Assignment 2: ASCII Art

Due: 20:00, Sat 9 Oct 2021 Full marks: 100

Introduction

The objective of this assignment is to let you practice control flow structures in C++. It also involves the use of variables, operators, expressions, and standard input/output to reinforce your learning in the course thus far. You are to write a program to draw a rocket pattern using characters in the ASCII character set as console output such as the following:

```
       |
      /*\
     /***\
    /*****\
   /*******\
  +---------+
  |.........|
  |.........|
  |.........|
//|.........|\\
//|.........|\\
//|.........|\\
  +---------+
     ***
    *****
    *****
     ***
      *
```

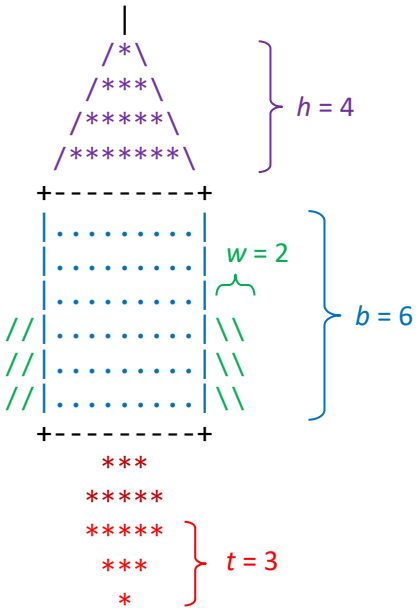
This is an example of ASCII art which has a long history dating back to as early as 1966. Some ASCII arts such as the above follow certain rules of regular patterns and can be reproduced in a systematic manner using loops and conditionals. In this assignment, instead of "hardcoding" the drawings, you are required to use loops and conditionals to print the various parts of the rocket shape, whose size parameters like height and width are variables and are controlled by the user via standard input.

Program Specification

There are four parameters to control the overall shape of the rocket:

1. ***h* (head)**: controls the height of the rocket's head.
2. ***b* (body)**: controls the height of the rocket's body.
3. ***w* (wing)**: controls the width of the rocket's wings.
4. ***t* (tail)**: controls the height of the rocket's tail (or flame).

To ease visualizing which part of the shape each of these parameters refers to, please look at the following drawing with each parameter annotated:



Part 1: Rocket Head

For the first line to print, the rocket pattern begins with a single pipe symbol "|", which acts as the tip of the rocket's head.

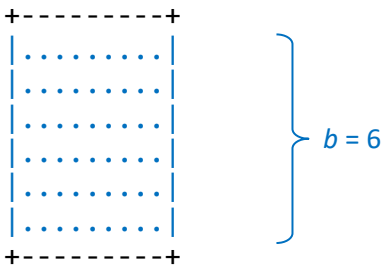
Then the program prints a triangular pattern which has its left and right edges formed by forward slashes "/" and backslashes "\" respectively, and is filled with asterisks "*". For example, it looks like:

```
   /*\
  /***\
 /*****\
/*******\
```

The number of "*" per line is always an odd number. The height of this triangular shape (a.k.a. the height of the head) is denoted by *h*, which is entered by the user via standard input. The above example refers to the case of *h* = 4, so this triangular shape is composed of four lines. The height of the head refers to the number of lines of asterisks "*" only, excluding the "|" tip and the line that follows, which looks like "+----------+".

Part 2: Rocket Body

There are two lines "+----------+" at the top and bottom of the rocket's main body. They are formed by hyphens and a plus at the start and end positions of the line ("+" 's are printed at the four corners of the rocket's body).

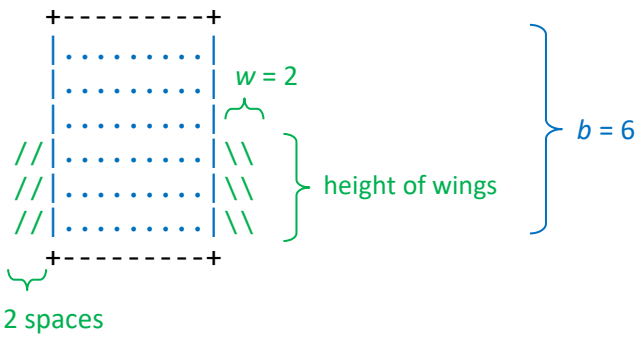


The body part is filled with dot "."; the left and right edges are formed by the pipe "|" symbol.

Note that *b* refers to the height of the body; it counts the lines of dots only, excluding the top and bottom lines "+----------+". So, for the above example, *b* is 6 only.

Part 3: Rocket Wings

The rocket has two wings: the left wing and right wing are denoted by patterns of forward slashes "/" and backslashes "\" respectively.



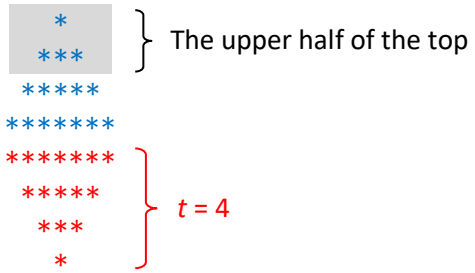
The two wings always have equal widths and heights. The height of the wings is set to half of the rocket body's height. For indivisible cases, we take the ceiling of the division, i.e., $\left\lceil \frac{b}{2} \right\rceil$.

For the above example, the wings have a width of 2, i.e., *w* = 2, and a height of 6 / 2 = 3.

Let's say if *b* = 7, then 7 / 2 = 3.5, taking the ceiling gives 4, so the wings' height is also 4.

Part 4: Rocket Tail (Flame)

The tail or flame part is the most complicated part in this assignment. It looks like a diamond shape but with some subtle differences. It is formed in the following way. Think of it as if two triangles are stacking on top of another, with the bottom one inverted:

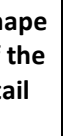


What's more, the upper half of the top triangle is chopped (grey out in the above diagram).

The parameter *t* refers to the height of the bottom triangle. For the above example, *t* = 4.

For odd *t*, the number of lines of asterisks to keep for the top triangle is the ceiling of the division of *t* by 2, i.e., $\left\lceil \frac{t}{2} \right\rceil$.

The following table shows the shapes of the tails for different values of *t*. For example, for *t* = 5, we have 5 / 2 = 2.5, taking the ceiling gives 3. So, we keep/print the lower 3 lines and chop the upper 2 lines from the top triangle for the case of *t* = 5.

t	2	3	4	5	6	7	8
Shape of the tail							

Requirements on Input Validation

For the drawing to look like a rocket, the following bounds on the input values are enforced:

- $h \geq 1$
- $b \geq 2$
- $w \geq 1$
- $t \geq 2$

There is no upper bound validation necessary for the parameters *h*, *b* and *w*. But due to the visibility constraints of a console screen, we assume only small values for *h*, *b* and *w* for testing your program, practically up to around 30 for each of these parameters.

However, for *t*, its size should have an upper bound since we don't want the tail to look wider than the rocket body. Let's do some analysis below:

- The width (number of "*") of the base of the triangle for the head part is $2h - 1$.
- The width (including all characters "| . . . . . |") of the body is $2h + 3$.
- The width of the tail (flame), i.e., $2t - 1$, should NOT be wider than the width of the rocket body. So, the user inputs must satisfy the following inequality:

$$2t - 1 \leq 2h + 3$$

You may assume that the user always enters positive integer values. However, if the user inputs for the 4 parameters violate any of the above requirements, your program will prompt the user again until a valid set of values is received.

Remarks:

While not necessary in this assignment, you can feel free to design your own functions for certain tasks if they can help save some redundant code or modularize your code.

Sample Runs

In the following sample runs, the blue text is user input and the other text is the program printout. You can try the provided sample program for other input. *Your program output should be exactly the same as the sample program* (same text, symbols, letter case, spacings, etc.). Note that *there is a space after the ':' in the program printout*.

```
Enter h, b, w, t: 1 2 1 2↵
   |
  /*\
 +---+
 |...|
/|...|\
 +---+
  ***
  ***
   *
```

```
Enter h, b, w, t: 2 2 3 3↵
      |
     /*\
    /***\
   +-----+
   |.....|
///|.....|\\\
   +-----+
     ***
    *****
    *****
     ***
      *
```

```
Enter h, b, w, t: 4 6 2 3↵
       |
      /*\
     /***\
    /*****\
   /*******\
  +---------+
  |.........|
  |.........|
  |.........|
//|.........|\\
//|.........|\\
//|.........|\\
  +---------+
      ***
     *****
     *****
      ***
       *
```

```
Enter h, b, w, t: 5 5 4 7↲
          |
         /*\
        /***\
       /*****\
      /*******\
     /*********\
    +-----------+
    |...........|
    |...........|
////|...........|\\\\
////|...........|\\\\
////|...........|\\\\
    +-----------+
       *******
      *********
     ***********
    *************
    *************
     ***********
      *********
       *******
        *****
         ***
          *
```

```
Enter h, b, w, t: 1 1 1 1↲   ← b and t are too small!
Enter h, b, w, t: 1 2 1 1↲   ← t is too small!
Enter h, b, w, t: 1 1 2 2↲   ← b is too small!
Enter h, b, w, t: 3 4 5 8↲   ← t is too big!
Enter h, b, w, t: 3 4 5 6↲   ← t is too big!
Enter h, b, w, t: 3 4 5 5↲
         |
        /*\
       /***\
      /*****\
     +-------+
     |.......|
     |.......|
/////|.......|\\\\\
/////|.......|\\\\\
     +-------+
       *****
      *******
     *********
     *********
      *******
       *****
        ***
         *
```

Submission and Marking

- Your program source file name should be `rocket.cpp`. Submit the file in Blackboard (https://blackboard.cuhk.edu.hk/).
- Insert *your name*, *student ID*, and *e-mail* as comments at the beginning of your source file.
- You can submit your assignment multiple times. Only the latest submission counts.
- Your program should be *free of compilation errors and warnings*.
- Your program should *include suitable comments as documentation*.
- ***Do NOT plagiarize.*** Sending your work to others is subject to the same penalty for copying work.