EE231002 Introduction to Programming

Lab09. GCD and LCM

Due: Nov. 23, 2019

Given any positive integer N, $N > 1$, one can express this integer as a product of its prime factors. For example, if $N = 100$ then

$$N = 2^2 \times 5^2. \tag{9.1}$$

Given two positive integers, N_1 and N_2, once both are expressed in the product of prime factors form, their Greatest Common Divisor (GCD) and Least Common Multiple (LCM) can also be found easily. For example, if $N_1 = 100$ and $N_2 = 225$, then

$$N_1 = 2^2 \times 5^2 \tag{9.2}$$
$$N_2 = 3^2 \times 5^2 \tag{9.3}$$
$$\text{GCD}(N_1, N_2) = 5^2 = 25 \tag{9.4}$$
$$\text{LCM}(N_1, N_2) = 2^2 \times 3^2 \times 5^2 = 900 \tag{9.5}$$

In this assignment, you will write a C program with the following functions.

1. `void factorize(int N, int factors[S], int power[S]);`
   This function factorizes the input N into its prime factors (`factors` array) and their associated powers (`power` array). Using $N_1 = 100$ as an example, after calling the `factorize` function, the two arrays' contents are:

   $$\texttt{factors[]} = \{2, 5, 1\}; \tag{9.6}$$
   $$\texttt{power[]} = \{2, 2, 1\}; \tag{9.7}$$

   Note that in the `factors` array the prime factors are ordered in ascending order and is terminated by 1. And, `S` is a predefined macro.

   ```
   #define S 20
   ```

2. `void GCD(int Afactors[S], int Apower[S], int Bfactors[S], int Bpower[S],`
   `int Cfactors[S], int Cpower[S]);`
   This function takes two factors arrays and two power arrays to produce two output arrays: one for GCD factors and the other for GCD power. Following the convention, the `Cfactors` should have the prime factors ordered in ascending order.

3. `void LCM(int Afactors[S], int Apower[S], int Bfactors[S], int Bpower[S],`
   `int Cfactors[S], int Cpower[S]);`
   This function takes two factors arrays and two power arrays to produce two output arrays: one for LCM factors and the other for LCM power. Again, the `Cfactors` array is in ascending order.

4. `void write(int factors[S],int power[S]);`
   This function prints out the factors and power arrays in product of prime factor form and the integer calculated using this product from. For example, with the arrays produced by the `factorize` function above, it prints out

$$\texttt{2\^{}2 * 5\^{}2 = 100} \tag{9.8}$$

Your C program reads in two integers at the beginning and then factorizes these two integers. Using the factors and power arrays, the GCD and LCM are then found and printed out. Example inputs and outputs of your program are shown below.

```
$ ./a.out
input A: 100
input B: 225
  A = 2^2 * 5^2 = 100
  B = 3^2 * 5^2 = 225
  GCD(A,B) = 5^2 = 25
  LCM(A,B) = 2^2 * 3^2 * 5^2 = 900
$ ./a.out
input A: 24
input B: 35
  A = 2^3 * 3 = 24
  B = 5 * 7 = 35
  GCD(A,B) = 1 = 1
  LCM(A,B) = 2^3 * 3 * 5 * 7 = 840
```

Notes.

1. Create a directory **lab09** and use it as the working directory.
2. Name your program source file as **lab09.c**.
3. The first few lines of your program should be comments as the following.

   ```
   // EE231002 Lab09. GCD and LCM
   // ID, Name
   // Date:
   ```

4. After you finish verifying your program, you can submit your source code by

   ```
   $ ~ee2310/bin/submit lab09 lab09.c
   ```

   If you see a "submitted" message, then you are done. In case you want to check which file and at what time you submitted your labs, you can type in the following command:

```
$ ~ee2310/bin/subrec lab09
```

It will show the submission records of lab09.

5. You should try to write the program as efficient as possible. The format of your program should be compact and easy to understand. These are part of the grading criteria.