

DOSP – Project2

Team Members:

1. Divyajyoti Ukirde, UFID: 30260576, Email: divyajyotiukirde@ufl.edu
2. Yashwanth Venkat Chandolu, UFID: 11429359, Email: ychandolu@ufl.edu

Project:

Gossip type 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 erlang. Since actors in erlang are fully asynchronous, the particular type of Gossip implemented is the so called Asynchronous Gossip.

To calculate the convergence of gossip algorithms: gossip and push sum, when used for either group communication (gossip algorithm) or while computing the aggregation (push sum algorithm) using simulation models. Given is one amongst the different network topologies (Full, 2D, Imp3D and Line) with a number of nodes as size of each network. Our goal is to experiment the given network of n nodes using akka actors and find the convergence time.

Working Aspect :

We able to run all line, full, 2D, and Imp3D in any combination with gossip or push-sum protocol. The convergence in Gossip protocol is achieved when all the nodes have converged. A node is set to be converged when it listens to the message for the 10th time. After convergence, the node stops transmitting the message to its neighbour. Once the network is converged i.e. all nodes are converged, the total time for convergence is printed out.

File Descriptions:

Start.erl : File that is used to start the program.

pushsum.erl : File contains the code for push sum implementation.

gossip.erl : File containing the code for gossip implementation.

Instruction Details:

This project has been developed using VS Code/ Atom Text Editor.

Please make sure you have erlang is installed in the system.

Compile all the 3 files by using `c(file_name)` command.

To execute the files, run

`start:run(number_of_nodes, "Topology", "gossip/pushsum").`

Ex: `start:run(100, "2D", "gossip").`

Results:

GOSSIP:

Imperfect 3D topology:

Output result:

```
i> start:run(100, "3D", "gossip").
#(16 => [6,15,6,26],79 => [69,78,69,89],18 => [8,17,8,28],54 => [44,53,44,64],5 => [4,6,15,16],65 => [55,64,55,75],93 => [83,92,83,67] => [57,66,57,77],19 => [9,18,9,29],42 => [32,41,32,52],92 => [82,91,82,91],94 => [84,93,84,84],84 => [74,83,74,94],27 => [17,26,17,37],49 => [39,48,39,59],62 => [52,61,52,72],56 => [46,55,46,66],70 => [60,69,60,80],35 => [25,34,25,45],10 => [9,28,19],24 => [14,23,14,34],66 => [56,65,66,76],50 => [40,49,60],53 => [43,52,43,63],30 => [20,35,20,46],82 => [72,81,72,92],4 => [3,5,14,15],96 => [86,95,86],21 => [11,20,11,31],87 => [77,86,77,97],52 => [42,51,42,62],22 => [12,21,12,32],17 => [7,16,7,27],55 => [45,54,45,65],68 => [48,57,48,68],90 => [80,89,80,100],75 => [65,74,65,85],3 => [2,4,13,14],8 => [7,9,18,19],97 => [87,96,87],1 => [2,11,12],99 => [89,100,100],74 => [64,73,64,84],83 => [73,82,73,93],7 => [6,8,17,18],2 => [1,3,12,13],60 => [50,59,50,70],14 => [4,13,4,24],15 => [5,14,5,25],78 => [68,77,68,88],20 => [10,19,30],41 => [31,40,31,51],95 => [85,94,85],77 => [67,76,67,87],40 => [30,39,30,80],59 => [49,58,49,69],13 => [3,12,3,23],38 => [28,37,28,48],88 => [78,79,78,90],51 => [41,50,41,61],86 => [76,85,76,96],68 => [58,67,58,78],72 => [62,71,62,82],6 => [5,7,16,17],64 => [54,63,64,74],91 => [92,81,85] => [75,84,75,98],28 => [18,27,18,38],20 => [15,24,30],34 => [24,33,24,44],32 => [22,31,22,42],76 => [66,75,66,86],9 => [8,18,19,20],37 => [27,36,27,47],11 => [1,12,21,22],81 => [71,80,71,91],98 => [88,97,88],31 => [21,30,21,41],46 => [36,45,36,56],71 => [61,70,61,81],100 => [99,90],63 => [53,62,53,73],88 => [78,87,78,98],69 => [59,68,59,79],26 => [16,26,16,36],57 => [47,56,47,67],48 => [38,47,38,68],45 => [35,44,35,55],39 => [29,38,29,49],43 => [33,42,33,53],30 => [20,29,20,40],61 => [51,60,51,71],89 => [79,88,79,99],47 => [37,46,37,57],29 => [19,28,19,39],23 => [13,22,13,33],44 => [34,43,34,54],73 => [63,72,63,83],12 => [2,11,2,22],23,33 => [23,34,43]}true
converged
Convergence time: 11.389 ms
```

Number of nodes vs time for convergence

i3D	Convergence
10	.63ms
100	13.059ms
200	36.99ms
300	73.76ms
400	128.69ms
500	193.62ms
600	300.359ms
700	358.886ms
800	421.866ms
900	478.256ms
1000	606.62ms
5000	30357.986ms
8000	104744.361ms

2D Topology :

```
2> start:run(100, "2D", "gossip").
#(16 => [6,15,6,26],79 => [69,78,69,89],18 => [8,17,8,28],54 => [44,53,44,64],5 => [4,6,15],65 => [55,64,55,75],93 => [83,92,83],67 => [57,66,57,77],19 => [9,18,9,29],42 => [32,41,32,52],92 => [82,91,82],
94 => [84,93,84],84 => [74,83,74,94],27 => [17,26,17,37],49 => [39,48,39,59],62 => [52,61,52,72],56 => [46,55,46,66],70 => [60,69,60,80],35 => [25,34,25,45],10 => [9,20],24 => [14,23,14,34],66 => [56,65,6
6,76],50 => [40,49,40],53 => [43,52,43,63],36 => [26,35,26,46],82 => [72,81,72,92],4 => [3,5,14],96 => [80,96,86],71 => [11,20,11,31],87 => [77,86,77,97],52 => [42,51,42,62],22 => [12,21,12,32],17 => [7,1
6,7,27],55 => [45,54,45,65],88 => [48,57,48,68],90 => [80,89,80,100],75 => [65,74,65,85],3 => [2,4,13],8 => [7,9,18],97 => [87,96,87],1 => [2,11],99 => [89,100,109],74 => [64,73,64,84],83 => [73,82,73,93],
7 => [6,8,17],2 => [1,3,12],60 => [50,59,50,70],14 => [4,13,4,24],15 => [5,14,5,25],78 => [68,77,68,88],20 => [10,19,30],41 => [31,40,31,51],95 => [85,94,85],77 => [67,76,67,87],40 => [30,39,30,60],59 =>
[49,58,49,69],13 => [3,12,3,23],38 => [28,37,28,48],80 => [70,79,70,90],51 => [41,50,41,61],86 => [76,85,76,96],68 => [58,67,58,78],72 => [62,71,62,82],6 => [5,7,16],64 => [54,63,54,74],91 => [92,81,85
=> [78,84,75,95],28 => [18,27,18,38],25 => [15,24,35],34 => [24,33,24,44],32 => [22,31,22,42],76 => [66,75,66,86],9 => [8,19,19],37 => [27,36,27,47],11 => [1,12,21],61 => [71,80,71,91],98 => [88,97,88],31
=> [21,30,21,41],46 => [36,45,36,56],71 => [61,70,61,81],100 => [99,98],63 => [53,62,53,73],88 => [78,87,78,98],69 => [59,68,59,79],26 => [16,25,16,36],57 => [47,56,47,67],48 => [38,47,38,68],45 => [35,4
4,35,55],39 => [29,38,29,49],43 => [33,42,33,53],30 => [20,29,20,40],61 => [51,60,51,71],89 => [79,88,79,99],47 => [37,46,37,57],29 => [19,28,19,39],23 => [13,22,13,33],44 => [34,43,34,54],73 => [63,72,63
,83],12 => [2,11,2,22],33 => [23,34,43])true
converged
Convergence time: 11.646 ms
```

Number of nodes vs time for convergence:

2D	
Number of nodes	convergence
10	0.74ms
100	11.86ms
200	29.78ms
300	62.58ms
400	110.189ms
500	178.267ms
600	272.886ms
700	330.89ms
800	405.60ms
900	490.88ms
1000	701.381ms

Line Topology:

```
1> start:run(100, "line", "gossip").
neighbor map
#(16 => [15,17],79 => [78,80],18 => [17,19],54 => [53,55],5 => [4,6],65 => [64,66],93 => [92,94],67 => [66,68],19 => [18,20],42 => [41,43],92 => [91,93],94 => [93,95],84 => [83,85],27 => [26,28],49 => [48
,50],62 => [61,63],56 => [55,57],70 => [69,71],35 => [34,36],10 => [9,11],24 => [23,25],66 => [65,67],80 => [49,51],53 => [52,54],36 => [35,37],82 => [81,83],4 => [3,5],96 => [95,97],21 => [20,22],87 => [86,88],62
=> [61,63],22 => [21,23],17 => [16,18],55 => [54,56],58 => [57,59],90 => [89,91],75 => [74,76],3 => [2,4],8 => [7,9],97 => [96,98],1 => [2],99 => [98,100],74 => [73,75],83 => [82,84],7 => [6,8],
2 => [1,3],60 => [59,61],14 => [13,15],15 => [14,16],78 => [77,79],20 => [19,21],41 => [40,42],95 => [94,96],77 => [76,78],40 => [39,41],59 => [58,60],13 => [12,14],38 => [37,39],80 => [79,81],51 => [50,5
2],86 => [85,87],68 => [67,69],72 => [71,73],6 => [5,7],64 => [63,65],91 => [90,92],85 => [84,86],28 => [27,29],25 => [24,26],34 => [33,35],32 => [31,33],76 => [75,77],9 => [8,10],37 => [36,38],11 => [10,
12],81 => [80,82],98 => [97,99],31 => [30,32],46 => [45,47],71 => [70,72],100 => [99,101],63 => [62,64],88 => [87,89],69 => [68,70],26 => [25,27],57 => [56,58],48 => [47,49],45 => [44,46],39 => [38,40],43
=> [42,44],30 => [29,31],61 => [60,62],89 => [88,90],47 => [46,48],29 => [28,30],23 => [22,24],44 => [43,45],73 => [72,74],12 => [11,13],33 => [32,34])true
converged
Convergence time: 9.799 ms
```

Number of nodes vs time for convergence:

Line	Number of nodes	convergence
10		0.66ms
100		9.864ms
200		26.531ms
300		58.36ms
400		94.539ms
500		140.837ms
600		204.678ms
700		304.181ms
800		388.835ms
900		450.83ms
1000		657.717ms
1500		1209.933ms
2000		2395.82ms
2500		3483.404ms
3000		5861.611ms
3500		10322.049ms
5000		25621.241ms
10000		151714.872ms
12000		314862.521ms

Full Topology:

```
5> start:=run(10, "full", "gossip").
#(1 => [2,3,4,5,6,7,8,9,10],2 => [1,3,4,5,6,7,8,9,10],3 => [1,2,4,5,6,7,8,9,10],4 => [1,2,3,5,6,7,8,9,10],5 => [1,2,3,4,6,7,8,9,10],6 => [1,2,3,4,5,7,8,9,10],7 => [1,2,3,4,5,6,8,9,10],8 => [1,2,3,4,5,6,7,9,10],9 => [1,2,3,4,5,6,7,8,10],10 => [1,2,3,4,5,6,7,8,9])true
converged
Convergence time: 0.399 ms
```

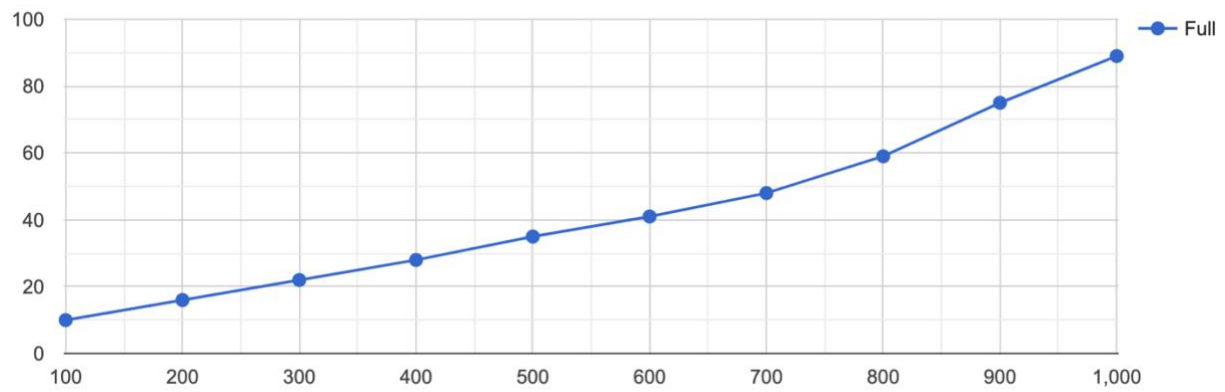
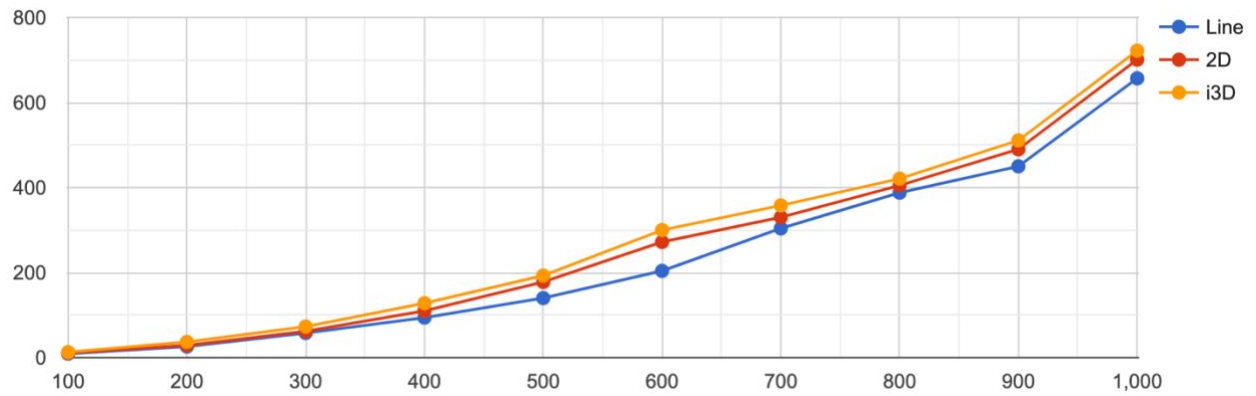
Number of nodes vs time for convergence:

Full	Number of nodes	convergence
10		
100		8.03ms
200		10ms
300		16.21
400		22ms
500		28.27ms
600		35.5ms
700		41.0ms
800		48.91ms
900		59.5ms
1000		75.78ms

Graphs:

y-axis is number time in milli seconds.

x-axis is the number of nodes.



Pushsum:

Full Topology:

```
3> start:run(10, "full", "pushsum").
#(1 => [2,3,4,5,6,7,8,9,10],2 => [1,3,4,5,6,7,8,9,10],3 => [1,2,4,5,6,7,8,9,10],4 => [1,2,3,5,6,7,8,9,10],5 => [1,2,3,4,6,7,8,9,10],6 => [1,2,3,4,5,7,8,9,10],7 => [1,2,3,4,5,6,8,9,10],8 => [1,2,3,4,5,6,7,9,10],9 => [1,2,3,4,5,6,7,8,10],10 => [1,2,3,4,5,6,7,8,9])true
4>
converged
Convergence time: 0.317 ms
```

Number of nodes vs time for convergence:

Number of nodes	convergence
10	.96ms
100	8.03ms
200	10ms
300	16.21
400	22ms
500	28.27ms
600	35.5ms
700	41.0ms
800	48.91ms
900	59.5ms
1000	75.78ms

Line Topology:

```
4> start:run(100, "line", "pushsum").
neighbor map
#(16 => [15,17],79 => [78,80],18 => [17,19],54 => [53,55],5 => [4,6],65 => [64,66],93 => [92,94],67 => [66,68],19 => [18,20],42 => [41,43],92 => [91,93],94 => [93,95],84 => [83,85],27 => [26,28],49 => [48,50],62 => [61,63],56 => [55,57],70 => [69,71],35 => [34,36],10 => [9,11],24 => [23,25],66 => [65,67],50 => [49,51],53 => [52,54],36 => [35,37],82 => [81,83],4 => [3,5],96 => [95,97],21 => [20,22],87 => [86,88],52 => [51,53],22 => [21,23],17 => [16,18],58 => [57,59],88 => [87,89],98 => [97,99],78 => [77,79],3 => [2,4],8 => [7,9],97 => [96,98],1 => [0,2],99 => [98,99],74 => [73,75],83 => [82,84],7 => [6,8],2 => [1,3],48 => [47,49],14 => [13,15],15 => [14,16],78 => [77,79],20 => [19,21],41 => [40,42],95 => [94,96],77 => [76,78],40 => [39,41],59 => [58,60],13 => [12,14],38 => [37,39],80 => [79,81],51 => [50,52],86 => [85,87],68 => [67,69],72 => [71,73],6 => [5,7],64 => [63,65],91 => [90,92],85 => [84,86],28 => [27,29],25 => [24,26],34 => [33,35],32 => [31,33],76 => [75,77],9 => [8,10],37 => [36,38],11 => [10,12],81 => [80,82],98 => [97,99],31 => [30,32],46 => [45,47],71 => [70,72],100 => [99,101],63 => [62,64],88 => [87,89],69 => [68,70],26 => [25,27],57 => [56,58],48 => [47,49],45 => [44,46],39 => [38,40],43 => [42,44],30 => [29,31],61 => [60,62],89 => [88,90],47 => [46,48],29 => [28,30],23 => [22,24],44 => [43,45],73 => [72,74],12 => [11,13],33 => [32,34])true
5>
converged
Convergence time: 9.869 ms
```

Number of nodes vs time for convergence:

Line	Number of nodes	convergence
10		.423ms
100		8.03ms
200		32.512ms
300		86.21ms
400		78.03ms
500		123.8ms
600		165ms
700		260.58ms
800		322.30ms
900		399.01ms
1000		567ms

2D Topology:

```
> start:run(100, "2D", "pushsum").
#16 => [6,15,6,28],79 => [69,78,69,89],18 => [8,17,8,28],54 => [44,63,44,64],5 => [4,6,16],65 => [55,64,55,75],93 => [83,92,83],67 => [57,66,57,77],19 => [9,18,9,29],42 => [32,41,32,52],92 => [82,91,82],
94 => [84,93,84],84 => [74,83,74,94],27 => [17,26,17,37],49 => [39,48,39,59],62 => [52,61,52,72],56 => [46,55,46,66],78 => [68,69,68,80],35 => [25,34,25,45],10 => [9,28],24 => [14,23,14,34],66 => [56,65,6
6,76],58 => [48,49,68],53 => [43,52,43,63],36 => [26,35,26,46],82 => [72,81,72,92],4 => [3,5,14],96 => [86,95,86],21 => [11,20,11,31],87 => [77,86,77,97],52 => [42,51,42,62],22 => [12,21,12,32],17 => [7,1
6,7,27],65 => [45,54,45,65],58 => [48,57,48,68],98 => [88,89,88,100],75 => [65,74,65,85],3 => [2,4,13],8 => [7,9,18],97 => [87,96,87],1 => [2,11],99 => [89,100,100],74 => [64,73,64,84],83 => [73,82,73,93],
7 => [6,8,17],2 => [1,3,12],68 => [58,59,58,70],14 => [4,13,4,24],15 => [5,14,5,25],78 => [68,77,68,88],20 => [10,19,38],41 => [31,40,31,51],95 => [85,94,85],77 => [67,76,67,87],48 => [38,39,38,50],59 =>
[49,58,49,69],13 => [3,12,3,23],38 => [28,37,28,48],88 => [78,79,78,98],51 => [41,50,41,61],86 => [76,85,76,96],68 => [58,67,58,78],72 => [62,71,62,82],6 => [5,7,16],64 => [54,63,54,74],91 => [92,81,8
=> [75,84,75,95],28 => [18,27,18,38],25 => [15,24,35],34 => [24,33,24,44],32 => [22,31,22,42],76 => [66,75,66,86],9 => [8,10,19],37 => [27,36,27,47],11 => [1,12,21],81 => [71,80,71,91],98 => [88,97,88],31
=> [21,30,21,41],46 => [36,45,36,56],71 => [61,70,61,81],100 => [99,98],63 => [53,62,53,73],88 => [78,87,78,98],69 => [59,68,59,79],26 => [16,25,16,36],57 => [47,56,47,67],48 => [38,47,38,58],45 => [35,4
4,35,55],39 => [29,38,29,49],43 => [33,42,33,53],38 => [28,29,28,40],61 => [51,60,51,71],89 => [79,88,79,99],47 => [37,46,37,57],29 => [19,28,19,39],23 => [13,22,13,33],44 => [34,43,34,54],73 => [63,72,63
,83],12 => [2,11,2,22],33 => [23,34,43]}true
>
converged
Convergence time: 11.924 ms
```

Number of nodes vs time for convergence:

Number of Nodes	Convergence
10	.32ms
100	15.12ms
200	33.98ms
300	69.25ms
400	106.68ms
500	174.09ms
600	234.49ms
700	352.78ms
800	444.69ms
900	478.816ms
1000	689.29ms

Imperfect 3D Topology:

```
[1> start:run(9, "i3D", "pushsum").
#1 => [2,4,5],2 => [1,3,5,6],3 => [2,6,5],4 => [1,5,7,8],5 => [2,4,2,8,9],6 =>
[3,5,3,9],7 => [8,4],8 => [5,9,11],9 => [8,6]}converged
Convergence time: 0.285 ms
true
```

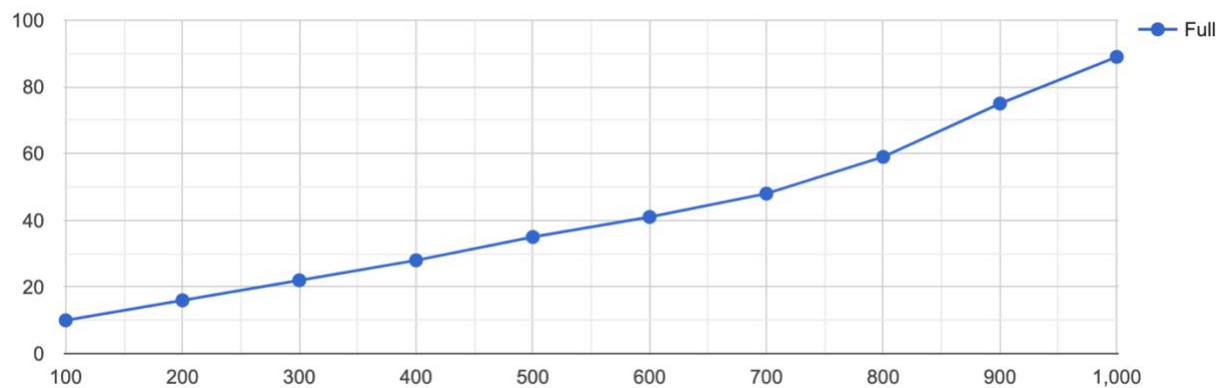
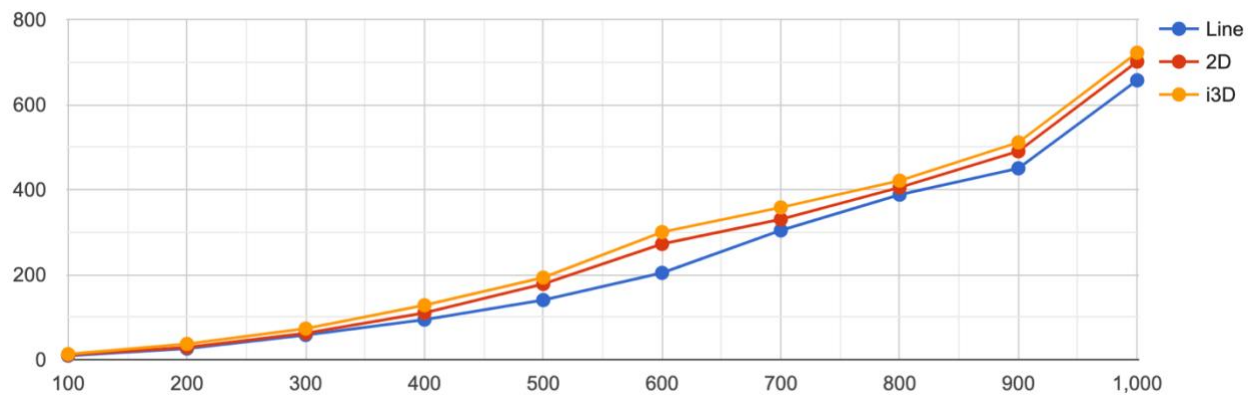
Number of nodes vs time for convergence:

i3D	
Number of Nodes	Convergence
10	.32ms
100	10.53ms
200	29.98ms
300	57.25ms
400	110.68ms
500	171.09ms
600	199.49ms
700	329.78ms
800	400.69ms
900	478.816ms
1000	703.29ms

Graphs for pushsum:

y-axis is number time in milli seconds.

x-axis is the number of nodes.



What is the largest network you managed to deal with for each type of topology and algorithm?

For full topology, the largest we managed to deal was 20k nodes.

For all the other topologies, we managed to deal with upto 15k nodes.