Randomized Methods For Approximation And Parameterized Algorithms

The GIAN course on *Randomized Methods For Approximation And Parameterized Algorithms* will be held in **hybrid mode** during **December 5th – 9th, 2022** at the **Indian Institute of Technology, Gandhinagar.**

Course website: https://randomizedalgos.netlify.app/
(Please check the course website for information about fees and other logistics.)

Most computational problems that model real-world issues are not known to admit efficient algorithms that are provably correct on all inputs. Many of these problems can be reduced to one of the classical problems called NP-complete problems which are unlikely to admit efficient algorithms in practice, and the issue of whether they do is a fundamental open problem in computer science. Although these problems are very unlikely to be solvable efficiently in the immediate future, computer scientists, over the last few decades, have come up with several "workarounds" to "cope" with NP-hardness.

Two fundamental approaches in this program include approximation and fixed- parameter tractability. An approximate algorithm is a way of dealing with NP- completeness for optimization problem. This technique does not guarantee the best solution. The goal of an approximation algorithm is to come as close as possible to the optimum value in a reasonable amount of time which is at most polynomial time. On the other hand, parameterized algorithms aim to restrict the exponential blow-up to an identified parameter of the problem, leading to efficient exact algorithms whenever the said parameter is reasonably small. In recent times, there has been substantial research that involves an interplay of techniques from both approaches as well.

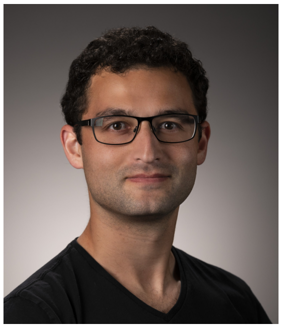
All paradigms of algorithm design, including efficient polynomial time algorithms as well as the methods of approximation and parameterization discussed above, are substantially more powerful when combined with techniques based on randomness. Carefully employed, randomization leads to approaches that are faster and easier to implement than their deterministic counterparts, making them particularly well-suited to practice.

Over the last two decades, sophisticated probabilistic techniques have been developed for a broad range of challenging computing applications. To begin with, this course will introduce the basic probabilistic techniques used in the design of randomized algorithms and in probabilistic analysis of algorithms. The course covers the basic probability theory required for working with these techniques and demonstrates their use in various computing applications, especially in the context of parameterized and approximation algorithms. This course will demonstrate the algorithmic techniques in the context of a variety of combinatorial optimization problems that have significant real-world applications. These include: Longest Path, Minimum Cut, Maximum Cut, Clustering, Vertex Cover, Feedback Vertex Set, and Closest String.

Objectives	i) Providing exposure to a wide range of problems at the foundations of theoretical computer science, and to powerful design and analysis techniques. ii) Developing the ability to recognize, when faced with a new combinatorial optimization problem, whether it resembles a known classical problem. iii) Being able to identify parameters with respect to which problems can be solved efficiently, even when theoretically intractable in general. iv) Designing linear programming or semi-definite programming relaxations and using randomized rounding to solve combinatorial optimization problems.
Modules	i) Introduction to randomized methods in algorithms, concentration bounds. ii) Examples of Randomized Algorithms. Color Coding and Chormatic Coding. iii) LPs and SDPs: deterministic and randomized rounding techniques. iv) Cut and Count v) Construction of k-wise independent sample spaces, universal sets, universal coloring families
Who can attend?	i) Graduate students in computer science ii) Advanced undergraduate students familiar with data structures and algorithms.

THE FACULTY

INSTRUCTOR



Daniel Lokshtanov is a Professor at the Department of Computer Science at the University of California Santa Barbara, before which he was a Professor at the Department of Informatics at the University of Bergen. He received his PhD in Computer Science (2009), from the University of Bergen. He spent two years (2010-2012) as a Simons Postdoctoral Fellow at University of California at San Diego.

His research interests span a wide area of algorithms, and he has made several fundamental contributions in the areas of exact exponential algorithms, parameterized and fine-grained algorithms and approximation algorithms. He has been awarded the Meltzer Prize for Young Researchers for his work at the University of Bergen. He is a recipient of the Bergen Research Foundation young researcher grant and of an ERC starting grant on parameterized algorithms. He is a co-author of two recently published texts: Kernelization (Cambridge University Press, 2019) and Parameterized Algorithms (Springer, 2015).

Website

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HOST-FACULTY

Neeldhara Misra is a Smt. Amba and Sri. V S Sastry Chair Associate Professor of Computer Science and Engineering at the Indian Institute of Technology, Gandhinagar. She completed her PhD from the Institute for Mathematical Sciences in 2012 in Theoretical Computer Science. Her research interests include the design and analysis of algorithms and computational social choice.

Website