Shashibhushan P. Borade

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Education

Massachusetts Institute of Technology 2004–6/2008 (expected)
Ph.D. Candidate, **EECS.** GPA: **5.0/5.0**
Advisor: Prof. Lizhong Zheng
Thesis: An information theoretic approach to unequal error protection

Massachusetts Institute of Technology 2002–2004
M.S., EECS. GPA: **5.0/5.0**
Advisors: Prof. Lizhong Zheng and Prof.Robert Gallager
Thesis: Maximizing degrees of freedom in wireless networks

Indian Institute of Technology, Bombay 1998–2002
B.Tech., EE. GPA: **9.72/10.0**
Ranked first in the department and third in the institute amongst 420 students.

Research Interests

Information Theory: role of Geometry and Large Deviations, Feedback Channels, Networks, Wireless Communications

Awards and Honors

- Hewlett Packard Graduate Fellowship 2005 – 2007
- MIT Presidential Fellowship 2002 – 2003
- Institute Silver Medal for the highest GPA in Electrical Engineering at IIT Bombay 2002
- National Talent Scholarship by the Government of India (about 750 awards per year across India). 1996

Research Experience

Laboratory for Information and Decision Systems (LIDS), MIT 2002–Present
Graduate Researcher

Unequal error protection

- Classical information theory assumes that all information is equally important and aims to protect it uniformly well. However, in many scenarios such as wireless networks, where sufficient error protection becomes a luxury, providing such a uniform protection to all the information may be either wasteful or infeasible. Instead, it is more efficient to protect a crucial part of information better than the rest. This research developed a general theoretical framework for a variety of such situations, characterized the fundamental limits, and found optimal strategies.

Geometry in Information Theory

- Problems in multi-user information theory often involve optimization of Kullback-Leibler divergence over probability distributions. Viewing probability distributions as points on a manifold, a geometric approach reveals the structure of these optimum solutions. We took this approach and studied error exponent problems based on a simple Pythgoras-like theorem for KL divergence. We later used a Euclidean approximation for KL divergence to simplify this geometry. With this simplification, we solved the open problem of broadcasting with degraded message sets as a canonical example of network information theory problems.

Wireless Communication at Low SNR ("Writing on Fading Paper")

- Developed optimal communication schemes for a low power wireless system, where the receiver is dumb and the transmitter is smart but has limited power. Also resolved an open problem about dirty-paper coding with causal channel state information.

Value of Coordination in a Network

- Investigated the effects of limited coordination between relay nodes in a wireless network and showed that some simple relay operations are optimal at low noise levels. Also found some new properties for eigenvalues of a product of matrices.

Swiss Federal Institute of Technology (EPFL), Switzerland. Summer 2004

Visiting Research Intern – Laboratory of Information Theory

Mentor: Prof. Emre Telatar

Using Feedback for Communication at Large Noise Levels

- In the limit of low power, characterized the information theoretic capacity of a wireless channel with feedback. Note that signal estimation is difficult at large noise levels but is crucial nonetheless for higher energy efficiency.

EE, IIT Bombay 2001 – 2002

Undergraduate research

Adaptive Algorithms for Signal Estimation

- Developed a fast adaptive algorithm for multi-user detection in wireless systems using minimum entropy method.

Swiss Federal Institute of Technology (EPFL), Switzerland. Summer 2001

Summer Intern – Laboratory of Information Theory

Mentors: Prof. Emre Telatar and Prof. Rüdiger Ubranke

Network Information Flow

- Resolved the converse for the network coding problem conjectured by Ahlswede *et al*. For a large network class, it proved the optimality of traditional routing—no need for any network coding.

Teaching Experience

EECS, MIT Spring 2004

Teaching Assistant – Wireless Communications

Instructors: Prof. Gregory Wornell and Prof. Lizhong Zheng

- Involved in development of this new course in its first year. Developed class notes from course lectures, which were distributed weekly to the class. Developed new problems for exams and problem sets. Graded exams.

EECS, MIT Fall 2003

Teaching Assistant – Digital Communications

Instructor: Prof. Robert Gallager

- Designed new problems for exams and problem sets, provided solutions, and managed course logistics. Graded problem sets. Tutored the class of 40 students through office hours and review sessions.

Professional Experience

D. E. Shaw and Co., New York, NY. Summer 2007

Quantitative Analyst Intern

- Applied information theoretic concepts for efficiently predicting very noisy data in a causal manner. Also investigated numerous other approaches from machine learning, signal processing, and statistics.

Hewlett Packard Laboratories, Palo Alto, CA. Summer 2006

Visiting Research Intern – Media Systems Labs

Mentor: Dr. Mitchell Trott

- Designed optimal schedulers for broadcasting common media to wireless users using convex and linear programming to. Computational cost was reduced using set theory and coding theory.

Qualcomm Inc., San Diego, CA. Summer 2005

Engineering Intern – Corporate R & D division

- Developed an iterative receiver algorithm for wireless systems. It reduced the computational complexity without any degradation in performance.

Professional Service

- Coordinator of Annual LIDS Colloquium Series in 2006-2007
- Coordinator of LIDS Student Conference 2003.
- Reviewer for IEEE Transactions on Information Theory, IEEE International Symposium on Information Theory, IEEE International Conference on Communications.

Publications

Journal Papers:

- S. Borade, L. Zheng, R. Gallager, "Amplify and forward in wireless relay networks: rate, diversity and network size", *IEEE Trans. on Info. Theory, Special Issue on Relaying and Cooperation in Comm. Networks*, Oct. 2007.
- S. Borade, B. Nakibolgu, L. Zheng, "Unequal error protection: some fundamental limits", submitted to *IEEE Trans. Info. The*ory.
- S. Borade, L. Zheng, "Wideband fading channels with feedback", submitted to *IEEE Trans. Info. The*ory.
- S. Borade, L. Zheng, "Writing on fading paper and causal transmitter CSI", submitted to *IEEE Trans. Info. The*ory.
- S. Borade, L. Zheng, "Euclidean information theory", *to be submitted.*

Conference Papers:

- S. Borade, B. Nakiboglu, L. Zheng, "Unequal error protection: some fundamental limits and optimal strategies", *Information Theorey and Applications Workshop,* UCSD, Jan. 2008.
- S. Borade, L. Zheng, "Euclidean information theory", *Allerton Conference*, Sept. 2007. ***(Invited)***
- S. Borade, L. Zheng, and M. Trott, "Multilevel broadcast networks", *IEEE Intl. Symp. on Info. Theory*, June 2007.
- S. Borade, L. Zheng, "On geometry of error exponents", *Allerton Conference*, Oct. 2006. ***(Invited)***
- S. Borade, L. Zheng, "Writing on fading paper and causal transmitter CSI", *IEEE Intl. Symp.on Info. Theory*, 2006.
- S. Borade, L. Zheng, "Wideband Fading Channels with Feedback", *Allerton Conference,* Oct. 2004. ***(Invited)***
- S. Borade, L. Zheng and R. Gallager, "Maximizing Degrees of Freedom in Wireless Networks", *Allerton Conference*, Oct. 2003.
- S. Borade, "Network information flow: limits and achievability", *IEEE Intl. Symp. on Info. Theory*, July 2002.

References

Available upon request