CS 6200: ADVANCED TOPICS IN ARTIFICIAL INTELLIGENCE

Course Description

Intensive study of a major sub-field such as neural networks, expert systems, machine learning/tutoring, natural language processing, pattern recognition, robotics, or others.

Course Syllabus

INTRODUCTION TO RULE-BASED EXPERT SYSTEMS

NOTE: When CS 6200 is taught, it explores one advanced area of artificial intelligence in considerable depth. Appropriate areas include pattern recognition, computer vision, game theory, data mining, speech recognition, neural networks, natural language understanding, artificial life, softbots (intelligent agents), robotics, and expert systems. When the subject is expert systems, the course could be organized as follows.

- **Introduction**
  - Definitions:
    - AI, Expert System, Rule-based Expert System
  - How a RBES Works
  - Brief History of RBES
  - Applications of RBES

- **Foundation of RBES: Rule-Based Production Systems (RBPS)**
  - Production System Formalisms
  - Operational Principles of RBPS
  - Evaluation of RBPS
    - Advantages
    - Disadvantages

- **Inference Engines (automated RBPS)**
  - Search
  - Chaining
  - Conflict Resolution
  - Success and Failure

- **Development of RBES using CLIPS (NASA's RBES tool)**
  - Tutorial on CLIPS
  - Preconditions
  - Stages
    - Problem Selection
    - Knowledge Acquisition: Elicitation and Induction
    - Knowledge Representation: Facts and Rules
    - Design of the Human Interface
    - Design of the Production System
    - Design of the Explanation System
    - Iterative Prototyping
• Verification:
  Consistency and Completeness
  • Validation
  • Application
    o Problems and Pitfalls
• Fuzzy Logic
  • Representation of Uncertainty
    ▪ Abstraction as a Solution
    ▪ Bayesian Logic as a Solution
    ▪ Certainty Factors as a Solution
    ▪ Fuzzy Logic as a Solution
  • Tutorial on Fuzzy Logic
    ▪ Classical Set Theory (Cantor)
    ▪ Multi-valued Logic (Lukasiewicz)
    ▪ Graded Set Membership (Zadeh)
    • Relationships:
  Complement, Containment, Intersection, Union
    • Formal Definitions
    • Membership Graphs: S, Z and Pi
    • Linguistic Variables, Values and Modifiers (Hedges)
• Development of RBES using Fuzzy CLIPS
  • Tutorial on Fuzzy CLIPS (an extension of CLIPS)
  • Design Considerations
    ▪ Preconditions for a "Fuzzy" Solution
    ▪ Methods of Representing Uncertainty in Fuzzy CLIPS
  • Major Application Areas for Fuzzy Expert Systems
  • Advantages of Fuzzy Inference Control
• Case Studies of successfully deployed expert systems
  • MACSYMA
  • MYCIN
  • XCON
  • PROSPECTOR
• Evaluation of expert systems
  • Ethical Issues in Expert Systems
  • Benefits of Expert Systems Compared to Human Experts
  • Limitations of Expert Systems

Laboratory Component
This course should include:

• a major project requiring the development of a RBES containing 50-100 rules
• a major project requiring the development of a Fuzzy RBES, perhaps with fewer rules since fuzzification reduces the need for rules