Unit 1, Part 2 prolog

Introduction to High Performance Computing

A Blue Waters Online Course
Fall 2016

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Course overview

- Introduction to central concepts, the hardware and software environments, and selected algorithms and applications of high performance computing
  - especially high performance computational science and engineering
  - emphasis on tightly coupled computations that are capable of scaling to thousands and even millions of processor cores
- Range of course material
  - some *high-level* surveys of motivating applications (like Part 1 of this unit, a case study motivated by computational aerodynamics)
  - some *low-level* details of implementation (examples to come)
  - most of the time *in between* analyzing parallelism in algorithms (today)
- Students run some demonstration codes provided and do a modest amount of their own programming
  - using PETSc, the "portable, extensible toolkit for scientific computing" (which is a high-level applications programmer interface for distributed memory programming)

Course flavor

- Targeting "parallel computer literacy"
  - develop intelligent critics and consumers
  - future developers of the infrastructure from CS and math
  - applications scientists and engineers, as well
  - acquaint student researchers with what is available in standard open-source parallel scientific software
    - what it can do for us
    - how it works
    - how it is layered and composed
- Scientific computing-oriented
  - crux of motivation for much of supercomputing!
  - scientific computing is the 1% that used to drive the 99% but is now increasingly driven by it

Pedagogical philosophy

- We will spiral-staircase through the material
- Each sector of the staircase is subject matter (algorithm, architecture, application, software, etc.)
- Each time we reach a new level with one sector, we are ready to revisit the next sector on a higher level

Review of Part 1 case study

- Application
  - opportunity for real-time computational aerodynamics
  - penetration of CFD into airplane design
- Architecture
  - limiting nature of speed of electrical signal propagation
  - pipelining
  - parallelism
  - Moore’s Law (1965)
- Algorithm
  - discretization of conservation laws
  - limiting nature of speed of physical signal propagation
  - Courant-Friedrichs-Levy stability criterion (1928)
  - Amdahl’s Law (1967)