

Distributed Operating Systems Principle: Project - 2

Submitted By:

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PROBLEM DEFINITION:

Gossip-type algorithms can be used both for group communication and for aggregate computation. The objective of this project is to use a simulator based on F# actors to determine the convergence of such algorithms. Because F# actors are entirely asynchronous, the type of Gossip implemented is known as Asynchronous Gossip.

INTRODUCTION:

The project folder has five files:

- ReadMe.pdf
- Gossip: This file has code related to the gossip simulator project. (names)
- Report.pdf
- Bonus: This file has code related to the bonus part of the project
- Bonus_report.pdf

REQUIREMENTS:

The following need to be installed to run the project:

- F#
- Visual Studio Code
- Ionide

BUILD PROCESS:

- Unzip the compressed file using `unzip filename.zip`
- Run the following command,
“`dotnet fsi --langversion: preview projname.fsx nodeNum topology protocol`”
where `nodeNum` is the number of nodes and `topology` is a type of topology (Full, line, 3D, imperfect 3D).
Values of the protocol can be either Push Sum or Gossip.

TOPOLOGIES IMPLEMENTED:

•Line topology: In Line Topology, each actor has only 2 neighbors (one left and one right). For gossip protocol and push-sum algorithm, we select one random node from its list of neighbors and pass on the gossip. For a large number of nodes, the network doesn't converge, and we were able to test it till 20000 nodes.

•Full topology: In this topology, every actor is surrounded by other actors. That is, every actor can talk directly to any other actor. For Gossip Protocol, Each actor will randomly select a node from its list of neighbors and pass on the gossip. The same process will occur for the push-sum algorithm as well.

•3D topology: For gossip protocol and push-sum algorithm, we select one random node from its six (up, down, left, right, front, back) neighbors and pass on the gossip.

•Imperfect 3D Topology: For gossip protocol and push-sum algorithm, we select one random node from its six (up, down, left, right, front, back) neighbors and another random neighbor to pass on the gossip.

ALGORITHMS IMPLEMENTED

- Gossip Protocol Algorithm: In our implementation of the gossip protocol algorithm, we are assuming that the network converges when 100% of nodes have received the gossip at least 10 times. It can still receive messages, but it stops transmitting the messages.
- Push Sum Algorithm: In our implementation of the Push-Sum Algorithm, the network converges when 100% of the node's s/w ratio isn't changing even after three rounds of receiving a message i.e., if the s/w ratio does not change more than 10^{-10} in 3 consecutive rounds. Convergence is achieved if all nodes satisfy the above exit condition.

WHAT IS WORKING:

We can run any combination of line, full, 3D, and Imp3D with gossip or push-sum protocol. When all of the nodes in the Gossip protocol have converged, the protocol is said to be converged. When a node listens to the message for the tenth time, it is considered converged. The node stops sending the message to its neighbor after convergence. The total time for convergence is reported once the network has converged, i.e. all nodes have converged.

WHAT IS THE LARGEST NETWORK YOU MANAGED TO DEAL WITH FOR EACH TYPE OF TOPOLOGY AND ALGORITHM?

For each topology and algorithm, we've managed to solve a network with a maximum of 20k nodes. Convergence is not achieved for some topologies for more than 20k nodes.

INTERESTING FINDINGS:

For gossip Protocol and Push Sum Algorithm:

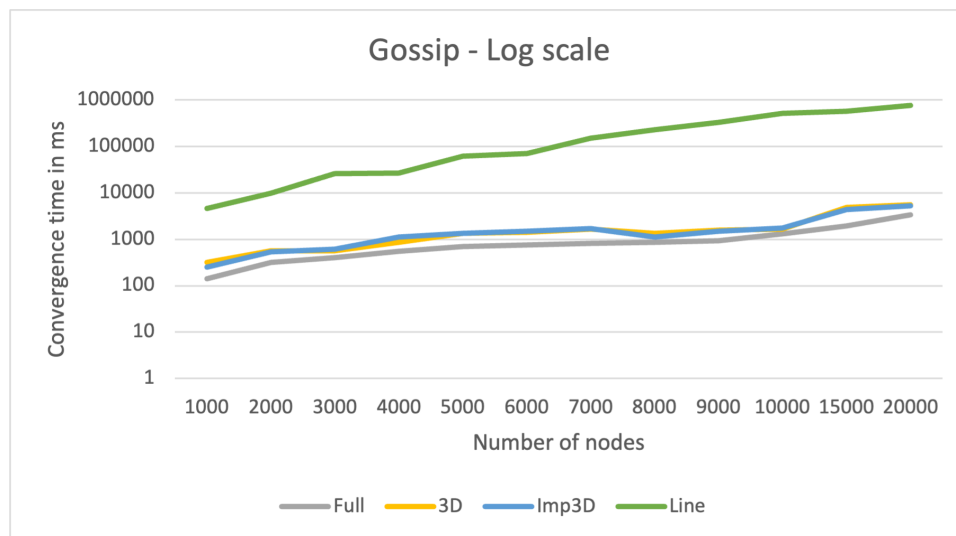
The best convergence time is for Full Network because the adjacency list has all the nodes except the node that it is transmitting. Since this node is connected to all other nodes, it is fastest to converge. The next best convergence time is for the Imperfect 3D network, because, the spread is huge, and it has 6 neighbors across the network. Since we are picking the node randomly, there is a possibility that the nodes are picked in a line fashion which is not spread across the network. Since Line topology has access only to two of its neighbors, it is the slowest to converge. Convergence time of Imperfect 3D and 3D fall in between Full and Line with imperfect 3D performing better than 3D.

The convergence times are in the following fashion.

Full < Imperfect 3D < 3D < Line

The converge times for Gossip are as follows.

Number of Nodes	Full	3D	Imp3D	Line
1000	141	316	250	4569
2000	320	560	541	9841
3000	396	563	608	25767
4000	545	861	1114	26652
5000	698	1320	1347	60647
6000	753	1419	1482	69490
7000	815	1641	1687	149272
8000	852	1324	1125	228037
9000	920	1549	1489	326127
10000	1306	1658	1752	513216
15000	1937	4843	4317	571813
20000	3341	5550	5280	756854



The converge times for Push Sum are as follows.

Number of Nodes	Full	3D	Imp3D	Line
1000	228	3841	312	35381
2000	531	9237	1518	47612
3000	874	19621	2184	125123
4000	1243	32561	2853	141237
5000	1632	48461	3711	224036
6000	1755	55311	4534	321489
7000	2051	72141	4847	541022
8000	2332	106022	5122	623175
9000	2381	127643	7113	905642
10000	2657	141812	8342	838234
15000	2814	238123	9912	913345
20000	4548	351272	11653	954231

