CS:4700/MATH:4860 High Performance and Parallel Computing

Class time and location: TTh(9:30am - 10:45am), 110MLH

Instructor: Peng Jiang

- Office: 201G MLH
- Email: peng-jiang@uiowa.edu

Instructor's office hours:

- TTh, 11am to 12:30pm

Teaching assistant: Tarun Roy

- Email: tarunkanti-roy@uiowa.edu

Teaching assistant's office hours:

- Friday 1 pm to 2.00 pm

Prerequisites

CS:2210 with a minimum grade of C- or MATH:4050
And CS:2230 with a minimum grade of C-.

Course Description and Goal

Diverse aspects of parallel programming and high-performance computing are covered. The core of this class is on basic parallel programming using standard libraries such as OpenMP for multicore processors, CUDA for GPUs, and MPI for distributed systems. Important concepts such as cache locality and data dependence are introduced as the fundamentals for understanding and optimizing performance. Programming examples and assignments are from applications in data analysis, machine learning, and scientific computing.

Topics and Schedule:

- Introduction (week 1)
- Single-core methods
  - Cache management (week 1-2)
  - Loop analysis and transformation (week 3)
  - Data dependence analysis (week 4)
• Parallel programming methods
  o Posix threads and OpenMP for shared memory multicore processors (week 5-6)
  o Message Passing Interface (MPI) for distributed systems (week 7-8)
  o CUDA for GPUs (week 9-11)
  o SIMD vectorization on CPUs (week 12-13)
• Project presentations (week 14-15)

Objectives

• Students will learn how to enhance the performance of programs by parallelizing loops, improving data locality, etc.
• Students will learn how to program parallel computers using CUDA, OpenMP, and MPI. This will introduce them to data parallel, shared memory, and distributed memory model of parallel computing.

System Requirements

Computing nodes will be provided. Students need to have personal computers to log into the computing nodes.

Required Textbook

No required textbook.

Assessment

Assessment for this course will be based on homework and program assignments (40%), a final project (40%), attendance (10%) and in-class activities (10%). All grades and labs will be posted on ICON, any corrections have to be made within one week after grades are posted.

Grade Evaluation

The course uses the +/- grading system. A+ grades are given only in extraordinary situations.

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<tr>
<th>Graded item</th>
<th>% of final grade</th>
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Attendance 10%

In-class activities 10%

Homework and program assignments 40%

Final project 40%

Collaboration policy

Homework and programming assignments: Students are encouraged to discuss activities, course materials, and programming. However, all homework and programming assignments must be your own work and in your own words.

Final project: The final project will be in groups of two or three. Each student in a group is expected to complete a similar amount of work and to contribute equally to the final project. Each student will complete a self-evaluation and a group evaluation, describing this equality or the lack of it during the group’s work. Students who misrepresent themselves as equal partners in this collaborative project but are letting others do the bulk of the work will be reported to the College for academic dishonesty. If you have questions, it is your responsibility to ask them.

Date and Time of the Final Exam

The course does not have a final exam, but all groups need to turn in a final project report by the final examination date and time that will be announced by the Registrar. I will announce the final time at the course ICON site once it is known.

Course Policies

Due dates and missed deadlines:

- Due dates of homework and programming assignments will be announced when they are assigned.
- Each student will be entitled to 3 late days. One late day may be used to delay the homework submission for a single day. A student can use all the 3 late days for a single homework assignment submission. Note that, late
submissions for which students have no late days available will not be accepted. Students should exercise the use of late days wisely as the homework assignments and projects are likely to be progressively harder. If the student (or, his/her group) submits the assignment 1 minute late, a late day will be counted. There will not be any fractional late days.

**Course attendance:** *Students are required to attend all lectures and project presentations. Students with mandatory religious obligations or UI-authorized activities must discuss their absences with me as soon as possible. Religious obligations must be communicated within the first three weeks of classes.*

**College of Liberal Arts and Sciences Information and Policies for Undergraduates**

See [https://clas.uiowa.edu/faculty/teaching-policies-resources-syllabus-insert](https://clas.uiowa.edu/faculty/teaching-policies-resources-syllabus-insert)