Lab 1: Review

1 Schoolwork

1.1 Pointer

Complete the following given functions

1. Swap 2 given integers.

   ```
   void swap(int* a, int* b)
   ```

2. Calculate the total value of 2 integers.

   ```
   int* sum(int* a, int* b)
   ```

3. Input an array with unknown size.

   ```
   void inputArray(int* a, int &n)
   ```

4. Print a given array

   ```
   void printArray(int* a, int n)
   ```

5. Find the largest value from a given array.

   ```
   int* findMax(int* arr, int n)
   ```

6. Find the longest ascending subarray from a given array.

   ```
   int* findLongestAscendingSubarray(int* a, int n, int &length)
   ```

7. Swap 2 given arrays.

   ```
   void swapArrays(int* a, int* b, int &na, int &nb)
   ```

8. Concatenate 2 given array.

   ```
   int* concatenate2Arrays(int* a, int* b, int na, int nb)
   ```

9. Given 2 ascending array with distinguish elements. Generate a new ascending array with all elements from the given array.

   ```
   int* merge2Arrays(int* a, int* b, int na, int nb, int&nc)
   ```

10. Generate a random matrix with keyboard input size.

    `void generateMatrix1(int** A, int &length, int &width)`

11. Given 2 1D arrays `a` and `b`. Generate the matrix `c` that c[i][j] = a[i] * b[j].

    `int** generateMatrix2(int* a, int* b, int na, int nb)`

12. Swap 2 columns / rows of a given matrix.

    `void swapRows(int** a, int length, int width)`

    `void swapColumns(int** a, int length, int width)`

13. Generate the transpose matrix of a given matrix.

    `int** transposeMatrix(int** a, int length, int width)`

14. Concatenate 2 given size-equal matrices, horizontally / vertically.

    `int** concatenate2MatricesH(int** a, int** b, int length, int width)`

    `int** concatenate2MatricesV(int** a, int** b, int length, int width)`

15. Multiple 2 given matrices.

    `bool multiple2Matrices(int** a, int** b, int lengtha, int widtha, int lengthb, int widthb)`

16. Given matrice a. Find the submatrix of a which satisfy keyboard input size and has the largest total value of its elements.

    `int** findSubmatrix(int** a, int length, int width, int &length_, int &width_)`

From No. 17. *to No.* 20. *are Searching Algorithms. Return the first position found, else, return* -1.

17. Sequential Search:
    - `int LinearSearch(int* a, int n, int key)`
18. Sequential Search (using flag):
    - `int SentinelLinearSearch(int* a, int n, int key)`
19. Binary Search:
    - `int BinarySearch(int* a, int n, int key)`
20. Binary Search (using recursion):
    - `int RecursiveBinarySearch(int* a, int left, int right, int key)`

1.2 Recursion

Complete the following functions using the Recursion technique (*you may declare some sub-functions*):

1. Calculate the sum of $S = 1 + 2 + 3 + ... + n$.
2. Calculate the factorial $n! = 1 * 2 * 3 * ... * n$.
3. Calculate x^n.
4. Count the number of digits of a given integer.
5. Verify if every digits of given integer are even.
6. Count the number of common divisor of 2 given integers.
7. Calculate the Greatest common divisor and Least common multiple of 2 given integers.
8. Calculate the reverse value of a given integer.
9. Calculate the i^{th} Fibonacci number.
   - $F_0 = 0, F_1 = 1$
   - $F_n = F_{n-1} + F_{n-2}, (n \geq 2)$
10. * Given 4 single distinguish characters. Print out all possible permutation.
    - Example: ABCD, ABDC, ACBD, ...

1.3 File Handling

1.3.1 Data Description

This lab's data is the anonymized data of the result of the High Graduation Exam 2018 - 2019. The information is provided in the file *"data.txt"*, which has the content as follow:

```
Số Báo Danh, Họ và Tên, Toán, Ngữ Văn, Vật Lý, Hóa Học, Sinh Học, Lịch Sử, Địa Lý, GDCD, KHTN, KHXH, Ngoại Ngữ, Ghi Chú, Tỉnh
BD1200000,,8.6,6.5,4.0,7.25,5.5,,,,,,8.4,N1,BinhDinh
BD1200001,,4.0,5.0,,,,4.25,7.0,7.75,,,2.0,N1,BinhDinh
BD1200002,,7.0,6.25,6.0,6.25,6.5,,,,,,5.2,N1,BinhDinh
BD1200003,,5.2,5.75,,,,5.75,7.25,9.25,,,4.6,N1,BinhDinh
BD1200004,,7.6,6.25,7.0,6.5,4.5,,,,,,6.2,N1,BinhDinh
BD1200005,,8.6,6.5,4.0,7.25,5.5,,,,,,8.4,N1,BinhDinh
```

in which:

- The first line provides the included information fields.
- For the next lines, each one is the information of 1 candidate, separated by a comma ",".
- The empty fields mean there is no information. If the empty field is a subject, that equal to a 0.
- The scores in the fields: Natural Sciences (KHTN) and Social Sciences (KHXH) will be instructed in the next part.

1.3.2 Programming

Given the `Examinee` data structure definition:

```
// Examinee.h
struct Examinee
{
    string id;
    float math, literature, physic, chemistry, biology, history, geography, civic_education, natural_science,
        social_science, foreign_language;
};
```

Fulfill the following requirements:

1. Read the information of one candidate:
   - `Examinee readExaminee(string line_info);`
   - **Input**: `line_info` - a line from *"data.txt"* which provides the information of 1 contestant.
   - **Output**: Return `Examinee` variable, which stores the info of the given contestant.
2. Read the information of a list of candidates:
   - `vector<Examinee> readExamineeList(string file_name);`
   - **Input**: `file_name` - path to input file *"data.txt"*.
   - **Output**: Return `vector<Examinee>` variable, which store the info of all contestants from the file.
3. Write the total score of candidates to file:
   - `void writeTotal(vector<Examinee> examinee_list, string out_file_name);`
   - **Input**: `examinee_list` - List of contestants.
     `out_file_name` - name of file to write.
   - **Output**: Calculate the total score of each contestant and write them to the *out_file_name* file using the following format:
     - Each line contains info of only one contestant.
     - Each contestant's info consists of ID and the total score separated by a single space.
   - **Example**:
     XX001 42.0
     XX002 38.5
     ...
     XX999 23.25

The total score is calculated as follows:

- The score of Natural Sciences and Social Sciences column in *data.txt* is not available by default. Calculate the score for each combination and store them into struct `Examinee`.
- The score of Natural Sciences combination = physic + chemistry + biology
- The score of Social Sciences combination = history + geography + civic education
- The total score = math + literature + foreign language + natural sciences + social sciences

1.4 Linkedlist

Given the following Linkedlist definition:

```
struct NODE{
    int key;
    NODE* p_next;
};
```

```
struct List{
    NODE* p_head;
    NODE* p_tail;
};
```

Complete the following functions to fulfill the given requirements:

1. Initialize a `NODE` from a given integer:
   - `NODE* createNode(int data)`
2. Initialize a `List` from a give `NODE`:
   - `List* createList(NODE* p_node)`
3. Insert an integer to the head of a given `List`:
   - `bool addHead(List* &L, int data)`
4. Insert an integer to the tail of a given `List`:
   - `bool addTail(List* &L, int data)`
5. Remove the first `NODE` of a given `List`:
   - `void removeHead(List* &L)`
6. Remove the last `NODE` of a given `List`:
   - `void removeTail(List* &L)`
7. Remove all `NODE` from a given `List`:
   - `void removeAll(List* &L)`
8. Remove a Node before Node with a given value `List`:
   - `void removeBefore(List* &L, int val)`
9. Remove an integer after a value of a given `List`:
   - `void romveAfter(List* &L, int val)`
10. Insert an integer at a position of a given `List`:
    - `bool addPos(List* &L, int data, int pos)`
11. Remove an integer at a position of a given `List`:
    - `void RemovePos(List* &L, int data, int pos)`
12. Insert an integer before a value of a given `List`:
    - `bool addBefore(List* &L, int data, int val)`
13. Insert an integer after a value of a given `List`:
    - `bool addAfter(List* &L, int data, int val)`
14. Print all elements of a given `List`:
    - `void printList(List* L)`
15. Count the number of elements `List`:
    - `int countElements(List* L)`
16. Create a new `List` by reverse a given `List`:
    - `List* reverseList(List* L)`
17. Remove all duplicates from a given `List`:
    - `void removeDuplicate(List* &L)`
18. Remove all `key` value from a given `List`:
    - `bool removeElement(List* &L, int key)`

1.5 Stack - Queue

Following is the representation of a Singly linked list node:

```
struct NODE{
    int key;
    NODE* pNext;
};
```

Utilize the Linked list above, define the data structure of Stack and Queue, then implement functions to execute the following operations:

1. Stack
   - **Initialize** a stack from a given key.
   - **Push** a key into a given stack.
   - **Pop** an element out of a given stack, return the key's value.
   - **Count** the number of elements of a given stack.
   - Determine if a given stack **is empty**.
2. Queue
   - **Initialize** a queue from a given key.
   - **Enqueue** a key into a given queue.
   - **Dequeue** an element out of a given queue, return the key's value.
   - **Count** the number of element of a given queue.
   - Determine if a given queue **is empty**.

2 Homework

Following is representation of a doubly linked list:

```
struct d_NODE{
    int key;
    d_NODE* pNext;
    d_NODE* pPrev;
};
```

```
struct d_List{
    d_NODE* pHead;
    d_NODE* pTail;

};
```

Implement functions to execute the operations from singly linkedlist section (section 1.4).