

1. PROGRAM 3 INSTRUCTIONS, CS102, PROF. LOFTIN

Vector in space can be represented by their three coordinates, usually written as (x, y, z) . This program is to implement some of the basics of vector arithmetic in a class `Vec`.

You should have a class `Vec` which has the following public methods

```
Vec (double a, double b, double c) //constructs vector (a,b,c)
double dot (Vec w) // returns the dot product of this and w
Vec cross (Vec w) // returns the cross product of this and w
double length () // compute the length of this
String toString () // returns a String in (x,y,z) format
```

Here are the formulas involved: If $\vec{p} = (x_1, y_1, z_1)$ and $\vec{q} = (x_2, y_2, z_2)$ are both vectors in space, then their dot product

$$\vec{p} \cdot \vec{q} = x_1x_2 + y_1y_2 + z_1z_2.$$

For example, if $\vec{p} = (1, 3, 2)$ and $\vec{q} = (0, 5, -1)$, then $\vec{p} \cdot \vec{q} = 1(0) + 3(5) + 2(-1) = 0 + 15 - 2 = 13$.

The cross product of $\vec{p} = (x_1, y_1, z_1)$ and $\vec{q} = (x_2, y_2, z_2)$ is another vector given by

$$\vec{p} \times \vec{q} = (y_1z_2 - y_2z_1, z_1x_2 - x_1z_2, x_1y_2 - y_1x_2).$$

So if as above $\vec{p} = (1, 3, 2)$ and $\vec{q} = (0, 5, -1)$, then

$$\vec{p} \times \vec{q} = (3(-1) - 2(5), 2(0) - 1(-1), 1(5) - 3(0)) = (-13, 1, 5).$$

The length of a vector is given by the formula

$$\|\vec{p}\| = \sqrt{\vec{p} \cdot \vec{p}}.$$

So for our $\vec{p} = (1, 3, 2)$,

$$\|\vec{p}\| = \sqrt{1(1) + 3(3) + 2(2)} = \sqrt{14}.$$

2. HOW TO DO IT

The `private` data of the `Vec` class consist of the three coordinates
`private double x,y,z;`

You should reuse your code whenever possible (so for example in computing the length, you should call the `dot` method).

3. PROGRAM REQUIREMENTS

Turn in your Java class called `Vec.java` to me by emailing it to me at `loftin@rutgers.edu`.

4. TO RUN YOUR PROGRAM

Your program should work with the following driver class. YOU MAY NOT MODIFY THE DRIVER CLASS AT ALL. IF YOUR PROGRAM WILL NOT COMPILE WITH THE DRIVER CLASS BELOW, YOU WILL GET A 0.

```
public class VecDriver{
    public static void main(String[] args){
        Vec p = new Vec (1,3,2);
        Vec q = new Vec (0,5,-1);
        System.out.println("The dot product of p = " + p + " and q = "
            + q + " is " + p.dot(q) + ".");
        System.out.println("The cross product of p and q is "
            + p.cross(q) + ".");
        System.out.println("The length of p is " + p.length()
            + ", the length of q is " + q.length()
            + ",\nand the length of their cross product is "
            + p.cross(q).length() + ".");
    }
}
```

Make sure the file `VecDriver.java` and your file `Vec.java` are in the same directory. To compile, type `javac VecDriver.java` at the pegasus prompt, and to run your program, type `java VecDriver`

5. SAMPLE OUTPUT

The dot product of $p = (1.0, 3.0, 2.0)$ and $q = (0.0, 5.0, -1.0)$ is 13.0. The cross product of p and q is $(-13.0, 1.0, 5.0)$. The length of p is 3.7416573867739413, the length of q is 5.0990195135927845, and the length of their cross product is 13.96424004376894.