ECE 613 Computational Intelligence Methods for Data Analysis
Design Elective
Spring Semester 2010
Tue, Thu 9:30-10:45am, Lutz 306
Instructor Jacek Zurada, Lutz 404, jacek.zurada@louisville.edu,
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Online Catalog Description:

Prerequisites (by Topic):
Matrix calculus, introduction to optimization

Textbooks:
M. Berthold, D. J. Hand (Eds.), Intelligent Data Analysis: An Introduction, Springer 1999

References:
Dana H. Ballard, An Introduction to Natural Computation, MIT Press 1997
Jacek M. Zurada, Introduction to Artificial Neural Systems, PWS, 1992
Ian H. Witten, Eibe Frank, Data Mining, Morgan Kaufmann, 2000
Hand-outs, papers, tutorials

Objectives:
Course will provide students with foundations of neural processing algorithms, fuzzy logic-based reasoning, evolutionary techniques and elements of machine learning for data analysis. It includes design assignments as part of homework and of class project involving student-written software, or existing tools such as MATLAB toolboxes (see Computer Use for details).

Course Learning Outcomes: Students who complete this course will be able to:

1. Analyze multilayer perceptron networks (MLP)
2. Design an MLP-based pattern classifier or regression analyzer
3. Perform clustering of data with unsupervised training methods, such as Winner-Takes-All (WTA)
4. Compress multidimensional data through Principal Component learning (PCA), SOFM or Hebbian learning
5. Design data projection/clustering/visualization software interface
6. Design a decision tree for machine learning-based classification
7. Apply fuzzy sets approach to approximation and fuzzy logic rules extraction
8. Apply linguistic descriptors as examples of fuzzy variables, use them to produce logic rules
9. Design a solution for a minimization problem with a genetic algorithm
10. Perform the Independent Component Analysis (ICA)
11. Apply heuristic methods of optimizations such as Particle Swarm Optimization
12. Identify a practical engineering problem and design a problem-solving software tool using one of the methods NN/FS/GA
13. Respond to need of life-long learning and browse through educational resources to study and master a selected topic of interest

Topics Covered by Class Schedule (class count in parentheses):
1. Spatial and temporal data representation, basic statistics, statistical inference (2)
2. Learning of a single neuron (perceptron, delta, Hebbian, WTA learning) (2)
3. Supervised learning of multilayer networks: EBP algorithm and its application for classification, function approximation, prediction, expert systems, logic rule extraction (3)
4. Data dimensionality reduction through Hebbian and PCA learning (2)
5. Competitive learning for clustering, learning vector quantization (2)
6. WTA learning within geometrical neighborhoods, Kohonen maps (2)
7. Elements of machine learning and rule induction (3)
8. Independent Component Analysis (ICA) (3)
9. Basic concepts of fuzzy sets theory and fuzzy logic: membership functions, unions, intersections, complements, level sets and the decomposition theorem, application to multi-criteria decision making (3)
10. Linguistic variables, fuzzy rules, and inference in fuzzy rule, fuzzy models from data (3)
11. Classical genetic algorithm, crossover and mutation operators (4)
12. Evolution strategies (2)
13. Particle swarm and ant colony optimization (2)
14. Hybrid approaches (2 classes)
15. Two quizzes and presentations (7 classes)

Topics Covered by Laboratory Schedule: none

Computer Use:
- Work with neural networks software (EBP networks, WTA, Kohonen maps), code algorithms in high-level language. Work with fuzzy sets-based function approximation, rule extraction, genetic algorithms-based optimization. Generate decision trees. Examples of computer-based projects include: design of classifiers, regression, decision trees and customization of heuristic and learning-based optimization tools (as specified by CLOs)

Evaluation:
1. Two quizzes (22.5% each)
2. Homework assigned weekly or bi-weekly (15%)
3. Software design project briefly presented/demonstrated (5-10 mins) to the class (12%) (joint assignment for two students, each must present and participate in 50% of effort)
4. Research seminar based on literature reading focused on a single topic (25 mins), PPT, MM or software presentation to class will be graded, no paper necessary (18%)
5. Class attendance (10%), 1% subtracted for each absence)

All above assignments but 3) are done individually

Grading Scale:
- [96, 100] = A+
- [92, 96] = A
- [88, 92] = A-
- [84, 88] = B+
- [80, 84] = B
- [76, 80] = B-
- [72, 76] = C+
- [68, 72] = C
- [64, 68] = C-
- [60, 64] = D+
- [56, 60] = D
- [52, 56] = D-
- [00, 52] = F

Contribution of Course to Meeting the Professional Component:
- Engineering Science: 1 credit or 33%
- Engineering Design: 2 credits or 67%

Relation of Course to Program Outcomes:
- This course supports the attainment of Program Outcomes 1 (apply science, math & engineering), 2 (design & conduct experiments), 3 (design components, devices, & system), 5, 7a&amp; 9, and 11 (use of techniques, skills, & tools of modern engineering).
Academic Integrity

Students are reminded of academic integrity. Collaboration and team efforts are only permitted in 3), other assignments are to be done as individual efforts. Cheating will not be tolerated, and academic penalties will be imposed if cheating is detected.


Prepared by: J. M. Zurada