Project Report

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Group members:

1. Satish Erappa, UFID: 85975669, hsitas444@ufl.edu

2. Vikaasa Ramdas Thandu Venkat Kumar, UFID: 44005810, vikaasa@ufl.edu

Implementation Details:

We have assumed that the convergence of the Gossip algorithm occurs when 90% of the nodes in the network have heard the rumor. We terminate the algorithm after convergence and measure the time taken to run the algorithm. In our implementation, when a particular node receives a rumor 10 times, it stops transmitting the rumor.

For Push-Sum algorithm, we assume that the convergence of a node happens when its average estimate (S/W value) does not change more than 10^{-10} in three consecutive message receive rounds. We terminate the algorithm after all the nodes in the network achieve convergence. We do this because on a large network, if we terminate the algorithm after the first node converges, the average estimate of the other nodes in the network will differ from the average estimate of the converged node. Moreover, the average estimate of the converged node varied from the actual average by a significant factor for large network, if we terminate the algorithm after the first node converges.

Graphs plotting convergence time vs size of the network for different topologies and algorithms:

Gossip Algorithm:

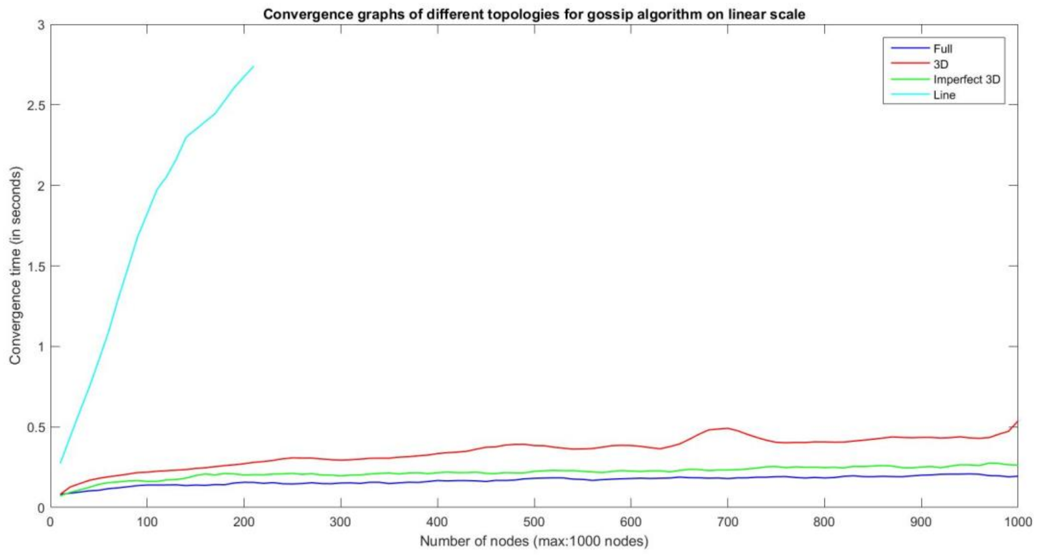

Figure 1: Convergence graphs of different topologies for gossip algorithm on linear scale

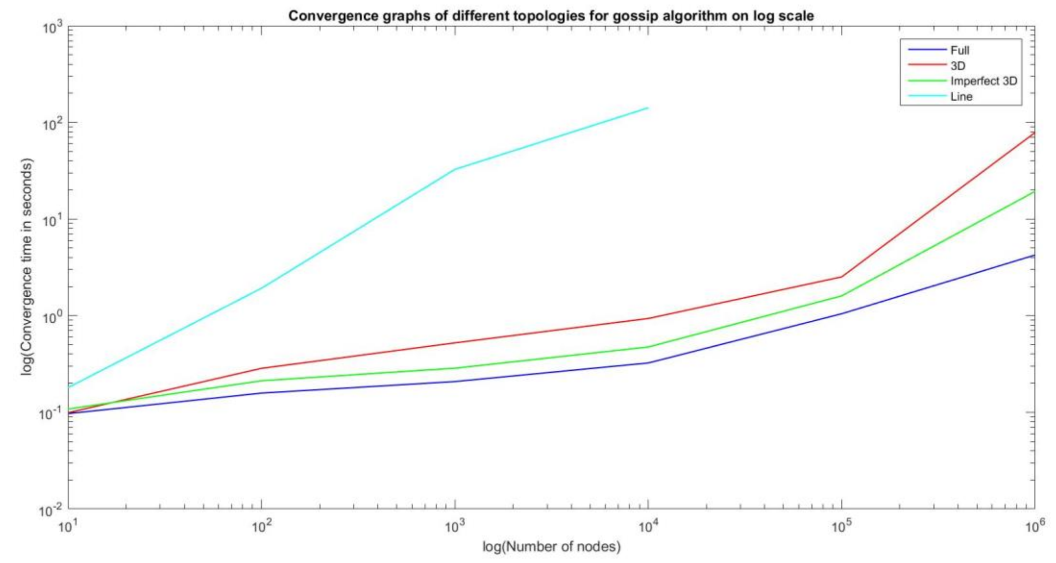

Figure 2: Convergence graphs of different topologies for gossip algorithm on log scale for large network

The two graphs above plot the convergence time vs the size of the network for all topologies using the gossip algorithm. In the first graph (Figure 1), we have restricted the number of nodes to 1000 and bounded the convergence time to 3 seconds, to analyze the convergence time on smaller network sizes up to 1000 nodes. The second graph (Figure 2) shows the convergence time vs network size on large network size up to one million nodes in log scale on both axes.

Push-Sum Algorithm:

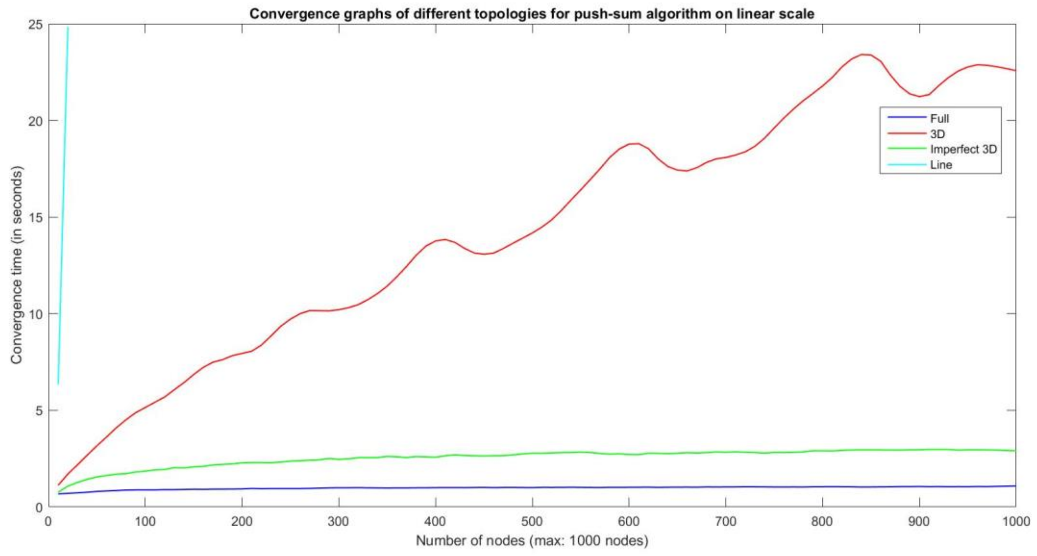

Figure 3: Convergence graphs of different topologies for push-sum algorithm

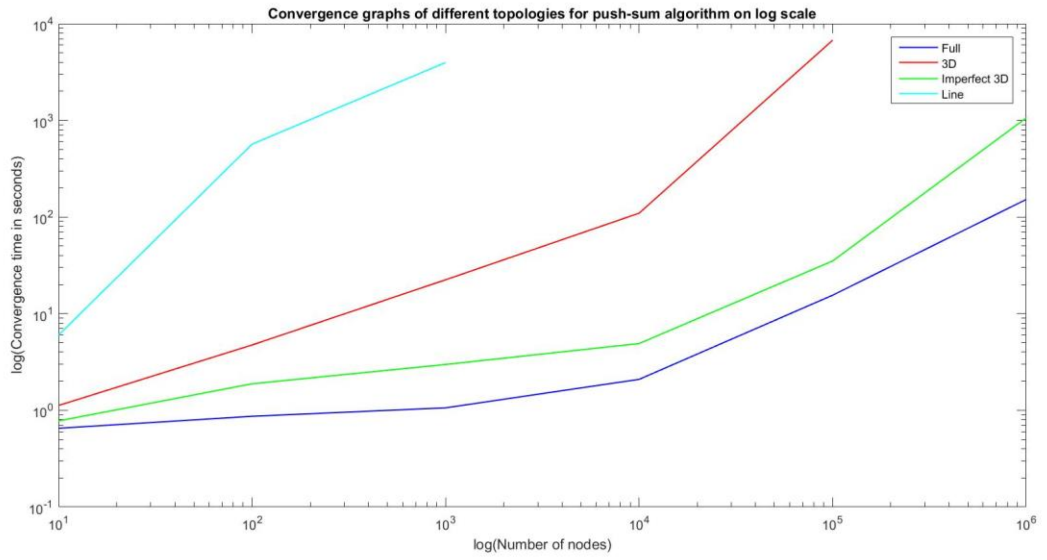

Figure 4: Convergence graphs of different topologies for push-sum algorithm on log scale for large network size

The two graphs Figure 3 and Figure 4, plot the convergence time vs the size of the network for all topologies for the push-sum algorithm. We follow the same procedure of bounding the convergence time (to 50 seconds) and restricting the number of nodes for the first graph(Figure3) in order to better analyze the data on smaller network sizes. While, the second graph (Figure 4) plots the data up to one million nodes in log scale on both axes.

Analysis:

The convergence time for all the topologies except line topology appears to be a logarithmic curve of the number of nodes in the network, with full topology having the least convergence time for smaller network sizes (up to 1000 nodes). However, when the network size is increased beyond ten thousand nodes, the convergence time tends to increase exponentially with number of nodes.

Line topology has the maximum convergence time when compared to all other topologies. Even on smaller network sizes, the convergence time of line topology appears to increase exponentially with number of nodes.

For both gossip and push-sum algorithms, the graphs show similar characteristics. This is because push-sum can be thought of an extension of the gossip algorithm, where the nodes should receive multiple messages for convergence.

Interesting Observations:

1. For imperfect 3d topology just by adding one random neighbor the convergence time for both the algorithms is reduced by a significant factor.

2. When we ran the push-sum algorithm for a large sized network of 1 million nodes, we observed that the computed average by the algorithm varied from actual average by a significant factor. This trend was observed in imperfect 3D topology for the network size of one million nodes and in 3D topology for hundred thousand nodes.