

Satish Babu Korada

Ch. de Chantemerle 6
1024 Ecublens
Switzerland

Phone: +41 78 9188 474
e-mail: satish.korada@epfl.ch
<http://people.epfl.ch/satish.korada>

Education

Ecole Polytechnique Fédérale de Lausanne

Ph.D. Candidate, Communication Theory Laboratory

Sept. 2005 - to date

Adviser: Prof. Rüdiger Urbanke & Dr. Nicolas Macris

Areas of Emphasis: Analysis of graphical models in communications, applications of statistical physics methods to problems in communications.

Pre-doctoral school,

Oct. 2004 - July 2005

The School of Computer & Communication Sciences

GPA 5.75/6.0

Indian Institute of Technology (IIT) - Delhi , India

May 2004

B.Tech. in Electrical Engineering

GPA 9.01/10.0

Thesis: Analysis of Unknown Signals

Graduate Courses

Probability and Stochastic Models, Random Walks and Large Deviations, Random Matrices, Mathematical Principles of Signal Processing, Information Theory, Coding Theory, Wireless Communications, Roles of Diversity in Wireless Communications.

Awards and Honors

- Best Student Paper Award at the IEEE International Symposium on Information Theory, Toronto, 2008.
- Awarded Certificate of Merit for being in the top 7% of the institute in 2000-2001.
- Placed 2nd in circuit design contest conducted at the National Level Technical Festival TRYST 2003, 3rd in the open-software contest at TRYST 2002 conducted by IIT-D.

Research Work

The following are some of the specific problems I have been working on.

Channel Polarization

Channel Polarization is a quite recent idea which provides a scheme to achieve capacity for symmetric channels with low complexity successive decoding algorithms. The error probability in this setting decays exponentially with the square root of the block length. In this work we generalize this scheme and show that the error probability can be made to decay exponentially in the block length. We also provide constructions of codes which achieve this performance.

Exchange of Limits

For communication over noisy channels, low-density parity-check (LDPC) codes have been very successful due to their excellent performance with low-complexity decoding algorithms like the message passing (MP) algorithms. The standard analysis of these algorithms is based on density evolution (DE). The assumption under which DE operates is not valid as soon as the number of iterations exceeds the girth of the graph. In spite of this, it is observed in practice that DE predicts the message densities quite accurately. In this work using expansion properties of the graphs and modeling the decoding algorithm as birth-death process, we show that for a large class

of MP algorithms and codes, if DE predicts a vanishing probabilities of error, then the actual error probability also converges to zero. Mathematically, it is equivalent to showing that one can exchange limits between the blocklength and the number of iterations when computing the probability of error.

Capacity of CDMA system

One of the most successful applications of methods from statistical physics to problems in communications is the analysis of code-division multiple access (CDMA) system. This analysis was accomplished via the so-called replica method, a powerful method that unfortunately still lacks a rigorous mathematical justification. We show that the replica result for the capacity of the system is a true upper bound. We do this by developing the interpolation method for the CDMA problem. This proof is quite different from the method developed for Gaussian energy models by Guerra and Toninelli. In fact, the problem resembles more the Hopfield model in statistical mechanics for which the interpolation method is still open. In the process we also show concentration of various quantities like the capacity and magnetization of the system.

Entropy of LDPC codes

The conditional entropy of LDPC codes gives the ultimate noise threshold under which reliable communication is possible. This quantity has many similarities to the free energy of p-spin model in statistical mechanics and it is difficult to compute. For communication over the binary erasure channel it has been computed for a large class of codes using combinatorial methods. This approach is very specific for the erasure channel and cannot be extended to other channels. By using statistical mechanics methods we compute the entropy for a class of codes. Although at present our method also works only for the erasure channel, we are hopeful that it can be extended to other channels in the future.

Journal Publications

1. Satish Babu Korada, Rüdiger Urbanke, “Exchange of Limits: Why Iterative Decoding Works”, accepted in IEEE Transactions on Information Theory.
2. Satish Babu Korada, Nicolas Macris, “Tight Bounds on the Capacity of Binary Input Random CDMA Systems”, submitted to IEEE Transactions on Information Theory.
3. Satish Babu Korada, Nicolas Macris, “Exact Solution of the Gauge Symmetric p-Spin Glass Model on a Complete Graph”, submitted to Journal of Statistical Mechanics.
4. Satish Babu Korada, Eren Sasoglu, Rüdiger Urbanke, “Polarization Codes with Large Exponent: Characterization and Construction”, submitted to IEEE Transactions on Information Theory.
5. Darryl Veitch, Julien Ridoux, Satish Babu Korada, “Robust Synchronization of Absolute and Difference Clocks over Networks”, to appear in IEEE/ACM Transactions on Networking, July, 2009.

Conference Publications

1. Dinkar Vasudevan, Satish Babu Korada, “On Broadcast with a Common Message over Networks”, Proc. IEEE International Symposium on Information Theory and Applications, Auckland, December 2008.
2. Satish Babu Korada, Rüdiger Urbanke, “Exchange of Limits: Why Iterative Decoding Works”, Proc. IEEE International Symposium on Information Theory, Toronto, July 2008.

3. Satish Babu Korada, Shrinivas Kudekar, Nicolas Macris, "Concentration of Magnetization for Linear Block Codes", Proc. IEEE International Symposium on Information Theory, Toronto, July 2008.
4. Satish Babu Korada, Dinkar Vasudevan, "Broadcast and Slepian Wolf Multicast for Aref Networks", Proc. IEEE International Symposium on Information Theory, Toronto, July 2008.
5. Satish Babu Korada, Nicolas Macris, "On the Capacity of a Code Division Multiple Access System" 45th Proc. Allerton Conference on Communication, Control and Computing, Monticello, IL, Sept. 2007.
6. Satish Babu Korada, Nicolas Macris, "On the Concentration of the Capacity for a Code Division Multiple Access System" Proc. IEEE International Symposium on Information Theory, Nice, June 2007.
7. Satish Babu Korada, Shrinivas Kudekar, Nicolas Macris, "Exact Solution for the Conditional Entropy of Poissonian LDPC Codes over the Binary Erasure Channel" Proc. IEEE International Symposium on Information Theory, Nice, June 2007.
8. Satish Babu Korada, Nicolas Macris, "Exact Solution of a p-Spin Model and its Relationship to Error Correcting Codes" Proc. IEEE International Symposium on Information Theory, Seattle, June 2006.
9. Darryl Veitch, Satish Babu, Attila Pasztor, "Robust Synchronization of Software Clocks Across the Internet", Internet Measurement Conference, pages 219-232, Proc. ACM SIGCOMM Internet Measurement Conference, 2004.

Experience

Summer School

Les Houches Summer School on Complex Systems

July 2006

Details: Attended four weeks of lectures on statistical physics and its applications to computer science, coding theory and biology.

Project: Message Passing for Sudoku

Academic Internship

University of Melbourne, Australia

May 2003 - July 2003

Adviser : Prof. Darryl Veitch

Project : Clock Synchronization over Networks

Teaching Experience

Advanced Digital Communication, Graph Theory, Principles of Digital Communication.

Professional Service

Reviewer for IEEE Transactions on Information Theory, IEEE Communication Letters and IEEE International Symposium on Information Theory.