CiiC4019/ICOM 6025
High Performance Computing
Project Description

Description

The purpose of this project is to give you hands-on experience in high performance computing. Students are expected to submit a final project report and perform a public demonstration.

Deliverables

- **Project proposal (2-3 pages)** (**Due: Nov 18; 10%)**
  - Describe the problem to be solved
  - State the specific objectives of the project
  - Discuss the scope of the project

- **Project Report (Due: Jan 18; 20%)**
  - Describe the technical approach to the problem
  - Describe performance metrics and experimental settings
  - Describe infrastructures and programming models used
  - Discuss the experimental results
  - Provide sound conclusions and discuss future work

- **10 minutes Demo** (**Due: TBD Final Exam; 10%)**
  - Project code is working properly and available at GitHub
  - Presentation is clear and concise

List of Potential Projects

- **Physical simulation:** implement a high-resolution fluid simulation, rigid body solver, cloth simulation
  - Dr. Juan Eduardo Ramirez
  - Dr. Ubaldo Cordova Group
- **Computer vision:** image similarity search in a large image database
- **Numerical Solvers:** Implement a parallel linear solver (using the conjugate-gradient or multi-grid method)
  - Dr. Gustavo Gutierrez
- **Performance Analysis:** improve algorithm performance or develop performance analysis
  - **problem-based parallel algorithm benchmark suite**
  - Compare the performance of different parallel algorithms for the same task on different machines Implement a lock-free data structure.
  - Performance of Data compression (throughput and compression rate)
- **Machine Learning Applications** on big data.
  - Google's Inception net (**here** or **here**)
  - Fully Convolutional Networks (**here**)
  - Spatial transformer networks (**here**)
  - Deep Residual Learning for Image Recognition (**here** or **here**)
  - 1-bit DNNS (**here**)
  - Deep compression (**here**)
  - Composing networks (**here**)
- **Trinity** (http://trinityrnaseq.github.io/) is a memory intensive bioinformatics application. It partitions sequence data into graphs, and then processes each graph independently. A good project is to research approaches to mitigate the data movement between the last level cache and memory.

- **Repast HPC** (http://repast.sourceforge.net/repast_hpc.html) is an agent based modeling program written in C++. Repast (like all other agent based modelers) run on GPUs, but may be ported to the Xeon Phi.

- **The Weather Research and Forecasting model (WRF)** is a next- generation mesoscale numerical weather prediction system designed to serve both atmospheric research and operational forecasting needs (http://www.wrf-model.org/index.php). Investigate a hybrid implementation using MPI and OpenMP.

- **MILC** (http://www.physics.utah.edu/~detar/milc/) is a set of codes written in C developed by the MIMD Lattice Computation (MILC) collaboration for doing simulations of four dimensional SU(3) lattice gauge theory on MIMD parallel machines. From preliminary investigation, it seems that there is some support for OpenMP in the MILC codebase, leading us to be optimistic about the potential of running MILC on the Xeon Phi accelerators.