SPECIAL TOPICS COURSE **Fall 2006**

The Pennsylvania State University
Department of Electrical Engineering

EE 597I – Intelligent Control

Time: TR 1:00 – 2:15PM Room: 201 Electrical Engineering West

Prerequisite: EE 428 (Control Engineering) or Graduate Standing

Text (Tentative): *Intelligent Control: Biomimicry for Optimization, Adaptation, and Decision-Making in Computer Control and Automation*, by K. M. Passino (Draft 8/14/00), *Biomimicry for Optimization, Control, and Automation*, by K. M. Passino, Springer-Verlag, London, UK, 2004

References: Lecture Notes and Handouts

Course Objectives:

The course will involve (i) gaining an understanding of the functional operation of a variety of intelligent controls and modern heuristic optimization techniques, (ii) the study of control-theoretic foundations of intelligent control systems, and (iii) use of the computer for simulation and evaluation of computational intelligence techniques. The objective will be to gain a "hands-on " working knowledge of several of the main techniques of computational intelligence and an introduction to some promising research directions.

Course Outline:

The course focuses on providing an introduction to the emerging area of intelligent control and optimization using a control-engineering approach. The course will be taught in two 75 min lectures each week for a semester (15 weeks):

1. Introduction (1 week):

   Intelligent Systems, Control and Intelligent Systems, Dimensions of Intelligent Systems, Working Definitions; Techniques in Intelligent Control; Control System Architectures; Need for Learning, Learning and Adaptation, Learning Algorithms

2. Decision-Making Techniques (1 week):

   Expert Systems - Components of an Expert System, Historical Perspectives, Different Development Levels in Expert Systems; Neural Networks, Fuzzy Systems, Heuristic Optimization Techniques

3. Neural Network Architectures for Modeling and Control (1 week):

   Representation of Plants; Modeling Architecture; Supervised Control Architectures; Reinforcement Learning Systems; Adaptive Critic Design, Parameterizing Linear Controllers

4. System Identification and Control (3 weeks):

   Neural Network Based Control System - Architecture for Diagonal Recurrent Neural Network (DRNN)-Based Control System, Neuro-Identifier, Neuro-Controller, Dynamic Backpropagation Algorithm for DRNN, Convergence and Stability; Optimal Tracking Neuro-Controller for Nonlinear Dynamic System, Neural Dynamic Programming

5. Fuzzy Systems (3 weeks):

   Fuzzy Sets and Systems, Fuzzy Logic Systems, Fuzzy Representations, Training of Fuzzy Logic Systems, Adaptive Fuzzy Control, Fuzzy Identifiers, Neuro-Fuzzy Identifiers, Self-Organizing Fuzzy Logic Control

6. Evolutionary Algorithms (3 weeks):

   Evolutionary Algorithms, Biological Basis, Genetic Algorithms (GA), Continuous and Discrete GA; Evolutionary Strategies, Evolutionary Programming; Differential Evolutionary Algorithm; Multiobjective Decision Problems, Pareto Multi-Objective Optimization

7. Swarm Intelligence (3 weeks):

   Particle Swarm Optimization, Ant Colony Swarms, Cultural Algorithms; Foraging; Collective Behavior in Natural Societies; Design, Control, and Optimization of Collective Artificial Systems

Grading Policy: Homeworks, Projects

- Homeworks and Projects will involve small problems involving MATLAB programming.

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