Introduction to programming (NF05A)
— exercices 2020-2021 —

Université de technologie de Troyes

Tutorial 3

Exercise 1. Swap in an array

Write a procedure that reads two indices in a table filled with integers and swaps the values in the table corresponding to these two indices. The program shall display the contents of the table before and after this transformation.

Exercise 2. Number of capital letters.

Write a procedure to calculate the number of upper and lower case letters and white spaces in a text.

Exercise 3. Addition, multiplication and subtraction of matrices.

Write a procedure that reads two matrices and then adds, subtracts and multiply them together.

Exercise 4. Complex Number

- Define a first type of structure allowing to define a complex number in rectangular form (real part and imaginary part). Define a second type of structure allowing to define a complex number in polar form (module and argument). To define a third type of structure (Cplx) allowing to represent a complex whatever its form.
- Write a function/procedure which allows to obtain the polar form the rectangular form as well as the inverse function.
- Write two functions/procedures (SumCplx, SubCplx) allowing to calculate the sum, the subtraction of two complex numbers.
- Write two functions/procedures (MulCplx, DivCplx) to calculate the product and division of two complex numbers.
- Write a program that solves a second degree equation with complex coefficients.

Additional exercises - To go further

Exercise 5. Insertion in a sorted array

Write a procedure that allows you to fill in a table with integers by inserting them in order. Take into account shifting if we have to insert in the middle of the table.

Exercise 6. Saddle point of a matrix

Write a procedure to calculate the saddle point of a matrix. A saddle point of a matrix is an element which is a `minimum on a row` and `maximum on a column`.

Exercise 7. Sorting arrays

Write a procedure to sort an array of integers in descending order.

Exercise 8. Sorting lines in a text

Given a text of several lines represented in a single string (Maximum 5000 characters). The separation between the lines in the string is made by a $. Thus, a text of three lines is written : *France is a European country.$ It is part of the European Union.$ It is a member of the United Nations.$*

- Write a procedure that orders this text alphabetically.
- Write a procedure that saves this text in a string array, where each line is an element of this array.

Exercise 9. Matrix transpose

Write a procedure to transpose a matrix and multiply it by a real one.

Exercise 10. π

Given a square with side 1 and the quarter of the circle which center is A and radius 1 (inscribed in the square), write a program that gives an approximation of π using the Monte Carlo method which can be described as follows:

A player randomly shoots n darts into the square and counts the number of times p where the impact is in the quarter circle. The p/n ratio gives an approximation of $\pi/4$ (the probability that the impact is in the quarter circle is equal to the area of the quarter circle / area of the square). The accuracy depends on n. To simulate this game, simply draw n times in a row and randomly two real x, y in [0.1] (M of (x, y) coordinates is the point of impact) and count the number of times that M is in the quarter circle.

- Define a data structure type to define a M point.
- Write a boolean function that determines if a test can be counted.
- Write a function that approximates π according to the number n.
- Give approximately the number of n trials needed to have an accuracy with an error margin of 10^{-3}.

Exercise 11. Parking management

A parking lot wants to make a program to manage its parking spaces. The parking lot can accommodate cars, trucks and motorcycles. Each vehicle has an owner's name (maximum 20 characters), a registration number (with AA-000-AA format), a year of registration (between 1990 and 2016) and a model. The models considered are : Renault, Peugeot, Citroen, BMW and Audi. For cars, the number of doors is also specified. For trucks, the gauge in meters is specified. Motorcycles have a maximum speed.

The parking lot has 20 car spaces, 10 truck spaces and 10 motorcycle spaces. The parking starts with empty spaces. A space is characterized by a pointer to the vehicle occupying it, the reservation time and the number of hours of reservation. Parking prices differ depending on the day. A weekday will cost 5 euro/hour and a weekend day will cost 3 euro/hour. The User must specify the number of hours and the day of the reservation at the time of the reservation. The reservation time is recorded for each place.

- Create the `vehicle` structure that groups the three types. Use the `unions` for the specific fields of each type and an enumeration to specify the type (car, truck and motorcycle).
- Create the parking and space structures
- Write the procedure `reserve` to reserve a place for a car, truck or motorcycle. The price of the reservation must be displayed before the reservation.
- Write a procedure `update` that allows to update the parking (remove vehicles for which the parking schedule has expired)

- Write a procedure `status` to display the parking lot and give the number of free spaces
- Write a procedure to remove a vehicle from its reserved place.
- Write a program that allows you to manage the parking lot with the functionalities implemented previously.