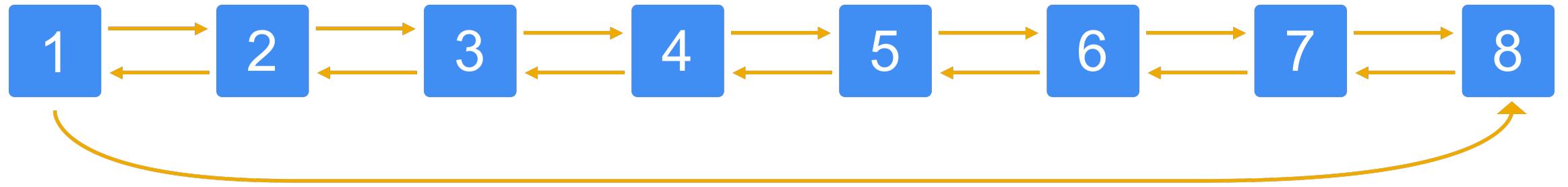


MPI SPARSE – PAGE RANK SIMULATION

Dan Levy

2 STEPS

1. Split up the sparse matrix and vectors
2. Minimize communication



PAGE LINKS

DENSE RANK MATRIX

0	1	2	3	4	5	6	7
0	0.5						
1	0.5		0.5				
2		0.5		0.5			
3			0.5		0.5		
4				0.5		0.5	
5					0.5		0.5
6						0.5	1.0
7	0.5					0.5	

STEP I: SPLIT UP THE DATA

STEP IA: SPLIT RANK MATRIX

8 Pages
4 Processes

Sparse Rank Matrix

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	0.5	0.5

Process 0

0	1	2
0.5	0.5	0.5

Process 1

0	1	2	3
0.5	0.5	0.5	0.5

Process 2

0	1	2	3
0.5	0.5	0.5	0.5

Process 3

0	1	2	3
0.5	1.0	0.5	0.5

STEP I B: SPLIT COLUMN VECTOR

8 Pages
4 Processes

Column Index Vector

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	0	2	1	3	2	4	3	5	4	6	5	7	0	6

Process 0

0	1	2
1	0	2

Process 1

0	1	2	3
1	3	2	4

Process 2

0	1	2	3
3	5	4	6

Process 3

0	1	2	3
5	7	0	6

STEP 1C: SPLIT ROW VECTOR

8 Pages
4 Processes

Row Index Vector

0	1	2	3	4	5	6	7	8
0	1	3	5	7	9	11	13	15

Process 0

0	1	2
0	1	3

Process 1

0	1	2
0	2	4

Process 2

0	1	2
0	2	4

Process 3

0	1	2
0	2	4

STEP 1C: SPLIT Y VECTOR

8 Pages
4 Processes

Y (Page Rank) Vector

0	1	2	3	4	5	6	7
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Process 0

0	1
0.0	0.0

Process 1

0	1
0.0	0.0

Process 2

0	1
0.0	0.0

Process 3

0	1
0.0	0.0

STEP ID: GLOBAL X VECTOR

**8 Pages
4 Processes**

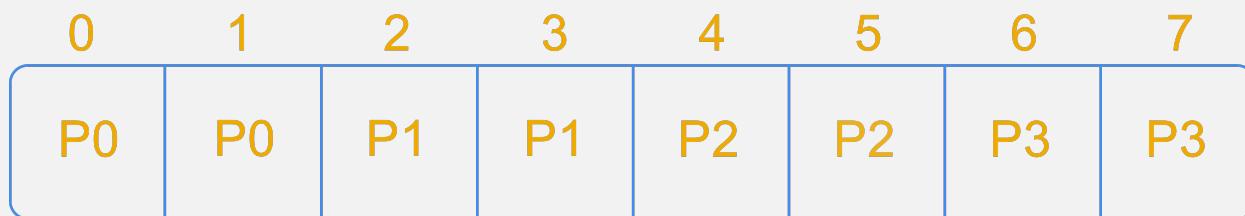
X (Multiply) Vector

STEP 2: MINIMIZE COMMUNICATION

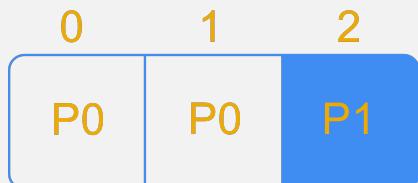
STEP 2: X VECTOR

8 Pages
4 Processes

X Vector Computations



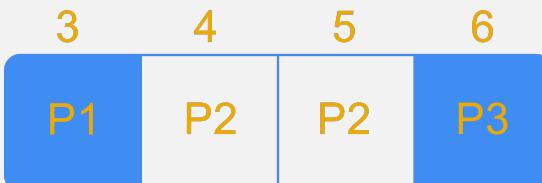
Process 0



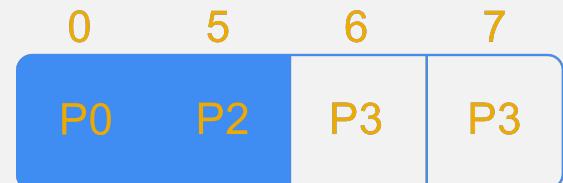
Process 1



Process 2



Process 3



OpenMP Sparse

Procs	Runtime (sec.)	Speedup
1	0.001707	1.000000
2	0.002311	0.738641
4	0.006632	0.257388
8	0.081032	0.021066
16	0.009028	0.189078

SPEEDUP STUDY

16 Pages

MPI Allgather Sparse

Procs	Runtime (sec.)	Speedup
1	0.001035	1.000000
2	0.003723	0.278002
4	0.003423	0.302366
8	0.015487	0.066830
16	4.587890	0.000226

MPI Send/Recv Sparse

Procs	Runtime (sec.)	Speedup
1	0.000898	1.000000
2	0.002835	0.316755
4	0.012240	0.073366
8	0.014347	0.062591
16	14.734795	0.000061

OpenMP Sparse

Procs	Runtime (sec.)	Speedup
1	0.081346	1.000000
2	0.086240	0.943251
4	0.145172	0.560342
8	0.147048	0.553194
16	0.134218	0.606074

SPEEDUP STUDY

1600 Pages

MPI Allgather Sparse

Procs	Runtime (sec.)	Speedup
1	0.072373	1.000000
2	0.068496	1.056602
4	0.061127	1.183978
8	0.056276	1.286037
16	31.336738	0.002310

MPI Send/Recv Sparse

Procs	Runtime (sec.)	Speedup
1	0.073745	1.000000
2	0.053150	1.387488
4	0.036749	2.006721
8	0.016838	4.379677
16	2.824470	0.026109

QUESTIONS?