Information Theory, Math 728.001
Instructor: George Androulakis, giorgis@math.sc.edu, (803)777-7539, web-site.
Meeting times and location: MWF 1:10-2 at LC 315.
Office hours: MW 3:45-5:15 or by appointment in LeConte 402, as well as online using the following link. After clicking at the office hours link, make sure that you allow Blackboard Collaborate to access your microphone, else I will not be able to hear you.

Course advertisement: Information theory is an area that lies in the intersection of Mathematics, (in particular probability theory), Computer Science and Statistics. It began with the work of Claude Shannon's paper "A Mathematical Theory of Communication" in the Bell System Technical Journal in 1948. It quantifies information of distributions associated with random variables in units of bits by using several information measures. An important subfield of information theory is the coding theory which studies coding of information for efficient storage or communication, as well as decoding of information often by implementing error correcting codes. Applications of information theory are found in communication theory which includes quantum communications, cryptography, machine learning, statistical physics and bioinformatics.

Course description: This class will give a one-semester graduate level introduction to Information theory. It is mainly addressed to graduate students of Mathematics, Computer Science, Statistics and Physics. The students who complete the class will learn about entropy, relative entropy, mutual information, asymptotic equipartition property, entropy rates of a stochastic process, data compression, source coding, universal codes, channel capacity, large deviations and hypothesis testing.

Prerequisites: The students are expected to have a graduate mathematical maturity with a basic understanding of undergraduate probability theory.

Learning Outcomes: The students who complete this class will be able to:

(1) provide the definitions of entropy, relative entropy and mutual information of random variables;
(2) state and prove the main properties of entropy, relative entropy and mutual information;
(3) provide definition of channel capacity;
(4) describe some commonly used data compression codes;
(5) describe some commonly used error correcting codes;
(6) explain the procedure and types of hypothesis testing;
(7) state and prove important inequalities that are used in the theory of large deviations.

Textbook: We will consult the following books:

- "Elements of information theory" by T. Cover and J. Thomas, (2005),
- "Introduction to information theory and data compression"by D.R. Hankerson, G.A. Harris and P.D. Johnson, (2003),
- "Information theory and statistics" by I. Sciszar and P.C. Schields, (2004),
- "Lecture notes on Information theory" by Y. Polyanskiy and Y. Wu, (2019).
- "Information theory, inference and learning algorithms" by D.J.C. MacKay, (2003).

However, the students do not have to purchase these books, since the instructor will provide lecture notes to the students.

Grading: The grade will be based on homework assignments. Homework assignments will be given out weekly. The assignments will be handed in in class, and they will be returned graded in the scale $0-10$ approximately one week later. All homework assignments will be weighted equally. The grading scale will be: $[9,10]$: A; $[8,9)$: B+; $[7,8)$: B; $[6,7)$: C+, $[5,6)$ C; $[2.5,5)$: D; $[0,2.5)$: F.

Exam dates and other important dates: There will be no midterm exams or final exam. The deadline to drop the course without a WF being recorded is Monday March 27.

Tentative time allocation framework:

Weeks 1, & 2	Mathematical Preliminaries
Weeks 3 & 4	Entropy, relative entropy, mutually information
Weeks 5 & 6	Data compression
Weeks 7 & 8	Error correcting codes
Weeks 9 & 10	Channel capacity
Weeks 11 & 12	Large deviations
Weeks 13 & 14	Hypothesis testing

Academic integrity: The students are encouraged to discuss with each other about class materials and homework assignments. The submitted homework assignments should be completely of their own.

Attendance policy: There will be no penalty for missing classes. However, the homework assignments will be based on topics that will be discussed in class. Therefore students who will miss classes will have difficult time to complete homework assignments. Moreover, if a student cannot attend class on the due date of a homework assignment, the student should email me the assignment by the class time. Late homework assignments will not be accepted except for health reasons.

Dissability services: Reasonable accommodations will be available for students with a documented disability. If you have a disability and may need accommodations to fully

participate in this class, contact the Office of Student Disability Services: 777-6142, TDD 777-6744, email sasds@mailbox.sc.edu. All accommodations must be approved through the Office of Student Disability Services.