Lab 13 Apply to Application

Note: The underlined text is an input data.

All assignments must use library `markrogoyski/math-php`.

1. **Rewrite the program in assignment 4 of week 4 that calculates matrix multiplication but now use library `markrogoyski/math-php`.**

   Remark: You do not need to write your own matrix multiply function just use the provided API from library.

   Now input data comes from file assigned by command-line arguments with the following format, **input file may contain multiple white-spaces**.

```
m n p
A11 A12 ...
A21 A22 ...
...
B11 B12 ...
B21 B22 ...
...
```

Example 01	Example 02

Input: `ass-01-input-01.txt`
`3 2 3`
` 1  2`
` 3  4`
` 5  6`
` 7  8  9`
`10 11 12`
	Input: `ass-01-input-02.txt`
	`2 3 4`
	` 1  2  3`
	` 4  5  6`
	` 7  8  9 10`
	`11 12 13 14`
	`15 16 17 18`

Run: `php ass-01.php ass-01-input-01.txt`
`Input matrix A( 3 x  2):`
`    1    2`
`    3    4`
`    5    6`
 	
`Input matrix B( 2 x  3):`
`    7    8    9`
`   10   11   12`
 	
`The result matrix C( 3 x  3):`
`   27   30   33`
`   61   68   75`
`   95  106  117`
	Run: `php ass-01.php ass-01-input-02.txt`
	`Input matrix A( 2 x  3):`
	`    1    2    3`
	`    4    5    6`
	
	`Input matrix B( 3 x  4):`
	`    7    8    9   10`
	`   11   12   13   14`
	`   15   16   17   18`
	
	`The result matrix C( 2 x  4):`
	`   74   80   86   92`
	`  173  188  203  218`

2. Write the program that solves the `n` variables from the given `n` equations for `m` sets of equations.

   The following equations

$$\begin{aligned} x_1 &+ x_2 &+ x_3 &= 6 \\ & 2x_2 &+ 5x_3 &= -4 \\ 2x_1 &+ 5x_2 &- x_3 &= 27 \end{aligned}$$

   We can rewrite in matrix form

$$\begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 5 \\ 2 & 5 & -1 \end{bmatrix} \times \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 6 \\ -4 \\ 27 \end{bmatrix}$$

$$A = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 2 & 5 \\ 2 & 5 & -1 \end{bmatrix}$$

$$X = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

$$B = \begin{bmatrix} 6 \\ -4 \\ 27 \end{bmatrix}$$

$$A \times X = B$$

   Then matrix X can be solved with $X = A^{-1} \times B$ where A^{-1} is an inverse matrix of A.

   Program will get equations data from file given by command-line arguments. And equations data is in the following format.

```
number_of_sets_of_equations(m)
number_1_of_equations(n)
A_1_1 A_1_2 ... A_1_n B_1
A_2_1 A_2_2 ... A_2_n B_2
...
A_n_1 A_n_2 ... A_n_n B_n
number_2_of_equations(n)
...
number_m_of_equations(n)
...
```

   Remark: Beware, input file may contain multiple white-spaces.

Example file: ass-02-input.txt

```
3
3
   1.00   1.00   1.00   6.00
   0.00   2.00   5.00  -4.00
   2.00   5.00  -1.00  27.00
2
   2.00   1.00   5.00
  -1.00   1.00   2.00
4
   1.00   1.00  -3.00   1.00   2.00
  -5.00   3.00  -4.00   1.00   0.00
   1.00   0.00   2.00  -1.00   1.00
   1.00   2.00   0.00   0.00  12.00
```

Example 01: php ass-02.php ass-02-input.txt

```
  5.00,   3.00,  -2.00
  1.00,   3.00
  1.29,   5.35,   4.94,  10.18
```

3. **Write the program that finds roots of the given polynomials. The polynomials come from file given by command-line augments.**

   The roots of $x^2 - 12x + 27$ are 3 and 9 because when we assign 3 or 9 to x then $x^2 - 12x + 27 = 0$.

   The input file is in the following format, number of coefficients <= 5.

   ```
   number_of_data
   cofficient1 cofficient2 ...
   cofficient1 cofficient2 ...
   ```

   For example, input data of $x^2 - 12x + 27$ and $x^3 - 6x^2 + 11x - 6$ are in the following input:

   ```
   1 -12 27
   1 -6 11 -6
   ```

   Example input: `ass-03-input.txt`

   ```
   5
   1 -12 27
   1 -6 11 -6
   1 -8.5 -4.5
   1 5 8 4
   2 -3 -4 5 1
   ```

   Example 01: `php ass-03.php ass-03-input.txt`

   ```
   x² - 12x + 27
       Roots: 3, 9
   x³ - 6x² + 11x - 6
       Roots: 3, 1, 2
   x² - 8.5x - 4.5
       Roots: -0.5, 9
   x³ + 5x² + 8x + 4
       Roots: -2, -1, -2
   2x⁴ - 3x³ - 4x² + 5x + 1
       Roots: -1.2975052378344, -0.17835950863739, 1.2568668534976,
   1.7189978929742
   ```