ECE 4990-005
CI: High-Performance Cluster Computing

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Class Location/Time: N/A

Course Description

Parallel computing is often a topic covered until the senior year for undergrads. Moreover, large-scale computing is becoming fundamental tool to researchers in many fields of science and engineering. This CI is dedicated to opening up parallel computing to all levels of undergrads in relevant fields of computational science and engineering. Through this CI, we explore how high-performance computing (HPC) systems are constructed, what it takes to program parallel applications, how to run parallel applications on an HPC system, and how to optimize applications. This CI is intended to introduce undergraduate students to parallel computing early in their undergraduate experience. Skills and knowledge gained though hands on activities, research, and trainings will prepare students for undergraduate research, provide skills to help students stand out and succeed in graduate school, and provide students an opportunity to test their skills against teams from all over the world at the annual Supercomputing Conference's Student Cluster Competition.

The CI is broken down into 2 semesters:

- During the Spring semester students will explore the area of parallel and cluster computing. This exploration provides the needed foundations for hands on exploration/research. In addition, the Spring semester will be used as a local competition to select the best students to compete in the Supercomputing's Student Cluster Competition (http://www.studentclustercompetition.us/).

- During the Fall semester, selected students from Spring train to compete at the Student Cluster Competition. The competition involves running real world scientific workloads to accomplish several tasks including benchmarking the team's cluster's performance and replicating computational and scientific results from a paper published at the conference the prior year. The problem domain changes from year to year (e.g. genetics, chemistry, aerospace, geophysics, hydrology, cosmology). The changing problem areas allows easier exposure to undergraduates from other STEM disciplines.

Course Objectives

Typical Spring Semester:

- Learn about clusters and large-scale system design.
    - Students will conduct their own research on different aspects of system design (e.g. network, computing, storage, memory)
    - Students will write a report on their finding and give a presentation to other CI members

- Learn about programming models:
    - Students will conduct their own research on different programming models, program optimizations, and performance (e.g. MPI, vectorization, GPUs, tasking). Students will write a report on their finding and give a presentation to other CI members

- Students will attend relevant workshops offered by CCIT

- Students will write and modify HPC applications based on acquired knowledge

- Design and select system configuration (software, possible hardware upgrades)

- Students will submit an application to compete at the Supercomputing Conference's Student Cluster Competition

- Students will write summary report over what they learned and its potential impacts on their careers and society

Typical Fall Semester:

- Students will attend relevant workshops offered by CCIT

- Students will explore, run, and optimize applications used during the competition

- Students will explore the competition's problem area (e.g., genetics, chemistry, aerospace, geophysics, hydrology, cosmology) to learn more about the science they are going to be verifying and replicating during the competition. This may include guest speakers from those departments

- Students will compete at the Supercomputing Conference's Student Cluster Competition

- Students will write summary report over what they learned and its potential impacts on their careers and society

Required Materials

Textbook: None
Internet connected laptop.

Course Management System

The Canvas© system will be used to make class announcements, turn in assignments, and provide students access to additional course materials.

Fall (No competition):

20%: Attend 1-2 CCIT workshops and provide a 1 paragraph summary of what you learned.
40%: Write a 2 page summary on one of the applications from the SCC or building the cluster.
40%: Write a 3 page report on what you learned about HPC over the course of the CI. Include details of your personal exploration into an application or programming aspect.

Spring:

20%: Attend 2 CCIT workshops (or personal online reading) and provide a 1 paragraph summary of what you learned.
20%: Write a 2 page summary on one of the applications from the SCC.
20%: Write a 3 page report on what you learned about HPC over the course of the CI. Include details of your personal exploration into an application or programming aspect.
40%: Contribute to writing and submitting the application

Late Assignments

Late assignments will have 1 letter grade deducted for each day that they are late. Examples of excused absences include a death in the immediate family or personal conditions requiring hospitalization or emergency treatment. Personal illnesses such as colds, general fatigue, or general sickness are not typically excused. If you are unsure if your situation will be excused, contact the professor in a professional manner prior to or as soon as possible after the missed assignment.