Project 2 Gossip Protocol

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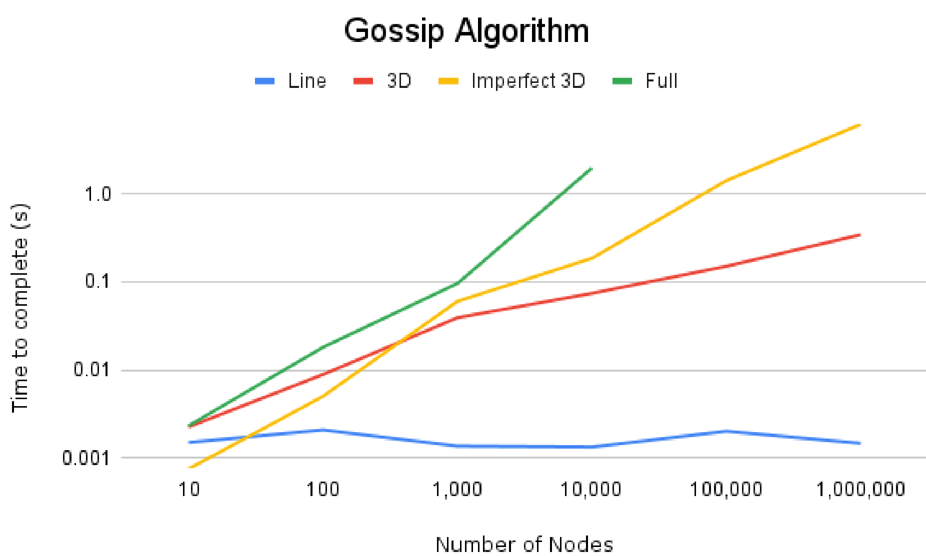
1 Gossip

The following table and graph shows the average time to convergence for different topologies under the Gossip protocol. The number of nodes simulated in the network is the first entry in the column after the Topology column:

Topology	10	100	1,000	10,000	100,000	1,000,000
Line	0.0015	0.0021	0.0014	0.0013	0.0020	0.0015
3-D	0.0023	0.0089	0.0392	0.0740	0.1504	0.3436
Imp-3D	0.0008	0.0050	0.0601	0.1854	1.4135	6.1576
Full	0.0023	0.0181	0.0960	1.9621	—	—

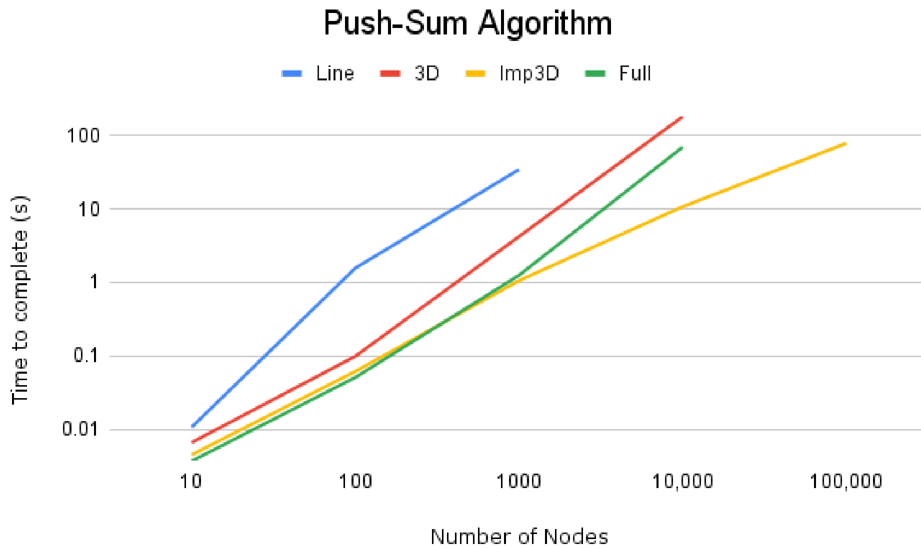


In the Gossip algorithm, we saw a lot more influence on the type of topology and the time it took for one node to have received a message 10 times. The line topology showed very little change with the addition of more nodes, as messages were often passed back to the adjacent neighbor which had just sent the message in the first place. Following this train of thought, the next fastest converging topology was 3-D as the probability of message passing reaching the same node was higher. With the introduction of a random neighbor in the imperfect 3-D topology, we see that the passing of a message to a far-away random neighbor would decrease the convergence time as the number of nodes grows larger. Finally, the Full topology shows the most required time to complete as the number of nodes increases.

2 Push-Sum

The following table and graph shows the average time to convergence for different topologies under the Push-Sum protocol. The number of nodes simulated in the network is the first entry in the column after the Topology column:

Topology	10	100	1,000	10,000	100,000
Line	0.0109	1.5704	34.0450	dnf	dnf
3-D	0.0068	0.0999	4.1992	177.603	dnf
Imp-3D	0.0046	0.0623	1.0605	10.6692	77.344
Full	0.0038	0.0516	1.2523	68.538	memory dnf



Compared to the Gossip Algorithm Graph, we notice initially that the vertical axis range for the time to complete is far larger. This is due to the termination protocol of the Push-Sum algorithm, which compared to the Gossip termination condition,is much more comprehensive over the entire network's receiving the message.

Other problems that we ran into in terms of running the simulations would include the sheer amount of time required for networks with 100,000 nodes or more, in which only the impartial 3D topology was able to terminate within reasonable time. Additionally, the line topology simulations would occasionally converge with outliers that were about a tenth of the average time. This outlier in convergence time samples was only seen in the line topology for the push-sum algorithm, with other times being consistent. Also, for a topology of over 1000 nodes, the line-topology would simply not terminate (within a reasonable time), while the other topologies were still able to converge.

The type of topology had less of an impact on the trends for the push-sum algorithm completion time, and as seen by the trends, the impartial 3-D topology was the fastest, clearly shown as it was the only one able to terminate within a reasonable time in a network over 100,000 nodes. Also, we noticed that the ratio that was returned upon convergence was always around one half of the number of nodes in the network regardless of the topology, showing that the protocol traversed the network more extensively than the gossip protocol did.

3 Conclusions

Although the Gossip-based message passing simulations terminated faster than the Push-Sum protocols in larger networks, I believe this doesn't show a fair comparison due to the nature of the protocols being compared. For example, in the line algorithm the push sum would converge very quickly for nearly all sizes of networks, but a majority of the nodes in the network would never receive a single message. On the other hand the Push-Sum would take extensively long as it traversed very slowly (as the topology is not very efficient for message passing to random neighbors) through the line topology, but more nodes would receive messages.