

**CO 739-2 Topics in Combinatorics**  
**Information theory and applications**  
**University of Waterloo, Spring 2022**

Ashwin Nayak

Although it was originally developed as a mathematical theory of communication, information theory has found a growing number of applications in seemingly unrelated domains. Through this course, we will study basic concepts from information theory, properties of entropic quantities, their operational interpretations, and applications in discrete mathematics and computer science. A tentative list of topics includes:

- Shannon entropy, divergence, and mutual information
- basic properties of entropic quantities
- Chain Rule, Pinsker Inequality, Data Processing Inequality
- one-shot and asymptotic compression
- compression of interactive protocols
- Noisy Coding Theorem and error-correction codes
- Bregman theorem, Shearer lemma and applications
- communication complexity of Set Disjointness
- applications of error-correction codes
- Lovasz Local Lemma
- extended linear programming formulations
- sample complexity in Learning theory

Prerequisites for the course include knowledge of elementary discrete probability theory and mathematical maturity. Familiarity with discrete mathematics and theoretical computer science will be helpful, but may be substituted by sufficient enthusiasm for these subjects.

Details of the Winter 2020 offering are available at:

[http://www.math.uwaterloo.ca/~anayak/Site/Information\\_Theory.html](http://www.math.uwaterloo.ca/~anayak/Site/Information_Theory.html)

and may be useful for gauging your preparedness for the course.