

ECE 563 — Information Theory

Fall 2018

Lecturer: Prof. Lav R. Varshney, varshney@illinois.edu
Office Hours: F 9:30-11:00am, 314 CSL and by appointment

Teaching Assistants: Ravi Kiran Raman, rraman10@illinois.edu
Office Hours: TBD

Sam Spencer, samster@uiuc.edu
Office Hours: TBD

Lecture: TR 12:30-1:50pm, 2015 Electrical & Computer Engineering Building

Problem Sessions: F 2:00-3:00pm, 141 Coordinated Science Laboratory

Course Webpage: <https://courses.engr.illinois.edu/ece563/>

Course Goals

- Learn how to establish the fundamental limits and optimal designs for communication systems, including the basic conceptual idea of coding.
- Develop skills in mathematical abstraction of engineering and natural systems, so as to define closed deductive systems within which to prove theorems.
- Attain facility with mathematical tools from information theory that may be broadly applicable.
- Gain confidence in using information-theoretic approaches for problems beyond communication, e.g. in learning, computing, biology, and social sciences.

Course Catalog Description

Mathematical models for channels and sources; entropy, information, data compression, channel capacity, Shannon's theorems, and rate-distortion theory.

Prerequisites

Solid background in probability (ECE 534, MATH 464, or MATH 564).

Requirements

- Homework [including programming assignments] (25%)
- Midterm exam [in class] (25%)
- Final exam [as designated by university] (25%)
- Group juxtaposition paper [in groups of three, in roughly Allerton format] (25%)

Note that all homework will be posted on the class website and will be due in class.

Details on the group juxtaposition paper will be discussed in lecture and also posted on the class website.

Textbook

- T. M. Cover and J. A. Thomas, *Elements of Information Theory*, 2nd ed., Wiley, 2006.

- Further readings and lecture notes will be provided through the course website.

Reference Texts (available at Grainger Engineering Library)

- R. Yeung, *A First Course in Information Theory*, Springer, 2006.
- I. Csiszár and J. Körner, *Information Theory: Coding Theorems for Discrete Memoryless Systems*, 2nd ed., Akadémiai Kiadó, 1997.

Detailed Course Topics

- The problem of communication / information theory beyond communications
- The idea of coding
- Information measures and their properties
- Concentration of measure, asymptotic equipartition property, and source coding theorem
- Variable-length and universal source coding
- Entropy rates for stochastic processes
- Slepian-Wolf theorem
- Noisy channel coding theorem
- Source-channel separation
- Continuous-valued channels
- Strong data processing inequalities and applications
- Large deviations and error exponents
- Quantization theory
- Rate-distortion theory
- Blahut-Arimoto algorithm
- Multiple-access and two-way channels
- Group theory and information theory

Note that the detailed lecture schedule will be posted on the course website, and may evolve a little bit as the semester progresses, based on student interest.

Academic Integrity

Academic integrity and discipline will be based on the standards set forth by the College of Engineering and the University of Illinois. The University has the responsibility for maintaining academic integrity so as to protect the quality of education and research on our campus and to protect those who depend upon our integrity. It is the responsibility of the student to refrain from infractions of academic integrity, from conduct that may lead to suspicion of such infractions, and from conduct that aids others in such infractions.

Examples of Infractions of Academic Integrity

A. Cheating -- Using or attempting to use in any academic exercise materials, information, study aids, or electronic data that the student knows or should know is unauthorized. During examinations, students should assume that external assistance (e.g., books, notes, calculators, conversation with others) is prohibited unless specifically authorized by the instructor. Substantial portions of the same academic work may not be submitted for credit more than once or by more than one student without authorization.

B. Fabrication -- Unauthorized falsification or invention of any information or citation in an academic endeavor. Fabrication also includes altering the answers given for an exam after the examination has

been graded. Fabrication also includes submitting false documents for the purpose of being excused from a scheduled examination or other academic assignment.

C. Facilitating Infractions of Academic Integrity -- Helping or attempting to help another to commit an infraction of academic integrity, where one knows or should know that through one's acts or omissions such an infraction may be facilitated. Examples include: 1) allowing another to copy from one's work during an examination, 2) taking an exam by proxy for someone else, and 3) unauthorized removal of an examination or quiz from a classroom, faculty office, or other facility (such as the proctor's office) would be committing a breach of academic integrity.

A complete listing of Infractions of Academy Integrity and University Policy can be found at this web site:
http://studentcode.illinois.edu/article1_part4_1-401.html