

CmpE 530 *Mathematical Fundamentals of Artificial Intelligence*

Fall 2008

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Class time: M 234 Off hours: M 1 W 23 and any time available

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Course objectives:

The goal of Artificial Intelligence (AI) has always been to imitate human intelligence but the methodology has changed radically. Previously learning was not that important but now learning is the centerpiece of AI research. Now human brain function is seeing major emphasis. Previously models of behavior were exclusively symbolic, but now sub-symbolic models receive the major focus. As the result of all these trends is that AI researchers need a background in mathematically oriented subjects such as probability theory, information theory, optimization theory, etc. The purpose of this course is to introduce certain background in order to describe computational models of intelligent behavior and their relationship to structures in the brain.

TEXT MATERIALS:

- **Introduction to Applied Statistical Signal Analysis**, Second Ed., Richard Shiavi, Academic Press, 1999.

References:

- Introduction To Natural Computation by Dana H. Ballard, [MIT Press](#) March 1997.
- “Digital Signal Processing Fundamentals”, “Probability and Statistics”, “Fuzzy Theory” and “Information Theory” text examples:
 - Digital Signal Processing, [Rabiner et al.](#), [Proakis et al.](#) (nice signal processing!)
 - Probability and Statistics, by [M. DeGroot](#). (a good old one!)
 - Fuzzy Theory, by [Bart Kosko \(a fuzzy theory book\)](#)
 - Statistical Pattern Recognition by [Fukunaga](#) (classical book)
 - Artificial Intelligence books

RECOMMENDED TOOLS:

- 1) Textbooks ready programs by CD
- 2) MATLAB, C/C++ programming

TENTATIVE TOPICS:

1. Introduction to signal terminology and signal processing (and applications)

- 1.1. Domain Types
- 1.2. Fourier Analysis and sampled-data signals
- 1.3. Continuous-time and Discrete-time system analysis

2. Empirical modelling and approximation (and applications)

- 2.1. Generalized least squares (LSE estimation, example: linear case)
- 2.2. Interpolation and extrapolation (Lagrange, Spline, etc.)

3. Probability concept and signal characteristics (and applications)

- 4.1. Distributions
- 4.2. Characteristics
- 4.3. Statistical Testing (Student's t test, Chi square test, ..)

4. Introduction to random processes and signal correlation (and applications)

- 5.1. Stationarity and moment functions
- 5.2. Correlation and signal structure
- 5.3. Markov chain and hidden markov model (HMM)

5. Learning Fundamentals (notes) (and applications)

- 3.1. Fundamental concepts (Supervised and unsupervised learning)

6. Information Theory (and applications)

- 6.1. Definitions, entropy, mutual information

7. Fuzzy concept (and applications)

- 7.1 Fuzziness and probability
- 7.2 Fuzzy definitions and examples

COURSE GRADING:

Midterm % 30

Presentation + Project + Homeworks + Quizzes % 35

Final % 35

IMPORTANT RULES:

- Attendance is required! (2/3 of the classes)
- No late presentations and projects will be accepted! (0 point)
- This course (like the other courses) requires regular studying!