CS 535 Object-Oriented Programming & Design
Fall Semester, 2010
Doc 3 More OO Introduction
Sept 2 2010

References

Object-Oriented Design Heuristics, Chapter 2

Designing Object-Oriented Software, Wirfs-Brock, Wilkerson, Wiener

Question a

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A method that computes the area of a circle.

Question b

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A reverse method that reverses the order of the characters in a string.

Question c

Using your favorite OO programming language (Java, C++, Ruby, etc) in which class would you place the following method?

A method that computes the checksum of a sequence of bits.

C - Version

Is this OO?

```
char* reverse(char *aString)
{
    int stringLength = strlen(aString);
    char reverse[stringLength + 1];
    for (k = 0; k < stringLength; k++)
        reverse[k] = aString[stringLength-k-1]
    return reverse;
}
```


Some details may be incorrect in the code, but that is not the issue here

C++

Is this OO?

```
class MyString
{
    public static char* reverse(char *aString);
}

char* MyString :: reverse(char *aString)
{
    int stringLength = strlen(aString);
    char reverse[stringLength + 1];
    for (k = 0; k < stringLength; k++)
        reverse[k] = aString[stringLength-k-1]
    return reverse;
}
```

Java

Is this OO?

```
class MyString
{
    public String reverse(String toReverse)
    {
        StringBuilder string = new StringBuilder(toReverse);
        StringBuilder reverse = string.reverse();
        return reverse.toString();
}
```

Java

Is this OO?

```
class MyString
{
    public static String reverse(String toReverse)
    {
        StringBuilder string = new StringBuilder(toReverse);
        StringBuilder reverse = string.reverse();
        return reverse.toString();
}
```

Relevant Heuristics

2.8 A class should capture one and only one key abstraction

2.9 Keep related data and behavior in one place

2.10 Spin off nonrelated information into another class

java.lang.Math

```
package java.lang;
import java.util.Random;

public final strictfp class Math {
    public static double abs(double a) {
        return (a <= 0.0D) ? 0.0D - a : a;
    }

    public static double toDegrees(double angrad) {
        return angrad * 180.0 / PI;
    }

etc.
```

So what do we lose doing this?

One disease long life

No disease short life

Heuristic

A method to help solve a problem, commonly informal

"rules of thumb"

Heuristic 2.3

Minimize the number of messages in the protocol of a class

"The problem with large public interfaces is that
you can never find what you are looking for"

Is this a design issue or a tool issue?

What do you do when the class does not have the method you need?

2.1 All data should be hidden within its class

```
public class Foo {
    public int x;
    public int y;
}
```

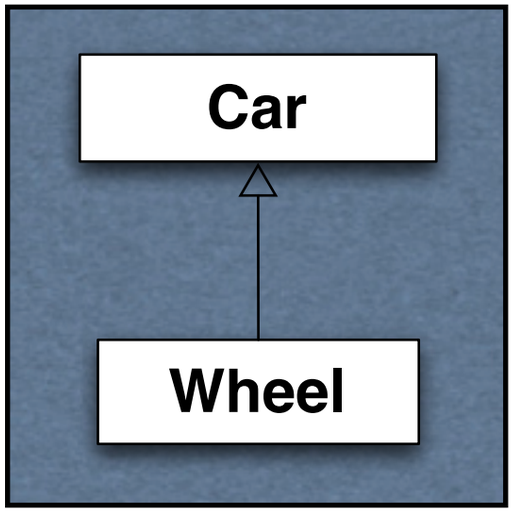
```
public class Foo {
    private int x;
    private int y;

    public int getX() {return x;}
    public int getY() {return y;}

    public void setX(int newX){
        x = newX
    }

    public void setY(int newY){
        y = newY
    }
}
```

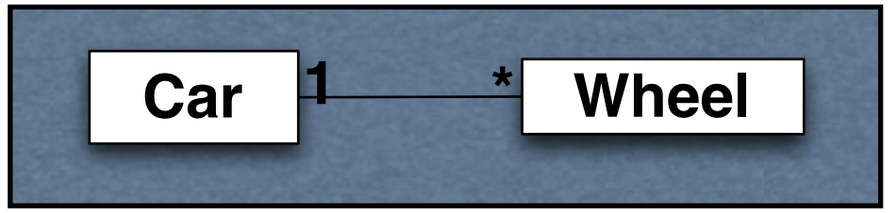

How is the version on the right better than the version on the left?

Role Versus Class

Is Mother a subclass of a Person class or an instance of it?

Inheritance verses Data Members






```
class Car { ... }
```

```
class Car {
    Wheel[ ]  tires;
    ...
}
```

```
class Wheel extends Car { ... }
```

Wheel is a type of car

Car has wheels

To test for inheritance ask "Is A a type of B" if yes then A is likely to be a subclass of B. If the answer to the question "does C have Ds" is true then it is likely that C has data members of type D.

Coupling

Strength of interaction between objects in system

"Unnecessary object coupling needlessly decreases the reusability of the coupled objects"

"Unnecessary object coupling also increases the chances of system corruption when changes are made to one or more of the coupled objects"

Design Goal

The interaction or other interrelationship between any two components at the same level of abstraction within the system be as weak as possible

Types of Coupling

Nil Coupling

No interaction between two classes

Export Coupling

One class uses the public interface of another

Overt Coupling

One class uses implementation details of another class with permission

Covert Coupling

One class uses implementation details of another class without permission

There are other categories of coupling. See Wikipedia on Coupling

Cohesion

Degree to which the tasks performed by a single module are functionally related

Each element in the module should be essential to the module's purpose

Coupling & Cohesion Heuristics

Classes should only exhibit nil or export coupling with other classes

A class should capture one and only one key abstraction

Keep related data and behavior in one place

Spin off nonrelated information into another class

Design Process

One OO Design Process

Exploratory Phase

Who is on the team?
What are their tasks, responsibilities?
Who works with whom?

Analysis Phase

Who's related to whom?
Finding sub teams
Putting it all together

This is known as the Responsibility-Driven process. See the Wirfs-Brock book listed in the references.

Exploratory Phase

Who is on the team?

What are the goals of the system?
What must the system accomplish?
What objects are required to model the system and accomplish the goals?

Finding the initial list of classes for the system

Exploratory Phase

What are their tasks, responsibilities?

What does each object have to know in order to accomplish its tasks?
What steps toward accomplishing each goal is it responsible for?

Candidate list of fields and methods

Exploratory Phase

Who works with whom?

With whom will each object collaborate in order to accomplish each of its responsibilities?
What is the nature of the objects' collaboration?

How do the objects interact

Analysis Phase

Who's related to whom?

Determine which classes are related via inheritance

Finding abstract classes

Determine class contracts

Analysis Phase

Finding sub teams

Divide responsibilities into subsystems

Designing interfaces of subsystems and classes

Analysis Phase

Putting it all together

Construct protocols for each class

Produce a design specification for each class and subsystem

Write a design specification for each contract