PROJECT 2: REPORT

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Implemented Topologies

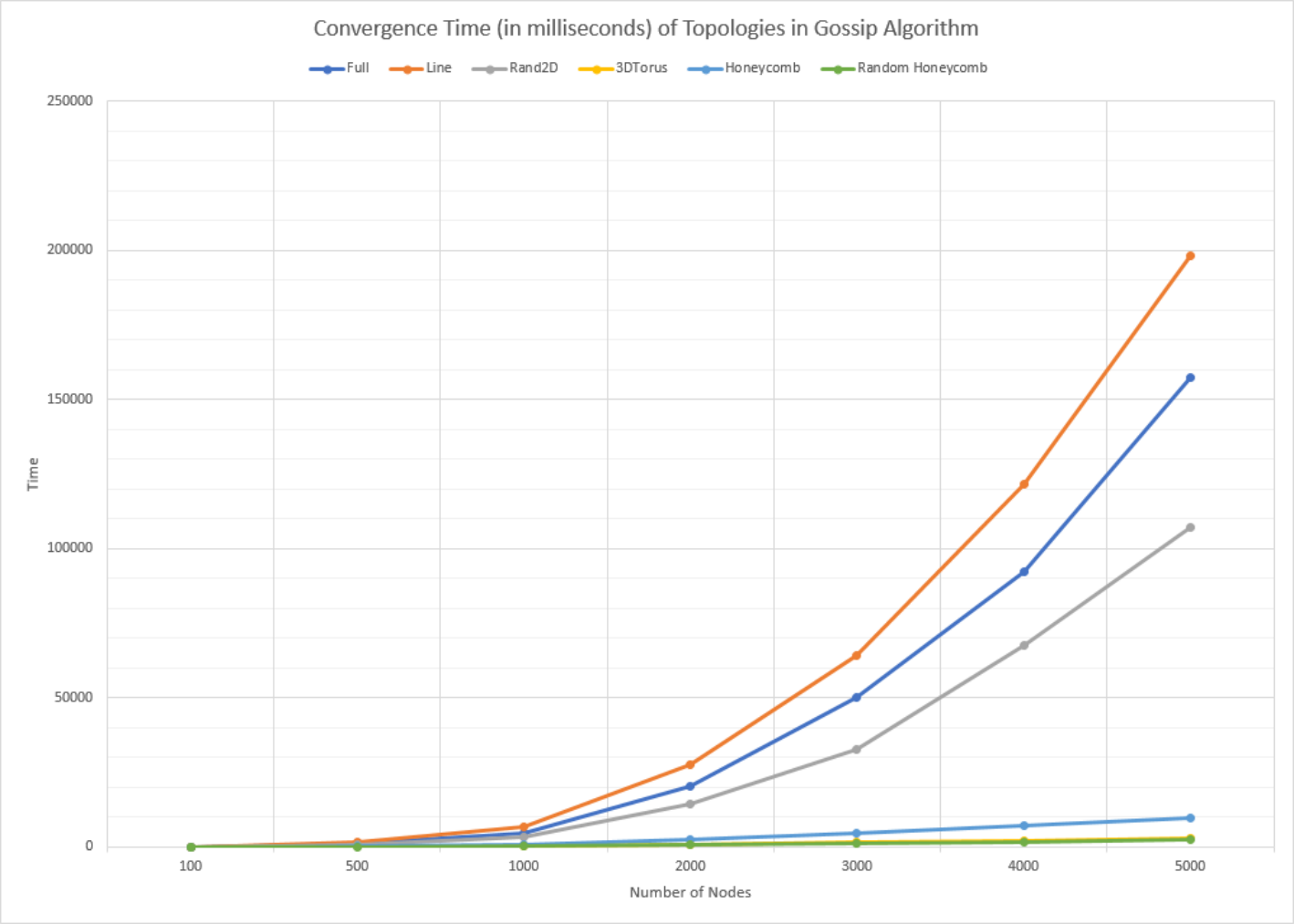
- **Full Network Topology**: Every actor is connected to every other actor in the network.
- **Line Topology:** The actors are arranged in a form of line. Every actor has a max degree of 2, i.e. it is connected to actors on the left and right except for the first and last node.
- **Random 2-D Grid Topology:** The actors are arranged in the form of a 2-D grid and connected to each other if they are within some distance of one another.
- **3D Torus Grid Topology:** The actors form a 3-D grid. The number of neighbors in a 3D torus network is 6. In case of nodes on the outer surface, the number of neighbors is limited, so, they are connected to the nodes on opposite sides.
- **Honeycomb Topology:** The actors are connected in the form of hexagons. Each actor can have a maximum degree of 3.
- **Honeycomb Topology with a Random Neighbor:** The topology is like honeycomb topology except that there is an extra connection to a random node in the entire network.

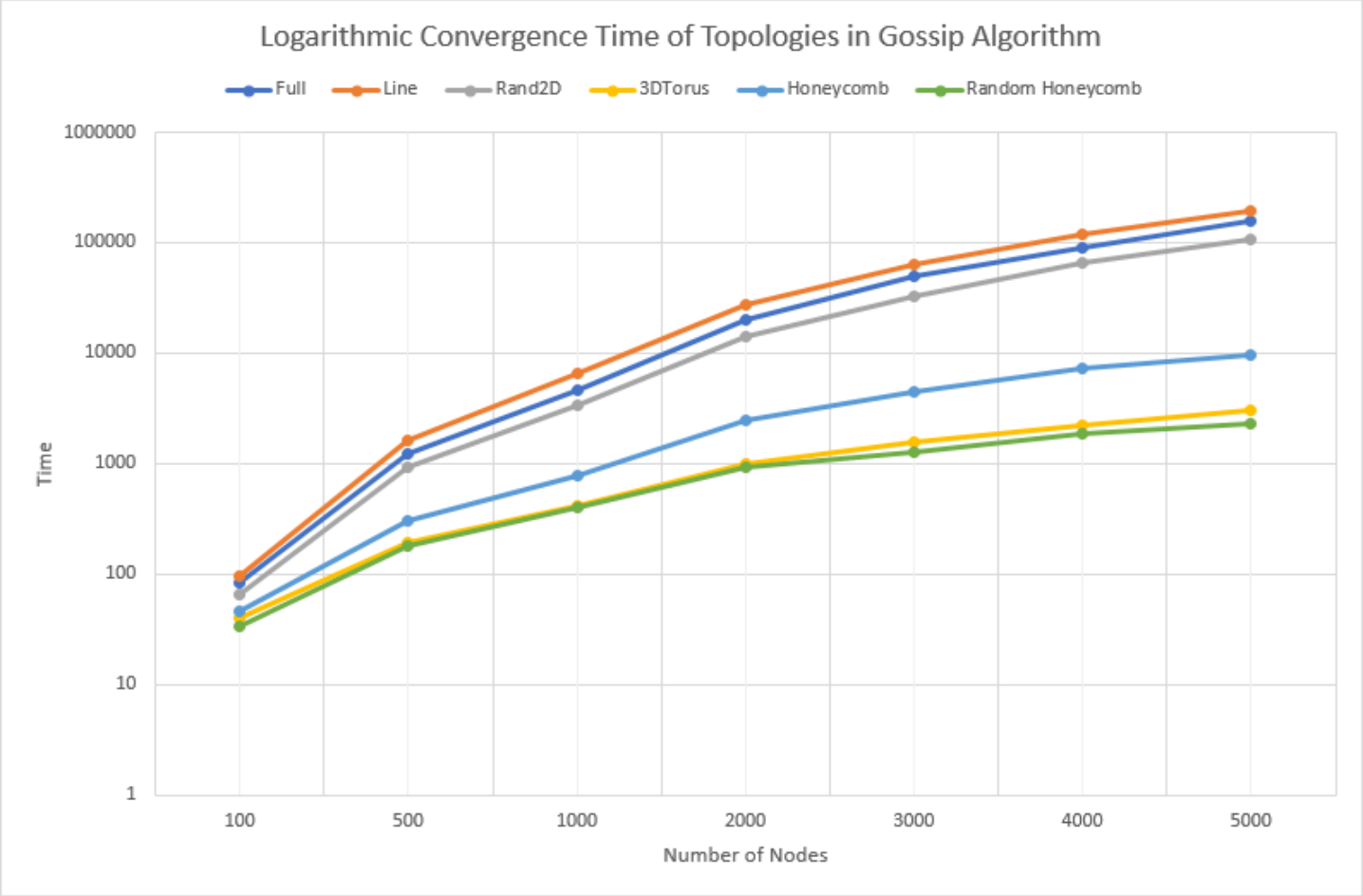
Implementation Details:

Gossip Algorithm

- The middle node (total_nodes/2) sends the rumor to its neighbors.
- On receiving, each node sends the message to all its neighbors.
- Each node keeps track of how many times it received the rumor, it stops transmitting the message once it has heard the rumor 10 times.

- Convergence is achieved when all the nodes have heard the rumor.



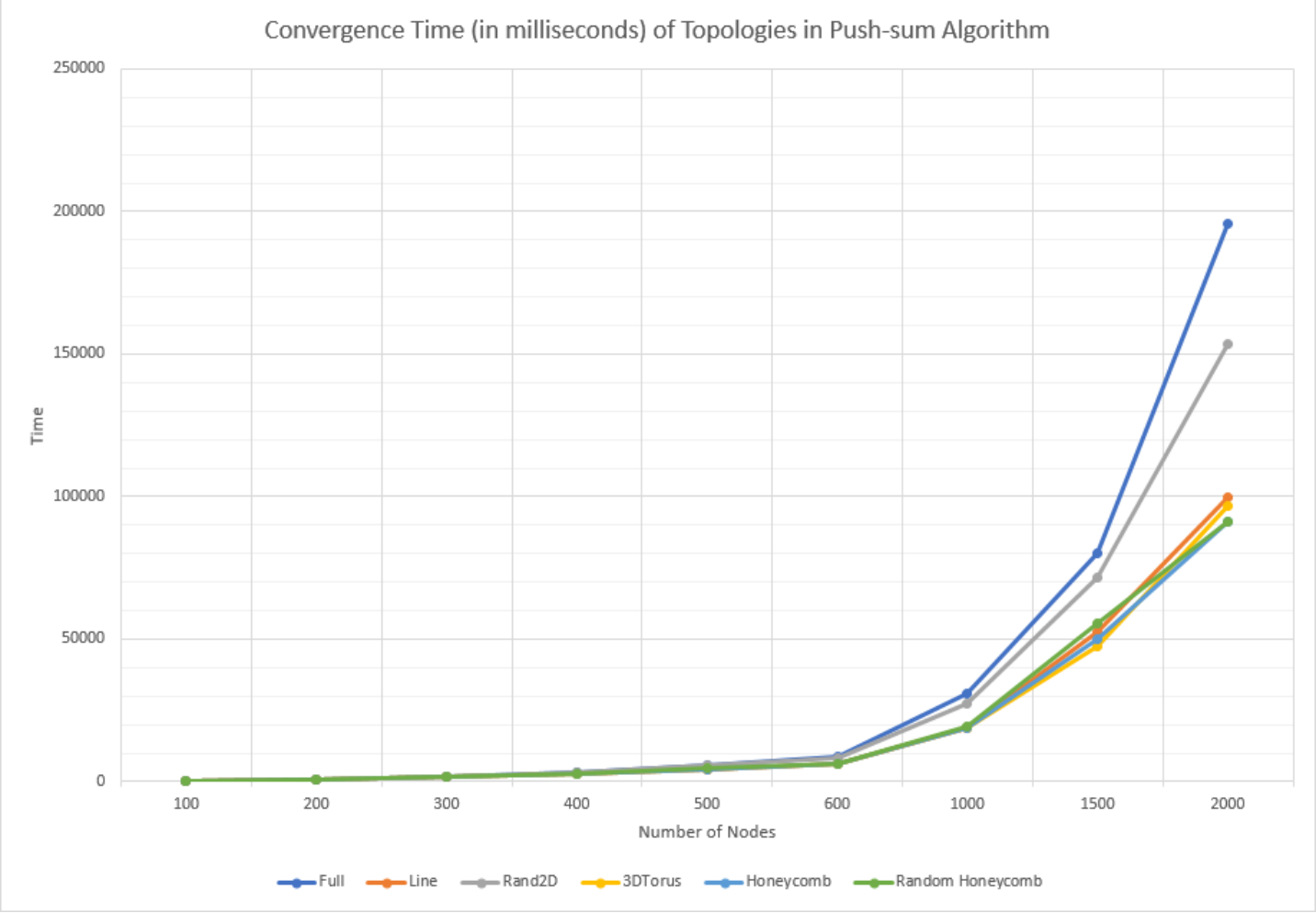


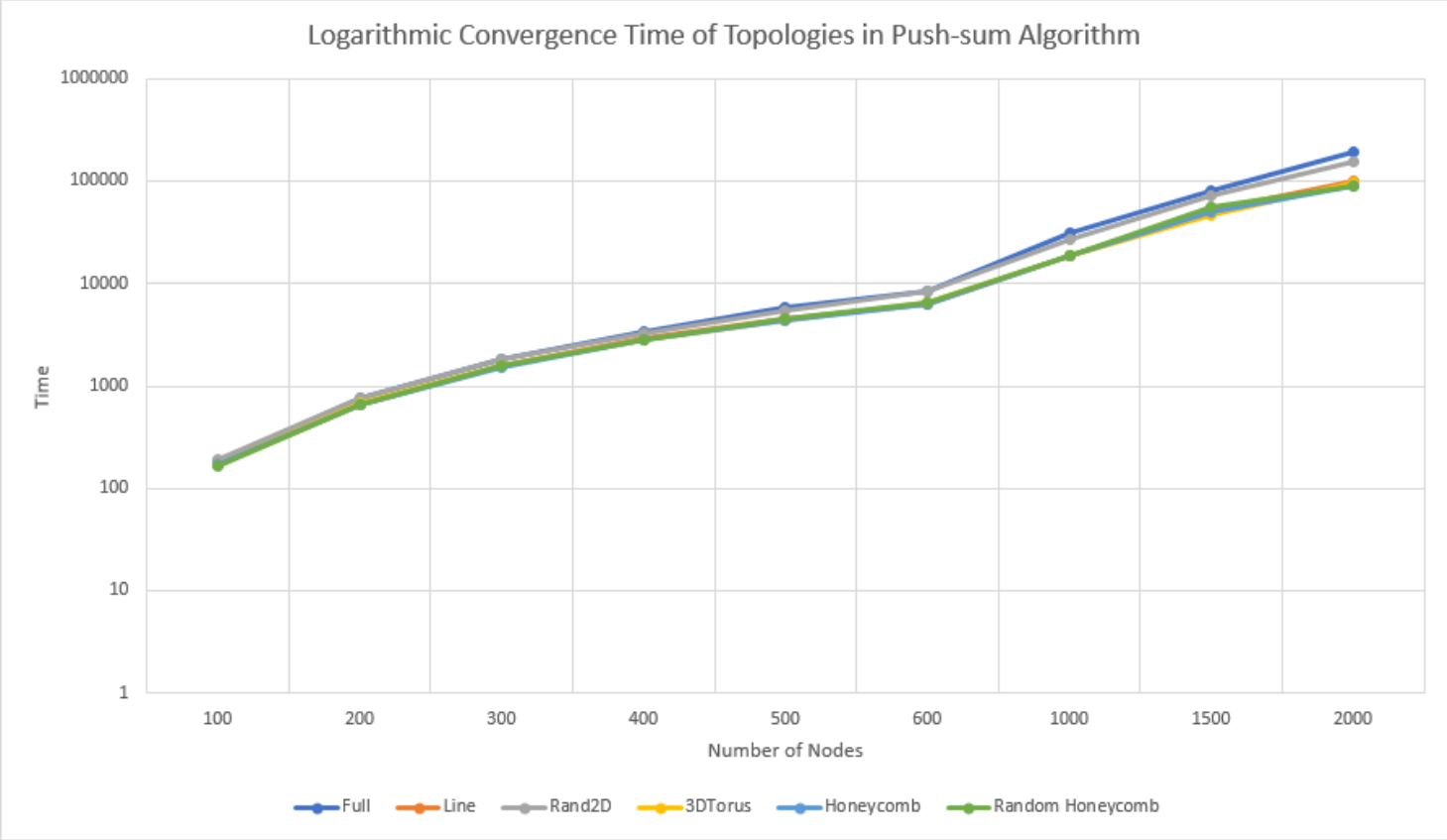
Observations:

- Line Topology has the highest convergence time (slowest) followed by Full Network Topology.
- 3D Torus has the lowest convergence time (fastest) along with Random Honeycomb attributed to the high degree (6 in case of 3D Torus, and 4 in the case of Random Honeycomb) and connection with a distant node which helps in spreading the rumor.
- For a small number of nodes, convergence time of a Full Network Topology is comparable to other topologies, but convergence time increases considerably in case of large number of nodes attributed to (n-1) neighbors of every n node.
- Random 2D Topology has convergence time better than Full Network Topology and Line Topology but is slower as compared to 3D Torus and Honeycomb Topology.

Push-Sum Algorithm

- Messages are sent and received in the form of (s, w). Upon receiving a message, an actor adds its own value of (s, w) and sends the message to a random neighbor.
- At any point in time, sum estimate is s/w where s and w are the current values of an actor.
- If s/w does not change in 10^{-10} in 3 consecutive rounds, the actor terminates.





Observations:

- For smaller number of nodes (less than 500), all the topologies converge in similar time.
- For a large network, Full Network Topology has the highest convergence time which is roughly double of fast performing topologies such as 3D Torus and Honeycomb topology.
- Random 2D Topology is the second slowest topology after Full Network Topology in case of Push-sum Algorithm, attributing to random placement of nodes.

Largest Network Tested:

Topology	Gossip	Push-Sum
Full	10,000	4,000
Line	10,000	4,000
Random 2D	10,000	2,000
3D Torus	100,000	5,000
Honeycomb	50,000	5,000
Random Honeycomb	100,000	5,000