GEORGIA INSTITUTE OF TECHNOLOGY

School of Electrical and Computer Engineering

ECE 6605
Information Theory and Inference
Fall Semester 2018

Instructor:

Faramarz Fekri
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Teaching Assistant:

TBA (if any)

Class Hours:

TR: 1:30-2:45 PM

Office Hours:

TR: After Class
Campus Students: 10:00AM-12:00PM Thursdays, (Location: My office at "Centergy One Building", room 5238)
Video Students: by appointment

Course Objectives:

To introduce the mathematical theory of information. Emphasis will be placed on Shannon's theorems and their applications to the analysis and efficient representation of stochastic source outputs, and analysis of information exchange over noisy channels. We also make attempt to unify information theory and machine learning by exploring the foundation to sampling, as an example case.

Text:

Elements of Information Theory (2nd edition), Wiley Inter-science, 2006. (required)
Authored by Thomas M. Cover, Joy A. *Thomas.*

Course Prerequisites:

ECE 3075, Probability Theory

Grading Formula:

Quiz#1 (Week of Sep. 24)	25%
Quiz#2 (Week of Oct. 23)	25%
Final	35% (or 30% if TA)
Homework	15% (or 20% if TA)

Homework:

The primary way to learn any ECE subject is to WORK HOMEWORK PROBLEMS: as many as possible, and work them CAREFULLY. Homework will be assigned almost bi-weekly on Thursdays and will be due at the beginning of the class on due dates (which

are likely two weeks from the date it was assigned). VIDEO students will always turn in their homework one week after the due date for campus students.
There will be total of seven HWKs. Late homework will NOT be accepted for grading**.** Homework is to be written up and submitted individually. Working with colleagues is encouraged but simply copying someone else's solution is not acceptable and will be treated as such. Homework will be graded and solutions will be available.

Attendance:

Regular attendance in class is mandatory**.**

Honor Code:

Please uphold the academic honor code (see http://www.gatech.edu/honor/). Violations will be reported to the office of Vice-President for Student Services

Class Web Page:

http://fekri.ece.gatech.edu/course_ece6605.html

Topical Outline:

Shannon Quantities and useful Inequalities in Information Theory
- -Entropy and Mutual Information Theory
- -Joint Entropy, Conditional Entropy
- -Data Processing Theorem
- -Fano's Inequality

Asymptotic Equipartition Principle
- -Weak Law of Large Numbers
- -Typical Sequences
- -Entropy, Sequence Encoding and the AEP

Entropy Rate of Stochastic Processes
- -Markov Chains
- -Conditional Independence and Markov Chains
- -Entropy Rate

Lossless Source (Sequence) Representation/Coding
- -Kraft Inequality
- -Bounds on Optimal Code Length
- -Shannon and Huffman Codes
- -Shannon, Fano, Elias Codes
- -Arithmetic Codes (briefly)
- -Limpel-Ziv Codes (Universal Scheme)

Capacity of Information Exchange Channels
- -Capacity and Mutual information
- -Symmetric Channels
- -Discrete Memoryless Channels and Their Capacity
- -Arimoto-Blahut Algorithm
- -Proof of the Converse of Channel Coding Theorem
- -Proof of the Channel Coding Theorem

Differential Entropy for Continuous Random Variables
-Entropy, Mutual Information, AEP for Continuous rv's

Capacity of Information Exchange Channels in Continuous Variable Settings
-Capacity of AWGN,
-Bandlimited AWGN Channels
-Capacity of Nonwhite Channels: Water Filling

Sampling Methods in Inference
- Monte Carlo Methods
- Importance Sampling
- Rejection Sampling,
- Metropolis-Hastings Method
- Gibbs Sampling

Rate Distortion Theory (Time Permitting)
-Quantization
-Rate Distortion Functions
-Entropy Maximization
-Shannon's Source Coding Thm
-Converse to the Rate Distortion Thm