PARAMETERIZED ALGORITHMS

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PRE-REQUISITES : Data Structures and Algorithms

INTENDED AUDIENCE : Undergraduate students who have already done a basic data structures/algorithms course.

COURSE OUTLINE :

This is a first course on techniques in parameterized algorithms, a paradigm of algorithm design that analyzes running time in finer detail than classical complexity theory: instead of expressing the running time as a function of the input size only, dependence on one or more parameters of the input instance is taken into account. This is a fast-evolving field and a fundamental approach to coping with NP-hardness, alongside approximation and randomized algorithms. The course will be a natural follow-up to a first course in algorithms and data structures for theoretically-inclined students and those who are curious about approaches to dealing with the theoretical limitations that emerge from the theory of NP-completeness.

Remark 1. A companion course might cover topics focused entirely on lower bounds (covering W-hardness, ETH and SETH-based hardness, hardness based on the UGC, and hardness of kernelization). A natural follow-up course might cover topics in the intersection of parameterized and approximation algorithms.

Remark 2. Lecture videos indicative of the course content can be found at this playlist from a previous offering of this course at the Institute for Mathematical Sciences, Chennai

ABOUT INSTRUCTOR :

Prof. Neeldhara Misra is an Assistant Professor of Computer Science and Engineering at the Indian Institute of Technology, Gandhinagar. Her primary research interest involves the design and analysis of efficient algorithms for "hard" problems in general, and parameterized algorithms in particular. The problems considered are typically concerned with combinatorial optimization, frequently in the context of graph theory, social choice, games, geometry, and constraint satisfaction.

Prof. Saket Saurabh is a Professor of Theoretical Computer Science at the Institute of Mathematical Sciences, Chennai, India. He is also affiliated to the Department of Informatics, University of Bergen, Norway (as a Professor). His other affiliations include Adjunct Professor at Indian Statistical Institute (ISI) Kolkata (2019-2024) and a member of IRL 2000 ReLaX. His work focuses on designing efficient algorithms (or prove that they do not exist) for hard problems arising in every domain. In particular, he has designed algorithms whose running time is analyzed in terms of different input parameters. In particular, he is interested in Multivariate Complexity or its two variable avatar Parameterized Complexity. His other interests include Graph Theory, Matroids, Matching Theory and Approximation Algorithms.

COURSE PLAN :

Week 1**:** Kernelization

Week 2**:** Bounded Search Trees

Week 3**:** Iterative Compression

Week 4**:** Randomized Techniques

Week 5**:** Treewidth - I

Week 6**:** Treewidth - II

Week 7**:** Miscellaneous Techniques: ILP and DP over subsets

Week 8**:** Important Separators

Week 9**:** Algebraic Techniques

Week 10**:** Cut and Count

Week 11**:** Matroids

Week 12**:** Parameterized Intractability