E2 214 Jan. 3:0

Finite-State Channels

Instructor

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Course Time:

Lecture venue:

Detailed Course Page: http://ece.iisc.ernet.in/~nkashyap/E2_214/

Announcements

Brief description of the course

This is an advanced course in information theory. A first course in information theory would expose a student to the class of discrete memoryless channels, which are important from a theoretical (and pedagogical) perspective, but they are not particularly good models for real-world communication channels. Discrete finite-state channels, on the other hand, are a broad class of channels with memory that serve as useful models for many channels encountered in practice. This course provides a comprehensive introduction to these channels. The course is aimed at graduate students who have already taken an introductory course in information theory and are interested in going deeper into the subject.

Prerequisites

A first course in information theory (E2 201 or equivalent)

Syllabus

The course intends to cover the following topics:

Basic definitions, motivation and applications; Gilbert-Elliott channel; intersymbol interference channels; unifilar channels; memoryless channels with input constraints

Information-theoretic capacity and channel coding theorems; computable bounds on channel capacity

Feedback capacity and its dynamic programming formulation; posterior matching schemes for achieving feedback capacity

Course outcomes

The course aims to bring students up to speed on the major directions of ongoing research on finite-state channels, and to provide the mathematical tools and techniques needed to carry out research in this field. In particular, students are exposed to the fundamental mathematical technique of dynamic programming.

Grading policy

10% for attendance; 40% for homeworks; 50% for course project

Assignments

Homework assignments consist primarily of exercises given during lectures. These may sometimes be supplemented with additional problems that are made available through the course website.

Resources

The basic material on finite-state channels is drawn from Chapters 4 and 5 of the following textbook:

R.G. Gallager, Information Theory and Reliable Communication, John Wiley & Sons, 1968.

Beyond this, the course material is sourced from a large number of papers:

M. Mushkin and I. Bar-David, "Capacity and coding for the Gilbert-Elliott channels", IEEE Transactions on Information Theory, vol. 35, no. 6, pp. 1277-1290, Nov. 1989.

A.J. Goldsmith and P.P. Varaiya, "Capacity, mutual information, and coding for finite-state channels", IEEE Transactions on Information Theory, vol. 42, no. 3, pp. 868-886, May 1996.

D.M. Arnold, H-A. Loeliger, P.O. Vontobel, A. Kavcic, and W. Zeng, "Simulation-based computation of information rates for channels with memory", IEEE Transactions on Information Theory, vol. 52, no. 8, pp. 3498-3508, Aug. 2006.

T. Holliday, A. Goldsmith, and P. Glynn "Capacity of finite state channels based on Lyapunov exponents of random matrices", IEEE Transactions on Information Theory, vol. 52, no. 8, pp. 3509-3532, Aug. 2006.

P.O. Vontobel, A. Kavcic, D.M. Arnold, and H-A. Loeliger, "A generalization of the Blahut-Arimoto algorithm to finite-state channels", IEEE Transactions on Information Theory, vol. 54, no. 5, pp. 1887-1918, May 2008.

G. Han, "A randomized algorithm for the capacity of finite-state channels", IEEE Transactions on Information Theory, vol. 61, no. 7, pp. 3651-3668, Jul. 2015.

E. Zehavi and J.K. Wolf, "On runlength codes", IEEE Transactions on Information Theory, vol. 54, no. 5, pp. 45-54, Jan. 1988.

G. Han and B. Marcus, "Asymptotics of input-constrained binary symmetric channel capacity", Annals of Applied Probability, vol. 19, no. 3, pp. 1063-1091, 2009.

A. Thangaraj, "Dual capacity upper bounds for noisy runlength constrained channels", arXiv, Sept. 2016.

S. Yang, A. Kavcic and S. Tatikonda, "Feedback capacity of finite-state machine channels", IEEE Transactions on Information Theory, vol. 51, no. 3, pp. 799-810, Mar. 2005.

S. Tatikonda and S. Mitter "The capacity of channels with feedback", IEEE Transactions on Information Theory, vol. 55, no. 1, pp. 323-349, Jan. 2009.

H.H. Permuter, T. Weissman and A.J. Goldsmith, "Finite state channels with time-invariant deterministic feedback", IEEE Transactions on Information Theory, vol. 55, no. 2, pp. 644-662, Feb. 2009.

H.H. Permuter, P. Cuff, B. Van Roy and T. Weissman, "Capacity of the trapdoor channel with feedback", IEEE Transactions on Information Theory, vol. 54, no. 7, pp. 3150-3165, Jul. 2009.

O. Sabag, H. Permuter and N. Kashyap, "The feedback capacity of the binary erasure channel with a no-consecutive-ones input constraint", IEEE Transactions on Information Theory, vol. 62, no. 1, pp. 8-22, Jan. 2016.

O. Sabag, H. Permuter and H.D. Pfister, "A single-letter upper bound on the feedback capacity of unifilar finite-state channels", IEEE Transactions on Information Theory, Dec. 2016 (online).

O. Sabag, H. Permuter and N. Kashyap, "Feedback capacity and coding for the BIBO channel with a no-repeated-ones input constraint", arXiv, Jan. 2017.

M. Horstein, "Sequential transmission using noiseless feedback", IEEE Transactions on Information Theory, vol. 9, no. 3, pp. 136-143, Jul. 1963.

O. Shayevitz and M. Feder, "Optimal feedback communication via posterior matching", IEEE Transactions on Information Theory, vol. 57, no. 3, pp. 1186-1222, Mar. 2011.

C.T. Li and A. El Gamal, "An efficient feedback coding scheme with low error probability for discrete memoryless channels", IEEE Transactions on Information Theory, vol. 61, no. 6, pp. 2953-2963, Jun. 2015.