University of Saskatchewan
Department of Computer Science

Parallel Programming for Scientific Computing
(CMPT 851)
Instructor: Dr. Raymond J. Spiteri

ASSIGNMENT 02
Due: 1:00 p.m. Tuesday, March 04, 2014

1. [**50 marks**] Write a brief proposal describing the project you intend to work on for this course.

   The proposal should be typeset in LATEX and be between 3 and 5 pages of single-sided, double-spaced text in length, including figures and a bibliography.

   Clearly identify which aspects of the proposed project are directly related to the material covered in the course.

2. [**25 marks**] The program `dotProductMPI.f90` computes the dot product of two vectors `X` and `Y` of size `N` on `P` processors, where it is not assumed that `P` divides evenly into `N`.

   Modify `dotProductMPI.f90` to produce an MPI program that is more efficient by using the `MPI_SCATTERV` command.

   Test the performance of both codes with $N = 1,000,000$ and $P = 1, 2, 4, 8, 16, 32, 64, 128$ processes on `socrates`. Comment on their scalability and performance relative to each other.

   You may re-write `dotProductMPI.f90` in C if you wish.

3. [**25 marks**] In this question, we will essentially re-solve Problem 4 of Assignment 1 using MPI.

   Find the global minimum of the function

   $$f(x, y) = e^{\sin(50x)} + \sin(60e^y) + \sin(70 \sin x) + \sin(\sin(80y)) - \sin(10(x + y)) + \frac{x^2 + y^2}{4}.$$

   This was Problem 4 of the SIAM 100-digit challenge. The goal was to compute the answer correct to 10 significant digits. A bit of straightforward analysis yields that the global minimum must lie not too far from the origin, so we restrict our attention to the domain $\{(x, y) \in [-1, 1] \times [-1, 1]\}$.

   (a) Write a program in MPI to sample $f(x, y)$ on a regular grid of the domain with $N = 8^4$ points in each direction. Find the minimum value obtained and print it to standard output.

   (b) Test the performance of your code with all combinations of processors $P = 1, 4, 16$ and `N`, `2N`, and `4N` sample points in each direction. Comment on the speed ups, efficiency, and scalability of your program.

   (c) What is the resolution of the timer used? Show how you obtained your answer.