

Exercise Set: Type Hierarchy, Polymorphism and Dispatching

In this exercise set, we have marked questions we think are harder than others with a [‡]. We have also marked questions for which solutions are provided at the end of the set ([SP]). To check solutions for other questions than those marked with [SP], ask one of the instructors or TAs or post a question to the google group!

1. Answer the following questions with true or false and explain your choice in one sentence. [SP]

a) A supertype extends the behaviour of a subtype.

b) The apparent type of the variable `aList` defined in the following statement is `List<String>`.
`List<String> aList = new ArrayList<String>();`

c) The actual type of the variable `aList` defined in the statement of question 1.b) is `List<String>`.

d) A class in Java can inherit from only one superclass, but can implement multiple interfaces.

e) A class extending another class has to override all methods of the superclass.

f) A class (that is not abstract) implementing an interface has to provide implementations for each method defined in the interface.

g) If a method in a subtype overrides a method in its supertype, the subtype is only substitutable for the supertype if the method's pre-conditions in the subtype are weaker than the pre-condition of the overridden method in the supertype.

2. Assume there is a class `Animal` and a class `Dolphin` that is a subclass of `Animal`. `Dolphin` defines a method `eat()` that is not defined in `Animal`. Is the following code correct and why or why not? [‡], [SP]

```
Animal anAnimal = new Dolphin();
anAnimal.eat();
```

3. Assume you are implementing a drawing program that allows a user to draw a variety of figures/objects. The figures/objects that the user should be allowed to draw are `Line`, `Circle`, `Square`, `ColoredLine`, `LineWithArrow`, `Rectangle`, `Ellipse` and `ColoredEllipse`. All of these types are subtypes of the supertype `Figure`.

a) Think about which type hierarchy would work well and draw a picture of it. Briefly explain how you chose the type hierarchy.[‡]

b) Why do you use inheritance in this example instead of creating each type as a stand-alone class?

4. Given the classes `Figure` and `SmallFigure` as defined below: is an object of type `SmallFigure` substitutable for an object of the supertype `Figure`? Explain why or why not!

```
class Figure{
    ...
    //pre-condition: width and height are positive integers
    //post-condition: returns a Graphics object that has the figure drawn
    onto it
    public Graphics drawFigure(int width, int height) {...}
    ...
}

class SmallFigure extends Figure{
    ...
    //pre-condition: 0 < width < 100 and 0 < height < 250
    //post-condition: returns a Graphics object that has the small figure
    drawn onto it
    public Graphics drawFigure(int width, int height) {...}
    ...
}
```

5. Given the classes `Figure` and `SmallFigure` as defined in question 4 and assume that method `drawFigure` in class `SmallFigure` does not have a call to the super method.

a) When you run the following code, the `drawFigure` method of which class is being executed? (explain why)

```
Figure aFigure = new SmallFigure();
aFigure.drawFigure(40, 38);
```

b) When you run the following code, the `drawFigure` method of which class is being executed? (explain why)

```
SmallFigure aSmallFigure = new SmallFigure();
aSmallFigure.drawFigure(40, 38);
```

6. What does it mean to override a method and why can it be useful to allow the overriding of methods? (Explain briefly.)

7. What is the difference between overloading and overriding of a method? (Explain briefly.)

SOLUTIONS:

1.

a) False.

A subtype extends the behaviour of a supertype.

b) True.

The apparent type is the declared type of the variable, which is `List` in this case.

c) False.

The actual type of the variable is `ArrayList<String>`.

d) True.

In Java, multiple inheritance is not allowed, however by implementing multiple interfaces, different parts of a Java software system can use an object from different perspectives.

e) False.

A class can override methods of its supertype but does not have to.

f) True.

If a class implements an interface, it means that it provides an implementation for the supertype; as an interface does not provide an implementation for any of the methods it defines, the implementing class has to provide them.

g) True.

A method in a subtype must allow at least all values that the method in the supertype allows.

2. No, the code is not correct. As the method `eat` is only defined on objects of the class `Dolphin` and the variable `anAnimal` is of the apparent type `Animal`, the method `eat` cannot be called on the object `anAnimal`.