Lab Assignment 1 (30 points)

Writing a multithreading pthread program

Due Monday, September 25, 2017

1. **Goal of this programming assignment**

   The primary goal of this assignment is to understand and gain some familiarity
   with pthread libraries in Linix Environment.

2. **Requirements**

   (1) Programming language: You have to use either C or C++ to develop your
       program.
   (2) Running Environment: <u>Your program should be compiled at **csegird** and be</u>
       able to be tested without errors. (If you don't have an account at csegrid,
       please contact at http://csehelp.ucdenver.edu at the Dept. of Computer Science
       and Engineering)

3. **Description of programming**

Write a C/C++ language program to implement multithreaded matrix multiplication
using Pthreads.

$$C_{i,j} \;=\; \sum_{n=1}^{k} A_{i,n} \;\times\; B_{n,j}$$

- Create a separate worker thread to <u>compute each **row** of the result matrix,</u>
  instead of a thread for each element.
- <u>Do not initialize the contents of the A and B matrices statically</u>. The A and B
  matrices will be initialized by reading data from an input file (see notes
  below).
- Be able to process multiple sets of input matrices by continuing to read data in
  the specified format (described below). If any other character than an integer
  including negative number is specified, output an error message and terminate
  the program with a non-zero return code.
- Each set of data processed must be labeled to indicate which set of data is
  being output (e.g., Matrix A, Matrix B, etc).
- Maximum size of Matrices can be 10000x10000

3.1 Input

The input file will be an ASCII file containing numbers that define the dimensions and contents of the A and B matrices for which a matrix product is to be computed. The first line of the input file will contain two numbers specifying the dimensions of the A matrix (M x K). Following that will be M lines, each with K numbers, representing the elements of matrix A. Next will be a line with two numbers specifying the dimensions of the B matrix (K x N). And following that will be K lines, each with N numbers, representing the elements of matrix B. For example, suppose that matrix A has 4 rows and 3 columns and matrix B has 3 rows and 4 columns, as follows:

<u>The lines in the input file would be as follows:</u>

```
4 3
2 1 3
0 -1 -2
5 1 -1
4 5 8
3 4
3 2 1 0
0 4 2 -1
-1 3 2 4
```

3.2 Output

Program should print the contents of matrix A and matrix B. It should then print lines showing the thread ID numbers for the worker threads it creates. Then it should print the contents of the result matrix C and total execution time. The output from program for the above input should look similar to the following:

```
Matrix A: 2 1 3
0 -1 -2
5 1 -1
4 5 8
Matrix B: 3 2 1 0
0 4 2 -1
-1 3 2 4

Created worker thread 15823744 for row 0  Created
worker thread 26375040 for row 1  Created worker
thread 35823744 for row 2  Created worker thread
46375040 for row 3

Matrix C = A x B: 3 17 10
11
2 -10 -6 -7
16 11 5 -5
4 52 30 27

Total execution time using 5 threads is 0.001 ms.
```

4. Deliverable

    (1) Program source codes includes all source program files, Makefile, and Readme – Via Email

    (2) Sample output (hard copy)

    (3) Test Report

    (4) Run your program with 1 thread, and keep testing your program by increasing number threads such as 2, 4, 8, 16, 32, 64, etc, and collect each total execution time.

    (5) Create a document which include a table and graph for total execution time and discuss the relationship between the number of threads and total execution time.

5. How to turn in my work

Please do the followings when you submit your programming assignment.

- Create a tar file or zip file that contains your written source code, makefile and readme. <u>DO NOT INCLUDE EXECUTABLES AND OBJECT FILES.</u>
- Please use the following convention when you create a tar file
  - First 3 letters of your last name + last 4 digits of your student ID
  - e.g.: If a student name is "Bill Clinton" and his ID is 999-34-5678, then his tar file name is "cli5678.tar".
  - If you want to know more about "tar" command, type "man tar" at Unix prompt

- Upload your compressed tar file into class Canvas.