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

DOCTOR STRANGE IN THE MULTIVERSE OF MADNESS
Part 1

HO CHI MINH CITY, JULY 2022

ASSIGNMENT SPECIFICATIONS

Version 1.2

1 Outcomes

After finishing this assignment, the student is revised and can proficiently use:

- Conditional statements
- Loop statements
- Array and 2-dimensional array
- String processing
- Function and function call
- File read operations

2 Introduction

The assignment is adapted from the movie ***Doctor Strange in the Multiverse of Madness****. However, some contents have been changed to satisfy the problems in this assignment.*

Figure 1: Doctor Strange. [2]

"America Chavez and a version of Dr. Stephen Strange are pursued by a demon in interstellar space while searching for the Book of Vishanti. When Strange was killed, Chavez accidentally created a portal that sent her and Strange's body to Earth-616, where the main universe version of Strange rescued Chavez from an octopus demon with help support from the Sorcerer Supreme Wong. Chavez explained that the demons hunted her down because she had the power to travel across the multiverse.

Recognizing the magic word on the demon's body, Strange went to Wanda Maximoff for help, only to realize that she was responsible for the attacks. Since acquiring the Darkhold book and becoming the Scarlet Witch, Wanda believes that controlling the multiverse with Chavez's powers will allow her to reunite with Billy and Tommy, the children she created using magic when she was in Westview.

So what does Strange have to do to protect Chavez? And will they be able to withstand Wanda's power? The truth will be revealed soon in this assignment." [1]

3 Input

A file named *input.txt* contains program's inputs. This file will contain information in the following format:

- The first line represents Strange's stats, each separated by a space character. These indicators are described particularly in the 5 section.
- The next line represents the events that Strange will encounter on his way to find a way to deal with Wanda. The sequence of events begins and ends with the character **!**. Events will include an event code (corresponding to the event order) and be accompanied (or not) with data directly related to the event. Each event is separated by #. The details of events are described in the 6 section.

4 Output

The output will be the sum of the values of Strange's indexes at the end of the journey.

5 Strange's parameters

HP LV EXP TS

We have:

- **HP**: Strange's energy index, which is an integer between 1 and 999. This value is also the value of Strange's maximum health (maxHP). When LV increases by 1 unit, the maxHP value will increase by 50 units, and the HP value will also increase by 10 units. However, in all events leading to an increase in HP, if HP increases beyond the maxHP threshold, then HP will be equal to maxHP, maxHP or HP increase beyond 999 will have a value of 999.
- **LV** (Level): Strange's level, which is an integer between 1 and 10. LV will increase by 1 when EXP reaches 100. At all events which leads to the LV increase above 10, the value LV remains at 10.
- **EXP** (Experience): Strange's experience index, which is an integer ranges from 0 to 100. If the EXP value exceeds 100, the LV increases by 1 unit, and the remainder will be incremented from the beginning (from 0) for EXP. In case the LV has reached 10 already, if the EXP value exceeds 100, the EXP value will remain at 100.
- **TS** (Time Stone): The number of time stones, which is an integer ranges from 0 to 5. This stone has an effect on resurrecting Strange upon death, and because of its power, Strange can only hold up to 5 at a time. When resurrected, the number of time stones decreases by 1. Strange will continue his journey at the next event with LV and EXP remain unchanged, HP will recover to the maxHP corresponding to the maxHP at the event causing Strange's death concurrently.

6 Detailed specifications for each event

6.1 Event 1 $\rightarrow$ 5 - Practice

This event does not have any attaching data.

If encountering an event with codes 1 to 5, Strange must engage the corresponding monster. Each monster will also have its own LVo level. If he catches a monster at **ith event**, the corresponding LVo of the monster will be calculated as follows:

Event	Monster	baseDamage	EXP
1	001	1.5	10
2	002	2.5	20
3	003	4.5	40
4	004	7.5	50
5	005	9.5	70

Table 1: baseDamage of monsters and their corresponding EXP.

$$\mathbf{b = i \ \% \ 10} \ (1)$$
$$\mathbf{LVo = i > 6 \ ? \ (b > 5 \ ? \ b : 5) : b} \ (2)$$

If Strange's LV is higher than the monster's LVo, Strange will win. At this time, Stranges's EXP will rise to the corresponding EXP described in table 1.

If Strange's LV is equal to the monster's LVo, the game draws. Strange continues with his journey and EXP index increases by half of the value obtained when killing monsters.

If Strange's LV is less than the monster's LVo, Strange is defeated and his HP index will be re-calculated as follows:

$$\mathbf{HP = HP - damage} \ (3)$$

With damage variable being calculated as follows:

$$\mathbf{damage = baseDamage * LVo * 10} \ (4)$$

Therein, baseDamage is dependent on each type of monsters which are described in Table 1.

Note that HP is always an integer number when doing calculations (only take the integral part, do not round up or round down). If HP is less than 0 after implementing the formula (3), or died due to some particular events. The program will exit and print -1.

Example 1, with inputs are:

172 2 30 0

!1!

Strange has HP of 172, LV of 2, EXP of 30 and no time stones. Strange encounters the monster 001 and the combat occurs. The monster 001 has LV of 1, Strange's LV is higher than the monster's LVo, so that Strange wins and receives 10 EXP.

Since there is no more events, the journey ends. The sum of indexes Strange gains at the present is $\mathbf{172 + 2 + 40 + 0 = 214}$. Therefore, the output is **214**.

Example 2, with inputs are: are:

172 1 30 0

!1#2!

Strange has HP of 172, LV of 2, EXP of 30 and no time stones. Strange encounters the monster 001 and the combat occurs. The monster 001 has LV of 1, Strange's LV is equal to the monster's LVo, so that they draw and Strange only receives 5 EXP. After that, Strange encounters the monster 002 which has LVo of 2. Because Strange's LV is less than the monster's LVo, Strange loses. Strange's HO is equal to **172 - (2.5 * 2 * 10) = 122**.

Since there is no more events, the journey ends. The sum of indexes Strange gains at the present is **122 + 1 + 35 + 0 = 158**. Therefore, the output is **158**.

Example 3, with inputs are: are:

172 1 25 0

!1#5#2!

Strange has HP of 172, LV of 1, EXP of 25 and no time stones. Strange encounters the monster 001 and the combat occurs. The monster 001 has LV of 1, Strange's LV is equal to the monster's LVo, so that they draw and Strange only receives 5 EXP. After that, Strange encounters the monster 005 which has LVo of 2. Because Strange's LV is less than the monster's LVo, Strange loses. Strange's HP is equal to **172 - (9.5 * 2 * 10) = -18**.

After calculating HP based on formula (3), Strange's HP is less than 0 and Strange does not have any time stones, so that Strange will die. The journey ends and the output is **-1**.

Example 4, with inputs are: are:

172 1 95 1

!2#1#5#3!

Strange has HP of 172, LV of 1, EXP of 95 and 1 time stone. Strange encounters the monster 002 and the combat occurs. The monster 002 has LV of 1, Strange's LV is equal to the monster's LVo, so that they draw and Strange only receives 10 EXP. EXP rises to 105, so that Strange's LV will increase by 1 unit and EXP at this time has value of 5, HP rises to 10 units, maxHP increases by 50 units (**maxHP = 222**), Strange's indexes are **182 2 5 1**. In the next event of encountering the monster 001, they draw and Strange receives 5 EXP **182 2 5 1**.

Then, Strange catches the monster 005 with LVo of 3, Strange's LV is less than LVo, so that Strange loses. Strange's HO is **182 - (9.5 * 3 * 10) = -103**. After calculating HP due to formula (3), Strange's HP is less than 0 and Strange owns 1 time stone. Therefore, he will use this stone to avoid death. MaxHP at this event is 222, so that Strange's indexes after reviving is **222 2 10 0**.

Strange continues his journey and encounters the monster 003 and loses. Strange's HP is **222 - (4.5 * 4 * 10) = 42**. Since there is no more events, the journey ends. The sum of indexes Strange gains at the present is **42 + 2 + 10 + 0 = 54**. Therefore, the output is **54**.

6.2 Event 6 - The battle with monster Gargantos

This event has attaching data. The data field is separated by character space.

Since Gargantos is a superior monster which is summoned by Wanda, normal attacks won't cause any damage to it. Moreover, the attacks Gargantos puts upon are cutthroat. Thus, in order to confront this superior figure, Strange needs to use witchcraft.

To use those witchcraft, Stranges must read a spell (only including the characters in Alphabet, both uppercase and lowercase characters). The spell contains ancient characters (archaisms), and inside the spell, there are 2 witchcraft:

- Attack witchcraft: **attack** (do not distinguish uppercase or lowercase archaisms)
- Defense witchcraft: **defense** (do not distinguish uppercase or lowercase archaisms)

However, due to the harsh combat with Gargantos, Strange cannot read a spell precisely. Thus, the order of archaisms in the spell is uncertain.

For example, the spell Strange uses to attack with Gargantos as follows:

aAtatckDetafcKeyxenSbe

Those archaisms can be used many times to create a spell. However, the spell needs to follow the order in which the character appears first and after. With the above spell, after combining archaism, the number of **attack** and **defense** witchcraft used are 7 and 2 respectively.

Known that to defeat Gargantos, the winning rate of Strange when using witchcraft must be higher than the function **F(x)**, with:

$$\mathbf{F(x) = (i + x) \ \% \ 100}$$

Therein,

- **i** the ordinal number of the event.
- **x** the total number of characters in the spell.

In addition, about the spell, if:

- As multiple **attack** witchcraft exist, Strange's winning rate will be tenfold as high as the number of **attack** spells at present.
- As multiple **attack** witchcraft exist, Strange's blood loss reduction rate will be tenfold as high as the number of **attack** spells at present.

If the winning rate is higher than the function **F(x)**, Strange wins against in this fight. Strange will receive 200 EXP and 1 time stone.

In contrast, if the win rate is less than or equal to the result of **F(x)** then Strange will lose. If Strange's HP is below 100 at present, Strange will lose all HP and die. Otherwise, Strange's HP will be calculated according to the formula:

HP = HP - HP * (100 - blood loss reduction rate) / 100

If the blood loss reduction rate is higher than or equal to 100, Strange's HP remains unchanged.

This event includes 2 data fields: the first one is event codes, the second one is spells.

Example 5, with inputs are: are:

456 4 25 0

!4#6 aAtatckDetafcKeyxenSbe!

Strange won the fight with the monster 004 and gained 50 EXP, the indexes now being **456 4 75 0**. Strange then fights against the monster Gargantos. The function **F(x) = F(22) = (2 + 22) % 100 = 24**. Then, with the spell **aAtatckDetafcKeyxenSbe**, Strange will cast 7 attack witchcraft and 2 defense witchcraft.

Therefore, the winning rate and blood loss reduction rate are now 70 and 20 respectively. Since the winning rate is greater than 24, Strange won the fight, gaining 200 EXP and 1 time stone. Strange's indexes are: **476 6 75 1** (maxHP is now 556). The output on the screen is: **558**

6.3 Event 7 - The Cloak of Levitation summoning

This event does not have any attaching data.

When Strange summons the Cloak of Levitation, the cloak will increase Strange's energy significantly.

When summoned and cloaked, Strange's LV will increase by 2 units but not by 10 and does not effect on the HP, maxHP. Also, if Strange puts on the cloak and still loses the fight, Strange will only take damage equal to a fraction of his normal damage. (calculated by the formula (4)) multiplied by the result of the function **G(y)**). The specific function formula **G(y)** is as follows:

$$\mathbf{G(y) = (i + y) \ \% \ 100}$$

Therein,

- **i** the ordinal number of the event.
- **y** the closest prime number to HP.

And damage taken when wearing the cloak (**only integral part**) will be re-calculated by:

$$\mathbf{damage = (baseDamage * LVo * 10) * (100 - G(y)) \ / \ 100}$$

When fighting with Gargantos, if Strange has the assistance of the Cloak of the Levitation, the winning and the blood loss reduction rate will be added to the value of the **G(y)** function.

Since the Levitation Cloak cannot resist damage more than 3 times. Therefore, if Strange wears the cloak and loses 3 battle events (from the time he firstly summons the cloak), it will lose all of its power on the next summoning. If Strange's LV is < 3, Strange's LV will have a value of 1 when the cloak is incapacitated.

The cloak becomes active again only when Christine Palmer (event 9) restores it. When Strange summons the Levitation Cloak, Strange will always wear it during his journey unless it is switched by the rogue Wong (event 8). And there's only one real Levitation cloak, so if Strange is wearing the real cloak, subsequent summons has no meaning.

Example 6. with inputs are:

172 1 30 0

!1#7#1#2!

After a draw with the monster 001. Strange summons the Levitation Cloak, Strange's current indexes are **172 3 35 0**. Strange then encounters the monster 001 and engages in a tie, continuing to gain 5 EXP. Encounter with monster 002 with an LVo of 4, because Strange's LV is less than LVo, so Strange loses the fight.

Because Strange is wearing a Levitation cloak, the damage level will be partially reduced. Specifically:

- G(y) = G(173) = (4 + 173) % 100 = 77
- damage = (2.5 * 4 * 10) * (100 - 77) / 100 = 23

So Strange's HP = 172 - 23 = 149 and the number of times the Cloak of Levitation takes damage is reduced to 2. After that, there are no other events, so the journey ends. The sum of Strange's current indexes is **149 + 3 + 40 + 0 = 192**. Therefore, the output to the screen is **192**.

6.4 Event 8 - A meeting with Sorcerer Supreme Wong

This event does not have any attaching data.

Sorcerer Supreme Wong can only help Strange (regardless of Strange's LV) win the fight with the monster in skirmish events from 1 to 5, prevent Strange from ingesting poisonous mushrooms, and destroy fake Wong. However, Wong only helped Strange 3 times after meeting and will return to Kamar-Taj temple and not come back to help Strange again.

Also, because there is only one Sorcerer Supreme, while the Sorcerer Wong was helping Strange and meeting Wong again, it was the fake Wong. The true Sorcerer Supreme will destroy that fake witch.

After using 3 support turns, Wong will return to the Kamar-Taj temple and will not return to help Strange again. So on the next journey, if Strange meets Wong again, it is also the fake Wong. The fake Wong will behave similarly to the real Wong (kill the other fake Wong but will harm Strange three times since meeting and then disappear). Wong will cast a spell to make Strange lose (regardless of Strange's LV) in skirmishes with monsters in events 1 through 5, still let Strange eat poisonous mushrooms, and swap out the real Levitation cloak for a fake. Strange won't know he's wearing the fake cloak until he meets Christine Palmer or summons it.

But, the fake Wong can only fool Strange when Strange's LV < 7. Otherwise, Strange will destroy the fake Wong. Besides, if Strange dies because Wong is harmed in combat or tricked

him into eating poisonous mushrooms and using the time stone to revive him (while the fake Wong still exists). Then Strange would know it was the fake Wong and destroy him. However, because he trust human, so if he continues to meet the fake Wong again on the next event, Strange still believes that he is Sorcerer Supreme.

Example 7, with inputs are:

172 1 30 0

!8#5#12#8!

Strange meets Wong at the first event. Then, he battles with the monster 005. Although Strange's LV is less than LVo, thanks to the support from Wong, he still wins and receives 70 EXP. After that, Wong helps Stranges avoid eating poisonous mushrooms and kill fake Wong. After 3 times of supporting, Wong comes back to Karmar-Taj temple. Strange's indexes at prsent are **182 2 0 0** and the output is **184**.

6.5 Event 9 - A meeting with Christine Palmer

This event does not have any attaching data.

If meeting Christine Palmer, Strange's HP will increase to maxHP, and the poisonous mushroom effect will be detoxicated. She will also help Strange get rid of the fake Wong, change into the real Levitation cloak if Strange is wearing the fake cloak, and restore the real cloak's energy to its original state.

6.6 Event 10 - Fibo mushroom gathering

This event does not have any attaching data.

When gathering and using Fibo mushroom, Strange's HP will increase to a Fibonacci number closest to the present HP value. If HP exceeds maxHP, HP will be equal to maxHP.

6.7 Event 11 - Poisonous mushroom gathering

This event does not have any attaching data.

When gathering and using poisonous mushroom, Strange's HP will lose 50 units (if HP less than equal 0, Strange will die). If after eating poisonous mushroom, Strange still stay alive, his LV reduces by 2 units in the next 3 events. However, if Strange's LV < 3, after eating poisonous mushroom, his LV only decreases to 1 unit in the next 3 events.

6.8 Event 12 - Negotiation

This event has attaching data. The data field is separated by character space.

After rescuing Chavez from the Gargantos monster successfully, Strange went to Wanda's place and learned of her intentions. Because Strange refused to hand over Chavez, Wanda would go directly to the Kamar-Tai temple to capture Chavez.

Before the combat, because of the intimacy in the rescue of the previous universe, Wanda still offers Strange a chance to either hand over Chavez or spare Strange's life. After that, they begin to negotiate with each other.

Because now, Wanda is looking forward to reuniting with her two children, she not only practices magic but also spends time practicing math. Knowing that Strange has a good skill of Mathematics, the negotiation is carried out through the following decoding:

First, Wanda will give Strange two codes:

- **Code 1**: The string needs to be encoded. Code 1 includes only characters of the Alphabet (both upper and lower case) and is not null.
- **Code 2**: The chain of result string, used to compare with code 1 after decoding. Code 2 also includes only Alphabet characters (both upper and lower case) and is not null.

Wanda then tells Strange how to generate the following cipher:

1. From Code 1, selecting the central character - the character at the position *(total number of characters in the string) / 2* (get the integral part). From that central character, we reverse the string on the left, then reverse the string on the right. These two left and right substrings do not include the central character, and if either or both of the substrings do not exist, do nothing.
2. Next, translating all characters in the resulting string obtained in step 1 to **ith** positions in the Alphabet (lowercase characters follow lowercase Alphabet and so on). With **ith** calculated by the formula:

ith = (total number of characters in Code 2) % 10

Strange's task is generating a new string from Code 1 (assuming the encrypted code is string S) based on the cipher generation and the string encryption. Strange would then have to look in this string S to see whether the result string (Code 2) exists (do distinguish lowercase or uppercase characters).

- If Code 2 exists inside the string S, the decryption is successful. Wanda will give Strange a bonus of not killing Strange if having a chance and only reducing Strange's current HP and maxHP by 10%. Wanda will also increase Strange's EXP by 30 for successful decryption.
- Otherwise, if Strange decryption fails, Wanda will deprive him of the Cloak of Levitation, and Strange will no longer be able to summon it (except during event 14). Taking over all the TS Stones and killing Strange whenever having chances. Wanda only gives 15 EXP for Strange because he tried hard to decode but failed.

This event will consist of 3 data fields: the first data field is the event code, the second data field is Code 1, and the third data field is Code 2.

Example 8, with inputs are:

172 1 2 3

!12 xAbcdez Daf#7#1!

At the negotiation event, Strange received Code 1 as: "*xAbcdez*", and Code 2 as: "*Daf*". Then proceeding to encrypt the Code 1, the central character is the **c** character at position 3 (the first character is at position 0 and 7 / 2 = 3). After the reverse operation, the value of the new string is **bAxczed**. Then translating all the characters up 3 positions (since Code 2 has 3 characters, 3 % 10 = 3) to get the new string **eDafchg**.

Conducting a search for Code 2 in Code 1, Strange detects the existence of Code 2 in Code 1. Therefore, Wanda will only reduce Strange's HP and maxHP by 10%, increase by 30 EXP, and will not kill Strange when having chance.

Strange's indexes are: **154 1 32 3**, maxHP = 154. In the next event, Strange successfully summons the Cloak of Levitation and engages in a draw with the monster 001 in the last event. Strange's indexes are **154 3 37 3**, the output is **197**.

6.9 Event 13 - Wanda attacks Kamar-Taj temple

This event has attaching data. The data field is separated by character space.

Since Strange would never hand over Chavez to Wanda, Strange also predicted that there would be a big fight in Kamar-Taj, so he prepared a defensive force.

The defense layer of the Kamar-Taj temple consists of many socerers, arranged in a 7x7 matrix (the index of the row and column is set at 1 originally), consisting of integers. For an effective attack, Wanda limits the attack range to a square matrix of size **m*m**. With **m** calculated by the formula

m = (i % 7) > 2 ? (i % 7) : 2, where **i** is the order in which the events occur.

The biggest weakness of the defense layer will appear in the sub-square matrix with the smallest sum of elements. If there are many square matrices with the above characteristic, Wanda will prioritize choosing the matrix in the row with the lowest index. If still many such matrices exist, Wanda will choose the matrix at the column with the lowest index.

After selecting the sub-matrix to be searched, if all columns in this matrix are ascending (the upper element is greater than or equal to the lower one), the defense is successful. On the contrary, Wanda broke through the defense layer of the Kamar-Taj temple.

If the defense is successful, Strange's HP is added to a value equal to the sum of all the elements in the sub-square matrix found above multiplied by the sum of the index of the first row and first column of that sub-matrix. And Wanda will turn to using gaslighting to break through the defenses from within, and this method will be successful.

In contrast, if Wanda successfully attacks without resorting to gaslighting witchcraft, Strange's HP will be subtracted by a value equal to the sum of all the elements in the square sub-matrix found above multiplied by the sum of the index of the first row and first column of that sub-matrix. However, if Strange's HP after subtracting is 0 or less, but the negotiation event is dealt, and Wanda has said not to kill Strange, then Strange's HP will be 1.

This event will include 2 data fields: the first data field is the event code. The second field is 49 representative values (each separated by a space character) for the 7 x 7 matrix. From left to right, the first 7 values correspond to 7 values (from left to right) on the first row of the matrix. The next 7 values correspond to the 7 values on the next row. And so on until the last row of the matrix.

Example 9, with inputs are:

172 1 2 3

!13 1 2 2 1 5 6 7 1 2 2 1 5 6 7 1 3 3 4 5 6 7 1 3 3 4 5 6 7 1 3 3 4 5 6 7 1 3 3 4 5 6 7 1 3 3 4 5 6 7!

At the event 14, Wanda attacked directly to Kamar-Taj temple. The defense layer is constructed as follows:

1 2 2 1 5 6 7

1 2 2 1 5 6 7

1 3 3 4 5 6 7

1 3 3 4 5 6 7

1 3 3 4 5 6 7

1 3 3 4 5 6 7

1 3 3 4 5 6 7

Since the value of m after applying the above formula is 2, the sub-square matrix that Wanda needs to search for attacking is 2x2 matrix.

Based on the data of the defense layer, Wanda found 2 sub-square matrices which have the smallest sum equals 6. However, depending on the row with the smallest index cannot determine the required matrix. Wanda will continue to consider the column with the smallest index and have identified the weak point to attack. Unfortunately, this matrix has all the columns in the ascending sequence, so the defense against Wanda's attack is successful.

Strange's HP will increase by 1 unit $\mathbf{(1 + 2 + 1 + 2) * (1 + 1) = 6 * 2 = 12}$. Strange's indexes at the present are still **172 1 2 3** (because > maxHP) and the output is **178**.

6.10 Event 14 - The battle inside Kamar-Taj temple

This event has attaching data. The data field is separated by character space.

After breaking through the defensive front line of the Kamar-Taj temple, Wanda attacks deep inside to find Chavez. However, as soon as Wanda entered the temple, Strange was suppressed and locked into a virtual space.

This virtual space will always contain an array of doors numbered with integers sorted in descending order. Using supreme magic, Wanda knew in advance how much the exit located in the doorway was worth.

But inside this virtual space, the path to that doorway is not easy, and Wanda can only move through $\log_2 n$ to reach the exit, where n is the total number of doors. One move counts as one value comparison.

With his mathematical knowledge, Wanda decided to use the Binary Search algorithm [3] to find the exit. If Wanda has run out of moves ($\log_2 n$) but still cannot search for the value corresponding to the exit doorway, or the value in the exit doorway does not exist, then Wanda is assumed to be unable to get out of this magic.

If Wanda can find an exit door, she will attack Strange back. Strange's LV will be reduced to 1 (if Strange's LV is 1, it will remain the same), and Strange's remaining HP will be calculated as follows:

$$\textbf{HP = HP - x * (i \% 10) * 7}$$

With:

- **x** the total number of Wanda's movements to the exit way.
- **i** the order in which events occur.

If Wanda cannot find the exit way, Strange will receive 150 EXP, recall the Cloak of Levitation and the number time stones (if available) Wanda deprived when the negotiation event failed (only mention about the latest failed negotiation event).

This event will include 3 data fields: the first data field is the event code, and the second data field is the must-search value (the value associated with the exit door). The third data field is the consecutive values representing the array of values corresponding to the doorways (the values in this array are separated by a space character, and the array is always valid).

Example 9, with inputs are:

172 5 2 3

!14 4 13 11 9 8 6 4 2 1!

At event 14, Wanda was locked into a virtual space and knew that door 4 was the exit door. Wanda starts using the Binary Search algorithm to move to the exit with a maximum number of moves of 3 ($\log_2 8 = 3$), specifically as follows:

1. Wanda compares 4 with a central element of 8 (because $(0+7)/2 = 3$). Wanda finds that $4 < 8$, so that Wanda will only continue searching at the element to the right of the center element.

2. Wanda compares 4 with the following central element after it is re-calculated as 4 (because (7+4)/2 = 5). As the value matches, Wanda has found the exit door, and costs only 2 moves.

Since Wanda successfully escaped the magic, Strange's HP was reduced to **158 (172 - 2 * 1 * 7)**. Strange's indexes are **158 1 2 3**, the output is **164**.

6.11 Event 15 - Time throwback

his event does not have any attaching data..

Upon encountering this event, Strange will use the time stone to return to the last event where Strange's HP reached its greatest value (as of this event) and begin his journey from that event. And if Strange returns to the previous event, then Strange's LV and EXP values will both be at their maximum thresholds, 10 and 100 respectively.

On the other hand, this event only happened once in the entire journey. At the following encountering, this event will be ignored. If Strange's HP at the time of this event reaches its maximum, nothing happens and the event will still be assumed as happened. Besides, this event is only assumed as occurred when Strange has the time stones in him.

Example 10, with inputs are:

172 1 30 1

!1#2#15!

At event 3 (event code 15), Strange's HP is **122 1 35 1** and Strange has a time stone. So Strange will return when Strange's HP reaches its maximum (and nearest) which means return to event 2. At this point, Strange's indexes are **172 10 100 0**, Strange easily defeats monsters 002. Due to having made time throwback once, Strange will ignore this event the next time he meets again. The result printed on the screen is **282**.

7 Tasks

Students are required to build a virtual program by using C++ language in order to simulate Strange's journey on the road to rescuing Chavez and thwarting Wanda's plot.

7.1 Ending

After the fierce battle that took place at the Kamar-Taj temple, countless deaths were caused. Despite advanced magic of imprisoning Wanda's soul, Wanda only had difficulty at first and still managed to get out of that illusion. Head-to-head combat ensued and even Strange and Wong were not Wanda's rivals. Everyone is in a situation where hanging in the balance. And at the most dangerous moment, Chavez accidentally activated his ability, teleported both himself and Strange across the multiverse from Earth-616 to Earth-838.

What will their next journey look like, and will Wanda find a way to reach the planet Earth-838 in another universe? Or did Strange find the Vishanti book to stop Wanda? Let's look forward to the following chapters!!!

8 Change log

Updating the spell at event 6 - The battle with the monster Gargantos

9 Submission

Students submit a file: **doctorStrange.h** in the site "Ky thuat lap trinh (CO1027)_HK213_ALL".

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.

10 Handling fraud

Students' source code will be check for similarities via a fraud detection system called MOSS. All assignments with **a similarity rate greater than 30%** are considered cheating.

References

[1] Doctor Strange in the Multiverse of Madness, Wikipedia, `https://en.wikipedia.org/wiki/Doctor_Strange_in_the_Multiverse_of_Madness`

[2] CuTeGuY699, https://wall.alphacoders.com/big.php?i=1199382.

[3] Binary search algorithm, Wikipedia, https://en.wikipedia.org/wiki/Binary_search_algorithm

END