CMSC 132: OBJECT-ORIENTED PROGRAMMING II

Java Language Constructs II

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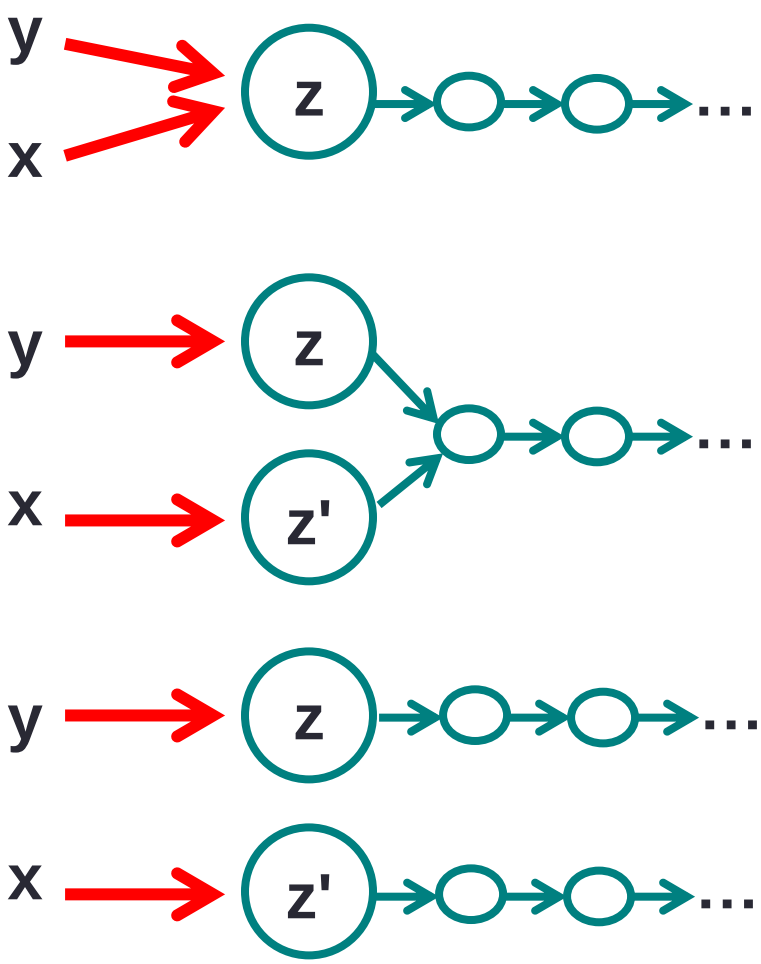
Three Levels of Copying Objects

Assume y refers to object z

1. Reference copy
   - Makes copy of reference
   - x = y;
2. Shallow copy
   - Makes copy of object
   - x = y.clone( );
3. Deep copy
   - Makes copy of object z and all objects (directly or indirectly) referred to by z



Cloning

- Cloning
  - We can create a copy of an object using the clone() method
- The **Object** class provides a clone() method that provides shallow copying
  - See prototype at https://docs.oracle.com/en/java/javase/11/docs/api/java.base/java/lang/Object.html
- To clone objects of a particular class, override the clone() method and call the Object class **clone** method. If the fields of the class are primitives or references to immutable objects, there is nothing else you need to do; otherwise you may need to duplicate objects referred by reference instance variables

Cloning

- Regarding overriding **clone()** method (Object class)
  - When overriding a method in Java, you can define the return type to be a subtype of the return type of the method being overridden. This is known as a **covariant return type**.
  - The above means that when defining a clone() method for a class the return type of the overriding clone() method can be changed to the class type. For example, if you are defining the clone() method for a **Mouse** class, the method we are overriding is

    protected Object clone() and we will override it with

    public Mouse clone()

Cloning

- A class needs to implement the Cloneable interface if it calls the Object class clone() method. If a class calls the clone method, but it does not implement the interface, the exception CloneNotSupportedException will be generated
- From the Java API
  - **CloneNotSupportedException** - Thrown to indicate that the clone method in class Object has been called to clone an object, but that the object's class does not implement the Cloneable interface
- The Object class **clone()** method is defined as protected
- **Example:** cloning package
  - Mouse.java, Computer.java, SuperComputer.java

Garbage Collection

- **Concepts**
  - All interactions with objects occur through reference variables
  - If no reference to object exists, object becomes garbage (useless, no longer affects program)
- **Garbage collection**
  - Reclaiming memory used by unreferenced objects
  - Periodically performed by Java
  - **Not guaranteed to occur**
  - Only needed if running low on memory
  - Suggesting JVM to do garbage collection using System.gc() method
    - https://docs.oracle.com/en/java/javase/11/docs/api/java.base/java/lang/System.html#gc()

Destructor

- Description
  - Method with name finalize()
  - The name is misleading as it does not destroy the objects
    - Contains action performed when object is about to be freed
  - Returns void
  - Invoked automatically by garbage collector
    - Not invoked if garbage collection does not occur
  - Usually needed only for non-Java methods
  - **finalize** is only called if the object is garbage collected, therefore there is no guarantee that **finalize** will always be called as an object might not be garbage-collected
  - Destructors are used a lot in C++
- Example

```
class Foo {
    void finalize() { … }              // destructor for foo
}
```

Initialization Block

- **Definition**
  - Block of code used to initialize static & instance variables for class
- **Motivation**
  - Enable complex initializations for static variables
    - Control flow
    - Exceptions
  - Share code between multiple constructors for same class

Initialization Block Types

- **Static initialization block**
  - Code executed when class is loaded
  - A class is loaded when it is needed and it is loaded only once (therefore static blocks only executed once)
- **Initialization block**
  - Code executed when each object created

    (at beginning of call to constructor)
- Example

```
class Foo {
    static { A = 1; }       // static initialization block
    { A = 2; }              // initialization block
}
```

Instance Variables Initialization

- Instance variables may be initialized
  - At time of declaration
  - In initialization block
  - In constructor
- Order of initialization
  1. Declaration, initialization block (in the same order as they appear in the source code)
  2. Constructor – overrides any other initializations
- **Example:** staticBlock package → VariableInitialization.java
- **Example:** staticBlock package → Person.java, PersonDriver.java
  - By using a static block we only need to create a single MILLENIUM object
- **Example:** nonStaticBlock package → Employee.java