Assignment 1: Global path planning

Introduction

The scope of this assignment is to compare the performance of Dijkstra and A* with an increasing number of nodes.

Assignment

1. Analyze the provided Dijkstra.py code. It selects two random points in Torin and computes the optimal path connecting them. The code outputs the number of **iterations** performed to find the solutions.
2. Modify the code to repeat the Dijkstra algorithm over 10 pairs of randomly selected points, and to compute the average number of iterations for repeating Dijkstra 10 times.
3. Collect the average number of iterations over 10 pairs of randomly selected points for the following cities: Torino, Aosta.
4. Compare the average number of iterations for the two cities (report the number of nodes, and edges for each city).
5. Modify the provided code, to implement the A* algorithm in three different variants corresponding to three different heuristic functions:
    a. Manhattan distance: $h(n) = |x_1 - x_2| + |y_1 - y_2|$
    b. Euclidean distance: $h(n) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$
    c. Haversine distance. It computes the great-circle distance between two points on a sphere given their latitude ($\emptyset$) and longitude (λ) in radians.

$$(\emptyset_1, \lambda_1)$$

$$(\emptyset_2, \lambda_2)$$

$$\Delta\emptyset = \emptyset_1 - \emptyset_2$$

$$\Delta\lambda = \lambda_1 - \lambda_2$$

$$a = \left(sin\left(\frac{\Delta\emptyset}{2}\right)\right)^2 + \cos(\emptyset_1)\cos(\emptyset_2)\left(sin\left(\frac{\Delta\lambda}{2}\right)\right)^2$$

$$c = 2atan2\left(\sqrt{a}, \sqrt{a-1}\right)$$

$$h(n) = Rc, R = 6371\ \text{km}$$

6. Repeat steps 3 and 4 using the three versions of A*, one for each heuristic.
7. Write a report, comparing the performance of Dijkstra with A* for the two cities

Instructions

- The report is individual
- Upload you work as a ZIP file using Portale della didattica
- The ZIP file must contain:
    - A PDF file with the report as per point 7 of the assignment
    - The Dijkstra.py file modified as per point 2
    - The Astar.py file as per point 5
- The deadline for delivering the assignment is: March 17th, 2026 at 11:30.