CS504/ECE504/ME578 Neural Networks Design
Spring 2006, Instructor: Dr. Milos Manic, *http://husky.if.uidaho.edu/ee578s06/*
Class description

Course outline:

Course title: ECE 578 Neural Network Design (3 cr)
Topics: Same as CS504 & ME 578. Introduction to neural networks and problems that can be solved by their application; introduction of basic neural network architectures; learning rules are developed for training these architectures to perform useful functions; various training techniques employing the learning rules discussed and applied; neural networks used to solve pattern recognition and control system problems. Prereq: perm. This course was offered last time in S05, & F03: http://husky.if.uidaho.edu
To be offered: Spring 2006 in Idaho Falls (live), Moscow (compressed video), and on tapes/dvds. http://husky.if.uidaho.edu/ee578s06/
Credits: 3 credit course

Schedule (tentative): TBD

Office hours (tentative): TBD

Location: Live in Idaho Falls (TAB 350A), CV in Moscow (room JEB 026), and on tapes/dvds.

Instructor:

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Class web page: *http://husky.if.uidaho.edu/ee578s06/*

Required textbooks:

Required textbooks include:

- Robert J. Schalkoff, "Artificial Neural Networks" co-published by MIT Press and the McGraw-Hill Companies 1997, ISBN 0-07-057118-X.
- J. M. Zurada, "Introduction to Artificial Neural Systems" - West Publishing Company 1992, ISBN: 0-314-93391-3.

Recommended text books related more towards applications:

- ed. by Ian Cloete & Jacek M. Zurada, "Knowledge-Based Neurocomputing", The MIT Press, 2000, ISBN: 0-262-03274-0.
- ed. by Emile Aarts, J.K.Lenstra, "Local Search In Combinatorial Optimization", John Wiley & Sons, 1998, ISBN: 0-471-948-225.
- ed. by D.B. Fogel, C.J. Robinson, "Computational Intelligence", John Wiley & Sons, IEEE Press, ISBN: 0-471-27454-2.
- Hagan, H. Demuth, M. Beale, "Neural Network Design", PWS Publishing Company 1995, ISBN: 0-534-94332-2

Required material will be provided through handouts and web based documentation. Also, there is a variety of recommended text books listed at course web page.

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Helpful prerequisites by topics:

Linear algebra and matrix manipulation. Computer programming skill MATLAB, C++, PERL, JAVA, or similar. Basic knowledge of Internet technologies, web browsers, and networking protocols.

Grading system:

Two exams, final exam, paper, and homework assignments.

Goal of this course:

This course provides first year graduates and seniors with the theoretical and practical tools for designing, simulating and implementing neural and fuzzy systems. Course equips students with tools to attack basic research and application oriented problems in intelligent systems.

Major topics:

Multilayer feedforward and recurrent network structures; perceptron classifiers; associative memories; bidirectional associative memories; self-organizing networks; winner-take-all; counterpropagation networks; adaptive resonance theory; fuzzy logic; fuzzy associative memories; bidirectional FAM; genetic algorithms; bioinformatics; case studies and pinnacle papers.

Detailed list of topics:

- Fundamental Concepts and Models of Neural systems. Biological Neurons and their artificial models. Feedforward and recurrent network structures. Neural network learning rules.
- Single layer perceptron classifiers. Decision regions and discriminant functions. Linear machine and minimum distance classification. Discrete and continuous perceptron classifiers.
- Multilayer feedforward networks. Delta learning rule and error back-propagation training. Learning factors. Classifying and expert systems. Functional link networks.
- Single layer recurrent networks. Discrete-time and gradient-type Hopfield networks. Transient response of continuous-time networks.
- Associative memories. Linear associator and recurrent autoassociative memory. Memory convergence versus corruption. Theory of Bidirectional Associative Memory (BAM) and memories with improved coding.
- Matching and self-organizing networks. Hamming and MAXNET networks. Unsupervised learning of clusters. Winner-Take-All (WTA) algorithm and its modification. Counterpropagation network and feature mapping. Adaptive Resonance Theory (ART).
- Theory of fuzzy logic. Fuzzy sets and degree of association. Basic fuzzy logic operations and "gama" operator. Fuzzy Hamming distance. Subsethood and entropy theorem. Fuzzy vector-matrix multiplication with Max-Min composition.
- Fuzzy Associative Memories (FAM). Fuzzy Hebb matrix and bidirectional FAM. Correlation-minimum and correlation-product encodings. Superimposing FAM rules and defuzzifications.
- Comparison of neural and fuzzy systems in various applications.
- Genetic algorithms

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Assigned projects: (equipment used – PC computer with simulation software)

- Design and training of single layer discrete and continuous neural system using various learning rules such as: minimum distance classifier, annealing, perceptron, delta and regression.
- Design and training of feedforward neural systems with error back-propagation learning rule.
- Solving an optimization problems using continuous Hopfield recurrent network.
- Design of an analog to digital converter using feedforward and recurrent networks.
- Design autoassociative and bidirectional memories. Storage and retrieve patterns form memories. Investigation of memory capacity versus corruption.
- Extracting a statistical properties of data using Winner-Take-All (WTA) algorithm for unsupervised learning of clusters.
- Design counterpropagation networks for both: classification and nonlinear mapping purposes.
- Storing and retrieving data in Fuzzy Associative Memories (FAM) using correlation-product and correlation minimum encoding.
- Design of a fuzzy controller based on fuzzy rules and fuzzy centroid principle.
- Comparison of neural and fuzzy controllers for dynamic systems (inverted pendulum controllers)
- 11. Implementation of genetic algorithms