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Lab 2 – Decorator Pattern

Objectives

Part 1 – Setting up the Project

Part 2 – Implementing the Decorator Pattern

Background/Scenario

In this lab you will work with code that handles orders. The idea is that over time, items are added into an Order instance, and when the customer is finished they proceed to the payment phase. Currently, this involves printing out all the items and stating the total cost for all items in the order. Imagine that the legacy order handling module is much more complex (deals with country and state tax calculations inline, etc.,) and there were not a lot of unit tests written for it, so it could be very brittle and easy to introduce a bug.

However, the company now wants to make the overall cost of the order a function that can be exposed on another service endpoint, not only of the items ordered, but also the type of shipping the customer desires. Additionally, they see an opportunity to add extra revenue by charging for credit card purchases.

Your task is to enable the company to do this without modifying the existing Order functionality. To do this, you will use the Decorator pattern.

Required Resources

- Visual Studio 2017

Part 1: Setting up the Project

Step 1: Download the DecoratorLabStarterCode

Open the DecoratorLabStarterCode project, familiarize yourself with the code and run it. It should display a set of items in the Order instance and a total cost for the items in the order. Your challenge is to add support for express shipping. This will add a fixed cost of $4.00 to the price of the order. Since there can't be any changes to the Order type functionality, you can't add a bool to the Order type to represent express shipping. Instead you will refactor the consuming client code and use the decorator pattern to facilitate adding the cost of shipping.

Some things to note in the starter code:

OrderItem's properties have been implemented using C# property syntax instead of C++ style setters and getters. For example:

```
private string productCode;
public string ProductCode
{
   get { return productCode; }
}
```

This code makes it possible to create an instance of OrderItem and then get the value of productCode by accessing the ProductCode property using the dot operator.

```
OrderItem item = new OrderItem();
Console.WriteLine("productCode: {0}", item.ProductCode);
```

Look at the Order.PrintOrderItems() method in the Order class for another example. If this is confusing ask for an explanation.

Part 2: Implementing the Decorator Pattern

Step 1: Create the AbstractBase

The first step in using the decorator pattern is to identify the type you wish to decorate—in this case the Order type. In order to decorate the Order type at runtime, the Order class needs a contract that contains its methods in an abstract form. The client code that uses the Order instance will be written against this contract. This allows the creation of concrete decorator objects that implement this new abstract Order type.

The steps for refactoring are:

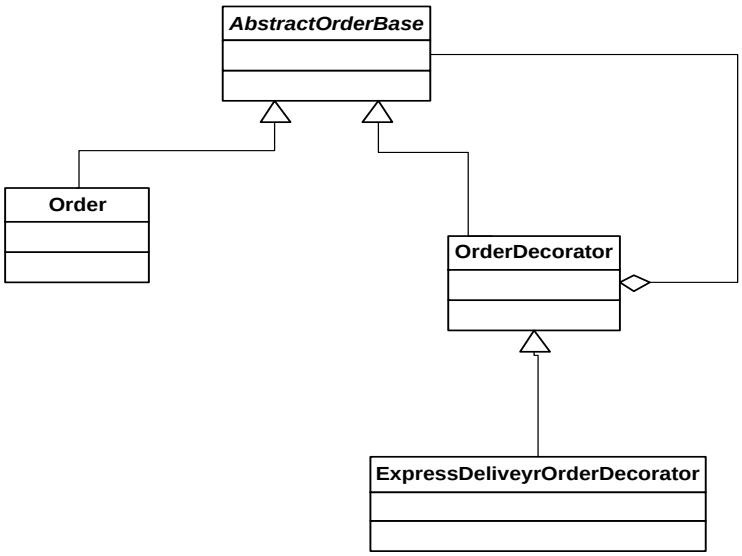
1. In the dll, create a new *public* abstract class called AbstractOrderBase and make all methods public abstract.
2. Remove the items list from the Order class and add it as a protected data member of AbstractOrderBase.
3. Derive Order from AbstractOrderBase
4. Override each of the AbstractOrderBase methods in Order. Each method should implement the original Order logic.

Recompile the code. It should run just the same as before. However, by implementing AbstractOrderBase, we now have a contract that we can use to decorate an Order.

Note: Code refactoring is the process of restructuring existing computer code—changing the factoring—without changing its external behavior.

Step 2: Create the Decorator classes

Now we can start adding classes that will decorate Order with additional behavior. The class diagram below shows the type hierarchy to implement. The first step is to create a public OrderDecorator type that all Order decorators will derive from. This makes sense since all decorators need to contain a reference to the object they are decorating. It also provides the "pass through" functionality for methods in the Order class that are not being decorated.



Step 3: Create the base class and implement derived classes

Create a public base class for your decorators. Call it OrderDecorator and derive it from AbstractOrderBase. Add a protected data member of type AbstractOrderBase—this is the type being decorated. Add a protected constructor that takes one parameter of type AbstractOrderBase. Use the constructor to initialize your protected data member to the value passed in as a parameter.

Implement each of the abstract methods defined in the AbstractOrderBase type. Each method's implementation should simply make the same method call using the protected data member you declared. (Pass through functionality.)

The application should compile.

Step 4: Implement the decoration

Now for the fun part… the decoration code. Create a public express shipping decorator type, call it ExpressDeliveryOrderDecorator. Derive ExpressDeliveryOrderDecorator from OrderDecorator.

Add a constructor to ExpressDeliveryOrderDecorator that takes an AbstractOrderBase as its only parameter. Pass the parameter to the base class constructor.

Start by decorating GetTotalCost(). It is very important that you understand that the other methods are handled by the OrderDecorator class. If this doesn't make sense, please ask in class.

Said another way, the OrderDecorator class does all of the heavy lifting in the Decorator pattern. Once it is implemented, each Decorator only needs to focus on the methods that need decorating.

Okay, getting back to GetTotalCost(). In this method, add a $4 delivery charge to the total items cost of the object being decorated and return the accumulated value.

Also, decorate PrintOrderItems(): add a Console.WriteLine that explains to the customer that a shipping cost may apply—call OrderDecorator.PrintOrderItems() to get the pass through behavior (Total Cost of Items), then add Console.WriteLine("Grand Total with Shipping {0:C}", GetTotalCost()); to output to the Grand Total to the console. Note that this calls the decorated GetTotalCost() which adds the $4 delivery charge for the Grand Total.

Time to refactor Main(). After creating an Order instance, decorate it by creating an ExpressDeliveryOrderDecorator instance and passing in the Order instance as a parameter. Now invoke PrintOrderItems via the Decorator. Compile and run the code, you should now see your order printed out with the shipping cost message and the additional shipping charge in the Grand Total.

Your output should look something like this:

```
A Shipping Cost May Apply
BroncoHats x 2 @ $1.50 = $3.00
BroncoGloves x 1 @ $3.00 = $3.00
BroncoSocks x 6 @ $1.90 = $11.40
BroncoBanners x 3 @ $8.00 = $24.00
BroncoFootballs x 4 @ $5.60 = $22.40
BroncoJerseys x 2 @ $2.30 = $4.60
Total Cost of Items $68.40
Grand Total with Shipping $72.40
```

Step 5: Extend the functionality further by adding credit card payment

Further extend the code for paying by credit card. Create two new decorators, one for Visa and one for American Express. If the customer chooses to pay by Visa there is a $2.00 charge. If they choose to pay by American Express there is a $5 charge.

In Main(), decorate the Order instance with the Visa decorator and call PrintOrderItems(). Then decorate the order instance with the American Express decorator and call PrintOrderItems().

Similar to the ExpressDeliveryOrder decorator, your output should explain to the user the details of the extended behavior.

Reflection

1. Why is the OrderDecorator constructor protected?

   Only derived classes should be able to call OrderDecorator constructor.

2. Draw a UML sequence diagram that shows the method calls that occur when creating an Order instance, an ExpressDeliveryOrder decorator instance, a Visa decorator instance, and a call to the decorator's PrintOrderItems();

   Save the diagram in your solution folder as both the original format (draw.io format or Visio format) and as an exported PNG image format.