

CS3210 Lab 4

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Hardware Specification

- i7-7700 has 4 physical cores, where each core has 2 hardware threads.
- xs-4114 has 10 physical cores, where each core has 2 hardware threads.

Exercise 13

There is not much difference in terms of overall execution time between the three configurations. Refer to appendix.

The computation time is quite similar for all the configurations, which is expected. This is because the workload distribution for each worker (i.e. the size of the matrix) is determined based on the number of processes that we launched.

However, on i7-7700, notice that the communication time of worker 3 is much longer than that of the other workers. I believe this is because there are only 4 physical cores on i7-7700, but we were launching 5 processes (i.e. 1 for master and 4 for workers). Therefore, two processes shared the same physical core and presumably ran on different hardware threads, thus the slower communication time observed due to blocking communications and overhead of hyperthreading. If we increase the number of processes, e.g. to 9, we would notice similar behavior, that worker 3 to 7 have significantly slower communication time.

The overall execution time of the program is bounded by the process with the longest communication and computation time.

Exercise 14

There are only 8 logical cores on i7-7700. The option `--overcommit` allowed us to launch more than one task per CPU, so we were able to launch 9 processes on the second configuration. Refer to appendix.

A significant performance downgrade is observed because the hardware does not have enough cores to execute all the processes in parallel, even with hyperthreading. Notice that the communication time for all the processes are quite similar, presumably due to some sort of task scheduling employed by the OS.

As the number of processes increases, the bottleneck of the performance is the duration of the longest communication time, since the cost of computation is relatively small.

Exercise 15

Change all the blocking communications to non-blocking (e.g. use `MPI_Isend` and `MPI_Irecv`). To maintain correctness, we need to ensure that all the data were received by the workers before they can carry on with the matrix computation.

Appendix

Note: some details are omitted.

```
$ srun -n 5 -p i7-7700 /nfs/home/$USER/mm-mpi 2048

--- WORKER 0: communication_time= 0.21 seconds; computation_time= 18.09 seconds
--- WORKER 1: communication_time= 0.21 seconds; computation_time= 26.40 seconds
--- WORKER 2: communication_time= 0.25 seconds; computation_time= 26.35 seconds
--- WORKER 3: communication_time= 8.45 seconds; computation_time= 18.16 seconds
--- MASTER 4: total time= 26.61 seconds

$ srun -n 5 -p xs-4114 /nfs/home/$USER/mm-mpi 2048

--- WORKER 0: communication_time= 0.31 seconds; computation_time= 28.90 seconds
--- WORKER 1: communication_time= 0.76 seconds; computation_time= 28.45 seconds
--- WORKER 2: communication_time= 1.04 seconds; computation_time= 28.17 seconds
--- WORKER 3: communication_time= 0.31 seconds; computation_time= 29.11 seconds
--- MASTER 4: total time= 29.42 seconds

$ srun -n 5 --nodes 2 --constraint="i7-7700*1_xs-4114*1" /nfs/home/$USER/mm-mpi 2048

--- WORKER 1: communication_time= 0.79 seconds; computation_time= 27.08 seconds
--- WORKER 0: communication_time= 0.79 seconds; computation_time= 27.34 seconds
--- WORKER 2: communication_time= 0.81 seconds; computation_time= 27.35 seconds
--- WORKER 3: communication_time= 10.51 seconds; computation_time= 17.67 seconds
--- MASTER 4: total time= 28.17 seconds
```

```
$ srun -n5 -N1 -p i7-7700 /nfs/home/$USER/mm-mpi 256

--- WORKER 1: communication_time= 0.01 seconds; computation_time= 0.03 seconds
--- WORKER 3: communication_time= 0.01 seconds; computation_time= 0.04 seconds
--- WORKER 2: communication_time= 0.01 seconds; computation_time= 0.04 seconds
--- WORKER 0: communication_time= 0.01 seconds; computation_time= 0.04 seconds
--- MASTER 4: total time= 0.05 seconds

$ srun -n9 -N1 --overcommit -p i7-7700 /nfs/home/$USER/mm-mpi 256

--- WORKER 0: communication_time= 7.95 seconds; computation_time= 0.01 seconds
--- WORKER 1: communication_time= 7.95 seconds; computation_time= 0.02 seconds
--- WORKER 2: communication_time= 7.95 seconds; computation_time= 0.02 seconds
--- WORKER 3: communication_time= 7.95 seconds; computation_time= 0.02 seconds
--- WORKER 5: communication_time= 7.96 seconds; computation_time= 0.01 seconds
--- WORKER 4: communication_time= 7.96 seconds; computation_time= 0.01 seconds
--- WORKER 7: communication_time= 7.96 seconds; computation_time= 0.02 seconds
--- WORKER 6: communication_time= 7.96 seconds; computation_time= 0.02 seconds
--- MASTER 8: total time= 7.96 seconds
```