Rensselaer

Course Information

Information Theory and Coding		**ECSE 4104**	**Fall 2018**
Lectures	MT	12:30pm - 1:305pm	JONSSN 4104

Course webpage:

Grades: `http://lms.rpi.edu`

Material: `https://piazza.com`

Prerequisite: The following two courses or their equivalents:

- ECSE 2500 Engineering Probability
- ECSE 6510 Introduction to Stochastic Signals and Systems (recommended but not required)

Instructor

Dr. Ali Tajer — `tajer@ecse.rpi.edu`
Office Location: JONSSN 6006 — (518) 276-6036
Office Hours: Mondays 10:am-11:00am and 4:00pm-6:00pm

Homework and Midterm Exam Schedules

Mid-term exam: will be given in class on October 5, 2018.

Assignments: There will be about 10 sets of assignments throughout the semester.

Final Project Delivery: 10-minuted presentation at the end of the semester.

Course Description:

Information theory was invented by Claude E. Shannon in 1948 as a mathematical theory for communication but has subsequently found a broad range of applications.

- The first one-third of the course covers the core concepts of information theory, including entropy and mutual information, and how they emerge as fundamental limits of data compression and communication.
- The second one-third will be focused on the applications of information theory to high-dimensional statistics and data analytics.
- The last one-third focuses on the applications of information theory to machine learning.

Course Texts:

- T. M. Cover and J. A. Thomas, *Elements of Information Theory*, 2nd Edition, Wiley, 2006.
- I.A. Ibragimov and R.Z. Has'minskii. *Statistical Estimation: Asymptotic Theory*. Springer, 1981.
- I.M. Johnstone. *Gaussian estimation: Sequence and Wavelet Models*, Stanford University, 2015.
- A.B. Tsybakov. Introduction to Nonparametric Estimation. Springer, 2009.
- A. Nemirovski *Topics in Non-parametric Statistics.* in P. Bernard, editor, Ecole d'Et é de Probabilités de Saint-Flour, 1998 volume XXVIII of Lecture Notes in Mathematics, New York: Springer, 2000.
- Pascal Massart. Concentration Inequalities and Model Selection. In J. Picard, editor, Ecole d'Et é de Probabilités de Saint-Flour, 2003 volume XXXIII of Lecture Notes in Mathematics, New York: Springer, 2007.
- S. van de Geer,*Empirical Process Theory in M-Estimation*, Cambridge University Press, 2000.
- R. van Handel, *Probability in High Dimension*, Princeton University, 2014.

Course Goals / Objectives:

On completion of this course, students should be sufficiently familiar with the theoretical basis, formal representation, computational methods, notation, and vocabulary of information theory to be able to analyze and design communication systems, high-dimensional statistical inference, and machine learning applications.

Student Learning Outcomes:

1. Be able to to analyze entropy of given of random variables and establish the fundamental properties of entropy and mutual functions.
2. Be able to analyze the capacity of discrete memoryless channels.
3. Be able to form detection decision rules for inference from high-dimensional data.
4. Be able to form estimation rules for inference from high-dimensional data.
5. Be able to apply information theory to machine learning.

Course Assessment Measures:

Assessment	**Date**	**Weight**	**Learning outcome**
Mid-term Exam	October 5, 2018	30%	1,2
Assignments	Weekly	40%	1,2,3,4,5
Final Project	End of Semester	30%	3,4,5

Grade Appeal: To appeal a homework grade or the exam grade, please send an email to the instructor within week from their return, attaching a detailed explanation of why you believe the grade to be in error.

Homework Policy: All assignments are due in class. Late homework will not be accepted. You may work in groups, but you must write up your solution individually and independently. Copied homework will receive a grade of zero.

Exam Policy: If you require extra time on exams or another form of accommodation, please contact the Dean of Students Office. Please do this early in the term so that we have plenty of time to plan.

Academic Integrity:

Student-Professor relationships are built on trust. Students must trust that professors have made appropriate decisions about the structure and content of the courses they teach, and professors must trust that the assignments that students turn in represent their own work. Acts that violate this trust undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty and you should make yourself familiar with these. In this class, all assignments that are turned in for a grade must represent the student's own work. In cases where unofficial help was received, or significant teamwork was involved, a notation on the assignment should indicate your collaboration. If you have any question concerning this policy before submitting an assignment, please ask for clarification. Any violation of this policy will result in a 0 score for the related evaluation. Repeat violation will result in F grade. For any case of academic dishonesty, a report will be filed to the Dean of Students.