

EE 568: Information Theory¹

Spring 2006

Instructor: Don Adjeroh, Room ESB 937; Tel: 293-0405 ext. 2567; email: don@csee.wvu.edu

Office Hours: Tuesdays and Thursdays 12:30pm – 2:00pm

Course Schedule: Tuesday and Thursday 11:00 – 12:15am, Venue: ESB G84

Course homepage: <http://www.csee.wvu.edu/~adjero/~/classes/ee568>

Purpose

What do radio and communication engineers, journalists, and geneticists have in common? --- They are all concerned with the transmission of some message from one point to another. But how are these related to the simple length of a program or to some theories of evolution?

Information Theory is pre-occupied with how we can code a message in order to transmit it faithfully from the message source to the receiver in an economical and efficient manner. In this course, we shall consider classical information theory as established by Claude Shannon in the late 1940's and some other views of information theory, for instance, algorithmic information theory as championed by Kolmogorov and Chaitin. We will look at information theory from three major perspectives:

- Coding for data reduction (data compression, source coding)
- Coding for data protection (error-protection, channel coding)
- Coding for data encryption (access control, cryptography)

From its traditional roots in statistical data communication to efficient data compression to studies of the genetic code in DNA sequences to the design of modern disk storage systems such as RAID devices, information theory has something to offer. Thus, if you have ever wondered why we can still have effective communication over noisy communication channels, or whether there could be a limit to data compression, or even to data communication, you might want to consider this course.

Expected Learning Outcomes:

At the end of the course, students are expected to:

- ◆ Have understood the notion of information in the quantitative sense, and how information can be measured
- ◆ Have understood the concept and properties of entropy and mutual information as applied to information
- ◆ Have understood, and be able to prove, the noiseless coding theorem (Shannon's First Theorem)
- ◆ Be able to construct compact and non-compact codes for a given data ensemble
- ◆ Have understood the notions of channels, different classes of channel, and channel capacity
- ◆ Have understood the fundamental coding theorem for noisy channels (Shannon's Second Theorem), and its implications
- ◆ Have understood simple methods for construction of error correction codes
- ◆ Be able to relate the limits of cryptography to information theory
- ◆ Have Understood the theory of rate-distortion

References

1. Required Text: Abramson A., *Information Theory and Coding*, McGraw-Hill, New York, 1963.

2. Required Text: Cover T.M. and Thomas J. A., *Elements of Information Theory*, Wiley, 1991

3. Others: Materials to be handed in class

Notes:

1. Ref #1 is out of print. The university bookstore is making copyright arrangements to make photocopies available.

Pre-requisite: Introductory knowledge of probability and statistics: STAT215 or STAT214; (EE513 is also acceptable).

Assessment:

	Worth	Release Date
Weekly quiz	10%	
3 Assignments	10%	Early February
	10%	Early March
	10%	Late March
Project & Presentation	25%	Mid February
Final Test (open-book)	35%	May 3, 2006,
Class Participation	5% extra on assignments	3:00pm–5:00pm

Grading
A ≥ 85
B 75-84
C 60-74
D 50-64
F < 50

¹Although this course has an EE code, it is also acceptable for CS graduate credit

Others

Academic Honesty

Students are encouraged to discuss class topics and analyze problems among themselves. However, copying assignment solutions or written reports (or parts of) is strictly forbidden. Also, while the Internet could be used as a research tool, copying materials verbatim from the Internet is plagiarism, and will not be tolerated in this class. Please, be aware that your submitted materials may be compared with each other, or with materials from the Internet during the evaluation.

Social Justice Statement

West Virginia University is committed to social justice. I concur with that commitment and expect to foster a nurturing learning environment based upon open communication, mutual respect, and non-discrimination. Our University does not discriminate on the basis of race, sex, age, disability, veteran status, religion, sexual orientation, color or national origin. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with Disability Services (293-6700).

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Weekly Course Schedule

Week	Starting	Topic	Notes
1	Jan. 9	Introduction Measurement of Information	
2	Jan. 16	Properties of an information measure	
3	Jan. 23	Entropy and mutual information	
4	Jan. 30	Asymptotic Equi-partition Property	
5	Feb. 6	Noiseless coding theorem (Source coding theorem)	Assignment 1 ready (due 2 weeks after)
6	Feb. 13	Construction of compact codes Universal codes	Project topics ready (due week of Apr. 24)
7	Feb. 20	Coding theorem for noisy channels (Channel coding theorem)	
8	Feb. 27	Error correcting codes	Assignment 2 ready (due 2 weeks after)
9	Mar. 6	Error correcting codes	
10	Mar. 13	SPRING BREAK	
11	Mar. 20	Information theory and cryptography	
12	Mar. 27	Rate distortion theory	Assignment 3 ready (due after 2 weeks)
13	Apr. 3	Rate distortion theory Algorithmic information theory	
14	Apr. 10	Algorithmic information theory	
15	Apr. 17	In-Class project presentations	
16	Apr. 24	DEAD WEEK In-Class project presentations Course review	Project reports due
17	May 1	FINALS WEEK	Final Test May 3, 2006, 3:00pm-5:00pm

Note that the above represents only an estimate of the weekly schedule. The actual date/week that a particular topic is discussed, and the specific topic sequence could vary during the semester.