Guest Lecture Report

Guest Lecture on

Design and Analysis of Algorithms: NP-Hard, NP-Complete and Approximation Algorithms

Date: 26 April 2026
Day: Sunday
Time: 9:30 AM – 11:30 AM
Mode: Online (Mandatory)

Resource Person

Dr. Nilesh T. Deotale
Associate Professor and Head
Department of Computer Engineering
SJCEM, Palghar

Faculty Coordinator

Ms. Swati Vyas
Assistant Professor, Department of Computer Engineering

Target Audience

Third Year Computer Engineering (TE CSE)

Objective of the Guest Lecture

The Department of Computer Engineering organized an online guest lecture on **"NP-Hard, NP-Complete and Approximation Algorithms"** to strengthen students' understanding of advanced topics in the Design and Analysis of Algorithms (DAA). The primary objective of the session was to introduce students to computational complexity theory, explain the classification of difficult computational problems, and provide insight into approximation techniques used when exact solutions are computationally infeasible.

Session Highlights

The lecture began with an overview of computational complexity and its significance in designing efficient algorithms. Dr. Nilesh T. Deotale explained how algorithmic complexity helps determine the feasibility of solving computational problems and emphasized the importance of selecting appropriate algorithms for real-world applications.

The session covered the following key topics:

- Introduction to computational complexity classes
- Polynomial-time (P) and Non-deterministic Polynomial-time (NP) problems
- Difference between NP-Hard and NP-Complete problems
- Polynomial-time reductions and their importance
- Cook's Theorem and the concept of NP-Completeness
- Characteristics of optimization and decision problems
- Common NP-Complete problems such as Travelling Salesman Problem (TSP), Knapsack Problem, Vertex Cover, Clique, Hamiltonian Cycle, and Graph Coloring
- Real-life applications of computationally hard problems

Dr. Deotale explained the concepts using intuitive examples and graphical illustrations, enabling students to understand the theoretical foundations behind computational complexity.

The second part of the lecture focused on **Approximation Algorithms**, where the speaker discussed techniques for obtaining near-optimal solutions for NP-Hard optimization problems. Students learned why approximation algorithms are essential when exact solutions require excessive computation time.

The following concepts were discussed:

- Introduction to approximation algorithms
- Approximation ratio and performance guarantees
- Greedy approaches for approximation
- Approximation techniques for Vertex Cover and Travelling Salesman Problem
- Trade-offs between solution quality and execution time
- Practical applications of approximation algorithms in logistics, network design, scheduling, and resource allocation

The resource person also highlighted the relevance of these concepts in competitive programming, research, and technical interviews conducted by leading software companies.

Student Interaction

The session was highly interactive, with students actively participating throughout the lecture. They asked insightful questions related to:

- Practical identification of NP-Hard and NP-Complete problems
- Designing polynomial-time reductions

- Selection of approximation techniques for optimization problems
- Real-world applications of approximation algorithms
- Frequently asked DAA interview questions and placement preparation
- Research opportunities in algorithm design and computational complexity

Dr. Deotale answered each query with practical examples and encouraged students to strengthen their analytical and problem-solving abilities through regular algorithmic practice.

Learning Outcomes

By the end of the session, students were able to:

- Understand the concept of computational complexity.
- Differentiate between P, NP, NP-Hard, and NP-Complete problems.
- Explain polynomial-time reductions and their role in proving NP-Completeness.
- Identify real-world problems that belong to NP-Hard and NP-Complete classes.
- Understand the need for approximation algorithms in solving computationally difficult optimization problems.
- Analyze the trade-off between computational efficiency and solution accuracy.
- Appreciate the applications of approximation algorithms in modern computing and software engineering.
- Enhance logical reasoning and problem-solving skills required for higher studies, research, and technical interviews.

Conclusion

The guest lecture provided students with a comprehensive understanding of advanced topics in the Design and Analysis of Algorithms. Dr. Nilesh T. Deotale effectively simplified complex theoretical concepts using practical examples and real-world applications, making the session highly engaging and informative. His discussion on NP-Hard, NP-Complete, and Approximation Algorithms enhanced students' conceptual clarity and motivated them to explore advanced algorithmic techniques and computational complexity. The session proved to be highly beneficial in strengthening students' analytical thinking and preparing them for competitive examinations, placements, and future research in computer science.

The Department of Computer Engineering expresses its sincere gratitude to **Dr. Nilesh T. Deotale** for delivering an insightful and enriching guest lecture. The department also appreciates the efforts of **Ms. Swati Vyas**, Faculty Coordinator, for successfully organizing and coordinating the online session.