Friday, April 22, 2022.

Data Structures and Algorithms LAB – Spring 2022
(BS-IT-F20 Morning & Afternoon)

Lab # 5 (Online Lab)

Submission Deadline: ***Friday, April 22, 2022 (till 11:00 PM)***

Instructions:

- Attempt the following tasks exactly **in the given order**.
- You must complete all tasks individually. Absolutely NO collaboration is allowed. Any traces of plagiarism/cheating would result in an **"F"** grade in this course and lab.
- **Indent** your code properly.
- Use meaningful variable and function names. Use the **camelCase** notation.
- Use meaningful prompt lines/labels for all input/output.
- Do NOT use any **global** or **static** variable(s). However, global named constants may be used.
- Make sure that there are **NO** ***dangling pointers*** or ***memory leaks*** in your programs.
- Late submissions will NOT be accepted, whatever your excuse may be.

Submission Procedure:

i. You are required to submit C++ program for **Task # 1**.

ii. Create an empty folder. Put all of the ***.CPP*** and ***.H*** files of Task # 1 into this folder. Do NOT include any other files in your submission, otherwise your submission will NOT be graded. Don't forget to mention your Name, Roll Number and Section in comments at the top of each CPP file.

iii. Now, compress the folder (that you created in previous step) in **.RAR** or **.ZIP** format. Then rename the RAR or ZIP file ***exactly*** according to the following format:

`Mor-Lab5-BITF20M123` (for Morning section) OR
`Aft-Lab5-BITF20A456` (for Afternoon section),

where the text shown in **BLUE** should be your **complete Roll Number**.

iv. Finally, submit the *single* **.RAR** or **.ZIP** file through **Google Classroom**.

Note: *If you do not follow the above submission procedure, your Lab will NOT be graded and you will be awarded ZERO marks.*

Task # 1

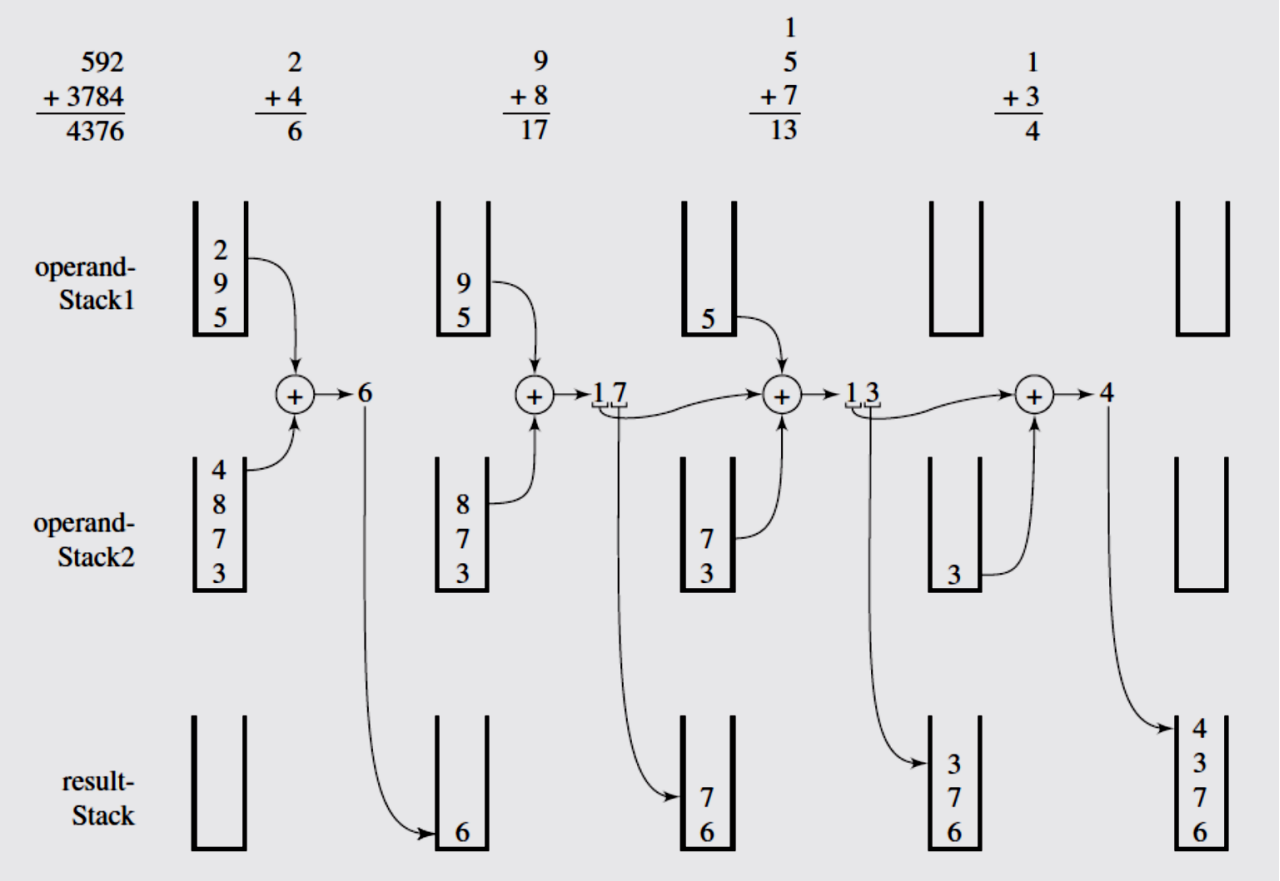
*Here is the description of the problem of **Adding two very large numbers** as described in Section 4.1 of the book "Data Structure and Algorithms in C++" (4th Edition) by Adam Drozdek:*

The largest magnitude of integers is limited, so we are not able to add **18,274,364,583,929,273,748,459,595,684,373** and **8,129,498,165,026,350,236**, because integer variables cannot hold such large values, let alone their sum. The problem can be solved if we treat these numbers as strings of characters, store the numbers (digits) corresponding to these characters on two stacks, and then perform addition by popping numbers (digits) from the stacks. The pseudo-code for this algorithm is as follows:

Algorithm addingLargeNumbers()

- ***a.*** *create 3 empty stacks of integers (**stack1**, **stack2**, and **resultStack**)*
- ***b.*** *read the digits of the first number (as characters) and store the numbers/digits corresponding to them on **stack1***
- ***c.*** *read the digits of the second number (as characters) and store the numbers/digits corresponding to them on **stack2***
- ***d.*** *integer **carry** = 0*
- ***e.*** ***while** at least one stack is not empty*
    - *i. pop a number from each nonempty stack and add them to **carry***
    - *ii. push the unit part of the sum on the **resultStack***
    - *iii. store carry (the tens part) in the variable **carry***
- ***f.*** *push **carry** on the **resultStack** if it is not zero*
- ***g.*** *pop numbers from the **resultStack** and display them*

The following figure (taken from Drozdek's book) shows an example of the application of this algorithm. In this example, the two numbers **592** and **3784** are being added.



The step-by-step working of the above example is explained below:

1. Numbers corresponding to digits composing the first number (i.e. **592**) are pushed onto **operandStack1**, and numbers corresponding to the digits of the second number (i.e. **3784**) are pushed onto **operandStack2**. Note the order of digits on the stacks.
2. Numbers **2** and **4** are popped from the stacks, and the result, **6**, is pushed onto **resultStack**.
3. Numbers **9** and **8** are popped from the stacks, and the unit part of their sum, **7**, is pushed onto **resultStack**; the tens part of the result, number **1**, is retained as a carry in the variable **carry** for subsequent addition.
4. Numbers **5** and **7** are popped from the stacks, added to the **carry**, and the unit part of the result, **3**, is pushed onto **resultStack**, and the carry, **1**, becomes a value of the variable **carry**.
5. One stack is empty, so a number is popped from the nonempty stack, added to **carry**, and the result is stored on **resultStack**.
6. Both operand stacks are empty, so the numbers from **resultStack** are popped and printed as the final result.

You are required to write a **C++ program** which implements the above algorithm for adding two very large numbers. Here are a few instructions that you need to keep in mind:

1. Implement and use the **`Stack`** class (for storing integers) that we have seen in the lecture.
2. Your program should take two numbers from the user and store them as two null-terminated **c-strings**. Assume that the maximum number of digits in a number is **40**.
3. After taking input, your program should determine the sum of these two large numbers using the above-mentioned algorithm (***`addingLargeNumbers`***) and display the sum on screen.

Two sample runs of your program may produce the following output (Text shown in **Red** is entered by the user):

Sample Run # 1

```
Enter 1st number: 12345678912345678912345678
Enter 2nd number: 123454321123454321

Sum of the two numbers is: 12345678924691111024691111
```

Sample Run # 2

```
Enter 1st number: 12345678912345678912345678
Enter 2nd number: 98765432198765432198765432

Sum of the two numbers is: 111111111111111111111111110
```