Graph and Network Analysis

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- The routing protocol in OSPF and RIP

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Introduction

Problem Discussion

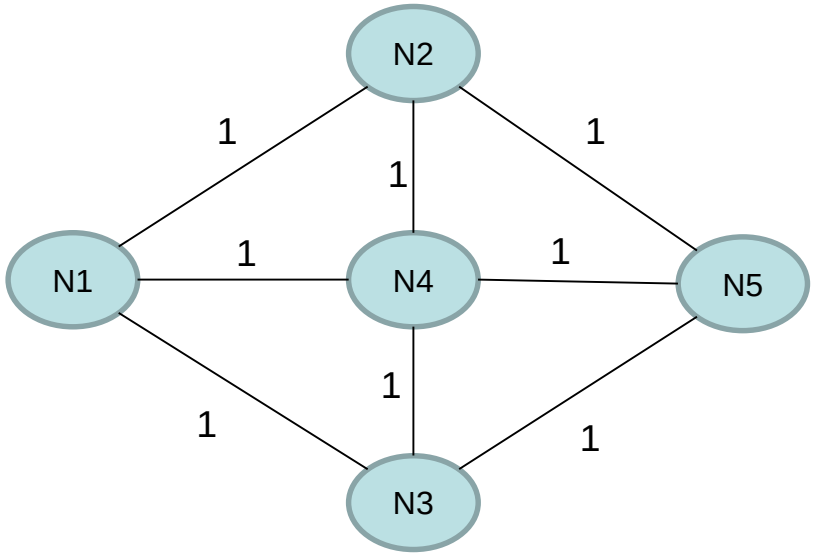
- Assume that the problem is based on graph. Given a graph $G = (V, E)$, V is a non-emptyfinite set of **nodes**. E is a non-empty finite set of **edges**, which are 2-element subsets of V
- **Static / Dynamic** means the **attributes of edges** (weight, congestion…) are **stable / unstable**
- **Known Topology :** $G = (V, E)$ structure is **full observable**, which means each node knows all others nodes / edges in $G = (V, E)$
- **Unknown Topology :** $G = (V, E)$ structure is **partially observable,** which means each node can only observe the structure of a **local area**.

Target

- To find the shortest path in { **Static , Dynamic }** x { **Known Topology , Unknown Topology }** environment.

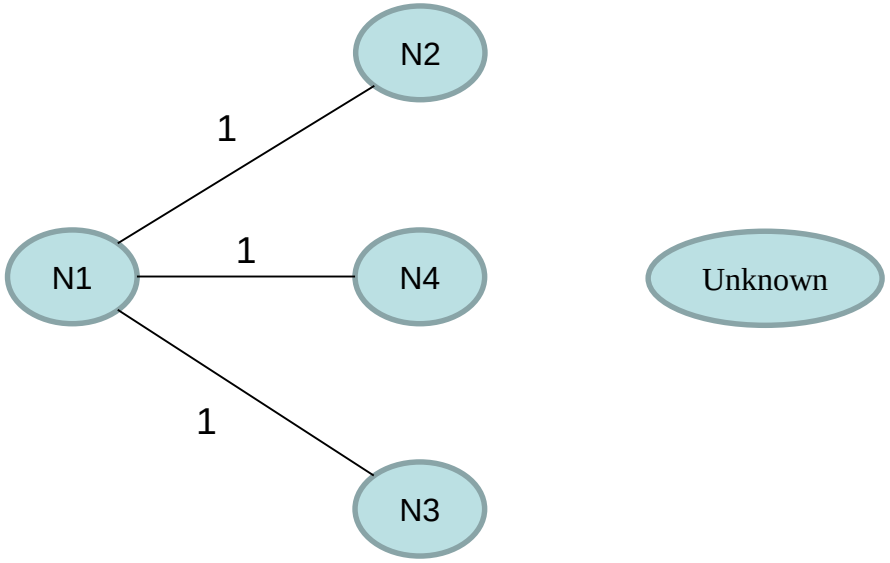
Introduction

A. Static + Known Topology



For **N1**, it knows all information of $G = (V, E)$, such as each node's location and each edge's attributes (e.g., weight, distance…).

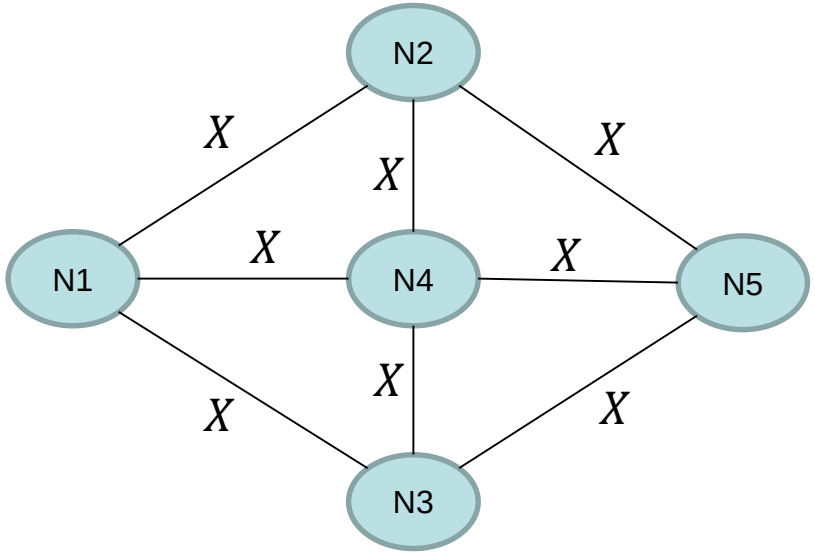
B. Static + Unknown Topology



For **N1**, it only observes its neighbors' location and knows the weights of edges.

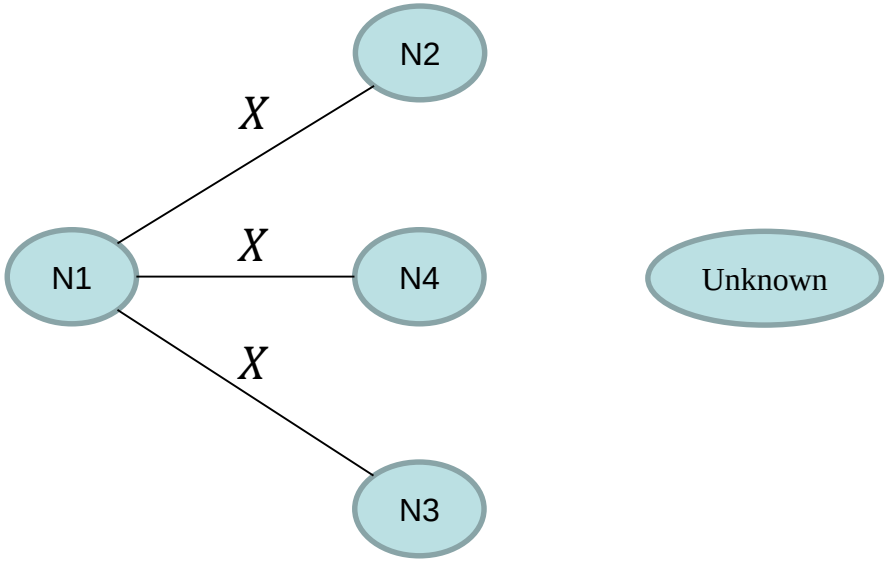
Introduction

C. Dynamic + Known Topology



For **N1**, it knows some information of $G = (V, E)$, such as each node's location. But the attributes (e.g., weight, distance…) of each edge are dynamic, according to a R.V. X

D. Dynamic + Unknown Topology



For **N1**, it only observes its neighbors' location. And the attributes (e.g., weight, distance…) of each edge are dynamic, according to a R.V. X

Introduction

Experiment Correction

- Define that the source is **Node 0** and the terminal **is Node 15.**
- The Shortest Path is 0 → 4 → 9 → 14 → 15

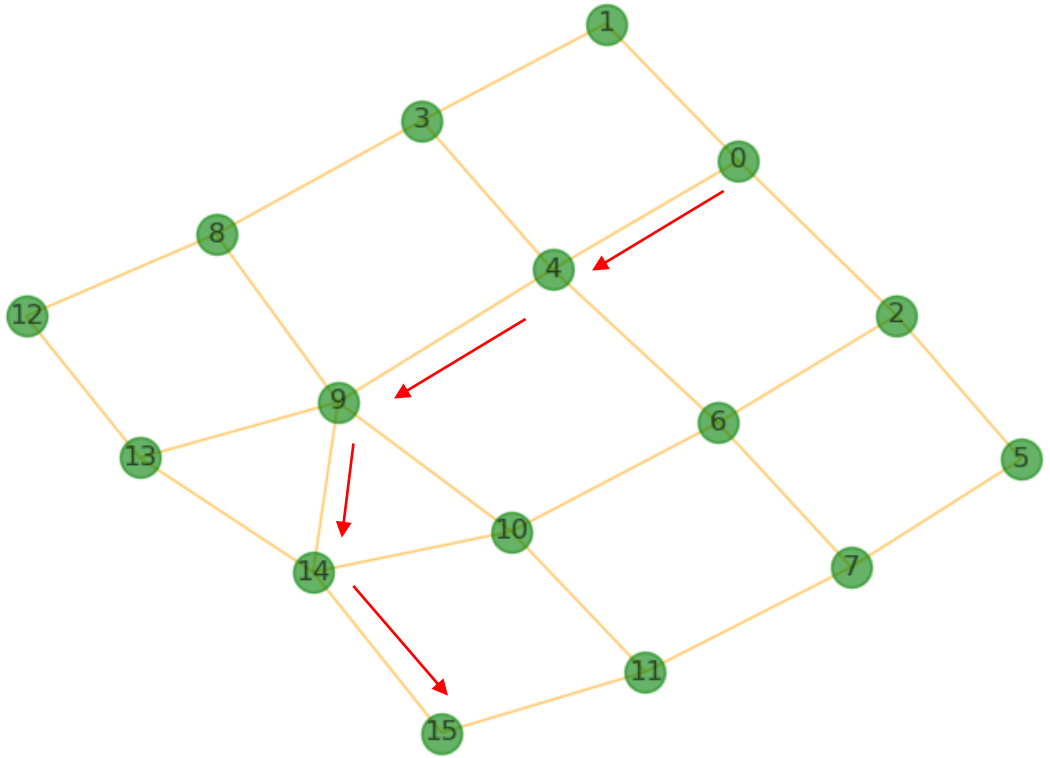


Fig.1 Graph Topology

Average Operation Time Comparison

Table 1. Average Operation Time Comparison

Introduction

Experiment Correction

- The average operation time of Q-Learning algorithm is **about the same** with Dijkstra, A Star and Bellman-Ford in the network shown as Fig1.
- It is proved that Q-Learning can be used to find the shortest path.

Survey Work

Routing Algorithm

	Link State / Decentralized	Protocol	Static / Dynamic	Topology
Dijkstra	Link State	OSPF	Dynamic	Known
Bellman-Ford	Decentralized Routing	RIP	Dynamic	Unknown

Definition:

Routing Algorithm can be divided into two type.

- Link State: Network topology and all link costs are known.
- Decentralized: No node has complete information about the costs of all links and topology.

Static / Dynamic

- means the routing paths can be changed as the network traffic loads or topology change.
- Static means the routing paths only can be changed as a result of human intervention.

Survey Work

The routing protocol in OSPF and RIP

- Routing Protocol Type:
  - The RIP is a **distance vector protocol** whereas the OSPF is a link state protocol. A Distance Protocol uses the distance or hop counts to determine the transmission path. The **link state protocol** analyzes sources like speed , cost , and path congestion while identifying the shortest path.
- Routing Table Restriction:
  - The RIP requests the routing table from the devices around the router that uses RIP. Then the router consolidated that information and constructs its own routing table. This table is sent to those neighboring devices at a regular interval and the consolidated routing table of the router is updated.
  - In OSPF, the router consolidates routing table by getting only required information from the neighboring devices. It never gets the entire routing table of the devices and the routing table construction is really simpler.

Experiments (Q-Learning)

- Assume that Path No.1 is the shortest path in time t_n , and Path No.2 is the shortest path in time t_{n+2}.
- In a time interval, the shortest path will change between Path No.1 and No.2.

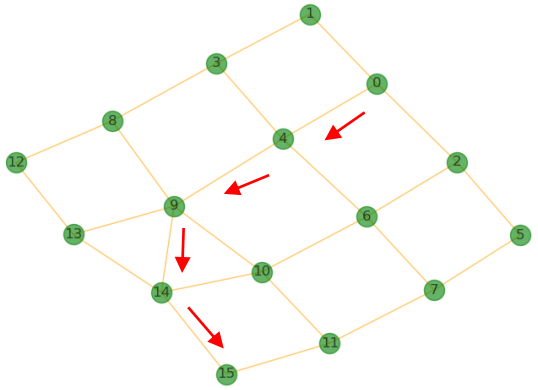


Fig.1 Path No.1

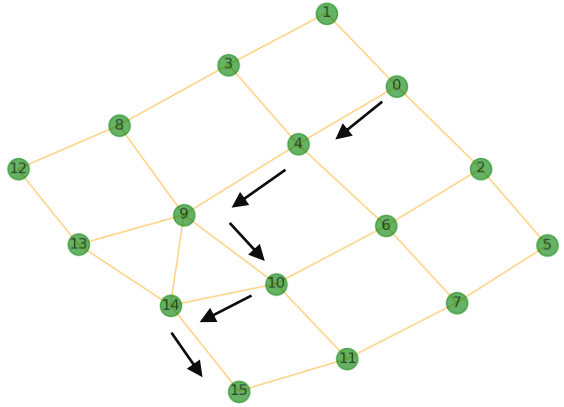
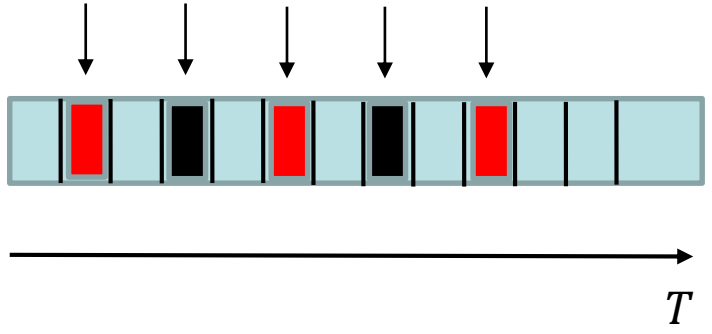


Fig.2 Path No.2



Experiments (Q-Learning)

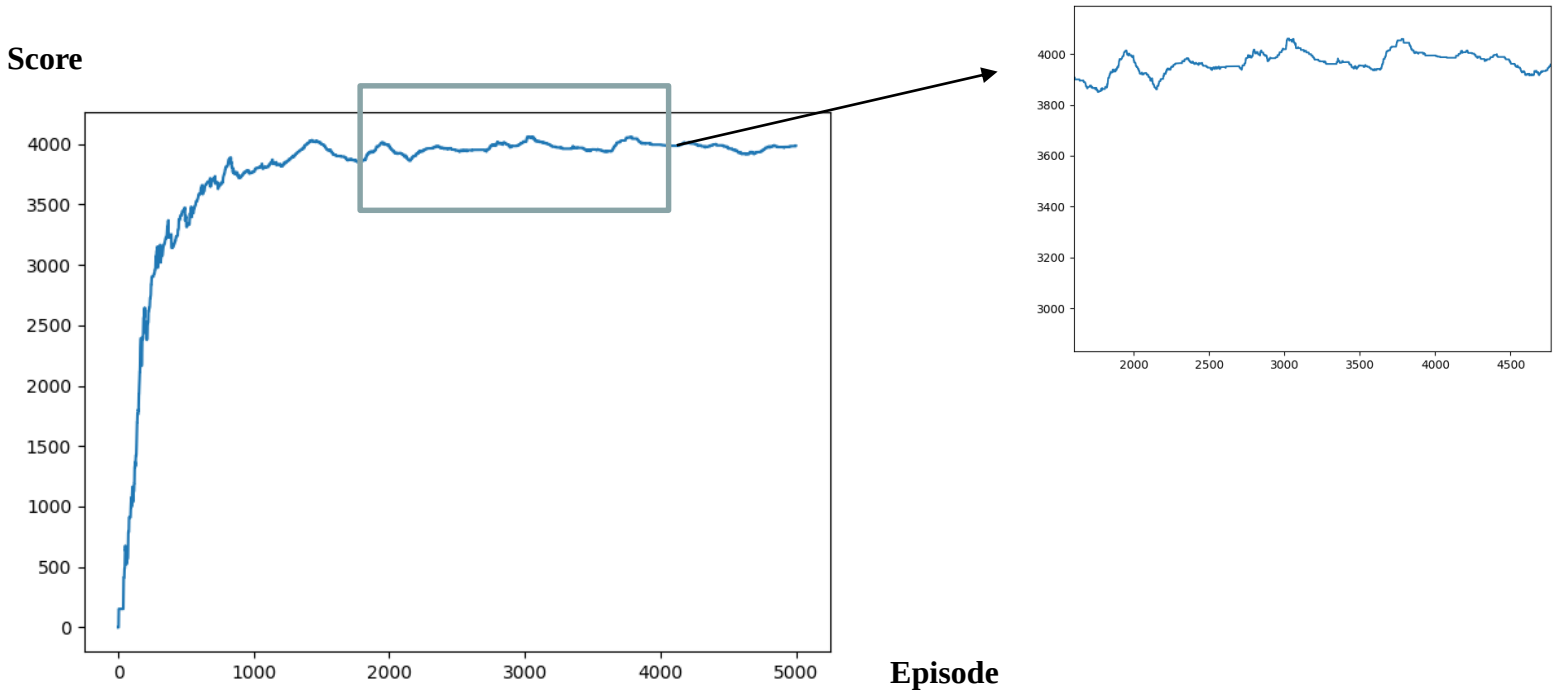


Fig.3 Q-Learning in Dynamic Environment

Conclusion

- Although the simulation environment is quite simple and it is not correspond the real network environment, because of the environment will not be change frequently.
- The result shows that Q-Leaning can not predict the network environment because the path is selected according to the static Q-table.
- In this word, Q-Learning is quite same as other algorithms like Dijkstra, which means Q-Learning must renew its Q-Table at a **regular interval**. It is a mechanism which is same as OSPF and RIP.

Conclusion

Future Work

- To preclude the limited **“Regular Interval”**
  - Q-Learning can not predict the network environment. So Q-Learning must be upgraded to DQN, Deep Q Network combines NN and Q-Learning, in order to fix the Q-Table by using a function.