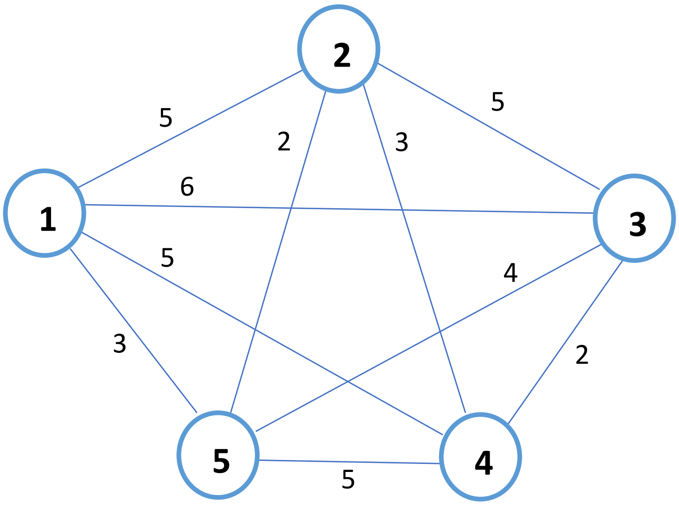
University Djilali Bounaâma of Khemis-Miliana
Department of Computer Science
Master 2 - GLSD
Retake Examination – Introduction to Artificial Intelligence (Corrected version)
March 2025

Exercise N°1 (11 pts): We want to solve the following customized Traveling Salesman Problem using a genetic algorithm.

About the problem: The Traveling Salesman Problem (TSP) is a classic optimization problem in computer science and mathematics. It can be described as follows: Given a list of cities and probable gains between each pair of cities, the task is to find the most profitable route that visits each city exactly once and returns to the starting city.

We aim to implement a genetic algorithm for the given graph, where the nodes correspond to cities, and the edges' values indicate potential gains between pairs of cities.



<u>Work to do:</u>

1. Write the pseudo-code of the algorithm using the following data:

- Starting population composed of **4** individuals
- Number of generations (populations to generate) = 2

2. Give a detailed description of your solution (Initial population, Adaptation function, Probability of selection,..)

3. Schematize the evolution process diagram.

Exercise 1 - Solution:

Pseudo-code (1.5 pt)

Algorithm GENETIC-ALGORITHM(k=4, nb_iterations=2)

1. *Population = set {n_1, n_2, n_3, n_4} of 6 chromosomes (Routes) choosen randomly*
2. *For t = 1 to 2:*
    1. *New_population = {}*
    2. *For i = 1 to 4:*
        1. *n = chromosome selected form Population with a higher probability relatively to F(n)*
        2. *n' = a different chromosome selected from Population – {n} with the same way as n*
        3. *n* = result of Cross-Over between n and n'*
        4. *With a small probability, apply a mutation to n**
        5. *Add n* to New_population*
    3. *Population = New_population*
3. *Return n in Population with the highest value of F(n)*

Initial population = 4 random routes: (02 pts)

Route 1 = 1 → 2 → 3 → 4 → 5 → 1 ⇒ Chromosome 1 = 23451

Route 2 = 2 → 5 → 1 → 4 → 3 → 2 ⇒ Chromosome 2 = 51432

Route 3 = 3 → 2 → 1 → 4 → 5 → 3 ⇒ Chromosome 3 = 21453

Route 4 = 4 → 5 → 2 → 1 → 3 → 4 ⇒ Chromosome 4 = 52134

Adaptation function = Sum of edges' gains of each route: (02 pts)

F(1) = 5+5+2+5+3 = 20

F(2) = 2+3+5+2+5 = 17

F(3) = 5+5+5+5+4 = 24

F(4) = 5+2+5+6+2 = 20

Probability of selection (Proportional to the adaptation): (02 pts)

P(1) = 20/(20+17+24+20) = 0.246

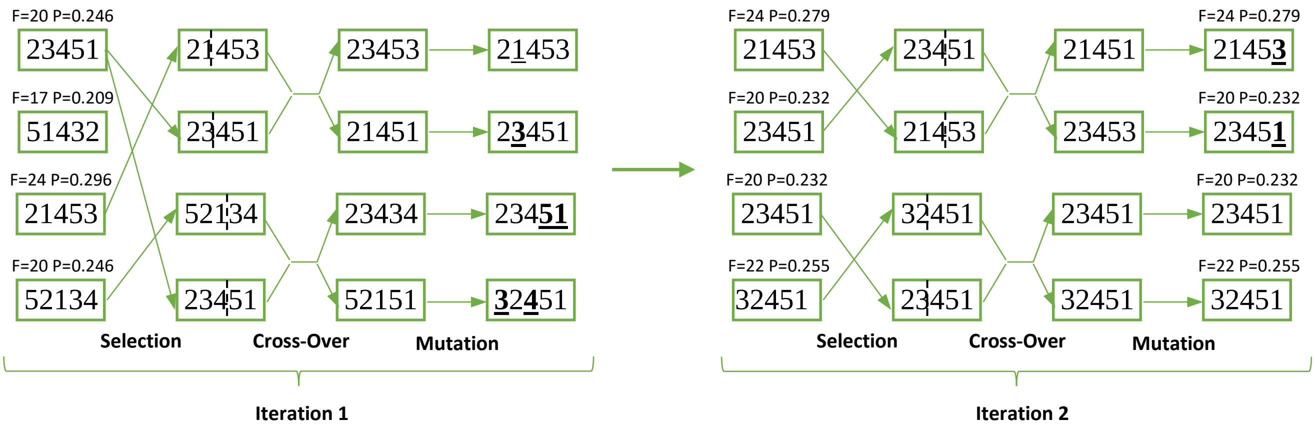
P(2) = 17/(20+17+24+20) = 0.209

P(3) = 24/(20+17+24+20) = 0.296

P(4) = 20/(20+17+24+20) = 0.246

Evolution process diagram: (02 pts)

Calculations for the second iteration: (0.75 pt)



Conclusion: The solution to return is the chromosome 21453 with a probability of 0.279. As a result, the most profitable route is: 3 → 2 → 1 → 4 → 5 → 3 **(0.75 pt)**

Exercise N°2 (09 pts): Let's consider a Constraint Satisfaction Problem (CSP) related to scheduling classes. The problem is to schedule classes for three professors: Professor A, Professor B, and Professor C in three available classrooms: Room 1, Room 2, and Room 3. No two professors can be in the same room at the same time and Each professor must be assigned to exactly one class slot at a time.

1. Give a formal representation to this CSP problem?

2. Let's consider that the same room is used only one time slot by the same professor. Give an example of a complete and consistent assignment?

Exercise 2 - Solution:

Formal representation:

Variables: (2.25 pts)

- A1, A2, A3 (Class slots for Professor A)
- B1, B2, B3 (Class slots for Professor B)
- C1, C2, C3 (Class slots for Professor C)

Domains: (01 pt)

- {Room 1, Room 2, Room 3} for each class slot variable

Constraints : (4.5 pts)

1. No two professors can be in the same room at the same time.
   - $A1 \neq B1$, $A1 \neq C1$, $B1 \neq C1$
   - $A2 \neq B2$, $A2 \neq C2$, $B2 \neq C2$
   - $A3 \neq B3$, $A3 \neq C3$, $B3 \neq C3$
2. Each professor must be assigned to exactly one class slot.
   - $A1 \neq A2$, $A1 \neq A3$, $A2 \neq A3$
   - $B1 \neq B2$, $B1 \neq B3$, $B2 \neq B3$
   - $C1 \neq C2$, $C1 \neq C3$, $C2 \neq C3$

A possible solution (1.25 pt) (a complete and consistent assignment) that satisfies the constraints could be:

- A1: Room 1
- A2: Room 2
- A3: Room 3
- B1: Room 2
- B2: Room 3
- B3: Room 1
- C1: Room 3
- C2: Room 1
- C3: Room 2

This assignment of rooms and time slots ensures that no two professors share the same room at the same time, and each professor is assigned to exactly one class slot.