ECE 563 - Information Theory Fall 2025

Lectures: TTh 12:30-1:50pm, ECEB 3081

Lecturer/Professor: Prof. Olgica Milenkovic, milenkov@illinois.edu
Office Hours: Thursdays 2:30-3:30pm, 311 CSL

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Office Hours: Tuesdays 3:00-4:00pm.

Course Webpage:
https://courses.grainger.illinois.edu/ece563/fa2025/index.html

Homework. Homework and additional reading material will be posted on the class website. Homework are due in class, at the start of the lecture. Late submissions are not accepted, but in special circumstances you will be allowed to skip a HW submission. Unlike previous semesters, homework will be issued **but not graded**. There will be one additional exam instead.

Class projects: Unlike previous semesters, there will be no class projects.

Exams: There will be three exams, two midterms and one final exam. For the exact dates/times please follow posts on the course website.

Textbooks
- T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd ed., Wiley, 2006.
- Y. Poliyanskiy and Y. Wu, Information Theory, Cambridge, 2025 (recommended).

TOPICS

1. Tuesday, August 26th: Introduction, Syllabus Overview, How to measure information in physics, engineering, communication theory

2. Thursday, August 28th: Axioms of Shannon entropy, derivation of the Shannon entropy function through an axiomatic approach, properties of Shannon entropy

3. Tuesday, September 2nd: Conditional entropy, Joint entropy, Conditioning reduces entropy, Kulback-Leibler, Renyi, Bregman divergence

4. Thursday, September 4th: Submodularity and Han's inequality

5. Tuesday, September 9th: Mutual information, Data processing inequality, Jensen's inequality, the Log-sum inequality, Fano's inequality

6. Thursday, September 11th: Extremization of mutual information and the Blahut-Arimoto algorithm

7. Tuesday, September 16th: Typical sequences and the asymptotic equipartition property, compressing typical sequences

8. Thursday, September 18th: Data compression - uniquely decodable codes, prefix codes, Kraft's inequality for prefix and uniquely decodable code, bounds on optimal code-length

9. Tuesday, September 23rd: Data compression - Shannon codes, Huffman codes, optimality of Huffman codes

10. Thursday, September 25th: Data compression - Extended Huffman codes, Entropy rates and compression of stationary sources

11. Tuesday, September 30th: Data compression - Adaptive Huffman codes, Asymmetric numeral systems

12. Thursday, October 2nd: Data compression - Tunstall codes, runlength codes

13. Tuesday, October 7: Examples of channels, information channel capacity, symmetric channels

14. Thursday, October 9th: Joint typicality, Shannon's second theorem (channel capacity theorem) - achievability

15. Tuesday, October 14th: Recap of Fano's inequality, Shannon's second theorem (channel capacity theorem) - converse

16. Thursday, October 16th: Feedback capacity, source-channel coding separation theorem

17. Tuesday, October 21st: Differential entropy

18. Thursday, October 23rd: Additive Gaussian noise channels and their capacity, parallel Gaussian channels and waterfilling arguments

19. Tuesday, October 28th: MSE distortion, scalar quantization, optimal uniform scalar quantizers

20. Thursday, October 30th: Nonuniform scalar quantization and Benett's integral, Rate-distortion theory

21. Tuesday, November 4th: Metric entropy (coverings and packings, volume bound etc)

22. Thursday, November 6th: Information projection and large deviations

23. Tuesday, November 11th: Basics of statistical decision theory

24. Thursday, November 13th: Large-sample asymptotic

25. Tuesday, November 18th: Mutual information method

26. Thursday, November 20th: Entropic bounds for statistical estimation

27. Tuesday, November 26th: Thanksgiving break

28. Thursday, November 28th: Thanksgiving break

29. Tuesday, December 2nd: Strong data processing inequality

30. Thursday, December 4th: Conclusion

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