NucE 530 - Parallel/Vector Algorithms for Scientific Applications

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Coverage
Development/analysis of parallel/vector algorithms (finite-differencing of PDEs and Monte Carlo methods) for engineering/scientific applications for shared and distributed memory architectures.

Textbook

Prerequisite
Programming experience in Fortran or C

Outline
1. Mathematical Modeling of Physical Systems
   a. Partial Differential Equations (PDEs)
   b. Computer Implementation:
      i. Discretization: Finite Difference
      ii. Solution Algorithms: Direct and Iterative Techniques
   c. Monte Carlo Method: Estimation of Integral Quantities
2. Basics of Multiprocessing
   a. Computer Architectures:
      i. Vector Computers
      ii. Shared Memory Multiprocessors
      iii. Distributed Memory Multiprocessors
   b. Synchronization and Parallel Granularity
   c. Communication Latency and Bandwidth
   d. Domain Decomposition
   e. Rudimentary Parallel Performance Model: Amdahl’s Law
3. Parallel Programming Models
   a. Shared Memory Programming
   b. Distributed Memory, Message-Passing Programming
4. Examples
   a. Monte Carlo Example
   b. Elliptic PDEs: The Diffusion Equation
5. Parallel Performance
   a. Measures of Parallel Performance: Speedup and Efficiency
   b. Measuring Parallel Performance
   c. Modeling Parallel Performance
6. Advanced Communication Schemes

Grading
Homework Assignments* 30%
Quizzes 10%
Midterm 20%
Final Project 40%

* Late Homework Policy: Up to one week past due date ★ Grade reduced by 50%
   No credit for homework submitted more than one week past the due date