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Project: Parallel Implementation of Iterative Solvers
Lab Course 2

Domain Decomposition and Inter Process Communication

The n x n grid of internal points were numbered using a 2D coordinate system where the variables (i,j) were integer numbers. These coordinates were in turn indexed lexicographically from 1 to (n^2-1). The following two diagrams show the lexicographical indices and the integer coordinates of an 8x8 grid respectively. Each box represents a grid point.

56	57	58	59	60	61	62	63
48	49	50	51	52	53	54	55
40	41	42	43	44	45	46	47
32	33	34	35	36	37	38	39
24	25	26	27	28	29	30	31
16	17	18	19	20	21	22	23
8	9	10	11	12	13	14	15
0	1	2	3	4	5	6	7

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

The coordinates (1,1) correspond to index 0, (2,1) to index 1 and so on.

A square grid of processes was set up and the indices of the n x n grid were initialized in their respective processes. Each process holds the lexicograhpical indices of the n x n grid in an array of size nbar x nbar where nbar = n/(sqrt(p)), where p is the number of processes (a square number). The array is named ‘A’ in the codes provided. The following diagram shows the distribution of the lexicographical indices of a 8x8 grid across 4 processes. Each colour represents one unique process.

56	57	58	59	60	61	62	63
48	49	50	51	52	53	54	55
40	41	42	43	44	45	46	47
32	33	34	35	36	37	38	39
24	25	26	27	28	29	30	31
16	17	18	19	20	21	22	23
8	9	10	11	12	13	14	15
0	1	2	3	4	5	6	7

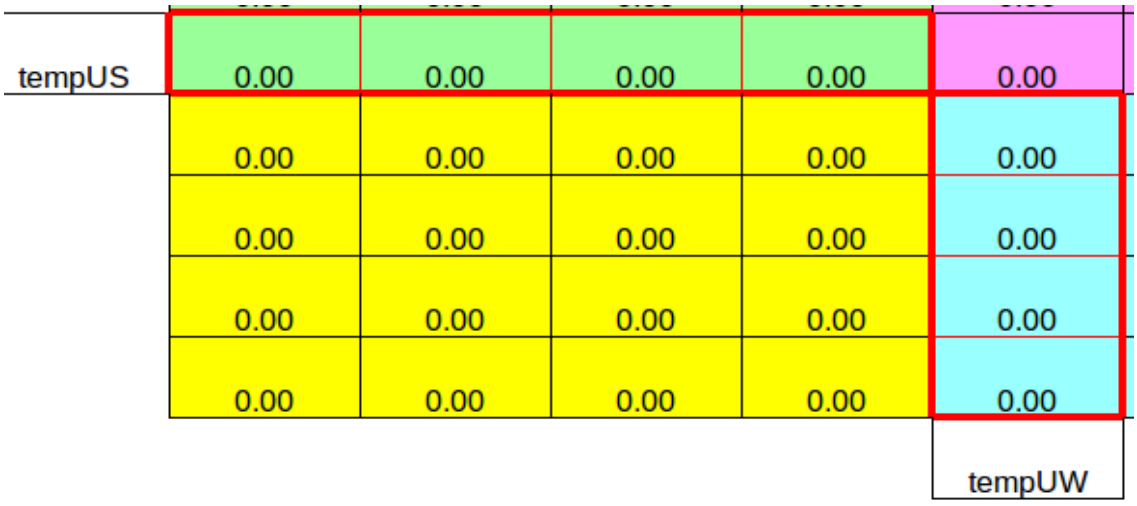
Furthermore, along with array ‘A’, an array named ‘U’ was also setup in a simillar fashion. This held the values of u for the corresponding indices from A. The setup of U is shown below.

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

As can be seen above, each process holds sixteen lexicographical indices in an array ‘A’ and the corresponding values of u in an array ‘U’.

To transmit the values of ‘U’ at the interface of two processes, a series of send and receive commands were introduced. These values were stored in arrays named tempUX, where X represents the direction in which the interface occurs.

For example, tempUN is the northern most row of values of each process and needs to be sent to the process that is to the north of the current process. The diagram shown below shows the yellow process after having received the required values of U. It has received 'tempUS' from the green process and tempUW from the blue process. They have been outlined in red. Along with the values of U, the lexicographical indices on which they occur were also sent in tempAx arrays in a simillar fashion.



Scaling Study

The following diagram shows the scaling study of the Jacobi and the SOR method (omega=1.8) for a 144 x 144 grid, for the test example given.