

# COMP 605 - HW03

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## 2D Domain Decomposition using MPI

Figure 1 below is an screenshot of the solution convergence of Process 0. The Stopping conditions were a error tolerance level of  $1.0e^{-2}$  and the maximum number iterations of iterations to 100. The difference between the updated values and the old values fell below the tolerance threshold, and the solution for Process 0 converged in 93 iterations.

```
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
Total Time Elapsed (avg): 0.002549s
```

Figure 1: Solution Convergence (Process 0)

(NOTE: Refer to code in the file jacobi-mpi.c and Makefile for MPI compilation and execution)

## Final Solution matrix [12x12]

-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
0	-0.45461	-0.61251	-0.67135	-0.68978	-0.68477	-0.65920	-0.60856	-0.51817	-0.34699	0.02713	1
0	-0.20649	-0.32511	-0.38459	-0.40476	-0.39203	-0.34537	-0.25864	-0.11859	0.10204	0.45495	1
0	-0.04728	-0.09886	-0.13992	-0.15601	-0.13689	-0.07528	0.03458	0.19760	0.41677	0.68957	1
0	0.1148	0.11407	0.07584	0.05279	0.07063	0.14138	0.26992	0.45368	0.67504	0.88510	1
0	0.39056	0.36114	0.27168	0.21501	0.21903	0.29405	0.44431	0.66742	0.94121	1.17403	3
2	1.08439	0.66458	0.42955	0.31031	0.28967	0.36469	0.53961	0.82530	1.24465	1.68786	3
2	1.28050	0.77954	0.46646	0.30079	0.25787	0.32862	0.51791	0.84431	1.34051	2.05082	3
2	1.25629	0.70320	0.35121	0.16276	0.10616	0.16776	0.35335	0.68873	1.21883	1.99314	3
2	1.03999	0.42294	0.06845	-0.11190	-0.16897	-0.12231	0.03422	0.33444	0.85009	1.70142	3
2	0.47966	-0.12191	-0.39131	-0.51325	-0.55157	-0.52599	-0.43202	-0.23812	0.14361	0.96140	3
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1

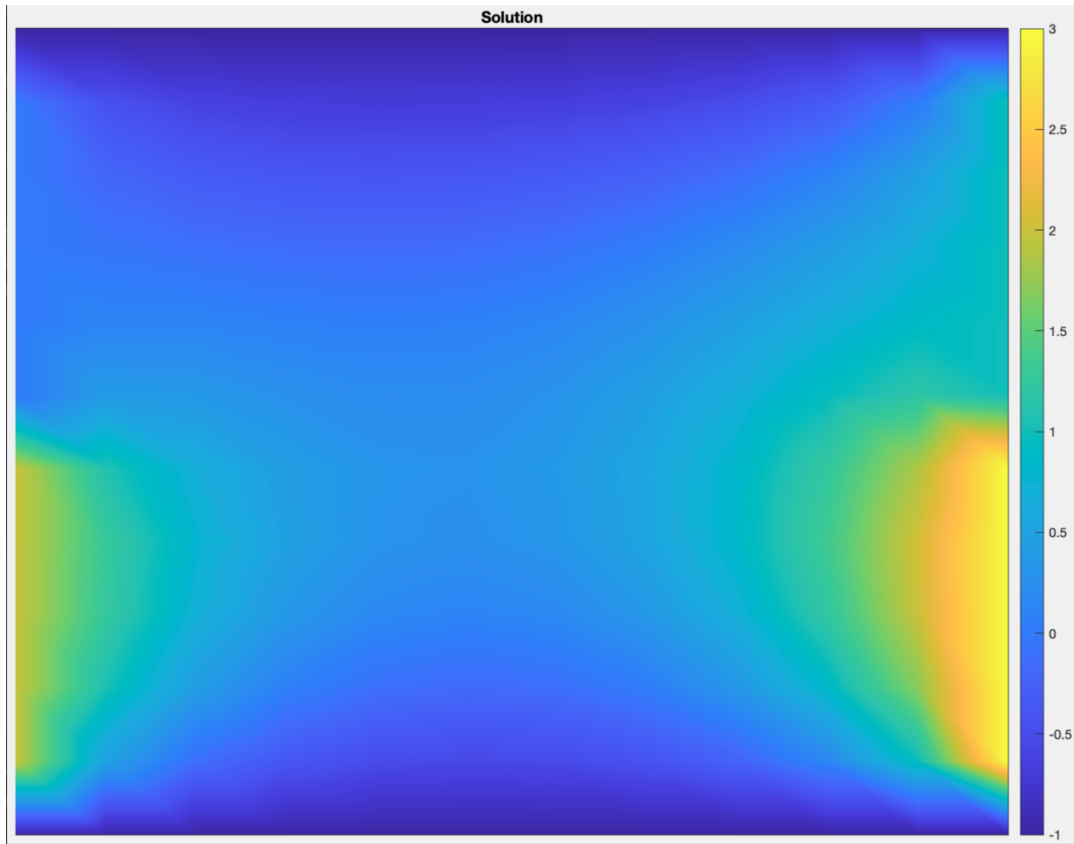


Figure 2: Approximated Solution for the 2D Laplace Equation

Figure 2 shows a heatmap of the approximated solution calculated using a simple Jacobi iteration and a 2D (bricks) domain decomposition between 4 processes. The size of the local array for each of the different process ranks were  $7 \times 7$ , where the two extra rows and columns simply acted as ghostpoints. I printed the final solution at each different process and combined the values to get the final solution matrix shown above. (Boundary Conditions and Initial conditions were used)