ELG 5196 / EACJ 5709 / CRN 34861 - Neural Networks and Fuzzy Systems

Fall 2004, Mon & Wed, 17:30-19:00, SCS E218

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Marking system:

Assignments ….	10%
Project report ...	50%
Final exam. …..	40%

Calendar Description:
Neuro-fuzzy and soft computing. Fuzzy set theory: rules, reasoning and inference systems. Regression and optimization; derivative-based optimization – genetic algorithms, simulated annealing, downhill simplex search. Neural Networks: adaptive networks; bi-directional associative memories; supervised and unsupervised learning; learning from enforcement. Applications: neuro-fuzzy modelling and control, pattern recognition.

Course outline:

1. **Introduction to soft computing.**
   Soft computing, encompassing both *neural networks* (NN) and *fuzzy logic* (FL) areas, represents a synergetic approach to the development of computationally intelligent systems for solving complex real-world problems. NN techniques provide the ability to recognize patterns, learn and adapt to changing environments. Fuzzy systems emulate the human mind ability to reason in uncertain environments.
2. **Fuzzy cognitive maps.**
3. **Fuzzy logic systems**.
   Fuzzy set theory. Fuzzification. Fuzzy rules. Defuzzification. Fuzzy reasoning. Fuzzy inference systems. Fuzzy logic control (FLC).
4. **Applications of FLC**
   Backing-up a car. Backing up of a tractor & trailer. **….**
5. **Regression and optimization**.
   Least-squares estimators. Derivative-based optimization: descent methods, steepest descent method, etc. Derivative-free optimization: genetic algorithms, simulated annealing, random search, downhill simplex search.
6. **Neural networks**
   Bidirectional associative memories. Adaptive networks and backpropagation. Supervised learning: perceptrons, backpropagation multilayer perceptrons, radial basis function NN. Learning from reinforcement. Unsupervised learning: competitive learning, Kohonen self-organizingf networks, Hebbian learning, Hopfield networks. Hardware NN architectures.
7. **Applications of NN**
   NN modeling of 3D objects. Pattern recognition. Inverse kinematics in robotics. **….**

References:

- J.-S.R. Jang, C.-T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing. A Computational Approach to Learning and Machine Intelligence, Prentice Hall, 1997
- K.M. Passino and S. Yurkowich, Fuzzy Control, Addison-Wesley, 1998
- M.T. Hagan, H.B. Demuth, and M. Beale, Neural Network Design, PWS Publishing Co., 1995
- B. Kosko, Neural Networks And Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence, Prentice Hall, 1992.

Note:

- The orientation of the course is toward practice-useful methodologies. The course is supported by MATLAB examples.
- The course will involve lectures and paper design projects.

Links:

- **Fuzzy Logic FAQ** => ftp://rtfm.mit.edu/pub/usenet/news.answers/fuzzy-logic/part1
- **Fuzzy Systems for Control Applications** (slides E.M. Petriu) => http://www.site.uottawa.ca/%7Epetriu/Fuzzy-tutor.PDF
- **An Overview of Neural Networks by Ben Best =>** http://www.benbest.com/computer/nn.html#intro
- **Neural Networks at your Fingertips** => http://www.neural-networks-at-your-fingertips.com/
- **Neural Networks** (slides E.M. Petriu) => http://www.site.uottawa.ca/%7Epetriu/presentations.htm