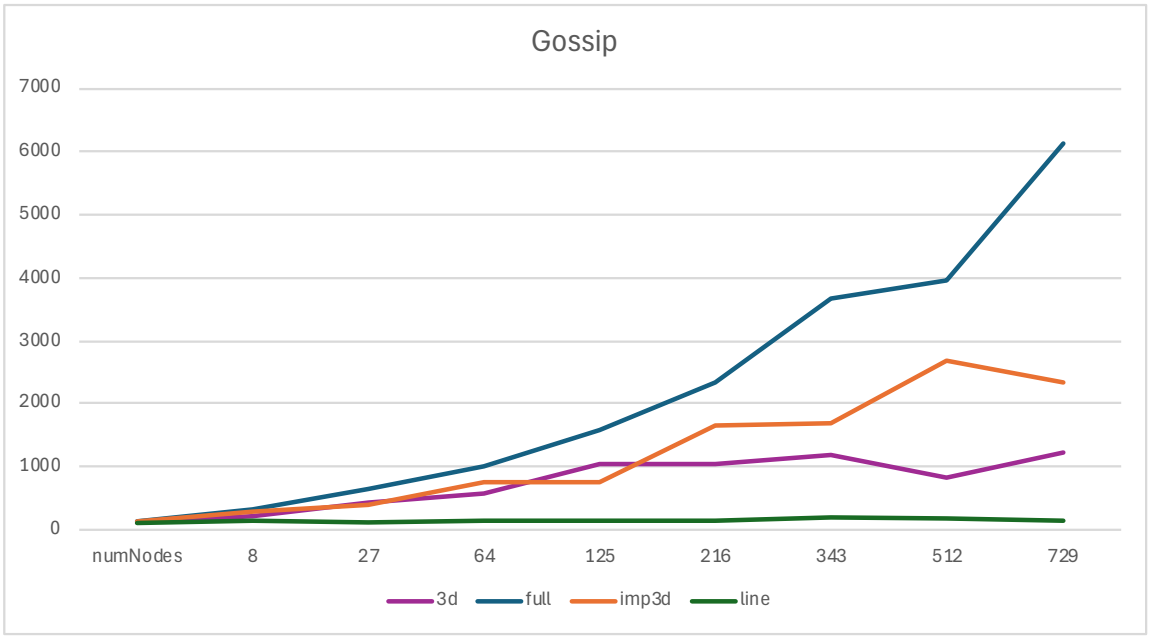
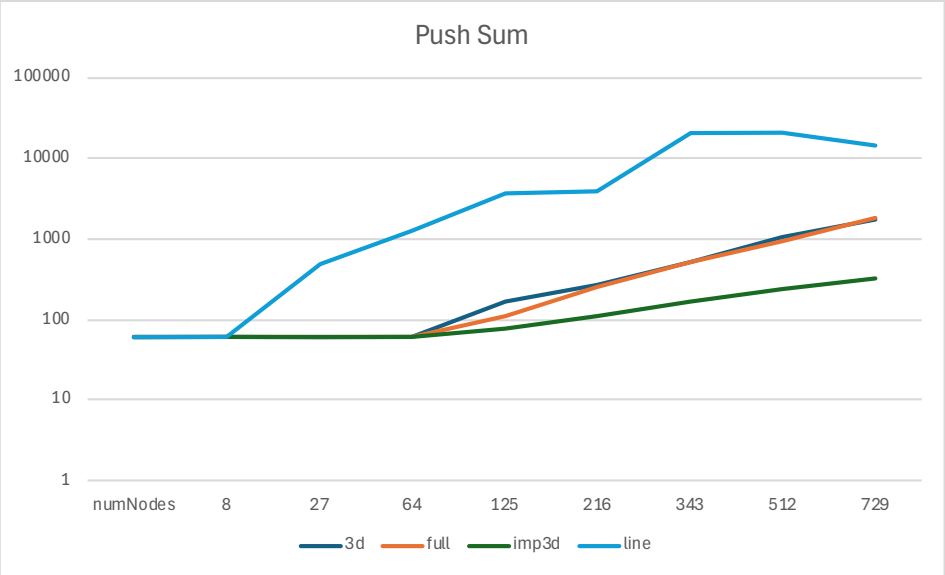


numNodes	topology	algorithm	run1_ms	run2_ms	run3_ms	average_ms
8	3d	gossip	116.159	117.937	120.542	118.2126667
27	3d	gossip	287.605	234.554	172.223	231.4606667
64	3d	gossip	286.352	435.007	550.506	423.955
125	3d	gossip	279.668	548.601	949.631	592.6333333
216	3d	gossip	1318.167	1271.673	551.695	1047.178333
343	3d	gossip	781.373	1177.053	1120.829	1026.418333
512	3d	gossip	743.419	682.646	2166.962	1197.675667
729	3d	gossip	697.006	232.029	1583.524	837.5196667
1000	3d	gossip	533.499	1669.26	1479.602	1227.453667
8	full	gossip	170.845	114.272	119.065	134.7273333
27	full	gossip	384.404	336.851	271.448	330.901
64	full	gossip	712.817	701.692	538.249	650.9193333
125	full	gossip	1127.644	647.025	1238.344	1004.337667
216	full	gossip	1369.326	1700.789	1694.918	1588.344333
343	full	gossip	2349.145	2436.465	2210.932	2332.180667
512	full	gossip	3642.946	3483.173	3918.059	3681.392667
729	full	gossip	4418.002	4057.007	3433.895	3969.634667
1000	full	gossip	6978.971	5441.92	5985.893	6135.594667
8	imp3d	gossip	166.104	116.029	116.266	132.7996667
27	imp3d	gossip	334.484	218.4	326.581	293.155
64	imp3d	gossip	384.583	486.857	328.835	400.0916667
125	imp3d	gossip	710.897	769.285	829.442	769.8746667
216	imp3d	gossip	843.595	716.24	683.596	747.8103333
343	imp3d	gossip	1274.085	1969.189	1685.251	1642.841667
512	imp3d	gossip	2020.132	1769.361	1273.14	1687.544333
729	imp3d	gossip	2756.682	2398.031	2903.036	2685.916333
1000	imp3d	gossip	2421.691	2409.333	2146.005	2325.676333
8	line	gossip	118.183	118.063	118.853	118.3663333
27	line	gossip	116.052	116.388	168.122	133.5206667
64	line	gossip	117.531	118.42	116.017	117.3226667
125	line	gossip	226.283	115.906	116.481	152.89
216	line	gossip	119.102	116.067	169.79	134.9863333
343	line	gossip	171.304	167.257	65.193	134.5846667
512	line	gossip	231.577	243.834	114.422	196.611
729	line	gossip	180.529	117.314	189.929	162.5906667
1000	line	gossip	75.321	176.931	177.537	143.263



numNodes	topology	algorithm	average_ms	avg_convergence	expected_value	is_expected
8	3d	push-sum	60.36166667	4.5	4.5	TRUE
27	3d	push-sum	60.94633333	14	14	TRUE
64	3d	push-sum	60.30133333	32.5	32.5	TRUE
125	3d	push-sum	60.725	63	63	TRUE
216	3d	push-sum	163.2503333	108.5	108.5	TRUE
343	3d	push-sum	265.414	172	172	TRUE
512	3d	push-sum	525.1033333	256.4999999	256.5	TRUE
729	3d	push-sum	1034.860333	364.9999998	365	TRUE
1000	3d	push-sum	1748.167667	500.5	500.5	TRUE
8	full	push-sum	60.62833333	4.5	4.5	TRUE
27	full	push-sum	60.76833333	14	14	TRUE
64	full	push-sum	60.61433333	32.5	32.5	TRUE
125	full	push-sum	60.689	63	63	TRUE
216	full	push-sum	112.0216667	108.5	108.5	TRUE
343	full	push-sum	249.442	172	172	TRUE
512	full	push-sum	523.0416667	256.5	256.5	TRUE
729	full	push-sum	963.81	365	365	TRUE
1000	full	push-sum	1831.733667	500.5	500.5	TRUE
8	imp3d	push-sum	60.28266667	4.5	4.5	TRUE
27	imp3d	push-sum	60.96333333	14	14	TRUE
64	imp3d	push-sum	60.79333333	32.5	32.5	TRUE
125	imp3d	push-sum	60.708	63	63	TRUE
216	imp3d	push-sum	77.94833333	108.5	108.5	TRUE
343	imp3d	push-sum	111.688	172	172	TRUE
512	imp3d	push-sum	165.708	256.5	256.5	TRUE
729	imp3d	push-sum	235.3606667	365	365	TRUE
1000	imp3d	push-sum	324.173	500.5	500.5	TRUE
8	line	push-sum	60.518	4.50000006	4.5	TRUE
27	line	push-sum	60.82566667	13.9990024	14	TRUE
64	line	push-sum	485.2766667	32.49660791	32.5	TRUE
125	line	push-sum	1267.583	57.63644434	63	FALSE
216	line	push-sum	3647.741333	91.9874592	108.5	FALSE
343	line	push-sum	3956.180333	119.2106024	172	FALSE
512	line	push-sum	20471.366	340.9014515	256.5	FALSE
729	line	push-sum	20975.00667	267.3100801	365	FALSE
1000	line	push-sum	14597.61867	652.6566637	500.5	FALSE

Analysis of Gossip and Push-Sum Algorithm Performance

This report details the experimental findings on the convergence times of the **Gossip** and **Push-Sum** algorithms. The experiments were conducted across four distinct network topologies (**line**, **3d**, **imp3d**, and **full**) with network sizes ranging from 8 to 1000 nodes.

Gossip Algorithm Analysis

The convergence time for the Gossip algorithm was found to be highly dependent on the network topology, specifically the number of neighbors each node has (node degree).

- **Line Topology (Fastest Convergence)**: The line topology exhibited the fastest convergence time, which remained nearly constant regardless of the network size. This is likely due to **localized message exchange**. In a line, a node has at most two neighbors. The random neighbor selection is therefore highly likely to be the same node as in the previous step. This causes a rapid exchange between a few nodes, allowing them to meet the local convergence criteria quickly (hearing a rumor a certain number of times). However, this rapid *local* convergence comes at the cost of poor *global* propagation of the information across the entire network.

- **Full Topology (Slowest Convergence)**: A fully connected graph, where every node is connected to every other node, showed the longest convergence times, especially as the network size increased. With a vast number of neighbors to choose from, messages are propagated widely. While this ensures the information spreads, it takes significantly longer for the entire network to reach a stable state where the convergence criteria are met for all nodes.

- **3D and Imp3d Topologies**: These topologies performed moderately, falling between the extremes of the line and full topologies. Their structured, but not total, connectivity provides a balance between message propagation and convergence speed.

Push-Sum Algorithm Analysis

In contrast to Gossip, the Push-Sum algorithm's performance is critically dependent on the efficient and uniform propagation of values (sum and weight) throughout the network.

- **Line Topology (Slowest & Inaccurate)**: The line topology performed the worst by a significant margin. The linear structure forces information to propagate sequentially from one node to the next. When a node receives an update from a neighbor, its internal sum/weight ratio can be thrown off by a large delta, preventing the values from stabilizing. This inefficiency probably is the reason for extremely slow convergence. Furthermore, for network sizes above 64 nodes, the algorithm **failed to converge to the correct value**.

- **Well-Connected Topologies (Fastest & Accurate)**: The **3d**, **full**, and **imp3d** topologies all performed very well, showing similar, rapid convergence times. Their high degree of connectivity allows the sum and weight values to be averaged out across the network efficiently, leading to fast and accurate results. In all tested cases, these topologies converged to the correct expected average of **(n+1)/2**.

- **Imp3d vs. Full Topology**: While the performance of all well-connected topologies was similar, the **imp3d** topology was the fastest. It appears to provide an optimal balance, providing good enough connectivity for efficient value propagation without the potential message overhead of a fully connected graph.

Team Members

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