Course Number: CSC 872
Course Title: Pattern Analysis and Machine Intelligence
Course Level: Graduate/Senior undergraduate
Number of Credits: 3
Home Department: Computer Science
Opening Term: Fall 2007
Schedule: Three hours of lecture/discussion per week.
Grading: Letter grading
Prerequisite: A grade of C or better in CSC 510 and CSC 520; or Consent of Instructor

Catalog Description
Introduction to the foundation of pattern analysis and machine intelligence. Artificial intelligence: agent, logic, search. Machine learning: Bayesian techniques, kernel-based methods, support vector machine. Pattern recognition: statistical regression and classification. Neural network: backpropagation, simulated annealing. Imaging: image segmentation, object recognition

Expanded Description

Introduction to Artificial Intelligence as a Pattern Analysis and Machine Intelligence (PAMI) Framework, Turing test, Branches of AI

Overview: Representation for Problems and Knowledge
Agent-based AI, Goal-based AI, Knowledge-based AI

Rational Knowledge
Rule-based AI, Propositional (Boolean) First Order Logic, Logical Inference

Probabilistic Knowledge
Uncertainty, Basic Bayesian Techniques, Graphical Knowledge Bases

Overview: Problem Solving

Search Algorithms
Uninformed Search, Informed Search, A* Search

Logical Inference with Uncertainty
Introduction to Fuzzy Logic

Continuous Optimization
Gradient-Descent Algorithm, Simulated Annealing

Overview: Learning

Learning the Algorithms
Decision-Tree,

Introduction to Biological and Artificial Neural Network

Learning the Parameters
Introduction to Statistical Pattern Recognition,
Regression and Classification, Linear Discriminant Analysis, Support Vector Machine

Learning the Knowledge
Data Modeling, Principal Component Analysis, Kernel Density Estimation

Overview: Imaging Applications

Segmentation
Intensity-based Segmentation, Mean Shift Segmentation, Connected-Component Analysis, Model-based Segmentation,

Classification and Recognition
Biomedical Data Analysis, Face Recognition, X-Component-Analysis, X-Discriminant-Analysis

Course Objectives
The objectives of this course include:

- Teach the foundation of modern pattern analysis and machine intelligence (PAMI) studies, including artificial intelligence, machine learning, pattern recognition, neural network.
- Teach the basic and general concepts of representation, problem solving, and computational learning across the various domain instances and disciplines, facilitating the student's understanding of how they relate to each other.
- Familiarize the students with fundamental and ubiquitous algorithms in the PAMI research and practice.
- Expose the students to imaging and vision applications as example problems.

Learning Outcomes
At the end of this course students will

- Have a comprehensive understanding of artificial intelligence, its related fields, and their relationships to one another.
- Be able to understand and formulate general problems in the PAMI formalism.
- Be able to apply pattern analysis and machine intelligence algorithms to learn and solve the PAMI problems.
- Be prepared for further advanced courses in the fields of artificial intelligence, machine learning, pattern recognition, neural network, computer vision and imaging.

These learning outcomes are designed to match with our programmatic goals by preparing students for further graduate studies in PhD level and by providing practical problem solving skills required to pursue an entry level research and development position in the industry.

Instructional Method
Classic classroom teaching via lectures by instructor and guest lecturers. Lab works for hands-on guided research projects.

Method of Evaluation
Student learning will be evaluated on the basis of

- Grade on homework assignments
- Grade on midterm examinations
- Grade on final examination or project
- Class participation.

The weight assigned to each element of evaluation will be determined by the instructor of the course on the first day of the class.

Required Textbook
Artificial Intelligence: A Modern Approach (2nd Ed), Russell, S.J. and Norvig, P., Prentice Hall, 2002

Recommended Reference
Pattern Classification (2nd Ed), Duda, R.O. and Hart, P.E. and Stork, D.G., Wiley-Interscience, 2000 (for pattern recognition)

Neural Network for Pattern Recognition, Bishop, C.M., Oxford University Press, 1996 (for machine learning and neural network and pattern recognition)

The Elements of Statistical Learning, Hastie, T. and Tibshirani, R. and Friedman, J.H., Springer, 2003 (for machine learning)

Digital Image Processing (2nd Ed), Gonzalez, R.C. and Woods, R.E., Prentice Hall, 2002 (for imaging)

Modified by: K. Okada
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