Mercredi 5 Novembre 2014

Midterm Exam - LO27
Duration: 2h
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Exercise 1: Image (12 points)

An image is considered as a Cartesian product consisting of a two-dimensional array of integers and two integers respectively indicating the height and the width of the considered image.

Question 1: Definition of the type Image (1 point)
Give in C the definition of the Image type.

Question 2: Initialization of an image (3 points)
Write the C code of the iterative subroutine "createAndInitializeImage" to create and initialize a variable of Image type using a given height and a given width, and containing zeros everywhere.

Question 3: Image mirroring (4 points)
Write the algorithm of the iterative subroutine "mirrorImage" to build the mirror image of the input image. The mirror image is built by taking one by one the pixels from the left side of the image and exchanging with the pixel value on the right side. A new image is thus created. If you take the pixels on the left side of the picture, and exchange them one by one to the right side of the picture, you can flip the original image horizontally.

function mirrorImage (i : Image) : Image

Example:

3	6	2
9	7	5

Original Image

2	6	3
5	7	9

Mirrored Image

Question 4: Image rotation (4 points)
Write the algorithm of the iterative subroutine "rotateImage" to rotate 90° clockwise a given image. A new image is thus created.

function rotateImage (i : Image) : Image

Example:

3	6	2
9	7	5

Original Image

9	3
7	6
5	2

Flipped image

Exercise 2: Josephus Problem (8 points)

The Josephus problem is a legendary means of picking a survivor from a group of n individuals. The idea is that the n individuals are formed into a circle and an integer m (n ≥ m ≥ 1) is chosen. Starting at a designated spot, the individuals count off from 1 to m. The mth individual is "removed" from the circle, and the process repeats, starting from the next individual, not from original spot. This repetition continues until one individual is left.

Example:
if Brian, Sue, Andrew, Keisha, Erica, Tom and Paula are arranged in circle, with m = 3 and Brian at the designated starting location, then the order of removal is Andrew, Tom, Sue, Paula, Erica and Brian, with Keisha remaining as the survivor

This exercise aims to implement two versions of the iterative subroutine "Josephus". The first version represents the circle of individuals by a singly circular linked list. The second version represents the circle of individuals by a Cartesian product of a one-dimensional array and an integer specifying the number of individuals in the circle.
In the two versions, each individual is represented by the Cartesian product of his name, his name and his age.

Question 1: Definition of the types Individual, and Circle of Individuals (2.5 points)
Give in C :
-   The definition of the "Individual" type.
-   The definition of the type "Circle of Individuals" (Circle) represented as a circular singly-linked list.
-   The definition of the type "Circle of Individuals" (Circle) represented as a Cartesian product of one-dimensional array and an integer (specifying the number of individuals in the circle).

Question 2: Josephus algorithm with a singly circular linked list (5,5 points)
Write in C the iterative subroutine "linkedlistJosephus" to determine the individual survivor of a circle of individuals by considering the "circle of individuals" as a circular singly linked list. The first element of the list is used as the process starting location.

function linkedlistJosephus (c : Circle, m: Integer) : Individual