Computing Over Communication Networks

Abstract

Sensor networks have put new life into computing functions of distributed data over communication networks. Nodes can compute and links can introduce errors. The problem essentially exploits the former to negate the latter and is a fascinating confluence of networking, information theory, probability theory and algorithms. One approach is to take the classical information theoretic view, links have rate constraints, sources are possibly correlated, the network topology is assumed known and simplistic and the interest is in determining the rate region of the link rates for computing the function at a certain rate. Another approach is in using network coding techniques to either design suitable topologies or to analyze specific topologies. A third approach, especially useful in wireless networks, is to consider the spatial distribution of the nodes and account for the possible spatial reuse. Random graph and coverage process analyzes are used to design transmission schedules that "achieve capacity". Algorithm analysis techniques provide lower bounding arguments. A fourth approach assumes that the computation algorithm is provided as a directed acyclic graph. The links of this graph are to be optimally mapped to paths in the communication graph and a schedule respecting the transmission constraints needs to be constructed.

In this tutorial we will briefly explain all the four approaches above.

Bio

Bikash Kumar Dey received his B.E. degree in electronics and telecommunication engineering from Bengal Engineering College, Howrah in 1996. He received his M.E. degree in signal processing from the Indian Institute of Science, Bangalore, India in 1999 and received his Ph.D. in Electrical Communication Engineering from the Indian Institute of Science in 2003.

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Dr. Dey was awarded the Prof. I. S. N. Murthy Medal from IISc as the best M.E. student in the Department of Electrical Communication Engineering and Electrical Engineering for 1998-1999 and Alumni Medal for best Ph.D. thesis in the division of Electrical Sciences for 2003-2004.

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D. Manjunath received his BE from Mysore University, MS from Indian Institute of Technology, Madras and PhD from Rensselaer Polytechnic Inst, Troy NY in 1986, 1989 and 1993 respectively. He has worked in the Corporate R&D Center of General Electric in Scehenectady NY (1990), Computer and Information Sciences Dept of the University of Delaware (1992--93) and the Computer Science Dept, University of Toronto (1993-94). He was with the Department of Electrical Engineering of Indian Inst of Technology, Kanpur during

1994--98. He has been with the Electrical Engineering Dept of IIT-Bombay since July 1998 where he is now a Professor. His research interests are in the general areas of communication networks and performance analysis. His recent research has concentrated on network traffic and performance measurement, analysis of random networks with applications in wireless and sensor networks, network pricing and queue control. He is a coauthor of "Communication Networking: An Analytical Approach" published by Morgan-Kaufman in May 2004. He is also the coauthor of another textbook "Wireless Networking" which was published by Morgan-Kaufman in April 2008.