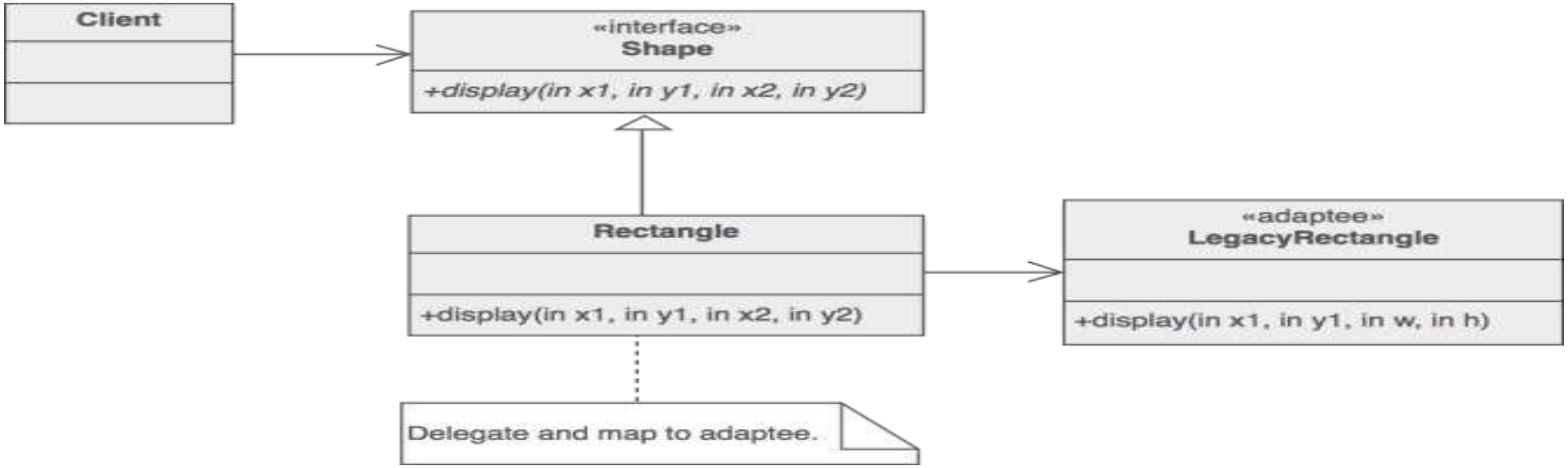
The Client doesn‘t want to deal with platform-dependent details. The Bridge pattern encapsulates this complexity behind an a[illegible]".

I[illegible]entifying and de[illegible]nentation" abstraction.



Example

The Bridge pattern decouples an abstraction from its implementation, so that the two can vary independently. A household switch controlling lights, ceiling fans, etc. is an example of the Bridge. The purpose of the switch is to turn a device on or off. The actual switch can be implemented as a pull chain, simple two position switch, or a variety of dimmer switches.



Check list

1. Decide if two orthogonal dimensions exist in the domain. These independent concepts could be: abstraction/platform, or domain/infrastructure, or front-end/back-end, or interface/implementation.
2. Design the separation of concerns: what does the client want, and what do the platforms provide.
3. Design a platform-oriented interface that is minimal, necessary, and sufficient. Its goal is to decouple the abstraction from the platform.
4. Define a derived class of that interface for each platform.
5. Create the abstraction base class that "has a" platform object and delegates the platform-oriented functionality to it.
6. Define specializations of the abstraction class if desired.

Rules of thumb

- Adapter makes things work after they're designed; Bridge makes them work before they are.
- Bridge is designed up-front to let the abstraction and the implementation vary independently. Adapter is retrofitted to make unrelated classes work together.
- State, Strategy, Bridge (and to some degree Adapter) have similar solution structures. They all share elements of the "handle/body" idiom. They differ in intent - that is, they solve different problems.

- The structure of State and Bridge are identical (except that Bridge admits hierarchies of envelope classes, whereas State allows only one). The two patterns use the same structure to solve different problems: State allows an object's behavior to change along with its state, while Bridge's intent is to decouple an abstraction from its implementation so that the two can vary independently.
- If interface classes delegate the creation of their implementation classes (instead of creating/coupling themselves directly), then the design usually uses the Abstract Factory pattern to create the implementation objects.

Composite Design Pattern

Intent

- Compose objects into tree structures to represent whole-part hierarchies. Composite lets clients treat individual objects and compositions of objects uniformly.
- Recursive composition
- "Directories contain entries, each of which could be a directory." 1-to-many "has a" up the "is a" hierarchy

Problem

Application needs to manipulate a hierarchical collection of "primitive" and "composite" objects. Processing of a primitive object is handled one way, and processing of a composite object is handled differently. Having to query the "type" of each object before attempting to process it is not desirable.

Discussion

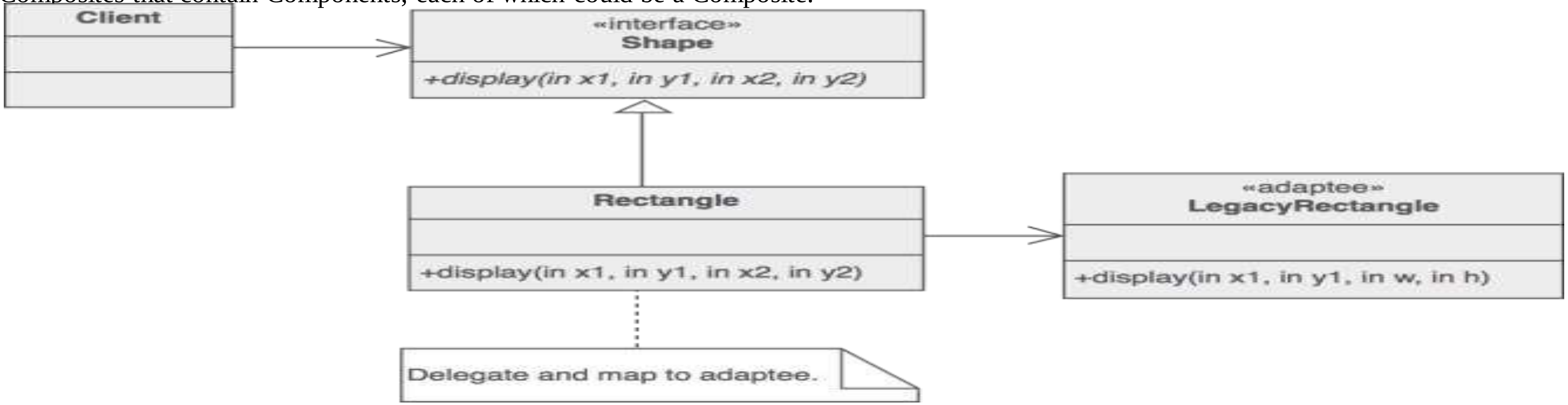
Define an abstract base class (Component) that specifies the behavior that needs to be exercised uniformly across all primitive and composite objects. Subclass the Primitive and Composite classes off of the Component class. Each Composite object "couples" itself only to the abstract type Component as it manages its "children".

Use this pattern whenever you have "composites that contain components, each of which could be a composite".

Child management methods [e.g. addChild(), removeChild()] should normally be defined in the Composite class. Unfortunately, the desire to treat Primitives and Composites uniformly requires that these methods be moved to the abstract Component class. See the "Opinions" section below for a discussion of "safety" versus "transparency" issues.

Structure

Composites that contain Components, each of which could be a Composite.



Menus that contain menu items, each of which could be a menu.

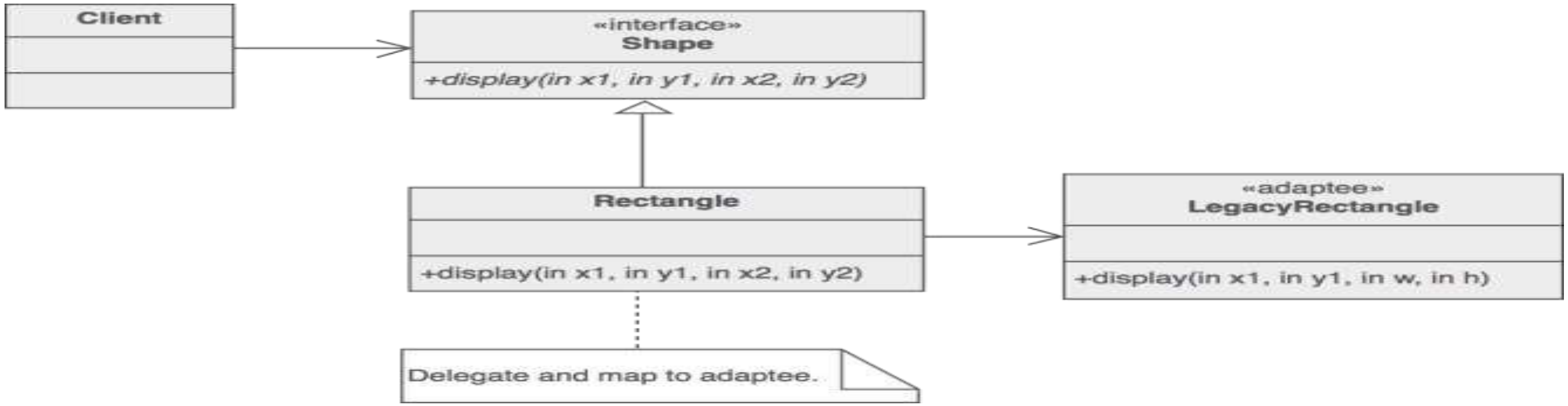
Row-column GUI layout managers that contain widgets, each of which could be a row- column GUI layout manager.

Directories that contain files, each of which could be a directory. Containers that contain Elements, each of which could be a

Container.

Example

The Composite composes objects into tree structures and lets clients treat individual objects and compositions uniformly. Although the example is abstract, arithmetic expressions are Composites. An arithmetic expression consists of an operand, an operator (+ - * /), and another operand. The operand can be a number, or another arithmetic expresssion. Thus, 2 + 3 and (2 + 3) + (4 * 6) are both valid expressions.



Check list

1. Ensure that your problem is about representing "whole-part" hierarchical relationships.
2. Consider the heuristic, "Containers that contain containees, each of which could be a container." For example, "Assemblies that contain components, each of which could be an assembly." Divide your domain concepts into container classes, and containee classes.
3. Create a "lowest common denominator" interface that makes your containers and containees interchangeable. It should specify the behavior that needs to be exercised uniformly across all containee and container objects.
4. All container and containee classes declare an "is a" relationship to the interface.
5. All container classes declare a one-to-many "has a" relationship to the interface.
6. Container classes leverage polymorphism to delegate to their containee objects.
7. Child management methods [e.g. addChild(), removeChild()] should normally be defined in the Composite class. Unfortunately, the desire to treat Leaf and Composite objects uniformly may require that these methods be promoted to the abstract Component class. See the Gang of Four for a discussion of these "safety" versus "transparency" trade-offs.

Rules of thumb

- Composite and Decorator have similar structure diagrams, reflecting the fact that both rely on recursive composition to organize an open-ended number of objects.
- Composite can be traversed with Iterator. Visitor can apply an operation over a Composite. Composite could use Chain of Responsibility to let components access global properties through their parent. It could also use Decorator to override these

properties on parts of the composition. It could use Observer to tie one object structure to another and State to let a component change its behavior as its state changes.

- Composite can let you compose a Mediator out of smaller pieces through recursive composition.
- Decorator is designed to let you add responsibilities to objects without subclassing. Composite's focus is not on embellishment but on representation. These intents are distinct but complementary. Consequently, Composite and Decorator are often used in concert.
- Flyweight is often combined with Composite to implement shared leaf nodes.

Opinions

The whole point of the Composite pattern is that the Composite can be treated atomically, just like a leaf. If you want to provide an Iterator protocol, fine, but I think that is outside the pattern itself. At the heart of this pattern is the ability for a client to perform operations on an object without needing to know that there are many objects inside.

Being able to treat a heterogeneous collection of objects atomically (or transparently) requires that the "child management" interface be defined at the root of the Composite class hierarchy (the abstract Component class). However, this choice costs you safety, because clients may try to do meaningless things like add and remove objects from leaf objects. On the other hand, if you "design for safety", the child management interface is declared in the Composite class, and you lose transparency because leaves and Composites now have different interfaces.

Smalltalk implementations of the Composite pattern usually do not have the interface for managing the components in the Component interface, but in the Composite interface. C++ implementations tend to put it in the Component interface. This is an extremely interesting fact, and one that I often ponder. I can offer theories to explain it, but nobody knows for sure why it is true.

My Component classes do not know that Compo[illegible]ovide no help for navigating Composites, nor any help for [illegible] of a Composite. This is because I would like the base class (and all its derivatives) to be reusable in contexts that do not require Composites. When given a base class pointer, if I absolutely need to know whether or not it is a Composite, I will use dynamic_cast to figure this out. In those cases where dynamic_cast is too expensive, I will use a Visitor.

Common complaint: "If I push the Composite interface down into the Composite class, how am I going to enumerate (i.e. traverse) a complex structure?" My answer is that when I have behaviors which apply to hierarchies like the one presented in the Composite pattern, I typically use Visitor, so enumeration isn't a problem - the Visitor knows in each case, exactly what kind of object it's dealing with. The Visitor doesn't need every object to provide an enumeration interface.

Composite doesn't force you to treat all Components as Composites. It merely tells you to put all operations that you want to treat "uniformly" in the Component class. If add, remove, and similar operations cannot, or must not, be treated uniformly, then do not put them in the Component base class. Remember, by the way, that each pattern's structure diagram doesn't define the pattern; it merely depicts what in our experience is a common realization thereof.

Structural Pattern Part-II

Decorator Design Pattern

Intent

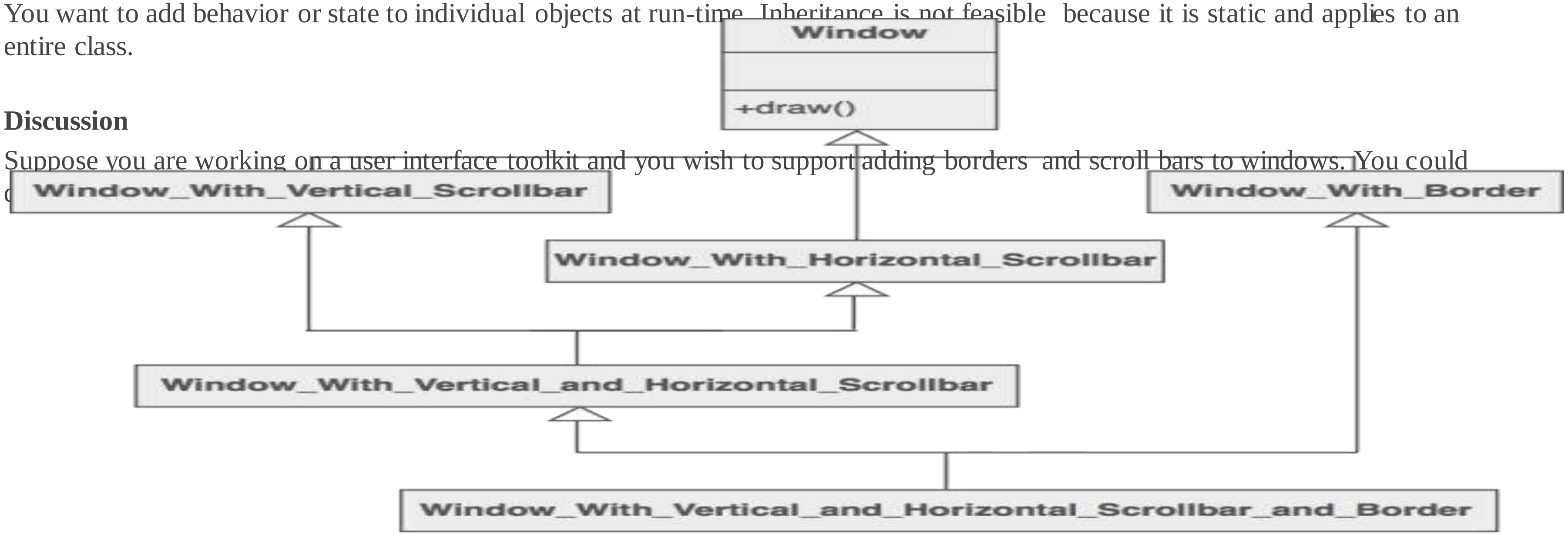
- Attach additional responsibilities to an object dynamically. Decorators provide a flexible alternative to subclassing for extending functionality.
- Client-specified embellishment of a core object by recursively wrapping it.
- Wrapping a gift, putting it in a box, and wrapping the box.

Problem

You want to add behavior or state to individual objects at run-time. Inheritance is not feasible because it is static and applies to an entire class.

Discussion

Suppose you are working on a user interface toolkit and you wish to support adding borders and scroll bars to windows. You could

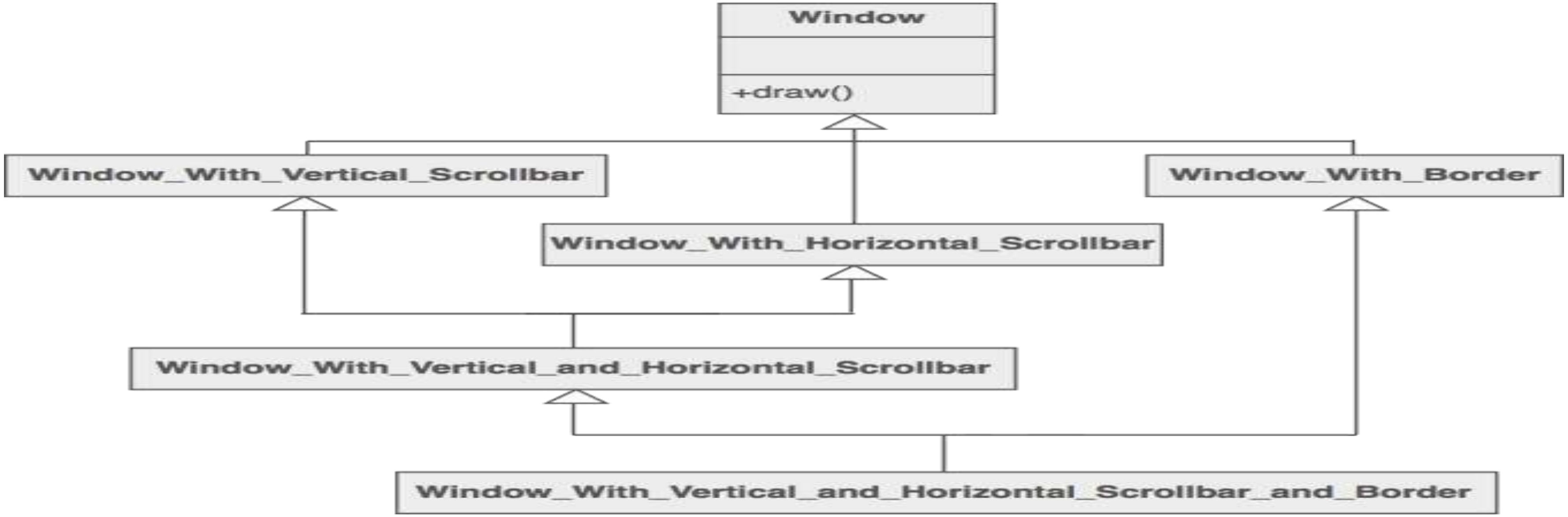


But the Decorator pattern suggests giving the client the ability to specify whatever combination of "features" is desired.

```
Widget* aWidget = new BorderDecorator(
  new HorizontalScrollBarDecorator(
```

```
  new VerticalScrollBarDecorator(
    new Window( 80, 24 )))); aWidget->draw();
```

This flexibility can be achieved with the following design



Another example of cascading (or chaining) features together to produce a custom object might look like ...

```
Stream* aStream = new CompressingStream(
  new ASCII7Stream(
    new FileStream("fileName.dat"))); aStream->putString( "Hello world" );
```

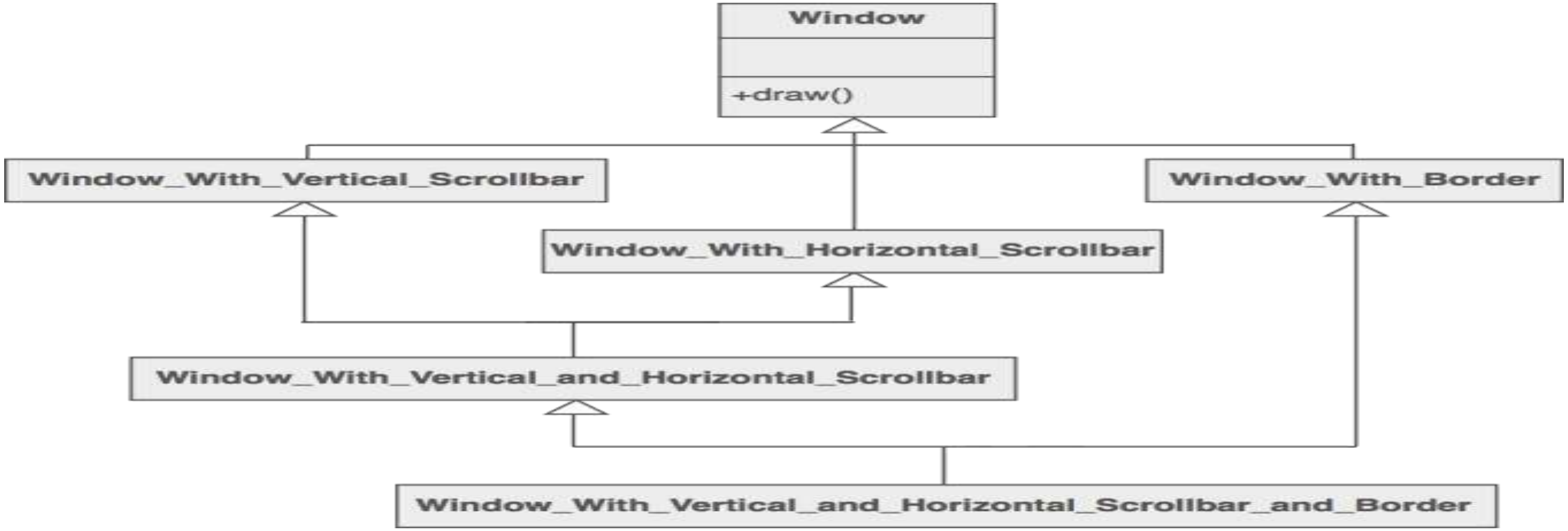
The solution to this class of problems involves encapsulating the original object inside an abstract wrapper interface. Both the decorator objects and the core object inherit from this abstract interface. The interface uses recursive composition to allow an unlimited number of decorator "layers" to be added to each core object.

Note that this pattern allows responsibilities to be added to an object, not methods to an object's interface. The interface presented to the client must remain constant as successive layers are specified.

Also note that the core object's identity has now been "hidden" inside of a decorator object. Trying to access the core object directly is now a problem.

Structure

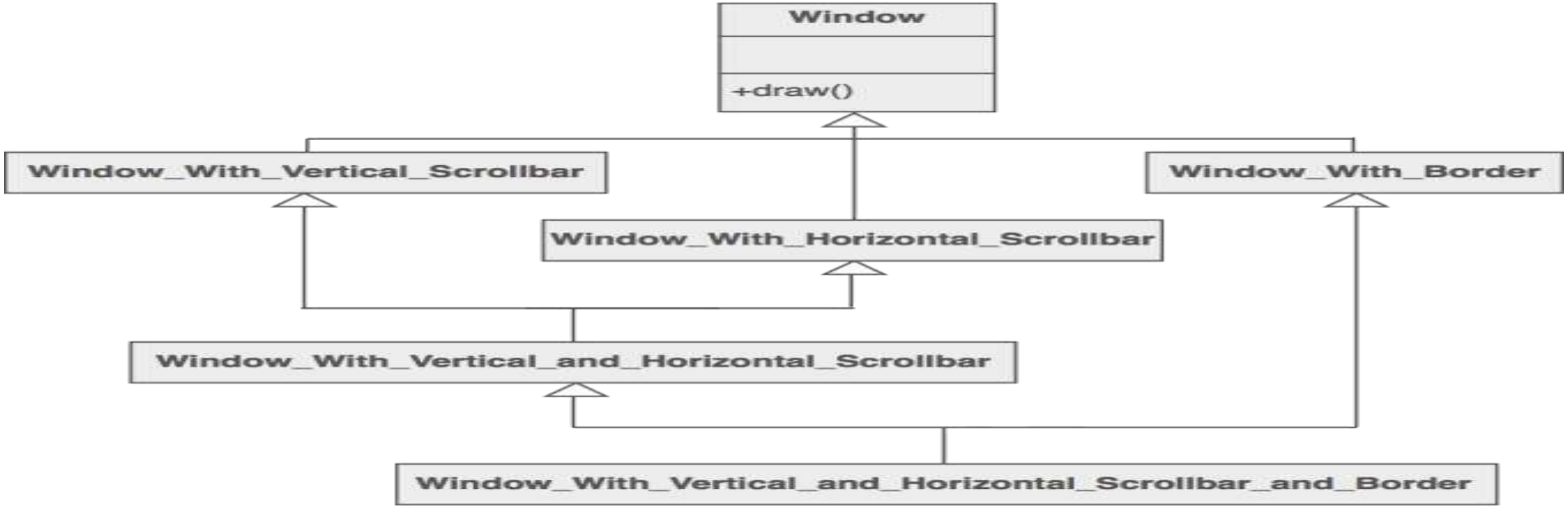
The client is always interested in CoreFunctionality.doThis(). The client may, or may not, be interested in OptionalOne.doThis() and OptionalTwo.doThis(). Each of these classes always delegate to the Decorator base class, and that class always delegates to the contained "wrappee" object.



Example

The Decorator attaches additional responsibilities to an object dynamically. The ornaments that are added to pine or fir trees are examples of Decorators. Lights, garland, candy canes, glass ornaments, etc., can be added to a tree to give it a festive look. The ornaments do not change the tree itself which is recognizable as a Christmas tree regardless of particular ornaments used. As an example of additional functionality, the addition of lights allows one to "light up" a Christmas tree.

Another example: assault gun is a deadly weapon on it's own. But you can apply certain "decorations" to make it more accurate, silent and devastating.



Check list

1. Ensure the context is: a single core (or non-optional) component, several optional embellishments or wrappers, and an interface that is common to all.
2. Create a "Lowest Common Denominator" interface that makes all classes interchangeable.
3. Create a second level base class (Decorator) to support the optional wrapper classes.
4. The Core class and Decorator class inherit from the LCD interface.
5. The Decorator class declares a composition relationship to the LCD interface, and this data member is initialized in its constructor.
6. The Decorator class delegates to the LCD object.
7. Define a Decorator derived class for each optional embellishment.
8. Decorator derived classes implement their wrapper functionality - and - delegate to the Decorator base class.
9. The client configures the type and ordering of Core and Decorator objects.

Rules of thumb

- Adapter provides a different interface to its subject. Proxy provides the same interface. Decorator provides an enhanced interface.
- Adapter changes an object's interface, Decorator enhances an object's responsibilities. Decorator is thus more transparent to the client. As a consequence, Decorator supports recursive composition, which isn't possible with pure Adapters.
- Composite and Decorator have similar structure diagrams, reflecting the fact that both rely on recursive composition to organize an open-ended number of objects.
- A Decorator can be viewed as a degenerate Composite with only one component. However, a Decorator adds additional responsibilities - it isn't intended for object aggregation.
- Decorator is designed to let you add responsibilities to objects without subclassing. Composite's focus is not on embellishment but on representation. These intents are distinct but complementary. Consequently, Composite and Decorator are often used in concert.
- Composite could use Chain of Responsibility to let components access global properties through their parent. It could also use Decorator to override these properties on parts of the composition.
- Decorator and Proxy have different purposes but similar structures. Both describe how to provide a level of indirection to another object, and the implementations keep a reference to the object to which they forward requests.
- Decorator lets you change the skin of an object. Strategy lets you change the guts.

Facade Design Pattern:

Intent

- Provide a unified interface to a set of interfaces in a subsystem. Facade defines a higher-level interface that makes the subsystem easier to use.
- Wrap a complicated subsystem with a simpler interface.

Problem

A segment of the client community needs a simplified interface to the overall functionality of a complex subsystem.

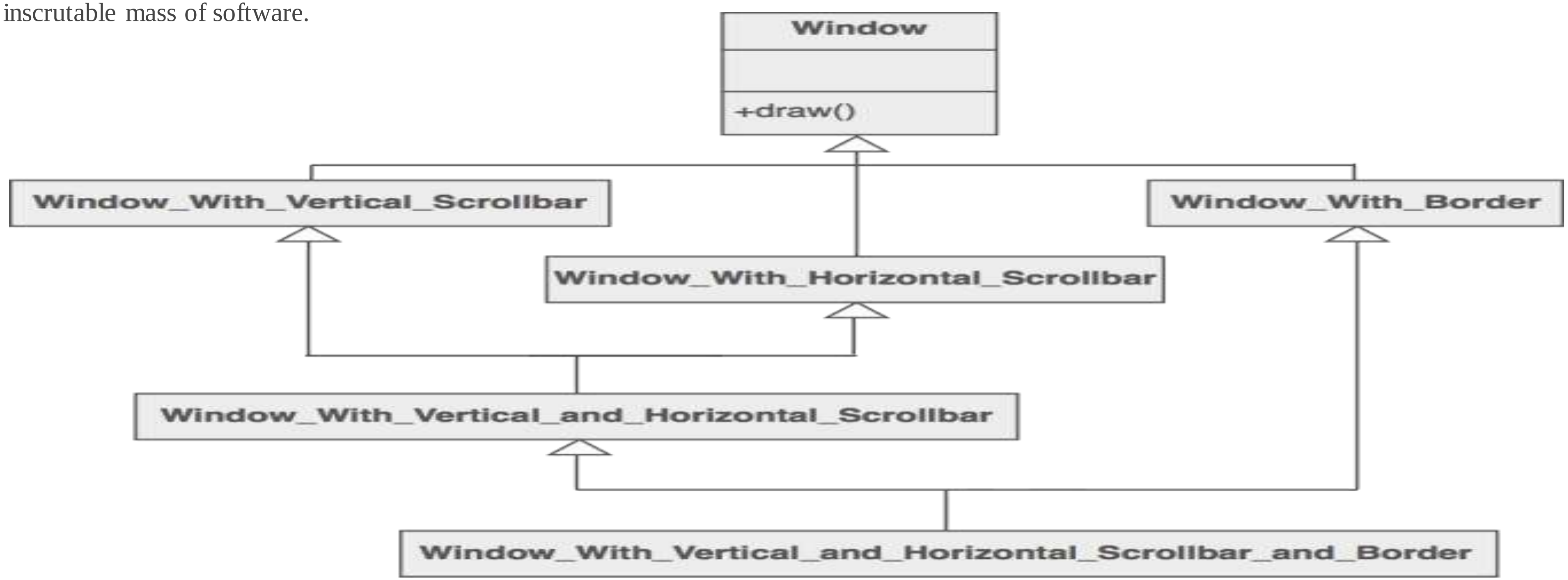
Discussion

Facade discusses encapsulating a complex subsystem within a single interface object. This reduces the learning curve necessary to successfully leverage the subsystem. It also promotes decoupling the subsystem from its potentially many clients. On the other hand, if the Facade is the only access point for the subsystem, it will limit the features and flexibility that "power users" may need.

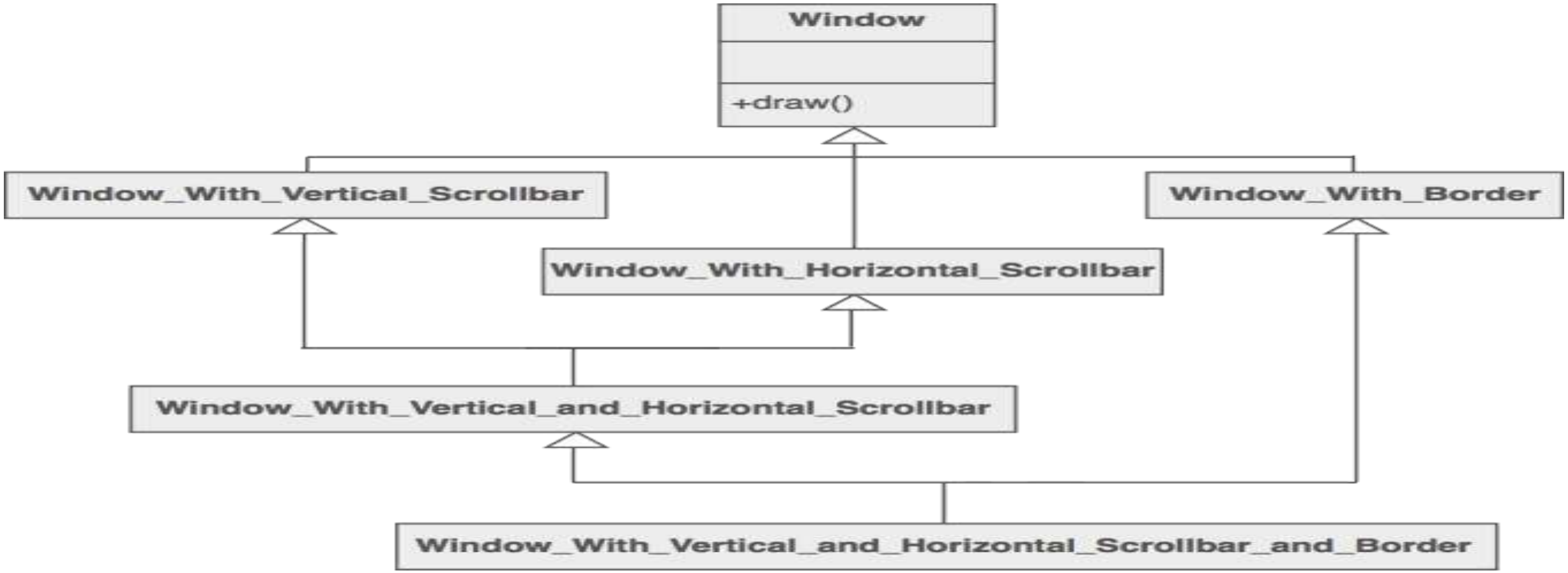
The Facade object should be a fairly simple advocate or facilitator. It should not become an all-knowing oracle or "god" object.

Structure

Facade takes a "riddle wrapped in an enigma shrouded in mystery", and interjects a wrapper that tames the amorphous and inscrutable mass of software.

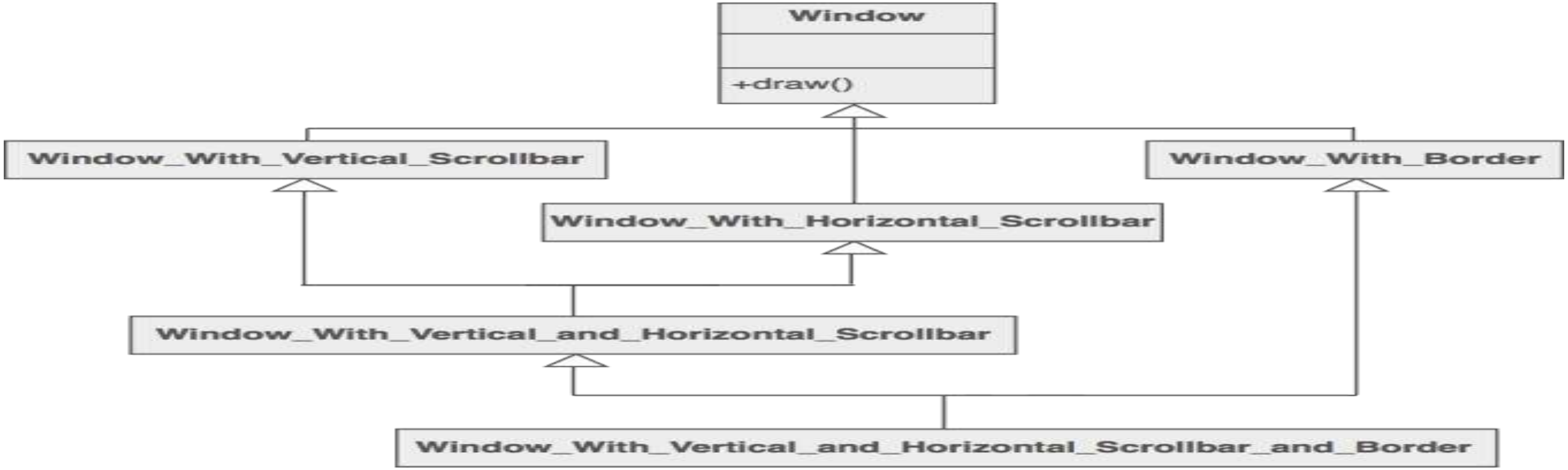


SubsystemOne and SubsystemThree do not interact with the internal components of SubsystemTwo. They use the SubsystemTwoWrapper "facade" (i.e. the higher level abstraction).



Example

The Facade defines a unified, higher level interface to a subsystem that makes it easier to use. Consumers encounter a Facade when ordering from a catalog. The consumer calls one number and speaks with a customer service representative. The customer service representative acts as a Facade, providing an interface to the order fulfillment department, the billing department, and the shipping department.



Check list

1. Identify a simpler, unified interface for the subsystem or component.
2. Design a 'wrapper' class that encapsulates the subsystem.
3. The facade/wrapper captures the complexity and collaborations of the component, and delegates to the appropriate methods.
4. The client uses (is coupled to) the Facade only.
5. Consider whether additional Facades would add value.

Rules of thumb

- Facade defines a new interface, whereas Adapter uses an old interface. Remember that Adapter makes two existing interfaces work together as opposed to defining an entirely new one.
- Whereas Flyweight shows how to make lots of little objects, Facade shows how to make a single object represent an entire subsystem.
- Mediator is similar to Facade in that it abstracts functionality of existing classes. Mediator abstracts/centralizes arbitrary communications between colleague objects. It routinely "adds value", and it is known/referenced by the colleague objects. In contrast, Facade defines a simpler interface to a subsystem, it doesn't add new functionality, and it is not known by the subsystem classes.
- Abstract Factory can be used as an alternative to Facade to hide platform-specific classes.

- Facade objects are often Singletons because only one Facade object is required.
- Adapter and Facade are both wrappers; but they are different kinds of wrappers. The intent of Facade is to produce a simpler interface, and the intent of Adapter is to design to an existing interface. While Facade routinely wraps multiple objects and Adapter wraps a single object; Facade could front-end a single complex object and Adapter could wrap several legacy objects.

Question: So the way to tell the difference between the Adapter pattern and the Facade pattern is that the Adapter wraps one class and the Facade may represent many classes?

Answer: No! Remember, the Adapter pattern changes the interface of one or more classes into one interface that a client is expecting. While most textbook examples show the adapter adapting one class, you may need to adapt many classes to provide the interface a client is coded to. Likewise, a Facade may provide a simplified interface to a single class with a very complex interface. The difference between the two is not in terms of how many classes they "wrap", it is in their intent.

Flyweight Design Pattern:-

Intent

- Use sharing to support large numbers of fine-grained objects efficiently.
- The Motif GUI strategy of replacing heavy-weight widgets with light-weight gadgets.

Problem

Designing objects down to the lowest levels of system "granularity" provides optimal flexibility, but can be unacceptably expensive in terms of performance and memory usage.

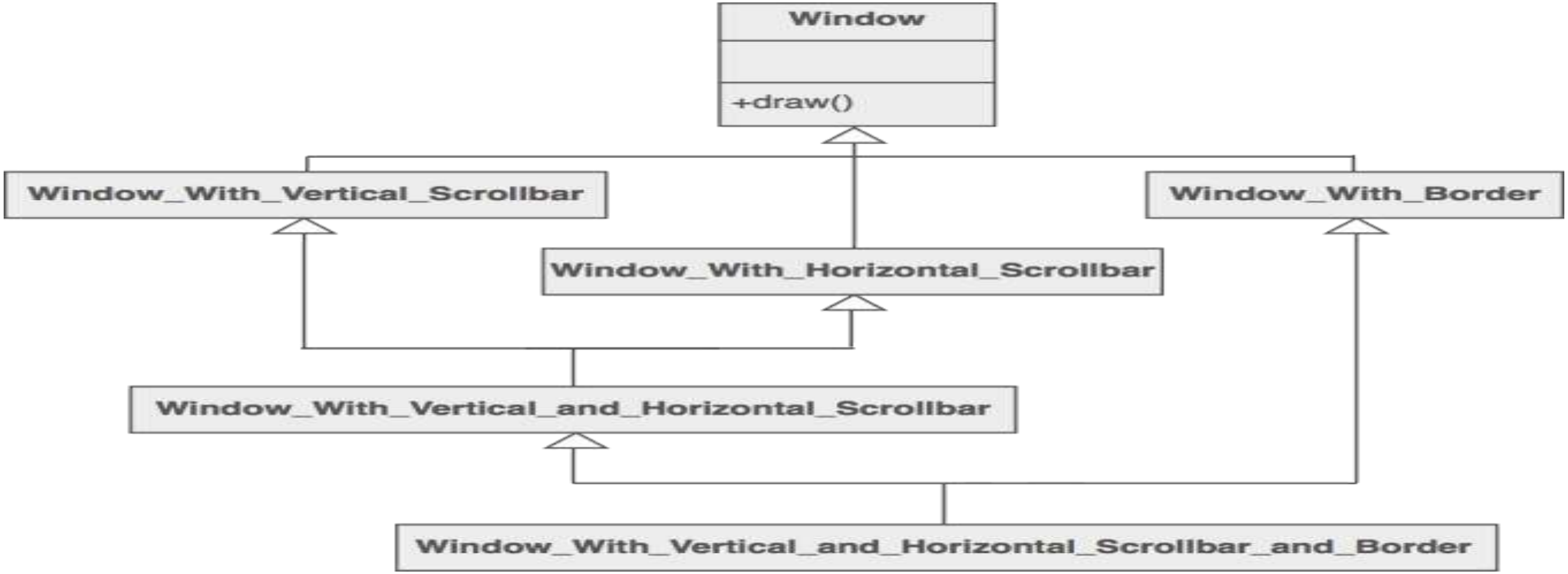
Discussion

The Flyweight pattern describes how to share objects to allow their use at fine granularities without prohibitive cost. Each "flyweight" object is divided into two pieces: the state- dependent (extrinsic) part, and the state-independent (intrinsic) part. Intrinsic state is stored (shared) in the Flyweight object. Extrinsic state is stored or computed by client objects, and passed to the Flyweight when its operations are invoked.

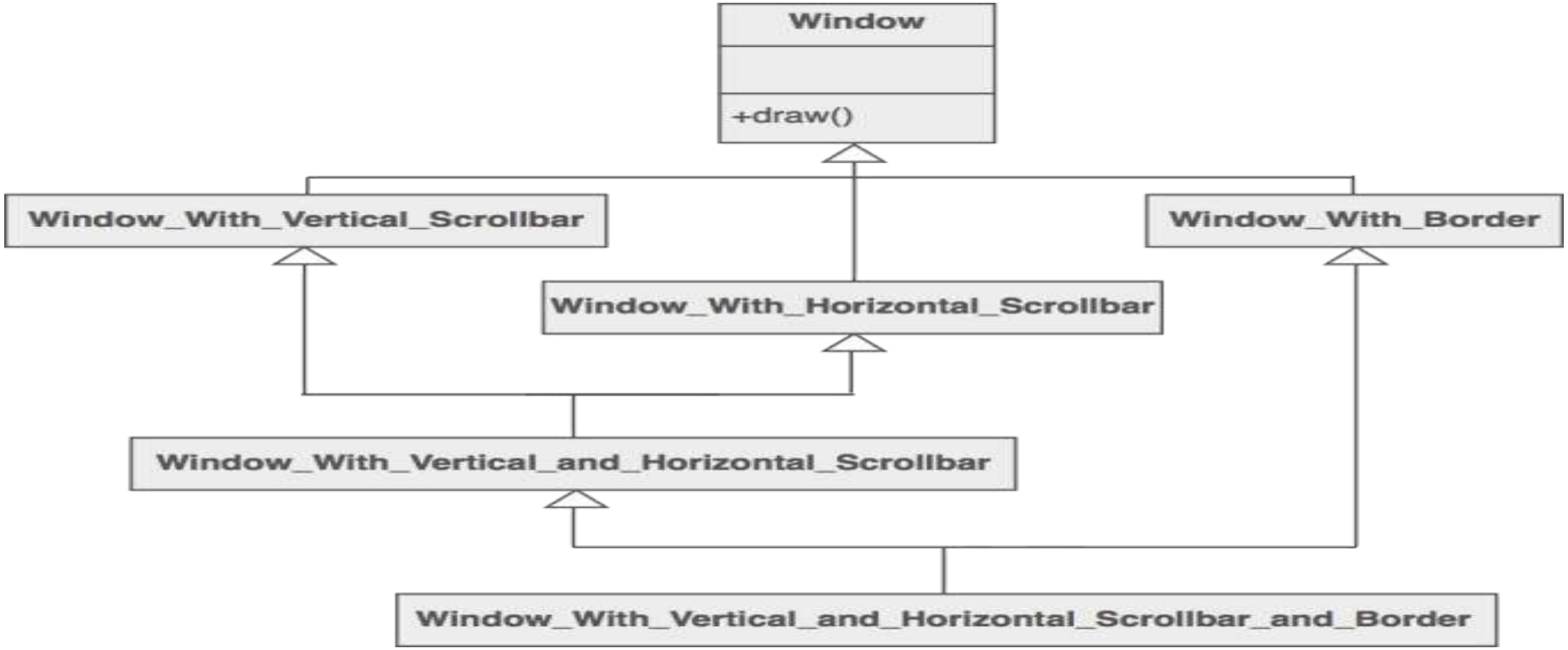
An illustration of this approach would be Motif widgets that have been re-engineered as light- weight gadgets. Whereas widgets are "intelligent" enough to stand on their own; gadgets exist in a dependent relationship with their parent layout manager widget. Each layout manager provides context-dependent event handling, real estate management, and resource services to its flyweight gadgets, and each gadget is only responsible for context-independent state and behavior.

Structure

Flyweights are stored in a Factory's repository. The client restrains herself from creating Flyweights directly, and requests them from the Factory. Each Flyweight cannot stand on its own. Any attributes that would make sharing impossible must be supplied by the client whenever a request is made of the Flyweight. If the context lends itself to "economy of scale" (i.e. the client can easily compute or look-up the necessary attributes), then the Flyweight pattern offers appropriate leverage.

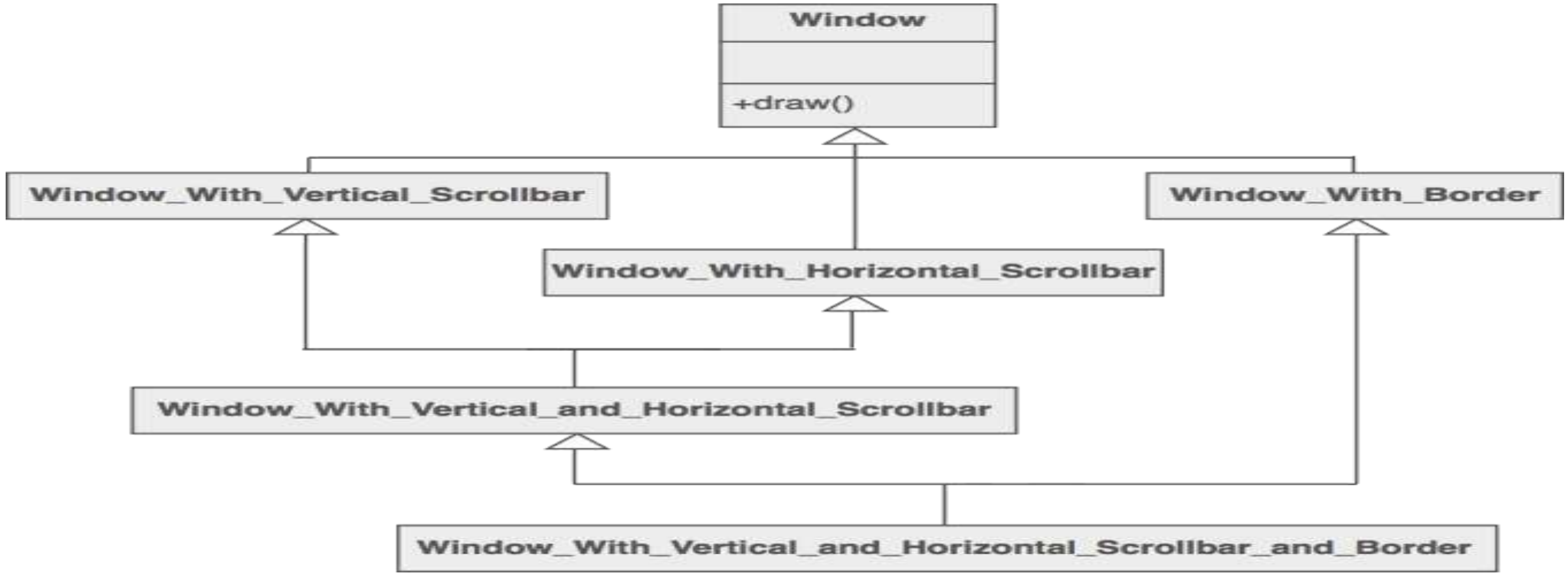


The Ant, Locust, and Cockroach classes can be "light-weight" because their instance-specific state has been de-encapsulated, or externalized, and must be supplied by the client.



Example

The Flyweight uses sharing to support large numbers of objects efficiently. Modern web browsers use this technique to prevent loading same images twice. When browser loads a web page, it traverse through all images on that page. Browser loads all new images from Internet and places them the internal cache. For already loaded images, a flyweight object is created, which has some unique data like position within the page, but everything else is referenced to the cached one.



Check list

1. Ensure that object overhead is an issue needing attention, and, the client of the class is able and willing to absorb responsibility realignment.
2. Divide the target class's state into: shareable (intrinsic) state, and non-shareable (extrinsic) state.
3. Remove the non-shareable state from the class attributes, and add it the calling argument list of affected methods.
4. Create a Factory that can cache and reuse existing class instances.
5. The client must use the Factory instead of the new operator to request objects.
6. The client (or a third party) must look-up or compute the non-shareable state, and supply that state to class methods.

Rules of thumb

- Whereas Flyweight shows how to make lots of little objects, Facade shows how to make a single object represent an entire subsystem.
- Flyweight is often combined with Composite to implement shared leaf nodes.
- Terminal symbols within Interpreter's abstract syntax tree can be shared with Flyweight.

- Flyweight explains when and how State objects can be shared.

Proxy Design Pattern:-

Intent

- Provide a surrogate or placeholder for another object to control access to it.
- Use an extra level of indirection to support distributed, controlled, or intelligent access.
- Add a wrapper and delegation to protect the real component from undue complexity.

Problem

You need to support resource-hungry objects, and you do not want to instantiate such objects unless and until they are actually requested by the client.

Discussion

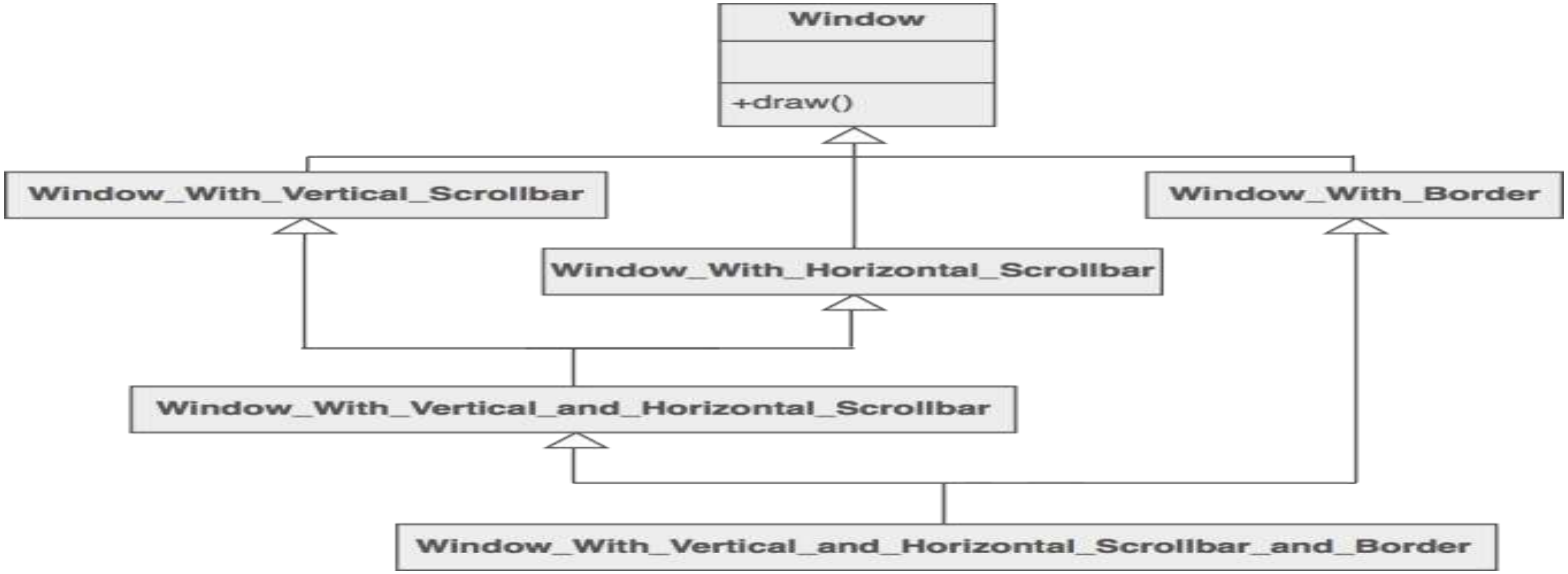
Design a surrogate, or proxy, object that: instantiates the real object the first time the client makes a request of the proxy, remembers the identity of this real object, and forwards the instigating request to this real object. Then all subsequent requests are simply forwarded directly to the encapsulated real object.

There are four common situations in which the Proxy pattern is applicable.

1. A virtual proxy is a placeholder for "expensive to create" objects. The real object is only created when a client first requests/accesses the object.
2. A remote proxy provides a local representative for an object that resides in a different address space. This is what the "stub" code in RPC and CORBA provides.
3. A protective proxy controls access to a sensitive master object. The "surrogate" object checks that the caller has the access permissions required prior to forwarding the request.
4. A smart proxy interposes additional actions when an object is accessed. Typical uses include:
    - Counting the number of references to the real object so that it can be freed automatically when there are no more references (aka smart pointer),
    - Loading a persistent object into memory when it's first referenced,
    - Checking that the real object is locked before it is accessed to ensure that no other object can change it.

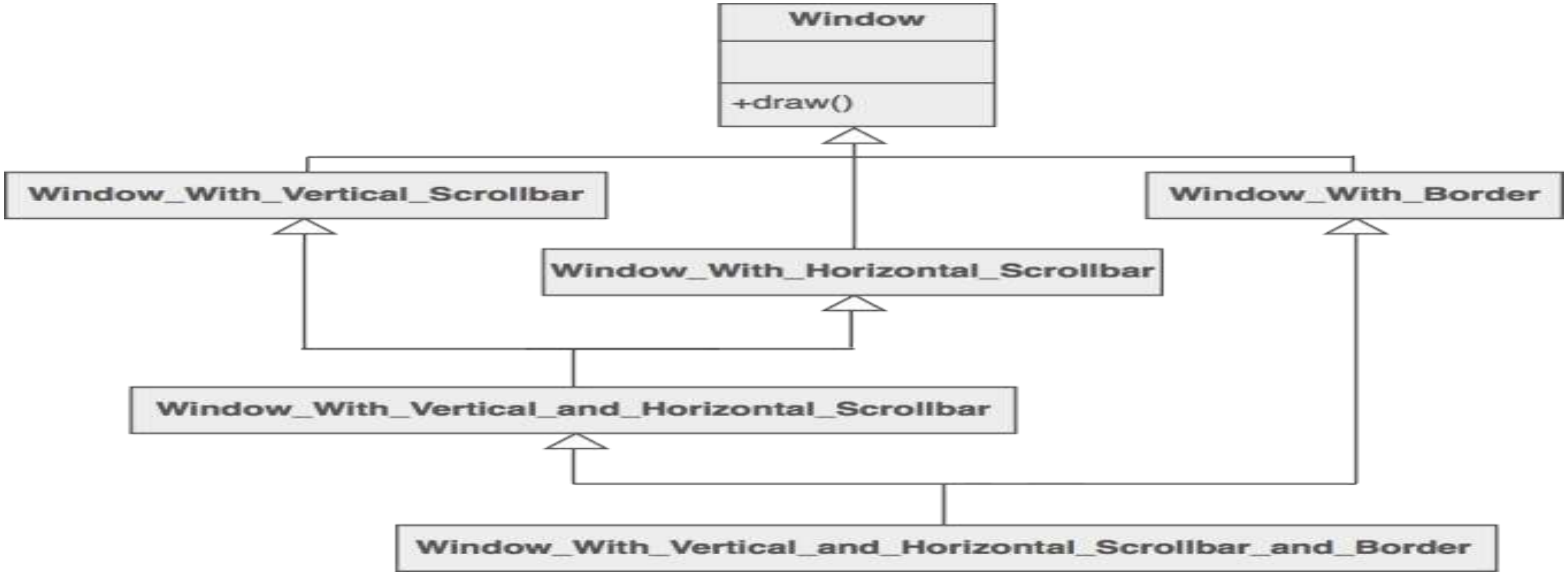
Structure

By defining a Subject interface, the presence of the Proxy object standing in place of the RealSubject is transparent to the client.



Example

The Proxy provides a surrogate or place holder to provide access to an object. A check or bank draft is a proxy for funds in an account. A check can be used in place of cash for making purchases and ultimately controls access to cash in the issuer's account.



Check list

1. Identify the leverage or "aspect" that is best implemented as a wrapper or surrogate.
2. Define an interface that will make the proxy and the original component interchangeable.
3. Consider defining a Factory that can encapsulate the decision of whether a proxy or original object is desirable.
4. The wrapper class holds a pointer to the real class and implements the interface.
5. The pointer may be initialized at construction, or on first use.
6. Each wrapper method contributes its leverage, and delegates to the wrappee object.

Rules of thumb

- Adapter provides a different interface to its subject. Proxy provides the same interface. Decorator provides an enhanced interface.
- Decorator and Proxy have different purposes but similar structures. Both describe how to provide a level of indirection to another object, and the implementations keep a reference to the object to which they forward requests.