Algorithms and Problem Solving (15B11CI411)
EVEN 2022

Module 1: Lecture 1

Jaypee Institute of Information Technology (JIIT)
A-10, Sector 62, Noida

Outline – Introduction to Course

1. Course Outline
2. Course Outcome
3. Evaluation Criteria
4. Relevant Resources
5. Know your Teachers

Algorithms and Problem Solving (15B17CI411)
Course Outline

Module No.	Topics	Count of Lectures
1	Introduction to problem solving approach; Asymptotic Analysis: Growth of Functions and Solving Recurrences; Notations- Big O, big omega, big theta, little o; Empirical analysis of sorting and searching algorithms – Merge sort, Quick sort, Heap sort, Radix sort, Count sort, Binary search, and Median search	6
2	Search Trees: Segment tree, Interval Tree	3
3	Fundamentals of Divide and Conquer (D&C) approach using Binary search, Quick sort, and Merge sort; Strassen's matrix multiplication; and Closest pair, etc.	4
4	Introduction to greedy based solution approach; Minimum Spanning Trees (Prim's and Kruskal algorithms); Shortest Path using Dijkstra's algorithm; Fractional and 0/1 Knapsack; Coinage problem; Bin packing; Job scheduling – Shortest job first, Shortest remaining job first, etc.; Graph coloring; and Text compression using Huffman coding and Shannon-Fano coding, etc.	6
5	Review of backtracking based solution approach using N queen, and Rat in a maze; M-coloring problem; Hamiltonian Cycle detection; Travelling salesman problem; Network flow	4
6	Fundamentals of Dynamic programming based solution approach; 0/1 Knapsack ; Shortest path using Floyd Warshall; Coinage problem; Matrix Chain Multiplication; Longest common subsequence; Longest increasing sequence, String editing	6
7	Naïve String Matching, Finite Automata Matcher, Rabin Karp matching algorithm, Knuth Morris Pratt, Tries; Suffix Tree; and Suffix Array	6
8	Problem Spaces: States, goals and operators, Factored representation (factoring state into variables) Uninformed search (BFS, DFS, DFS with iterative deepening), Heuristics and informed search (hill-climbing, generic best-first, A*)	4
9	Efficiency and Tractability, P, NP, NP-Complete, NP- Hard problems	2

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Course Outcome

	Course Outcomes (CO)	Cognitive Levels
CO1	Analyze the complexity of different algorithms using asymptotic analysis.	Analyze Level (Level 4)
CO2	Select an appropriate data structure and apply related operations for a given problem.	Apply Level (Level 3)
CO3	Apply algorithmic principles for solving a given problem.	Apply Level (Level 3)
CO4	Identify, formulate and design an efficient solution to a given problem using appropriate data structure and algorithm design technique.	Create Level (Level 6)

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Evaluation Criteria

S. No.	Evaluative Components	Marks
1	T1	20
2	T2	20
3	End Semester Examination	35
4	Teachers Assessment: Attendance / PBL / Assignments	25
	Total	100

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Relevant Resources - I

Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Reference Books, Journals, Reports, Websites etc. in the IEEE format)	
1.	Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein , Introduction to Algorithms, MIT Press, 3rd Edition, 2009
2.	Steven Skiena ,The Algorithm Design Manual, Springer; 2nd edition , 2008
3.	Knuth, The art of Computer Programming Volume 1, Fundamental Algorithms, Addison-Wesley Professional; 3 edition,1997
4.	Horowitz and Sahni, Fundamentals of Computer Algorithms, Computer Science Press, 2008
5.	Sedgewick, Algorithms in C, 3rd edition. Addison Wesley, 2002
6.	Alfred V. Aho, J.E. Hopcroft, Jeffrey D. Ullman, Data Structures and Algorithms, Addison-Wesley Series in Computer Science and Information Processing, 1983
7.	ACM Transactions on Algorithms (TALG)
8.	Algorithmica Journal, Springer
9.	Graphs and Combinatorics, Journal, Springer
10.	The ACM Journal of Experimental Algorithmics
Recommended Reading material: Author(s), Title, Edition, Publisher, Year of Publication etc. (Text books)	
1.	Tim Roughgarden, Algorithms Illuminated: Part 1: The Basics, Soundlikeyourself Publishing, September 27, 2017
2.	Tim Roughgarden, Algorithms Illuminated:Part 2: Graph Algorithms and DataStructures ,Soundlikeyourself Publishing, First Edition, 2018.
3.	Tim Roughgarden, Algorithms Illuminated :Part3:Greedy Algorithms and Dynamic Programming,Soundlikeyourself Publishing, First Edition, 2019.
4.	Weiss, Data Structures and Algorithm Analysis in C++, 4th Edition, Pearson, 2014

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Relevant Resources - II

S. No.	E-contents and Platforms

1	NPTEL:
	    Design and Analysis of Algorithms
	    Introduction to Algorithms and Analysis
	    Data Structures and Algorithms
	    Fundamental Algorithms: Design and Analysis
	    Programing, Data Structures and Algorithms

2	Resources from MIT, Stanford, Cornell, etc
3	GeekforGeeks, etc
	Virtual Lab https://www.vlab.co.in/

Module 1

- Introduction to problem solving approach; Asymptotic Analysis: Growth of Functions and Solving Recurrences; Notations- Big O, big omega, big theta, little o; Empirical analysis of sorting and searching algorithms – Merge sort, Quick sort, Heap sort, Radix sort, Count sort, Binary search, and Median search

Algorithms

- What is an Algorithm?

Algorithms

- What is an Algorithm?

  - It is a combination or a sequence of finite steps required to solve a given problem

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
  - ➢ It should produce atleast one output;
  - ➢ It should not have any ambiguous statements;
  - ➢ It should be loop invariant;
  - ➢ It should produce an output within a finite amount of time;
  - ➢ It should take a finite number of inputs.
  - ➢ It should be language independent.
  - ❖ Correctness: It should produce the same output for the given same input at any given time.

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
- Why "Analysis of Algorithm"?

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
- Why "Analysis of Algorithm"?
- What is the goal of "Analysis of Algorithm"?

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
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Analysis
- Posteriori
- Priori

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
- Why "Analysis of Algorithm"?
- What is the goal of "Analysis of Algorithm"?

Time Complexity: Compile-time + Run-time

Algorithms

- What is an Algorithm?
- What are the properties of an Algorithm?
- Why "Analysis of Algorithm"?
- What is the goal of "Analysis of Algorithm"?

Order of Magnitude

Algorithms

- Revision of known searching and sorting algorithms.