PROJECT-2
DISTRIBUTED OPERATING SYSTEM PRINCIPLES
COP-5615

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Outline:

We have used a simulator based on actors written in Erlang to determine the convergence of algorithms based on group communication and for aggregate computation. We have used two algorithms-gossip for information propagation and push sum for sum computation.

Implementation

For gossip algorithm, according to the project statement, when a node hears a rumor 10 times, it is terminated (achieves convergence). As long as it has neighbor nodes that are still functional but unable to receive messages, the node will continue to transmit. Once convergence is reached by all nodes, the algorithm is finished. At this stage, the start time, end time, and overall convergence time are calculated.

For Push Sum algorithm, every node has an index and a weight. The node achieves convergence when the ratio of the index to the weight (S/W) does not change by more than 10^{-10} for three consecutive messages received. The values of S and W are halved each time a message is sent. The network should be terminated once all nodes in it achieve convergence.

Topologies used:

Line: Actors are organized in a line, with the exception of the first and last actors, each actor having just two neighbors.

Full Network: Every actor is a neighbor of every other actor in a full network.

2D Grid: The actors are arranged in a grid, with each actor having its diagonal and nearby neighbors.

Imperfect 3D: It adheres to the 2D Grid pattern and adds one random neighbor to the actors' list of neighbors.

Screenshots of the results

Largest Network: For all topologies and using both techniques, the largest network was 10000 nodes.

```
2> main:start().
Enter the number of Nodes: 10000
Enter the type of topology: full
Enter the algorithm to be used: gossip
Actors 10000, Topology "full", Algorithms "gossip"
Starting Gossip
creating neighbours for actors 10000  and Topology is "full"
```

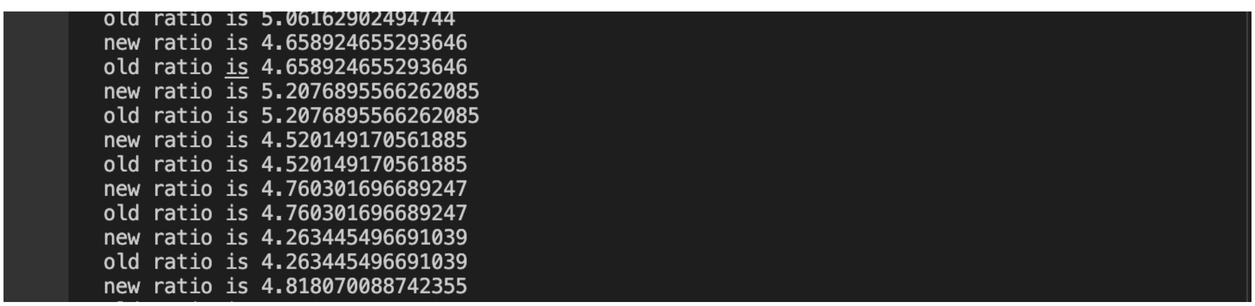
The input for the program is depicted in the accompanying figure (node count, topology and algorithm)

```
Starting Gossip
creating neighbours for actors 5  and Topology is "full"
Actor list is [<0.83.0>,<0.84.0>,<0.85.0>,<0.86.0>,<0.87.0>]
 and neighbor list is [[<0.84.0>,<0.85.0>,<0.86.0>,<0.87.0>],
                       [<0.83.0>,<0.85.0>,<0.86.0>,<0.87.0>],
                       [<0.83.0>,<0.84.0>,<0.86.0>,<0.87.0>],
                       [<0.83.0>,<0.84.0>,<0.85.0>,<0.87.0>],
                       [<0.83.0>,<0.84.0>,<0.85.0>,<0.86.0>]]
```

The above figure depicts the neighbor list for a full topology

```
Message from <0.97.0> to <0.96.0>
Convergence Attained for <0.92.0>
Message from <0.91.0> to <0.92.0>
Convergence Attained for <0.95.0>
Convergence Attained for <0.94.0>
Message from <0.94.0> to <0.95.0>
Convergence Attained for <0.93.0>
Message from <0.93.0> to <0.94.0>
Message from <0.94.0> to <0.93.0>
Convergence Attained for <0.90.0>
Convergence Attained for <0.88.0>
Message from <0.91.0> to <0.90.0>
Convergence Attained for <0.89.0>
Message from <0.89.0> to <0.88.0>
```

The above figure depicts algorithm convergence



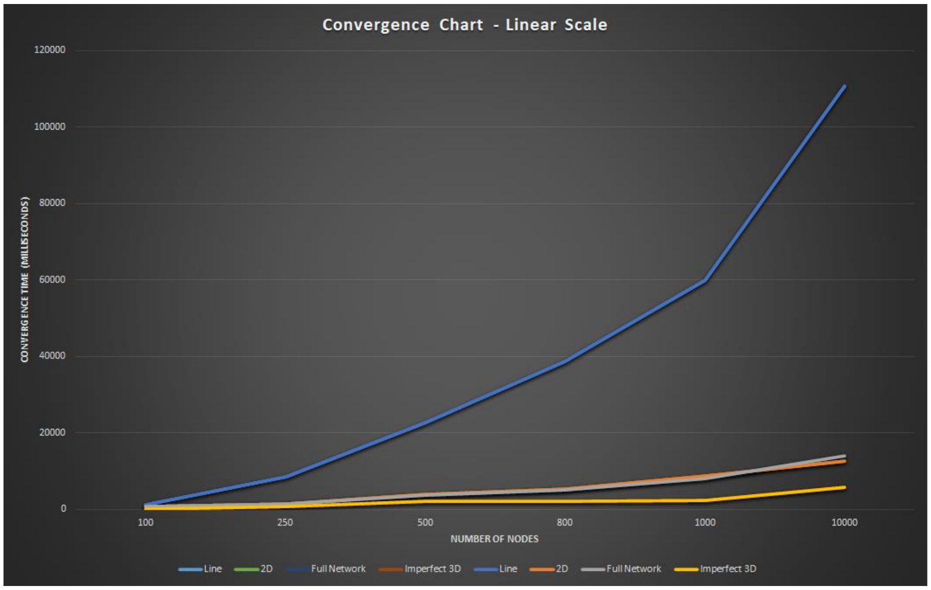
```
old ratio is 5.06162902494744
new ratio is 4.658924655293646
old ratio is 4.658924655293646
new ratio is 5.2076895566262085
old ratio is 5.2076895566262085
new ratio is 4.520149170561885
old ratio is 4.520149170561885
new ratio is 4.760301696689247
old ratio is 4.760301696689247
new ratio is 4.263445496691039
old ratio is 4.263445496691039
new ratio is 4.818070088742355
```

The above figure depicts convergence in the push-sum algorithm

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

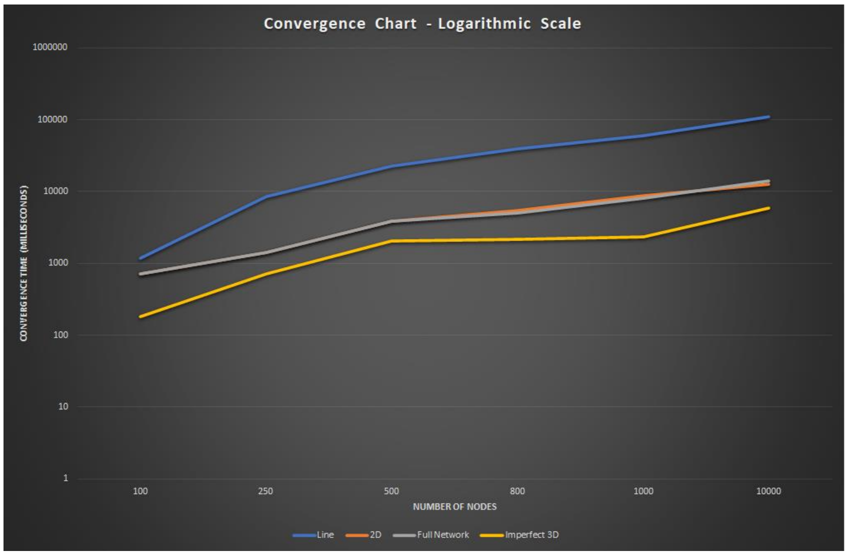
GOSSIP ALGORITHM:

PICTURE 1:



The graph above shows how the gossip algorithm's convergence times vary with the number of nodes for various topologies.

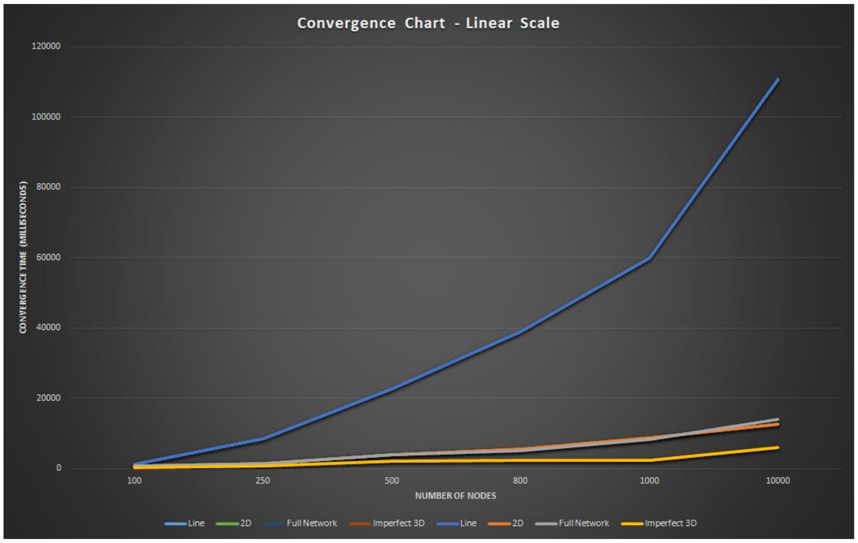
PICTURE 2:



The graph above shows the log of the gossip algorithm's convergence times as a function of the number of nodes for various topologies.

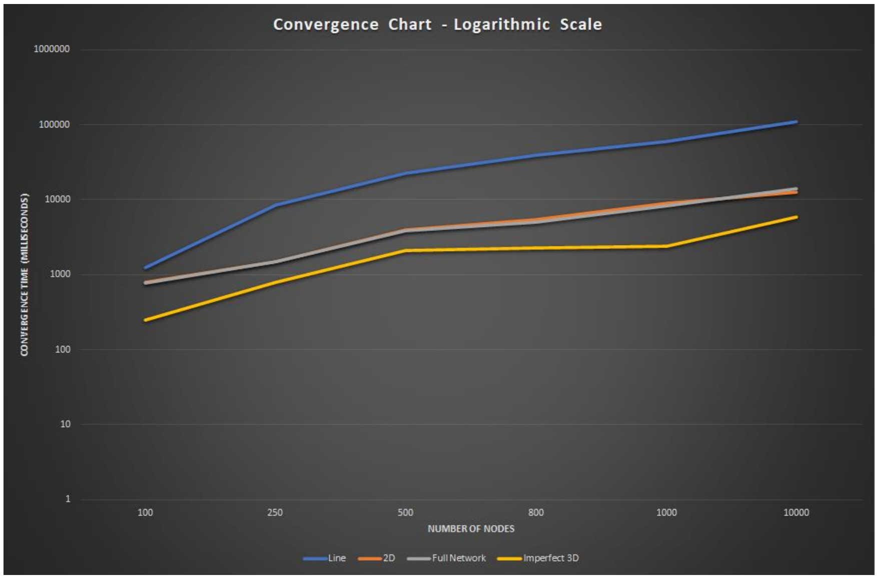
PUSHSUM ALGORITHM:

PICTURE 1:



The graph above shows the push-sum algorithm's convergence times as a function of the number of nodes for various topologies.

PICTURE 2:



The graph above shows the log of the push-sum algorithm's convergence times as a function of the number of nodes for various topologies.

Observations

- Line topology demonstrated the fastest convergence times for both algorithms. The fact that each node has a maximum of two neighbors must be the cause of this. As a result, the rumor spreads through the network slowly.
- Due to the connections between each node, we had an intuitive belief that full topology would have the fastest convergence time. However, the data show that this belief was incorrect.
- The 2D with imperfections had the shortest convergence time. This occurred as a result of each node receiving that random neighbor, which caused the rumor to propagate swiftly throughout the network and hastened convergence.
- Both the gossip method and the push-sum approach produced comparable findings and graphs. This must be because they both convey the idea in a way that is fundamentally identical.