Lecture 2:
Object Oriented Programming I

Procedural vs. Object-Oriented Programming

- The unit in procedural programming is *function*, and unit in object-oriented programming is *class*
- Procedural programming concentrates on creating functions, while object-oriented programming starts from isolating the classes, and then look for the methods inside them.
- Procedural programming separates the data of the program from the operations that manipulate the data, while object-oriented programming focus on both of them

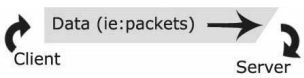


figure1: procedural

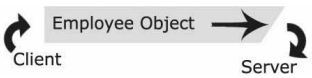


figure2: object-oriented

Concept of Class and Object

- "Class" refers to a blueprint. It defines the variables and methods the objects support
- "Object" is an instance of a class. Each object has a class which defines its data and behavior

Class Members

- **A class can have three kinds of members:**
  - ***fields***: data variables which determine the status of the class or an object
  - ***methods***: executable code of the class built from statements. It allows us to manipulate/change the status of an object or access the value of the data member
  - ***nested classes and nested interfaces***

Sample class

```
class Pencil {
    public String color = “red”;
    public int length;
    public float diameter;

    public static long nextID = 0;

    public void setColor (String newColor) {
          color = newColor;
    }
}
```

Fields – Declaration

- **Field Declaration**
  - a type name followed by the field name, and optionally an initialization clause
  - primitive data type vs. Object reference
    - boolean, char, byte, short, int, long, float, double
  - field declarations can be preceded by different modifiers
    - access control modifiers
    - static
    - final

More about field modifiers (1)

- Access control modifiers
  - *private:* private members are accessible only in the class itself
  - *package:* package members are accessible in classes in the same package and the class itself
  - *protected:* protected members are accessible in classes in the same package, in subclasses of the class, and in the class itself
  - *public:* public members are accessible anywhere the class is accessible

Pencil.java

```
public class Pencil {
    public String color = “red”;
    public int length;
    public float diameter;
    private float price;

    public static long nextID = 0;

    public void setPrice (float newPrice) {
          price = newPrice;
    }
 }
```

CreatePencil.java

```
public class CreatePencil {
    public static void main (String args[]){
          Pencil p1 = new Pencil();
          p1.price = 0.5f;
    }
}
```

```
%> javac Pencil.java
%> javac CreatePencil.java
CreatePencil.java:4: price has private access in Pencil
      p1.price = 0.5f;
         ^
```

More about field modifiers (2)

- static
  - only one copy of the static field exists, shared by all objects of this class
  - can be accessed directly in the class itself
  - access from outside the class must be preceded by the class name as follows

    ```
    System.out.println(Pencil.nextID);
    ```

    or via an object belonging to the class
  - from outside the class, non-static fields must be accessed through an object reference

```
public class CreatePencil {
    public static void main (String args[]){
          Pencil p1 = new Pencil();
          Pencil.nextID++;
          System.out.println(p1.nextID);
          //Result? 1

          Pencil p2 = new Pencil();
          Pencil.nextID++;
          System.out.println(p2.nextID);
          //Result? 2

          System.out.println(p1.nextID);
          //Result?  still 2!
    }
}
```

Note: this code is only for the purpose of showing the usage of static fields. It has POOR design!

More about field modifiers (3)

- final
  - once initialized, the value cannot be changed
  - often be used to define named constants
  - static final fields must be initialized when the class is initialized
  - non-static final fields must be initialized when an object of the class is constructed

Fields –Initialization

- **Field initialization**
  - not necessary to be constants, as long as with the right type
  - If no initialization, then a default initial value is assigned depending on its type

Type	Initial Value
boolean	false
char	'\u0000'
byte, short, int, long	0
float	+0.0f
double	+0.0
object reference	null

Methods – Declaration

- Method declaration: two parts
  1. method header
     - consists of modifiers (optional), return type, method name, parameter list and a throws clause (optional)
     - types of modifiers
       - *access control modifiers*
       - *abstract*
         - the method body is empty. E.g.

           ```
           abstract void sampleMethod( );
           ```
       - *static*
         - represent the whole class, no a specific object
         - can only access static fields and other static methods of the same class
       - *final*
         - cannot be overridden in subclasses
  2. method body

Methods – Invocation

- Method invocations
  - invoked as operations on objects/classes using the dot (.) operator

    ```
    reference.method(arguments)
    ```
  - static method:
    - Outside of the class: "`reference`" can either be the class name or an object reference belonging to the class
    - Inside the class: "`reference`" can be ommitted
  - non-static method:
    - "`reference`" must be an object reference

Method - Overloading

- A class can have more than one method with the same name as long as they have different parameter list.

```
public class Pencil {
       . . .
       public void setPrice (float newPrice) {
              price = newPrice;
       }

       public void setPrice (Pencil p) {
              price = p.getPrice();
       }
}
```

- How does the compiler know which method you're invoking? — compares the number and type of the parameters and uses the matched one

Methods – Parameter Values

- Parameters are always passed by value.

```
public void method1 (int a) {
    a = 6;
}

public void method2 ( ) {
    int b = 3;
    method1(b);   // now b = ?
                  // b = 3
}
```

- When the parameter is an object reference, it is the object reference, not the object itself, getting passed.

☹ Haven't you said it's past by value, not reference ?

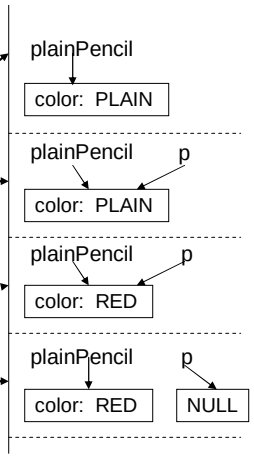
another example: (parameter is an object reference)

```
class PassRef{
   public static void main(String[] args) {
      Pencil plainPencil = new Pencil("PLAIN");
      System.out.println("original color: " +
   plainPencil.color);

      paintRed(plainPencil);   ------------------

      System.out.println("new color: " +
   plainPencil.color);
   }

   public static void paintRed(Pencil p) {
      p.color = "RED";
      p = null; ------------------------------
   }
}
```



- If you change any field of the object which the parameter refers to, the object is changed for every variable which holds a reference to this object

- You can change which object a parameter refers to inside a method without affecting the original reference which is passed

- What is passed is the object reference, and it's passed in the manner of "PASSING BY VALUE"!

The Main Method - Concept

- **main** method
  - the system locates and runs the main method for a class when you run a program
  - other methods get execution when called by the main method explicitly or implicitly
  - must be public, static and void

The Main Method - Getting Input from the Command Line

- When running a program through the `java` command, you can provide a list of strings as the real arguments for the `main` method. In the `main` method, you can use `args[index]` to fetch the corresponding argument

```
class Greetings {
   public static void main (String args[]){
     String name1 = args[0];
     String name2 = args[1];
     System.out.println("Hello " + name1 + "&" +name2);
   }
}
```

  - `java Greetings Jacky Mary`

```
Hello Jacky & Mary
```

- Note: What you get are strings! You have to convert them into other types when needed.

Modifiers of the classes

- A class can also has modifiers
  - public
    - publicly accessible
    - without this modifier, a class is only accessible within its own package
  - abstract
    - no objects of abstract classes can be created
    - all of its abstract methods must be implemented by its subclass; otherwise that subclass must be declared `abstract` also
  - final
    - can not be subclassed
- Normally, a file can contain multiple classes, but only one public one. The file name and the public class name should be the same