CP 431/631 Assignment 2  
**By group 2 (Omer Tal, Elizabeth Gorbonos, Tianran Wang)**

1. Assignment description:

The assignment is to write the parallel merging algorithm to merge two large randomly generated sorted arrays *A* and *B*.

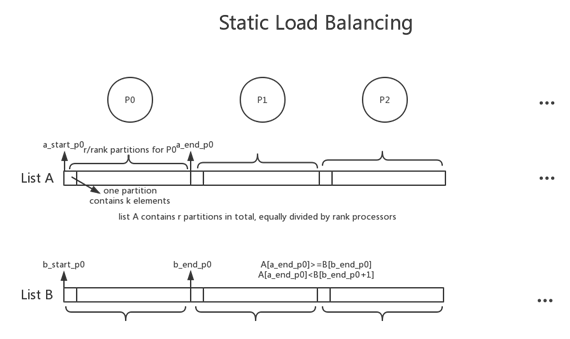
To accomplish this, we have written a MPI python 3 program ([appendix 1](#_Appendix_1_:)).

We assume the arrays are of the same length which is a power of two (), *k* is a command line parameter.

First, we calculate the number of partitions to split both arrays into. Each partition of array A will consist of *k* elements, besides possibly the last one. We then generate the two random sorted arrays *A* and *B* of length *n* in process 0 and broadcast them to all other processes.

The work division is done by a method of static load balancing, each process calculates the range of partitions in array *A* to works on according to: .

Each process’s range starts from partition: .



For each partition we perform a binary search to find the index in array *B* which stores the largest element (in B) that is smaller than the largest element in . is the upper bound of the corresponding partition . The lower bound of is equal to the upper bound of .

The lower bound of for all *p* > 0 is received from process *p*-1 (upper bound +1 of ).

Every partition is then merged by its process and added to a list in an ascending order. The merged lists are gathered by process 0, resulting in a sorted list of lists.

The final product is tested for correctness and written to a file by process 0.

1. Results:

We benchmarked the parallel section of the program, neglecting the array generation and output. The following benchmarks are based on merging arrays *A* and *B* of size each.

Due to the large size of the output files we are only attaching the logs of Orca’s sqsub ([appendix 2](#_Appendix_2:_Program)) and a print screen of a sample output. The full output files are available in /scratch/otwluq1/a2/.

|  |  |  |
| --- | --- | --- |
| Data size (n) | Number of CPUs | Time (seconds) |
|  | 2 | 8.67 |
| 3 | 6.21 |
| 4 | 4.82 |
| 5 | 4.25 |
| 6 | 3.41 |
| 7 | 2.98 |
| 8 | 2.92 |

# Appendix 1 : Program code











# Appendix 2: Program logs

2 Processor:  
  
Done with input stage  
Total time to compute: 8.667797 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_12098.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927619  
 exit status: 0  
 cpu time: 50s / 2.0h (0 %)  
 elapsed time: 33s / 1.0h (0 %)  
 virtual memory: 784.9M / 1.0G (76 %)  
  
Job completed successfully  
  
--------------------------------------------------------------------------  
3 Processor:  
  
Done with input stage  
Total time to compute: 6.214778 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_12165.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927620  
 exit status: 0  
 cpu time: 64s / 3.0h (0 %)  
 elapsed time: 32s / 1.0h (0 %)  
 virtual memory: 263.3M / 1.0G (25 %)  
  
Job completed successfully  
  
--------------------------------------------------------------------------  
4 Processor:  
  
Done with input stage  
Total time to compute: 4.816678 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_11544.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927621  
 exit status: 0  
 cpu time: 79s / 4.0h (0 %)  
 elapsed time: 32s / 1.0h (0 %)  
 virtual memory: 401.4M / 1.0G (39 %)  
  
Job completed successfully  
  
--------------------------------------------------------------------------  
5 Processor:  
  
Done with input stage  
Total time to compute: 4.247634 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_9748.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927622  
 exit status: 0  
 cpu time: 104s / 5.0h (0 %)  
 elapsed time: 31s / 1.0h (0 %)  
 virtual memory: 520.8M / 1.0G (50 %)  
  
Job completed successfully  
  
--------------------------------------------------------------------------  
6 Processor:  
Done with input stage  
Total time to compute: 3.405965 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_27651.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927623  
 exit status: 0  
 cpu time: 105s / 6.0h (0 %)  
 elapsed time: 24s / 1.0h (0 %)  
  
Job completed successfully  
  
  
--------------------------------------------------------------------------  
7 Processor:  
  
Done with input stage  
Total time to compute: 2.980946 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_27727.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927624  
 exit status: 0  
 cpu time: 121s / 7.0h (0 %)  
 elapsed time: 28s / 1.0h (0 %)  
 virtual memory: 613.4M / 1.0G (59 %)  
  
Job completed successfully  
  
  
--------------------------------------------------------------------------  
8 Processor:  
  
Done with input stage  
Total time to compute: 2.916491 seconds  
Tested and found correct  
Sucessfully wrote results to file /scratch/otwluq1/a2/output\_27803.txt  
--- SharcNET Job Epilogue ---  
 job id: 10927625  
 exit status: 0  
 cpu time: 136s / 8.0h (0 %)  
 elapsed time: 27s / 1.0h (0 %)  
 virtual memory: 117.2M / 1.0G (11 %)  
  
Job completed successfully

Output File Sample:

