Study Guide

Week 4 February 1st, 2016 – February 7th, 2016

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Study Materials on Moodle

- *PowerPoint Slides*
  - Stencil pattern
  - Introduction to MPI
- *Videos*
  - Lecture 5-1 video: 75-minute video of the first part of Lecture 5 in Fall 2014 covering the stencil pattern and Assignment 2.
  - Lecture 6-2 video: Second part of Lecture 6 video in Fall 2014 introducing MPI
  - Lecture 7 video: 75-minute video of Lecture 7 in Fall 2014: continues MPI.
- *Sample Quiz Questions*
  - MPI

Tasks

- **Mini-Quiz:** Answer the short posted quiz before 11:55 pm Sunday February 7th, 2016.
- **Assignment 2** OpenMP heat distribution problem, graphics
  - Assignment 2 Instructions
    Also refer to "Creating graphical output using X11 graphics"
  - Assignment 2 Due: *Sunday February 14th, 2016* (Week 5)

Moodle Saba meeting – To be decided.

Stencil Pattern-I introduces the stencil pattern and the iterative stencil pattern (stencil pattern in a loop). It then describes one application - solving Laplace's equation as embodied in the steady state Heat equation to find the heat distribution in a space given fixed heat source(s). Note the heat sources do not change in temperature hence the term steady state or static Heat equation. This is an important distinction as if the heat sources change over time, one has to solve a different equation (general Heat equation, which is Poisson's equation). The notes also has two code implementations, one using a 2-D array that requires the contents to be updated on every iteration, and one using a 3-D array that eliminated that update and improves the performance. In the assignment below, you will use the 3-D array approach. Also note the term "Jacobi" iteration, which refers to an iteration algorithm that only uses the values from the previous iteration to compute the next values. The Jacobi method requires a lot of iterations to converge and we would generally want something better. (It is possible, and we shall see later, to compute values from the present and previous iterations or even the present iteration only.)

Assignment 2 Instructions: This assignment continues programming with OpenMP, where now you write the code completely. The objective here is to implement the Stencil pattern and solve the heat distribution problem. As with many programming assignments, you are first asked to write the code sequentially (in C), which can then be compared to the parallel version. You are asked to create X11 graphical output, and sample X11 graphical code is given as guide in a separate document (read "*Creating graphical output using X11 graphics*"). The advantage of using X11 graphics is that it can be created and tested on any

Linux distribution including the provided VM and when executed on the cluster, easily forwarded from the cluster to the provided VM or a Linux platform. However, it is very low level and needs a lot of set-up code. So, I have provided a macro with the set-up code as an initialization routine to make it easier. You still have to use X11 routines to do the actual drawings. The macro also has define statements to make it a little easier to specify colors. Apart for the information provided you can find out about X11 routines online.

Now the course moves onto programming distributed computers with separate memories, typically complete computers connected together with an interconnection network such as Ethernet. Programming is typically done using message passing libraries, notably MPI.

Introduction to MPI introduces MPI routines for point-to-point message passing, use of message tags, MPI communicator, (locally) blocking send/receive routines, and instrumenting code for execution time. In Fall 2014, this material was started in the second part of the Lecture 6 video in Fall 2014 posted in Week 3 and continued in Lecture 7 video posted this week. MPI will be continued next week. You are expected to understand the semantics of the MPI routines, for example when they return (which depends upon the actual routine). The video of Lecture 7 includes how to use a cluster at UNC-Wilmington, which has a job scheduler. However we will not this cluster this semester. Instead we will use a cluster at UNC-Charlotte, which does not use a job scheduler. The posted slides reflect that we will be using the UNC-Charlotte cluster. You are not expected to know for exam purposes about the job scheduler at UNC-Wilmington. However many clusters do use job schedulers to control user programs on them.