ESC101 : Fundamental of Computing

Lab 7 for 26th September 2008

1. (Marks = 5)

A vector in 2-D space can be denoted by $a\mathbf{i} + b\mathbf{j}$, where $\mathbf{i}$ and $\mathbf{j}$ are unit vectors in the direction of positive x-axis and y-axis respectively, and a and b are scalar quantities. We define x_component of vector $a\mathbf{i}+b\mathbf{j}$ as a, and the y_component as b. You are familiar with various operations on vectors. For example, addition of two vectors is defined as

$$(a\mathbf{i} + b\mathbf{j}) + (c\mathbf{i} + d\mathbf{j}) = (a + c)\mathbf{i} + (b + d)\mathbf{j}$$

Other operations and terminologies which you must have learned during preparation for JEE are : a unit vector, dot product of two vectors, orthogonality of two vectors, parallel vectors, etc.

Design and implement a public class vector for two dimensional vectors using the following attributes and methods.

Attributes :

```
private double x_component;
private double y_component;
```

Constructors :

- `public vector(double a, double b)`
  Used to initialize the `x_component` and `y_component` with `a` and `b` respectively.
- `public vector()`
  Initialize both the `x_component` and `y_component` with 0 i.e., *null vector* .

Methods :

(a) `public vector add(vector v)`
return the reference to a vector which is formed by adding the vector `v` to the current vector (on which we are executing the method add).

(b) `public vector subtract(vector v)`
return the reference to a vector which is formed by subtracting the vector `v` from the current vector.

(c) `public vector scalarMultiply(double alpha)`
return the reference to a vector which is formed by multiplying the current vector with the scalar `alpha`.

(d) `public vector unitVector()`
Returns reference to a vector which is a unit vector in the same direction as that of the current vector.

(e) `public double dotProduct(vector v)`
Returns the dot product of the current vector and the vector `v`.

(f) `public double magnitude()`
Returns the magnitude of the current vector.

(g) `public double angle(vector v)`
Returns the angle in degrees between the current vector and the vector `v`.
You may use the following methods which are available from the Math class available in JAVA.

- public static double acos(double a) This method returns the arc cosine of an angle, in the range of 0.0 through pi.
- public static double toDegrees(double angrad) This method returns the value of angle angrad measured in radians after converting it to degrees (approximately).

(h) `public boolean isOrthognal( vector v)`
Returns true if the current vector and vector `v` are orthogonal, otherwise return false.

(i) `public boolean isParallel(vector v)`
Returns true if the current vector and the vector `v` are parallel, otherwise returns false

2. (marks = 5)
Use the vector class defined above to solve this problem. You have to write a program which reads the x_component and y_component of two vectors **A** and **B** respectively from the command line. It should print the following information with suitable messages on the screen.

(a) Magnitude of vectors **A** and **B**.

(b) Dot product of vectors **A** and **B**.

(c) The vector **A - B**.

(d) The vector **A + B**.

(e) Unit vector in the direction of **A + B**

(f) The angle in degrees between vector **A** and **B**. (use dotProduct and angle methods here).

(g) Is the vector **A+B** orthogonal to vector **i + j** ? (use dotProduct method here).

(h) Is the vector **A+B** parallel to vector **i - j** ? (use dotProduct method here).