CS 4752
Introduction to Computational Intelligence
Lecture 1
September 8, 2011

Introduction

• Course Schedule
• References:
  – Computational Intelligence: An Introduction, Andries Engelbrecht, Wiley, 2007 (A.E.)
Student introduction

• Name
• Major
• Programming languages you are familiar with
• Knowledge/experience with Computational Intelligence
• Are you graduating and looking for a job

What is Computational Intelligence

• The study of computer systems that are equipped with adaptive mechanisms to enable or facilitate intelligent behavior in complex and changing environment.
  – Adaptive mechanisms: the ability to learn (machine learning)
  – Intelligent behavior: reasoning, discovery, generalization, association and abstraction
  – Deal with new situations (robust)
Computational Intelligence vs. Classical Artificial Intelligence

- Modeling biological and natural intelligence
  - Evolutionary computation
  - Neural network
  - Fuzzy logic
  - Swarm intelligence
- Based on logic and deductive reasoning
  - Expert systems
  - Case based reasoning
  - Symbolic machine learning

Soft Computing vs. Hard Computing

- Soft computing
  - Computational intelligence techniques can produce useful but inexact answers to those computational intractable problems.
  - Heuristic Methods
  - Probabilistic Methods
  - Sub-optimal but computational traceable solutions
- Hard computing
  - Classical AI techniques that are bounded by the NP-completeness concept.
  - I.e. there are problems which are too hard and computationally intractable to be solved by these techniques.
Computational Intelligence Paradigms

• Origins in biological systems.
  – Evolutionary computation: model the process of natural evolution.
  – Swarm intelligence: model social behavior of organisms living in swarms or colonies.
  – Fuzzy logic: model the vagueness of human reasoning in the environment.

This Term

• Evolutionary Computation: 40%
• Swarm Intelligence: 40%
• Fuzzy logic: 20%
• Artificial neural network: CS-4760 by Dr. Siwei Lu
Evolutionary Computation

- Natural evolution: survival of the fittest
  - A population of individuals
  - Fitness function
  - Selection
  - Reproduction
- Evolution is an iterative process for many generations.

EC Algorithms

- Developed by different scholars with similar ideas, hence with different names.
- Genetic Algorithms: John Holland
  - Model genetic evolution.
- Genetic Programming: John Koza
  - Apply GA to evolve computer programs.
- Evolutionary Programming: Lawrence Fogel
  - Model phenotypic evolution.
- Evolution Strategies: Ingo Rechenberg and Hans-Paul Schwefel
  - Model the strategies parameters that control variation in evolution.
Swarm Intelligence

• Model the social behavior of organisms living in swarms or colonies:
  – A swarm can be defined as a structured collection of interacting organisms, such as ants and birds.
  – Each organism influence each other to produce the global behavior of the swarm.

Swarm Intelligence Algorithms

• Particle Swarm Optimization
  – Bird flocks fly synchronously and can change direction suddenly with a regrouping in an optimal formation.
  – PSO models the social behavior of birds within a flock to find the optimal solutions.
• PSO was developed by Eberhart and Kennedy in 1995.
Swarm Intelligence Algorithms

• Ant Colony Optimization
  – Ants have different morphological structures and perform different tasks, but all contributing to a common goal.
  – ACO models the pheromone-following behavior to find the shortest path.
• ACO was developed by Marco Dorigo in the early 1990s.

Fuzzy Logic

• Fuzzy logic models the approximate reasoning of humans.
• For example, humans are capable of understanding terms such as “most people” and “pretty soon” which are associated with uncertainty and vagueness.
• Fuzzy logic allows computer system to reason with these uncertain facts to infer new facts with a degree of uncertainty.
• FL was developed by Lotfi Zadeh in 1965.