



HECTOR course syllabus: “Parallel Programming with MPI”

Introduction to HPC

What is HPC?; basic terminology and concepts; architectural classifications; memory classification; communication networks; types of supercomputer and major vendors.

Introduction to Parallel Programming

Parallel decomposition; message passing (MPI); shared memory parallel computing (OpenMP); MPI, OpenMP or hybrid MPI/OpenMP?; other languages for parallel processing; batch systems.

Introduction to MPI

The MPI standard; MPI_Init and MPI_Finalize; rank and size; error checking; basic code checklist and templates; linking and running MPI codes.

Point-to-point Communication Part 1

The MPI_Send and MPI_Recv calls; MPI datatypes; blocking communication and deadlocks; the MPI_Sendrecv call; other types of blocking send.

Timing Programs

The MPI_Wtime and MPI_Wtick calls.

Point-to-point Communication Part 2

Non-blocking communication; the calls MPI_Isend, MPI_Irecv, MPI_Wait and MPI_Test.

Collective Communication

Barriers; broadcasts; gathering and scattering data using MPI_Gather and MPI_Scatter; reduction operations.

Message Passing Numerical Libraries

A short overview of message passing numerical libraries, including PBLAS, ScaLAPACK and FFTW.

The HECToR Service

The HECToR service; hardware; software; getting time on HECToR; the HECToR CSE service.

Cartesian Topologies

Defining a Cartesian topology using `MPI_Cart_create`; topology inquiries; converting between Cartesian coordinates and ranks; shifting data using `MPI_Cart_shift`.

MPI Derived Datatypes

Committing and freeing MPI derived datatypes; constructing MPI datatypes for contiguous and strided arrays; constructing MPI datatypes for Fortran types and C structures.

User-Defined Binary Operators

How to define a binary operator for use in reduction routines.

Groups and Communicators

Groups and communicators; size and rank revisited; group constructors; communicator constructors, including duplicating and splitting communicators; inter-communicators.

Background Reading

It is not essential to do any reading in advance of the course but the following references may be useful.

1. MPI Standard Documents, <http://www.mpi-forum.org/docs/docs.html>
2. Gropp, Lusk and Skjellum, "Using MPI: Portable Parallel Programming with the Message-passing Interface (Scientific and Engineering Computation)", MIT Press, second edition.