Create a java program which solves a system of 3 equations in 3 variables. Test your program using the following set of equations:

which can be modeled:

$$3x + 2y - 4.3z = 4.56$$

$$-x - 3y + 2z = -3.0$$

$$-3z + 3y - 5.2 \cdot z = 1$$

$$\begin{pmatrix} 3 & 2 & -4.3 \\ -1 & -3 & 2 \\ -3 & 3 & -5.2 \end{pmatrix} \cdot \begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 4.56 \\ -3.0 \\ 1 \end{pmatrix}$$

More generally: $A \cdot X = b$

where:

$$A := \begin{pmatrix} 3 & 2 & -4.3 \\ -1 & -3 & 2 \\ -3 & 3 & -5.2 \end{pmatrix} \qquad b := \begin{pmatrix} 4.56 \\ -3.0 \\ 1 \end{pmatrix}$$

Using the inverse method, this has a solution:

$$X := A^{-1} \cdot b = \begin{pmatrix} 0.731 \\ 0.564 \\ -0.288 \end{pmatrix}$$

where:

$$A^{-1} = \begin{pmatrix} 0.166 & -0.043 & -0.153 \\ -0.193 & -0.491 & -0.029 \\ -0.207 & -0.259 & -0.121 \end{pmatrix}$$

You may ONLY use Gaussian reduction **as an alternative** for solving this system of equations. **Use of Cramer's rule is NOT permitted.**

Specifics:

1. Write a class named Solver which imports the A array (2D) and b array (1D) from the SolverApp and returns X (the 1D solution array to 3 decimal place accuracy) to the SolverApp.
2. Write a test (app) class named SolverApp which creates the A and b array then calls method(s) from the Solver class to obtain a solution.
3. Ensure SolverApp gives the user the ability to enter ANY 3 equations / 3 variable system of equations. *You may want to create code that provides the solution for ANY reasonably sized system of equations but, this is NOT required.*
4. Research solving systems of equations numerically (with computers) since the INVERSE method has been around for a LONG time. Logic / code should be readily available to obtain the inverse You may have me teach you the way to calculate the inverse if you wish.
5. Provide an MS Word document which contains the code for both classes and adequate INPUT / OUTPUT. Use the input above to test your Solver class to confirm its operation.
6. Send the MS Word.docx to mheinen_1@msn.com NLT midnight Saturday 12/7/13.

Attached material will help refresh your mathematics about the basics of linear equations.

Three (basic) operations permitted in linear algebra:

- **You may multiply any row by any non-zero constant.**
- **You may swap any row with any other row.**
- **You may add a linear combination of ANY row to ANY other row.**

Matrix addition and subtraction.

To be able to add together arrays, their dimensions must be the same!

The sum of two arrays (assuming they have the same dimensions and can be added together) will be the same as the original arrays.

Example:

$$A := \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} \quad B := \begin{pmatrix} 5 & 6 \\ 7 & 8 \end{pmatrix} \quad C := \begin{pmatrix} 9 \\ 10 \end{pmatrix}$$

A + C or B + C cannot be done (since the array dimensions are NOT the same)

$$A + B = \begin{pmatrix} 1+5 & 2+6 \\ 3+7 & 4+8 \end{pmatrix} = \begin{pmatrix} 6 & 8 \\ 10 & 12 \end{pmatrix}$$

Matrix multiplication

The columns of the 1st array must = the rows of the 2nd array otherwise the arrays cannot be multiplied together! **If** they can be multiplied together then:

The product array dimensions will be the rows of the 1st array by the columns of the 2nd array.

Example

$$A := \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix} \qquad B := \begin{pmatrix} 5 & 6 & 7 \\ 8 & 9 & 10 \end{pmatrix}$$

$$A \cdot B = \begin{pmatrix} 1\cdot5 + 2\cdot8 & 1\cdot6 + 2\cdot9 & 1\cdot7 + 2\cdot10 \\ 3\cdot5 + 4\cdot8 & 3\cdot6 + 4\cdot9 & 3\cdot7 + 4\cdot10 \end{pmatrix} = \begin{pmatrix} 21 & 24 & 27 \\ 47 & 54 & 61 \end{pmatrix}$$

Given the following arrays:

$$A := \begin{pmatrix} 1 & 2 & -4 \\ 1 & 0 & -1 \\ 2 & 2 & 0 \end{pmatrix} \qquad B := \begin{pmatrix} 1 & 1 \\ -2 & 3 \\ 2 & 0 \end{pmatrix}$$

$$C := \begin{pmatrix} 2 & 2 & 2 \\ -1 & 2 & 3 \end{pmatrix} \qquad D := \begin{pmatrix} 1 & 0 & 2 \\ 1 & -1 & 4 \\ 0 & 4 & 2 \end{pmatrix} \qquad E := \begin{pmatrix} 2 \\ 0 \\ 1 \end{pmatrix}$$

Examples of matrix operations:

1.

$$A + D = \begin{pmatrix} 2 & 2 & -2 \\ 2 & -1 & 3 \\ 2 & 6 & 2 \end{pmatrix}$$

2.

$A - B =$ NOT_Feasibl

3.

$$A \cdot B = \begin{pmatrix} -11 & 7 \\ -1 & 1 \\ -2 & 8 \end{pmatrix}$$

4.

$$A \cdot D = \begin{pmatrix} 3 & -18 & 2 \\ 1 & -4 & 0 \\ 4 & -2 & 12 \end{pmatrix}$$

5.

$$B \cdot C = \begin{pmatrix} 1 & 4 & 5 \\ -7 & 2 & 5 \\ 4 & 4 & 4 \end{pmatrix}$$

6.

$$C \cdot B = \begin{pmatrix} 2 & 8 \\ 1 & 5 \end{pmatrix}$$

7.

$$(A - D) \cdot E = \begin{pmatrix} -6 \\ -5 \\ 2 \end{pmatrix}$$

8.

$$C \cdot E = \begin{pmatrix} 6 \\ 1 \end{pmatrix}$$

$$I = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

is the identity array

9.

$$D \cdot C = \text{NOT\_feasibl}$$