Lecture 3:
Object Oriented Programming **II**

Object Creation

```
class Body {
  private long idNum;
  private String name = “empty”;
  private Body orbits;
  private static long nextID = 0;
}
```

```
Body sun = new Body( );
```

define a variable *sun* to refer to a Body object

create a new Body object

- An object is created by the ***new*** method
- The runtime system will allocate enough memory to store the new object
- If no enough space, the automatic garbage collector will reclaim space from other no longer used objects. If there is still no enough space, then an `OutOfMemoryError` exception will be thrown
- No need to delete explicitly

Constructor

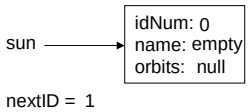
- constructor is a way to initialize an object before the reference to the object is returned by new
- has the same name as the class
- can have any of the same access modifiers as class members
- similar to methods. A class can have multiple constructors as long as they have different parameter list. Constructors have **NO** return type.
- Constructors with no arguments are called *no-arg* constructors.
- If no constructor is provided explicitly by the programmer, then the language provides a *default no-arg* constructor which sets all the fields which has no initialization to be their default values. It has the same accessibility as its class.

Sample Class and Constructors

```
class Body {
  private long idNum;
  private String name= "empty";
  private Body orbits;
  private static long nextID = 0;
  Body( ) {
    idNum = nextID++;
  }
  Body(String bodyName, Body orbitsAround) {
    this( );
    name = bodyName;
    orbits = orbitsAround;
  }
}
```

Assume no any Body object is constructed before:

```
Body sun = new Body( );
```



nextID = 1

Assume no any Body object is constructed before:

```
Body sun = new Body("Sol", null);
Body earth = new Body("Earth", sun);
```

nextID = 1 nextID = 2

Usage of *this*

- inside a constructor, you can use ***this*** to invoke another constructor in the same class. This is called *explicit constructor invocation.* It **MUST** be the first statement in the constructor body if exists.
- ***this*** can also be used as a reference of the current object. It **CANNOT** be used in a static method

Example: usage of ***this*** as a reference of the current object

```
class Body {
    private long idNum;
    private String name;
    private Body orbits;
    private static long nextID = 0;
    private static LinkedList bodyList = new LinkedList();

    . . .

    Body(String name, Body orbits) {
        this.name = name;
        this.orbits = orbits;
    }

    . . .

    private void inQueue() {
        bodyList.add(this);
    }

    . . .

}
```

Other initialization methods(1)

- Initialization block
  - a block of statements to initialize the fields of the object
  - outside of any member or constructor declaration
  - they are executed **BEFORE** the body of the constructors!

Without initialization block

```
class Body {
   private long idNum;
   private String name = "noNameYet";
   private Body orbits;
   private static long nextID = 0;

   Body(String bodyName, Body orbitsAround)
   {
      name = bodyName;
      orbits = orbitsAround;
   }
}
```

=

With initialization block

```
class Body {
   private long idNum;
   private String name = "noNameYet";
   private Body orbits;
   private static long nextID = 0;

   Body(String bodyName, Body orbitsAround)
   {
      name = bodyName;
      orbits = orbitsAround;
   }
}
```

Other initialization methods(2)

- Static initialization block
  - Resembles a non-static initialization block except that it is declared `static`, can only refer to static members and cannot throw any checked exceptions
  - Gets executed when the class is first loaded

Example

```
class Primes {
   static int[] primes = new int[4];

   static {
     primes[0] = 2;
     for(int i=1; i<primes.length; i++) {
        primes[i] = nextPrime( );
     }
   }
   //declaration of nextPrime( ). . .
}
```

Packages

- Classes can be grouped in a collection called *package*
- Java's standard library consists of hierarchical packages, such as java.lang and java.util

  `http://java.sun.com/j2se/1.4.2/docs/api`
- Main reason to use package is to guarantee the uniqueness of class names
  - classes with same names can be encapsulated in different packages
  - tradition of package name: reverse of the company's Internet domain name

    e.g. hostname.com -> com.hostname

Class importation (1)

- Two ways of accessing **PUBLIC** classes of another package
  1) explicitly give the full package name before the class name.
     - E.g.

       ```
       java.util.Date today = new java.util.Date( );
       ```
  2) import the package by using the `import` statement at the top of your source files (but below package statements). No need to give package name any more.
     - to import a single class from the java.util package

       ```
       import java.util.Date;
       Date today = new Date( );
       ```
     - to import all the public classes from the java.util package

       ```
       import java.util.*;
       Date today = new Date( );
       ```
     - * is used to import classes at the current package level. It will **NOT** import classes in a sub-package.

Sample class:

```
import javax.swing.*;

public class SampleClass {
  MenuEvent c;
}
```

```
%> javac SampleClass.java
SampleClass.java:4: cannot find symbol
Symbol  : class MenuEvent
Location: class SampleClass
    MenuEvent c;
    ^
1 error
```

MenuEvent is a class in the package `javax.swing.event`, which locates in the package `javax.swing`. You need this statement:

```
import javax.swing.event.*;
```

Class importation (2)

- What if you have a name conflict?

  E.g

```
import java.util.*;
import java.sql.*;
Date today = new Date( );  //ERROR:java.util.Date
                           //or java.sql.Date?
```

  - if you only need to refer to one of them, import that class explicitly

```
import java.util.*;
import java.sql.*;
import java.util.Date;
Date today = new Date( ); // java.util.Date
```

  - if you need to refer to both of them, you have to use the full package name before the class name

```
import java.util.*;
import java.sql.*;
java.sql.Date today = new java.sql.Date( );
java.util.Date nextDay = new java.util.Date( );
```

See this code:

```
import java.lang.Math;

public class importTest {
   double x = sqrt(1.44);
}
```

Compile:

```
%> javac importTest.java
importTest.java:3: cannot find symbol
symbol  : method sqrt(double)
location: class importTest
double x = sqrt(1.44);
           ^
1 error
```

?

For the static members, you need to refer them as **className.memberName**

Static importation

- In J2SE 5.0, importation can also be applied on static fields and methods, not just classes. You can directly refer to them after the static importation.
  - E.g. import all static fields and methods of the Math class

```
import static java.lang.Math.*;
double x = PI;
```

  - E.g. import a specific field or method

```
import static java.lang.Math.abs;
double x = abs(-1.0);
```

- Any version before J2SE 5.0 does NOT have this feature!

Encapsulation of classes into a package

- Add a class into a package — two steps:
  1. put the name of the package at the top of your source file

```
package com.hostname.corejava;
public class Employee {
       . . .
}
```

  2. put the files in a package into a subdirectory which matches the full package name

stored in the file “Employee.java” which is stored under “somePath/com/hostname/corejava/”

To emphasize on data encapsulation (1)

Let’s see a sample class first

```
public class Body {
  public long idNum;
  public String name = “<unnamed>”;
  public Body orbits = null;
  public static long nextID = 0;

  Body( ) {
   idNum = nextID++;
  }

  Body(String bodyName, Body orbitsAround) {
   this( );
   name = bodyName;
   orbits = orbitsAround;
  }
}
```

Problem: all the fields are exposed to change by everybody

To emphasize on data encapsulation (2)

improvement on the previous sample class with data encapsulation

```
public class Body {
  private long idNum;
  private String name = "<unnamed>";
  private Body orbits = null;
  private static long nextID = 0;

  Body( ) {
   idNum = nextID++;
  }

  Body(String bodyName, Body orbitsAround) {
   this( );
   name = bodyName;
   orbits = orbitsAround;
  }
}
```

Problem: but how can you access the fields?

To emphasize on data encapsulation (3)

*improvement on the previous sample class **with accessor methods***

```
public class Body {
  private long idNum;
  private String name = "<unnamed>";
  private Body orbits = null;
  private static long nextID = 0;

  Body( ) {
   idNum = nextID++; }

  Body(String bodyName, Body orbitsAround) {
   this( );
   name = bodyName;
   orbits = orbitsAround; }

  public long getID() {return idNum;}
  public String getName() {return name;};
  public Body getOrbits() {return orbits;}
}
```

Note: now the fields `idNum`, `name` and `orbits` are read-only outside the class. Methods that access internal data are called ***accessor methods*** sometime

To emphasize on data encapsulation (4)

modification on the previous sample class with methods setting fields

```
class Body {
   private long idNum;
   private String name = "<unnamed>";
   private Body orbits = null;
   private static long nextID = 0;

   // constructors omitted for space problem. . .

   public long getID() {return idNum;}
   public String getName() {return name;};
   public Body getOrbits() {return orbits;}

   public setName(String newName) {name = newName;}
   public setOrbits(Body orbitsAround) {orbits = orbitsAround;}
}
```

Note: now users can set the `name` and `orbits` fields. But `idNum` is still read-only

- Making fields private and adding methods to access and set them enables the users adding actions in the future
- Don't forget the `private` modifier on a data field when necessary! The default access modifier for fields is `package`

How the virtual machine located classes?

- How to tell the java virtual machine where to find the .class files? Answer: set the ***class path***.
- Class path is the collection of all directories and archive files that are starting points for locating classes.

  E.g.

  - first suppose the following is the current classpath:

  /home/user/classdir:.:/home/user/archives/archive.jar

  - then suppose the interpreter is searching for the class file of the com.horstmann.corejava.Employee class. It will first search class in the system class files that are stored in archives in the jre/lib and jre/lib/ext directories. It can't find the class there, so it will turn to search whether the following files exist in the following order:

    1) /home/user/classdir/com/horstmann.corejava/Employee.class
    2) ./com/horstmann.corejava/Employee.class
    3) com/horstmann/corejava/Employee.class inside /home/user/archives/archive.jar

  - if any of them is been found, then the interpreter stops searching process

Setting the class path

- Tedious way: set the class path with the `-classpath` option for the `javac` program

  javac –classpath /home/user/classdir:.:/home/user/archives/archive.jar MyProg.java

  (in Windows, use semicolon to separate the items of the class path)

- Set the CLASSPATH environment variable in a permanent way
  - UNIX/Linux
    - If you use the C shell, add a line such as the following to the .cshrc file in your home directory

      ```
      setenv CLASSPATH /home/user/classdir:.
      ```

    - If you use `bash`, add a line such as the following to the `.bashrc` or `.bash_profile` file in your home directory

      ```
      CLASSPATH=$CLASSPATH:.:/home/user/classdir
      export CLASSPATH
      ```

    - after you save the modified files, run the command

      ```
      source .bashrc(or .cshrc or .bash_profile)
      ```

  - Windows NT/2000/XP
    - Open the control panel, then open the **System** icon and select the **Environment** tab. Add a new environment variable named CLASSPATH and specify its value, or edit the variable if it exists already.

Naming conventions

- ***Package names***: start with lowercase letter
  - E.g. java.util, java.net, java.io . . .
- ***Class names***: start with uppercase letter
  - E.g. File, Math . . .
  - avoid name conflicts with packages
  - avoid name conflicts with standard keywords in java system
- ***Variable***, ***field and method names***: start with lowercase letter
  - E.g. x, out, abs . . .
- ***Constant names***: all uppercase letters
  - E.g. PI . . .
- ***Multi-word names***: capitalize the first letter of each word after the first one
  - E.g. HelloWorldApp, getName . . .
- ***Exception class names***: (1) start with uppercase letter (2) end with "Exception" with normal exception and "Error" with fatal exception
  - E.g. OutOfMemoryError, FileNotFoundException

Supplemental reading

Object-Oriented Programming Concepts
http://java.sun.com/docs/books/tutorial/java/concepts/index.html

Object and Classes in Java
http://java.sun.com/docs/books/tutorial/java/javaOO/index.html