Project2 failure model report

In this project, we set the failure nodes to 10% of the numNodes and implemented 6 different topologies: full network, 3D grid, random 2D grid, torus, line and imperfect line, to test how fast gossip and push-sum can work on these different topologies and how failure nodes will affect the results.

In gossip, each actor selects a random neighbor and tells it the rumor, each actor keep track of rumors and how many times it has heard the rumor. It stops transmitting once it has heard the rumors 100 times (we kill nodes in this case, and it cannot receive message).

In push-sum, node send out its quantities s and w only when receiving other node's s and w, algorithm converge when sum estimation s/w did not change more than 1.0e-10 in 3 consecutive rounds.

To achieve the failure model, we randomly choose some nodes as failures. Failures cannot send message and they will be removed from their neighbors' neighbor list. Which means failures will not be able to send or receive messages.

When measuring time to converge, we do it 3 times and calculate the average (plot using average).

In figure 1, Gossip cannot propagate on line topology if the failure happened. Another point should be noticed is that, the trend of the line represents full topology seems different with the one in non-failure model. Rest topologies seems similar with those ones in non-failure model, but cost some more time to converge.

In Figure 2, Pushsum algorithm, on 3D grid, lines represent full, 3D grid, impline and torus show similar trends. As usual, few nodes cannot build a random 2D topology, but gradually, it becomes close to other topologies. Line topology still shows a relatively steady line with unanticipated fluctuate since its running time changes each time.

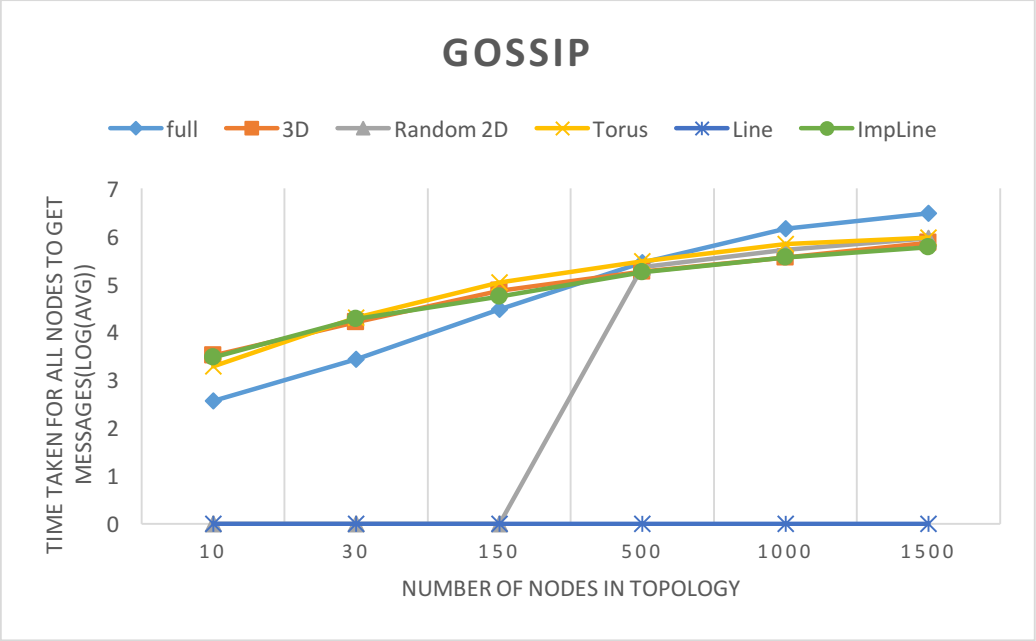

Figure 1a Convergence time for gossip_with_failures on six topologies

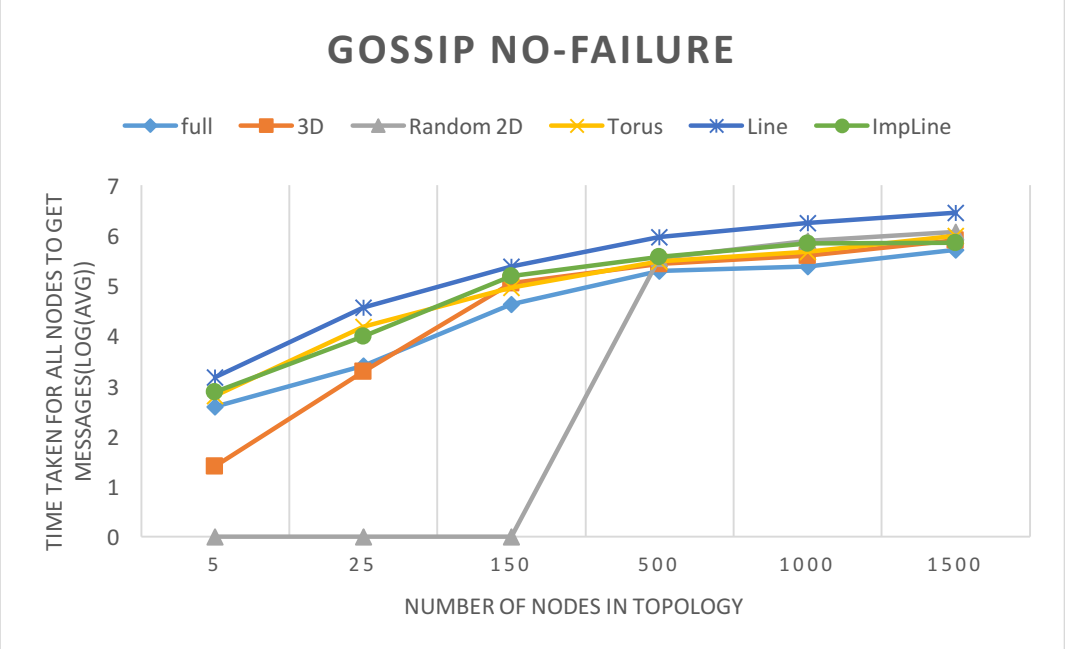

Figure 1b Convergence time for gossip_without_failures on six topologies

In gossip:

1. Line would be choked and cannot move if failure occurs, this is easy to understand that line can only propagate forward or backward, some nodes would have no chance to receive the gossip, so the time would be unlimited, which we set to 0.

2. Another different topology is full, since in the small number of nodes, the failure nodes which can spread any other nodes without limitation, so the failure nodes

decrease the time spent on the spreading, however, as the number of nodes increasing, its cost of converging time increasing exponentially and thus last longer time the others.

3. 3D, random 2D, torus and imperfect line model are almost the same, which can be explained by their similar conditions. They all have limited neighbors and can gossip with an uncertain direction.

4. Compared with no-failure model, after applying failures, most of topologies become closer to each other.

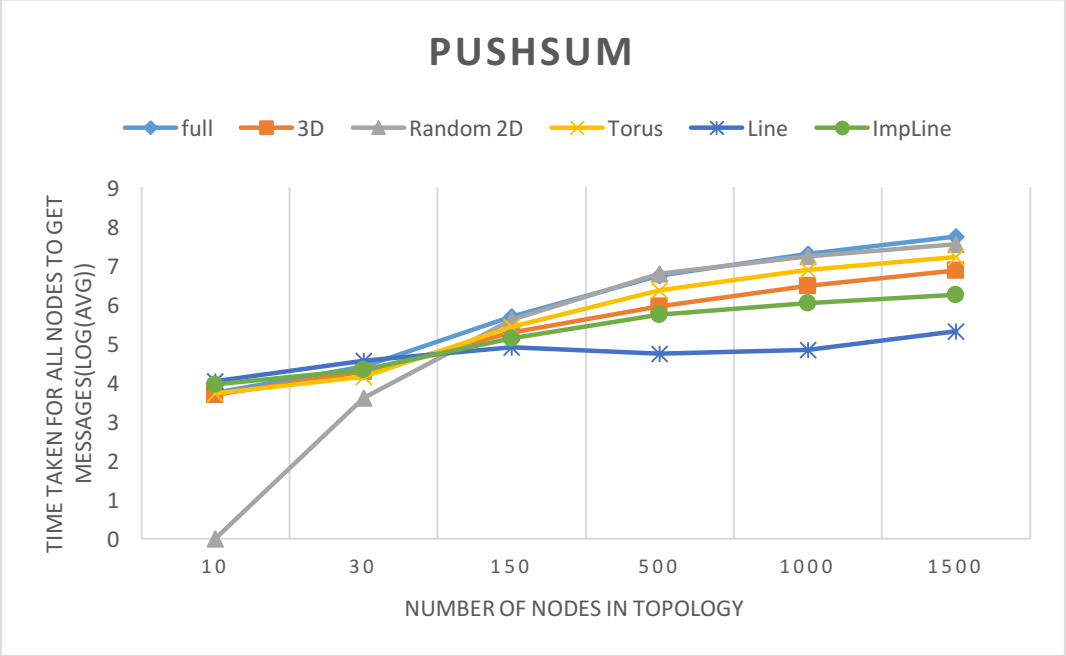

Figure 2a Convergence time for pushsum_with_failures on six topologies

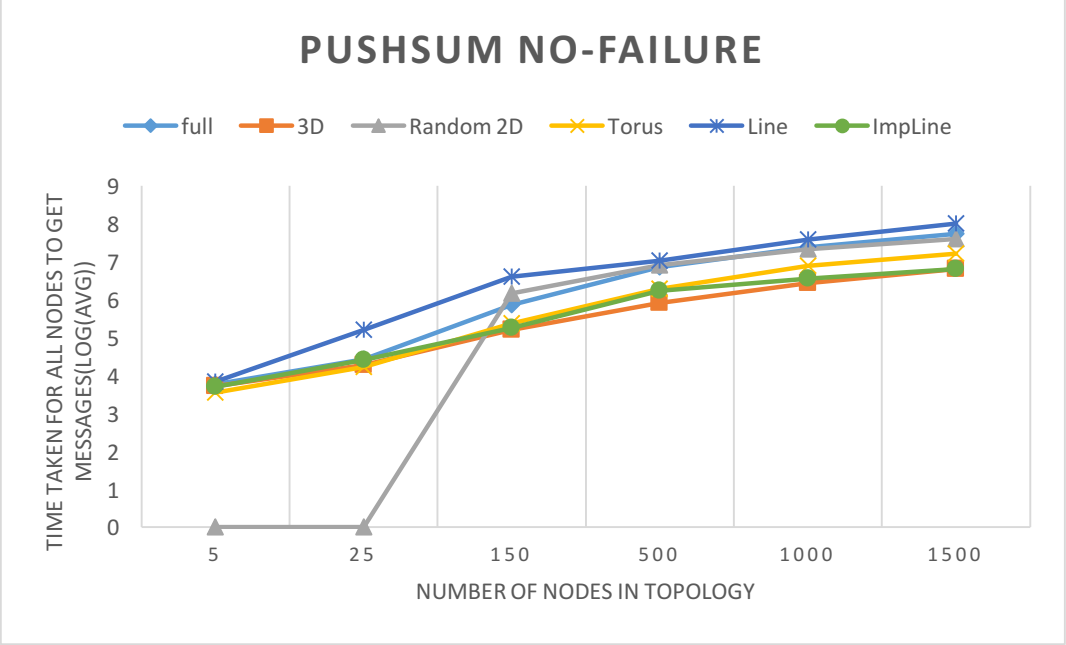

Figure 2b Convergence time for pushsum_without_failures on six topologies

In Pushsum:

1. When applying only a few nodes, it is difficult to build a connected random 2D topology, some nodes are isolated. When number of node increases, it shows a similar trend with other lines since they all have limited number of neighbors.

2. Applying failures helps improve the small number of nodes condition in random 2D. In a no-failure model, before the number of nodes increasing over 150, there is a high possibility to choose an isolated node as the start point and lead algorithm to be forced termination. While after applying failures, some isolated may be marked as failures and cannot be chosen to be the start point.

3. Compared with no-failure model, the line represents line topology in failure model looks much different with the one in no-failure model. It's easy to explain this: line is a topology with only two directions, the existence of failures shrink the range of nodes where pushsum messages are passed between, thus it is quicker to converge.

4. Another observation hasn't been shown in graph is: in no-failure model, the converged estimated value is approximately half of the numNodes, while in failure model, the converged estimated value changes in a little range.

APPENDIX: Original data measured for the plots

Without failure model

Gossip full

Times \ numNodes	10	30	150	500	1000	1500
1	342us	2364us	32248us	246618us	1387427us	2725326us
2	401us	3324us	30715us	282788us	1602638us	3265912us
3	346us	2339us	26307us	309900us	1391440us	3114908us
Avg	363us	2676us	29757us	279769us	1460502us	3035382us
Log10(Avg)	2.56	3.43	4.47	5.45	6.16	6.48

Gossip 3D

Times \ numNodes	10	30	150	500	1000	1500
1	2684us	16838us	75923us	202742us	375953us	748331us
2	4305us	15165us	69341us	163037us	364718us	681715us
3	2777us	15443us	71587us	178538us	352277us	750446us
Avg	3255us	15815us	72284us	181439us	364316us	726831us
Log10(Avg)	3.51	4.20	4.86	5.26	5.56	5.86

Gossip rand2D

Times \ numNodes	10	30	150	500	1000	1500
1				242804us	415960us	905262us
2				228658us	603400us	852802us
3				197711us	522285us	945478us
Avg	0	0	0	223058us	513882us	901181us
Log10(Avg)	0	0	0	5.35	5.71	5.95

Gossip torus

Times \ numNodes	10	30	150	500	1000	1500
1	1834us	19295us	101267us	320533us	599384us	947232us
2	1915us	19108us	112821us	264021us	732399us	944759us
3	2122us	21769us	110945us	326813us	689863us	926507us
Avg	1957us	20057us	108344us	303789us	673883us	939499us
Log10(Avg)	3.29	4.30	5.03	5.48	5.83	5.97

Gossip line

Times \ numNodes	10	30	150	500	1000	1500
1						
2						
3						
Avg	0	0	0	0	0	0
Log10(Avg)	0	0	0	0	0	0

Gossip impline

Times \ numNodes	10	30	150	500	1000	1500
1	3662us	19675us	50889us	165997us	359730us	587774us

2	1745us	20080us	64548us	165255us	357308us	578549us
3	3439us	15840us	49810us	205729us	379800us	603012us
Avg	2949us	18532us	55082us	178994us	365613us	589778us
Log10(Avg)	3.47	4.27	4.74	5.25	5.56	5.77

Pushsum full

Times / numNodes	10	30	150	500	1000	1500
1	5549us	22941us	508671us	5310480us	18903556us	58231682us
2	5758us	25716us	494003us	5102094us	20454860us	54398511us
3	5567us	29640us	467933us	6237577us	20631257us	50915032us
Avg	5625us	26099us	490202us	5550050	19996558us	54515075us
Log10(Avg)	3.75	4.42	5.69	6.74	7.3	7.74

Pushsum 3D

Times / numNodes	10	30	150	500	1000	1500
1	4691us	19033us	221603us	903289us	3304043us	6529219us
2	4552us	18351us	172306us	845861us	3301013us	7383690us
3	5494us	19209us	174736us	917355us	2533806us	9077716us
Avg	4912us	18864us	189548us	888835us	3046287us	7663542us
Log10(Avg)	3.69	4.28	5.28	5.95	6.48	6.88

Pushsum rand2D

Times / numNodes	10	30	150	500	1000	1500
1		3021us	482071us	6287494us	15029485us	37784099us
2		3218us	639175us	6081810us	18683268us	31073206us
3		5871us	88271us	6066336us	17007753us	36965349us
Avg	0	4037us	403172us	6145213us	16906835us	35274218us
Log10(Avg)	0	3.61	5.61	6.79	7.23	7.55

Pushsum torus

Times / numNodes	10	30	150	500	1000	1500
1	6811us	11592us	296129us	2580783us	7067844us	14857481us
2	4922us	18005us	248984us	2240024us	7800421us	15987867us
3	4540us	14109us	277303us	2009022us	8233014us	18487769us

Avg	5424us	14569us	274139us	2276610us	7700426us	16444372us
Log10(Avg)	3.73	4.16	5.44	6.36	6.89	7.22

Pushsum line

Times \ numNodes	10	30	150	500	1000	1500
1	8125us	19200us	49093us	28503us	34880us	108494us
2	14231us	55494us	169661us	113563us	83410us	92196us
3	10353us	37041us	20318us	24985us	96139us	419096us
Avg	10903us	37245us	79691us	55684us	71476us	206595us
Log10(Avg)	4.04	4.57	4.90	4.75	4.85	5.32

Pushsum impline

Times \ numNodes	10	30	150	500	1000	1500
1	9297us	18127us	155615us	602881us	1163867us	1665505us
2	10330us	21038us	123233us	537881us	1108086us	2119550us
3	6931us	25619us	139133us	498057us	1006910us	1540837us
Avg	8853us	21595us	139327us	546273us	1092954us	1775297us
Log10(Avg)	3.95	4.33	5.14	5.74	6.04	6.25