Can the Internet learn?

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Introduction

- Computer network – collection of nodes and edges

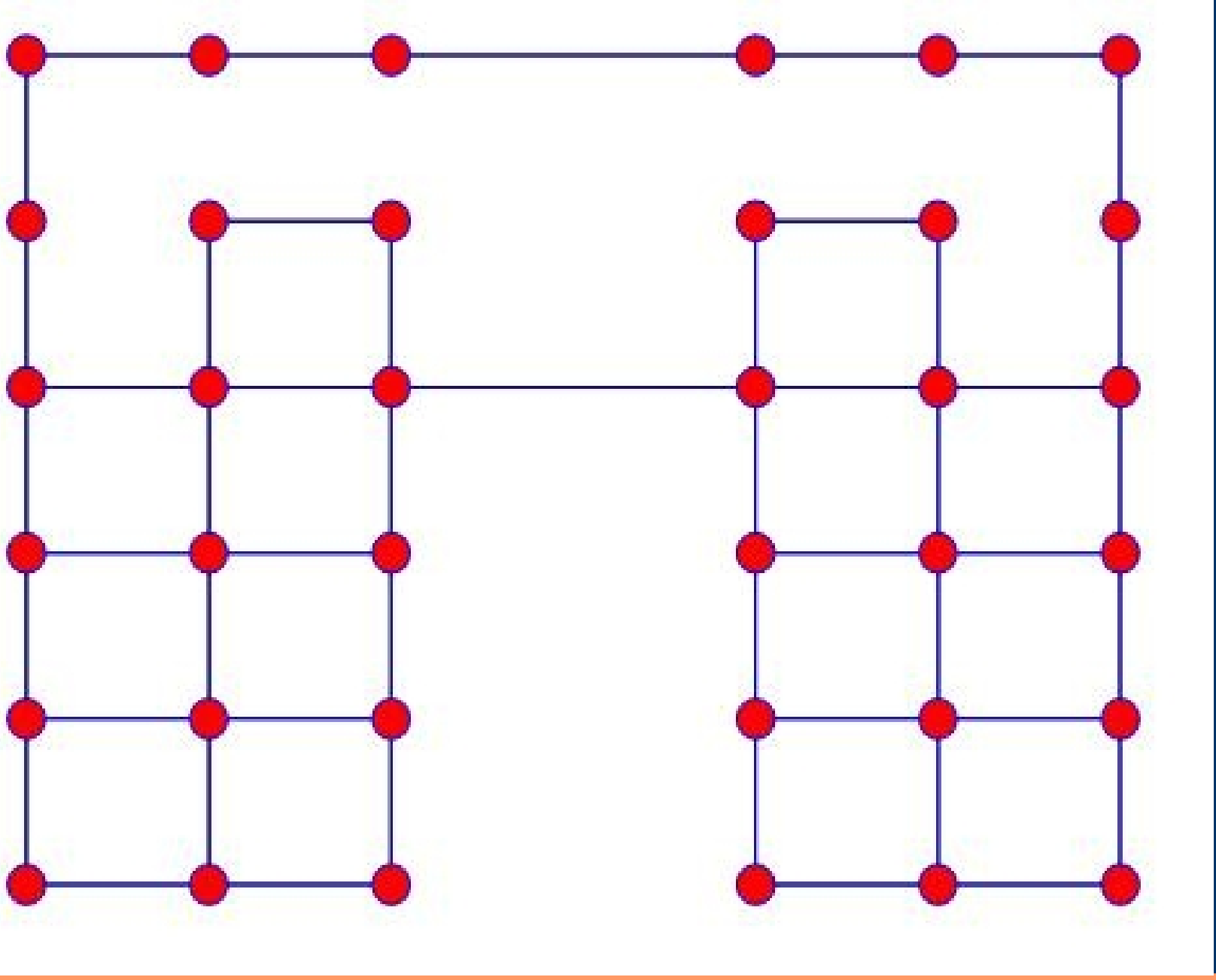
The Big Question:

How do you efficiently route packets of information through the network as quickly as possible?

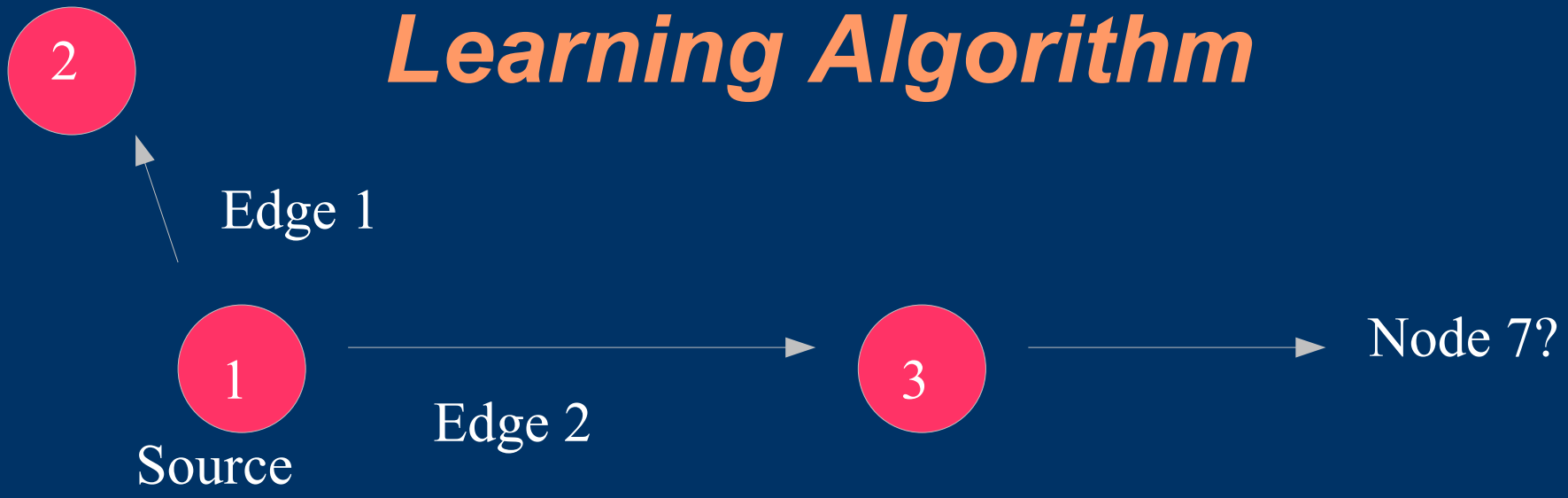
Background

- Current routing algorithms – shortest path in terms of number of “hops” through nodes
- Link-State algorithms – know global information about network graph (e.g. Dijkstra)
- Distance-Vector algorithms – only knows information about neighbors, distributed information exchange (e.g. Bellman-Ford)

The Problem...



Learning Algorithm



Q-Table stores estimated time for packet to reach destination

Columns represent each node

Rows represent each edge

0	3	5	1	9	10	13
0	7	3	9	6	6	**9**

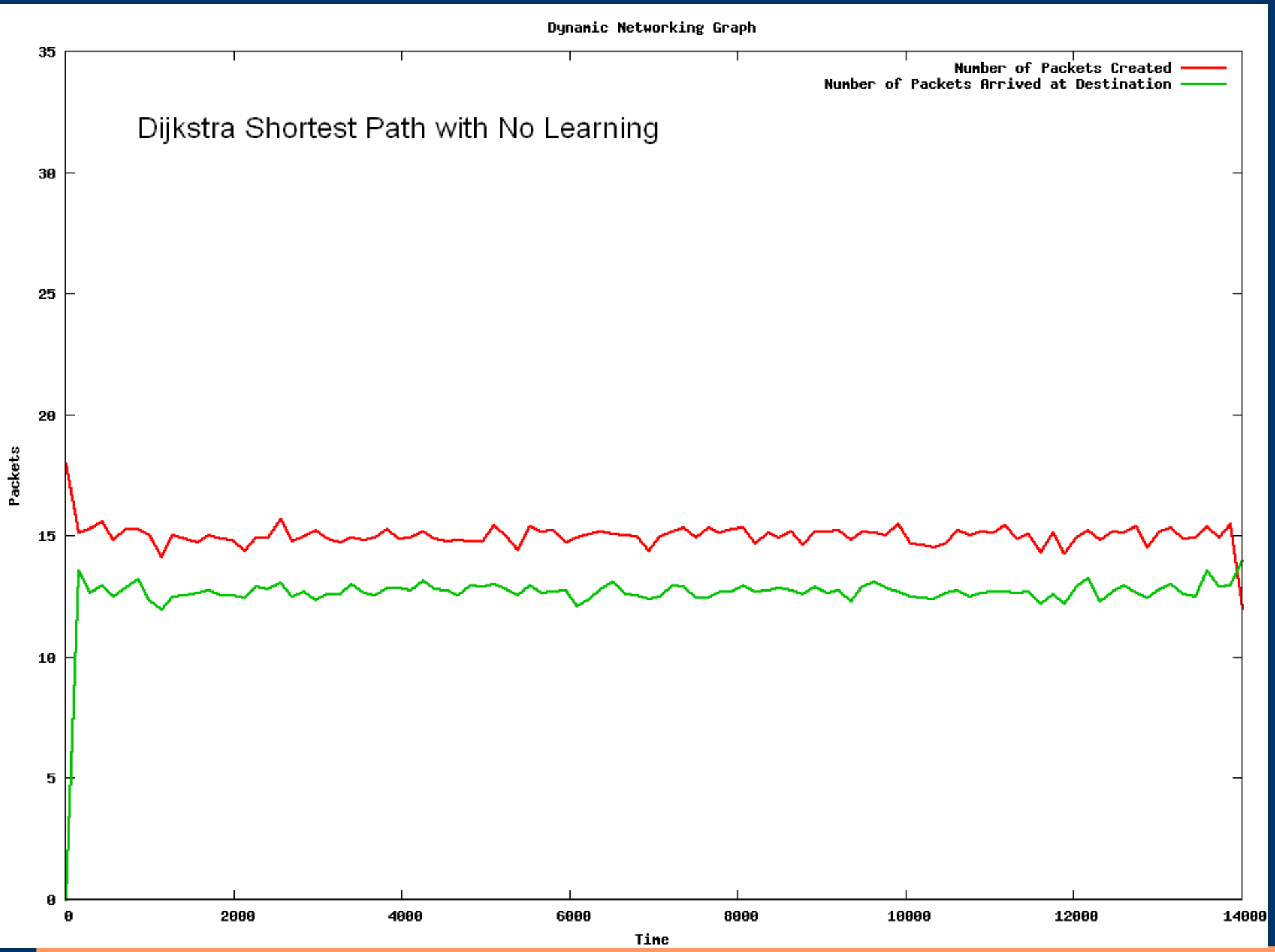
Packet gets sent!

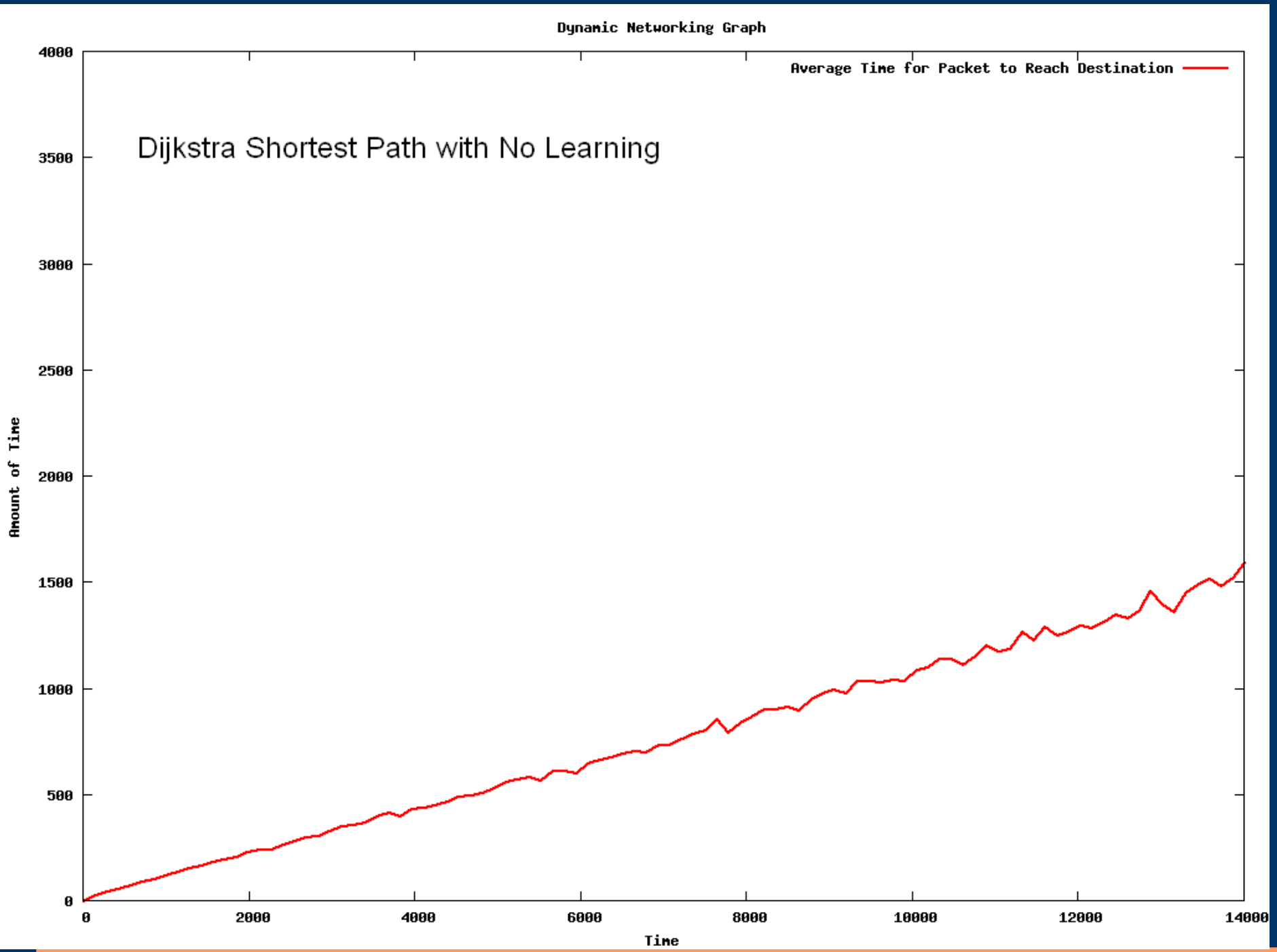
Learning Algorithm (cont.)

Node 1 gets back the q-table estimate from Node 3

New Q-value = L (q + s + t – Old Value)

L = learning rate (0.5 in our runs)
q = time spent in queue (buffer) in Node 1
s = time in transmission between nodes
t = new estimate from Node 3


Dynamic Networking Graph
Number of Packets Created
Number of Packets Arrived at Destination
Dijkstra Shortest Path with No Learning
Packets
Time
0
5
10
15
20
25
30
35
0
2000
4000
6000
8000
10000
12000
14000


Dynamic Networking Graph
Average Time for Packet to Reach Destination
Dijkstra Shortest Path with No Learning
Amount of Time
Time
0
500
1000
1500
2000
2500
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3500
4000
0
2000
4000
6000
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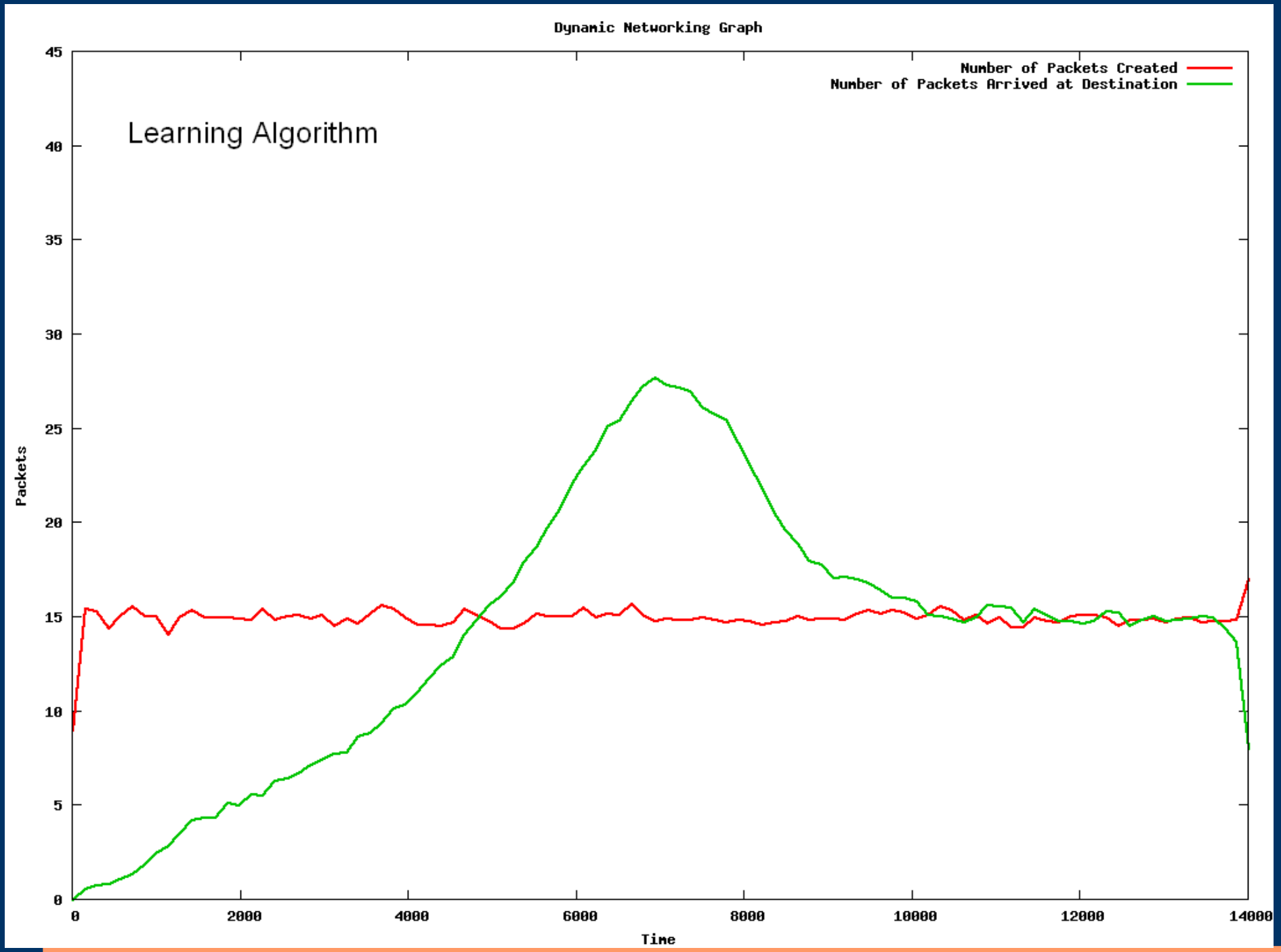
Dynamic Networking Graph
Learning Algorithm
Number of Packets Created
Number of Packets Arrived at Destination
Packets
Time
0
5
10
15
20
25
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35
40
45
0
2000
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8000
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12000
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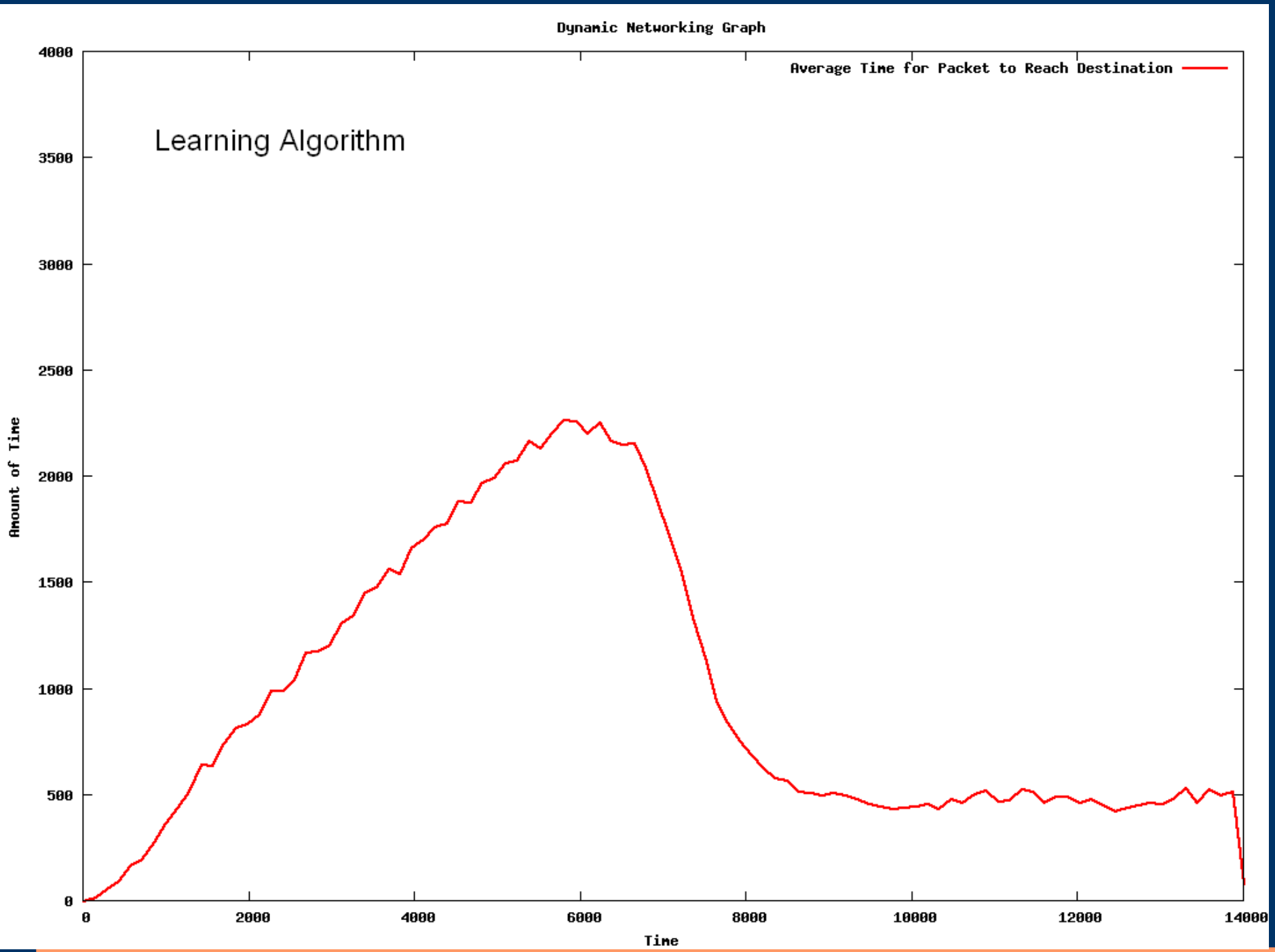
Dynamic Networking Graph
Average Time for Packet to Reach Destination
Learning Algorithm
Amount of Time
Time
4000
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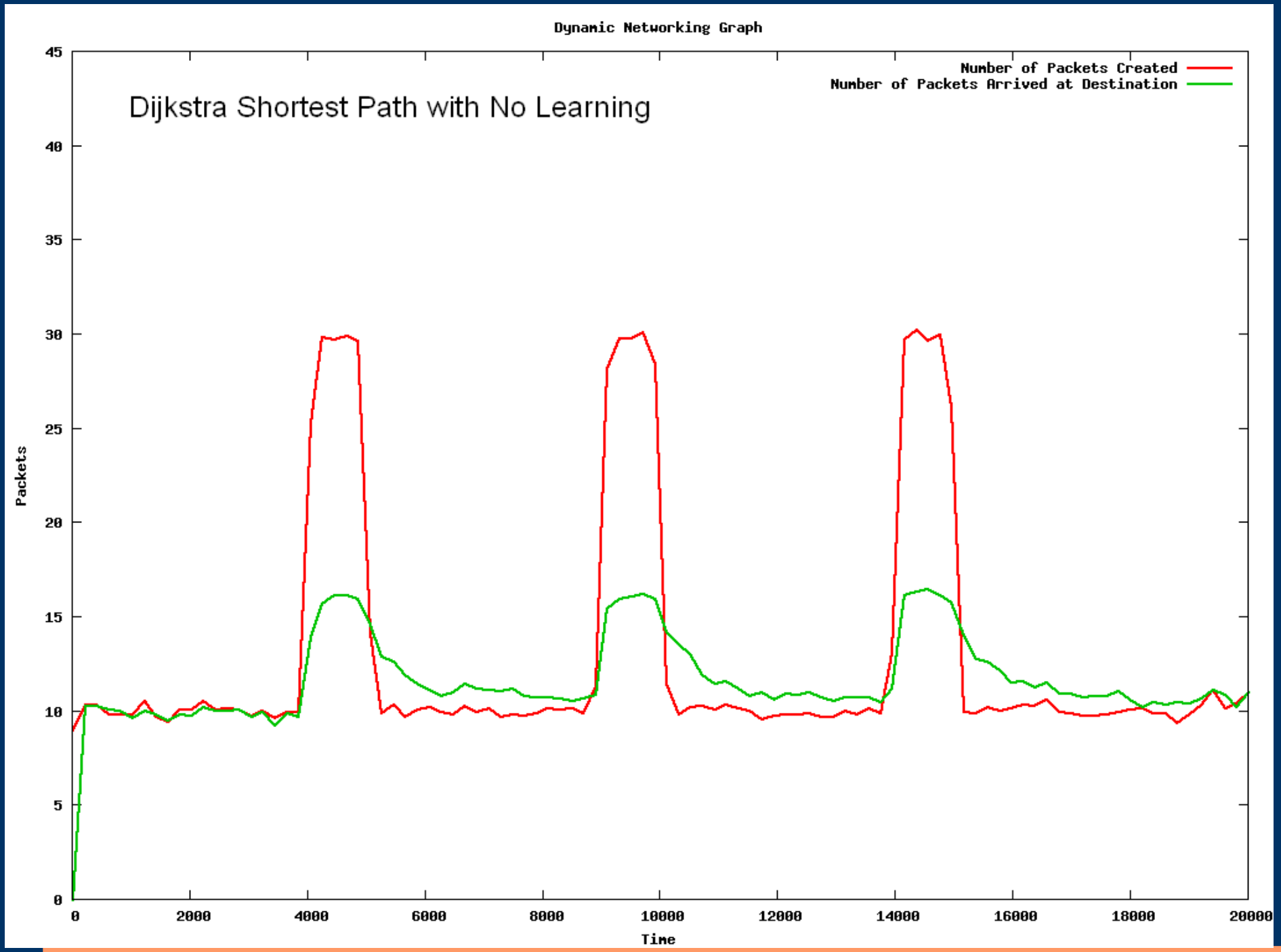
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Dijkstra Shortest Path with No Learning
Number of Packets Created
Number of Packets Arrived at Destination
Packets
Time
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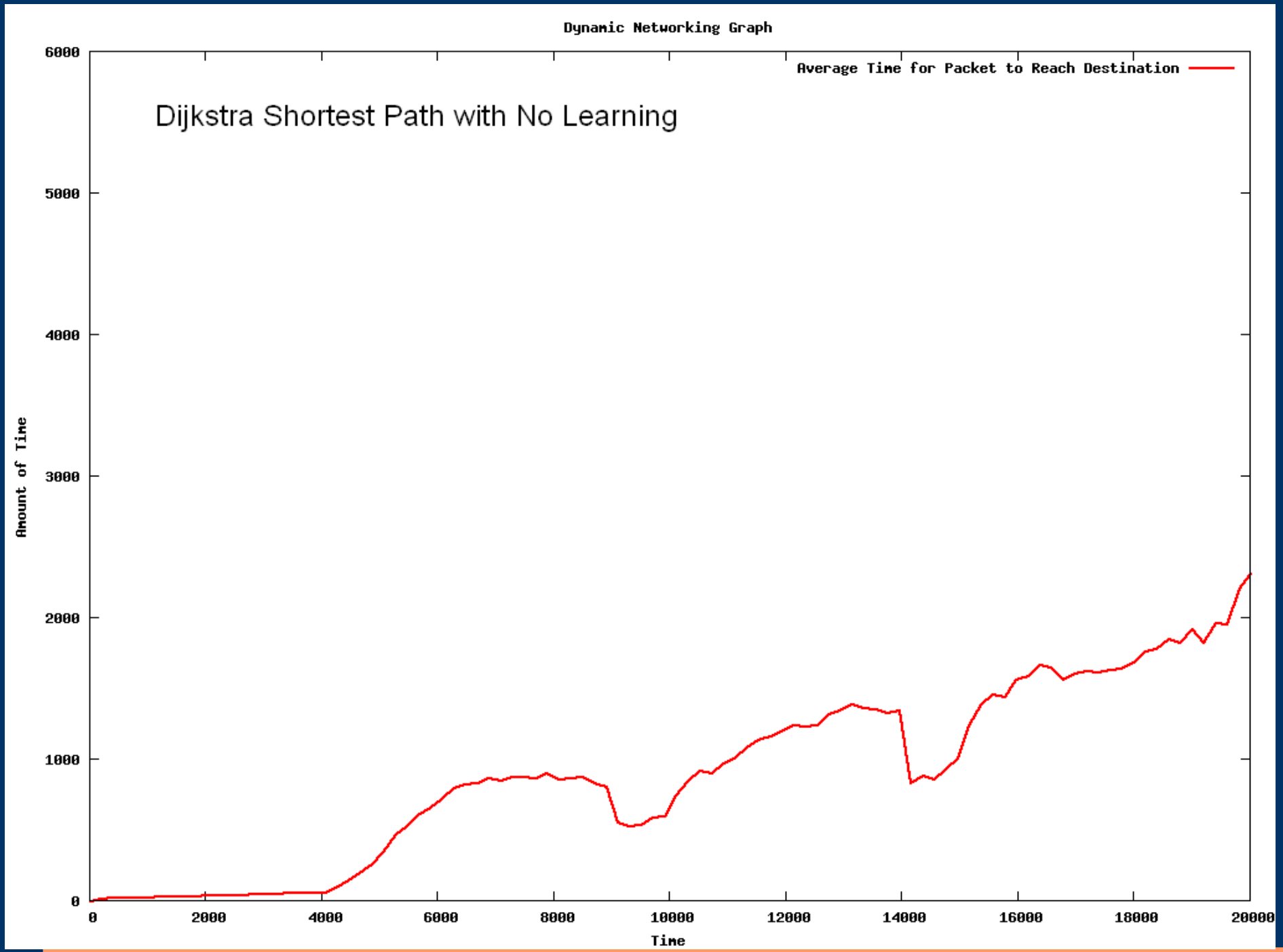
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Dijkstra Shortest Path with No Learning
Amount of Time
Time
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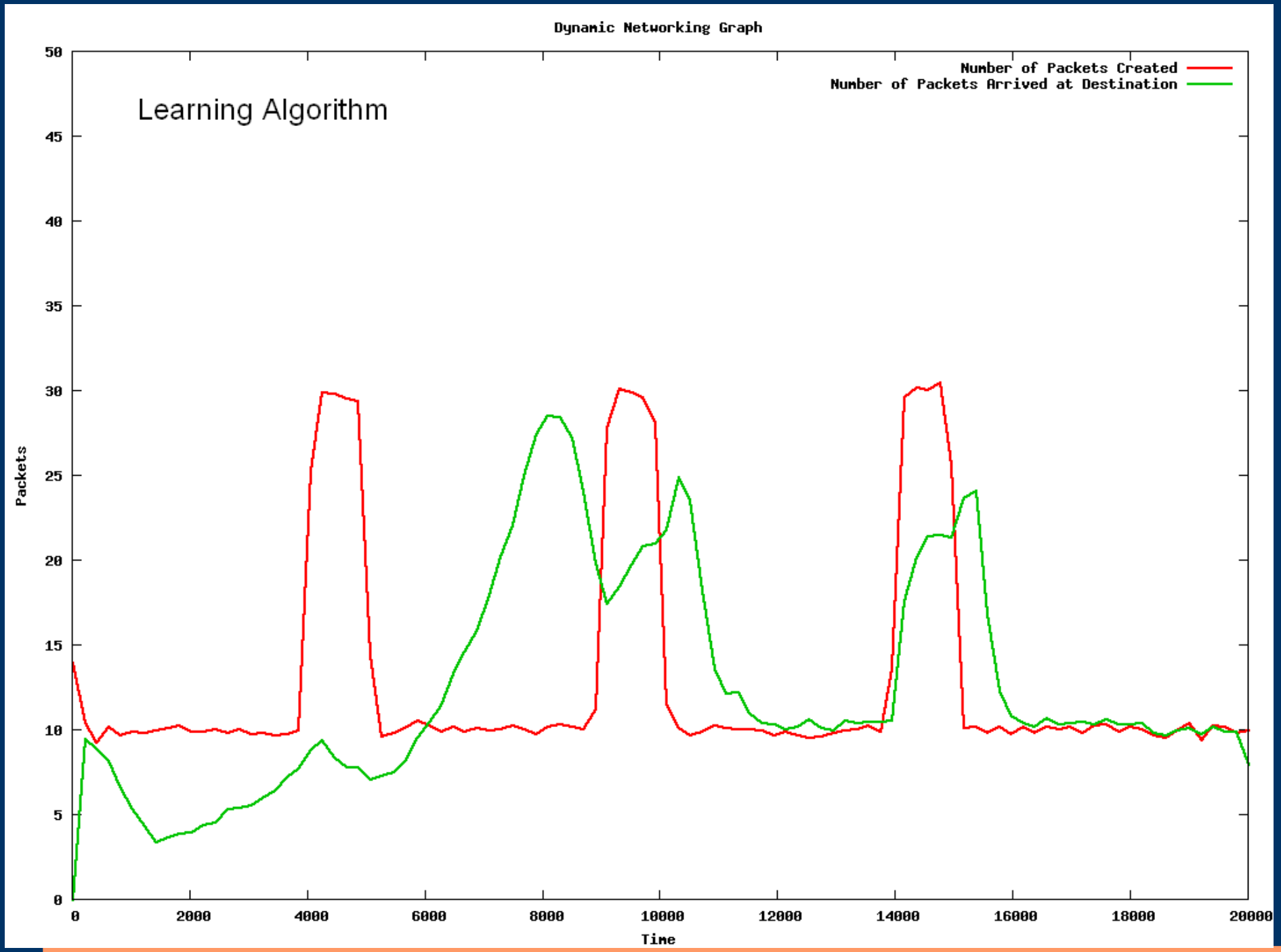
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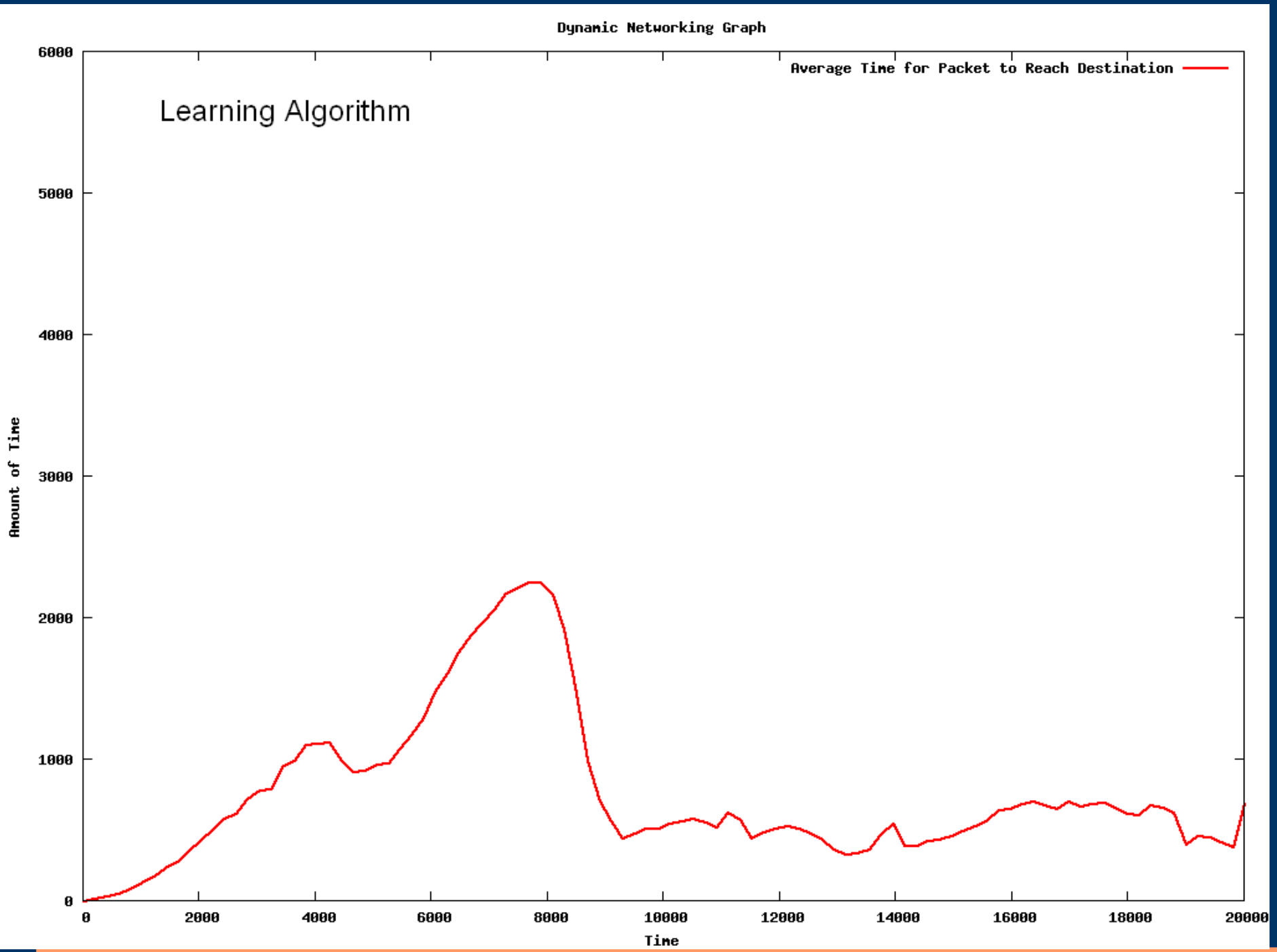
Dynamic Networking Graph
Average Time for Packet to Reach Destination
Learning Algorithm
Amount of Time
Time
6000
5000
4000
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2000
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0
2000
4000
6000
8000
10000
12000
14000
16000
18000
20000

Advantages of Learning Algorithm

- Fast in dynamic changing networks
- Works well under fairly high load
- Performs better than current shortest-path algorithm

Disadvantages of Learning Algorithm

- Requires storage of full network table, thus probably will not scale well
- Initial learning very costly

Future Work

- Change learning rate based on network load (exploration versus exploitation)
- Run on real network or simulator
- Distributed storage of Q-Tables
- Examine caching technology or P2P protocols like Bittorrent

Thanks To:

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- Dr. Amy McGovern
- Dennis, Will, and super-coder Laura

Thanks! Are there any questions?