

Introduction to Computer Programming and Data Structures

Assignment 03

Maximum Marks: **150**

Submission Deadline: **2022-Sep-01**

Bonus: **20** –for well indentation, variable name and programming style

Topic: Iterative and Recursive Programming. Introduction to data structure.

Assignment problem # AP0301

- Problem: Find the GCD of two integers using the Euclidean algorithm. Write two functions `GCD_R` and `GCD_I` with recursion and iteration, respectively. Compute the respective execution time $Time_R(a, b)$ and $Time_I(a, b)$ for input a and b .

- Input: n followed by N space separated a, b

n

$a_1 b_1$

$a_2 b_2$

\vdots

a_n, b_n

Where, $(a_i, b_i \in \mathbb{Z}$ and $0 < N \leq 10000)$. The name of the input file must be `input_AP0301.txt`

- Output: $a_i b_i gcd(a_i, b_i)$ separated by space

$a_1 b_1 GCD_R(a_1, b_1) GCD_I(a_1, b_1) Time_R(a_1, b_1) Time_I(a_1, b_1)$

$a_2 b_2 GCD_R(a_2, b_2) GCD_I(a_2, b_2) Time_R(a_2, b_2) Time_I(a_2, b_2)$

\vdots

$a_n b_n GCD_R(a_n, b_n) GCD_I(a_n, b_n) Time_R(a_n, b_n) Time_I(a_n, b_n)$

Time can be in second.

[30]

Assignment problem # AP0302

- Problem: In mathematical terms, the sequence F_n of Fibonacci numbers is defined by the recurrence relation $F_n = F_{n-1} + F_{n-2}$ with seeded value $F_0 = 0$ and $F_1 = 1$. The series can be given as 0, 1, 1, 2, 3, 5, 8, 13, 21, 34, 55, 89, 144, ...

Write two functions `Fibonacci_R` and `Fibonacci_I` with recursion and iteration, respectively. Compute the respective execution time $Time_R(n)$ and $Time_I(n)$ for input n .

- Input: N followed by N space separated n_i s

N

$n_1 n_2 \cdots n_N$

Where, ($n_i \in \mathbb{Z}$ and $0 < n_i \leq 100000$). The name of the input file must be `input_AP0302.txt`

- Output:

n_1 `Fibonacci_R`(n_1) `Fibonacci_I`(n_1) $Time_R(n_1)$ $Time_I(n_1)$

n_2 `Fibonacci_R`(n_2) `Fibonacci_I`(n_2) $Time_R(n_2)$ $Time_I(n_2)$

\vdots

n_N `Fibonacci_R`(n_N) `Fibonacci_I`(n_N) $Time_R(n_N)$ $Time_I(n_N)$

Time can be in second.

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Assignment problem # AP0303

- *Building Rational number library.* A rational number is a type of real number, which is in the form of p/q where $p, q \in \mathbb{Z}$ and $q \neq 0$. A rational number can be represented as a structure of two integers– numerator and denominator.

```
struct rational {  
    int num;  
    int den; };
```

Build your rational number library with the following operations.

1. $0/1 \leftarrow \text{rational_init}(\&r, x, y)$, given an address of a rational numbers structure r and two values x, y , it outputs the numerator and denominator with x and y respectively. Finally returns 0 on failure and 1 on success.
2. $r_3 \leftarrow \text{rational_add}(r_1, r_2)$, given two rational numbers r_1 and r_2 , it outputs another rational number r_3 such that $r_3 = r_1 + r_2$.
3. $r_3 \leftarrow \text{rational_sub}(r_1, r_2)$, given two rational numbers r_1 and r_2 , it outputs another rational number r_3 such that $r_3 = r_1 - r_2$.
4. $r_3 \leftarrow \text{rational_mul}(r_1, r_2)$, given two rational numbers r_1 and r_2 , it outputs another rational number r_3 such that $r_3 = r_1 * r_2$.
5. $r_3 \leftarrow \text{rational_div}(r_1, r_2)$, given two rational numbers r_1 and r_2 , it outputs another rational number r_3 such that $r_3 = r_1/r_2$.

- Input: n followed by N space separated $x_i, y_i, op_i, x'_i, y'_i$

```
n  
x1 y1 op1 x'1 y'1  
x2 y2 op2 x'2 y'2  
⋮  
xn yn opn x'n y'n
```

Here op_i is one of $\{+, -, *, /\}$, $r_i = x_i/y_i, r'_i = x'_i/y'_i \in \mathbb{Q}$. Input file `input_AP0303.txt`

- Output: If $r''_i = x''_i/y''_i$ is the output of i th input then

```
x''1 y''1  
x''2 y''2  
⋮  
x''n y''n
```

[40]

- A rational number p/q is said to be in canonical form if p and q are co-prime, and $q > 0$. Output the results of the above four operations in canonical form. Hint: use GCD..

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Assignment problem # AP0304

- Problem: Suppose, a freshly graduated student, Chatur gets a job offer from a reputed company with an initial salary Rs. s /month when his/her age is a . Chatur wants to deposit 10% of his salary in an Employees' Provident Fund (EPF) and 10% in an Equity Linked Savings Schemes (ELSS). Suppose, EPF and ELSS give 0.65% and 1% monthly interests respectively.
 1. If annual growth of the salary is 8%, what will be the expected values in EPF ($savings_{epf}$) and ELSS ($savings_{elss}$) funds after n years.
 2. If 10% of the ELSS fund is withdrawn for vacation every year, what will be the expected value ($savings_{welss}$) in ELSS fund after n years.
 3. One year later, a colleague advised Chatur to invest in a small cap Small cap index fund SCF that can monthly return 1.5%. If $savings_{scf}$ is the expected value in that fund after n years, then compute $savings_{scf}$.
 4. Let, Annual inflation in India be at 7.5%, some Govt. agency wants to give monthly interest on savings just enough to keep the savings invariant with inflation. So, it gives a monthly interest of 0.61%. If $savings_{inf}$ be the value of that fund after n years, find $savings_{inf}$.
 5. However, Chatur is new and afraid of market volatility. He wants a peaceful life. So, he decides to keep 10% of his salary in a Recurring Deposit (RD) that gives monthly returns of 0.41%. However, from the 5th year onward, he has to give 20% of its interest yearly as tax to the government. If $savings_{FD}$ be the value of that fund after n years, find $savings_{FD}$.
- Input: The number of input followed by N inputs $s a n$ each in a new line. Input file `input_AP0304.txt` as usual.
- Output: For each input line, print in terminal followings, separated by tab in new line.

– $savings_{epf} \quad savings_{elss} \quad savings_{welss} \quad savings_{scf} \quad savings_{inf} \quad savings_{FD}$

[40]