CSC1016S Assignment 4: Classes and Modelling

Assignment Instructions

This assignment involves constructing programs in Java using object composition (i.e. write class declarations that define types of object that contain and manipulate other objects), and involves developing OO models of real world scenarios.

Exercise One [35 marks]

Programming problems often involve representing money. It's tempting to store amounts as type *double*, however, that's not ideal for something that requires 'exactness'. A better solution is to work with integer amounts, typically in the currency's minor unit e.g. cents in the case of Rand.

To go a step further, integers still aren't a good representation of money because we can do things with integers that don't make sense with money e.g. 45^2 is 2025, but (45 cents)^2? Money squared?

In this exercise we sort the problem out by making Money and Currency classes. (Turns out that 'money is ~~no~~ an object'!) You will find the specifications for the classes on the following pages.

We recommend that you begin with the Currency class. You will find test harness classes on the Vula page. (*TestCurrency.java* and *TestMoney.java*.)

To give a feel for how the components function, here are a couple of code snippets to illustrate.

First, the Currency class:

```
Currency rand = new Currency("R", "ZAR", 100);
String s = rand.format(30511);
long a = rand.parse(s);
System.out.println(s);
System.out.println(a);
```

The code creates a Currency object to represent the South African Rand. It uses the object to create a String representation of the cents amount 30511, and it uses the object to translate the String back into a cents amount. Finally, it prints the String and the cents amount. Here's the expected output:

```
R305.11
30511
```

Now here is the Money class (assume that we are carrying on from the snippet above):

```
Money mOne = new Money("R14.50", rand);
Money mTwo = new Money("R450.00", rand);
Money mThree = mOne.add(mTwo);
System.out.println(mThree.toString());
```

The code creates two Money objects, one to represent R14.50, and the other to represent R450. It adds them together to get a third money object, and it uses the 'toString()' method to get a String representation of the sum that it then prints out. Here's the output:

```
R464.50
```

NOTE: A Money object will use its associated Currency object to perform String translations.

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Class Money

An object of this class represents an amount of money in a particular currency. Amounts can be added and subtracted.
The amount is stored as a quantity of the minor unit of the currency e.g. 1 Rand will be stored as 100 cents.

Instance variables

private Currency currency;
private long minorUnitAmount;

Constructors

public Money(String amount, Currency currency)

// Create a Money object that represents the given amount of the given currency.
// The String is assumed to have the following format: <currency symbol><quantity of
// units>.<quantity of minor units> e.g. in the case of USD, $50.30, $0.34.

public Money(long minorUnitAmount, Currency currency)

// Create a Money object that represents the given amount of minor units of the given currency.

Methods

public long longAmount()

// Obtain a long integer that represents this Money object's value as a quantity of the minor unit of
// the currency. For example, if the Money object represents £1.10 (GBP), then this method will
// produce the long integer 110.

public Currency currency()

// Obtain the currency of this Money.

public Money add(Money other)

// Add the other amount of money to this amount and return the result. The objects must be of the
// same currency.

public Money subtract(Money other)

// Subtract the other amount of money from this amount and return the result. The objects must be
// of the same currency.

public String toString()

// Obtain a string representation of the monetary value represented by this object e.g. "€45.10" for
// a Money object that represents 45 euros and 10 cents.

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Class Currency

An object of this class represents a Currency such as US Dollars or British Pound Stirling.
A currency has an ISO 4217 currency code and a symbol denoting the currency's major unit. Many currencies have a minor (or fractional) unit such as the cent in the case of US dollars.

A currency object provides facilities for creating strings and for interpreting strings that represent amounts of the currency.

It is assumed that the currency symbol always appears in front of an amount; that negative amounts are represented by a minus sign, '-', that precedes the currency symbol, "-£34.50" for example; that the decimal point is always represented using a full stop; that no attempt is made to group the digits of large quantities, so for example, one million Rand is assumed to be represented as "R1000000" (as opposed to "R1,000,000").

Instance variables

private String symbol;
private String code;
private int minorPerMajor

Constructors

public Currency(String symbol, String code, int minorPerMajor)
// Create a Currency object that represents the currency with the given unit symbol (e.g. "£" for // Sterling), ISO 4217 code, and number of minor units per major units (e.g. 100 in the case of // pennies per British Pound).

Methods

public String symbol()
// Obtain the symbol or sign for this currency.

public String code()
// Obtain the ISO 4217 code for this currency.

public int minorPerMajor()
// Obtain the number of minor units per major unit e.g. there are 100 cents to the Euro.

public String format(long amount)
// Obtain a string representation for the amount given.
// The amount is assumed to be in the currency's minor unit e.g. pennies for Stering, cents for Rand.

public long parse(String amount)
// Obtain a numerical value for the quantity represented by the given string.
// The result is given as a quantity of the currency's minor unit.
// The String is assumed to have the format: [-]<symbol><quantity of units>.<quantity of minor // units>. (The square brackets indicate that the minus sign is optional.)

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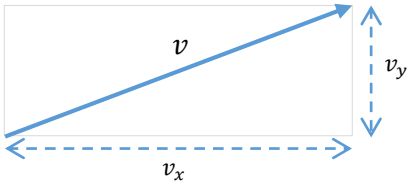
Exercise Two [35 marks]

This exercise concerns the construction of a Java class to represent a vector in two dimensions. A vector has magnitude and direction. The following is a graphical depiction of a vector, v:



A vector can be represented by its horizontal and vertical components i.e. $v = (v_x, v_y)$.

There are a number of operations that can be performed on vectors:

Operation	*Description*
Obtain magnitude	The magnitude of a vector $v = (v_x, v_y)$ is $\sqrt{{v_x}^2 + {v_y}^2}$
Vector add	Given two vectors $v = (v_x, v_y)$ and $v' = (v'_x, v'_y)$, the result of adding them together is the vector $(v_x + v'_x, v_y + v'_y)$.
Scalar Multiply	The multiplication of a vector $v = (v_x, v_y)$ by a value m produces a vector $v' = (mv_x, mv_y)$.
Dot product	Given two vectors $v = (v_x, v_y)$, and $v' = (v'_x, v'_y)$, their dot product is the value of $(v_x \times v'_x, v_y \times v'_y)$.

On the Vula page you will find a test harness called *TestVector.java*. *(This is all that remains of Stephan's efforts to write a very nice Vector class – one with methods for the given operations, a constructor and even a* `toString()` *method. It's a sad story. Best not to go into it. The medication helps.)*

Your task is, given the information above, to develop a Vector class that is compatible with TestVector i.e. TestVector should compile and run without modification.

Sample I/O:

```
Make a selection and press return:
(0) Quit, (1) Test getMagnitude(), (2) Test add()
(3) Test scalar multiply(), (4) Test dotProduct()
1
Enter x component and y component (separated by a space):
3 4
Created a Vector object with the given values for vx and vy.
Result of calling getMagnitude(): 5.00

Make a selection and press return:
(0) Quit, (1) Test getMagnitude(), (2) Test add()
(3) Test scalar multiply(), (4) Test dotProduct()
2
Enter x component and y component (separated by a space):
-3 3
Created Vector object: v = (-3.00, 3.00)
Enter x component and y component (separated by a space):
```

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```
4 -4
Created Vector object: v = (4.00, -4.00)
Result of adding the vectors: v = (1.00, -1.00)

Make a selection and press return:
(0) Quit, (1) Test getMagnitude(), (2) Test add()
(3) Test scalar multiply(), (4) Test dotProduct()
3
Enter x component and y component (separated by a space):
-3 3
Created Vector object: v = (-3.00, 3.00)
Enter multiplier:
.5
New Vector: v = (-1.50, 1.50)

Make a selection and press return:
(0) Quit, (1) Test getMagnitude(), (2) Test add()
(3) Test scalar multiply(), (4) Test dotProduct()
4
Enter x component and y component (separated by a space):
-3 3
Created Vector object: v = (-3.00, 3.00)
Enter x component and y component (separated by a space):
4 2
Created Vector object: v = (4.00, 2.00)
Result of dot product of the vectors: -6.0

Make a selection and press return:
(0) Quit, (1) Test getMagnitude(), (2) Test add()
(3) Test scalar multiply(), (4) Test dotProduct()
0
```

NOTE: The String class 'format' method can be used to produce a string representation of a real number rounded to 2 decimal places e.g. `String.format("%.2f", 4.896)` produces the result `"4.90"`.

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Exercise Three [30 marks]

This exercise concerns the development an OO representation of the employees of the Fynbos Flower Company from the point of view of timekeeping. Consider the following English language description:

Scenario

The Fynbos Flower company is flexible on the hours that employees work, and as a consequence, timekeeping is an important administrative practice. The company records the dates and times of shifts (for want of a better word). Employees sign-in when they arrive and sign-out when they leave (and only work one shift per day).

This information supports a range of enquiries

- whether an employee is present,
- whether an employee was present on a given day,
- the details of the shift worked on a given day,
- the total hours worked during a given week.
- the shifts worked during a given week.

Though, currently, none of the employees bear the same name, the company assigns each a unique ID number that may be used to disambiguate.

The concept of a "week" bears elaboration. A business week starts on a Monday and ends on a Sunday. The weeks are numbered. The first week of the year is the one that contains the first Thursday of the year.

Your task is to develop a specification for an Employee class along with whatever supporting classes are found necessary (such as a Shift class).

- Your specifications should be in the form commonly used for assignment exercises.
  - Give instance variable declarations.
  - Give signatures of constructors and descriptions of behaviour.
  - Give method signatures and descriptions of behaviour.
- Aim for a **RICH** representation – think about exercise one, which aims for a richer representation of Money that that provided by integers or double.

Start with the Employee class and think about the variables and methods required to support the enquiries listed.

- What are the responsibilities of an object of this class?
- How are responsibilities fulfilled? *This question will lead to other classes and other responsibilities.*

Focus on the details given. Think of your task as being to create a Java version of the given English description.

NOTE: Each Fynbos employee is associated with a collection of shifts. You will need some type of collection object.

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- Lists and arrays are types of collection, however, you don't need to restrict yourself to these. You may wish to design one that better suits the task at hand.
- Whatever type of collection object you choose, to avoid over complicating matters, you don't need to give instance variable declarations in your specification. Methods will suffice.

You should expect to develop specifications for *at least* 4 classes. You should submit your work in the form of a PDF document called 'Solutions.pdf'.

Marking and Submission

Submit the *Currency.java*, *Money.java* and *Vector.java* files, and the *Solutions.pdf* document containing your timekeeping design all contained within a single .ZIP folder to the automatic marker. The zipped folder should have the following naming convention:

yourstudentnumber.zip

END