Parallel N-Sized Sudoku Solving

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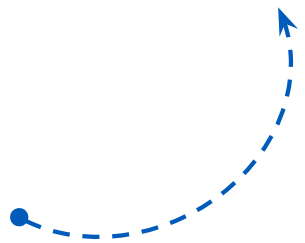
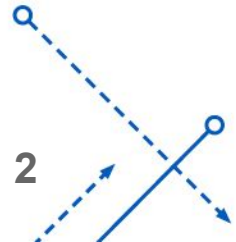
The Standard Problem

- A 9 x 9 grid of numbers
- Objective: place numbers such that each column, row, and subgrid contains one of each number 1 - 9

	2				4	3		
9				2				8
			6		9		5	
								1
	7	2	5		3	6	8	
6								
	8		2		5			
1				9				3
		9	8				6	

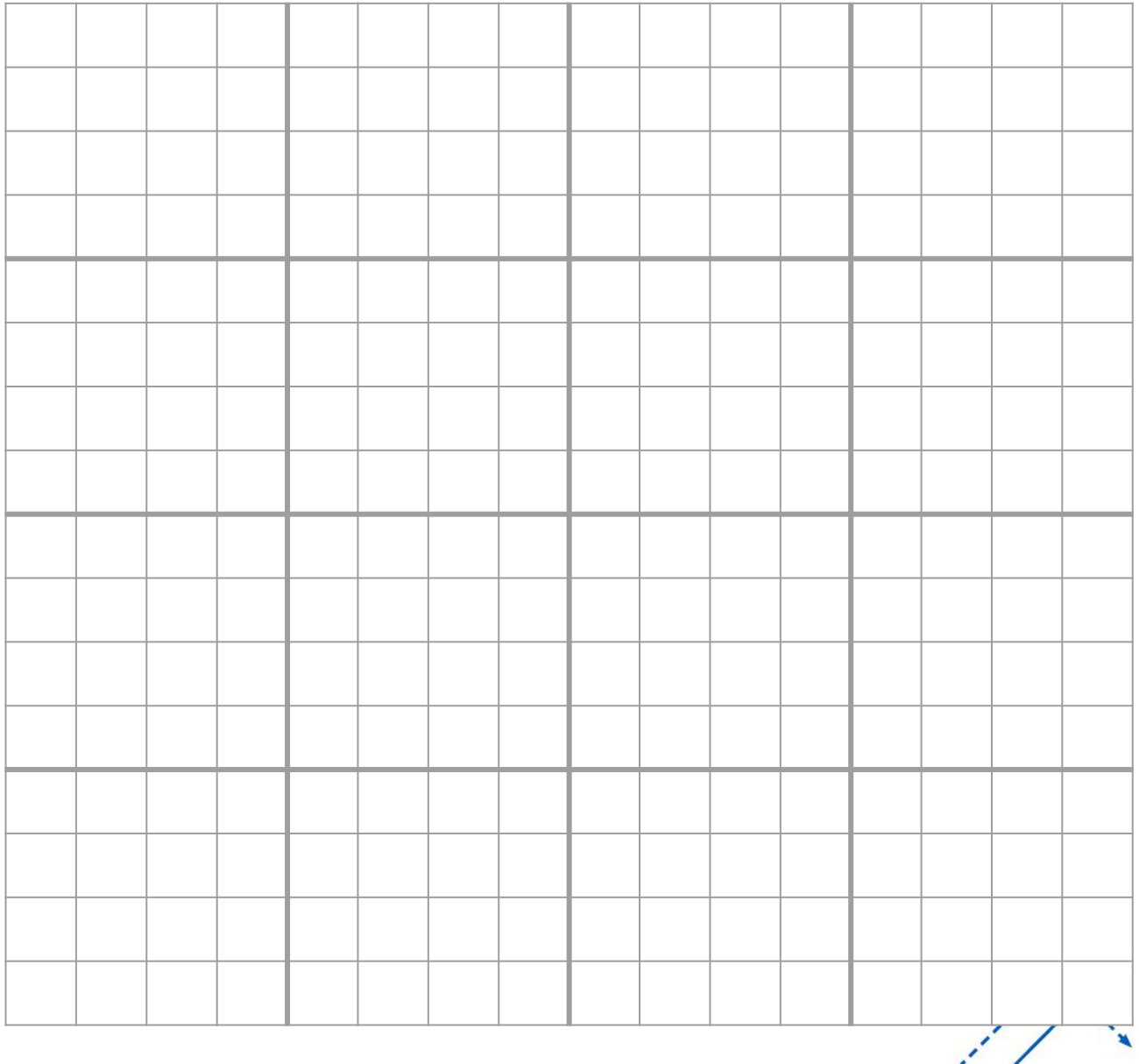
8	2	7	1	5	4	3	9	6
9	6	5	3	2	7	1	4	8
3	4	1	6	8	9	7	5	2
5	9	3	4	6	8	2	7	1
4	7	2	5	1	3	6	8	9
6	1	8	9	7	2	4	3	5
7	8	6	2	3	5	9	1	4
1	5	4	7	9	6	8	2	3
2	3	9	8	4	1	5	6	7





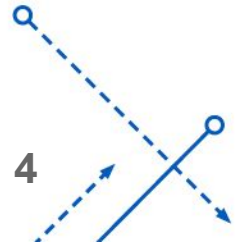
The Expanded Problem

- A n x n grid of numbers
- Objective: place numbers such that each column, row, and subgrid contains one of each number (1 - n)



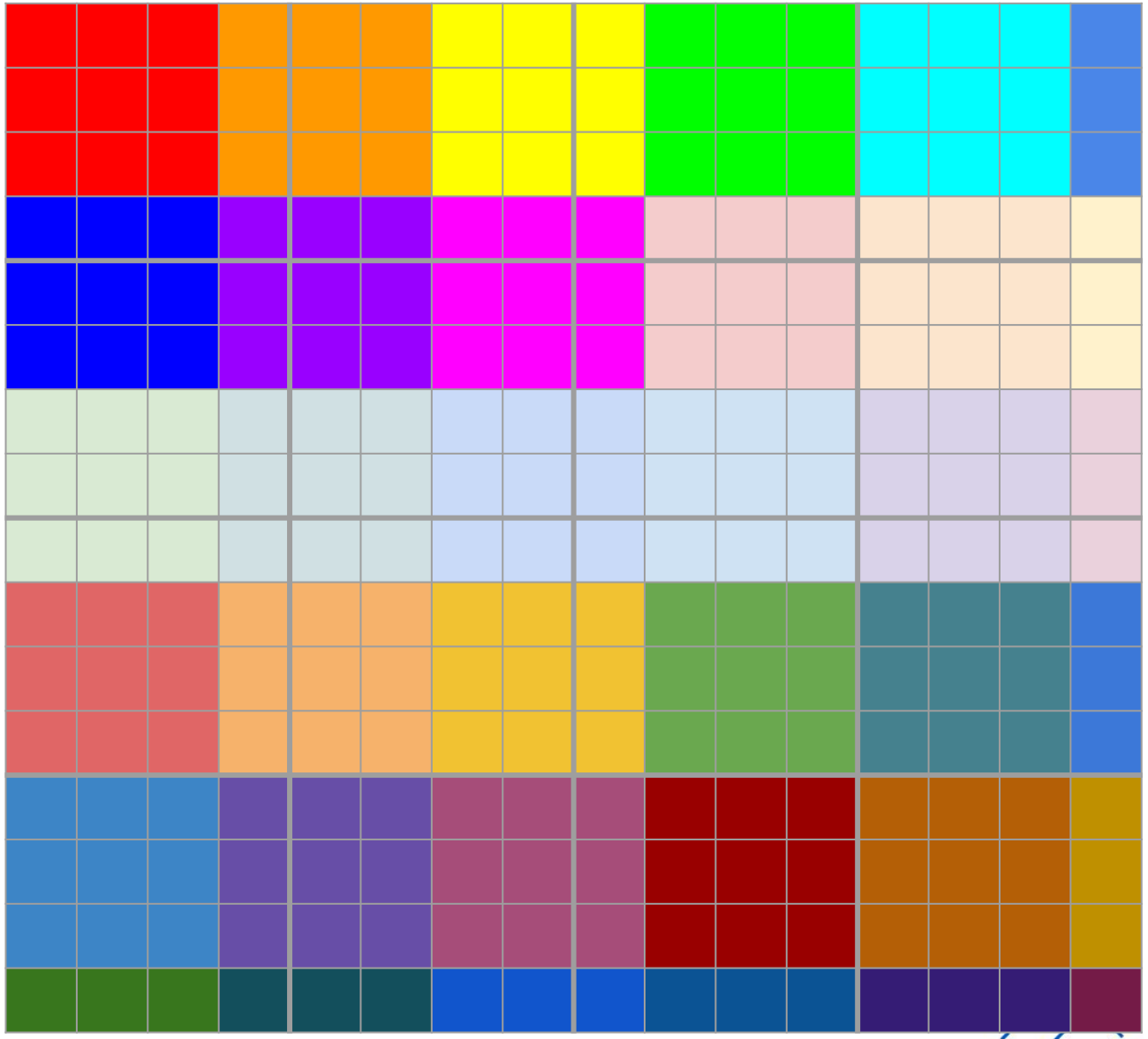
Solving Techniques

- Only one possible number can fit in a cell -> Insert into solution
- Only one cell in an entire row, column, or sub-grid can contain a number -> Insert into solution
- A set of x number of cells in a row, column, or sub-grid is known to contain a set of exactly x unique digits -> Remove numbers in x from possibilities for other cells in the same row, column, or sub-grid



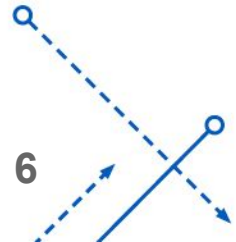
Partitioning the Data

- Divide into small square grids
- Only need to know info from rows, column, and sub-grids intersected
- Keeps the cells from needing to know about the entire board



Parallel Algorithm

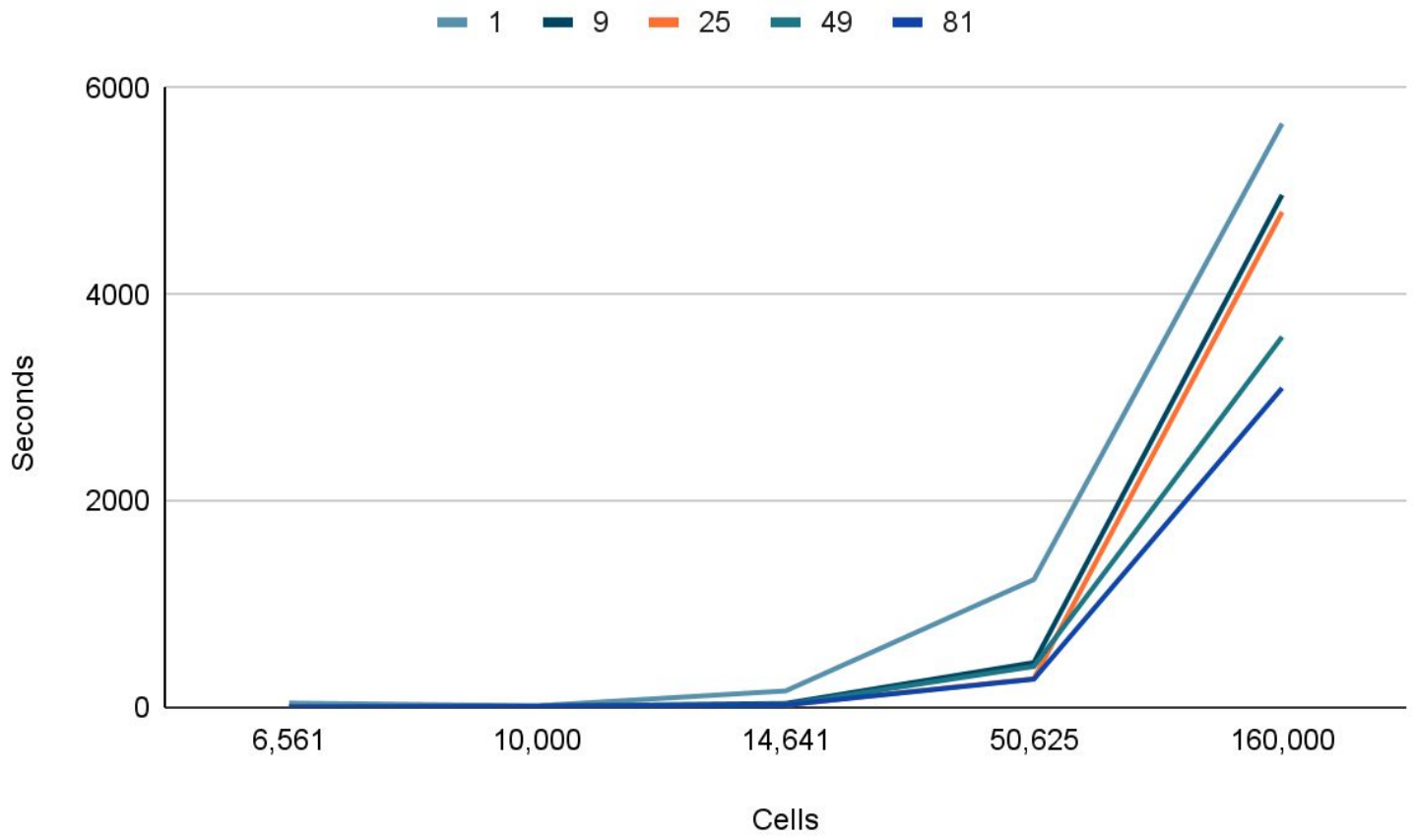
- Each node keeps tries to find the solution for the cells it is responsible for
- As parts of the solution are found, communicate with other nodes that could be affected
- As possibilities are eliminated, communicate that with other nodes as well



Results - Average Runtimes

Processes	81x81 (6,561 Cells)	100x100 (10,000 Cells)	121x121 (14,641 Cells)	225x225 (50,625 Cells)	400x400 (160,000 Cells)
1	42 Seconds	16 Seconds	160 Seconds	1,239 Seconds	5,656 Seconds
9	7 Seconds	13 Seconds	39 Seconds	435 Seconds	4,965 Seconds
25	6 Seconds	9 Seconds	25 Seconds	278 Seconds	4,800 Seconds
49	5 Seconds	10 Seconds	27 Seconds	397 Seconds	3,590 Seconds
81	4 Seconds	10 Seconds	25 Seconds	274 Seconds	3,094 Seconds

Results - Average Runtimes



Results - Average Speedup

Processes	81x81 (6,561 Cells)	100x100 (10,000 Cells)	121x121 (14,641 Cells)	225x225 (50,625 Cells)	400x400 (160,000 Cells)
1	N/A	N/A	N/A	N/A	N/A
9	5.99	1.24	4.11	2.85	1.14
25	7.70	1.81	6.40	4.45	1.18
49	8.72	1.56	5.77	3.12	1.58
81	11.25	1.51	6.42	4.52	1.83