Data Preservation in Robotic Sensor Network : Covering Salesman Approach

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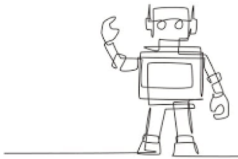
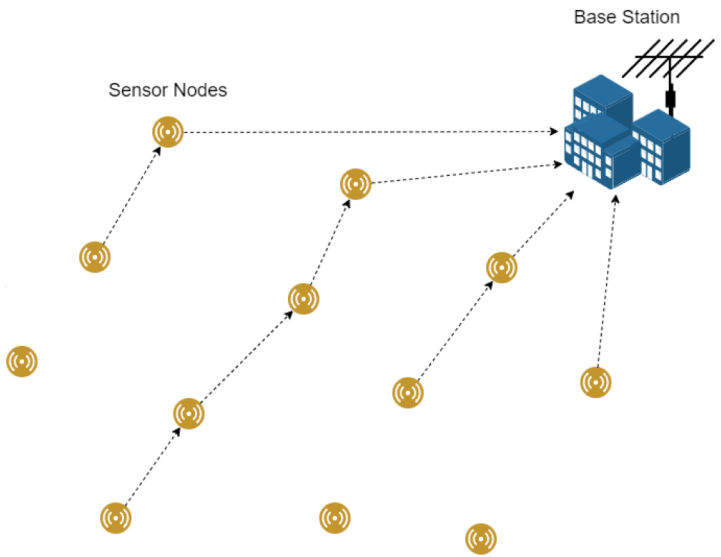


Advisor:- Dr. Bin Tang

Outline

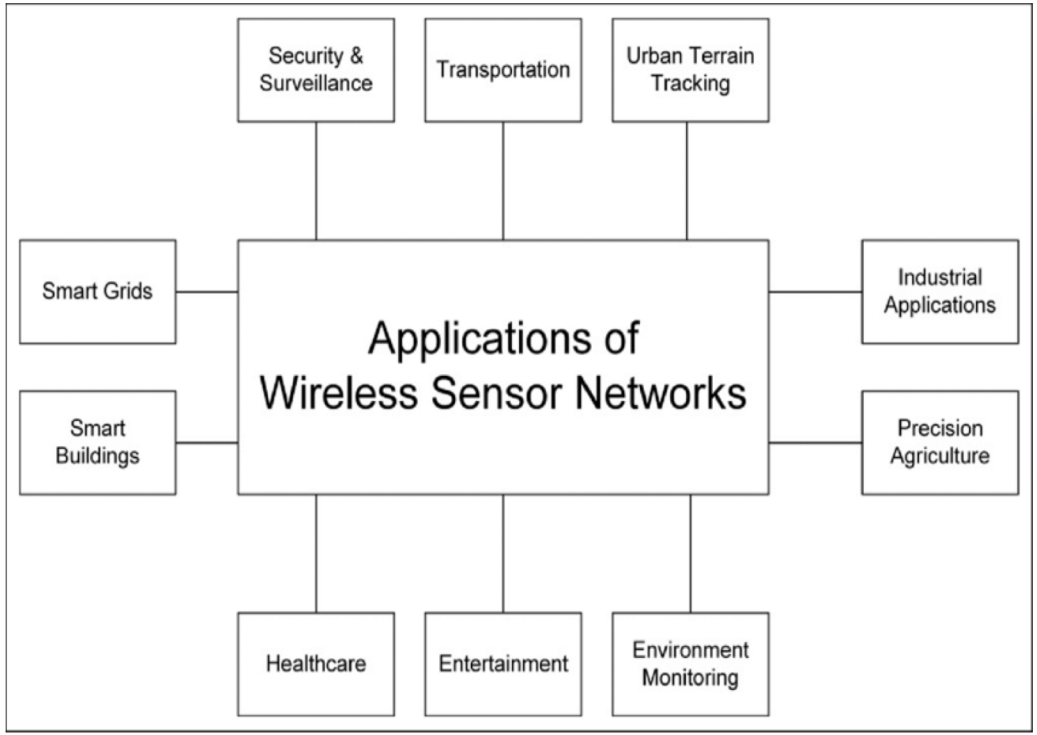
Background and Motivation

What are Wireless Sensor Networks



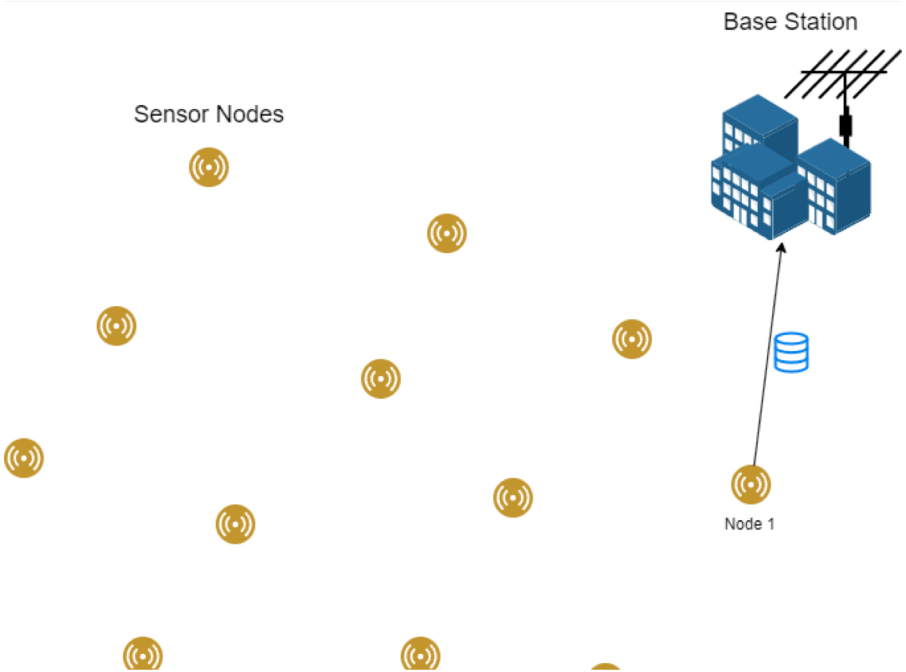
- Sense
- Collect
- Transmit

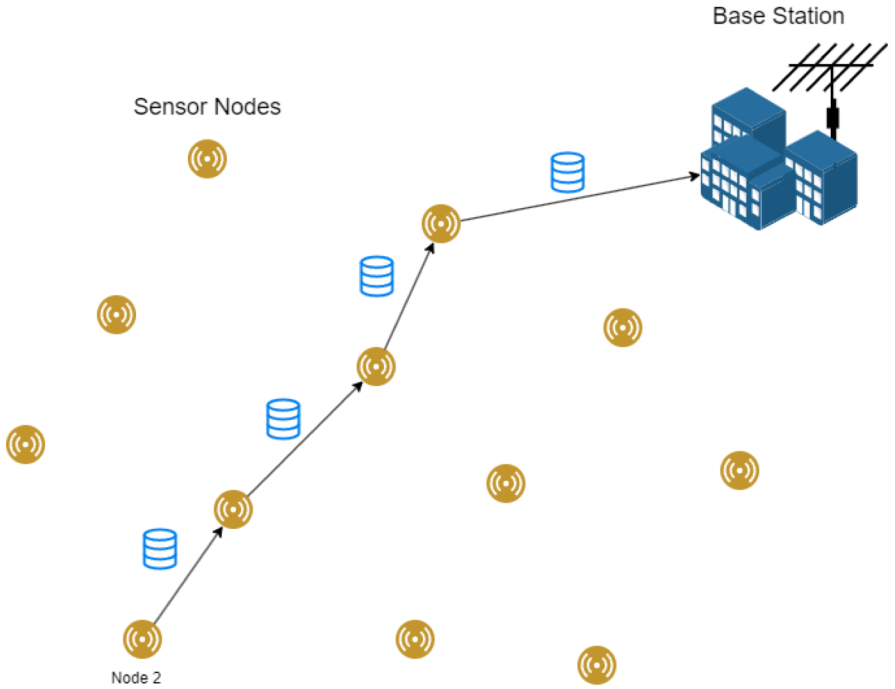
Applications



Background and Motivation

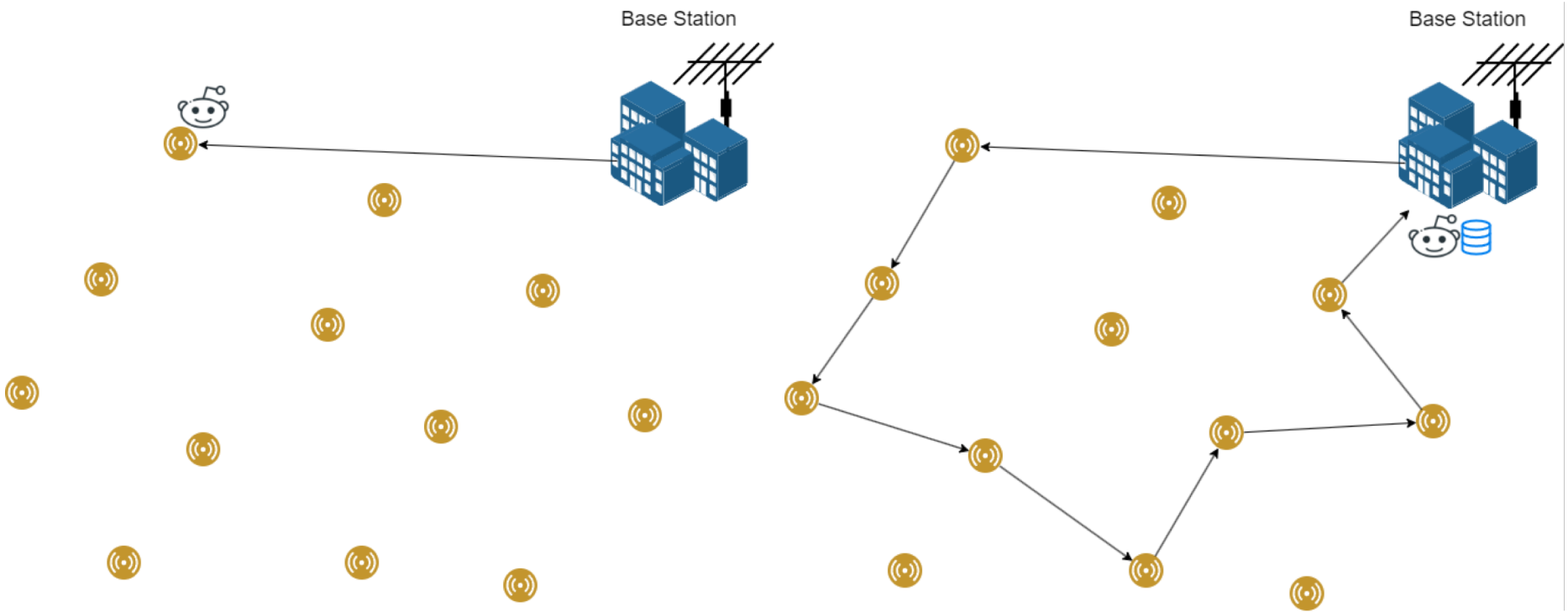
The Traditional Approach (Multi-Hop)





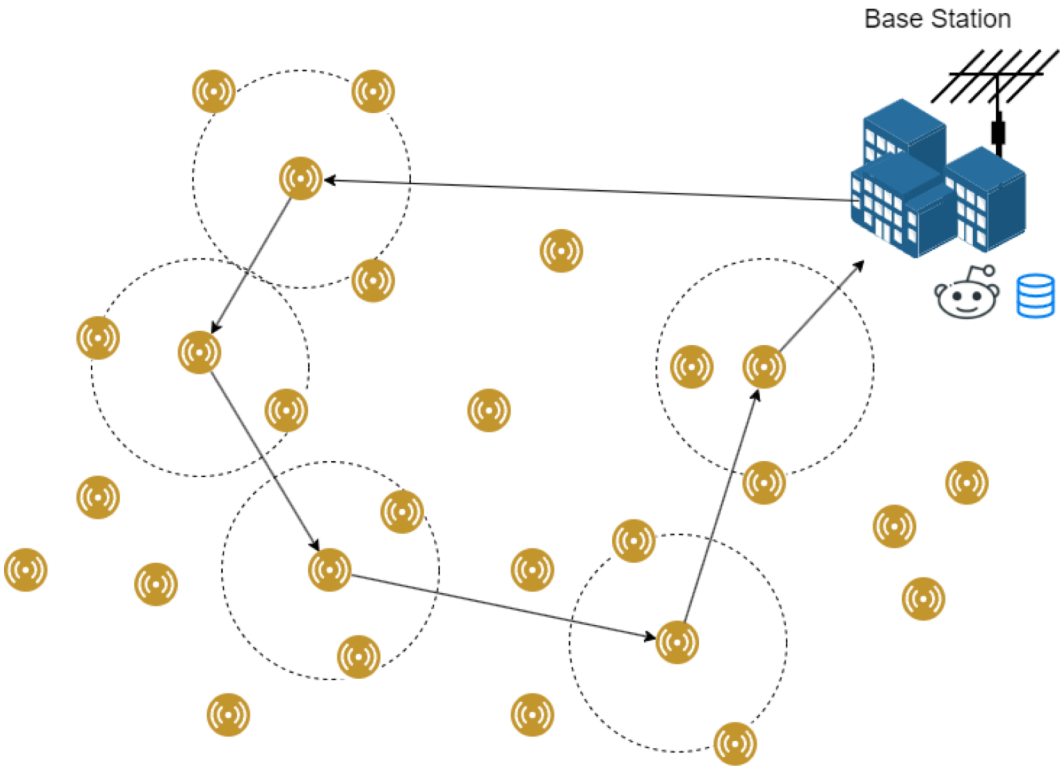
Background and Motivation

Robot/Data Mule/Mobile Data Sink Approach (Budget Constraint Travelling Salesman Problem)



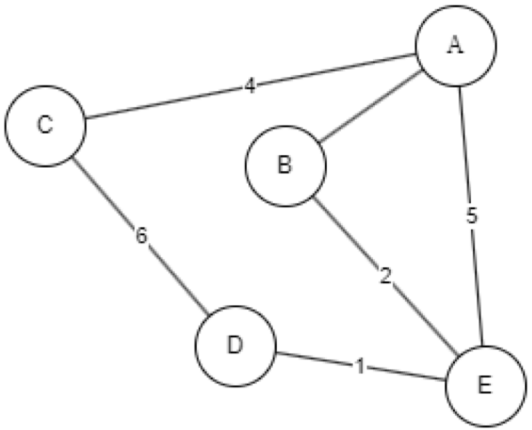
Background and Motivation

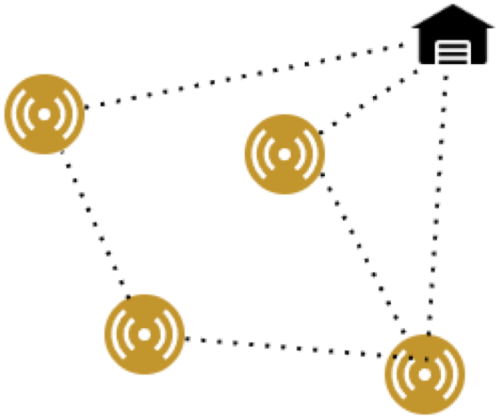
Proposed *Covering Salesman Approach*



- Robot has a range.
- Collect data from multiple sensor nodes.

Problem Formulation





Weighted graph G (V, E)

(u,v) ∈ E has weight w(u,v)

i ∈ V has prize P_i

Network size : 2000m X 2000m
Sensor Nodes : 200
Transmission Range: 200m

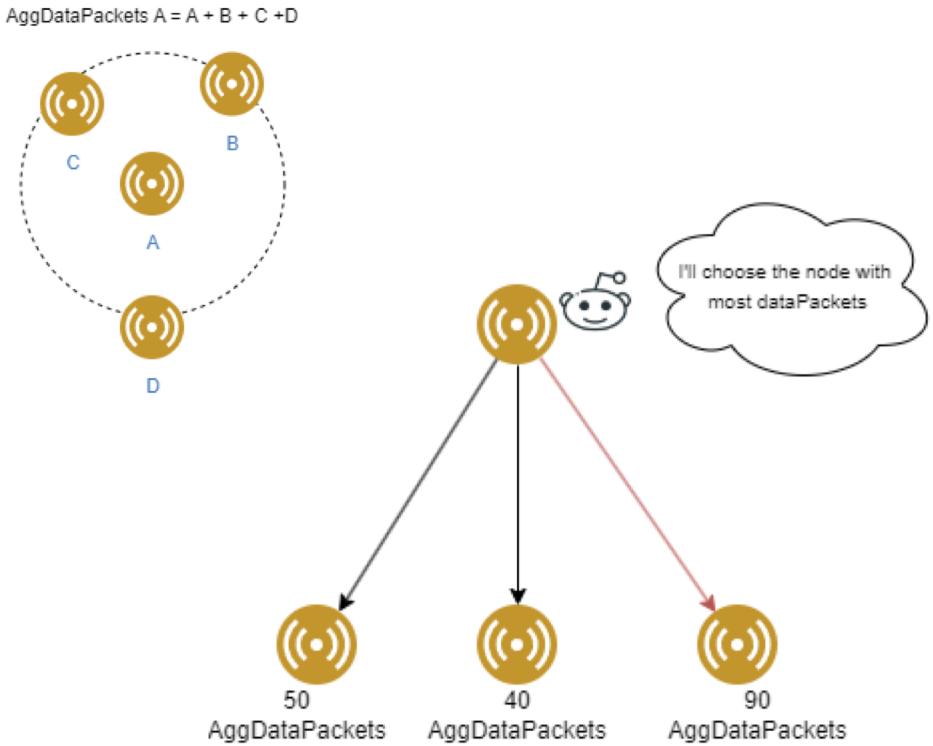
Methodology

Greedy P

Selects node with most data packets to visit next.

Ability to collect more data packets.

Exhausts budget very quickly.



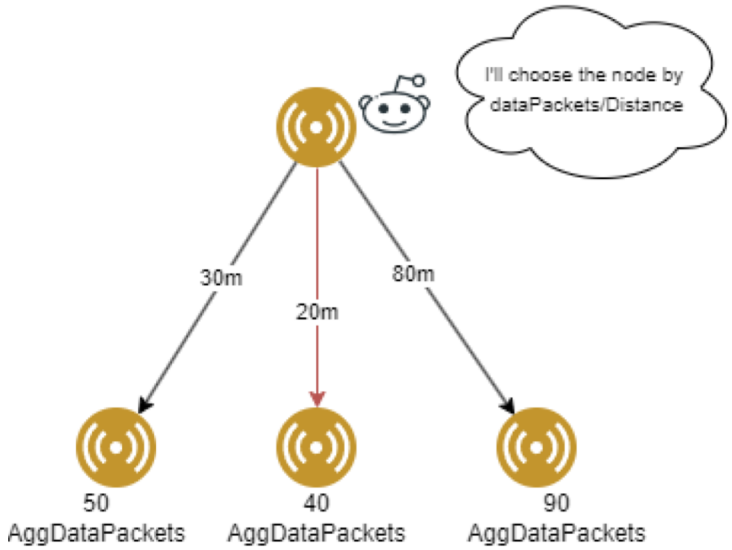
Methodology

Greedy R

Selects the node based on prize cost ratio.

Can visit more nodes than Algorithm 1.

Has more budget left.



Methodology

MARL

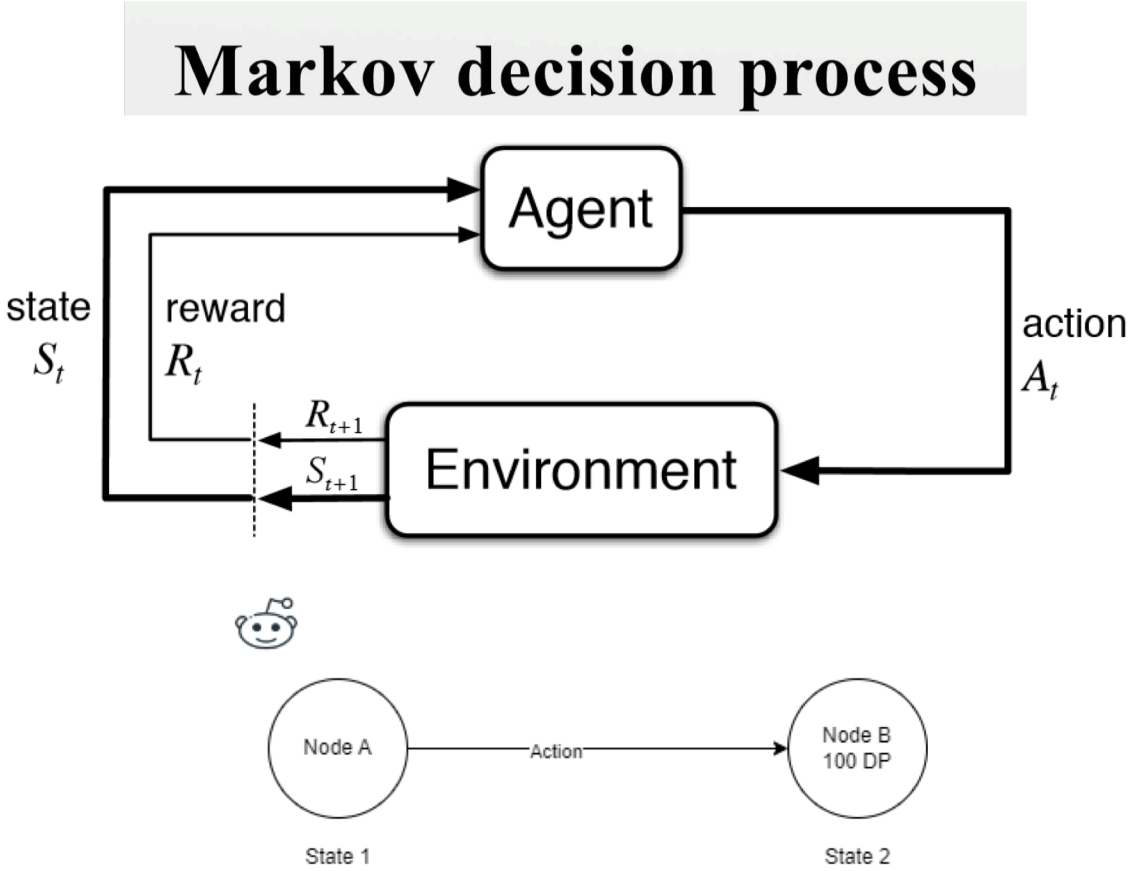
Multi Agent Reinforcement Learning

Observes the environment.

Exploits and Explores to find best action.

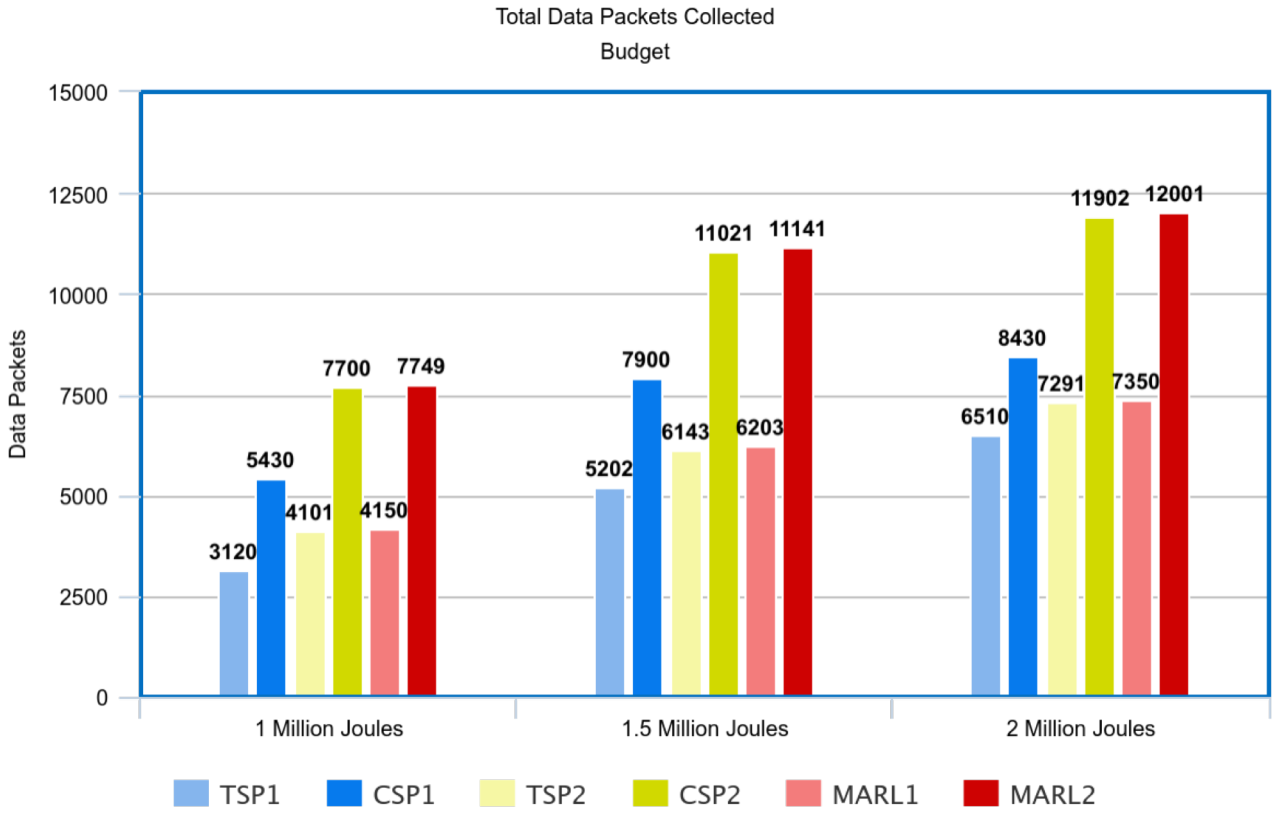
Gets a reward based upon the action.

Maximize the cumulative reward.

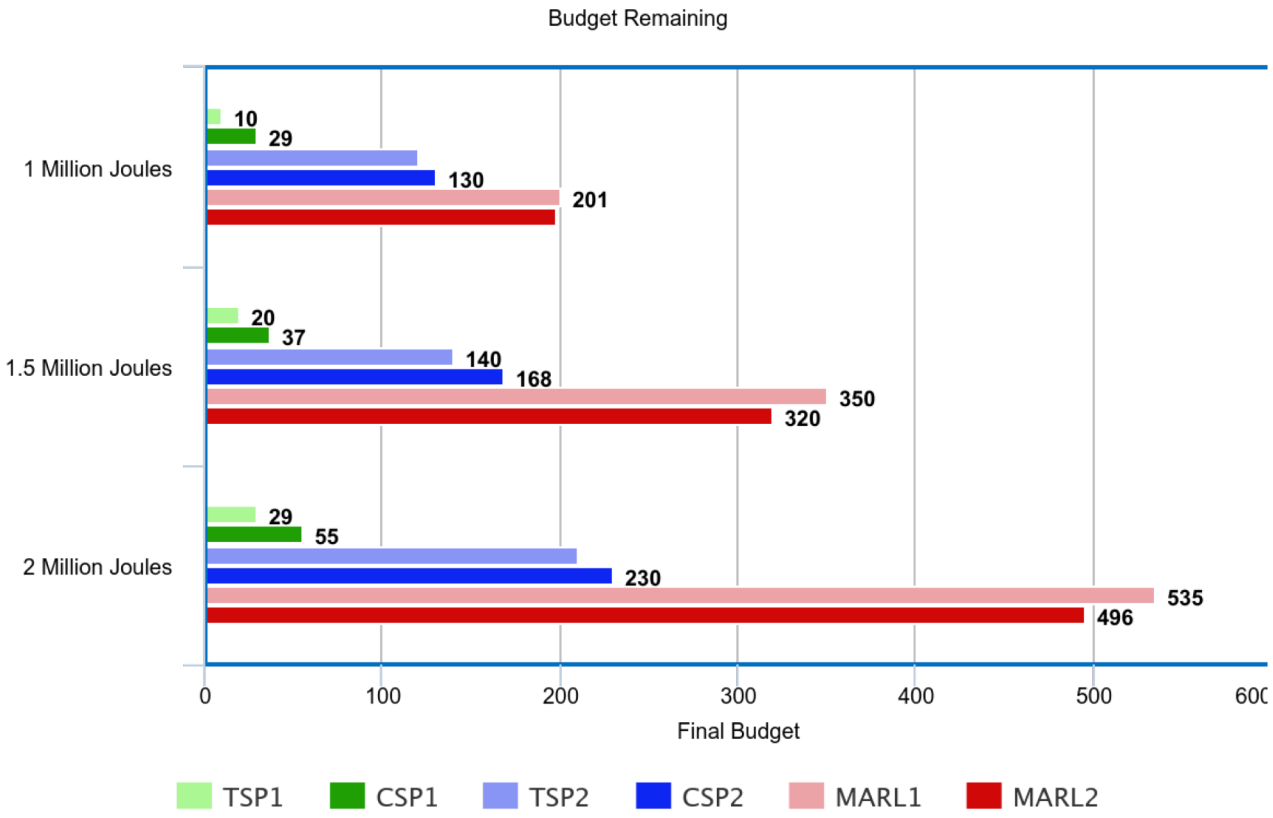


We are first to implement RL technique to BCTSP and CSP !!!

Results


Total Data Packets Collected
Budget
Data Packets
15000
12500
10000
7500
5000
2500
0
3120
5430
4101
7700
4150
7749
5202
7900
6143
11021
6203
11141
6510
8430
7291
11902
7350
12001
1 Million Joules
1.5 Million Joules
2 Million Joules
TSP1
CSP1
TSP2
CSP2
MARL1
MARL2

Results

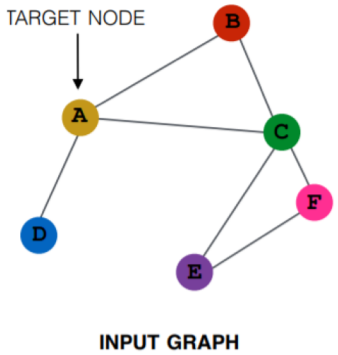

Budget Remaining
1 Million Joules
10
29
130
201
1.5 Million Joules
20
37
140
168
350
320
2 Million Joules
29
55
230
535
496
0
100
200
300
400
500
600
Final Budget
TSP1
CSP1
TSP2
CSP2
MARL1
MARL2

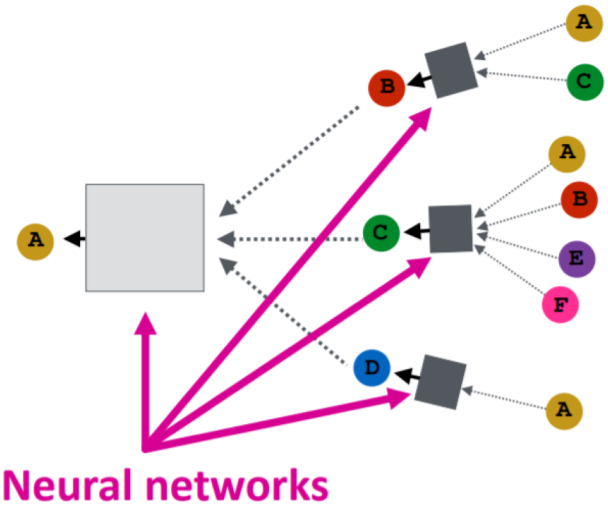
Conclusion

- Covering Salesman(*Travelling Salesman but with range*) Approach collects **45% more data packets,** than the existing solution of TSP.
- The budget remaining after completing a tour is more significantly more in CSP1 and CSP2 , but a slight change in MARL.
- Both MARL algorithms outperform the Greedy Algorithms and the CSP approach MARL is the best among all.

Future work

- Applying Graph Neural Networks.
  - Optimize Execution Time
  - Get rid of the heuristics





Thank You

Questions ?