Information Theory

Fall Semester 2009/2010

Prof. Dr. Stefan M. Moser

Syllabus

http://moser.cm.nctu.edu.tw/nctu/it/

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1 Website

There is a website which is always kept up-to-date:

http://moser.cm.nctu.edu.tw/nctu/it/

You will find there all necessary information and current announcements about this course. All handouts and exercises that are handed out during classes will also be available for download on this page. Note that while the website is available worldwide, the documents can only be downloaded from within the National Chiao Tung University (NCTU) and the National Tsing Hua University (NTHU).

2 Course Objective

This course is an introduction to Information Theory. We will cover the most important results concerning data compression and reliable communication over a communication channel. The course will follow approximately the following schedule:

- Introduction and basic definitions:
  - entropy
  - mutual information
  - relative entropy
  - gambling and horse betting
- Source coding: how to compress data efficiently?
  - Kraft inequality
  - source coding theorem for a single random variable
  - Shannon-Fano codes
  - Huffman codes
  - source coding theorem for a discrete memoryless source
  - Tunstall codes
  - universal codes
- Channel coding: how to transmit data reliably?

- Fano's inequality and data processing lemma
- converse to channel coding theorem for discrete memoryless channel
- AEP and typical sequences
- channel coding theorem
- continuous random variables and entropy
- channel coding theorem for the AWGN channel
- band-limited AWGN channel

We hope that a student who finishes the course will be able to understand the basic principles underlying any communication or data storage system.

3 Prerequisites

The following lectures/topics are recommended:

- Probability
- once more Probability
- Principles of Communication Engineering I and II (preferably, but not necessary)
- joy in math and engineering

4 Instructor

Prof. Stefan M. Moser
Engineering Building IV, Office 727
phone: 03-571 21 21 ext. 54548
e-mail: `stefan.moser@ieee.org`

5 Time and Place

There will be two lectures per week:

- Tuesday, 10:10–12:00, Engineering Building IV, Room B01 (EDB01)
- Thursday, 15:40–17:30, Engineering Building IV, Room B01 (EDB01)

The course starts on Tuesday, 15 September, and finishes on Thursday, 14 January. For a more detailed program see the above mentioned website. Note that the second hour each Thursday usually is reserved for exercises.

6 Office Hours

NCTU requests that every teacher offers two hours per week where students may come to ask questions:

- Tuesday, 13:30–15:30, Engineering Building IV, Office 727

However, we would like to encourage you to show up in the teacher's or teaching assistant's office at any time in case you have questions about the class or related subjects. Moreover, we are always available during and after classes and particularly in the second hour on Thursday (the "exercise" lecture).

7 Textbook

The course will mainly be based on

- Thomas M. Cover and Joy A. Thomas: *Elements of Information Theory,* second edition, Wiley, 2006.

For certain topics there will be additional handouts during classes.

Further references and recommended readings:

- James L. Massey: "Applied Digital Information Theory I and II," lecture notes, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland.
- Robert G. Gallager: *Information Theory and Reliable Communication,* Wiley, 1968.
- Po-Ning Chen and Fady Alajaji: "Lecture Notes in Information Theory," Volume I & II, National Chiao Tung University (NCTU), Hsinchu, Taiwan.
- Raymond W. Yeung: *A First Course in Information Theory,* Kluwer Academic Publishers, 2005.

8 Exercises

Every week, an exercise will be distributed in class. This exercise will consist of several problems that need to be solved at home and handed in during the class of the following week. A model solution will be handed out afterwards.

We believe the exercises to be extremely important and crucial to the understanding of the course. They also serve as a preparation for the mid-term and final exams and we therefore highly recommend to solve them. **To pass the course you need to hand in at least 10 exercises.**

9 Exams

There will be one mid-term and one final exam. Both exams are going to last three hours and be open-book. Details about the covered material will be published in due time.

10 Grading

The grade will be an average of

- the homework (15%),
- the midterm exam (35%), and
- the final exam (50%).

The grade of the homework will not be based on the correctness of the answers, but rather on the effort the student shows in trying to solve them. This course is worth 3 credits.

11 Special Remarks

The lecture will be held in English.