RANDOMIZED METHODS IN COMPLEXITY

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TYPE OF COURSE: New | Elective | UG/PG
COURSE DURATION: 12 Weeks (18 Jan’2021 - 09 Apr’2021)
EXAM DATE: 25 Apr 2021

PRE-REQUISITES: Preferable (but not necessary)- Theory of Computation, or Algorithms, or Discrete Mathematics

INTENDED AUDIENCE: Computer Science & Engineering, Mathematics, Electronics, Physics, & similar disciplines


COURSE OUTLINE:
In this course we will study how randomness helps in designing algorithms and how randomness can be removed from algorithms. We will start by formalizing computation in terms of algorithms and circuits. We will see an example of randomized algorithms-- identity testing --and prove that eliminating randomness would require proving hardness results. We prove hardness results for the problems of parity and clique using randomized methods.

ABOUT INSTRUCTOR:
He completed his Bachelors in Computer Science from the Indian Institute of Technology, Kanpur in 2002 and completed his PhD under Manindra Agrawal in 2006. He is broadly interested in Computational Complexity Theory, Algebra, Geometry and Number Theory. He has been a visiting graduate student in Princeton University (2003-2004) and National University of Singapore (2004-2005); a postdoc at CWI, Amsterdam (2006-2008) and a Bonn Junior Fellow (W2 Professor) at Hausdorff Center for Mathematics, Bonn (2008-2013). Since April 2013, He has a faculty position in the department of CSE, IIT Kanpur.

COURSE PLAN:
Week 1: Outline. Introduction to Complexity
Week 2: Circuits. Polynomial Identity Testing (PIT)
Week 3: Derandomize & get a lower bound
Week 4: Constant-depth circuits are weak
Week 5: Monotone circuits are weak
Week 6: Random Walk converges fast
Week 7: Expansion properties
Week 8: Construct Explicit Expanders
Week 9: Pseudorandom generator (prg) & hardness
Week 10: Error-correcting codes
Week 11: List Decoding. Local List Decoding
Week 12: Error-correcting codes amplify hardness