

Laboratory 9

Topics

1. Lists and tables

Exercises

9.1 On average. Write the function `neighbor_average(values, row, column)` that, in a table `values`, calculates the average value of an element's neighbors in the eight directions, indexed as shown in the figure below (excluding the element itself). If, however, the element is on an edge of the table, the average should be calculated by considering only those neighbors that belong to the table. For example, if `row` and `column` are both `0`, the element has `3` neighbors. [P6.23]

<code>[i - 1] [j - 1]</code>	<code>[i - 1] [j]</code>	<code>[i - 1] [j + 1]</code>
<code>[i] [j - 1]</code>	<code>[i] [j]</code>	<code>[i] [j + 1]</code>
<code>[i + 1] [j - 1]</code>	<code>[i + 1] [j]</code>	<code>[i + 1] [j + 1]</code>

9.2 Magic squares. A $n \times n$ matrix containing the integer numbers $1, 2, 3, \dots, n^2$ is a “magic square” if the sum of its elements in each row, in each column, and in the two diagonals is the same. For example, this is a magic square of size `4`:

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

Write a program that acquires by the user 16 values, and places them in a table of 4×4 in order, one row at a time from top to bottom, and in each row from left to right, and check whether, after placing them, they form a magic square. Verify two properties:

- I. All and only the numbers 1, 2, ..., 16 are present in the acquired data.
- II. When the numbers are placed in the table, the sums of the rows, columns and diagonals are all equal to each other. [P6.21]

Bonus: write a program that reads 16 values from a file, with each value separated by a whitespace (' ')

9.3 Tic-tac-toe. Write a program that plays the tic-tac-toe game. The game of tic-tac-toe is played on a 3×3 grid. The game is played by two human players taking turns. The first player marks the moves with a circle ('o'), the second one with a cross ('x'). The player who has formed a horizontal, vertical or diagonal sequence of 3 equal symbols. The program must, at each turn, display the game board, ask the user for the coordinates of the next move symbol (row and column, numbered from 1 to 3) as input, reverse the players after each move, and, when the game is over, decree the winner or a tie condition. [P6.28]

x		o
	x	o
o	o	x

9.4 Spring. Write a program that models and simulates the motion of an object of mass m attached to an oscillating spring. When the spring is displaced from its equilibrium position by a quantity x , Hooke's law states that the restoring force is given by the formula:

$$F = -kx$$

where k is a constant depending on the spring. For this simulation, use $k = 10 \text{ N/m}$. Start with a given displacement x (i.e., $x = 0.5 \text{ m}$). Set the initial speed to $v = 0$. Calculate the acceleration a based on Newton's law ($F = ma$) and Hooke's law, using a mass $m = 1 \text{ kg}$. Use a small time interval $\text{delta_t} = 0.01 \text{ s}$ and, at each step, update the speed, by calculating a change of $a\Delta t$, and the displacement, by calculating a change of $v\Delta t$.

[Peer review]

9.5 A concert to save Alan Wake. The Old Gods of Asgard, a metal band, created a song to celebrate the famous writer Alan Wake. Cooperating with him, they are guiding him out of the Dark Place. However, each person needs to learn their part of the song.

Each line of the song is sung by one of the characters. The character is separated by the line with a " ": a colon and a space.

Write a program that reads all the lines of the song and, after assigning them to all the characters, asks for the name of the character you want to show the lines of. For instance, if the character is "Alan Wake", you shall print all the lines that he must sing in order of appearance. You can find the text of the song in the file *herald_of_darkness.txt*.