Introduction to Information Theory

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Timetable: 16 hrs. Class meets on Monday 11:00-13:00 and Tuesday 14:00-16:00 for four weeks starting October 08, 2018, with the exception of the week of Oct. 15 in which the classes will be on Thursday 11:00-13:00 and Friday 14:00-16:00. Department of Information Engineering, Via Gradenigo 6B, Room: Sala Riunioni DEI/D.

Course requirements:

Examination and grading: Grades will be based on a final exam

SSD: Information Engineering

Aim: The aim of this course is to introduce basic information theoretic concepts to students. We will start by introducing entropy, divergence, and, mutual information, and their mathematical properties. The rest of the course will be dedicated to illustrating engineering applications of these seemingly abstract quantities. We will see that entropy corresponds to the ultimate limit in data compression, divergence provides the best error exponent in hypothesis testing (i.e., binary classification), and mutual information sets the limit of how much data one can transmit reliably over a noisy communication channel.

Syllabus:

1. Week 1: Information measures
   - Day 1: Entropy, divergence, mutual information
   - Day 2: Properties of information measures (chain rule, data processing inequality, convexity)
2. Week 2: Lossless data compression
   - Day 1: Asymptotic equipartition property (AEP)
   - Day 2: Kraft inequality, Huffman coding and its optimality
3. Week 3: Information theory and learning
   - Day 1: Method of types, universal source coding, large deviations: Sanovs theorem
   - Day 2: Hypothesis testing, Steins lemma, Chernoff exponent
4. Week 4: Channel coding
   - Day 1: Channel capacity theorem, achievability, joint AEP
   - Day 2: Converse to channel coding theorem, feedback capacity, Joint source-channel coding

References:

1. R. B. Ash, Information Theory, Dover, 1990.
2. T. M. Cover and J. A. Thomas, Elements of Information Theory, Wiley, 1991.
3. R. G. Gallager, Information Theory and Reliable Communication, Wiley, 1968.