LESSON IV.
Encapsulation and Class Building

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Objectives

- Understand the application of object oriented principles in Java
- Acquaint how to declare a class and its members

Content

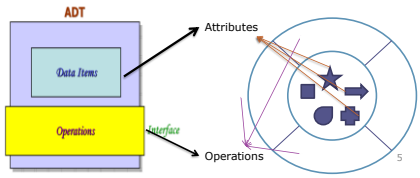
- Data abstraction
  - Overview
  - Class and instance
  - Message passing
- Encapsulation
  - Visibility
- Class building
  - Declaration
    - Class declaration
    - Class member declaration
  - Data hiding

Abstraction

- Abstraction hides the detailled information about object.
- Abstraction is a view or representation of an object that includes only the most significant attributes
  - These attributes make dicstinction this object with others.

Abstract data type

- Abstract data type = data type + operation performed on this type
  - Every operation related to a data structure is grouped together
  - Only possible operation are provided in the type's definition
- Java allows implementing ADT in the form of classes.
- A class comprises of attributes and operations.



2. Class

- A class is the blueprint from which individual objects are created.
- A class specifies the common attributes and operations of many individual objects all of the same kind.
- A class defines a new data type, whose values are objects:
  - A class is a template for objects; it abstracts a set of objects
  - An object is an instance of a class; it concretes a class.

Attributes and operations

- Attribute
  - An attribute of a class is an identified common state of all instances of this class (i.e. set of concrete objects).
  - An attribute specifies all possible values that can be assigned as concrete state of these of objects.
  - → Each object maintains a private copy of each attribute value
- Operation
  - An operation of a class is an identified common behavior of all instances of this class (i.e. set of concrete objects). The behavior operates on the class attributes and usually derives the change of a class' state.

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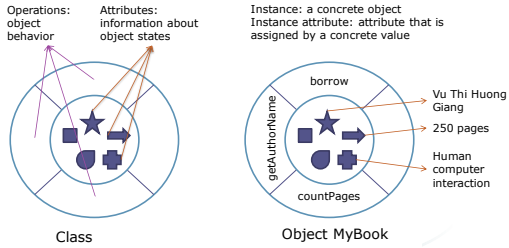
Example: Class and instance



3. Message passing

- Message passing is the only way to interact with objects
  - Objects communicate by sending messages
  - Objects respond to a message that is sent to them by performing some action.

II. Encapsulation

- Encapsulation: Prevents the code and data being randomly accessed by other code defined outside the class.
  - Group data and operations performed on these data together in a class
  - Hide details about the class implementation from the user.

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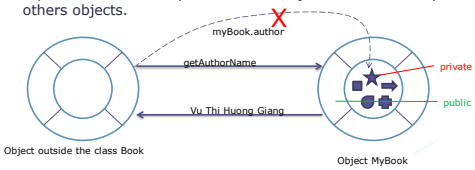
Visibility scope

- Scope determines the visibility of program elements with respect to other program elements.
- Given a class:
  - A private attribute or operation of an object is accessible by all others objects of the same class
  - A public attribute or operation of an object is accessible by all others objects.



If an attribute or operation is declared private, it cannot be accessed by anyone outside the class

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III. CLASS BUILDING

1. Declaration
2. Data hiding

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III.Class building
1. Declaration

a. Class declaration

```
[package package-name;]
[access-modifier] class class-name {
   // class body
   access-modifier type instance-variable-1; …
   static type class-variable-2; ...
   type method-name-1(parameter-list) {…} …
}
```

- A class encapsulates following members:
  - Name
  - Variables: declare the attributes of a class
  - Methods: declare the operations of class
- Related classes can be grouped into a package to easily control the access to these classes.
- The visibility scope of a class can be explicitly set by declaring an access modifier.

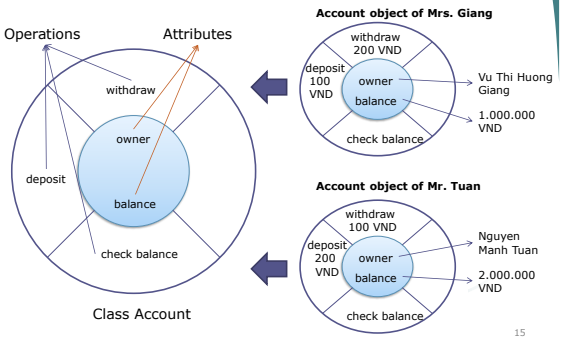
III.Class building
1. Declaration
a. Class declaration

Access modifier: Class' and members' visibility scope

- Four visibility scopes are identified in term of access modifiers to limit the access to the attribute and the operation:
  - public: visible to the world (free access)
  - private: visible to the class only (class access)
  - protected: visible to the package and subclasses (only with an inheritance relationship)
  - default (no modifier declared): visible to the package (package access)
- Example:

```
package acu.java.example;
class Account {
…
}
```


Example: Class and Object



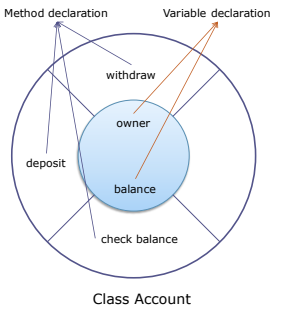
III. Class building
1. Declaration
a. Class declaration

b. Variable declaration

- Variables must be declared within a class
  - Instance variables (member variables): declared within a class + outside any method
  - Class variables : declared within a class, outside any method, with the static keyword
  - Local variables: declared inside methods, constructors or statement blocks (invisible outside them)

```
class class-name {
   [access-modifier] type instance-variable-1; …
   static datatype class-variable-1; ...
   datatype method-name-1(parameter-list) {
        datatype local-variable-1;
        …
   } …
}
```


Example: Class and variables



- Declaration of a class with two variable members:

```
class Account{
   String owner;
   long balance;
…
}

class Account1{
   private String owner;
   private long balance;
…
}
```

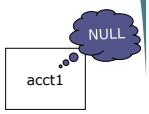
Can you show the difference between these 2 declarations ?
→ Use private modifier for declaring the concrete state of an object.

Variable creation

`datatype var1 = new datatype();`

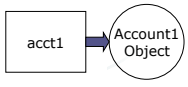
- A variable **`var1`** is declared to refer to the object of class **`datatype`**.

```
Account1 acct1;
// acct1 represents nothing
```

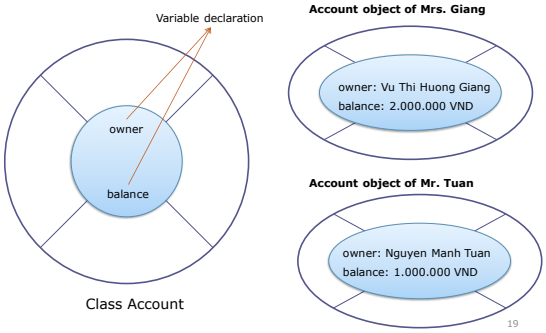


- After the assignment, the reference variable **`var1`** contains the address of a concrete **`datatype`** object that was created in memory.

```
acct1 = new Account1();
// acc1 refers to an Account1 object
```



Example: instance variable creation

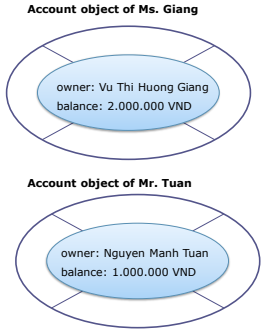


Example: instance variable creation

- New Account objects are created and new values are assigned to theirs 2 variables:

```
Account acc1 = new Account();
acc1.name =
   "Vu Thi Huong Giang";
acc1.balance = "2000000";
Account acc2 = new Account();
acc2.name = "Nguyen Manh Tuan";
acc2.balance = "1000000";
```

→ each object has its own data space
→ changing the value of a variable in one object doesn't change it for other



III. Class building
1. Declaration
a. Class declaration
b. Variable declaration

Class (static) variables

- Class variable: declared with the **`static`** keyword
- Memory space for a class variable is created when the class is first referenced
- It holds the same value for all objects instantiated from this class → changing the value of a static variable in one object changes it for all others
- Declaration format:

```
[access-modifier] static data-type
      member-variable-name;
```

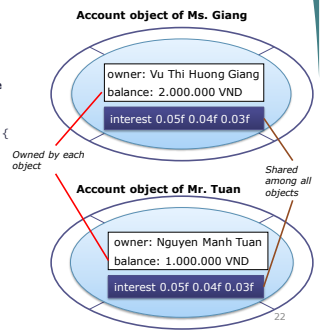
- Reference format:

```
class-name.member-variable-name;
object-name.member-variable-name;
```


Static variable

```
class Account {
// Member variable
String name; // Account name
long balance; // Balance
static float interest;//Deposit rate
}
class AccountClassUsage{
 public static void main(String[] args) {
      Account.interest=0.05f;
      Account giang= new Account();
      Acount tuan = new Account();
      giang.interest=0.04f;
      tuan.interest=0.03f;
 }
}
```

→ **Static variable cannot be used within a non-static method.**



III. Class building
1. Declaration
a. Class declaration
b. Variable declaration

c. Method declaration

- A Java method has two parts:
  - Declaration:
    - Specifies the name of the method, its return type and its formal parameters (if any)
    - Is used to hide the internal data structures of a class, as well as for their own internal use.
  - Implementation:
    - Specifies a collection of statements that are grouped together to perform an operation.
    - These statements are executed when a method is called.
    - It is through the implementation of the method that the state of an object is changed or accessed.

III. Class building
1. Declaration
a. Class declaration
b. Variable declaration

c. Method declaration

- Syntax

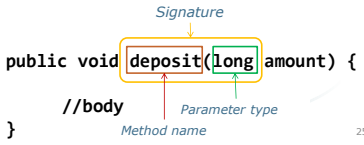
```
[access-modifier] return-type name(parameter-list) {
   // body
   [return return-value;]
}
```

where:
  - return-type: type of values returned by the method (void if a method does not return any value)
  - name: name of the method
  - parameter-list: sequence of type-identifier lists separated by commas
  - return-value: what value is returned by the method.

III. Class building
1. Declaration
a. Class declaration
b. Variable declaration
c. Method declaration

Signature

- The signature of a method consists of
  - The method's name
  - A list of parameter types, in which the number and the order of parameters are respected.
- Example: the signature of the following method is **deposit(long)**



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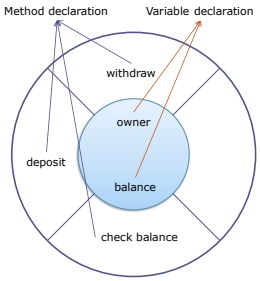
Example: Method declaration and implementation



Class Account

- The type of a variable assigned the value returned by a method must agree with the return type of this method:

```
class Account1{
   private String name;
   private long balance;
   // deposit money
   public void deposit(long money) {
         balance += money;
   }
   // Check the account balance
   public long checkBalance() {
         return balance;
   }
...
}
```

- Member variables can be used anywhere inside the class.

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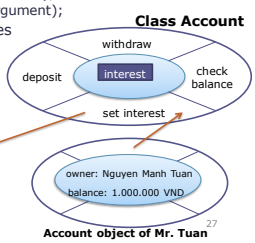
Static method

static return-type name(parameter-list) { … }

- Several restrictions:
  - can only call static methods
    - Class name.method_name(argument);
    - Object name.method_name(argument);
  - must only access static variables

```
class Account {
// Member variable
...
static float interest;//Deposit rate
public static void setInterest(float pInterest){
    interest = pInterest;
}
}

Account.setInterest(0.05f);
Account tuan = new Account();
tuan.setInterest(0.04f);
```



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Method with a variable-length argument

- Declaring a variable-length parameter allows passing many values of the same data type.
  - No explicit number and order of arguments is declared
  - You may not pass the value to a variable-length argument.
- The passed arguments are treated as an array.
- Syntax:

```
modifier return-type method-name
   (data-type variable-length-parameter) {
   // body
   return return-value;
}
```

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Example

```
public class VariableLengthArgumentUsage {
    public static double average( double... numbers ) {
        double total = 0.0;
        for ( double d : numbers )
          total += d;
        return total / numbers.length;
    }
    public static void main(String[] args) {
        double d[] = {10.0, 20.0, 30.0, 40.0, 50.0};
        System.out.printf("Mean value of this array is");
        System.out.printf(" %.1f\n", average(d[0], d[1], d[2],
          d[3], d[4]));
    }
}
```

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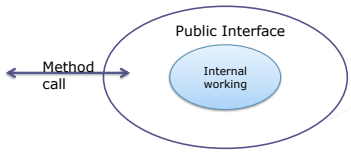
III. Class building
1. Declaration

2. Data hiding

- A class provides data hiding
  - Data is in a unique scope; access controlled with public, private, protected keywords
  - Data is accessed through public methods; a collection of the signatures of public methods of a class is called interface.
  - → Avoid illegal modification of attributes



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Quiz 1 – variable and method declaration

- Declare the class Media describing media products such as book, that has following attributes and operations
  - Title
  - Category
  - Price
  - Show the title, price, category of a media product
  - Set a title, price, category for a media product

Quiz 1 – solution

```
public class Media {
    private String title;
    private String category;
    private float cost;
    public String getTitle() {
      return title;
    }
    public String getCategory() {
      return category;
    }
    public float getCost() {
      return cost;
    }
    public void setCategory
      (String category) {
      this.category = category;
    }
    public void setCost
      (float cost) {
      this.cost = cost;
    }
    public void setTitle
      (String title) {
      this.title = title;
    }
}
```


Quiz – static variable and static method

2. In the class Media:
   - Declare the product distributor as a static variable
   - Declare and implement the static method that allows changing the distributor of all media products.
3. In the class Media:
   - Declare and implement a method for displaying information about a concrete media product. Explain which attributes can be displayed by this method and why.
   - Declare and implement a method with variable-length argument for displaying all information about a concrete media product.
4. Write a program that
   - calls the static method using the class name
   - calls an instance of the method with/without variable-length argument

Quiz 2 - Solution

```
public class Media {
   private String title;
   private String category;
   private float cost;

   static String distributor;

   // ... implementation of methods as in the solution of Quiz 1

   public static void setDistributor(String dist) {
        distributor = dist;
   }
}
```


Quiz 3 - Solution

```
public void displayInstanceInfo() {
    System.out.println("Information about a
    concrete media product: ");
    System.out.println("Title: "+ title);
    System.out.println("Category:" +
    category);
    System.out.println("Price:" + cost);
    // can not access to static variable
}

public static void displayStaticInfo() {
    System.out.println("Distributor: " +
    distributor);
    // can not access to instance variable
}
```

```
public static void displayInstanceInfo
    (String... values) {

    System.out.println("Information
    about the media product: ");

    for ( String v : values )
          System.out.print(v);
}
```


Quiz 4 - solution

```
public class MediaClassUsage {
     public static void main(String[] args) {
          // static reference of variable
          System.out.println("Distributor: " + Media.distributor);
          // create a concrete media product
          Media media = new Media();
          media.setTitle("Vivaldi: The Four Seasons");
          media.setCategory("CD"); media.setCost((float) 14.38);
          media.setDistributor("Amazon");
          // static method call
          Media.displayStaticInfo();
          // call of instance method without variable-length args
          media.displayInstanceInfo();
          // call of instance method with variable-length args
          media.displayInstanceInfo("Title: ", media.getTitle(), "\n",
            "Category: ", media.getCategory(),"\n",
            "Price: ", Float.toString(media.getCost()),"\n",
            "Distributor: ", media.distributor);
     }
}
```

Review

- Data abstraction:
  - the class is the abstract data type, defining the representation of and operations on objects of the type.
- Encapsulation:
  - Class encapsulates objects
  - Object encapsulates data and implementation
- Visibility: To control the access to a class and to its members, we can use
  - Access modifiers: public, private, protected, default
    - Private: for hidden members
    - Public: for interface members
    - Protected: for inheritance (discuss later)
  - Package scope: members of all classes in a package that have default modifiers are visible throughout the package
- Class building
  - Variable declaration
  - Method declaration

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Review

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