Lecture4 – OOP concepts in Java

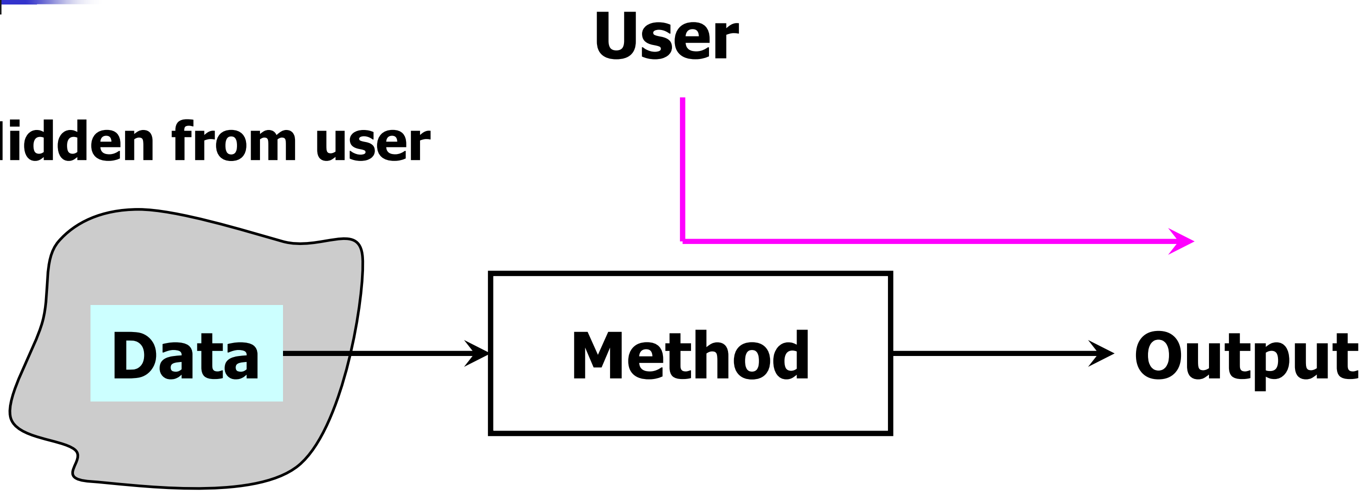
- Object Oriented Programming in Java
  - Review
    - Concept of class/object
      - Constructors
    - Data encapsulation
  - Inheritance
  - Abstract classes and Interfaces
  - Polymorphism
  - Abstract classes
  - Interfaces
- Other features of Java
  - static, final, finalize

Data encapsulation - review

Data encapsulation

- Hide the data from end user
- Need to know what methods are implemented
- Not how they are implemented
- Provide interfaces (APIs) to access data
- E.g. To compute interest in a bank an user
  - Needs to know what function to call
  - NOT how the function is implemented

Data encapsulation … contd.



- Methods act on data to provide output.
- User needs to see only method, not data.
- User should not be affected by
  - Implementation details of methods.
  - Changes in implementation of methods.

Data encapsulation … contd.

- Not all data needs to be hidden
  - It is fine to give direct access to some data.
- Not all methods need to be given access
  - Some methods may be hidden – for internal use by classes

⇒ Data and methods both need access restrictions.

- How can data/methods be hidden?
  - By using access modifiers.
- Different access modifiers:
  - public – accessible to every class, function
  - private – accessible only to class and package
  - protected – accessible to class package and subclass
  - No modifier – accessible only to class and package

Access modifiers

Modifier	class	package	subclass	others
public	Yes	Yes	Yes	Yes
protected	Yes	Yes	Yes	No
No modifier	Yes	Yes	No	No
private	Yes	No	No	No

Source: Oracle.com

Data encapsulation in account example

In an object of account

- user_ssn and accountNumber are declared private
    - Accessible only to account and nothing else.
    - Methods are public
        - Anyone can access them.

```
public class Account
{
  private  int user_SSN;                       // Accessible only to Account
  private  int accountNumber;                  // Accessible only to Account
  public   Account ( ) { .. }                       // Accessible to all
  public   void withdrawMoney (int amount) { .. } ; // Accessible to all
  public   void depositMoney (int amount)   { .. };  // Accessible to all
  public   void computeInterest( )          { .. };  // Accessible to all
 …
};
```

Inheritance

Inheritance

- Let’s take the account example again
- There can be many types of accounts
  - Checking, saving, money market, IRA, etc.
- All accounts may have
  - Some common members.
    - Account number, user SSN, etc.
  - Some class specific members.
    - Checks cleared, investment options, etc.
- Method implementation may be
  - Same in different classes
  - Different in different classes.

Inheritance – base class & derived class

- Base class

```
class account
{
    private int user_SSN;
    private int accountNumber;
    public Account ( ) { .. }
    public void deposit (int amount)   { …  }
    public void withdraw (int amount) { …  }
};
```

- Derived class or child class

```
class checkingAccount  extends account    // checkingAccount is
{                                         // derived from account
    private int lastCheckCleared;         // not present in account
    public  void showAllChecksCleared( ) { } // not present in account
};
```

Inheritance - base class and derived classes

- Base Class

```
class account
{
  private int user_SSN;
  private int accountNumber;
  public  Account ( ) { … } // code
  public  void deposit (int amt)
   {
     // code
   }
  public  void withdraw (int amt)
   {
     // code
   }
};
```

- Derived (or child) class-1

```
class checkingAccount extends account
{
     private int lastCheckCleared;
     public checkingAccount ( ) { … };
     public void showChecksCleared ( ) { //code
      }
};
```

- Derived (or child) class-2

```
class IRA_account extends account
{
     public IRA_Account ( ) { … };
     public void buyFund (int fund_ID)  {
     //code
      }
     public void sellFund (int fund_ID)  {
     //code
      }
};
```

Inheritance - continued.

- Important points to note:
  - Derived classes have access to members of base classes in this example.
  - Derived classes can have their own members.
    - E.g. showLastCheckCleared( ), buyFund( ), sellFund( ), etc.
    - Members of one derived class are not accessible to another.

Examples

- Valid usage in an external function
  - Account acct = new Account ( );
  - checkingAccount ca = new checkingAccount ( );
  - acct.deposit (700);
  - acct.withdraw (300);
  - checkingAccount.deposit (1000);
  - checkingAccount.withdraw (600);
- Invalid usage in an external function
  - acct.user_SSN = 1234; // Can't access user_SSN
  - acct.accountNumber = 567;

Inheritance … Object class

- In Java Object is the base class for every Java class.
- Object is a built-in class.
- Defines useful functions.
  - hashCode
  - toString
  - equals
  - notify, etc.

Polymorphism

Polymorphism

- Poly – many, Morphism – ability to take many forms
  - Ability of objects to behave differently
  - Achieved by using different implementations of the same function in different classes.
  - Parent class defines and implements a function in one way.
  - Child classes can override the function.

Polymorphism

```
public class Account
{
    public Account() { }

    public void showAccountType  ( )
    {
        System.out.println ("Account");
    }

    public static void main (String args[ ])
    {
       Account a  = new Account();
       Account ca = new CheckingAccount( );
       Account sa = new SavingsAccount( );
       a.showAccountType( );  //Account
       ca.showAccountType( ); //CheckingAccount
       sa.showAccountType( ); //SavingsAccount
    }
};
```

```
class CheckingAccount extends Account
{
    public CheckingAccount() { }

    public void showAccountType  ( )
    {
       System.out.println ("CheckingAccount");
    }
};

class SavingsAccount extends Account
{
    public SavingsAccount( ) { }

    public void showAccountType  ( )
    {
        System.out.println ("SavingsAccount");
    }
};
```

Polymorphism … contd.

- In the previous example
  - a, ca and sa are defined of type Account
  - But they each executed a different showAccountType function.
    - a executed the function in class Account
    - ca executed the function in class CheckingAccount
    - sa executed the function in class SavingsAccount.
  - Reason this is possible
    - Each object is created differently
    - a is created as Account, ca as CheckingAcocunt, sa as SavingsAccount
    - This is an example of late binding or runtime binding
    - At runtime, objects are bound to the correct type and the corresponding function is executed.

Executing a member function

- In any class, when a member function is called,
  - The member function of the most specific class is executed.
- E.g. object o is created of type class c
- If a member function o.f( ) is called, function in c is executed, if it exists.
- Otherwise, the function f( ) in the closest parent in the hierarchy is executed.

Overloaded functions

- A function with the same function name
  - With different arguments
    - Same number of arguments, but different types
    - Different number of arguments
- E.g.

```
class foo
{
   void overloadedFn(int a) {… };
   void overloadedFn(String s) {…};
   void overloadedFn( ) {…};
   void overloadedFn(int a, double b) {…};
}
```

Abstract class

Abstract classes

- Consider an object of Account.
- It makes sense to have
  - A specific type (e.g., checking) of account
  - Not just a generic account object.
- A user should be able to create
  - Specific object types.
  - NOT generic objects.
- An abstract class is the generic class.
  - Cannot create objects of this class
- Classes derived from the abstract classes are specific objects.
  - Can create objects of the derived classes.

Abstract classes … contd.

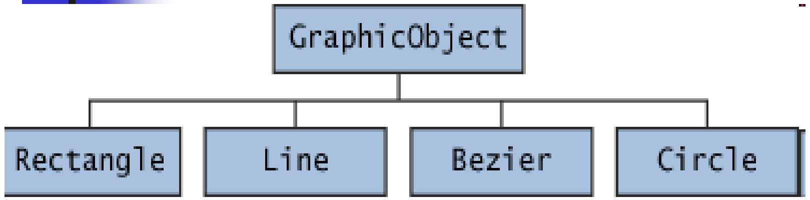
- Abstract class
  - A class that has abstract keyword (prefix)
  - May have the following methods:
    - abstract – no implementation, only declaration
    - non-abstract – have implementation
  - Cannot be instantiated
  - Can be extended by (non) abstract subclasses

Abstract class - Example

```
abstract class shape
{
   abstract int findArea( );
   public String showShape( )
     {
         return (“defaultShape”);
     }
};
```

```
class square extends shape
{
   private int length;
   public square ( ) { length = -1; }
   public int findArea ( )
     {
        return (length * length);
      }
    public String showShape ( )
     {
        return (“square”);
     }
};
```

Abstract class … Example-2



```
abstract class GraphicObject
{
    int x, y;
    // non-abstract method
    // has actual code
    void moveTo (int x1, int y1)
     { … }
    // abstract methods
    // No code or implementation
    abstract void draw(  );
    abstract void resize( );

 }
```

```
class Circle extends GraphicObject
{
    void draw ( ) { … }
    void resize ( ) { … }
 };

 class Rectangle extends GraphicObject
{
    void draw( ) { … }
    void resize( ) { … }
 } ;
```

Source: Oracle.com

Interfaces

Java interfaces

- Interface
  - Similar to abstract class
    - Cannot be instantiated.
  - Difference
    - Member functions can only be defined.
    - No implementation for ANY member function.
  - Derived classes need to implement functions.

Interface … example

```
interface myInterface
{
    void function1( );
     int function2( );
}
```

Note: No implementation for function1 or function2

```
class myClass implements
    myInterface
{
    void function1( )
      {
          System.out.println ("fn1");
      }
    int function2( )
      {
          System.out.println ("fn2");
          return (1);
      }
}
```

Multiple inheritance in Java

- Java allows implementation of multiple interfaces.
  - class myClass implements intfc1, intfc2 is allowed
- Java does not allow extension of more than one class.
  - class myClass extends class1, class2 is NOT allowed.
- Extension of one class, implementation of multiple interfaces is allowed.
  - Class myClass extends class1, implements interface1, implements interface2 is allowed.

final in Java

- final can have several meanings in Java
  - final class cannot be extended
  - final methods cannot be overridden by members of child classes
  - final variables can only be assigned once

```
public final class myClass // Cannot be extended
{
        public static final PI = 3.1415926
        public static final someFinalMethod( ) { …}
 }
```

Static members

- Specific to class, not individual objects
- Common to all objects
- Can be used with data or functions.
- E.g. main function is static

```
class staticExample
{
    staticExample( ) { }
    static int static_var = 1;
    static void static_fn( ) { }
    public static void main ( String args[ ] )
    {
      System.out.println (static_var); // No object is created
      static_fn( );                    // No object is created
   }
};
```