CS19003 : Programming and Data Structures Laboratory

Assignment 1 : Data Types and Operators in C

Date: 06-April-2021

Problem Statement:

The city of joy, Kolkata, is deeply threatened by a series of two murders that happened over the past two weeks. Detective Mr. Byomkesh Bakshi and his helping friend (a writer by profession) Mr. Ajit Kumar Banerjee are being involved in figuring out this murder mystery. Looking at the nature of the past two murders, they suspect that this sequence of murders may further recur in the next week as well. Hence, Mr. Bakshi and Ajit are firstly trying to predict the tentative location of the next murder so that they can catch the murderer then and there. Though the exact locations of the past two murders are unknown, but two clues that are found regarding these murders are mentioned in the following.

Clue-1: The past two murder locations are spotted to be within a range/interval of (tentative) distances, both from the Victoria Memorial.

Clue-2: From the motive of the murderer, there is a chance that the next murder position may follow a mathematical pattern from these two position of the past two murders.

Hence, Mr. Bakshi and Ajit are trying to calculate all possible operations over these two ranges of past murders in order to predict the next murder location range. Can you write a C-program to help their cause?

In particular, your program will do the following (with the help of arithmetic or logical operators), **without using any conditional statements** (such as *if-elseif-else*, *switch-case* or *ternary operators* '`a?b:c`'):

- Take from user two murder position intervals/ranges as pairs of real numbers, $I_1 = [x_1, x_2]$ and $I_2 = [y_1, y_2]$. All x_1, x_2, y_1, y_2 are entered as positive Reals in `double` format separately.
- Print the two murder position as intervals in proper format, that is, like $I = [a, b]$.
- Compute the following mathematical operations over/with each of these two intervals and Print the following results in the interval format, that is $[a, b]$.
  - `ADDITION` of I_1 with I_2 [*Hint*: $(I_1 + I_2) = [x_1 + y_1, x_2 + y_2]$]
  - `SUBTRACTION` of I_2 from I_1 [*Hint*: $(I_1 - I_2) = [x_1 - y_2, x_2 - y_1]$]
  - `MULTIPLICATION` of I_1 with I_2 [*Hint*: $(I_1 \times I_2) = [x_1 \times y_1, x_2 \times y_2]$]
  - `RECIPROCAL` of I_1 and I_2 (separately) [*Hint*: $\frac{1}{I_1} = \frac{1}{[x_1,x_2]} = [\frac{1}{x_2}, \frac{1}{x_1}]$]
  - `DIVISION` of I_1 by I_2 [*Hint*: $\frac{I_1}{I_2} = I_1 \times \frac{1}{I_2}$]
  - `CONTINUOUS-UNION` of I_1 with I_2 [*Hint*: $(I_1 \cup I_2) = [\min\{x_1, y_1\}, \max\{x_2, y_2\}]$]
  - `INTERSECTION` of I_1 and I_2 [*Hint*: $(I_1 \cap I_2) = \begin{cases} [\max\{x_1, y_1\}, \min\{x_2, y_2\}], & \text{overlap exists} \\ [0, 0], & \text{overlap none} \end{cases}$]
- *What if these two intervals are considered in Argand/Complex-plane, where I_1 is the real interval and I_2 is the imaginary interval?* Print the realization of such complex interval in proper format, that is, like

$$C = I_1 + I_2.i = [x_1, x_2] + [y_1, y_2].i$$

- Compute the following mathematical operations over this complex interval and Print the following results in the complex interval format, that is $[x_1, x_2] + [y_1, y_2].i$.
  - `MODULUS` Interval of C [*Hint*: $|C| = [\sqrt{x_1^2 + y_1^2}, \sqrt{x_2^2 + y_2^2}]$]
  - `CONJUGATE` of C [*Hint*: $\overline{C} = I_1 + (-I_2).i$]
  - `ARGUMENT` Interval of C [*Hint*: $arg(C) = [tan^{-1}(\frac{y_1}{x_2}), tan^{-1}(\frac{y_2}{x_1})]$]
  - `SQUARE` of C [*Hint*: $C^2 = (I_1 + I_2.i)^2 = (I_1 \times I_1 - I_2 \times I_2) + (2 \times I_1 \times I_2).i$]
  - `CUBE` of C [*Hint*: $C^3 = (I_1 + I_2.i)^3 = (I_1 \times I_1 \times I_1 - 3 \times I_1 \times I_2 \times I_2) + (3 \times I_1 \times I_1 \times I_2 - I_2 \times I_2 \times I_2).i$]
  - `RECIPROCAL` of C [*Hint*: $\frac{1}{C} = \frac{1}{I_1 + I_2.i} = \frac{I_1 - I_2.i}{I_1^2 + I_2^2} = I_1 \times (\frac{1}{I_1 \times I_1 + I_2 \times I_2}) - I_2 \times (\frac{1}{I_1 \times I_1 + I_2 \times I_2}).i$]

Note: You may need to include ⟨`math.h`⟩ library (as header) to perform the mentioned mathematical operation.

Example Execution Details:

Sample-1:

```
++ Enter Ranges [x1,x2] for Interval-1 (two space-separated positive numbers): 1 5
++ Enter Ranges [y1,y2] for Interval-2 (two space-separated positive numbers): 3 7

** Interval-1: I1 = [1.000000,5.000000]
** Interval-2: I2 = [3.000000,7.000000]
** Interval after ADDITION: (I1 + I2) = [4.000000,12.000000]
** Interval after SUBTRACTION: (I1 - I2) = [-6.000000,2.000000]
** Interval after MULTIPLICATION: (I1 x I2) = [3.000000,35.000000]
** RECIPROCAL Interval: ~I1 = [0.200000,1.000000]
** RECIPROCAL Interval: ~I2 = [0.142857,0.333333]
** Interval after DIVISION: (I1 / I2) = [0.142857,1.666667]
** Interval after CONTINUOUS-UNION: (I1 U I2) = [1.000000,7.000000]
** Interval after INTERSECTION: (I1 ^ I2) = [3.000000,5.000000]

** Complex Interval: C = [1.000000,5.000000] + [3.000000,7.000000].i
** MODULUS of Complex Interval: |C| = [3.162278,8.602325]
** CONJUGATE of Complex Interval: ~C = [1.000000,5.000000] + [-7.000000,-3.000000].i
** ARGUMENT of Complex Interval: arg(C) = [0.540420,1.428899]
** SQUARE of Complex Interval: C^2 = [-48.000000,16.000000] + [6.000000,70.000000].i
** CUBE of Complex Interval: C^3 = [-734.000000,98.000000] + [-334.000000,498.000000].i
** RECIPROCAL of Complex Interval: 1/C = [0.013514,0.500000] + [-0.700000,-0.040541].i
```

Sample-2:

```
++ Enter Ranges [x1,x2] for Interval-1 (two space-separated positive numbers): 5 8
++ Enter Ranges [y1,y2] for Interval-2 (two space-separated positive numbers): 2 4

** Interval-1: I1 = [5.000000,8.000000]
** Interval-2: I2 = [2.000000,4.000000]
** Interval after ADDITION: (I1 + I2) = [7.000000,12.000000]
** Interval after SUBTRACTION: (I1 - I2) = [1.000000,6.000000]
** Interval after MULTIPLICATION: (I1 x I2) = [10.000000,32.000000]
** RECIPROCAL Interval: ~I1 = [0.125000,0.200000]
** RECIPROCAL Interval: ~I2 = [0.250000,0.500000]
** Interval after DIVISION: (I1 / I2) = [1.250000,4.000000]
** Interval after CONTINUOUS-UNION: (I1 U I2) = [2.000000,8.000000]
** Interval after INTERSECTION: (I1 ^ I2) = [0.000000,0.000000]

** Complex Interval: C = [5.000000,8.000000] + [2.000000,4.000000].i
** MODULUS of Complex Interval: |C| = [5.385165,8.944272]
** CONJUGATE of Complex Interval: ~C = [5.000000,8.000000] + [-4.000000,-2.000000].i
** ARGUMENT of Complex Interval: arg(C) = [0.244979,0.674741]
** SQUARE of Complex Interval: C^2 = [9.000000,60.000000] + [20.000000,64.000000].i
** CUBE of Complex Interval: C^3 = [-259.000000,452.000000] + [86.000000,760.000000].i
** RECIPROCAL of Complex Interval: 1/C = [0.062500,0.275862] + [-0.137931,-0.025000].i
```

Sample-3:

```
++ Enter Ranges [x1,x2] for Interval-1 (two space-separated positive numbers): 2.5 7.5
++ Enter Ranges [y1,y2] for Interval-2 (two space-separated positive numbers): 2.5 7.5

** Interval-1: I1 = [2.500000,7.500000]
** Interval-2: I2 = [2.500000,7.500000]
** Interval after ADDITION: (I1 + I2) = [5.000000,15.000000]
** Interval after SUBTRACTION: (I1 - I2) = [-5.000000,5.000000]
** Interval after MULTIPLICATION: (I1 x I2) = [6.250000,56.250000]
** RECIPROCAL Interval: ~I1 = [0.133333,0.400000]
** RECIPROCAL Interval: ~I2 = [0.133333,0.400000]
** Interval after DIVISION: (I1 / I2) = [0.333333,3.000000]
** Interval after CONTINUOUS-UNION: (I1 U I2) = [2.500000,7.500000]
** Interval after INTERSECTION: (I1 ^ I2) = [2.500000,7.500000]

** Complex Interval: C = [2.500000,7.500000] + [2.500000,7.500000].i
** MODULUS of Complex Interval: |C| = [3.535534,10.606602]
** CONJUGATE of Complex Interval: ~C = [2.500000,7.500000] + [-7.500000,-2.500000].i
** ARGUMENT of Complex Interval: arg(C) = [0.321751,1.249046]
** SQUARE of Complex Interval: C^2 = [-50.000000,50.000000] + [12.500000,112.500000].i
** CUBE of Complex Interval: C^3 = [-1250.000000,375.000000] + [-375.000000,1250.000000].i
** RECIPROCAL of Complex Interval: 1/C = [0.022222,0.600000] + [-0.600000,-0.022222].i
```

Submit a single C source file. Do not use *conditional-statements* and global/static variables.