CENG 113 - HW1

Solving simple equation systems

Please implement a program that solves an equation system consisting of 2 linear equations each of which contains the same 2 variables.

An example run:

```
Enter the first equation:
+2x-2y+5+4y=+18-1x
Enter the second equation:
-10y+5x-4y+10y=+7
Equations in the simplified form:
3x+2y=13
5x-4y=7
Solution:
x=3
y=2
```

Pay attention to the the colors: inputs and outputs of the program.
The submissions will be mostly graded automatically (not manually by a human), so the outputs should be ***exactly** the same (For example, you need something like this: eq1 = input("Enter the first equation:**\n**"). Mind the newline at the end). In the simplified form, show the terms even if their coefficients are 0 (e.g. 2x+0y=5) and show the coefficients even if they are 1 (e.g. 1x+3y=8). Both for the simplified form and the solutions display **x** first and then **y**.

Rules:

- Name your Python file as **ceng113_hw1_⟨StudentID⟩.py** (Don't write the angle brackets! It is a notation for placeholders. It should be, for example, ceng113_hw1_123456789.py if your student id is 123456789). Submit this file through **Teams** until due time which is **04.12.2020 23:59**.
- Cheating, including "teamwork" or getting "help" from somebody other than a course assistant, is strictly **forbidden** and will not be tolerated if detected. Moreover, this behaviour would be extremely harmful for your professional development. We don't only design the homeworks to evaluate your skills but also to prepare you to the exams, to the courses you will take in the following semesters, and more importantly to the professional life.
- **Always** ask your questions related to homework definition in the **assistance** tab (not privately) and **never** share a part of the solution! It is our duty to help you understand the problem but **not** to help you solve the problem!
- You **cannot** import any module. You **cannot** use any feature that you did not learn in the lessons or labs.

This problem can be solved writing less than 100 lines of code. If you wrote more than 200 lines, you probably did something wrong. Try to split the code into simple parts and check the intermediate results.

This homework is this simple and you can ignore the other sections in this document if you think you can easily do this. However, you are highly recommended to read the other sections as well.

Terminology and assumptions

A user input example:

+2x-2y+5+4y=+18-1x
-10y+5x-4y+10y=+7

Terminology:

- **+2x-2y+5+4y=+18-1x** and **-1y+5x-4y+1y=+7** is an equation system.
  (You need to simplify it: **3x+2y=13** and **5x-4y=7**. You can use 6 variables to represent the simplified form: a=3, b=2, c=13, d=5, e=-4, f=7. If a variable is missing in an equation, the coefficient for that variable is 0. For example +5x=+10 means +5x+0y=+10.)
- +2x-2y+5+4y=+18-1x is an **equation**.
- -4y is a **term**.
  (Some terms do not contain a variable, e.g. +18. They are called constant terms.)
- y is a **variable**.
  (Unfortunately "variable" is an ambiguous term for us. Mathematically speaking, there are only 2 variables for any given example: x and y. But in programming, of course we have many other variables.)
- -4 is a **coefficient** (extracted from the term -4y).
  (Constant terms such as +13 are also called a coefficient.)
- +2x-2y+5+4y is the **left-hand side** (LHS) of an equation.
- +18-1x is the **right-hand side** (RHS) of an equation.
- An equation consists of an equality sign and a series of terms on both sides. All terms have a coefficient. Some terms have a variable.
- x=3 and y=2 is the **solution**.

Bad news:

- As you can see, the user doesn't have to enter the equations in a simplified form (You need to simplify each of them independently).

Good news (Assumptions):

- There are 2 equations (entered separately).
- There are only 2 variables in the system (Some of them may be missing. In this case their coefficients are 0.) and their names are always x and y.
- User doesn't enter spaces or parentheses or any character other than +-=0123456789xy
- All terms, including the first terms, start with a sign (+ or -). After the sign there is the absolute value of the coefficient. After the coefficient, there may (e.g. -1x) or may not (e.g. +18) be a variable.
- Coefficients are integers and explicitly shown even if there is no need (e.g. +1x instead of x).
- Solutions are integers.
- The equation system has a unique (i.e. 1) solution (In general, these equation systems may have 0 or infinite number of solutions as well. For example: x+y=1 and x+y=2 has 0 solutions. x+y=1 and 2x+2y=2 has infinitely many solutions (e.g. x=1, y=0 or x=-1, y=2). Ignore these possibilities.).
- Perfect user assumption: User enters a valid input (e.g. Don't even worry about an input like +-=2=3x).

A note on solving the equation systems

An equation system consisting of 2 linear equations each of which contains the same 2 variables can be formulated (in the simplified form) as the following:

ax+by=c
dx+ey=f

For example:

3x+2y=13
5x-4y=7

Here a=3, b=2, c=13, d=5, e=-4, f=7. Notice that some of these coefficients may be negative (e.g. e=-4 in this example) or 0 (for example if one of the equations is 2x=8).

One way of solving such equation systems is

- isolating one of the variables (x) in one of the equations (3x+2y=13)
  x = (13 - 2y) / 3
- then plug it in the other equation (5x-4y=7).
  5 * ((13 - 2y) / 3) - 4y = 7
- You will find the value of the second variable (y)
  y = 2
- and then you can calculate the first variable (x) using the first equation you considered (3x+2y=13) since the value of the second variable (y) is known.
  x = 3

Another way is multiplying one of the equations with a number and add the result to the other equation multiplied by another number so that one of the variables will be eliminated. You will find the value of the remaining variable. Then using one of the equations you can find the value of the other variable:

- We can multiply **3x+2y=13** with -5 to obtain **-15x-10y=-65**
  and multiply **5x-4y=7** with 3 to obtain **15x-12y=21**.
  (Here you can calculate least common multiple (LCM) to determine the multipliers. However, there is a much easier solution. If you want to eliminate x, you can multiply the the first equation with **-d** which is -5 here, and the second equation with **a** which is 3 here.)
- The sum of two equations is **-22y=-44**. Thus **y = 2**.
- Since **y = 2** and **3x+2y=13** is true, then **x = 3**.

Before starting to implement the solution using Python, make sure that you can solve such equation systems using pen and paper.

Hint: In your program, first determine the values of the coefficients (a, b, c, d, e, f). Then somehow determine the values of the variables (first y, then x) using the coefficients only.

A note on parsing the inputs

In order to parse the user inputs (i.e. to determine the simplified form), you may want to iterate over the characters of an equation one by one. Maybe initialize the coefficients with 0 and accumulate each new term. Notice that + or - signals that a new term is starting. You may want to get a slice (i.e. substring) of the string and parse it using the function int(). = starts the RHS, so these terms can be negated (e.g. +3x on the RHS actually means -3x). This way, you can calculate ax+by-c=0 then you can easily obtain ax+by=c. Note that there are many other ways of implementing this part of the homework. Study string methods for more practical solutions.

Testing your own code

We shared a Python script which can be used for testing your program automatically. This script will not only let us easily evaluate your homeworks but also it will help you to know if you did any mistake. Multiple examples with the correct solutions are also shared. You are highly recommended to test your code using our examples before submitting it (You can modify the examples as well as the correct solutions to test your code further. We will be evaluating your code using different but similar examples.).

If you cannot understand how to use this script, ask your question in the assistance tab. If you think this script has bugs, please report it.