Path Scanning Algorithm Implementation – Icy Road Project

Contents

- Task Allocation Algorithm
- Path Scanning Algorithm
- Results

Task Allocation Algorithm

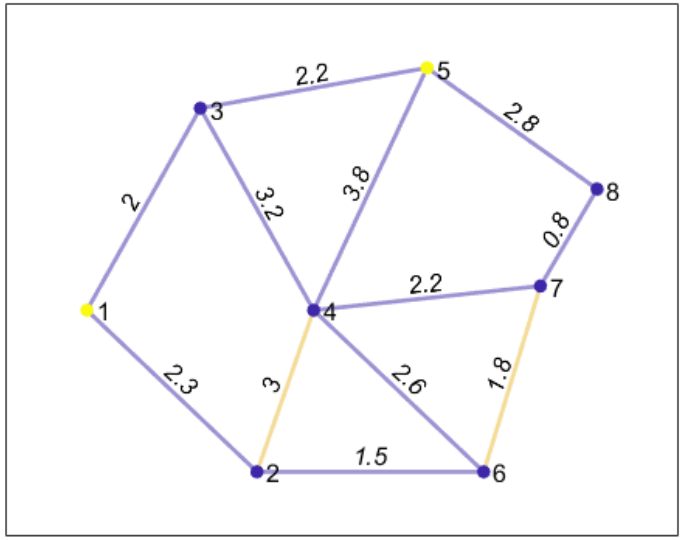
Task allocation algorithm assigns desired road segments to base stations based on

1. Closeness of the desired road segments to the base stations.
2. Availability of drones in the bases stations.

For Icy road UAV routing problem, a simple Dijkstra algorithm is implemented to determine the closest road segment to the base station subject to the availability of UAVs.

Task allocation algorithm is implemented before path scanning algorithm to avoid multiple UAVs from different base stations to traverse through same desired road segment multiple times.

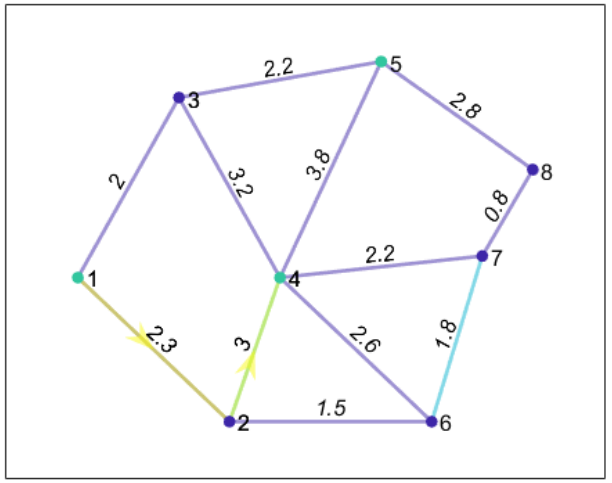
Task Allocation Algorithm – Scenario 1



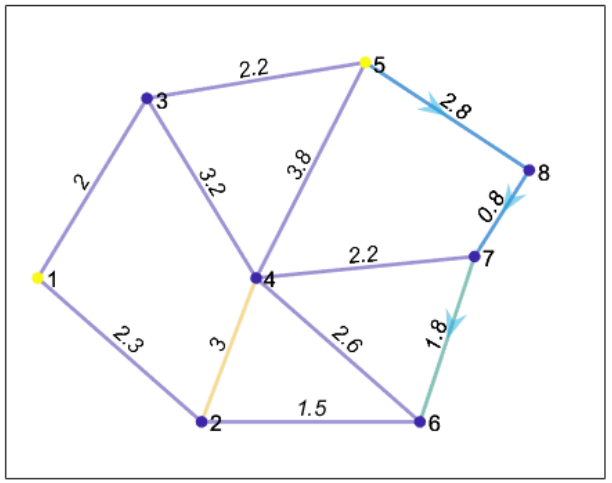
Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 1
Number of the UAV in depot node 5 = 1
Vehicle Capacity = 14

Task Allocation Algorithm

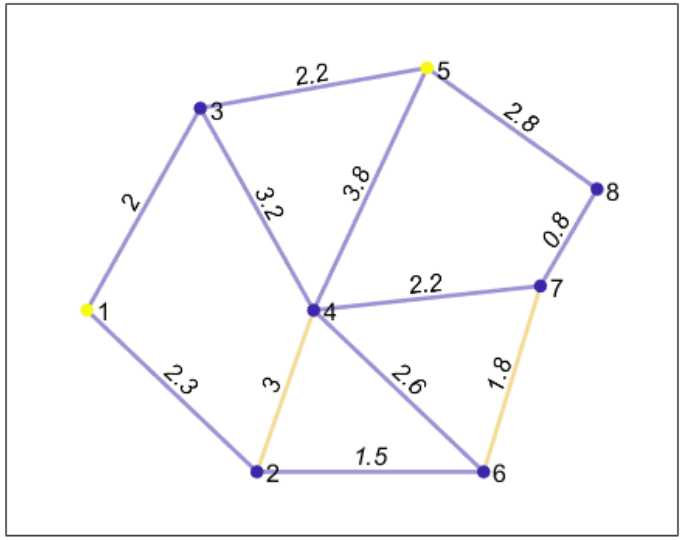
Assigning depot 1 to edge (2-4)
Distance = 5.3
Number of UAVs used = 1



Assigning depot 5 to edge (6-7)
Distance = 5.4
Number of UAVs used = 1



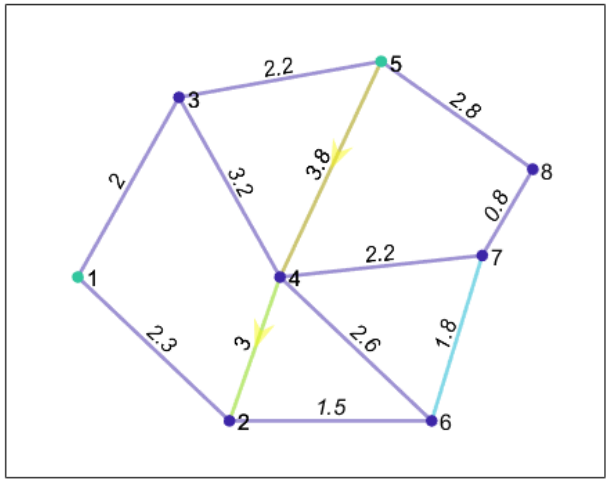
Task Allocation Algorithm – Scenario 2



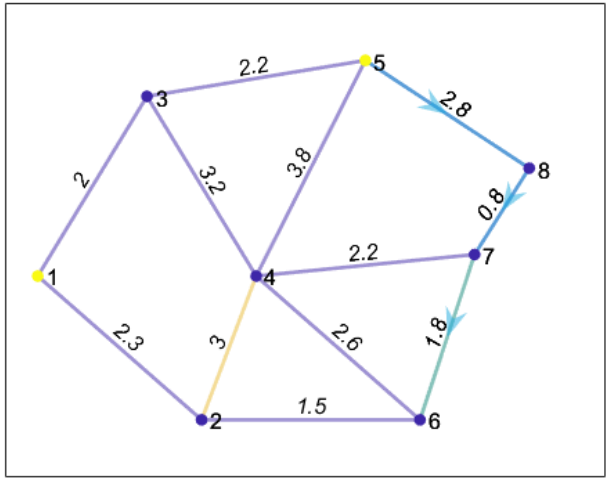
Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 0
Number of the UAV in depot node 5 = 2
Vehicle Capacity = 14

Task Allocation Algorithm

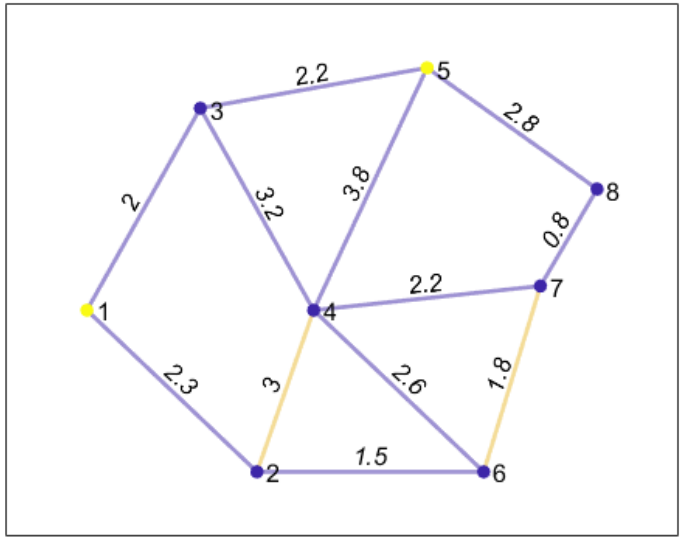
Assigning depot 5 to edge (2-4)
Distance = 6.8
Number of UAVs used = 1



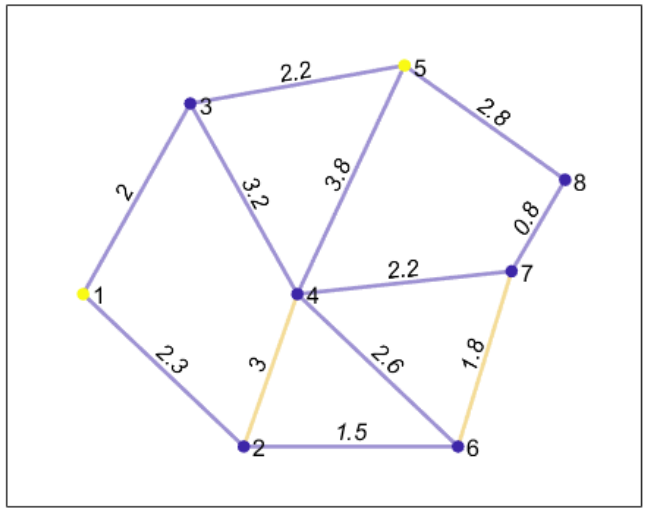
Assigning depot 5 to edge (6-7)
Distance = 5.4
Number of UAVs used = 1



Task Allocation Algorithm – Scenario 3



Task Allocation Algorithm



Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 0
Number of the UAV in depot node 5 = 1
Vehicle Capacity = 14

Assigning depot 5 to edge (2-4) & (6-7)
Number of UAVs used = 1
Failure Scenario

Path Scanning Algorithm

Path Scanning algorithm constructs feasible cycles one at a time based on myopic optimization criteria.

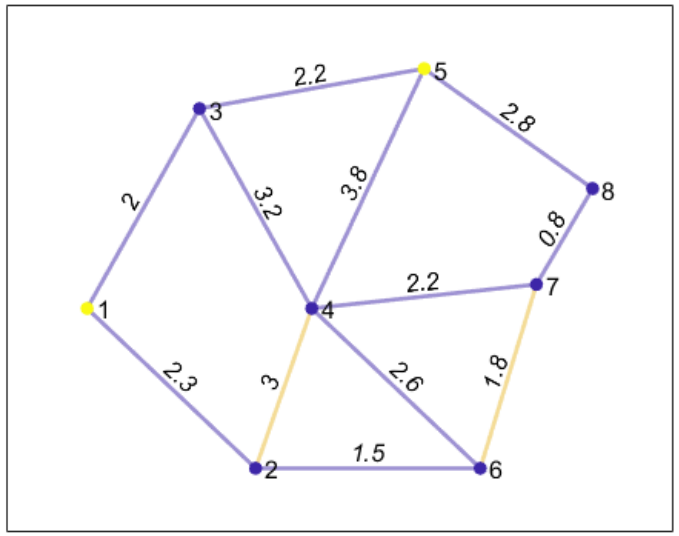
It is a greedy approach which constructs path by adding best possible edge one at a time.

For Icy road UAV routing problem, the optimization conditions considered are:

1. Minimizing the cost from the base station to the desired road segments.
2. Minimizing the cost from the desired road segments back to the base station.

1. Pearn, W. (1989). Approximate solutions for the capacitated arc routing problem. *Comput. Oper. Res., 16,* 589-600.
2. Golden, B., Dearmon, J., & Baker, E.K. (1983). Computational experiments with algorithms for a class of routing problems. *Comput. Oper. Res., 10,* 47-59.

Path Scanning Algorithm Results – Scenario 1

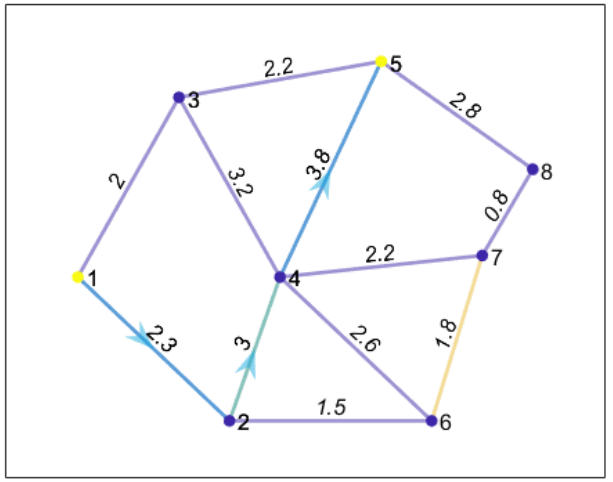


Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 1
Number of the UAV in depot node 5 = 1
Vehicle Capacity = 14

Path Scanning Algorithm

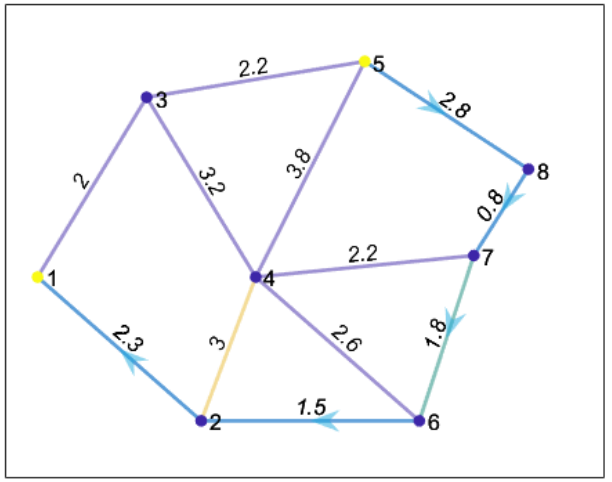
Path 1: 1 → 2 → 4 → 5

Best Cost = 9.1

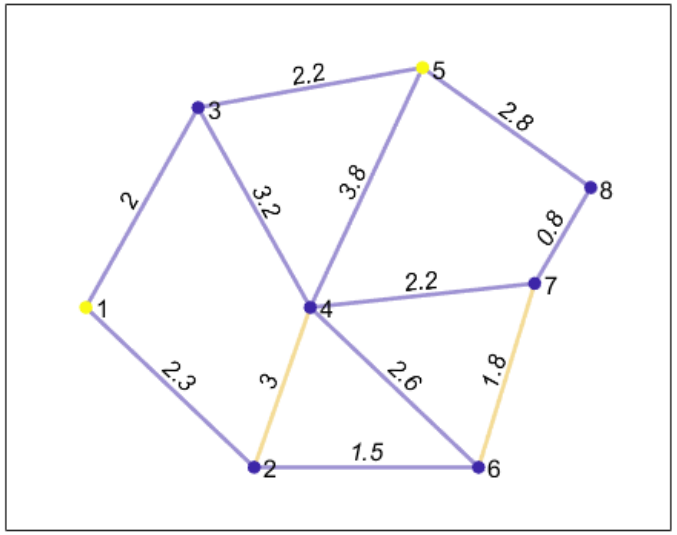


Path 2: 5 → 8 → 7 → 6 → 2 → 1

Best Cost = 9.2



Path Scanning Algorithm Results – Scenario 2

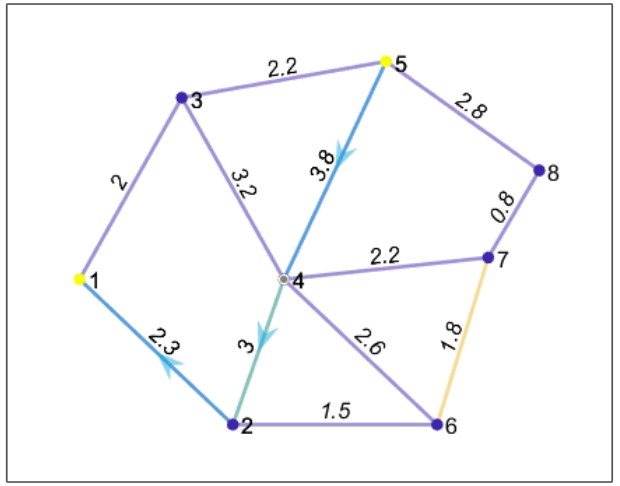


Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 0
Number of the UAV in depot node 5 = 2
Vehicle Capacity = 14

Path Scanning Algorithm

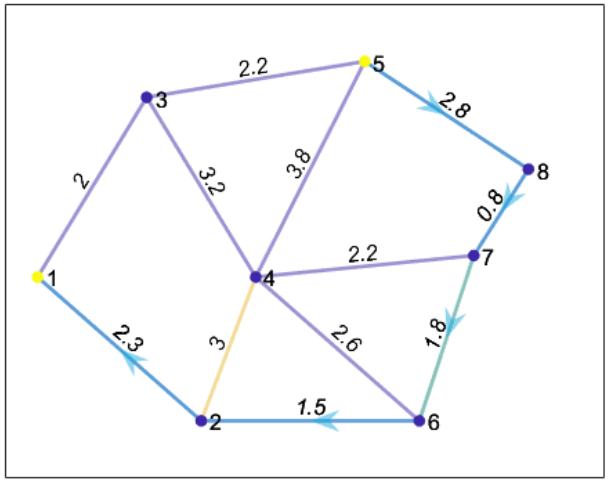
Path 1: 5 → 4 → 2 → 1

Best Cost = 9.1

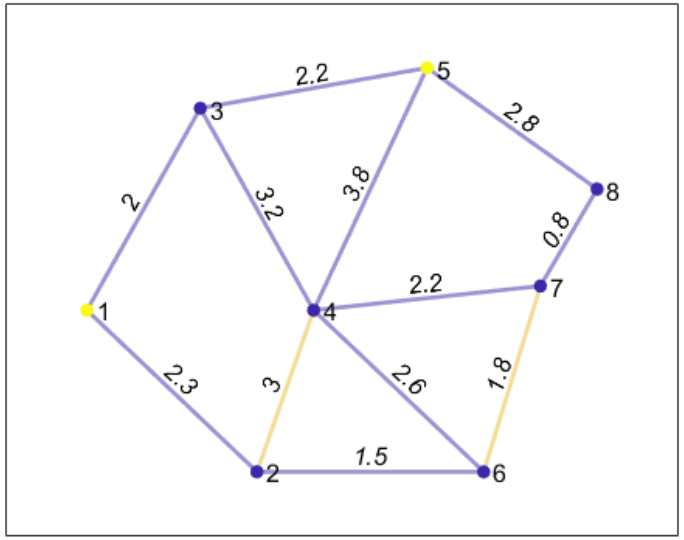


Path 2: 5 → 8 → 7 → 6 → 2 → 1

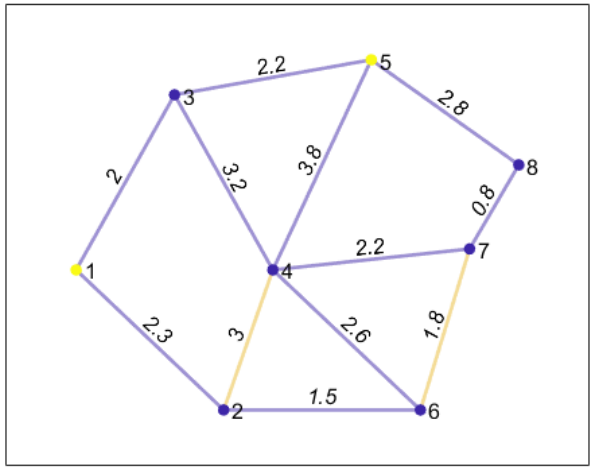
Best Cost = 9.2



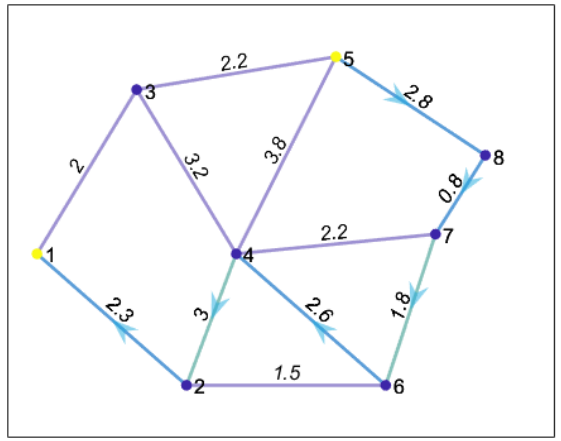
Scenario -3 Results



Path Scanning Algorithm



No Solution



Depot Nodes – 1,5
Required Edges – (2-4), (6-7)
Number of the UAV in depot node 1 = 0
Number of the UAV in depot node 5 = 1
Vehicle Capacity = 14

Optimal Path: 5 → 8 → 7 → 6 → 4 → 2 → 1

Best Cost = 13.3

Implications

Path Scanning algorithm fails to produce solution in scenario 3 where 1 UAV needs to traverse more than one desired road segments.

This is because path scanning algorithm is not able to traverse the second desired arc and reach the base station within the battery capacity.