

CMPE 326 Concepts of Programming Languages

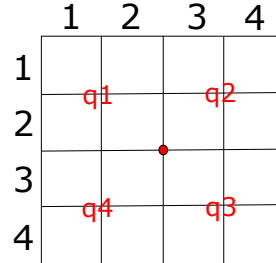
Spring 2019

Homework 3

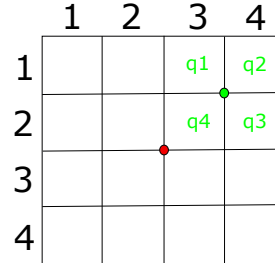
Due date: 17/05/2019 23:59

In this assignment, you are going to write a program in C that works with a format based on *quadtrees*. This format can express a square image in a compressed way by dividing it into 4 equal quadrants. A quadrant may be further divided into quadrants until it is either one pixel or composed of same pixels (i.e., having same color or content). In this homework, we will use this quadtree format to represent simple images like QR codes.

First, let us describe a quadrant. Figure 1a depicts an image canvas of size 4x4. Considering its center, the 4 quadrants are labeled by $q1$, $q2$, $q3$, and $q4$. For instance, quadrant 1 ($q1$) is the sub-image formed by the intersection of rows 1 and 2 with the columns 1 and 2. Similarly, quadrant 3 ($q3$) is the sub-image formed by the intersection of rows 3 and 4 with the columns 3 and 4 of the original image. Note that one can continue dividing a quadrant into further quadrants unless it is already a pixel. Figure 1b shows further division of the second quadrant ($q2$) into 4 quadrants of size 1x1 each (they are shown using green color).



(a) An 4x4 image and its quadrants



(b) Quadrants of a quadrant

Figure 1

Now, we can describe how an ASCII image can be encoded in quadtree format. Consider the image shown in Figure 2a. In order to encode a quadrant, we use the character `+` followed by encodings of its quadrants $q1$, $q2$, $q3$, and $q4$ (**in this order**). If a quadrant is fully composed of same ASCII character, it can be encoded by that character in the format. Let us first consider the second quadrant ($q2$) of the image given in Figure 2a (i.e., the sub-image formed by the intersection of rows 1 and 2 with the columns 3 and 4). It can be encoded as:

`+xoox`

While its first and fourth quadrants are encoded as `x`, second and third quadrants are encoded

+o+xoox+ooxox

O	O	X	O
O	O	X	O
X	X	O	O
X	X	O	X

O	O	X	O
O	O	X	O
X	X	O	O
X	X	O	X

(b) Same image with quadrant centers

Figure 2

Input/Output Specification

```
$ cat input1
+o+xoox+ooxox
$ hw3 < input1
ooxo
ooxo
xxoo
xxox
```

```
$ cat input2
+ . + . + ** . + . * . * + + . * . + * . . * + * . * + . * . . + . + . * * . + * . . *
```

```
$ hw3 < input2
```

```
.....  
.....  
.....***  
....*...  
...*...*.  
...*...**.  
..*...**.  
..*...**.  
..*...**.
```

There will be no syntactic or semantic errors in the input. So, you do not need to check for errors.

Submission

You will be provided with some test cases by your teaching assistant. You must follow the output specifications strictly. Otherwise (even a single space character difference between your output and expected output), you will lose points. Note that having a correct output for the provided examples does not necessarily mean that you have a correct program. Please check your program with other example cases.

Each person must submit **his or her own work**.

Information about submitting your homework via Moodle will be provided by your teaching assistant.

You are **not allowed** to use external libraries of C. Of course, you can use standard C library.

You may be asked for a demo session.

There will be 1 day **questions fence** for this homework. You are not allowed to ask questions to the instructor or the teaching assistant in 1 day period before the deadline (i.e., during 17/5/2019).

Your submission will be graded w.r.t. the maximum points calculated according to the following formula: $100 - (2^{\text{NumOfLateDays}} \times 5)$.