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Institute for Advancing Intelligence, TCG CREST
(TCG Centres for Research and Education in Science and Technology)

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

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,$\cdots$

  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_is
  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. $0/1 \leftarrow$`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. $r_3 \leftarrow$`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. $r_3 \leftarrow$`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. $r_3 \leftarrow$`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. $r_3 \leftarrow$`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
  $x_1\ y_1\ op_1\ x'_1\ y'_1$
  $x_2\ y_2\ op_2\ x'_2\ y'_2$
  $\vdots$
  $x_n\ y_n\ op_n\ x'_n\ y'_n$
  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 ith input then
  $x''_1\ y''_1$
  $x''_2\ y''_2$
  $\vdots$
  $x''_n\ y''_n$

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- 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 1% and 0.65% 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, monthly 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.

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

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