Course Title: ECE 5630: Information Theory for Data Transmission, Security and Machine Learning
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Authorship or Revision Date: 28/10/2019
Credit Hours: 4 hours
Course Website: http://people.ece.cornell.edu/zivg/ECE5630.html

Catalog Description:
This is a graduate-level introduction to mathematics of information theory. We will cover both classical and modern topics, starting from f-divergences, information measures and relations between them. Using these tools, we will study the fundamental limits of data transmission over noisy channels. Wiretap channels, where information-theoretic security versus a malicious eavesdropped must be ensured, will also be covered. Passive and adversarial models will be considered. Finally, we will explore connections between information theory and machine learning, examining how they can cross-fertilize each other.

Course Offering and Frequency:
Offered every alternating spring semester

Prerequisites:
ECE 4110 or equivalent

Corequisites:
None

Student Preparation Summary:
The primary requirement is fluency in probability theory, as obtained from ECE 4110 or graduate courses on the topic. Even ECE 3100 is generally insufficient.

Textbook(s) and/or Other Required Materials:
The course is mostly based on original material. Parts can be found in:

Books/lecture notes:

- Y. Polyanskiy and Y. Wu, "Lecture notes on Information Theory," 2017.
- T. M. Cover and J. A. Joy, "Elements of Information Theory," 2n Edition, Wiley, 2006.
- M. Bloch and J. Barros, "Physical-Layer Security," Cambridge University Press, 2011.

Lecture, Section, and Laboratory Schedule:
Lectures: Two 75 min lectures per week

Assignments, Exams and Projects:
Homework: A total of approximately 7 homework assignments
Exam: One prelim and a comprehensive final

Course Grading Scheme: 20% Homework assignments, 30% Prelim, 50% Final Exam.

List of Topics Covered (subject to minor changes):

1. Information measures (f-divergences, entropy mutual information) and their properties
2. Typical sets and the `asymptotic equipartition property'
3. Channel coding theorem: fundamental limit of reliable data transmission over noisy channels
4. Distribution simulation and channel resolvability
5. Physical-layer security: reliable and (information-theoretically) secure communication.
6. Classic (passive eavesdropper) wiretap channel and active `wiretap channel of type II'
7. Estimating mutual information using neural estimator
8. Learning wiretap codes using neural networks

Academic Integrity:

Students expected to abide by the Cornell University Code of Academic Integrity with work submitted/presented for credit representing the student's own work. Collaboration on homework assignments is permitted but the final work should represent the student's own work and understanding. Course materials are intellectual property belonging to the authors. Students are not permitted to buy or sell any course materials, or distribute in any form, without the express permission of the instructor. Such unauthorized behavior will constitute academic misconduct.