Parallel Computing: EECS 587

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Texts: None, but some on-line computer manuals will be used, and there will be various papers, book excerpts, and web resources that I'll place in Canvas. It is important to pay attention to the material presented in the lectures and discussion sections.

Course Overview: The course will survey parallel computing with an emphasis on the user viewpoint. While the emphasis is on developing efficient parallel programs, there will be a little discussion of the basic structure of parallel architectures and systems software since they significantly affect the efficiency of parallel programs. As you will see, parallel systems vary widely. We will discuss ways of analyzing, predicting, and improving parallel performance. Issues discussed will include languages (such as CUDA for GPUs), language extensions (such as MPI for distributed memory systems and OpenMP for shared memory systems), synchronization, load balancing, communication minimization, and latency toleration. Parallel programming paradigms such as divide-and-conquer and manager-workers will be applied to various problems.

Grading: Graded work will consist of written homework, programs, and a final project, with perhaps a small quiz or two. There are no tests. About 15% of the grade is written homework, about 40% is programs, and about 45% is the project. The percentages may change depending on whether we can get adequate access to computing resources and on how well the constraints of remote teaching can be handled. The programs will be run on computer systems here on campus and/or national supercomputing centers. The programs are not long since they emphasize the parallelization aspects, not the complexity of the underlying application. The written homework includes developing very simple algorithms for abstract models of parallel computers, and analyzing their performance.

The final project is a project of your choosing (though I must approve it). It must be related to parallel computing, but other than that you have a wide latitude in picking the topic. Some students pick a project to reinforce work they are doing elsewhere, e.g., it is something they can use for their thesis. Other students pick a project to try something new, to see if they are interested in pursuing the topic.

For the projects I might be able to get access to more exotic systems or simulators, such as quantum computers. However, I cannot promise that I'll be able to do this, and I certainly cannot get enough time for numerous projects on these systems.

Final projects will be due Dec. 8, 2020.

For people who turn in all of the assignments on time the most common grades are A- and B+. Historically there are a few A+ grades, and few grades below B.

You will not pass the course if your homework programs do not work correctly.

If your program doesn't work correctly when you turn it in then you'll have to continue working on it until it is correct. I won't pass someone in parallel computing if they can't get at least one simple program working for MPI, OpenMP, and CUDA.

Course Format: The course will be taught on-line for all lectures, discussion sections, and office hours. The class has more students than the college can accommodate with adequate social distancing. I'll try synchronous lectures, where you can listen and participate live or view a recording later, but might switch to asynchronous lectures if problems develop. There are officially 2 discussion sections, but at most 1 will be synchronous. The other will be a recording of the first, so it doesn't really have a specified time. You can participate in the synchronous section no matter what section you are registered in. Some weeks we'll just use the discussion section time for office hours.

GSIs and Office Hours: TBD. We'll try to accommodate students in different time zones.

Class Email and Announcements: The university's Canvas system will be used. When you send email to us, preface the subject line with "587".

Your Homework Should be Yours Alone: Unless otherwise instructed, for the homework assignments you are not allowed to work with anyone else, though you may ask others for help in understanding the problems. You cannot look on the web to see if you can find a solution posted there, nor can you ask students from previous years to help you. If they do the college may reduce their grade retroactively. Similarly, you cannot post any of the homework assignments or other material from the course that I have a copyright to without my permission.

However, for anything that is not an assigned homework problem you are allowed (and encouraged) to communicate with others. For the term project you will probably talk with others about it, but everything you turn in must be your own work. Term projects can be single person or 2-person projects (this will be discussed in the class, and might be extended to allow 3-person projects).

Honor Code: The Engineering Honor Code, described at
www.engin.umich.edu/college/academics/bulletin/rules
applies to all assignments in this class. Basically it says that you shouldn't cheat.

Turning in Homework: The homework must be typewritten, though you can draw figures by hand. LaTeX is a useful system for typesetting technical material, though you may use other systems such as Word. We'll tell you later how to submit the homework.

For the few problems for which you are to provide an algorithm:

- produce an algorithm optimal for the worst case (unless given other instructions, such as optimal expected case),
- make sure that your algorithm is clearly described,
- show that the algorithm is correct, and
- analyze its worst-case time in generalized O-notation.

You may be unfamiliar with some of these instructions, but they will be explained before you need to apply them. There will only be a few such homework problems.

For programming assignments you need to provide:

- a very short description of the approach you used (you're writing to us, not a general audience, so you don't need to provide an overview of the problem since we know what it is)
- a performance analysis of your program, typically analyzing how the time changed as a function of input size and the number of processors.

There will be further discussion of these requirements before the first program is due.

It is your job to make the descriptions and analyses clear, rather than our job to decipher what you have done. You can lose points for unclear write-ups. Further, do not just write down a large body of material in the hope that some of it is relevant.

Homework will be graded by the GSIs. If you have questions about a homework grade then you should discuss this with them. If you request a regrading it must be within 1 week of the time your homework was returned. Attach a note explaining why you think it should be regraded. Merely asking for more points is a plea, not an explanation.

Prof. Stout will grade the final project and assign the course grade.