University of Delaware
Department of Electrical and Computer Engineering
ELEG652 - Principles of Parallel Architectures
Fall 2014
Prof. Guang R. Gao

Assignment 2
Vector Processing and Parallel Programming using MPI

Due on Friday Oct. 3rd, 23:59

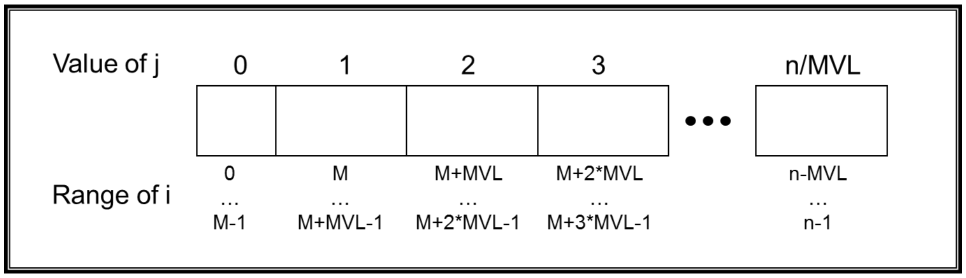
Vector Processing

1. [35%] See the Lecture on Vector Processing (slides 14-17):

a) [5%] Name three advantages of vector architectures.

b) [5%] Using your own words, explain the concept of strip mining.

c) [5%] Explain the following figure for strip mining and the values on it, assuming a maximum vector length of 32 and a vector size of 200.



d) [10%] Write a C/C++ program that computes the DAXPY operation (shown below) in two ways: in its original form and using strip mining. The program must check the correctness of results of the strip-mining version against the original form.

```
for(i = 0; i < n; ++i)
    y[i] = a * x[i] +y[i]
```

The vector's length ***n*** and the scalar ***a*** must be entered by the user. The vectors ***x*** and ***y*** must contain random values. As maximum vector length, use the L2 cache line present in your test machine.

e) [10%] Measure the vector performance of your machine following the slides 53 and 54 of Lecture on Vector Processing. For this, use the algorithm DAXPY code and measure the time obtained for different values of the vector's length ***n***. You must plot a least two points, extrapolate the line (by hand or in a computer), and determine the value of r_∞.

MPI

2. [30%] Create a ring program in MPI in which each process will output its rank to stdout in order. For example: if run with 4 processors, the numbers 0, 1, 2, and 3 should be outputted to stdout, in order, by ranks 0, 1, 2, and 3 respectively.

3. [35%] A Matrix-Vector Multiply program is defined as C=Axb: A is a matrix of NxN elements, b is a vector of Nx1 elements, and C is a vector Nx1:

a) [25%] Implement a Matrix-Vector Multiply using MPI, distributing the computing to different processes statically and as even as possible. Use the process with rank 0 to report the results on stdout.

b) [10%] Analyze the theoretical parallel speedup of the Matrix-Vector Multiply algorithm on P processors using the methodology shown in slides 28 and 29 in the lecture "Introduction to Parallel Programming" by Haitao Wei.

Submission:

Submit a report with your answers using an IEEE Paper Template for the report (http://www.ieee.org/conferences_events/conferences/publishing/templates.html). Remember to cite all your sources.

Include any source files you wrote. Each program you write must be commented and have its own Makefile.

Remember to include the HW/SW specifications of the machine(s) where you run your experiments.

Send all the files as a single ZIP named *<YOUR_NAME>-lab<NUMBER_OF_LAB>-eleg652-14f.zip* (e.g. *johndoe-lab1-eleg652-14f.zip*) to Jaime Arteaga jaime@udel.edu with subject *ELEG652-14F LAB2* before the specified deadline.

If you miss the deadline, you can submit the homework until 17.45 of the following Tuesday, with the homework's total grade being decreased by 10% per day (i.e. homework will be graded over 100% until 23.59 of Friday, 90% until 23.59 of Saturday, 80% until 23.59 of Sunday, 70% until 23.59 of Monday, 60% until 17.45 of Tuesday).