CS555: *High Performance Computer Systems* [Fall 2020]

Instructor	Aftab Hussain
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Class Information	Mondays & Wednesdays: Lectures (10am to 11.20am) Fridays: Labs (2.00pm to 4.40pm)
Office Hours	Mondays 10am to 11am
Website	https://aftabhussain.github.io/Teaching/index.html

Introduction

Welcome to the CS555: High Performance Computer Systems Course. This course is open to Junior and Senior Engineering and ICS Students interested in a software development career in the Systems Domain. This 10-week course is designed to give you the experience of building large scale software systems, and in the process, help you learn about the most fundamental domains in computer science, which will help you in building such systems. We plan to have a few mandatory, and some optional lab classes, along with weekly lecture classes.

Student Learning Outcomes

After successful completion of this course, students should be able to:

- Write code to implement computation and search algorithms to solve real world problems
- Identify performance costs of an existing algorithm, and optimize it
- Design large-scale systems, for a specific application area
- Build a system on top of an existing large-scale system, for a specific application area
- Analyze and evaluate performance of large-scale real world systems, like Map-Reduce, using tools

Resources

All readings will be shared in before and after class lectures. The readings will include renowned papers from different domains in Computer Science. Some recommended books (for reference):

* Big Data: Principles and best practices of scalable realtime data systems 1st Edition, by Nathan Marz, James Warren (https://www.amazon.com/Big-Data-Principles-practices-scalable/dp/1617290343)

* Algorithms for Optimization (The MIT Press) March 12 2019, Hardcover –by Mykel J. Kochenderfer, Tim A. Wheeler (https://www.amazon.com/Algorithms-Optimization-Press-Mykel-Kochenderfer/dp/0262039427/ref=sr_1_9?dchild=1&keywords=algorithms&qid=1592224838&s=books&sr=1-9)

Advice to succeed in this course

This course designed to quickly immerse you into the world of large scale software development, and we are going to focus on building a project only. Since the course is also open to Engineering students from non-CS majors, it is important that you participate in the initial lab sessions to master coding, even though these sessions are not mandatory. Make sure all participants of the project are involved

and can explain what is going on their project. Each participant would be expected to explain the inner-works of their projects during the presentations and demonstrations.

Website/Canvas

Please stay up-to-date with all material that are expected to be momentarily posted online. I plan to post materials before and after each lecture class. Also stay-tuned for any special announcements made in Canvas.

Project Submissions

There are no exams in this class, but a large-scale software building group project of 4-5 teammates. In week 9, you will need to present and demonstrate your project in front of the class. In the finals week you'll be required to submit code and a report on the project.

How to Properly Contact Me

Please mail me at aftabh@uci.edu, with the subject title format as follows,

"CS555: [First name] [Last Name] [Student ID] – [Subject]"

If you need to meet me in person outside the office hours mentioned at the top, please send me an email before coming to my office in case you find me unavailable.

Academic Dishonesty

All students are expected to adhere to the UCI Academic Dishonesty Policies (for more information, please visit https://aisc.uci.edu/students/academic-integrity/index.php .

Attendance

Classes attendance is not mandatory for lectures but highly encouraged. There are a few mandatory labs that you must attend, as indicated in the weekly schedule. Please make sure to let me know beforehand (at least 3 days before those class times) if you would be unable to attend during those class times.

Disability Services

Please contact the Disability Services Center (DSC) at the University of California, Irvine to get guidance and assistance on taking class activities. Please feel free to contact me if you need help reaching them.

Grading

Project Demo	**25 points**
Project Presentation	**25 points**
Source Code	**25 points**
Final Report	**25 points**
Total	**100 points**

Scale

A	**90 and above**
B	**80-89**
C	**70-79**
D	**50-69**
F	**49 and below**

Schedule

Week 1: Intro to HPCs and the pillar of all HPCs

M - Intro to HPC Systems, the different verticals of a HPC System and their relevant CS Domains

W - CS Domain 1: Algorithms and Data Structures - real life applications

F - Advanced Java Coding Review, tutorial on a coding real-life application using on an existing large scale system

Week 2: Tuning algorithms to improve performance

M - Design challenges in HPCs, how Algorithms and Data Structures again come into play

W - CS Domain 1: Algorithms and Data Structures - optimizing algorithms

F - Advanced Java Coding Review, tutorial on implementing search algorithms, and how to optimize it.

Week 3: Graphs

M - CS Domain 1: Algorithms and Data Structures - Graphs, applications

W - CS Domain 1: Algorithms and Data Structures - Graph Algorithms, and applications

F - Tutorial on implementing graph search algorithms, and how to optimize them.

Week 4: Big Data Systems

M - Application of HPCs: Big Data

W - Big Data and MapReduce, and an overview of other Big Data systems

F - Implementing a graph algorithm on Map Reduce (Mandatory)

Week 5: Want to design large scale software systems? Know the hardware

M - CS Domain 2: Computer Architectures - fundamental concepts

W - CS Domain 2: Computer Architectures - overview of real-world Systems and their approaches

F - Holiday

Week 6: Measuring hardware performance, and why algorithms still matter

M - Interrelating CS Domains I and 2 - understanding the impacts of algorithms and data structures on computer architecture design

W - Understanding performance metrics used to evaluate processors

F - Tutorial on measuring performance of a processor using existing tools. (Mandatory)

Week 7: Let's not forget what's running the hardware, and start of project

M - CS Domain 3: Operating Systems - fundamental concepts, OS algorithms, and interrelating it with CS Domain 1

W - Designing a system based on Map Reduce, and how to evaluate your system.

F - Tutorial on building an application on Map Reduce, evaluating performance metrics of an existing system. (Mandatory)

Week 8: Project!

M - Activity Learning: Brainstorm in your project groups on the systems you are designing

W - Discuss the challenges in student projects

F - Project related discussion

Week 9: Project Progress

M - Project Demo & Presentation

W - Project Demo & Presentation

F - Project Related Discussion

Week 10: Finale

M - Project Feedback from the instructor and final tips to improve them during the Finals Week (Week 11)

W - Holiday

F - Project Related Discussion

Week 11: Finals Week

Thursday – 11.59pm Submission Due for Project (Source Code + Report).