EE194 – Network Information Theory

General Information

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Course Description

EE19416 is a special topic course focusing on network information theory with application in communications. After reviewing the basics of information theory, single-user channel capacity and random coding concepts, we will cover the fundamentals of the multiple access channel, broadcast channel, channels with state, interference channel, relay channel, network coding and MIMO multiuser channels. The aim is for students to grasp the core ideas of network information theory, including key multiuser coding techniques, proof ideas and performance analysis, with emphasis on understanding the techniques and applying them in modern communications.

Students are expected to perform a research project as part of the course credit. For the project, students are encouraged to explore applications of the ideas introduced in class to modern communications as well as information theory.

Prerequisites:

- Probability and Random Signal, or equivalence.
- Information Theory.

Syllabus

1. Review of basic information theory concepts (entropy, mutual information)
2. Single-user channel coding (DMC, Gaussian, MIMO, random coding, typicality)
3. Multiple access channel (capacity, successive interference cancellation, Gaussian)
4. Broadcast channel (superposition coding, Marton binning, duality for Gaussian)
5. Channels with state (causality, Gelfand-Pinsker coding, dirty-paper coding)
6. Interference channel (rate splitting, Han-Kobayashi scheme, non-unique decoding)
7. Relay channel (decode-forward, compress-forward, block Markov encoding, list coding, backward decoding, sliding window decoding)
8. Multicast and interference networks (network coding, noisy network coding, interference alignment, as time permits)

Some of the advanced topics will be covered as time permits.

Assessment

- Breakdown:
  10% homework
  30% midterm exam
  30% project
  30% final exam
  We reserve the right to change these weights based on performance of the entire class.

- Midterm exam: The midterm exam is open-book and will be in class.
- Final exam: The final will be a 48 hour take-home exam.
- Homework: There will be approximately 5-6 bi-weekly homework sets. Homework is due in class on the due date. Although homework does not contribute much to the grade, it is essential for learning the materials.
- Project: The project will focus on applying ideas and techniques introduced in the course to modern communication and network problems. We will provide a list of suggested topics, but students are also encouraged to propose their own topic that is related to their research. The project will involve a presentation to the class and a report. The presentation will be scheduled during the last two weeks of the semester, and the report will be due on the last day of the semester.

Text and References

1. Abbas El Gamal and Young-Han Kim, *Network Information Theory*, Cambridge University Press, 2012. (lecture notes available online at http://arxiv.org/abs/1001.3404)

References

1. Thomas Cover and Joy Thomas, *Element of Information Theory*, 2nd ed., Wiley-Interscience, 2006.
2. Imre Csiszar and Janos Korner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, 2nd ed., Cambridge University Press, 2011.
3. Raymond W. Yeung, *A First Course in Information Theory*, Kluwer, 2001.
4. Robert G. Gallager, *Information Theory and Reliable Communication*, John Wiley & Sons, Inc., 1968.

Course website

http://www.ece.tufts.edu/ee/194NIT

Students should check the website regularly for homework sets, sample exams, lecture notes and announcements.