# ECGR 6165/8165: Information Theory
(cross-list: ITCS 6165/8165: Coding and Information Theory)

Instructor: Prof. Ahmed Arafa, Spring 2024 (MW: 4:00–5:15 pm, EPIC 2230)

This course introduces the science of information along with its current and emerging applications. This branch of science has been first introduced by Claude E. Shannon in his widely celebrated 1948 paper: **A Mathematical Theory for Communication**, and has since evolved tremendously over the years. Owing to its generic mathematical treatments, it has a wide range of applications in engineering, statistics, mathematics and computer science.
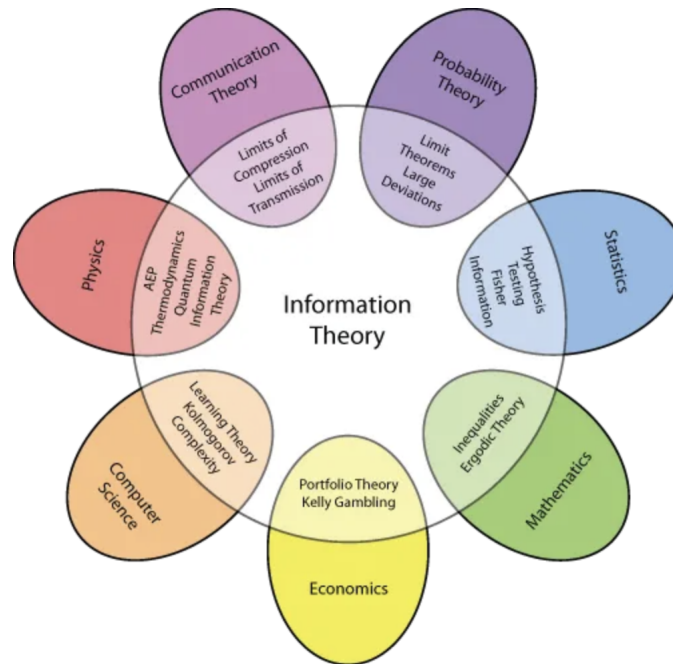
The course will be divided into two main parts:

1. ($\sim$ 2/3 of classes) **Elements of information theory:**
   Information measures and inequalities; Source coding & compression; Channel coding & capacity; Rate-distortion & quantization; Network information theory (*time-permitting*).

2. ($\sim$ final 1/3 of classes) **Applications:**
   Information theory in machine learning (*main focus*); Information-theoretic security; Private information retrieval; Low latency communications.

Part 1 will be covered in a fairly accessible way to most students; it will also include a review of probability and random variables. Students will be divided into groups to conduct a research project on selected topics from Part 2.

- Grading: homework (25%); exam (25%); class participation (10%); research project (40%).

- Prerequisites: probability & random variables + a taste for mathematical reasoning.

- Who should take this class? communication engineers interested in efficient communication system design; computer scientists interested in variant views of privacy & security; data scientists interested in information measures; people interested in mathematical beauty.

- Videos: IEEE Information Theory Society's Great Papers Series (Visual illustrations of some of the impactful results that Information Theory has brought to our world.)