HW3
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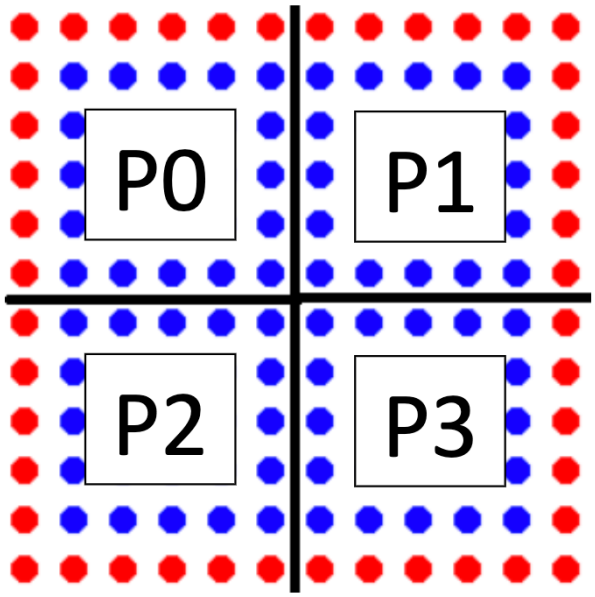
Problem

You must perform a 2D domain decomposition using MPI. Your code has to properly work for exactly 4 processes (np = 4), such that:



Solution

I used Fortran to solve the 2D Laplace decomposition.
The original solution divided the matrix into 4 processes horizontally, and the objective of this assignment is to divide matrix into cross-shaped sections. The solution code already solved most of the assignment. The only major modification of the code was the part sending and receiving the rows and columns. The pseudo-code is shown below.

Row exchange:
If (rank = 0 or 1):
    MPI_Send(xlocal(last row, all columns), …, 2 or 3(receiving process), …)
If (rank = 2 or 3):
    MPI_Recv(xlocal(first row, all columns), …, 0 or 1(sending process), …)
If (rank = 2 or 3):
    MPI_Send(xlocal(second row, all columns), …, 0 or 1(receiving process), …)
If (rank = 2 or 3):
    MPI_Recv(xlocal(last row, all columns), …, 2 or 3(sending process), …)

Column exchange:
If (rank = 0 or 2):
    MPI_Send(xlocal(all row, last column), …, 1 or 3(receiving process), …)
If (rank = 1 or 3):
    MPI_Recv(xlocal(all row, first columns), …, 0 or 2(sending process), …)
If (rank = 1 or 3):
    MPI_Send(xlocal(all row, second columns), …, 0 or 2(receiving process), …)
If (rank = 0 or 2):
    MPI_Recv(xlocal(all row, last columns), …, 1 or 3(sending process), …)

The result of the 2D decomposition is shown below:

At iteration 1 diff is 3.984344E+00
At iteration 2 diff is 1.824315E+00
At iteration 3 diff is 1.264177E+00
At iteration 4 diff is 9.979838E-01
At iteration 5 diff is 8.355507E-01
At iteration 6 diff is 7.208148E-01
At iteration 7 diff is 6.332607E-01
At iteration 8 diff is 5.636390E-01
At iteration 9 diff is 5.068933E-01
At iteration 10 diff is 4.598256E-01
At iteration 11 diff is 4.202215E-01
At iteration 12 diff is 3.864696E-01
At iteration 13 diff is 3.573663E-01
At iteration 14 diff is 3.319991E-01
At iteration 15 diff is 3.096694E-01
At iteration 16 diff is 2.898372E-01
At iteration 17 diff is 2.720816E-01
At iteration 18 diff is 2.560715E-01
At iteration 19 diff is 2.415434E-01
At iteration 20 diff is 2.282857E-01
At iteration 21 diff is 2.161264E-01
At iteration 22 diff is 2.049245E-01
At iteration 23 diff is 1.945631E-01
At iteration 24 diff is 1.849445E-01
At iteration 25 diff is 1.759862E-01
At iteration 26 diff is 1.676184E-01
At iteration 27 diff is 1.597810E-01
At iteration 28 diff is 1.524227E-01
At iteration 29 diff is 1.454989E-01
At iteration 30 diff is 1.389709E-01

At iteration 31 diff is 1.328048E-01
At iteration 32 diff is 1.269711E-01
At iteration 33 diff is 1.214434E-01
At iteration 34 diff is 1.161988E-01
At iteration 35 diff is 1.112167E-01
At iteration 36 diff is 1.064787E-01
At iteration 37 diff is 1.019685E-01
At iteration 38 diff is 9.767141E-02
At iteration 39 diff is 9.357404E-02
At iteration 40 diff is 8.966440E-02
At iteration 41 diff is 8.593151E-02
At iteration 42 diff is 8.236541E-02
At iteration 43 diff is 7.895693E-02
At iteration 44 diff is 7.569765E-02
At iteration 45 diff is 7.257983E-02
At iteration 46 diff is 6.959626E-02
At iteration 47 diff is 6.674029E-02
At iteration 48 diff is 6.400571E-02
At iteration 49 diff is 6.138671E-02
At iteration 50 diff is 5.887788E-02
At iteration 51 diff is 5.647412E-02
At iteration 52 diff is 5.417063E-02
At iteration 53 diff is 5.196291E-02
At iteration 54 diff is 4.984670E-02
At iteration 55 diff is 4.781797E-02
At iteration 56 diff is 4.587291E-02
At iteration 57 diff is 4.400789E-02
At iteration 58 diff is 4.221947E-02
At iteration 59 diff is 4.050440E-02
At iteration 60 diff is 3.885955E-02
At iteration 61 diff is 3.728198E-02
At iteration 62 diff is 3.576885E-02
At iteration 63 diff is 3.431747E-02
At iteration 64 diff is 3.292526E-02
At iteration 65 diff is 3.158978E-02
At iteration 66 diff is 3.030867E-02
At iteration 67 diff is 2.907968E-02
At iteration 68 diff is 2.790068E-02
At iteration 69 diff is 2.676960E-02
At iteration 70 diff is 2.568447E-02
At iteration 71 diff is 2.464343E-02
At iteration 72 diff is 2.364465E-02

At iteration 73 diff is 2.268641E-02
At iteration 74 diff is 2.176706E-02
At iteration 75 diff is 2.088501E-02
At iteration 76 diff is 2.003874E-02
At iteration 77 diff is 1.922680E-02
At iteration 78 diff is 1.844778E-02
At iteration 79 diff is 1.770035E-02
At iteration 80 diff is 1.698322E-02
At iteration 81 diff is 1.629516E-02
At iteration 82 diff is 1.563499E-02
At iteration 83 diff is 1.500157E-02
At iteration 84 diff is 1.439383E-02
At iteration 85 diff is 1.381072E-02
At iteration 86 diff is 1.325124E-02
At iteration 87 diff is 1.271442E-02
At iteration 88 diff is 1.219936E-02
At iteration 89 diff is 1.170517E-02
At iteration 90 diff is 1.123101E-02
At iteration 91 diff is 1.077605E-02
At iteration 92 diff is 1.033952E-02
At iteration 93 diff is 9.920685E-03

The total time elapsed for each process is shown below:

Process 0:	0.013891129 s
Process 1:	0.013885629 s
Process 2:	0.013892082 s
Process 3:	0.013904254 s
Total Time Elapsed:	0.05557309 s