# Project 2 Report

Gossip Simulator:

Gossip algorithms can be used both for group communication and for aggregate computation. The goal of this project is to determine the convergence of such algorithms through a simulator based on actors written in F# Akka.Net. Since actors are fully asynchronous, the Gossip implemented is the so-called Asynchronous Gossip.

Network Topologies:

The Network topologies used in Gossip and Push-sum are,

Full network: In full network each actor has all other actors in the network as its neighbors.

Line: In line topology each actor has only two neighbors unless you it is the first or last actor. The first actor has only one neighbor, it is right to it and the last actor has only one neighbor to the left.

3D Grid: The actor forms a 3D grid, and each actor can only talk to its adjacent grid neighbors.

Imperfect 3D Grid: It is similar to 3D grid except that each actor has an additional neighbor that is selected randomly from the entire grid.

Architecture:

- Initially the number of nodes in the network, the topology and the algorithm are taken from the command line.
- The boss actor takes the topology and initializes an actor pool with the desired number of actors.
- It then initializes the child actors (actors in the actor pool) with the neighbors depending on the topology.
- Next it selects a random actor from the actor pool and sends a message to start gossip.
- The actor upon receiving message from the boss selects a random actor from its neighbor list and spreads the rumor.
- Next a scheduled actor is activated such that it selects a random actor that is not converged and sends it the rumor message ensuring that the transmission does not cut off.
- If an actor receives 10 rumors it is converged. The time taken for all the actors to converge is given to the user.

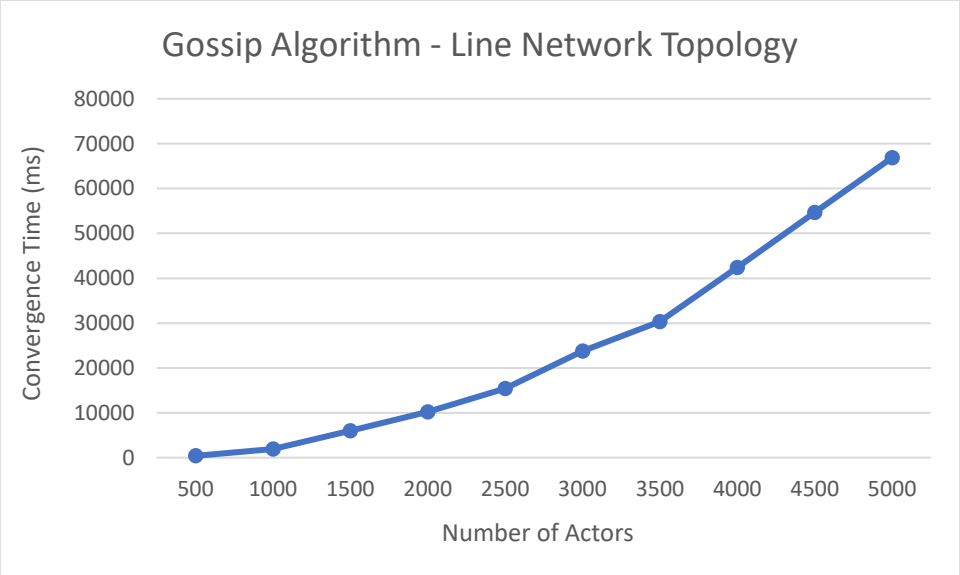
Commands to run:

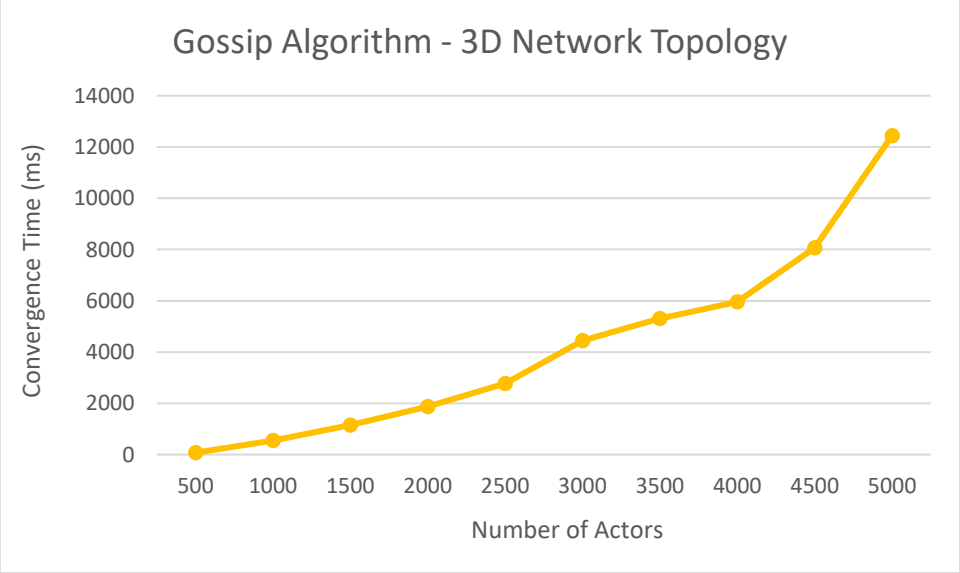
dotnet fsi project2.fsx numberOfNodes topology “gossip”

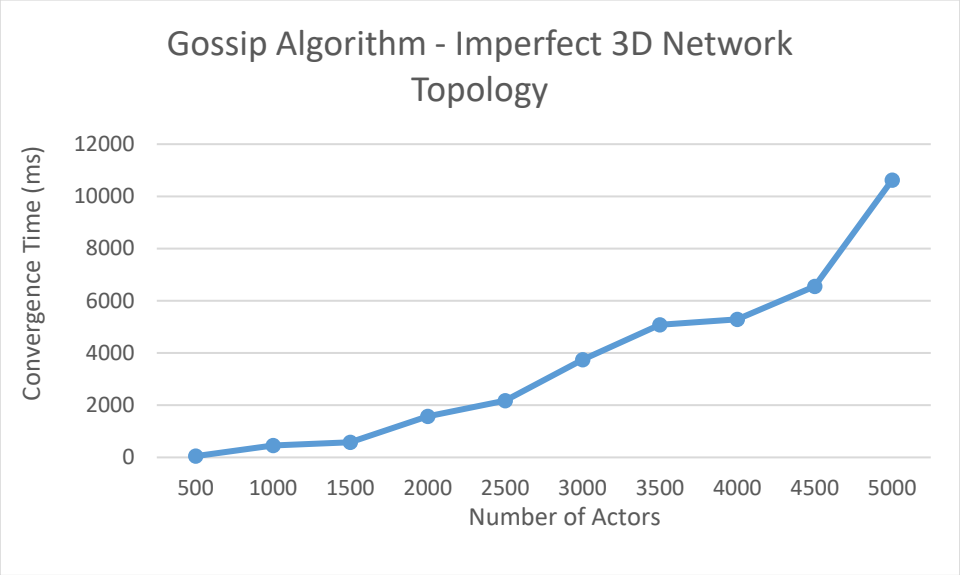
Observations:

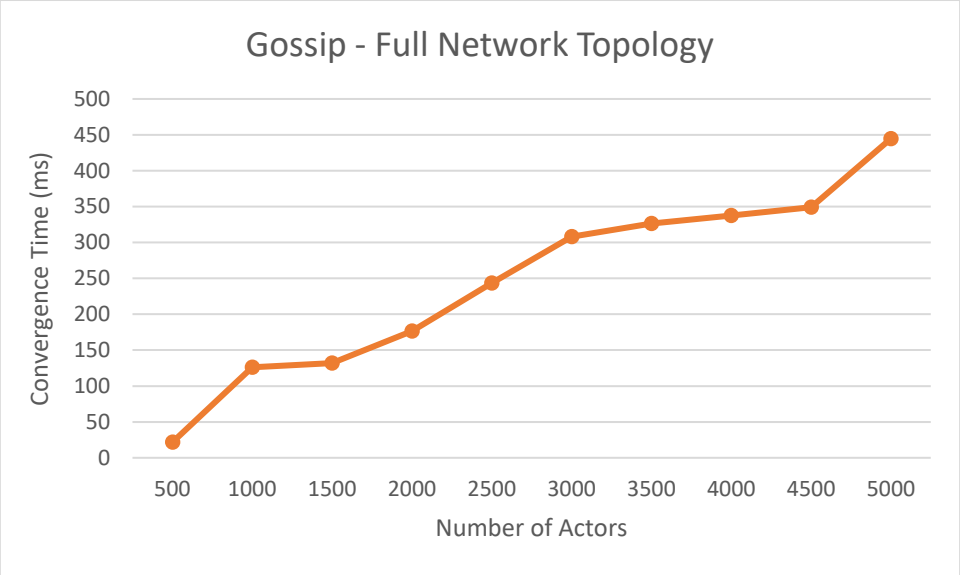
- By plotting graphs with convergence time against number of actors we have observed that the convergence time is least in the Full network topology
- The convergence time is highest in Line topology as it has only two neighbors and it takes extremely high time for the message to traverse through the entire network
- The imperfect 3D network has the lowest convergence time after the full network. It is faster than 3D because it has an additional neihbor

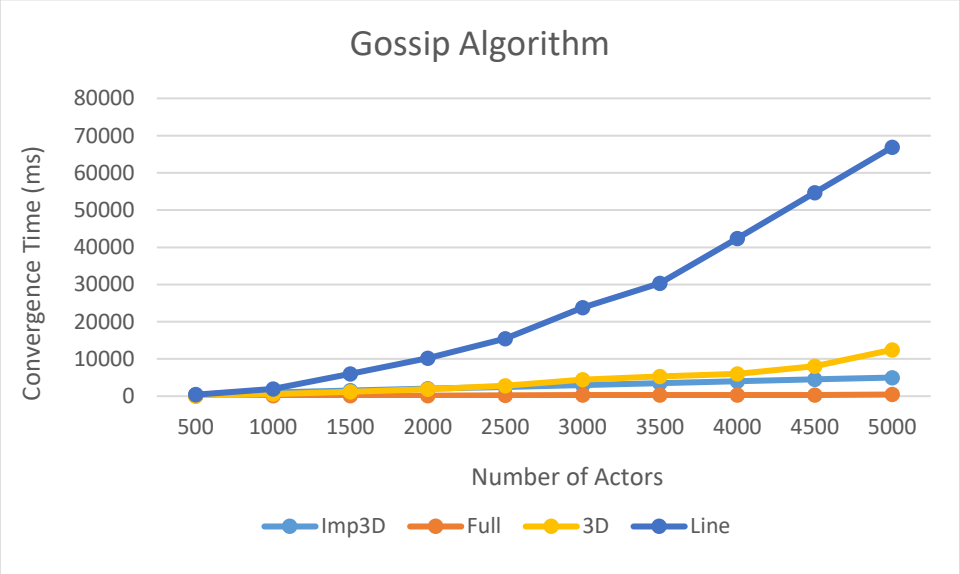
- It is observed that as the number of neighbors increase the convergence time decreases.
- The convergence times of topologies in increasing order is, Full Network, imperfect 3D Network, 3D Network and Line Network.
- We observed that if any node falls in a loop it cannot connect with other nodes. By scheduling it we can make sure that even it is stuck its neighbors can get called.
- We implemented a scheduler actor which picks an random actor from the actor pool that is not yet converged and sends it the rumor. This way it can be ensured that the transmission of messages to an actor neighbors does not end.
- Below are the plots with number of nodes against convergence time for all the topologies with Gossip algorithm,




Gossip Algorithm - Imperfect 3D Network Topology
Convergence Time (ms)
12000
10000
8000
6000
4000
2000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Number of Actors


Gossip - Full Network Topology
Convergence Time (ms)
500
450
400
350
300
250
200
150
100
50
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Number of Actors


Gossip Algorithm
Convergence Time (ms)
80000
70000
60000
50000
40000
30000
20000
10000
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Number of Actors
Imp3D
Full
3D
Line

Push-sum Simulator:

The push sum protocol is one of the gossip-based aggregation algorithms that is based on the interactive pairwise distribution of aggregated values among particulars entities.

Architecture:

- Each actor maintains two quantities s and w. Initially s is the actor number and w = 1.

- Messages sent and received are pairs of the form (s, w). A random actor is selected from the main process to start push-sum.

- Upon receiving, an actor should add received pair of (s, w) to its own corresponding values. Upon receive, each actor selects a random neighbor and sends it a message.

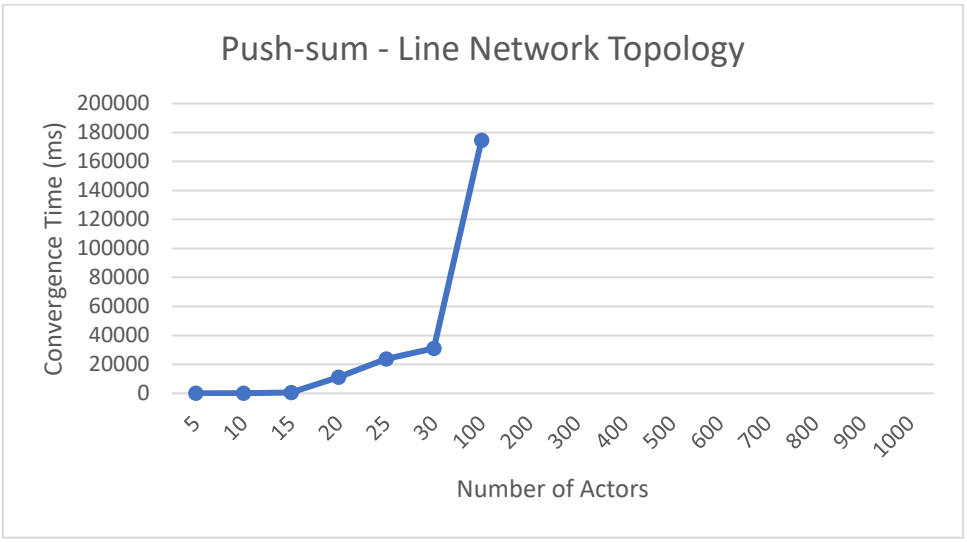
- When sending a message to another actor, half of s and w is kept by the sending actor and half is placed in the message.
- At any given moment of time, the sum estimate is s/w where s and w are the current values of an actor.
- If an actor's s/w ratio did not change more than 10 power -10 in 3 consecutive rounds the actor terminates. The time taken for all the actors to terminate is the convergence time

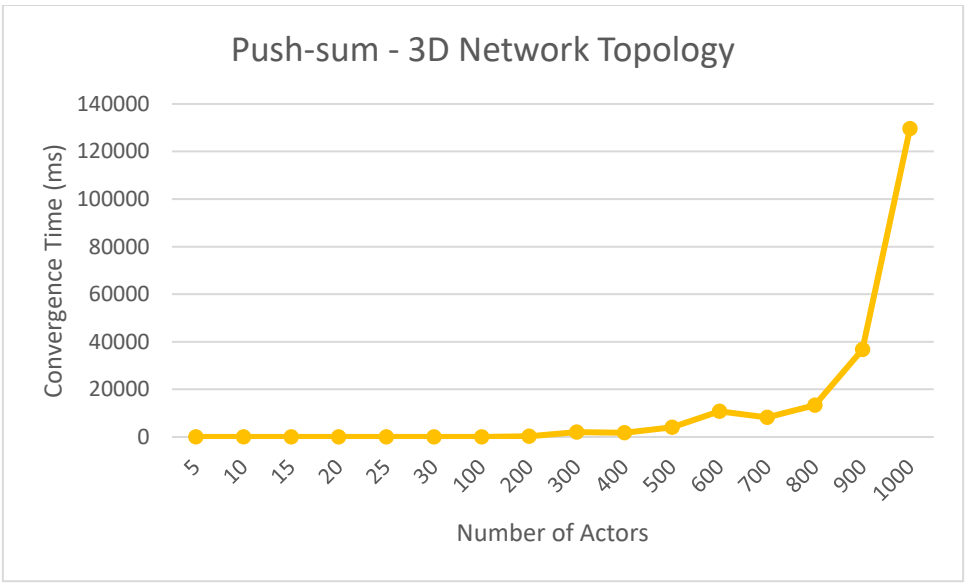
Commands to run:

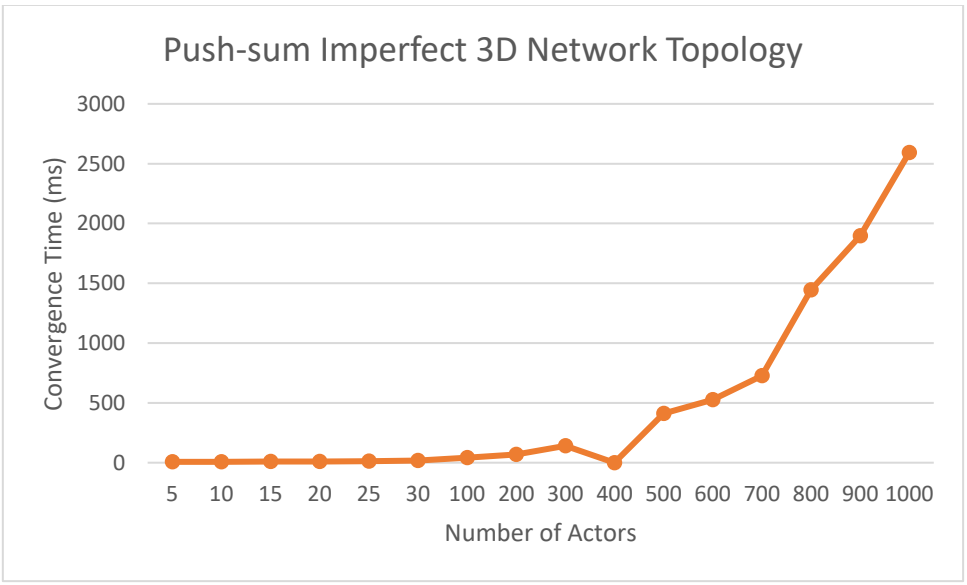
dotnet fsi project2.fsx numberOfNodes topology "pushsum"

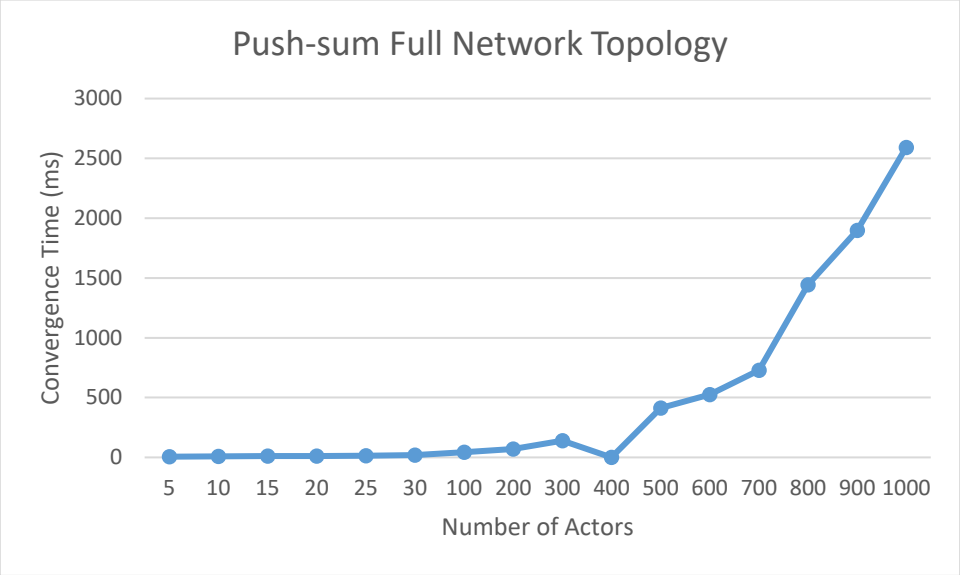
Observations:

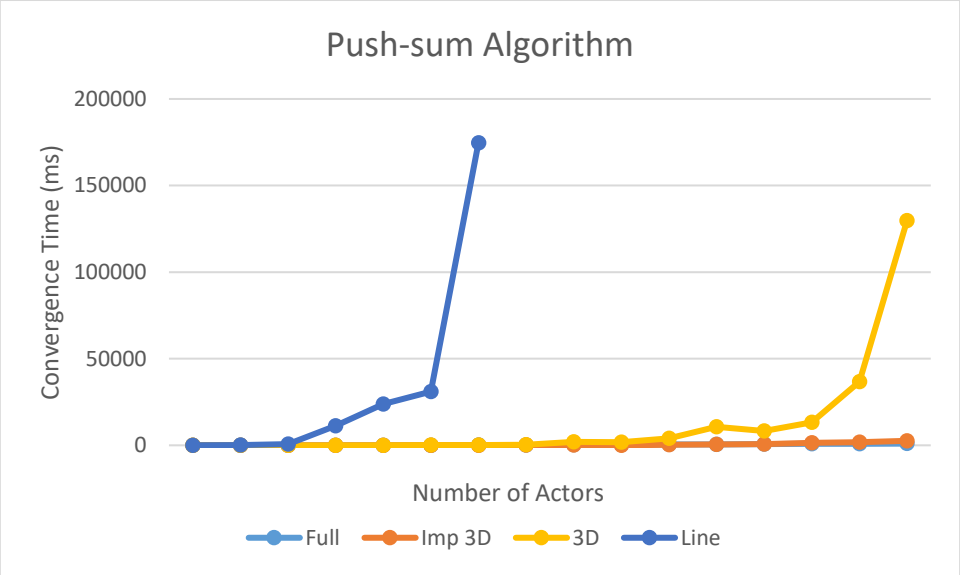
- The convergence time in the Push-sum is in the same order as in Gossip.
- The fastest is Full Network as it has the most neighbors followed by imperfect 3D network, 3D Network and line Network.
- The line network took lot of time for Convergence. As it has only two neighbors and it depends on the randomness of picking the neighbor, so the pushsum convergence takes a lot of time.
- Compared to gossip Push-sum took more time for convergence in all topologies.
- We were only able to achieve convergence of 40 actors in the line topology as it has the least neighbors.
- Below are the plots with number of nodes against convergence time for all the topologies using Push-sum algorithm,


Push-sum - Line Network Topology
Convergence Time (ms)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
5
10
15
20
25
30
100
200
300
400
500
600
700
800
900
1000
Number of Actors


Push-sum - 3D Network Topology
Convergence Time (ms)
140000
120000
100000
80000
60000
40000
20000
0
5
10
15
20
25
30
100
200
300
400
500
600
700
800
900
1000
Number of Actors


Push-sum Imperfect 3D Network Topology
Convergence Time (ms)
3000
2500
2000
1500
1000
500
0
5
10
15
20
25
30
100
200
300
400
500
600
700
800
900
1000
Number of Actors


Push-sum Full Network Topology
Convergence Time (ms)
3000
2500
2000
1500
1000
500
0
5 10 15 20 25 30 100 200 300 400 500 600 700 800 900 1000
Number of Actors


Push-sum Algorithm
Convergence Time (ms)
200000
150000
100000
50000
0
Number of Actors
Full
Imp 3D
3D
Line