Introduction to Java for C++ Programmers

Segment – 3

JAC 444

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Polymorphism

- Polymorphism enables you to “program in the general” rather than “program in the specific.”
- It’s a concept which leads towards performing a single action by different ways.
- In particular, polymorphism enables you to write programs that process objects that share the same superclass (either directly or indirectly) as if they’re all objects of the superclass; this can simplify programming.

Defining a Contract

- Class defines **contract**

"I have these kind of methods…."

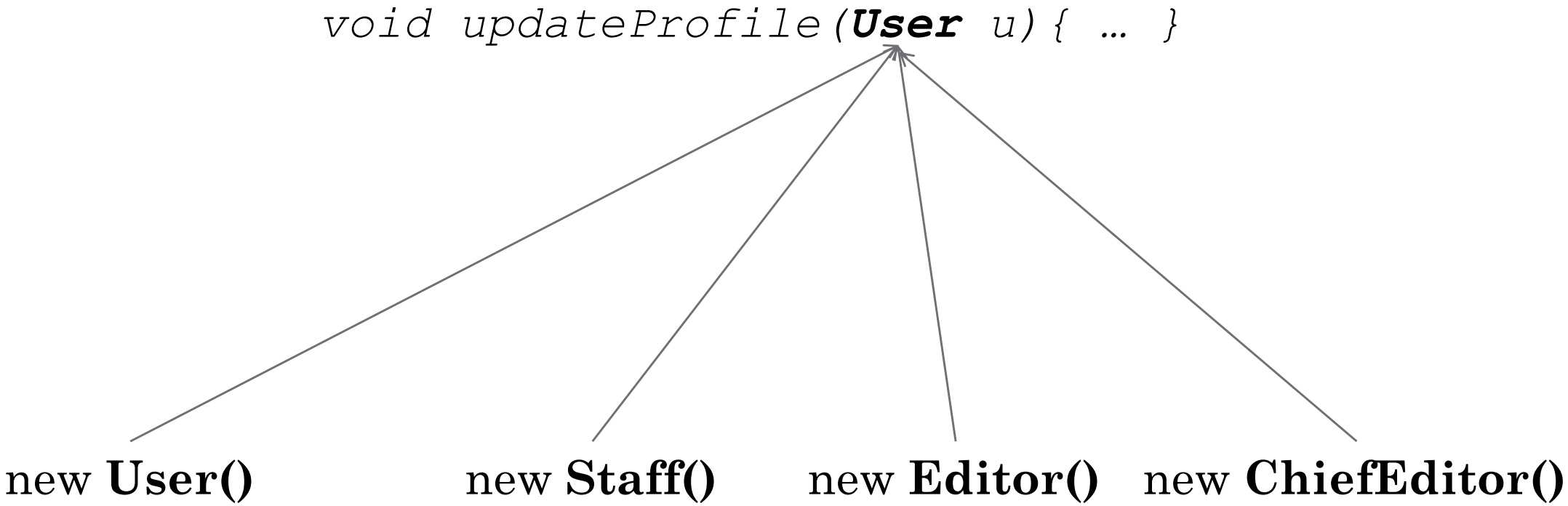
Defining common protocol

- Supertype defines **common protocol (methods)**

"Myself and my subtypes have the same kind of methods…"

Polymorphism

- **Supertype = subtypes**



- How can you perform polymorphism?

1. Method overloading
2. Method overriding

```
public class PolymorphismDemo {
  public static void main(String[] args) {
    m(new GraduateStudent());
    m(new Student());
    m(new Person());
    m(new Object());
  }

  public static void m(Object x) {
    System.out.println(x.toString());
  }
}

class GraduateStudent extends Student {
}

class Student extends Person {
  public String toString() {
    return "Student";
  }
}

class Person extends Object {
  public String toString() {
    return "Person";
  }
}
```

Method m takes a parameter of the Object type. You can invoke it with any object.

An object of a subtype can be used wherever its supertype value is required. This feature is known as *polymorphism*.

When the method m(Object x) is executed, the argument x's toString method is invoked.

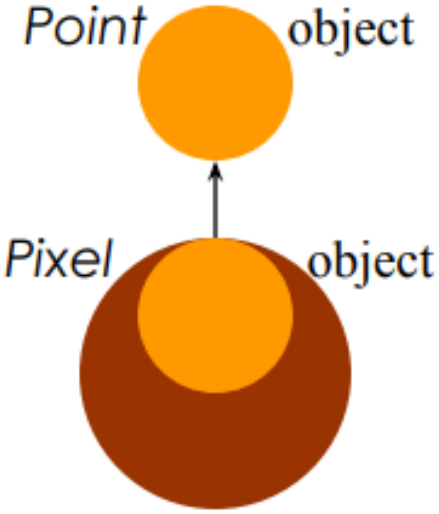
x may be an instance of GraduateStudent, Student, Person, or Object.

Classes GraduateStudent, Student, Person, and Object have their own implementation of the toString method.

Which implementation is used will be determined dynamically by the Java Virtual Machine at runtime.

This capability is known as *dynamic binding*.

```
class Point {
        int x; int y;
        void clear() { x = 0; y = 0 }
}
class Pixel extands Point{
    Color color;
    public void clear() {
        super.clear();
        color = null;
    }
}
```



Pixel extends both data and behavior **of its Point superclass.**

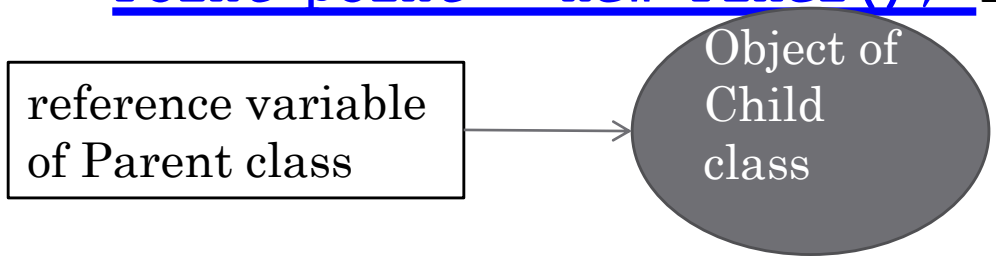
All the Point code can be used by anywhere with a Pixel in hand.

A single object like **Pixel** could have many (poly) forms (-morph)

It can be used as both a **Pixel** object and a **Point** object.

Pixel's behavior extends **Point**'s behavior.

```
Point point = new Pixel();
```
Implicit casting – Upcasting



Casting Objects

Casting can also be used to convert an object of one class type to another within an inheritance hierarchy. In the preceding section, the statement

```
m(new Student());
```

assigns the object new Student() to a parameter of the Object type. This statement is equivalent to:

```
Object o = new Student(); // Implicit casting
m(o);
```

The statement Object o = new Student(), known as implicit casting, is legal because an instance of Student is automatically an instance of Object.

Why Casting Is Necessary?

Suppose you want to assign the object reference o to a variable of the Student type using the following statement:

```
Student b = o;
```

A compilation error would occur.
Why does the statement **Object o = new Student()** work and the statement **Student b = o** doesn't?
This is because a Student object is always an instance of Object, but an Object is not necessarily an instance of Student.

```
Student b = (Student)o; // Explicit casting
```

Casting from Superclass to Subclass

Explicit casting must be used when casting an object from a superclass to a subclass. This type of casting may not always succeed.

```
Apple x = (Apple)fruit;

Orange x = (Orange)fruit;
```

The `instanceof` Operator

Use the `instanceof` operator to test whether an object is an instance of a class:

```
Object myObject = new Circle();
... // Some lines of code
/** Perform casting if myObject is an instance of Circle
 */
if (myObject instanceof Circle) {
  System.out.println("The circle diameter is " +
                     ((Circle)myObject).getDiameter());
  ...
}
```

- **Upcasting:** casting to a supertype. Generally you can upcast whenever there is an *is-a* relationship between two classes. Happens automatically in Java, no need to do explicitly.

- a cast from a **Dog** class to an **Animal** class, because a **Dog** *is-a* **Animal.**

- **Downcasting:** casting to a subclass. Java does not do it directly you have to explicitly do it.

- **Animal** animal = new **Dog();**
- **Dog** castedDog = **(Dog)** animal;

Method Matching vs. Binding

- The compiler finds a matching method according to parameter type, number of parameters, and order of the parameters at compilation time. A method may be implemented in several subclasses.
- The Java Virtual Machine dynamically binds the implementation of the method at runtime.

Example

Polymorphism can be demonstrated with a minor modification to the Bicycle class.
For example, a **printDescription** method could be added to the class that displays all the data currently stored in an instance.

```
public void printDescription(){
    System.out.println("\nBike is " + "in gear " +           this.gear + "
with a cadence of " + this.cadence      + " and travelling at a speed of "
+ this.speed     + ". ");
}
```

To demonstrate polymorphic features in the Java language, extend the Bicycle class with a **MountainBike** and a **RoadBike** class.
For **MountainBike**, add a field for **suspension**, which is a **String** value that indicates if the bike has a front shock absorber, **Front**. Or, the bike has a front and back shock absorber, **Dual**.

```
public class MountainBike extends Bicycle {
    private String suspension;
    public MountainBike( int startCadence, int startSpeed,
           int startGear, String suspensionType){
        super(startCadence, startSpeed, startGear);
        this.setSuspension(suspensionType);
    }
    public String getSuspension(){ return this.suspension; }
    public void setSuspension(String suspensionType) {
    this.suspension = suspensionType; }
    public void printDescription() { super.printDescription();
    System.out.println("The " + "MountainBike has a" +
              getSuspension() + " suspension."); }
}
```

Note the overridden **printDescription** method. In addition to the information provided before, additional data about the suspension is included to the output.

Here is the RoadBike class:

```
public class RoadBike extends Bicycle{
    // In millimeters (mm)
    private int tireWidth;
    public RoadBike(int startCadence, int startSpeed,
           int startGear, int newTireWidth){
         super(startCadence, startSpeed, startGear);
           this.setTireWidth(newTireWidth); }

    public int getTireWidth(){ return this.tireWidth; }

    public void setTireWidth(int newTireWidth){
         this.tireWidth = newTireWidth; }

    public void printDescription(){
         super.printDescription();
        System.out.println("The RoadBike" + " has " +
    getTireWidth() + " MM tires."); } }
```

Note that once again, the **printDescription** method has been overridden. This time, information about the tire width is displayed.

Here is a test program that creates three Bicycle variables. Each variable is assigned to one of the three bicycle classes. Each variable is then printed.

```
public class TestBikes {
    public static void main(String[] args){
    Bicycle bike01, bike02, bike03;
    bike01 = new Bicycle(20, 10, 1);
    bike02 = new MountainBike(20, 10, 5, "Dual");
    bike03 = new RoadBike(40, 20, 8, 23);
    bike01.printDescription();
    bike02.printDescription();
    bike03.printDescription(); }
}
```

The following is the output from the test program:

```
Bike is in gear 1 with a cadence of 20 and travelling at a
speed of 10.
Bike is in gear 5 with a cadence of 20 and travelling at a
speed of 10. The MountainBike has a Dual suspension.
Bike is in gear 8 with a cadence of 40 and travelling at a
speed of 20. The RoadBike has 23 MM tires.
```

Keyword: super

- Accessing fields and methods in superclass through object reference: **super**

```
class KeySuper {
    public void methodM() {
        System.out.println("Coming from Superclass.");
    }
}
class Sub extends KeySuper {
    // overrides methodM in the KeuSuper class
    public void methodM() {
        super.methodM();
        System.out.println("Coming from Subclass");
    }
public class Test{
    public static void main(String[] args) {
        Sub x = new KeySuper();
        x.m(); // what does it print?
    }
}
```

```
KeySuper superObj = new Sub();
if( superObj instanceof Sub)
      ((Sub) superObj).methodM();
```

Final Classes / Methods

- A class can be declared as final with the declaration:

```
public final class X { …}
```

- A class that is declared final cannot be subclassed

  Example: `java.lang.String`

- A method can be declared as final with the declaration:

```
public class Y {
  public final void m() {…}
}
```

A method that is declared final cannot be overridden or hidden by subclasses