

IT3312E – Data structures and algorithms
Midterm exam 20232 (Duration: 70 minutes)

Full name: _____ Student ID: _____

Problem 1 (3 points). Given set $N = \{1, 2, 3, \dots, n\}$. Each n -element permutation of set N is represented by the array $\{a[1], a[2], \dots, a[n]\}$. An n -element permutation of set N is called perfect if each element $a[i]$ (where $i = 1, 2, \dots, n$) satisfies **one of the following two conditions**:

- 1) $a[i]$ is divisible by i ;
- 2) i is divisible by $a[i]$.

Input: a positive integer n ($1 \leq n \leq 15$).

Output: The number of perfect n -element permutations of set N .

Example 1: Input: 1 Output: 1	Example 2: Input: 5 Output: 10
--	---

Problem 2 (3 points). In the class, we already studied the problem the Longest common subsequence (LCS) that is defined as follows: "Given 2 sequences $X = \langle x_1, \dots, x_m \rangle$ and $Y = \langle y_1, \dots, y_n \rangle$. A subsequence of sequence A is a sequence obtained by deleting k ($k \geq 0$) elements from A . Find the length of the longest common subsequence of X and Y ". The following is a variation of the LCS problem: "Each sequence X and Y can contain the wildcard characters "?", and this wildcard in each different position in the sequence (X or Y) is allowed to "match" with any other character of the remaining sequence. Note: wildcard ? of the sequence X must not "match" with wildcard character ? of the sequence Y , and vice versa.". Let's solve this variation of the LCS problem.

For example: $X = a?bb?da$, $Y = a?bcd$. We have:

- $X = a?bb?da \rightarrow$ if the first wildcard matches with "a" and second wildcard matches with c \rightarrow then $X = \underline{a}bb\underline{c}da$
- $Y = a?bcd \rightarrow$ if the first wildcard matches with "b" \rightarrow then $Y = \underline{a}bb\underline{c}d$

So, the longest common subsequence is abbcd, and the length is 5

Input:

- Line 1: sequence X (with length ≥ 1 and ≤ 50)
- Line 2: sequence Y (with length ≥ 1 and ≤ 50)

Output:

The length of the longest common subsequence of X and Y.

Example 1: Input: a?bb?da a?bedc Output: 5	Example 2: Input: a?bb?dac a?bedc? Output: 6
--	--

Problem 3 (4 points). In order to store products information in the shopping cart when shopping online, we use a **singly linked list** where each node of the list is declared as follows:

```
typedef struct Item {  
    char ID[12]; //product code  
    int quantity; //the number of products in the shopping cart  
    char insertDate[21]; /*the moment the product is added into the shopping cart:  
                           represented by a character string YYYY-MM-DD HH:MM:SS*/  
    double price; //the price of product  
    struct Item* next;  
} Item;
```

Requirement: Download the available code from the link. Complete the content of the following 4 functions, **MUST NOT CHANGE THE PARAMETERS IN THE FUNCTIONS, THE CONTENT OF ALL THE COMMAND LINES IN THE CODE FILE PROVIDED BY THE TEACHER:**

- 1) The function returns the total amount of the shopping cart:
double checkCartTotalPrice(Item* head)
- 2) Search for a product in the cart by using product ID:
Item* findanItemByID(Item* head, char ID[])
- 3) Reduce the quantity of a product in the shopping cart. If the obtained quantity is ≤ 0 , remove the product from the cart:
int reduceItemQuantityByID(Item** head, char ID[], int reduceQuantity)
- 4) Add a product with ID code to the cart. If the cart already has this product, increase the quantity of the product. If not, add the product to the end of the list in the cart:
void addNewItem(Item** head, char ID[], int quantity, char insertDate[], double price)

Note:

- Can declare additional variables, data types or external libraries if needed.
- If you use additional function, you can declare more.
- Must not change the position of provided functions, must not change the content command lines in the code file provided by the teacher.
- If you can do any function correctly, you can earn points for that function.