IHPC 2009 In-Class Exercises #1

Thursday, August 6, 2009

The following exercises may be completed in either C or Fortran.

1. Hello World in Parallel
   Write a parallel version of the "Hello World" program using MPI and run it to observe the output. The basic elements of this simple program are: initialize MPI, determine the number of each processor and total number of processors, have each process write out the message "Hello World. I am processor 3 of 4 processors" to the screen (standard output), and finalize MPI. Run the program interactively using 16 processors to observe the output.

   (a) In what order do the messages appear on the screen?

   (b) Modify the program using the appropriate logic and MPI calls to ensure that the messages on the screen appear in order.

2. Monte Carlo Determination of the Value of π
   Using the Monte Carlo method of numerical integration, determine the value of π. This is accomplished by choosing N random points within a box $-1 \leq x \leq 1$ and $-1 \leq y \leq 1$, and calculating the integral using

   $$\pi = 4\frac{n}{N}$$

   where n is the number of the random points that fall within a circle of radius $r = 1$.

   (a) First, write a serial code that calculates this value of π.

   (b) Next, use MPI to make the code paralle and verify that it gives you the same results. (Keep the working serial version intact for the next step).

   (c) Calculate the time it takes to perform this calculation with $N = 10^8$ points using 1, 2, 4, 8, and 16 processors. You may use compiler function calls to calculate the time, or use the unix command `time` before the run, for example,
   `time pbsyod -size 16 ./mc_pi`
   NOTE: Be sure to consider whether or not you want to include the initialization time in these performance tests.

3. 1-D Diffusion Equation