High Performance Computing
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Assignment 5 (due April 29, 2019)

Note: All CPU computations were performed with an Intel Core i7-8750H Processor with base frequency 2.20 GHz. The maximum main memory bandwidth is 41.8 GB/s. At 16 double precision operations per cycle, the theoretical max flop rate would be about 35.2 GFlops/s. It has 6 cores and can reach 12 threads through hyper-threading.

1. **MPI Ring Communication** Ring communication was implemented using MPI. The 0th process is given the value 0, which then gets passed cyclically to each process and gets that process's rank added to it. This is repeated N times, and the result is compared to the expected solution, $NM(M-1)/2$, where M is the number of processes. We use this to estimate the latency of message passing, and then pass a 2 MB array to test bandwidth. We use $N = 10000$ and get the following results:

Processes	Latency (ms)	Bandwidth (GB/s)
2	0.00057	2.32
3	0.00178	1.2
4	0.0018	0.75
5	0.002	0.55

Table 1: Latency and Bandwidth for message passing using MPI as a function of number of processes.

From here we see that as we increase the number of processes, the latency increases and the bandwidth decreases. This is to be expected as it takes longer to communicate when processes are not on the same core.

I attempted to run MPI over a network using the different Crunchy servers, but the code kept hanging. I am not sure why.

2. **Project**

Project: A parallel implementation of the IB method		
Week	Work	Who
04/15-04/21	Think about algorithm. How to do spread in parallel? OpenMP or MPI? Which FFT library to use?	AT, TG, OM
04/22-04/28	Write OpenMP version of spread and interpolate	OM
04/22-04/28	Research OpenMP, MPI FFTW algorithms	TG, AT
04/29-05/05	Write parallel fluid solver	TG, AT
04/29-05/05	Write C++ initialization routines, force calculation	OM
05/06-05/12	Finish implementation, think about possible GPU or MPI implementation of spread and interpolate	AT, TG, OM
05/13-05/19	Run scalability tests, work on presentation slides and report	TG, AT, OM