



Network Information Theory

IERG 5254

Instructor Info —



Chandra Nair



Office Hrs: TBD



SHB 811



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Course Info —



Prereq: Probability



Wed & Thurs



W: 1:30p-3:15p & H: 12:30p - 2:15p



SHB 801

TA Info —



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SHB 805



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Overview

During the first part of this course, I will review some basic facts about information measures and derive some inequalities concerning them. If you have not seen information theory earlier, this part will be slightly fast paced. After this, the course will mainly focus on channel coding problems in information theory. We will warm up to the task with the point-to-point channel and then quickly move on to the multiuser settings.

Material

Required Material

Lecture Notes posted on Piazza. This is a work in progress, so be on the lookout for potential typos.

Recommended Text

El Gamal, A, & Kim, Y-H, *Network Information Theory*, Cambridge University Press, 2012.

Discussion forum

Sign up Link: <https://piazza.com/cuhk.edu.hk/spring2023/ierg6154>
Any material posted on Piazza discussion forum.

Grading Scheme

20%	Homework
40%	Written Examination
40%	Project

Class Project

Around the midway point of this course, I will hand out project topics for your final project. These are problems that I consider interesting and perhaps doable. If you pick one of the questions that I give, I will be happy to work closely with you on the class project. Alternately, you can pick your own question or paper but you have to discuss it with me and get my approval. Sometimes the projects have turned into first-rate contributions to the field.

Remarks

- The emphasis will be on the mathematical details and a thorough learning of a few of the basic concepts as opposed to a breadth of topics.
- A particular focus of this offering of the course will be in non-convex optimization problems that arise in the computation of the various rate regions.
- This course intends to equip you with the relevant tools and techniques needed to conduct research in multiuser information theory. You will see a variety of open problems that will come up during the course of the lectures.

FAQs

? Do we prove theorems in this class?

! Yes, we do prove theorems in this class. If you are uncomfortable with proofs, please contact the instructor immediately

? Who is this class for?

! The class is designed for the following groups of graduate students: those who are interested in wireless communications and would like to know how some fundamental limits of reliable communication are derived, mathematically minded students who would like to know some interesting theoretical applications and questions in information theory, and finally students who wish to pursue research in the area of network information theory.

? Will this course be useful for my research?

! I cannot truthfully answer this question. All I know is that you will learn some fantastic new ideas and be exposed to some deep results.

? Is this field dead?

! That is unfortunately a prevalent misconception. It is not a hot area, but definitely not a dead field. I teach this class every two years. Each time, the results from previous projects have led me to revisit my notes and progress is continuously being made on various fronts. Indeed, some previous projects on this class have gone on to really make fundamental differences in the way I perceive certain questions.

Academic Integrity

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details may be found at <http://www.cuhk.edu.hk/policy/academichonesty/>.

With each project submission, students will be required to submit a signed declaration that they are aware of these policies, regulations, guidelines and procedures.

In the case of group projects, all members of the group should be asked to sign the declaration, each of whom is responsible and liable to disciplinary actions, irrespective of whether he/she has signed the declaration and whether he/she has contributed, directly or indirectly, to the problematic contents. For projects in the form of a computer-generated document that is principally text-based and submitted via VeriGuide, the statement, in the form of a receipt, will be issued by the system upon students' uploading of the soft copy of the assignment. Assignments without the properly signed declaration will not be graded by teachers.

Only the final version of the project should be submitted via VeriGuide.

The submission of a piece of work, or a part of a piece of work, for more than one purpose (e.g. to satisfy the requirements in two different courses) without declaration to this effect shall be regarded as having committed undeclared multiple submissions. It is common and acceptable to reuse a turn of phrase or a sentence or two from one's own work; but wholesale reuse is problematic. In any case, agreement from the course teacher(s) concerned should be obtained prior to the submission of the piece of work.

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NETWORK INFORMATION THEORY

Topic 1	Information measures Information Inequalities Typical Sets and Measure concentration
Topic 2	Point-to-point Channel (and Source) Coding Theorems
Topic 3	Multiple Access Channel: Capacity Region Caratheodory's theorem and cardinality bounding techniques
Topic 4	Superposition Coding & Concave envelopes Degraded Broadcast Channel: Capacity Region
Topic 5	Interference Channel: Inner and Outer bounds to the capacity region
Topic 6	Random Binning & Distributed Lossless Source Coding: Capacity Region
Topic 7	Channels dependent on State Variables
Topic 8	General Broadcast channel: Inner and Outer bounds
Topic 9	Vector Gaussian (MIMO) Broadcast Channels: Capacity region
Topic 10	Miscellaneous Topics: Instructor's choice
