

Option 4: Solving Systems of Equations with Matrices

Solve a system of 3 equations and 3 unknowns using Cramer's Rule.

Cramer's Rule states that if
$$\begin{cases} ax + by + cz = d \\ ex + fy + gz = h \\ ix + jy + kz = l \end{cases}$$
 is a system of

equations, then the solution of the system can be found as follows:

$$x = \frac{\begin{vmatrix} d & b & c \\ h & f & g \\ l & j & k \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}} \quad y = \frac{\begin{vmatrix} a & d & c \\ e & h & g \\ i & l & k \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}} \quad z = \frac{\begin{vmatrix} a & b & d \\ e & f & h \\ i & j & l \end{vmatrix}}{\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}}$$

The determinant $\begin{vmatrix} a & b & c \\ e & f & g \\ i & j & k \end{vmatrix}$ can be solved in the following way:

$$(a) \begin{vmatrix} f & g \\ j & k \end{vmatrix} - (b) \begin{vmatrix} e & g \\ i & k \end{vmatrix} + (c) \begin{vmatrix} e & f \\ i & j \end{vmatrix}$$

To complete this project you must develop a Matrix3By3 class.

This class will have one instance field:

```
private int[][] matrix = new int[3][3];
```

It will represent each of the numerators in the formulas above, as well as the denominator.

This class should have only the following method:

```
public int determinant() To find the determinant of each of the 3 numerators above as well as the denominator. Because of the process of calculating the determinant of a 3x3 matrix, you may have to look up how to calculate the determinant of a 2x2 matrix.
```

This task will also require a CramersRule class. It will have 2 instance fields:

```
private int[][] coef = new int[3][3];    Holds the coefficient matrix  
private int[] cnst = new int[3];        Holds the constant matrix
```

This class should have the following 3 methods:

```
public double getX() Each of these classes will call the determinant method  
public double getY() of the Matrix3By3 class and do the required division to  
public double getZ() get the values of x, y, and z.
```

This task also requires a driver class that will have the user enter all coefficients and constants, construct a CramersRule object, and use that object to determine the solution to the system. This driver class must also be prepared for a system that has NO SOLUTION (The determinant in the denominator equals zero). Below you will find the 2 systems you must solve.

$$\left\{ \begin{array}{l} x + y - z = 14 \\ 4x - y + 5z = -22 \\ 2x + 2y - 3z = 35 \end{array} \right. \quad \left\{ \begin{array}{l} x + 3y - 2z = 4 \\ 4x - y + z = -1 \\ 3x - 4y + 3z = -5 \end{array} \right.$$

Since this course is all about *Object Oriented Programming*, I have tried to describe solutions that use logical objects. If you have alternate solutions, that are equally dependent upon objects, that should be just fine. But, please discuss your solutions with me before you begin.