EE/CSCI 451
Parallel and Distributed Computation
Spring 2019

Units: 4.0

Term—Day—Time—Location:
Spring – Tuesday, Thursday 3:30 – 4:50pm, GFS 101
Lab/Lecture: Fri 3:30 – 4:50pm, SLH 100

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Course Description

Application developers' perspective of architectural principles underlying modern processors. Parallel models of computation: PRAM, network, LOG P. Introduction to parallel programming techniques: software performance optimization strategies, and application mapping to multi-core, GPU and cloud platforms. Parallelization examples drawn from high performance computing, signal and image processing, networking, machine learning and data science.

Learning Objectives

- Understand the key architectural concepts of multicore platforms for parallel programming
- Develop simple parallel algorithms to solve computational problems
- Implement key algorithms on multi core and many core platforms
- Understand and determine the computational complexity of simple parallel algorithms
- Write parallel programs using message passing and shared memory paradigms
- Select an appropriate basic data structure (e.g. arrays) and access methods (e.g., pointers) to optimize performance
- Understand communication and coordination issues in parallel computing
- Understand basic principles of Cloud computing and Big Data processing

Prerequisite(s): EE 355 or CSCI 201
Co-Requisite(s): None
Concurrent Enrollment: None
Recommended Preparation: High level programming

Course Notes
Lecture slides will be made available in advance of the lectures.

Technological Proficiency and Hardware/Software Required
Desktop or notebook for accessing the computing resources at USC HPC and remote Cloud.

Required Readings and Supplementary Materials
Introduction to Parallel Computing, 2nd Ed.
Grama, Karypis, Kumar, Gupta
Addison-Wesley
USC Bookstore.

Description and Assessment of Assignments
There will be approximately ten home works and five programming homeworks. The course will also include a parallel programming project.

Grading Breakdown

Assignment	% of Grade
Class participation	5
Homework	10
Programming HW	10
Course project	10
Midterm 1 exam	20
Midterm 2 exam	20
Final exam	25
TOTAL	100

Assignment Submission Policy

Home works to be submitted in class or in a designated collection box. Programming homeworks to be submitted online.

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Tentative Course Schedule: A Weekly Breakdown for Lectures

	Topics/Daily Activities	**Readings and Homework**	**Due Dates**
Week 1 Dates	Course introduction and logistics (Jan 8) Parallel Computer Architecture (Jan 10)	Chapter 1 Chapter 2.1 ~ 2.2	
Week 2 Dates	Parallel Computer Architecture (Jan 15) Parallel Computer Architecture (Jan 17)	Chapters 2.3 ~ 2.7 **Homework 1 on 1/17**	
Week 3 Dates	Principle of algorithm and concurrency (Jan 22) Principle of algorithm and concurrency (Jan 24)	Chapter 3	**Homework 1 due 1/26**
Week 4 Dates	Principle of algorithm and concurrency (Jan 29) Basic communication operators (Jan 31)	Chapter 4 **Homework 2 on 1/26**	
Week 5 Dates	Basic communication operators (Feb 5) Analytical modeling of parallel programs (Feb 7)	Chapter 4 Chapter 5.1 ~ 5.2 **Homework 3 on 2/2**	**Homework 2 due 2/2**
Week 6 Dates	Analytical modeling of parallel programs (Feb 12) Mid-term exam 1 review (Feb 14)	Chapter 5.3 ~ 5.7 **Homework 4 on 2/9**	**Homework 3 due 2/9**
Week 7 Dates	**Mid-term exam 1 (Feb 19)** Programming with message passing (Feb 21)	**Scope: Chapter 1 ~ 5** Chapter 6.1 ~ 6.4	**Homework 4 due 2/16**
Week 8 Dates	Programming with message passing (Feb 26) Programming shared memory (Feb 28)	Chapter 6.5 ~ 6.7 Chapter 7.1 ~ 7.5 **Homework 5 on 2/26**	
Week 9 Dates	Programming shared memory (Mar 5) Dense matrix algorithms (Mar 7)	Chapter 7.6 ~ 7.10 Chapter 8.1 ~ 8.2 **Homework 6 on 3/7**	**Homework 5 due 3/7**
Week 10 Dates	Dense matrix algorithms (Mar 19) Mid-term exam 2 review (Mar 21)	Chapter 8.3 ~ 8.4 **Homework 7 on 3/19**	**Homework 6 due 3/17**
Week 11 Dates	**Mid-term exam 2 (Mar 26)** Sorting algorithms (Mar 28)	**Scope: Chapter 6 ~ 8** Chapter 9.1 ~ 9.3	**Homework 7 due 3/30**
Week 12 Dates	Sorting algorithms (Apr 2) Graph Algorithms (Apr 4)	Chapter 9.4 ~ 9.6 Chapter 10.1 ~ 10.3 **Homework 8 on 4/2**	
Week 13 Dates	Graph algorithms (Apr 9) Search algorithms for optimization (Apr 11)	Chapter 10.4 ~ 10.7 Chapter 11.1 ~ 11.3 **Homework 9 on 4/9**	**Homework 8 due 4/9**
Week 14 Dates	Search algorithms for optimization (Apr 18) Dynamic programming (Apr 19) **(discussion slot used as the lecture, discussion on Apr 16)**	Chapter 11.4 ~ 11.6 Chapter 12.1 ~ 12.3 **Homework 10 on 4/19**	**Homework 9 due 4/16**
Week 15 Dates	Dynamic programming (Apr 23) Distributed data analytics, -- machine learning and graph processing (Apr 25)	Chapter 12	**Homework 10 due 4/28**

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Tentative Course Schedule: A Weekly Breakdown for Lab

	Topics/Daily Activities	**Readings and Homework**	**Deliverable/ Due Dates**
Week 1 Dates	Account setup and lab overview (Jan 11)		
Week 2 Dates	Pthreads (Jan 18)	Programming HW 1 out	
Week 3 Dates	Big Data Basics (Jan 25)		Programming HW 1 due
Week 4 Dates	OpenMP (Feb 1)	Programming HW 2 out	
Week 5 Dates	Course project discussion (Feb 8)		Programming HW 2 due
Week 6 Dates	MPI (Feb 15)	Programming HW 3 out	
Week 7 Dates	MPI (Feb 22)		Programming HW 3 due
Week 8 Dates	CUDA (Mar 1)		Course project proposals due
Week 9 Dates	CUDA (Mar 8)	Programming HW 4 out	
Week 10 Dates	Spark (Mar 22)		Programming HW 4 due
Week 11 Dates	Big Data Applications (March 29)	Programming HW 5 out	
Week 12 Dates	Big Data Applications (April 5)		Programming HW 5 due
Week 13 Dates	Course project presentation (April 12)		
Week 14 Dates	Course project presentation (**April 16, lecture time/location**)		
Week 15 Dates	Course project presentation (April 26)		Course project due

Note: The above are tentative outlines for Lectures and Lab sessions. Based on the number of students enrolled and the student interest, I expect to make some changes including schedule for the midterm exams, some project materials to be covered in the lecture or in the lab session, and schedule for various topics to be covered in the lecture and lab sessions.

Statement on Academic Conduct and Support Systems

Academic Conduct
Plagiarism – presenting someone else's ideas as your own, either verbatim or recast in your own words – is a serious academic offense with serious consequences. Please familiarize yourself with the discussion of plagiarism in *SCampus* in Part B, Section 11, "Behavior Violating University Standards" https://policy.usc.edu/student/scampus/part-b. Other forms of academic dishonesty are equally unacceptable. See additional information in *SCampus* and university policies on scientific misconduct, http://policy.usc.edu/scientific-misconduct.

Discrimination, sexual assault, intimate partner violence, stalking, and harassment are prohibited by the university. You are encouraged to report all incidents to the *Office of Equity and Diversity/Title IX Office* http://equity.usc.edu and/or to the *Department of Public Safety* http://dps.usc.edu. This is important for the health and safety of the whole USC community. Faculty and staff must report any information regarding an incident to the Title IX Coordinator who will provide outreach and information to the affected party. The sexual assault resource center webpage http://sarc.usc.edu fully describes reporting options. Relationship and Sexual Violence Services https://engemannshc.usc.edu/rsvp provides 24/7 confidential support.

Support Systems
A number of USC's schools provide support for students who need help with scholarly writing. Check with your advisor or program staff to find out more. Students whose primary language is not English should check with the *American Language Institute* http://ali.usc.edu, which sponsors courses and workshops specifically for international graduate students. *The Office of Disability Services and Programs* http://dsp.usc.edu provides certification for students with disabilities and helps arrange the relevant accommodations. If an officially declared emergency makes travel to campus infeasible, *USC Emergency Information* http://emergency.usc.edu will provide safety and other updates, including ways in which instruction will be continued by means of Blackboard, teleconferencing, and other technology.