VIETNAM NATIONAL UNIVERSITY - HO CHI MINH CITY
HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
FACULTY OF COMPUTER SCIENCE AND ENGINEERING

PROGRAMMING FUNDAMENTALS - CO1027

ASSIGNMENT 1

SECOND MONGOL INVASIONS OF VIETNAM

HO CHI MINH CITY, 03/2021

ASSIGNMENT'S SPECIFICATION

Version 1.0.1

1 Assignment's outcome

After completing this assignment, students review and make good use of:

- Branching structure
- Loops structure
- Function and function call
- String processing

2 Introduction

"The world was defeated by the Mongols, the Yuan Dynasty troops are only terrified of this Dai Viet country" (Ancient poetry)

After 27 years since the victory in First Mongol invasion, Dai Viet entered a peaceful period, the warmth of warm people doing business. A more important part is because Mongolia is focusing on the battle to finish the Southern Song dynasty to destroy the entire Chinese territory.

Not long after the resistance victory, the Emperor Tran Thai Tong gave the throne to the prince, ie the Emperor Tran Thanh Tong. Enlighten this precious peace, Dai Viet under the reign of Tran Thai Tong and Tran Thanh Tong, the court actively organized for the people to dig many water channels and treat water flooding. It has shown the strength of the people and the spirit of solidarity between the people and the Dai Viet army.

In East Asia, the horses of the Mongol empire has trampled the richest civilization at that time was the Jin dynasty and the Song Dynasty, causing the tragic death for many people. After destroying the South Dynasty, acquiring all China, Kublai summed up as a king to set up Yuan dynasty (1271). This is the world's most powerful empire at that time. With a new strength, Kublai are determined to attack Dai Viet, a country with a particularly important position on the road to expansion to the southern lands.

In 1278, Tran Thai Tong died, the king Tran Thanh Tong retired and made crown prince Tran Khan (as known as Tran Nhan Tong, known to the Mongol as Tran Nhat Ton) his

successor. Kublai sent a mission led by Chai Chun to Dai Viet, one again urged the new king to come to China in person, however the Yuan mission ended in failures as the king resisted to go. The Yuan then refused to recognize him as king and tried to place a Vietnamese defector as king of Dai Viet. Frustrated with these failed diplomat missions, many Yuan officials urged Kublai to send a punitive expedition to Dai Viet. In 1283, Khubilai Khan sent Ariq Qaya to Dai Viet with an imperial request for help from Annam (Dai Viet) to attack Champa through Vietnamese territory, with demands for provisions and other support to the Yuan army (actually, attack Dai Viet). The two Kings Tran immediately embarked on preparing the resistance organization.

3 Input data

The program's input data is stored in file `input.txt`. The input data distinguishes uppercase and lowercase letters. This file stores the information in the following format:

NID
NID line ID_i
N_1
input1
input2
input3
input4
N_5
input5
input6
N_7
k V i j
input7

In detail:

- **NID** is the number of Tran Dynasty troopers in the mission. Each Tran Dynasty trooper will have a identification string, corresponding to **NID** next line.

- ID_i is identification string of ith trooper of Tran Dynasty troops. In particular, there will be troopers with special character strings:
  - The string contains the word **VUA** at the beginning used to identify the King Tran Nhan Tong. For example: "VUA122a" or "VUAaa12" represents the king, "vua122a", "Vua122a", or "aa12VUA" is not.
  - The string contains the word **THD** in the middle used to identify General Tran Hung Dao. For example: "aTHDbc", "123THDabc" represents General Tran Hung Dao, while "THDabc", "abcTHD", or "athdbc" is not.
- N_i is the number of lines corresponding to input ith, the input which does not have N has the number of lines in fixed input data.
- **input** will be explained clearly in each mission.

4 Mission

Students are asked to build a program in C++ to simulate the battle above, through the missions described below. Note, a mission may have many functions that need to be implemented.

4.1 Our army prepares against enemies

It was said that facing threat from the north, in October 1282, the Retired Emperor Tran Thanh Tong and the Emperor Tran Nhan Tong gathered all members of royal family, the Tran clan and officials in royal court in Binh Than to discuss about the unadvoidable war. Although being a member of the royal family, Tran Quoc Toan was not invited because the 16-year-old marquis was too young to be considered in the meeting. As a result, Tran Quoc Toan felt so ashamed and stimulated that he crushed an orange with his own hand and began to mobilize his house servants and relatives for the purpose of fighting against the Yuan Dynasty. Eventually, Tran Quoc Toan was able to form an army of over one thousand soldiers and he created himself a flag with six characters:

"Pha cuong dich, bao hoang an"

Then, in early 1285, King Tran opened the Dien Hong Conference to summon elders to represent the local people to the court to unify their determination to resist and encourage the entire people to fight the enemy. Complete Annals of Dai Viet reported that, when asked by the

emperor to fight against the Nguyen people, the elders "said as if from one mouth:" Fight!"". The spirit of "Sat That" tingle in the army and the people. Tran Hung Dao was appointed as the Commander-in-chief of the armies (Quoc Cong Tiet che). He has also appealed Exhortation to the military officers (Hich tuong si) - immortal literature has great significance, arousing the patriotism, pride and sense of responsibility of the warrior against the loss of the nation. Tran Hung Dao chose a strategy: moving from directly confronting the Nguyen army to retreating, implementing an *"Vacated or evacuated houses, abandoned (or uncultivated) gardens"* to cut off the supplies of Yuan's food. Just like that, the Tran army avoided confrontation with the enemy for months, waiting for the enemy to weaken due to lack of salary and a breakdown of willpower, then he gathered his counterattack troops to win decisive victory. The princes enthusiastically recruited troops and practiced ready to follow the orders of the court. The localities, the militia have been strengthened, trained, and fenced in the village. Large parades and drills were held in the capital and critical places.

Students are required to write a function to describe the process of preparing for the troops as follows:

- Function name: readyForBattle
- Parameters:
  - Single dimension array $\mathbf{ID_i}$ is identification string of ith trooper of Tran Dynasty troop
  - Integer **NID** is the number of elements in array $\mathbf{ID_i}$
  - Single dimension array **input1** has string type, with each element corresponding to each line of "**input1**" from input data
  - Integer $\mathbf{N_1}$ is the number of elements in array **input1**
- Return value: String as required

Our army proceeded to build the following cryptographic decryption tool:

- Step 1: Decode binary bit strings to decimal bits:
  The elements in the **input1** array are bit strings separated by a space. For each bit string, every 2 bits will convert to a corresponding integer by converting from binary to decimal.

Example of input data for mission 1	
10 1111 1010 11 01 1010	Each line is an element in the array **input1**, decoded to: 2 33 22 3 1 22

- Step 2: Decode decimals to characters:

Number	The corresponding characters
0	E/F/G/H/I/J/K
1	L/M/N/O/P/Q/R
2	#/T/U/V/W/X/Y
3	@/A/S/Z/B/C/D

Each number in column 1 has 7 corresponding characters in the column specified in the above table, the characters are separated by a "/". A string of numbers after decoding in step 1 will continue to be used to decode in step 2 by taking the corresponding character in column 2 with the number of occurrences of the character. Know that the characters '#' and '@' will never stand side by side in the string. In addition, the characters after '#' and '@' must be specially transformed. Special transforms are only applied to characters other than '#' and '@', if the above two special characters persist in the string, a separate transformation must be performed for the following characters.

- For the character '#', the normal characters after it must add a new character at the end of the string, the character added is the next character in the English alphabet of the last character in the initial string (if the last character is Z, the next character is A)
- For the '@' character, the normal characters after it must be in reverse order.

Examples:

String	Decode	Explain
0	E	There is only one number 0 so we will get the first character
00	F	There are two number 0 so we will get the second character
0000000	K	
00000000	E	If the number of characters exceeds 7, return to the beginning and continue
333 33	SA	Space is used to distinguish strings from each other, and between S and A there are no spaces.
2 33 22	#ATU	The string begins with #, so we will add the letter U because U is the next character after T in the English alphabet. The original code is #AT
2 33 22 3 1 22	#ATU @TL	The string begins with @, reversing the order of the characters. The original code is @LT
3 1 22 3 1 222	@TL@UL	The original code is @LT@LU

Note that, the decoding must take place on each element of the array itself (specifically each string in the array **input1** will be decoded discretely as specified above). After successfully decoding the string, if a '#' or @ character appears in the string, delete them from the string. If there exists King Tran Nhan Tong in the list of troopers identifiers in the Tran Dynasty, the string of characters will be transformed as follows, for example, the solved string is "ABCDEFG":

- Step 1: Creates a new string, whose characters are reversed from the original position by parity (reverse the characters in the even position, and reverse the characters in the odd position). For example, the string "ABCDEFG" is reversed to "GFEDCBA" (reverses the characters in the odd position "ACEG" and the characters in the even position "BDF").
- Step 2: Combine the newly created string with the original string according to the rule of comparing each character, if any larger characters in ASCII charset will be retained. For example, the string "ABCD" and "DBDB" will be "DBDD".

In addition, if General Tran Hung Dao exists in the list of troopers identifiers, because he wants to increase the security of the secret letter after decoding, the string after decoding will be converted to a new string by removing the characters in the 3-divisible position (starting position 0). Then sort the characters in the string in ascending direction of the ASCII charset. For example, there is the string "afaoeq", removing all characters at the position divisible by 3 to "faeq", and sorting in ascending order to "aefq".

After finishing decoding all of the string in **input1** as required, the function must return a string, which is a concatenation of all string elements in the array, separated by a space.

Example 1: Let the decoded array **input1** = [”ABC”,”DEF”]. The string this function returns will be ”ABC DEF”.

4.2 The Tran troops defended and retreated

In the beginning of 1285, 60,000 Yuan troops were led by the son of Kublai Khan, Prince Zhennan Toghon, as commander-in-chief at the same time invading our country. The Tran Dynasty's border defenders were defeated in the battles at Vinh Chau, Noi Bang, Thiet Luoc and Chi Lang. Hung Dao Vuong retreated to keep Van Kiep wharf. According Complete Annals of Dai Viet, military Tran was shattered; Tran Quoc Tuan was able to escape because Yet Kieu was determined to keep the boat waiting for the general. To know where the king is, the army has the following password:

Given two strings A and B of length $[1, 10^6]$, the password is the number of occurrences of string B in string A. Students are required to implement the function to help the king solve the password code above.

- Function name: decode
- Parameters:
  - Strings A and B of length $[1, 10^6]$. These two strings are taken from the two lines in **input2** in the input specification.
- The return value is an integer that is the number of occurrences of string B in the string A.

Example 2: String A = ”helloCSE, this is CSE ASM”, and string B = ”CSE”. We have decode(A,B) = 2.

Until February 11, 1285, Toghoh assigned Omar Baatur led troops raiding boats Van Kiep. The Dai Viet army resisted fiercely, but then withdrew to avoid the strong enemy's position, conducting diversion made the enemy tired and then counterattacked. The entire Tran army withdrew from Van Kiep, Pha Lai, and Binh Than to battle on the banks of the Red River near Thang Long citadel. The Yuan army advanced along the road back to Thang Long. Here, the two kings gathered the navy and built a fortress on the south bank to hold the Nguyen

army, creating time for the evacuation of the militia from the citadel following the "Vacated or evacuated houses, abandoned (or uncultivated) gardens", and using strategy 'scorched earth', burn villages and fields near the city.

In order to easily find the way, our troops had to solve secret messages about the way. Students are asked to write a function to describe the troop's preparation as follows:

- Function name: findRoute
- Parameters:
  - Single dimension array **ID$_i$** identification string of ith trooper of Tran Dynasty troop
  - Integer **NID** is the number of elements in array **ID$_i$**
  - String **input3**, corresponds to a line of **input3** as above specification of input data
- Return value: String as required

String **input3** is defined as follows :

input3	Explain
N B S	- N is event code - B is an integer in $[-10, 10]$ - S is a string containing 1 of 4 characters "U,D,R,L" which is up, down, right and left respectively

Assuming the area to go through is a 2-dimensional coordinate plane, the starting position of our piece is in coordinates (0, 0). Returns the last position of the ta after moving according to the instructions of the string S, knowing that each up, down, left, right character moves only 1 unit. However, this string S needs to be changed twice accordingly in order to properly display the instructions. First of all with the integer B:

- If B = 0: No need to change the string S.
- If B ¡ 0: Shift left the string S —B— characters.
- If B ¿ 0: Shift right the string S —B— characters.

Then, for each character in the string we will convert $|N-2\times i|$ times, where i is the position of the character in the string, starting at position 0. Once we convert the character, we will replace that character with the next character follows the rule: $U \rightarrow D \rightarrow L \rightarrow R \rightarrow U \rightarrow ....$

Example 3: With N = 3 and S = "UDL",
We convert the first U character $|N - 2 \times i| = |3 - 0| = 3$ times, character D 1 time, ...
Converts the first U 3 times to R ($U \rightarrow D \rightarrow L \rightarrow R$), the character D 1 times to L.
Thus, the string becomes "RLR".

After the processing is done, the format string "(x, y)" is returned, where x and y are integer coordinates, without quotes.

On February 17, the two sides fought again on the banks of the Red River. The Nguyen prevailed, but the army and people of Dai Viet promptly evacuated from Thang Long. The two kings led their army withdrew along the Red River towards Thien Truong and Truong Yen. Toghoh took Thang Long, then divided his army into 2 waterways and roads of aggressively pursuing. During their pursuit, they continuously sent intelligence messages back to Toghoh, similarly, to ensure confidentiality, intelligence messages were also encrypted. Students are asked to construct a function to decode.

- Function name: decodeVfunction
- Parameters:
  - String A and B from **input4** in the input specification
- Return value: A*B

The format of the strings A and B is as follows: we have 2 constants denoted by 0 and a one-variable function V that returns a natural number. We define 2 numbers A, B have the form 0 or V(0) or V(V(0)) or V(....V(0)).

In addition, we also define the following math operations:

- x + 0 = x
- x * 0 = 0
- x + V(y) = V(x+y)
- x * V(y) = x*y +x

Know that A, B are no more than 10000 characters long. The result is a string that is the result of the A*B operation, which must be of the form 0, V(0) or V(... V(0)).

Example 4:
With A=V(V(0)); B=0. A*B = 0

With A=V(V(0)); B=V(0). A*B = V(V(0))*0 + V(V(0)) = 0 + V(V(0)) = V(0+V(0)) = V(V(0+0)) = V(V(0))

In late February, Sogetu's forces marched from the south penetrated the pass of Nghe An, captured the cities of Vinh and Thanh Hoa. Toghon launched a full offensive against Dai Viet. Yuan fleet under the command of Omar attacked along the Duong River, succeeded capturing Hanoi while driving king Nhan Tong to the sea. Planning to weaken the Mongol strength, the Vietnamese abandoned the capital and retreated south while enacting a scorched earth campaign by abandoning empty capital and cities, burning villages and crops where the Mongols occupied. In the next day, Toghon entered the capital and found an empty palace. Many Vietnamese royals and nobles were frightened and defected to the Yuan, including prince Tran Ich Tac.

Toghon divided troops to hold important positions and established communication stations with each other. The main force coordinated with the militia to organize guerrilla attacks in the predominant enemy area and prepared a counterattack. Yuan army depleted, fatigue, suppressed food supply lines, to meet seasonal heat to inflammation, sickness arising epidemic, attacking, holding kept difficult.

In the Tran army there were a few betrayals, most of the troops knew them, but it was difficult to say, so our troops used pointers through voting. There are a total of 26 suspects, numbered "A-Z". Each trooper in the army will be assigned 1 vote to choose the 6 traitors they most suspect. The ballot will be a 6-character string, each character is the name of the suspect and the order of appearance indicates the difference in ranking of each person. On each ballot, the first name will score 6 points, the ones who rank then will get the number of points decreasing, finally 1 point. Suppose the trooper submits the vote "BACDEF" which means that B gets 6 points, A gets 5 points and C gets 4 points, similarly F gets 1 point.

Find out 3 people who are suspected of being the most betrayals (the higher the score, the more suspected). If 2 or more people equal points, priority is given by alphabetical order. Suppose, A and B are the two most suspect people with the same number of points, now we prioritize A in alphabetical order.

- Function name: findBetrayals
- Parameters:
  - A single dimensional array of elements is a string taken from lines **input5** in the input specification

  - Integer N_5 is the number of elements in array **input5**

- Return value: The string consists of 3 characters corresponding to the 3 traitors

input5	Explain
XXXXXX XXXXXX ... XXXXXX	Each line contains a 6-character string corresponding to 1 vote

Example:

input5	Explain
ABCDEF GHEABC HGCBAE	A got 11 points (6+3+2=11) B got 10 points (5+2+3=10) C got 9 points (4+1+4=9) ...

4.3 Tran army counterattacked

Seizing the opportunity, in May 1285, Tran Quoc Tuan organized a counterattack. A series of great battles from Truong Yen to Thang Long. They were the battles A Lo (Nam Dinh), Tay Ket, Ham Tu (on the Red River bank in Hung Yen), Chuong Duong (Thuong Tin, Ha Tay) that broke the defensive line along the Red River and attacked Thang Long.

- Function name: attack
- Parameters:
  - A 10-element single dimensional array is the string taken from 10 lines of **input6** in the input specification
- Return value: an integer indicating the position of the row we need to attack first (the first row in the array is at position 0).

After reconnaissance plan of the enemy deployment, generals need to determine the order of priority to attack. To give our troops an early morale, the general intended to attack the weakest lines of the enemy and then fight up. Know that the enemy deployment plan is a 10x10 matrix where 1 is a trooper and 0 is a civilian. A row is considered weaker if there are more civilians. In the rows there may also be 2 which is a elite trooper, when there is elite trooper

in the line, it is necessary to avoid fighting this line even though the line has many civilians. Please determine the attack order of the general.

Note: If there are 2 or more equally weak rows, the general will choose the row with the higher index.

Example of input data for mission 6	
0 0 1 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 0 1 1 1 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 0 0 0	
	output
4	There are 3 weakest rows, 0, 3, 4 because there are 9 civilians. Row 3 has 2 - elite troops, so we can't attack. With the remaining rows 0 and 4, w

The result is: 4 is the first row that our army will attack (the first row in the array is at position 0).

In addition, in order to achieve victory, our troops need to wait for the right opportunity, so our troops have to wait a while before they can fight back. Students are asked to implement the function to calculate the number of days waiting for our troops:

- Function name: calculateNoOfWaitingDays
- Parameter was taken from **input7** in input data specification:
  - String**input7Str** consists of integers separated by a space, where:
    - Integer k is the number of matrices (size $\mathbf{N_7} \times \mathbf{N_7}$) A_1, A_2, ..., A_k
    - Any integer V satisfies the constraint
    - Integer i is the number of rows
    - Integer j is the number of columns
  - **input7** has k lines, represents k matrices, each line has $\mathbf{N_7} \times \mathbf{N_7}$ elements; These k lines are contained in the parameter **input7Matrix** is a single dimensional array

consisting of string elements, characters separated by spaces, representing an array. When saving characters in an array, it must be in the row before the following column.

> **Example 5:** With **input7Matrix[0]** = "1 2 3 4", $N_7 = 2$, we store by row in array (temporarily called arr) first, the following column means arr[0][0]=1, arr[0][1] = 2, arr[1][0] = 3, arr[1][1] =4

- N_7 is the integer representing the size of the matrices.

- Parameter conditions:
  - $0 \leq N_7 \leq 100$
  - $1 \leq i \leq j \leq N_7$
  - $k \leq 500$
  - $1 \leq V \leq 10^{18}$
- Return value: integer as required

Matrix multiplication is an important operation in linear algebra. Let k matrices A1, A2,... Ak have the same size n x n. Let B be the resulting matrix of the multiplication of the matrices A_1, A_2, ..., A_k. We calculate R as the remainder of the division between an element in row i, column j in a matrix B and V. The function result returns an integer R.

Taking advantage, the Vietnamese force under Tran Quoc Tuan sailed to the north and attacked Van Kiep, the important Mongol camp and cut off the Mongol supplies. Many Yuan generals were killed in the battle, included the senior Li Heng who was struck by a poisoned arrow. The Yuan forces became disarrayed, and Sogetu was killed in Chuong Duong by Cham-Vietnamese force in June 1285. To protect Toghon from being shot, the soldiers made a copper box in which they hid him until they reach the Guangxi border. Yuan generals Omar and Liu Gui ran to the beach, found a small boat and escaped back to China. The Yuan remnants retreated back to China on late June 1285 as the Vietnamese king and royals returned to capital Thang Long after the 6-months resistance war.

Tran Quang Khai wrote a poem to celebrate the victory [1]:

[1] Translated by Tham Seong Chee. Tham Seong Chee 1981, p. 305

RETURN TO THE CAPITAL
(Pho gia ve kinh)

At Chuong Duong Port, we seized the enemy's spears,
At Ham Tu Pass, we held the barbars back.
Peace is here: let's strive further
To keep the Fatherland for ever.

4.4 Ending

Thus, the resistance war of Dai Viet army and people under the leadership of two kings Tran Thanh Tong and Nhan Tong won completely, demonstrating the "Hao khi Dong A" of Dai Viet at that time. The Tran defeated the Mongols for the second time, this time on a much larger scale and the circumstances were much more difficult. The Song Dynasty in the north was lost, without any shields, Dai Viet had to directly confront the Nguyen Dynasty on the whole northern border line. After defeating Nam Song, the strength of the Yuan also increased compared to before.

5 Submission

Students submit a file: **mongol.h** in the site "Ky thuat lap trinh (CO1027)_HK202"

Deadlines for submission are announced at the submission site above. By the deadline for submission, the link will be locked automatically, so students will not be able to submit them late. To avoid possible risks at the time of submission, students MUST submit their papers at least **one hour** before the deadline.

6 Handling fraud

Assignment must be done BY YOURSELF. Students will be considered fraudulent if:

- There is an unusual similarity between the source code of the submissions. In this case, ALL submissions are considered fraudulent. Therefore, students must protect the source code of their assignments.
- Students do not understand the source code written by themselves, except for the parts of the code provided in the initialization program. Students can consult from any source, but make sure they understand the meaning of all the lines they write. In the case of

not understanding the source code of the place they refer, students are especially warned NOT to use this source code; instead use what has been learned to write programs.

- Mistakenly submit another student's assignment on your personal account.

In the case of cheating, students will get a 0 for the entire subject (not just the assignment).

DO NOT ACCEPT ANY INTERPRETATION AND NO EXCEPTION!

After each major assignment has been submitted, a number of students will be called for random interviews to prove that the assignment has been done by themselves.

7 Change from previous version

- Function **readyForBattle**: Add example for string decoding.
- Function **calculateNoOfWaitingDays**: Add example for parameter input7Matrix.
- Function **readyForBattle**: Add specification for the function return type, the string that function needs to return and also the example for this specification.

References

[1] Ha Thanh. "Thang Long voi ke sach "thanh da" trong chong giac ngoai xam" (Vietnamese version). Quoc Phong Toan Dan Magazine.

[2] Le Manh That (1999). "Chapter III: Vua Tran Nhan Tong va Cuoc chien tranh ve quoc nam 1985.". TTran Nhan Tong: Con nguoi va tac pham (Vietnamese version). Publishers Ho Chi Minh City.

[3] Ha Van Tam va Pham Thi Tam (1972), Cuoc khang chien chong quan xam luoc Nguyen Mong the ky XIII, Publishers Quan doi Nhan dan, reprint in 2003.

[4] Video TOM TAT CHIEN TRANH NGUYEN MONG - DAI VIET LAN THU HAI (NAM 1285) of Tom tat bach su at Link section 1 và Link section 2

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