CS 365 - Randomized Algorithms

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Handout #2 (9/23/08) – Course Outline

The last couple of decades has witnessed a tremendous growth in the area of randomized algorithms. During this period, randomized algorithms went from being a tool in computational number theory to finding widespread application in many types of algorithms. Two benefits of randomization have spearheaded this growth: simplicity and speed. This course presents the basic concepts in the design and analysis of randomized algorithms at a level accessible to advanced undergraduates and to graduate students.

The course will be organized into two parts which will be presented in an interleaved fashion. The first part will develop basic tools from probability theory and probabilistic analysis that are recurrent in algorithmic applications. The second part of the course will focus on specific areas of application. Applications will be given along with each tool to illustrate it in concrete settings.

The following is a tentative outline of the course.

Tools and Techniques: basic probability theory; randomized complexity theory; game-theoretic techniques; Markov, Chebyshev, and moment inequalities; limited independence; coupon collection and occupancy problems; tail inequalities and the Chernoff bound; conditional expectation and martingales; the probabilistic method; Markov chains and random walks; algebraic techniques; probability amplification and derandomization.

Applications: sorting and searching; data structures; combinatorial optimization and graph algorithms; geometric algorithms and linear programming; approximation and counting problems; parallel and distributed algorithms; online algorithms; number-theoretic algorithms.

Prerequisites: Basic undergraduate courses in Algorithms and in Probability Theory.

Text-books: The first book below is a required text-book for this course. The other two books are recommended as good introductions to probability theory.

1. Motwani and Raghavan, *Randomized Algorithms*, Cambridge University Press, 2000. [*Available in the bookstore.*]

2. William Feller. *An Introduction to Probability Theory and Its Applications,* Volumes I and II, John Wiley, New York, 1968.

3. Patrick Billingsley, *Probability and Measure,* John Wiley & Sons, 1986.