10.2 Polymorphism Examples

Let’s consider several additional examples of polymorphism.

Quadrilaterals

If class `Rectangle` is derived from class `Quadrilateral`, then a `Rectangle` object *is a* more *specific* version of a `Quadrilateral`. Any operation (e.g., calculating the perimeter or the area) that can be performed on a `Quadrilateral` can also be performed on a `Rectangle`. These operations can also be performed on other `Quadrilateral`s, such as `Square`s, `Parallelogram`s and `Trapezoid`s. The polymorphism occurs when a program invokes a method through a superclass `Quadrilateral` variable—at execution time, the correct subclass version of the method is called, based on the type of the reference stored in the superclass variable. You’ll see a simple code example that illustrates this process in Section 10.3.

Space Objects in a Video

Game

Suppose we design a video game that manipulates objects of classes `Martian`, `Venusian`, `Plutonian`, `SpaceShip` and `LaserBeam`. Imagine that each class inherits from the superclass `SpaceObject`, which contains method `draw`. Each subclass implements this method. A screen manager maintains a collection (e.g., a `SpaceObject` array) of references to objects of the various classes. To refresh the screen, the screen manager periodically sends each object the *same* message—namely, `draw`. However, each object responds its *own* way, based on its class. For example, a `Martian` object might draw itself in red with green eyes and the appropriate number of antennae. A `SpaceShip` object might draw itself as a bright silver flying saucer. A `LaserBeam` object might draw itself as a bright red beam across the screen. Again, the *same* message (in this case, `draw`) sent to a *variety* of objects has "many forms" of results.

A screen manager might use polymorphism to facilitate adding new classes to a system with minimal modifications to the system's code. Suppose that we want to add `Mercurian` objects to our video game. To do so, we'd build a class `Mercurian` that extends `SpaceObject` and provides its own `draw` method implementation. When `Mercurian` objects appear in the `SpaceObject` collection, the screen-manager code *invokes method* `draw`*, exactly as it does for every other object in the collection, regardless of its type.* So the new `Mercurian` objects simply "plug right in" without any modification of the screen-manager code by the

programmer. Thus, without modifying the system (other than to build new classes and modify the code that creates new objects), you can use polymorphism to conveniently include additional types that were not even considered when the system was created.

Software Engineering Observation 10.1

Polymorphism enables you to deal in generalities and let the execution-time environment handle the specifics. You can tell objects to behave in manners appropriate to those objects, without knowing their specific types, as long as they belong to the same inheritance hierarchy.

Software Engineering Observation 10.2

Polymorphism promotes extensibility: Software that invokes polymorphic behavior is independent of the object types to which messages are sent. New object types that can respond to existing method calls can be incorporated into a system without modifying the base system. Only client code that instantiates new objects must be modified to accommodate new types.