CS-2009 Design and Analysis of Algorithms

Spring 2024

National University of Computer and Emerging Sciences – FAST, Lahore

Credit Hours: 3

Prerequisites: Data Structures

Instructors: Ms. Saira Karim (saira.karim@nu.edu.pk)

Office Hours: Monday and Friday 11:00 – 12:30

Textbook:

- *Introduction to Algorithms* by Cormen, Leiserson, Rivest, and Stein, 3rd Ed., MIT Press, 2001.

Reference Books:

- Jon Kleinberg, Éva Tardos, Algorithm Design, Pearson/Addison-Wesley
- Sanjoy Dasgupta, Christos Papadimitriou, Umesh Vazirani, Algorithms, McGraw-Hill Education
- *Algorithms in C++* by Robert Sedgewick, Addison-Wesley, 1992.
- *Data Structures and Algorithms* by Aho, Hopcroft, and Ullman.

Course Description:

The objective of this course is not to fill your brains with every algorithm that you would ever need. One of the aims of this course is to teach you to reason about algorithms and describe them. In addition, many known algorithms to solve known problems will be taught. At the end of the course, you should be able to choose an appropriate algorithm from a set of algorithms for a given problem.

Course Learning Outcomes (CLOs):
1. Design algorithms using different algorithms design techniques i.e. Brute Force, Divide and Conquer, Dynamic Programming, Greedy Algorithms and apply them to solve problems in the domain of the program
2. Analyze the time and space complexity of different algorithms by using standard asymptotic notations for recursive and non-recursive algorithms.
3. Evaluate the correctness of algorithms by using theorem proving or executing test cases
4. Implement the algorithms, compare the implementations empirically, and apply fundamental algorithms knowledge to solve practical problems related to the program.
5. Solve problems using graph algorithms, including single-source and all-pairs shortest paths, and at least one minimum spanning tree algorithm

Grading Policy:

Grades will be awarded using **absolute grading scheme** on the basis of continuous assessment through quizzes, assignments, two midterm exams and a final exam. The distribution of marks is as under:

- Quizzes 10%
- Assignments 10%
- Mid term I 15%
- Mid term II 15%
- Final exam 50%

In writing up your assignments and in answering questions in exams, be as clear, precise, and concise as you can. **Understandability will be an important factor in grading**.

Academic Integrity: All work MUST be done individually. Any copying of work from other person(s) or source(s) (e.g. the Internet) will automatically result in at least an F grade in the course. It does not matter whether the copying is done in an assignment, quiz, midterm exam, or final exam, it will be considered equally significant.

Note: in order to pass the course student needs at least 50% marks. Absolute grading will be used to award letter grades.

Outline and Distribution:

Lectures	Description	Chapters of Text
Week -1	The role of algorithms in computers, Asymptotic functions and notations (Bid-oh, big-omega, theeta) best and worst case time complexity	1, 2, 3
Week – 2, 3, 4	Divide and Conquer (maximum subarray, quicksort, merge sort, Counting inversions) + Solving recurrences	2, 3, 6
Week – 5	Lower bound for comparison based sorting, Sorting in linear time: Count Sort, Radix Sort, Bucket Sort	8
	Midterm – I	
Week – 6, 7	Greedy Algorithms (Activity selection, fractional knapsack and Huffman codes) proof of correctness	16
Week – 8, 9	Dynamic Programming (maximum subarray, rod cutting, edit distance, Binary knapsack)	15
Week – 10	Introduction to graphs (revision of BFS, DFS) and their application (Bridges and articulation point, topological sort, strongly connected components)	22
	Midterm – II	
Week – 11	Minimum Spanning Trees (MST)(Prim's Algorithm and Kruskal's Algorithm)	23
Week – 12, 13	Shortest Path Algorithms (dijkstra's Algorithm, BellmanFord and Warshall Algorithm	24
Week – 14	B-Trees/Hashing/Exhaustive Search intractable problems	
	Final Exam	Comprehensive