

## Coin Purse

Objectives	Implement an object-oriented program using a <b>List</b> for collection of objects.
Sample Code	Sample source code is <b>coinpurse-sample.zip</b> in the week3 folder.
What to Submit	Submit a project named <b>coinpurse</b> on Github. The source code should be in the package name <b>coinpurse</b> (which will appear <i>inside</i> your <b>src/</b> directory) and there should be a descriptive <b>README.md</b> . Please <b>don't</b> submit binaries (use <b>.gitignore</b> as instructed in week1).

## Requirements

1. Write an application to simulate a coin purse that we can **insert** and **remove** coins.
2. A purse has a **fixed capacity**. Capacity is the maximum number of coins that you can put in the purse, not the *value* of the coins. The value is unlimited.
3. A purse can tell us **how much money** is in the purse.
4. We can **insert** and **withdraw** money. For withdraw, we ask for an **amount** and the purse decides which coins to withdraw.

## Application Design

In designing an O-O software application you need to do the following (among other things). Try to complete steps 2-4 on your own before reading the rest of the lab sheet.

1. Identify Classes: We need at least 3 classes for the application

Coin

Purse (like a Coin Machine)

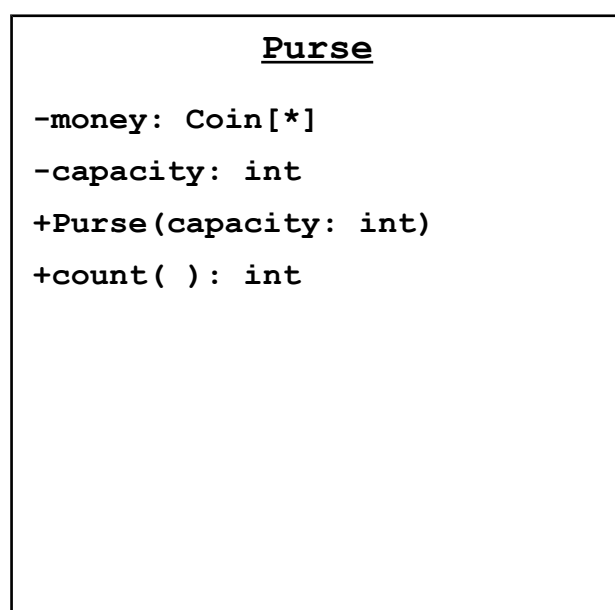
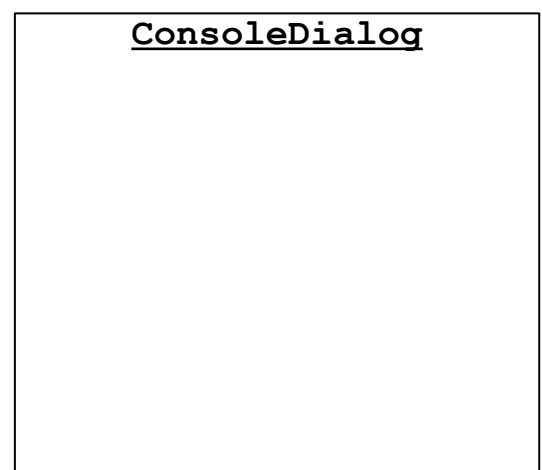
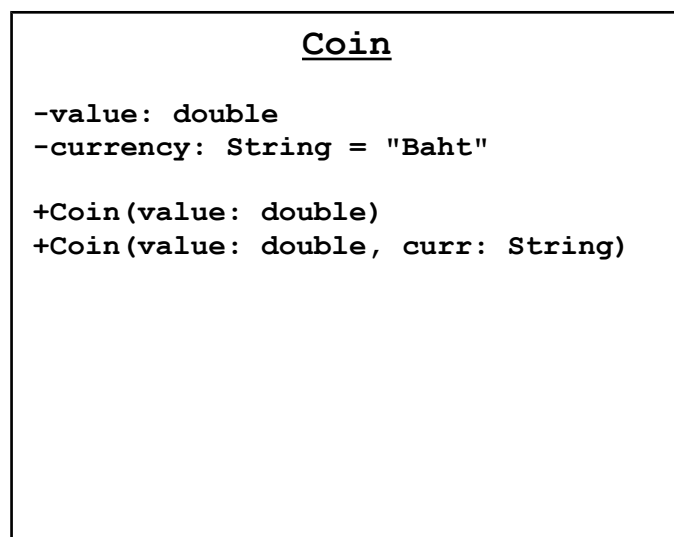
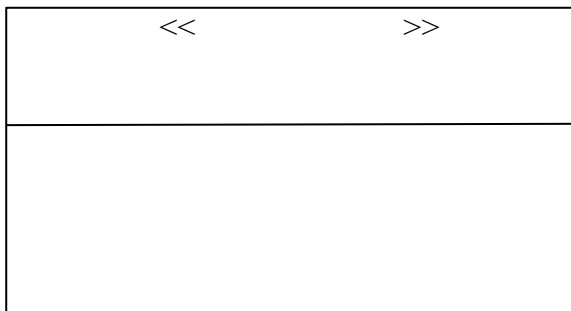
User Interface

2. Identify Responsibilities. What is the *main responsibility* of each class?
3. Assign behavior to classes: what methods should an object have to fulfill its responsibilities?
4. Determine attributes of objects: what does each object need to *know*?



## Exercise 1: Complete the UML diagram and submit it before end of lab

1. complete attributes and methods.
  2. **show relationships**: association, dependency, implements.
- The TAs must check your UML diagram before end of lab. You will be given one chance to fix errors.



Coin[\*] means a collection of Coin objects.

## Exercise 2: Design and Write the Coin Class

A Coin has a value and a currency that cannot be changed. A Coin can be **compared** to **other Coins**, so we can sort them by value. In this lab, set the default currency to "Baht". We will use other currencies later.

Attributes: \_\_\_\_\_ and \_\_\_\_\_

1. Implement the Coin class in a package named **coinpurse**.
2. Write 2 constructors: Coin(value) uses the default currency, Coin(value, currency) to specify a currency
3. Implement these methods, as described in the handout "Fundamental Java Methods".

getValue( ), getCurrency()      accessor methods

equals(Object arg)      two coins are equal if they have the same value and currency. Use the standard template for writing equals: test for null, test the class of the arg, then cast and compare values.

compareTo(Coin c)      order Coins by value so that the *smaller* value comes first. See week3 lecture slides for the meaning of the return value.  $a.compareTo(b) < 0$  means "a is before b".

toString()      return String such as "5-Baht" or "0.25-Rupie".

4. Write good Javadoc comments for the class and all methods.

```
package coinpurse;
/**
 * Coin represents coinage (money) with a fixed value and currency.
 * @author Bill Gates
 */
public class Coin implements Comparable<Coin> {
```

Write descriptive comments!

Comparable is an interface in the Java API. Don't write this Interface yourself !!

## 2.2 Test the Coin class in BlueJ or Eclipse.

Test all the Coin methods. Here are some *examples*, but don't just copy! Create your own tests.

```
> import coinpurse.Coin;
> Coin one = new Coin(1);
> Coin five = new Coin(5);
> Coin malay = new Coin(0.5, "Ringgit");
> one.toString()
"1 Baht"
> one.compareTo(five)
-1          // 1-Baht comes "before" 5-Baht. Any value < 0 is ok.
> five.compareTo(one)
           // what should value be?
> one.equals(five)
false
more tests...
```

## Exercise 3: Implement the Purse Class

The sample code for this lab contains a partial Purse class.

1. Complete all the methods.
2. Write good Javadoc comments for class and methods.

Attributes (knowing): what does a Purse need to know?

For the Coins, use a **List** since the number of coins can vary and maybe removed from the purse.

Methods (behavior) and constructor:

Purse( capacity )	a constructor that creates an empty purse with a given capacity. <code>new Purse( 6 )</code> creates a Purse with capacity 6 coins.
int count( )	returns the <i>number</i> of coins in the Purse
double getBalance( )	returns the <i>value</i> of all the coins in the Purse. If Purse has two 10-Baht and three 1-Baht coins then <code>getBalance()</code> is 23. Ignore the currency for now.
int getCapacity( )	returns the <b>capacity</b> of the Purse
boolean isFull( )	return <b>true</b> if the purse is full
boolean insert( Coin )	Insert a coin in Purse. Returns <b>true</b> if insert OK, <b>false</b> if the Purse is full or the Coin is not valid (value <= 0).
Coin[ ] withdraw(amount)	try to withdraw money. Return an <u>array</u> of the Coins withdrawn. If purse can't withdraw the exact amount, then return <b>null</b> .
toString( )	return a String describing what is in the purse.

**Example:** A Purse with capacity 3 coins.

<code>Purse purse = new Purse( 3 );</code>	
<code>purse.getBalance( )</code>	returns 0.0 (nothing in Purse yet)
<code>purse.count( )</code>	returns 0
<code>purse.isFull( )</code>	returns false
<code>purse.insert(new Coin(5))</code>	returns true
<code>purse.insert(new Coin(10))</code>	returns true
<code>purse.insert(new Coin(0))</code>	returns false. Don't allow coins with value <= 0.
<code>purse.insert(new Coin(1))</code>	returns true
<code>purse.insert(new Coin(5))</code>	returns false because purse is full (capacity 3 coins)
<code>purse.count( )</code>	returns 3
<code>purse.isFull( )</code>	returns true
<code>purse.getBalance( )</code>	returns 16.0
<code>purse.toString()</code>	returns "3 coins with value 16.0"
<code>purse.withdraw(12)</code>	returns null. Can't withdraw exactly 12 Baht.
<code>purse.withdraw(11)</code>	return array: [Coin(10), Coin(1)] (coins can be in any order in array)

## 3.2 Test the Purse

Test all the methods. Test both valid and invalid values, such as a coin with negative value. Also test *borderline cases*, like a Purse with capacity 1.

## 3.3 (Optional) Test using JUnit and PurseTest

The sample code has a source file named `PurseTest.java`. This is a JUnit 4 test class. To use this class you must do 2 things:

1. add JUnit 4 to your project (Eclipse will prompt you to do this)
2. run the tests by right-click on `PurseTest` (in Navigator pane) and choose **Run As -> JUnit Test**.
3. Eclipse will show which tests "pass" or "fail". For failed tests, it shows where the code failed.

## Hints for withdraw method

1. When you are trying to withdraw money, sort the coins first (or write an `insert` method that always keeps the coins sorted). Examine each coin starting from most valuable coin, and select any coin that can help you withdraw the amount needed. Each time you select a coin for withdrawal, deduct its value from the amount you need to withdraw. If the amount is reduced to zero, then withdraw succeeds!

While trying to find coins to withdraw, you don't know if you can withdraw the exact amount yet. So, you have two choices:

a) remove coins from the Purse's money list as you go. But, if withdraw fails you must add them back to the Purse's money list.

b) *copy a reference* to coins you want to withdraw to a temporary list, but don't remove them from Purse's money list. If withdraw succeeds, then use the temporary list to remove those coins from Purse. If withdraw fails, you don't have to do anything since you didn't change the Purse's money list.

2. Don't use `money.removeAll( templist )` to remove coins from the Purse, because `removeAll()` will remove all coins that match any `Coin` (using `equals`) in `templist`. Instead, use a loop and remove one coin at a time. Use `list.remove(Object)`.

3. `ArrayList` has a method named `toArray` that copies elements of a list into an array:

```
Coin [] array = new Coin[ templist.size() ]; // create the array
templist.toArray(array); // copy to array
toArray also returns a reference to the same array
```

## Exercise 4: Console User Interface

The sample code contains a *boring* `ConsoleDialog` that lets you deposit and withdraw coins.

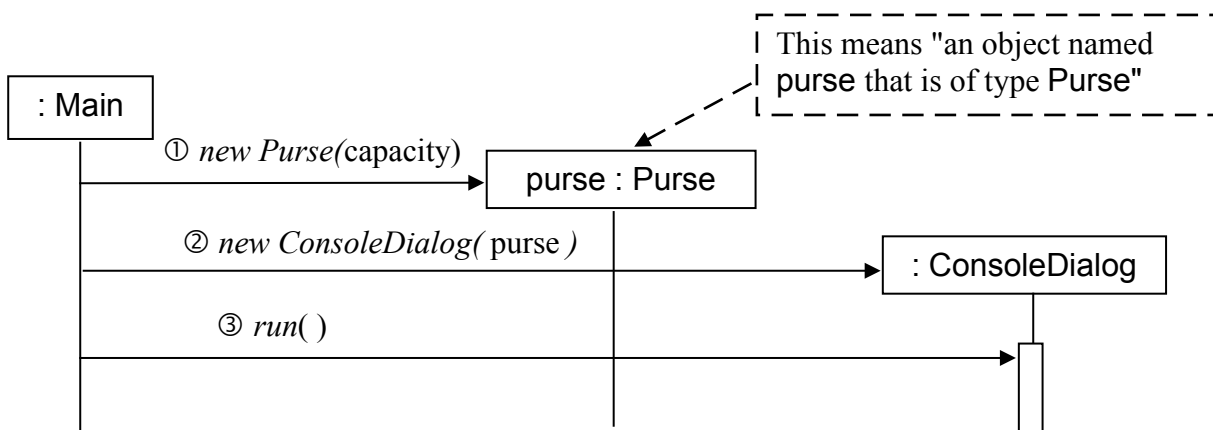
4.1 The `ConsoleDialog` needs a *reference* to a `Purse`. We **don't** want the user interface to *create* its own `Purse`! We want it *use an existing Purse*, not create one.

Modify the `ConsoleDialog` so that code (executed in the `Main` class) works:

```
// set a reference to purse object in the ConsoleDialog
ConsoleDialog ui = new ConsoleDialog( purse );
```

## Exercise 5: Write a Main (Application) class to start the program

Write a **Main** class with a static **main** method to 1) create objects, 2) "connect" them together, and 3) invoke the user interface. The **main** method should implement this *Sequence Diagram*:



(1) create a `Purse` object with some capacity

(2) create a user interface and give it a *reference* to the `purse` it should use.

(3) call `consoleDialog.run( )` to start the `ConsoleDialog` object

```
package coinpurse;
/**
 * Main (application) class creates objects and starts the application.
 */
public class Main {
    private static int CAPACITY = 10;

    public static void main( String [] args ) {

        //TODO implement the steps shown in the sequence diagram
    }
}
```

## Exercise 6. Write CoinUtil methods to Practice using Lists

Complete the methods in the class `CoinUtil`. There are 3 methods, with Javadoc comments telling you what to do.

6.1 Run the main method in `CoinUtil` and verify that your results are correct.

static List<Coin> filterByCurrency(List<Coin> coinlist, String currency)	Return a List of Coins that contains only the coins from coinlist (the parameter) that have same currency as the currency parameter.
static void sortByCurrency(List<Coin> coins)	Sort the coins by currency. You can't use the Coin's own compareTo because that orders the coins by value. Write a Comparator for this.
static void sumByCurrency(List<Coin> coins)	Sum the value of coins for each currency that appears in the <b>coins</b> list. Print the sum for each currency on a separate line. See the sample code Javadoc for example.

## OO Design Principle: Use Dependency Injection

Objects need to interact with each other, so we need a way for objects to "know about" or share a reference to an object they interact with. We also want to write flexible, reusable code, and enable polymorphism.

These factors mean we can't just write "new Purse()" or "new GuessingGame()" whenever we want to use an object! A solution is to give one class responsibility for creating shared objects, and have this class set a reference into other objects. This is called *dependency injection*.

Here are 2 ways of doing dependency injection:

1. Set a reference using constructor (called *constructor injection*):

```
// in the main class: Purse is the shared object
Purse purse = new Purse(10);
// "set" the purse to use into the UI
ConsoleDialog ui = new ConsoleDialog( purse );
```

2. Set a reference using a set method (called *setter injection*):

```
// in the main class:
GuessingGame game = new GuessingGame(1000);
// create user interface without any game yet
GameConsole ui = new GameConsole( );
// "set" the game to play
ui.setGame( game );
```

## List methods used in this Lab

Create ArrayList that can hold any Object	<pre>List list = new ArrayList( ); // List is an interface, ArrayList is a class.</pre>
Create an ArrayList to hold Coin objects	<pre>List&lt;Coin&gt; money = new ArrayList&lt;Coin&gt;( );</pre>
Number of items in a list	<pre>int size = money.size(); // # items in the list</pre>
Add object to a list.	<pre>boolean ok = list.add( object ); if ( ! ok ) /* add failed! */; // This never happens for ArrayList</pre>
Get one Coin from list without removing it.	<pre>Coin coin = money.get(0); // get item #0 Coin coin2 = money.get(2); // get the 3rd item</pre>
Get one Coin and remove it from list	<pre>Coin c = money.remove(0); // remove item 0 or: Coin coin = money.get(k); // get some coin money.remove(coin); // remove matching coin Note: money.remove(somecoin) uses the equals() method of Coin to find the first object in the list that equals somecoin. The object removed may not be the same object as somecoin!</pre>
Iterate over all elements in a list	<pre>// A for-each loop to print each coin in list: for(Coin coin : list)     System.out.println( coin );  // A for loop with an index (k). for(int k=0; k &lt; list.size(); k++)     System.out.println( list.get(k) );</pre>
Copy a List into an array of exactly the same size	<pre>List&lt;String&gt; list = new ArrayList&lt;String&gt;( ); // first create array of the correct size String[] array = new String[ list.size() ]; list.toArray( array ); // copies list to array</pre>
Copy everything from list2 to the end of list1.	<pre>List list1 = new ArrayList( ); List list2 = new ArrayList( ); list2.add( ... ); // add stuff list1.addAll( list2 ); // copy everything</pre>