

COMP 4510 - Introduction to Parallel Computing

Description: An overview of the architectures of current parallel processors and the techniques used program them.

Prerequisite: COMP 3370 and COMP 3430.

Outline

This is a senior level course focusing on the current issues of parallel computing. Following the recommended book and the notes provided in class prepared from various sources, an in-depth look is taken at techniques for the design and analysis of parallel algorithms, two commonly available commercial platforms to program such algorithms (distributed memory machines using MPI and shared memory machines using OpenMP) are discussed and a look is taken at the current state of parallel computers such as processor in memory (PIM) or cellular architectures.

Various design techniques and their implementation for topics such as sorting (e.g. hyperquicksort), searching (e.g. backtracking), graph algorithms (e.g. shortest path, DFS, BFS), scientific computations (e.g. Cannon's matrix multiplication) and current algorithms in applications such as image processing (in particular FFT) and computational biology (DNA sequencing using dynamic programming) are also covered.

- 1) Introduction and overview (1/2 week)
- 2) Models of Parallel Computers and Computation (1 week)
- 3) Technique for Designing Parallel Algorithms (2 weeks)
 PCAM technique (Partitioning, Communication, Agglomeration and Mapping), synchronization and load balancing.
- 4) Message Passing Computing and MPI (2 weeks)
- 5) Distributed Shared Memory Systems and Cache coherence protocols (1 week)
- 6) Shared Memory and OpenMP (2 weeks)
 DSM is covered and hybrid programming (MPI with OpenMP).
- 7) Introduction to Multithreading (1 week)
 Prefetching, simultaneous multithreading, chip multiprocessing (CMP), SMT.
- 8) Interconnection Networks (1 week)
 Hypercube, omega networks, butterfly, etc.
- 9) Performance and Scalability of Parallel algorithms (1 week)
 Interconnection networks and programming platforms, Amdahl's and Gustafson's law, Isoefficiency, Scalability measures, Communication and computation time of the parallel algorithms/programs depending on the programming platform used.
- 10) Current developments in parallel computers (1/2 week)
 FFT (image processing application), butterfly network, DNA sequencing using dynamic programming.

Recommended Text: Michael J. Quinn, *Parallel Programming in C with MPI and OpenMP*, McGraw Hill, 2003.

Other recommended text books are placed on reserve in the library on a loan period.