Information Theory

Syllabus Number 4C303

Special Subjects
Elective 2 credit

MORI, Takuo

1. Course Description

In this course, students learn the information theory that is a theory of digital communications and storage which supports the information society of nowadays.

Information theory is a theory that deals with the theoretical bounds of encoding and concrete encoding algorithms. In this theory, encodings are classified into source coding to increase the efficiency of communications, and into channel coding to increase the reliability of communications.

In this course, students aim at being possible to discuss theoretically the infimum of the average code length of source coding, and the supremum of the code rate of channel coding without errors giving the probabilistic model of a source or a channel. In addition, students aim at being able to decide which encoding algorithm is effective for a given purpose concretely.

Moreover, this course deals with analog source/channel, analog-to-digital or digital-to-analog conversion, the sampling theory, character encoding, the relation between information theory and cryptology.

Students acquire skills related to the diplomatic policy 2 of Department of Information Science Correspondence Course.

2. Course Objectives

The goal of this class is that students master the following abilities;

Students can explain the relation of system model of communication, noise source, source coding and channel coding.
Students can explain the purpose of source/channel coding, the meanings of Shannon's source coding theorem and Shannon's noisy-channel coding theorem.
Students can explain the model of the memoryless source, source with memory, the memoryless channel, the burst channel.
Students can explain features which source coding algorithms should have by using code tree.
Students can process basic source coding/encoding algorithm as for basic source coding algorithms.
Students can explain the amount of information, entropy, mutual information, and can compute those values
as for some basic sources.
Students can explain the meanings of channel capacity, and compute that as for some basic channels.
Students can process basic binary source coding algorithms as for some basic channel coding algorithms.
Students understand the sampling theorem and can obtain appropriate sampling frequency given maximum frequency of a signal.
Students can explain the necessity of character encoding and the features of representative character encoding.

3. Grading Policy

Grading policy: Examination(100%).

The way of feedback;
Answers for questions or feedback for the contents of class and examination will be given in a class, through LMS or during office hours.

4. Textbook and Reference

Textbook
今井秀樹著　情報理論　改訂2版
　オーム社、ISBN-13: 978-4274223259

5. Requirements(Assignments)

In order to earn credits of this course, students must submit two reports and get 60% points for each report before taking an examination.

Before taking this course, students should take the following courses;
Linear Algebra, Mathematical Logic, Discrete Mathematics, Mathematical Statistics and Computer Networks.

At the same semester with this course, students should take the following courses;
Information Security, Digital Image Processing and Digital Communications.

After taking this source, students should take Information Security.
Digital Signal Processing 1 and DIgital Signal Processing 2

6. Note

7. Schedule

[1]	Introduction Problems in the Information Theory
[2]	Review of Probability Theory Modeling digital information sources
[3]	Modeling digital channels
[4]	Analog information sources, channels Fourier seriese expansion, Sampling Theory, Analog to Digital Conversion, Character codes
[5]	Source coding and its bound Basic concepts on source coding, the bound of average code length
[6]	Source coding and its bound Huffman coding, extended information source, block coding, Shannon's source coding theorem
[7]	Entropy of basic information source/Source coding1 Entropy of independently, identically distributed(i.i.d.) information source, Entropy of Markov information source, Huffman Block Coding, Run-length Huffman Coding
[8]	Source coding 2 Entropy and Mutual Information, Arithmetic coding
[9]	Entropy, distortion
[10]	Channel coding and its bound Channel Capacity, Basic concepts on channel coding, noisy channel coding theorem
[11]	Channel Coding 1 Single error detection/correction
[12]	Channel Coding 2 Cyclic codes
[13]	Channel Coding 3 Decoding of cyclic codes, Cyclic Redundancy Codes(CRC), Cyclic Hamming Codes
[14]	Analog information source and analog channel, Information Theory and Cryptology
[15]	Summary