Object Interaction in Java – Class Hierarchies

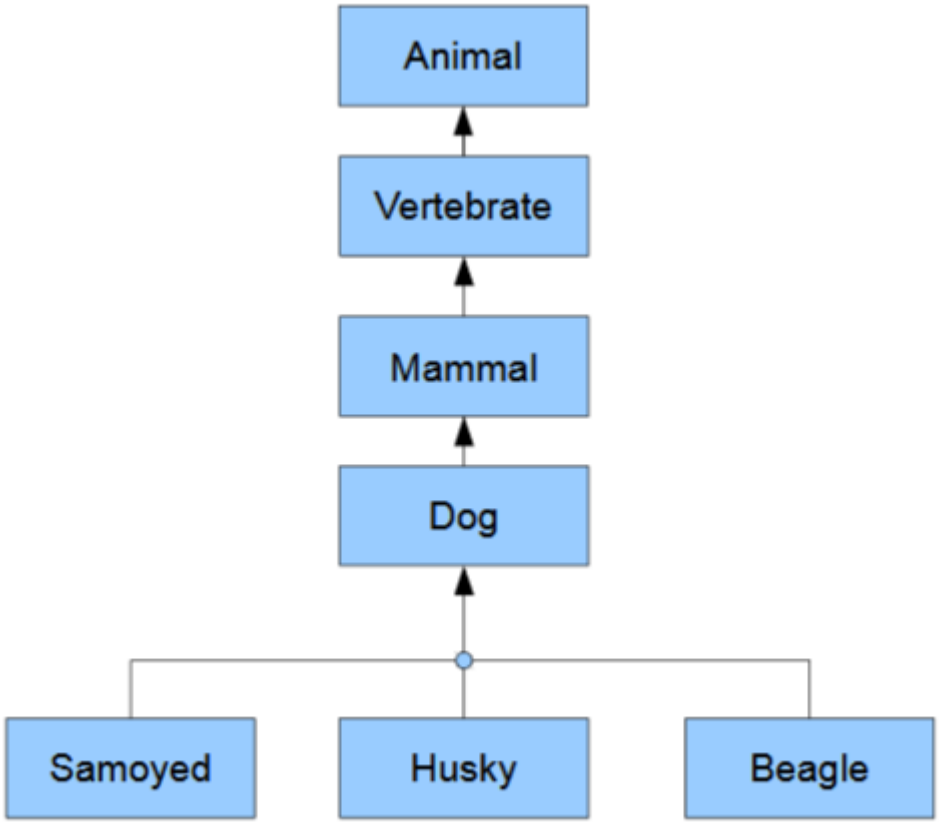
Consider the following: a dictionary might describe the *Samoyed* as a dog of medium size with a thick white coat, erect ears, and a tail which curls over the back. Even if you had never heard of such a dog breed before, these few descriptive phrases would give you a fairly clear picture of the Samoyed.

The key to such a clear picture is all of the additional information that is carried along with the word *dog*. Without knowing that the Samoyed is a type of dog, you might have a very difficult time trying to picture it. The additional information provided helps to distinguish the Samoyed from other dogs, but all dogs share certain characteristics that we can use as a starting point for this particular breed. We say that the Samoyed **inherits** characteristics from dogs, in general.

In computer programming, and Java in particular, we would consider the Dog and Samoyed as classes. From our analogy, the Dog class is the **superclass** of Samoyed. Considering the relationship in the opposite direction, we say that the class Samoyed is a **subclass** of Dog, or that Samoyed **extends** Dog.

A class such as Dog may have many subclasses, such as Husky or Beagle. Conversely, any class may have only a single superclass. It is possible, however, to form a chain of superclasses, so a single class may actually inherit from many classes.

Example 1 – Consider the following class-hierarchy diagram which includes the dog breeds we have been discussing, and adds several layers of superclasses.



Each class in the chain inherits from all of the classes above it. In this case, the Samoyed inherits from Dog (as previously discussed), but also from Mammal, Vertebrate, and Animal. In this example, the top class is Animal, which doesn't have a superclass. All animals (obviously) inherit from this class.

In Java, the class with this property is the Object class. All other classes inherit from Object, although most do so without actually referring to object.

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To indicate in Java that a class extends another class, we use the keyword extends in the class header. If Samoyed and Dog were actual Java classes, the header of Samoyed would be

class Samoyed extends Dog

If no class is specified using the extends clause, Object is the default superclass. Thus the following headers are equivalent:

class Fraction
class Fraction extends Object

The classes from which a class inherits are sometimes called the *ancestors*. The classes which inherit from a class are sometimes called the *descendants* (like a family tree).

The concept of **inheritance** is fundamental to object-oriented programming. When a class inherits from another class, it incorporates all of the fields and methods of the superclass into its own class definition.

Example 2 – Building a Student class.

Suppose we being by defining a Person class

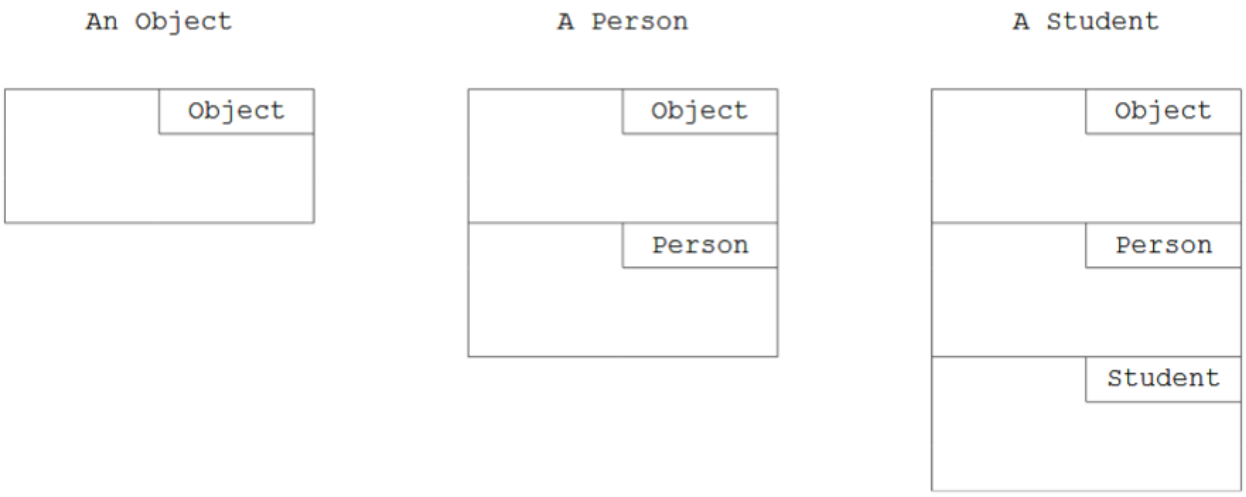
```
class Person
```

or

```
class Person extends Object
```

From here, we could define a Student class as an extension of the Person class.
class Student extends Person

A more convenient form of diagram to represent the relationship between classes is as follows.



Notice how the diagrams reflect the inheritance relations. Any Person object has both an Object part and a Person part. Similarly, any Student object has an Object part, a Person part, and a Student part.

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Exercises

1. **a) In the class hierarchy diagram shown in Example 1, what is the superclass of Mammal?**

The superclass of Mammal is the class Vertebrates.

b) What class or classes does Dog extend?

The Dog class extends the Mammal class, Vertebrate class and Animal class.

- Dog extends the Mammal class
- Mammal extends the Vertebrate class
- Vertebrate extends the Animal class

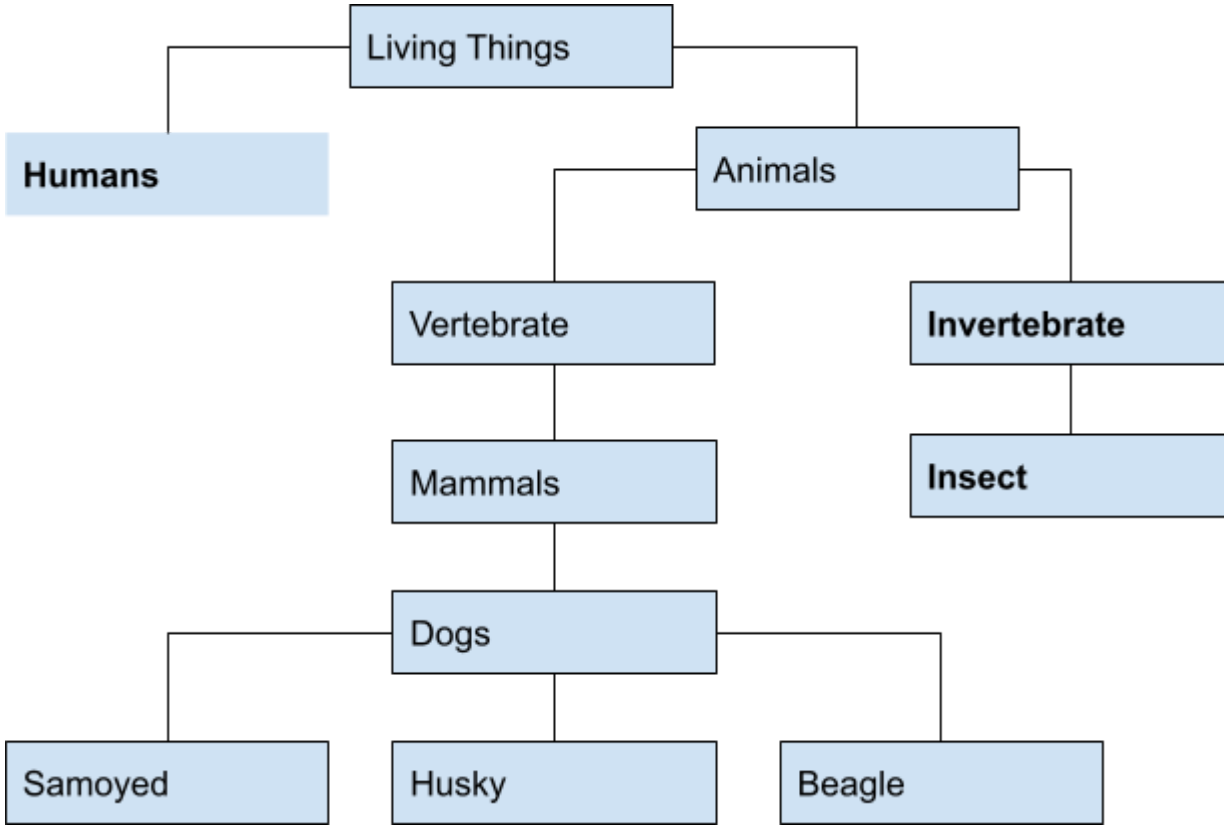
c) From what class or classes does Husky inherit?

Husky inherits from the Dog class, Mammal class, Vertebrate class and Animal class.

d) What class or classes does Dog extend?

The Dog class extends the Mammal class, Vertebrate class and Animal class.

e) Extend the diagram to include Invertebrate, Human, and Insect.



f) Suggest names of two other subclasses of Vertebrate.

Two other subclasses of Vertebrate that I suggest include:

1. Reptiles
2. Birds

2. If you were to write a definition of each of the following, what class would you extend? (Do *not* actually write the definitions)

a) Carrot **b) Apartment**

c) Flute **d) Neutrino**

a) Vegetable class
b) Property class
c) Woodmind class
d) Particles class

3. Does every Java class have a superclass? Explain.

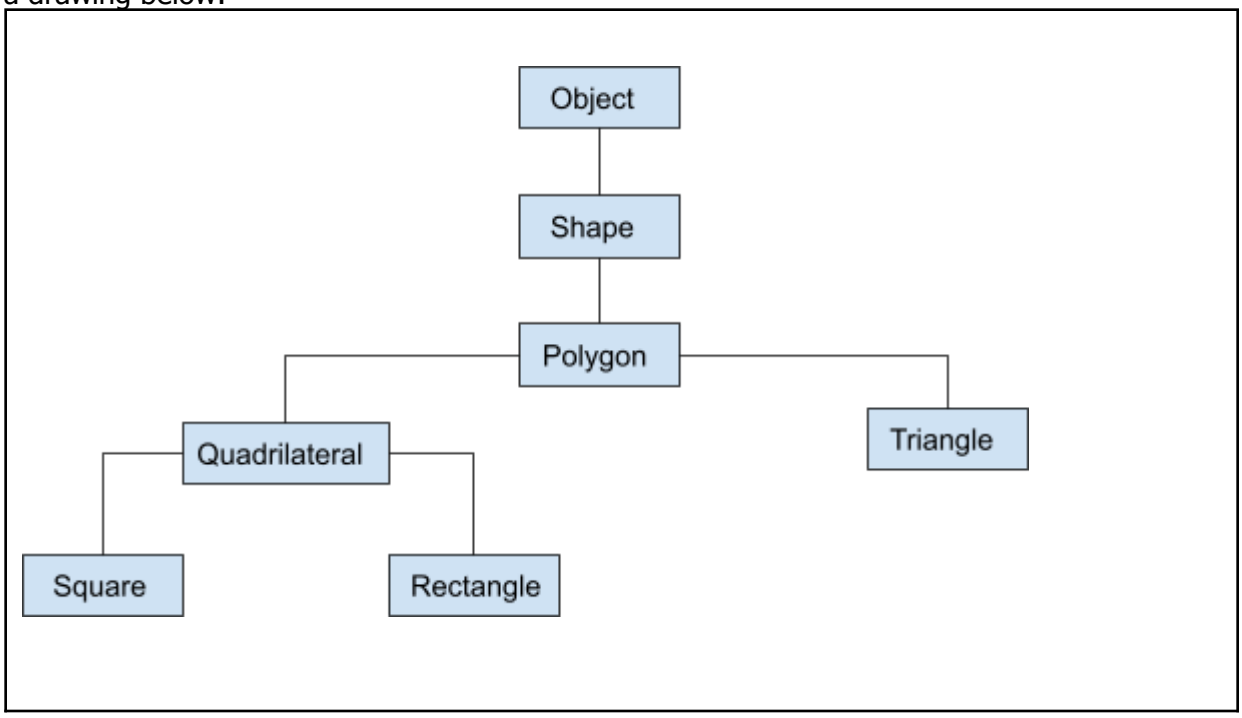
Yes at very least, every class has the Object superclass by default

4. Explain the difference between the statements "ClassA extends ClassB" and "ClassA inherits from ClassB".

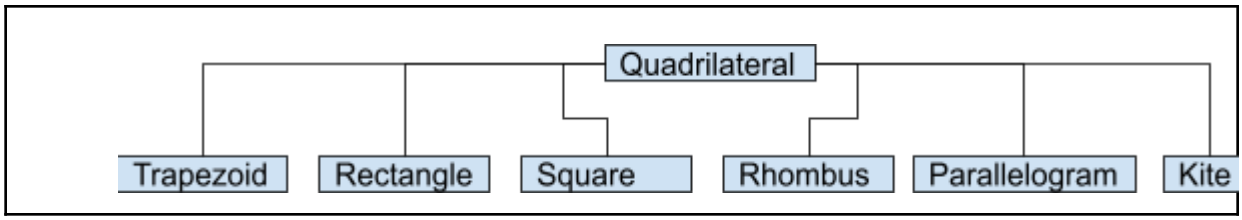
"ClassA extends ClassB" and ClassA inherits from ClassB" mean the same thing. They claim that ClassA inherits some properties and characteristics from ClassB. Therefore ClassA is a subclass of ClassB.

5. Draw a diagram, like the one in Example 1, showing the hierarchical relationship between the following classes: Rectangle, Polygon, Quadrilateral, Square, Object, Triangle, and Shape.

Insert a drawing below:



Draw a diagram, like the one in Example 2, to show the structure of the object.


Quadrilateral
Trapezoid
Rectangle
Square
Rhombus
Parallelogram
Kite