Due date: May 1, 2025
Late submission: 20% per day.
Teams: You can do the project in teams of 2. Teams must submit only 1 copy of the project.
Purpose: The purpose of this project is to solve a real-world problem with search.

Optimization Strategies for Local Package Delivery Operations

In this project, you will simulate and optimize the operations of a local package delivery shop. The goal is to design algorithms and strategies to efficiently manage delivery routes and resource allocation, minimizing operational costs.

Project Overview:

You are responsible for running the operations of a small package delivery shop. Every day, you receive a set of packages. Each package is characterized by a destination location, a weight in kilograms, and a priority (a number between 1 and 5, with a lower number indicating higher priority). Your task is to assign each package to one of the available delivery vehicles that you have and also determine the route that each vehicle will follow to minimize the operational cost, which is defined by the total distance traveled by all vehicles. While the goal is to prioritize delivering higher-priority packages first, this is not a strict constraint and can be violated if doing so would result in significantly higher costs. Each vehicle has a limited capacity (in kg). You need to ensure that the total weight of the packages assigned to a vehicle does not exceed its capacity.

Project Goal:

The goal of this project is to implement a system that solves the package-to-vehicles assignment problem, minimizing the total traveled distance by all the vehicles in the shop. For simplicity, assume that there is a direct straight-line route between any two locations (i.e., the distance between two locations is calculated using the Euclidean distance formula). The location of your shop and the destination location of any package is represented by (x, y) coordinates.

Requirements:

- Implement **both** of the following algorithms: simulated annealing, and genetic algorithms. At run time, the user should be able to choose which algorithm to use to generate the solution.
- You must tune the parameters of the implemented algorithms (for example, mutation rate, temperature schedule, ...etc.)
- To test the system, the user should be able to specify the number of available vehicles, their capacity, and the specifications of the packages in the store to be delivered.
- Your system should include a user-interface that displays the generated solution of your algorithm.

Submission:

- A report of up to 8 pages that describes your formulation of the problem, any heuristics that you used, how you handled constraints violations, effects of parameters tuning (at least one parameter per algorithm), and some test cases. Do not include code snippets in the report
- Source code
- Demo: you will be asked to present a demo of your project. During the demo, you should expect questions about your code and you might be asked to apply some minor modification.

Remarks:

Algorithm Parameters (To Be Used By All Teams)

All teams must use the following ranges or default values for their optimization algorithms unless explicitly justified in the report.

Simulated Annealing Parameters:

Parameter	**Recommended Value Range**	**Notes**
Initial Temperature	1000	Fixed value
Cooling Rate	Between 0.90 and 0.99	Students choose within range
Stopping Temperature	1	Stop when temperature < 1
Number of Iterations per Temperature	100	Fixed

Genetic Algorithm Parameters:

Parameter	**Recommended Value Range**	**Notes**
Population Size	Between 50 and 100	Students choose within range
Mutation Rate	Between 0.01 and 0.1	Students choose within range
Number of Generations	500	Fixed for all teams

Distance and Coordinates:

- All package destinations are defined within a 2D grid:
  $x \in [0, 100]$ km
  $y \in [0, 100]$ km
- Shop Location: (0 km, 0 km) Distance between two locations is calculated using the Euclidean Distance Formula and is measured in *kilometers (km)*.
- Package weight and vehicle capacity are measured in *kilograms (kg)*.

Honor Policy: All are required to adhere to the university honor policy and violations will be dealt with according to university regulations.