Planning and Decision Making - Assignment 2

Graph Search

Due date: Monday, December 01, 11:59am
Submit by Brightspace before noon

Course: RO47005 Planning & Decision Making, TU Delft, CoR
Contact: Zuleika Redondo Garcia, email: Z.M.RedondoGarcia@student.tudelft.nl

Deliver a PDF (maximum 4 pages) with the answers to all questions in this assignment on Brightspace before the due date. Questions can be asked in the Q&A sessions or on the Brightspace forum. The solutions to this assignment will be discussed in the Q&A session in the week of the submission deadline.

1 Graph search (2,0 pt)

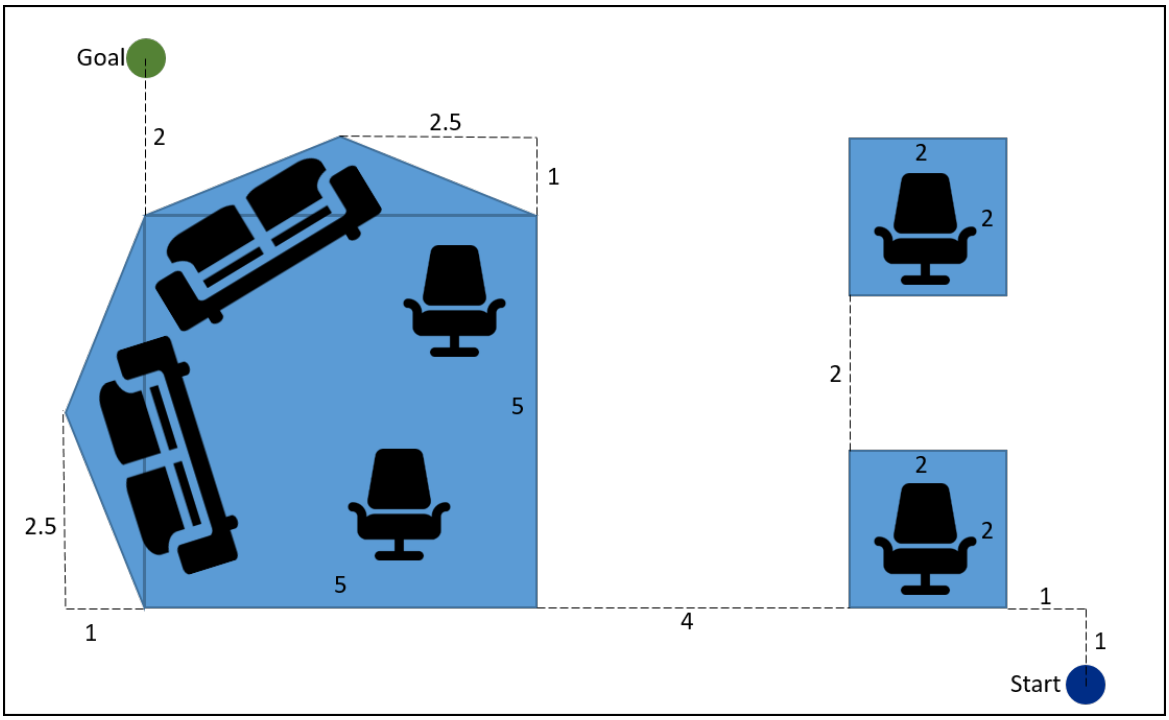
Consider a directed graph $G = (V, E)$, with distances $d(e)$ for each $e \in E$, and consider two nodes $s, t \in V$. For each node v we define the function $P_s(v)$, which gives the length of the shortest path from s to v. Similar we define the function $P_t(v)$, which gives the length of the shortest path from v to t.

Question 1.1 (0,5 pt) Show that for every edge $e = (u, v)$, the length of the shortest path from node s to node t that uses the edge e is $P_s(u) + d(e) + P_t(v)$.

Question 1.2 (1,5 pt) Let Q be the shortest path between the nodes s and t. Use the property obtained in Question 1.1, to propose an algorithm that finds the second shortest path from s to t (i.e., considering all paths that are not exactly equal to Q).

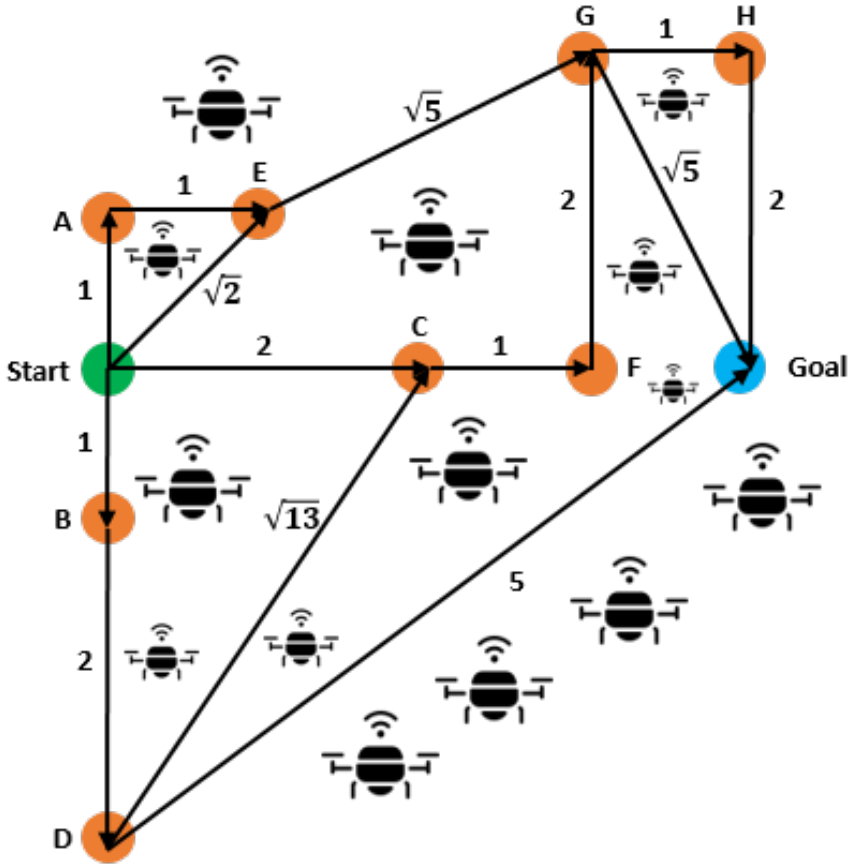
2 Map to Graph (2,0 pt)

In most cases a graph to operate on is not provided directly. It needs to be extracted from an environment or map first. Use the given map, shown below, to find the **shortest-path roadmap** that can be used to find the shortest path from the indicated start to the goal location. Obstacles are shown in blue. Also connect the start and goal to the roadmap. Solve this problem graphically. Use the given obstacle sizes and distances to determine the costs of seven edges of your choice.



3 Dijkstra and A* (4,0 pt)

Given an environment of operating drones a graph was extracted, similar to the previous exercise. The directed graph avoids collisions with all drones. The cost to traverse an edge is proportional to the distance of nodes and is indicated at each respective edge.



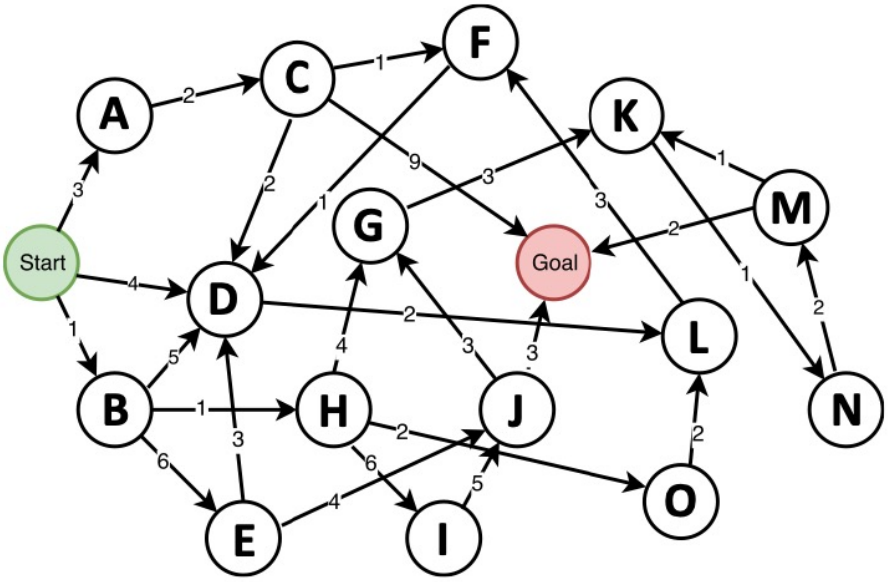
Question 3.1 (1,5 pt) Find a path form the "start"-node to the "goal"-node using the Dijkstra algorithm. Explain each step.

Question 3.2 (2,0 pt) Find a path form the "start"-node to the "goal"-node using the $A^{\star}$ algorithm. Define a heuristic H(x) and explain each step.

Question 3.3 (0,5 pt) State the difference in determining the results between A* and Dijkstra and explain why.

4 Dijkstra (2,0 pt)

Here a more complex directed graph, where the cost, indicated at each edge, is given. Find a path form the "start"-node to the "goal"-node using the Dijkstra algorithm. Show all steps.



Question 4.1 (2,0 pt) Find a path form the "start"-node to the "goal"-node using the Dijkstra algorithm. Explain each step.

Question 4.2 (Optional) (1.0 pt) Complete all gaps, indicated by "#TODO", within the provided jupyter-notebook. Add the final result graph to your report.