1 Introduction

1.1 Grading

- Homework $\approx \frac{1}{3}$ grade
- Final exam $\approx \frac{1}{3}$ grade
- Project $\approx \frac{1}{3}$ grade

1.2 Course Outline

- Intro to HPC
- Parallelization using MPI
- Program opt: serial, parallel
- Overview of using OpenMPI for shared memory paralellization
- Semester projects

1.3 Machines

- HPC class (here at ISU–shared memory not feasible)
- Ranger at TACC (Austin, Texas)
- Semester projects...you choose!

2 What is HPC?

The primary goal of HPC is speed, often achieved using multiple processors and/or cores

2.1 Examples

- Cummins Diesel
  - 11 processors, 256 GB RAM (this was huge back then)
  - simulated entire physical process of running diesel engine
  - memory to CPU access is much quicker than disk to CPU access
- Pratt and Whitney
  - Could not simulate entire jet engine at the same time, had to break down into stages
- Car crash testing: cannot compete in auto industry testing today without HPC
- Human genome mapping would not be possible without HPC
- Financial modeling
  - Bond firm gets rich with switch to HPC (estimates in 4 hours rather than 24)
  - High-speed trading (kind of like gambling)

3 Overview of HPC

Parallelization can be accomplished with shared or distributed memory

- shared memory is easier to program
- however, shared memory paradigm does not scale well (to lots of processors) since the memory bus gets saturated
- Stanford (SGI) solution: common address space for all (distributed) memory

3.1 Today's HPC machines

- Collection of shared memory compute nodes
- Until about 1990, most HPC used custom (expensive) hardware ⇒ low volume, harder to make a profit
- Now with large volume, processors are very cheap
- Today's HPC hardware is typically high volume commodity hardware used in smaller devices
- This is the idea behind GPUs–high volume, low cost; however, GPU is fast only for single precision arithmetic (most science applications need double precision)); lacked ECC (error correcting memory–necessary for scientific computing)
- Top 3 machines for Linpock Benchmark
  1. GPU machine
  2. Jaguar at ORNL
  3. Chinese GPU machine