



Course Overview:

This course provides an advanced data structure and algorithms analysis, types of data structures and programming principles. Additionally, this course covers advanced data structure techniques on computer memory and algorithm analysis that manipulates the data for the purpose of efficiency. It focuses on operations sets of numbers, intervals or strings by various data structures including search trees, structures for sets of interval, heaps, hash tables, and structures for strings. Recursive function, algorithm efficiency, order of magnitude analysis and Big O notation will be discussed. Students will implement operations that can be applied to data structures using various sorting and searching techniques. Further, students will be exposed to linear data structures such as linked lists, stack and queue. Non-linear data structures such as tree and graphs will also be discussed. Moreover, the course focuses on to apply some modern algorithms that applied in many fields such as optimization and search engine. At the end of the course, students should be able to implement and apply the theory and concepts of data structure in the mini project which is conducted in group.

Course Instructor

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References

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- ↓ Robert Kruse, Data Structures and Program Design , Prentice Hall, 1984
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- B. Moret & H. Shapiro, Algorithms from P to NP vol. 1: Design and Efficiency, Benjamin/Cummings, 1991

Topics

Implicit in a topic is the standard analysis of the relevant algorithms. We have omitted the traditional storage management material.

1. General concepts

- Abstract data structure as an organization of data with specified properties and operations
- **4** Complexity of Algorithms Big oh and theta notations
- 4 Average, best and worst case analysis
- **4** Simple recurrence relations and use in algorithm analysis

2. Linear data structures

- ♣ Arrays, lists, stacks, queues
- 4 Array and linked structure implementations of lists, stacks, queues





4 Array of nodes and dynamic pointer implementations of linked structures

3. Trees

- **4** General and binary trees
- **4** Representations and traversals
- **4** General trees as binary trees
- **H** Binary search trees
- Applications
- **4** The concept of balancing and its advantages
- \rm AVL Tree
- \rm Heap

4. Dictionaries

- ∔ Sets
- 📥 Dictionaries
- ∔ Hash Tables
- Closed Hashing
- Hashing Functions
- 4 Analysis of Closed Hashing
- Hash Table Restructuring
- 📥 Skip Lists

5. Sorting

- Elementary sorts: selection, insertion, bubble sort. Quicksort, merge sort, heap sort.
- ∔ Shell Sort, Radix Sort
- Bucket sorting
- 🖊 External sorting
- ↓ Worst case and average behavior
- 4 Lower bound for sorting using comparisons

6. Graphs and digraphs

4 Representions





- **4** Breadth and depth first searches
- **4** Connectivity algorithms
- ♣ Shortest path
- **4** Minimal spanning tree
- \blacksquare The union find problem
- Hereit Warshall's Algorithm
- 4 Hamiltonian path and travelling salesperson problems
- Network flow
- \rm Matchings

7. File Processing and External Sorting

- Frimary versus Secondary Storage
- **4** Buffers and Buffer Pools
- **4** The Programmer's View of Files

8. Algorithm design techniques

- ♣ Greedy methods
- 4 Priority queue search
- **4** Exhaustive search
- \blacksquare Divide and conquer
- 4 Dynamic programming
- Recursion
- 4 Some problems are recursive in nature
- 4 Influence of data structure on algorithm performance
- 4 Advance Search and Optimization such as ABC, Anti Colony.

9. NP vs. P

- ↓ The spaces P and NP
- 4 Polynomial reduction
- **4** NP complete problems
- **4** Boolean satisfiability and Cook's theorem
- Binpacking, knapsack, Hamiltonian path, TSP, independent set, max clique, integer
- 4 linear programming, graph coloring
- Approximation algorithms

10. Theory of Algorithms

4 Analysis Techniques





- **4** Summation Techniques
- Amortized Analysis
- 4 Optimal Sorting
- Patterns of Algorithms
 - **4** Dynamic Programming
 - **4** Randomized Algorithms
 - **With States Algorithms**