Lahore University of Management Sciences

CS202/EE202 – Data Structures

Spring 2018

Instructor	Dr. Ihsan Ayyub Qazi (http://web.lums.edu.pk/~ihsan/)
Class Timings	4:30pm-5:45pm, Monday/Wednesday
Room No.	SBASSE 9-G14A, Computer Science Department, LUMS
Office Hours	3:30pm-4:30pm every Monday or by appointment
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Teaching Assistants (TAs)	TBA
Course URL	LMS (https://lms.lums.edu.pk)

Course Basics				
Credit Hours	3 credit hours			
Lecture(s)	2 Per Week		Duration	75 mins
Tutorial (per week)	1 Per Week		Duration	60 mins

Course Distribution	
Core	CS Majors, EE Majors, and CS Minors
Elective	All
Open for Student Category	All
Close for Student Category	None

COURSE DESCRIPTION

Data structures are abstractions for storing data in a computer system and form an essential building block in the design of efficient algorithms. The knowledge of data structures plays a central role in computer science and engineering and is highly sought-after in the technology industry. They are used in a wide variety of applications today including search engines (e.g., Google, Bing), social networking applications (e.g., Facebook, Twitter), embedded systems (e.g., cell phones, robots), and DNA analysis. This course introduces the *fundamentals* of data structures and aims to provide a deep understanding of how to systematically *organize* data in a computer system. The students will be introduced to *analytical tools* for comparing different data structures in terms of their time and space complexity. Finally, the course will augment student's theoretical understanding of data structures with rigorous *programming assignments*, which form an essential component of the course.

COURSE PREREQUISITE

- CS 200 Introduction to Programming

COURSE OBJECTIVES

- To understand the fundamental *tradeoffs* in the design of data structures
- To introduce tools for *analyzing* the time and space complexity of data structures and algorithms
- To provide rigorous 'hands-on' experience with *implementing* different data structures in a programming language

Learning Outcomes

- Students will be able to understand basic data structures
- Students will be aware of how data structures are used in real-world applications
- Students will understand the fundamental tradeoffs that exist in the design of data structures
- Students will be able to compare the time and space efficiency of different data structures
- Students will be able to appreciate how changing application requirements can lead to new data structures
- Students will be able to write programs to efficiently store, retrieve, and manipulate data

Grading Breakup and Policy

Programming Assignment(s) + Homeworks: 30%
Quiz(s): 20%
Midterm Examination: 20%
Final Examination: 30%

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Examination Detail	
Midterm Exam	Yes/No: Yes Duration: 3 hours Preferred Date: TBA Exam Specifications: TBA
Final Exam	Yes/No: Yes Duration: 3 hours Exam Specifications: TBA

Textbook(s)/Supplementary Readings

Required Textbooks

- **(GTM)** Data Structures and Algorithms in C++ by Michael T. **G**oodrich, Roberto **T**amassia, and David **M**ount (2nd Edition)
- **(Weiss)** Data Structures and Algorithm Analysis in C++ by Mark Allen **Weiss** (2nd Edition)

Session	Topics	Recommended Readings
1	Overview: Data Structures, Abstract Data Types, and Applications	
2	Analysis Tools: Experimental Analysis, Asymptotic Notation	(GTM) Chapters 4.1-4.2 + (Weiss) Chapter 6
3	Analysis Tools: Asymptotic Analysis, Arrays	(GTM) Chapters 3.1-3.4 + (Weiss) Chapters 16
4	Arrays, Lists (Singly Linked List, Doubly Linked List), Stacks	Above + (GTM) Chapters 5.1+(Weiss) Chapter 17, 16
5	Stacks, Queues	(GTM) Chapters 5.1-5.3 + (Weiss) Chapter 16
6	Trees: Foundations, Tree Traversals	(GTM) Chapters 7.1, 7.2 + (Weiss) Chapter 18.1
7	Trees: Tree Traversals, Binary Trees	Above + (GTM) Chapters 7.3 + (Weiss) Chapter 18.4
8	Binary Trees: Analysis, Applications	(GTM) Chapters 7.3 + (Weiss) Chapter 18.2, 18.3
9	Binary Search Trees (BST): Basics, BST Analysis	(GTM) Chapters 10.1 + (Weiss) Chapter 19.1-19.3
10	Balanced Binary Trees: AVL Trees	(GTM) Chapters 10.2 + (Weiss) Chapter 19.4
11	Balanced Binary Trees: AVL Trees, Red-Black Trees (optional)	(GTM) Chapters 10.5 + (Weiss) Chapter 19.4, 19.5
12	Hash Tables: Hash Functions	(GTM) Chapters 9.2 + (Weiss) Chapter 20.1, 20.2
13	Hash Tables: Chaining, Open Addressing	(GTM) Chapters 9.2 + (Weiss) Chapter 20.3
14	**Midterm Exam**	
15	Priority Queues: Foundations, Binary Heaps	(GTM) Chapters 8.1-8.3 + (Weiss) Chapter 21.1
16	Heaps: Binary Heaps, HeapSort	(GTM) Chapters 8.3 + (Weiss) Chapter 21.1, 21.2
17	Sorting: Insertion Sort, Selection Sort, Mergesort	(GTM) Chapters 11.1 + (Weiss) Chapter 9.1-9.5
18	Sorting: Quicksort, Bucket-Sort, Radix-Sort (optional)	(GTM) Chapters 11.2, 11.3 + (Weiss) Chapter 9.6-9.8
19	Data Compression: Applications, Huffman Coding	(GTM) Chapters 12.4 + (Weiss) Chapter 13.1 + Notes
20	Tries: Standard, Compressed, Suffix Tries	(GTM) Chapters 12.5
21	Graphs: Basics, Data Structures for Graphs	(GTM) Chapters 13.1, 13.2 + (Weiss) Chapter 15.1
22	Graph Traversals: Depth First Search, Breadth First Search	(GTM) Chapters 13.3 + (Weiss) Chapter 15.2
23	Weighted Graphs: Minimum Spanning Trees, Topological Sort	(GTM) Chapters 13.6 + (Weiss) Chapter 15.5
24	Weighted Graphs: Directed Graphs, Connected Components	(GTM) Chapters 13.4, 13.5 + (Weiss) Chapter 15.5
25	Shortest-Path Algorithms: Dijkstra's Algorithm	(GTM) Chapters 13.5 + (Weiss) Chapter 15.3
26	Advanced DS: Distributed Hash Tables, Bloom Filters	Slides/Notes
27	Advanced DS: Memory Locality, Parallel Algorithms & Data Structures	Slides/Notes
28	Advanced DS: Parallel Algorithms & Data Structures	Slides/Notes
29	Advanced DS: Parallel Algorithms & Data Structures + **Review**	Slides/Notes