Exercise 1

Write a simple program to implement a version of the BCO algorithm to find the minimum of the De Jong test function f(x) =$\sum_{i=1}^{k} x_i{}^2 \quad -5.12 <= \text{xi} <= 5.12$

(Implement all phases of the algorithm)

Exercise 2

Write the pseudo code of the general bee colony optimization algorithm applied to the problem:

- KSP.
- SAT-3.
- Graph coloring .
- Eight queens
- TSP

Exercise 3

1) Rewrite the pseudo code of the general bee colony optimization algorithm applied to PVC.
2) Evaluate the complexity of this algorithm.
3) Explain the impact of each of the following parameters on the efficiency of the algorithm:
    - Number of scout bees;
    - Number of elite bees;
    - Number of bees for nectar-rich sites;
    - Number of bees for nectar-poor sites;
    - Neighborhood size.

Exercise 4

We want to manufacture the same batch of n car parts by k different production units, where the production of each part by unit i requires $t_i > 0$ units of time, i = 1,2, ..., k.
Try to allocate the workload so that the production of parts is completed as soon as possible.
Formulate the problem and then propose an OCA algorithm to solve it.

Exercise 4

In an OCA algorithm, active foragers search the vicinity of the previous source x_i for new sources v_i with more nectar, then calculate their fitness. In order to produce a new food source from the old one, the formula is used:

$$v_{ij} = x_{ij} + \phi_{ij}(x_{ij} - x_{kj})$$

Where $k \in \{1, 2, \dots, Bn\}(Bn\ est\ le\ nombe\ des\ butineuses\ actives) et\ j \in \{1, 2, \dots, Sn\}$ are randomly chosen indices. Although $k$is determined randomly, it must be different from $i.\phi_{ij}$ is a random number belonging to the interval [-1, 1], it controls the production of a food source in the neighborhood of x_{ij}.
After the discovery of each new food source v_{ij}, a greedy selection mechanism is adopted, that is, this source is evaluated by the artificial bees, its performance is compared to that of x_{ij}. If the nectar of this source is equal to or better than that of the previous source, it is replaced by the new one. Otherwise, the old one is kept.

For a minimization problem, fitness is calculated using the formula:

$$fit_i(\overrightarrow{x_i}) = \begin{cases} \dfrac{1}{1+f_i(\overrightarrow{x_i})} & si\ f_i(\overrightarrow{x_i}) \geq 0 \\ 1 + abs\big(f_i(\overrightarrow{x_i})\big) & si\ f_i(\overrightarrow{x_i}) < 0 \end{cases}$$

Such that $f_i(\overrightarrow{x_i})$is the value of the objective function of the solution $\overrightarrow{x_i}$.

At this stage, inactive foragers and scouts are waiting within the hive. At the end of the search process, active foragers share information about the nectar of food sources and their locations with other bees via the waggle dance. The latter evaluate this information from all active foragers, and choose food sources according to the probability value $P_i$associated with this source, and calculated by the following formula:

$$P_i = \frac{fit_i}{\sum_{n=1}^{SN} fit_n}$$

Where $fit_i$is the fitness of the solution i, which is proportional to the amount of nectar in the food source of position i).

The food source whose nectar is abandoned by the bees, the scouts replace it with a new source. If during a predetermined number of cycles called "limit" a position cannot be improved, then this food source is assumed to be abandoned.

Use these formulas to manually run the OCA algorithm applied to the optimization of the function f(x) = $-x^2 + 4x$ in the interval [1 , 3] with a precision of 1/10 using the following parameters:

Number of bees n =8;
Number of best sites m=5;
Number of elite bees e = 3;
Rich recruitment n2 =2;
Poor recruitment n1=1;
Neighborhood size ngh = 1 .