MPI

- MPI = Message Passing Interface
  - Message passing parallelism
  - Cluster computing (no shared memory)
  - Process (not thread oriented)

- Parallelism model
  - SPMD: by definition
  - Also implement: master/worker, loop parallelism

- MPI environment
  - Application programming interface
  - Implemented in libraries
  - Multi-language support (C/C++ and Fortran)
Vision

- Supercomputing Poster 1996
SPMD (Again)

- Single program multiple data
  - From wikipedia “Tasks are split up and run simultaneously on multiple processors with different input in order to obtain results faster. SPMD is the most common style of parallel programming.”
  - Asynchronous execution of the same program (unlike SIMD)

https://www.sharcnet.ca/help/index.php/Getting_Started_with_MPI
A Simple MPI Program

- Configure the MPI environment
- Discover yourself
- Take some differentiated activity

See mpimsg.c

Idioms

- SPMD: all processes run the same program
- MPI_Rank: tell yourself apart from other and customize the local processes behaviours
  - Find neighbors, select data region, etc.
Build and Launch Scripts

- Scripts wrap local compiler and link to MPI

- `mpirun` to launch MPI job on the local machine/cluster
  - Launch through scheduler on HPC clusters (do not run on the login node)

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HPC Schedulers

- Maui/Torque
- SLURM
- OGE

- Each with their own submission scripts
  - Not mpirun

https://www.osc.edu/supercomputing/getting-started/hpc-basics
Managing the runtime environment

- Initialize the environment
  - MPI_Init ( &argc, &argv )

- Acquire information for process
  - MPI_Comm_size ( MPI_COMM_WORLD, &num_procs )
  - MPI_Comm_rank ( MPI_COMM_WORLD, &ID )
  - To differentiate process behavior in SMPD

- And cleanup
  - MPI_Finalize()

- Some MPI instances leave orphan processes around
  - MPI_Abort()
  - Don’t rely on this
MPI is just messaging

- And synchronization constructs, which are built on messaging
- And library calls for discovery and configuration

- Computation is done in C/C++/Fortran SPMD program

- I’ve heard MPI called the “assembly language” of supercomputing
  - Simple primitives
  - Build your own communication protocols, application topologies, parallel execution
  - The opposite end of the design space from MR, Spark