

The University of Hong Kong
COMP1117B Computer Programming
Assignment 2

Due date: 23:59, 22 Mar 2024

About the submission

- This assignment involves some console input/output. You are reminded that the VPL system on HKU Moodle evaluates your program with a full score under the condition that your program output is the exact match of the expected output. In other words, any additional or missing space character, tab character, newline character, etc., will be treated as errors and you will receive 0 mark.
- Write/upload your programs (Assignment 2 Question 1, Assignment 2 Question 2, and Assignment 2 Question 3) in the corresponding Moodle VPLs under the Assignments section.
- We will grade your programs with another set of test cases (i.e., not limited to the sample test cases in the assignment sheet). Therefore, you are advised to make more test cases on your own to test your program.
- Late submissions will NOT be accepted.
- Plagiarism is prohibited.

Definition of Plagiarism

As defined in the University's Regulations Governing Conduct at Examinations, plagiarism is "the unacknowledged use, as one's own, of work of another person, whether or not such work has been published.", or put it simply, plagiarism is copying (including paraphrasing) the work of another person (including an idea or argument) without proper acknowledgement.

In case of queries on plagiarism, students are strongly advised to refer to "What is Plagiarism?" at <https://tl.hku.hk/plagiarism/>.

- If a student commits plagiarism, with evidence after investigation, no matter whether the student concerned admits or not, a penalty will be imposed:
 - First Attempt: if the student commits plagiarism (in an assignment/test of a CS course) for the first time in his/her entire course of study, the student shall be warned in writing and receive zero mark for the whole assignment or the whole test; if the student does not agree, s/he can appeal to the BEng(CompSc) Programme Director within a week;
 - Subsequent Attempt: if the student commits plagiarism more than once in higher course of study, the case shall be referred to the Programme Director for consideration. The Programme Director shall investigate the case and consider referring it to the University Disciplinary Committee, which may impose any of the following penalties: a published reprimand, suspension of study for a period of time, fine, or expulsion from the University.

- Both the student who copies other's work and the student who offers his/her work for copying shall be penalized.”

Question 1 – Count the number of digits in a range (30%)

Write a program that counts the total number of target digits in a range specified by the user.

The program will receive user input:

1. The start value of the range (inclusive)
2. The stop value of the range (inclusive)
3. The target digit n , where $0 \leq n \leq 9$.

You can assume that the stop value is larger than the start bound in the input, and both can be negative numbers.

Some test cases are as follows.

Test case	Input	Output	Explanation
1	111 113 1	7	In the range [111, 112, 113], there are 7 "1"s.
2	4 10 3	0	In the range 4 to 10, there is no "3".
3	-10 5 4	2	In the range -10 to 5, these are 2 "4"s from -4 and 4.

Hint: There are many programming approaches to solving this problem. If you want to simplify the solution, consider using this function to help you.

- You may use `str()` to convert a number into a string.

Question 2 – Substitution Cipher (40%)

Cryptography is the fundamental discipline of information security. Substitution Cipher is an easy method to encrypt messages in the history of cryptography. Note that this method is no longer secure in reality. The main idea of substitution cipher is that each letter of the plaintext (the original message) is replaced by another letter of the alphabet, resulting in the ciphertext (the encrypted message). In this question, we adopt the following formula to find the ciphertext.

For each letter m in a given plaintext, encrypt m to obtain the corresponding encrypted letter c in the ciphertext by:

$$\hat{c} = (k_1 \hat{m} + k_2) \bmod 26$$

where k_1 and k_2 are two integers composing the key for the encryption, \hat{c} and \hat{m} are the integer representations of the letters c and m , respectively. Integer representations for letters are given by: 'A' \leftrightarrow 0, 'B' \leftrightarrow 1, 'C' \leftrightarrow 2, ..., 'Z' \leftrightarrow 25.

Write a program to encrypt the plaintext given by the user and print the corresponding ciphertext.

You can assume that the plaintext only contains English alphabets and white spaces. k_1 and k_2 can be any integer number.

Your program should keep the letter case in the ciphertext.

The program will receive user input:

1. The plaintext m
2. The key k_1
3. The key k_2

Test case	Input	Output	Explanation
1	Hello World 9 13	YxiiJ Djkio	'H' \leftrightarrow 7 $\hat{c} = (9 \times 7 + 13) \bmod 26$ $\hat{c} = 24$ 24 is mapped back to Y. Repeat the same process for the remaining letters.
2	Computer Programming 7 2	Qwidmfer Drwsrcliigps	-
3	CIPHER 12 6	EYEMCC	-
4	Assignment two 15 -20	Gqqwsteotf fyi	-

Hints:

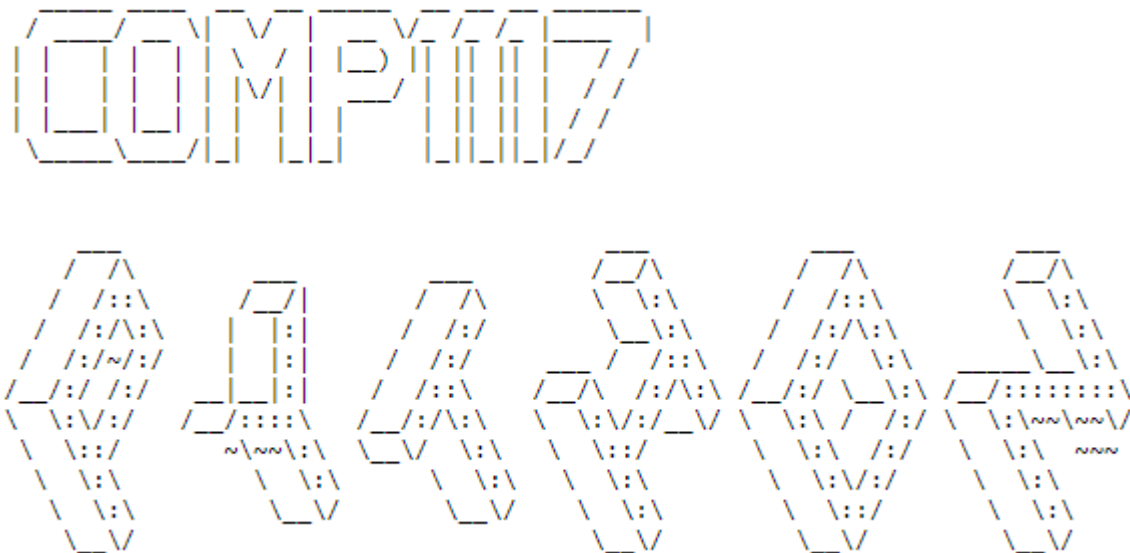
- You may use `index()` to get the index of item in the list.
- You may use `isupper()`, `islower()`, `lower()`, `upper()` to check or change the case of an alphabet.
- You may use the modulo operator `%` to find the remainder of the Euclidean division.

For your information, the key should be chosen carefully in this substitution cipher scheme. In the example of Test case 3 above, 'C' and 'P' are both encrypted to 'E'. We cannot decrypt uniquely if the ciphertext contains 'E'. Similarly, 'E' and 'R' are both encrypted to 'C'. That test case demonstrated the result of a bad choice of key.

Question 3 – ASCII art (30%)

ASCII art is a graphic design technique that uses computers to generate pictures pieced together from characters.

Here are some examples of ASCII art on texts.



You can try something else at <https://patorjk.com/software/taag/>.

In this question, you are going to draw some trains in ASCII art.

A train of length n consists of n carriages. The front and end of the train are drawn with "[" and "]", respectively; the train body is drawn as sharp, and two carriages are connected by a dash "-".

On top of the train body, there is an overhead line drawn in dashes "-".

Below the train body are the rail and wheels. The rail is drawn as underscore "_" and the wheel is drawn as "o".

Here is an example of a bare train of length 4.

```
-----  
[#####-#####-#####-#####]  
_oo__oo__oo__oo__oo__oo__oo__oo__
```

In this question, there are two types of trains.

- Diesel train: has an exhaust on the 1st car, represented by "H".
- Electric train: has a pantograph, represented by "T", on every even number of carriages, except that the carriage is the first or the last carriage.

The program takes from the user inputs:

1. The type of train, which is either "D" or "E".
"D" indicates diesel train.
"E" indicates electric train.
2. The length of the train, which is larger than 2.

The program should output the corresponding drawing of the train.

Test case	Input	Output
1	D 3	--H----- [#####-#####-#####] _oo__oo__oo__oo__oo__oo__
2	E 3	-----T----- [#####-#####-#####] _oo__oo__oo__oo__oo__oo__
3	E 4	-----T----- [#####-#####-#####-#####] _oo__oo__oo__oo__oo__oo__oo__
4	E 5	-----T-----T----- [#####-#####-#####-#####-#####] _oo__oo__oo__oo__oo__oo__oo__oo__oo__

Hint:

- Throughout this question, you should think about how to print something without a newline character at the end.

Troubleshooting:

If the program output looks the same as the expected output but fails to pass on Moodle, you should check whether the program prints extra invisible characters.

- There should be NO white space at the end of lines.
- There should be EXACTLY ONE newline at the end of lines, including the last line.