Princeton University
Department of Electrical Engineering
Information Sciences and Systems (ISS) Seminar

Speaker: Wojciech Szpankowski, Purdue University
Date: Thursday, April 26, 2007
Time: 4:30pm
Room: B205 ~ Equad
Title: ALGORITHMS, COMBINATORICS, AND INFORMATION

Abstract:
Algorithms are at the heart of virtually all computing technologies; combinatorics provides indispensable tools for finding patterns and structures arising in various problems of science and engineering; information permeates every corner of our lives and shapes our universe, so understanding and harnessing information allows the potential for significant advances. In the first part of this talk, we discuss a handful of technical results of source coding (better known as data compression) to illustrate the interplay between algorithms, combinatorics, and information. We first present an algorithm that solves a long-standing problem of eliminating the devastating effect of a limited number of errors in the popular Lempel-Ziv’77 scheme. We achieve this goal by recovering multiple matches in LZ’77 and using them for error correction. An array of analytic, combinatorial, and probabilistic methods are applied to show that the number of redundant bits is well concentrated around the mean, a highly desirable property.

The second problem we tackle concerns the redundancy rate problem that determines by how much the actual code length exceeds the optimal code length. We examine the worst case minimax redundancy for memoryless and Markov sources. Precise analysis of redundancy for such sources requires the use of the tree generating functions arising in counting labeled rooted trees and integer partitions. Finally, we deal with the method of types, a powerful technique in information theory, large deviations, and analysis of algorithms. We shall argue that counting types can be accomplished efficiently by enumerating Eulerian paths (Markov types) or binary trees with a given path length (universal types). In the last part of this talk we reflect on information in its generality, and muse on some problems in the interface of computer science and information theory. In conclusion, we describe a few pertinent challenges that bridge Shannon information with Boltzmann’s entropy, Maxwell’s demon, Landauer’s principle, Bennett’s irreversible computations, and also timeliness and value of information.