CSCI 446 – ARTIFICIAL INTELLIGENCE
FINAL EXAM STUDY OUTLINE

Introduction to Artificial Intelligence

I. Definitions of Artificial Intelligence
- A. Acting Like Humans -- Turing Test
- B. Thinking Like Humans -- Cognitive Modeling
- C. Thinking Rationally -- Logicist Approach
- D. Acting Rationally -- Rational Agents

II. Foundations of Artificial Intelligence
- A. Philosophy
- B. Mathematics
- C. Psychology
- D. Computer Engineering
- E. Linguistics

III. History of Artificial Intelligence
- A. Gestation
- B. Early Enthusiasm, Great Expectations
- C. Dose of Reality
- D. Knowledge Based Systems
- E. AI Becomes and Industry
- F. Return of Neural Networks
- G. Recent Events

Intelligent Agents

I. Agents and Environments
- A. Vacuum Cleaner World Environment

II. Rationality

III. PEAS – Performance Measure, Environment, Actuators, Sensors

IV. Environment Types
- A. Observable
- B. Deterministic vs. Stochastic
- C. Episodic vs. Sequential
- D. Static vs. Dynamic
- E. Discrete vs. Continuous
- F. Single Agent vs. Multi-Agent

V. Agent Types
- A. Simple Reflex Agents
- B. Reflex Agents with State
- C. Goal-Based Agents
- D. Utility Based Agents
- E. Learning Agents

State Spaces, Uninformed Search

I. Problem Formulation
    A. Problem Types
        1. Deterministic, fully observable: Single-State Problem
        2. Non-observable: Conformant Problem
        3. Nondeterministic and/or partially observable: Contingency Problem
        4. Unknown state space: Exploration Problem
    B. Single State Problem Formulation
        1. Initial State
        2. Successor Function
        3. Goal Test
        4. Path Cost
        5. Solution
II. State Space
III. Tree Search Algorithms
    A. General Tree Search
        1. Completeness
        2. Time Complexity
        3. Space Complexity
        4. Optimality
    B. Breadth First Search
    C. Uniform Cost Search
    D. Depth First Search
    E. Depth Limited Search
    F. Iterative Deepening Search
IV. Graph Search

Heuristic Search

I. Best-First Search
    A. Heuristic Function h(n)
II. A* Search
    A. Actual Cost to Current Node g(n)
III. Heuristics
    A. Admissible Heuristic
    B. Consistency or Monotonicity
    C. Dominance
    D. Relaxed Problems

Local Search

I. Hill Climbing
    A. Gradient Ascent or Descent
    B. Local Maxima
    C. Global Maximum
II. Simulated Annealing
III. Genetic Algorithms

Constraint Satisfaction Problems (CSPs)

I. Examples
II. Backtracking Search
    A. Order of Variable Assignment
        1. Degree Heuristic
    B. Order of Value Assignment
        1. Least Constraining Value Heuristic
    C. Early Detection of Inevitable Failure
        1. Forward Checking
        2. Arc Consistency
    D. Problem Structure
III. Problem Structure and Decomposition
IV. Local Search for CSPs

Games (Adversarial Search)

I. Overview
II. Minimax (Perfect Play)
III. α–β Pruning
IV. Nondeterministic Games
    A. Chance Nodes

Logical Agents

I. Knowledge Based Agents
    A. Knowledge Base
    B. Inference Engine
    C. Separation of Knowledge and Process
II. An Example
    A. Wumpus World
III. General Logic
    A. Entailment
    B. Models
    C. Inference
IV. Propositional Logic
    A. Syntax
    B. Truth Tables
V. Equivalence, Validity, Satisfiability
VI. Inference Rules / Theorem Proving
    A. Forward Chaining
    B. Backward Chaining
    C. Resolution
        1. Conjunctive Normal Form (CNF)
        2. Conversion to CNF
        3. Resolution

First Order Logic

I. Overview
II. Syntax and Semantics
    A. Basic Elements
    B. Atomic Sentences
    C. Complex Sentences
    D. Models
    E. Universal Quantification
    F. Existential Quantification
III. Fun with Sentences
    A. Equality

Inference in First Order Logic

I. Unification
    A. Universal Instantiation
    B. Existential Instantiation
    C. Reduction to Propositional Inference
    D. Unification
II. Generalized Modus Ponens
III. Forward and Backward Chaining
    A. Forward Chaining
    B. Backward Chaining
IV. Logic Programming
V. Resolution

Fuzzy Logic

I. Membership Functions
II. Linguistic Variables
III. Fuzzy Set Operations
IV. Fuzzy Inference
    A. Fuzzification
    B. Rule Inference
    C. Rule Composition
    D. Defuzzification

Planning

I. Search vs. Planning
    A. Actions, States, Goals, Plans
    B. Situational Calculus
II. STRIPS Operators
    A. Initial and Final States
    B. Operators
        1. Action
        2. Preconditions
        3. Effects (Postconditions)
III. Partial-Order Planning

IV. The Real World
    A. When Things go Wrong
        1. Incomplete Information
        2. Incorrect Information
        3. Qualification Problem
V. Conditional Planning
VI. Monitoring and Replanning

Uncertainty

I. Uncertainty
    A. Sources of Uncertainty
    B. Methods for Handling Uncertainty
II. Probability
    A. Terms
        1. Sample Space
        2. Event
        3. Random Variables
        4. Propositions
III. Syntax and Semantics
    A. Prior Probability
    B. Joint Probability
    C. Conditional Probability
IV. Inference
    A. Enumeration
        1. Normalization
V. Independence
    A. Absolute
    B. Conditional
VI. Bayes' Rule

Bayesian Networks

I. Syntax
    A. Nodes
    B. Directed Arcs
    C. Conditional Probabilities
    D. D-Separation
II. Semantics
    A. Global and Local
    B. Constructing a Bayes Net
III. Inference
    A. Enumeration
    B. Variable Elimination
        1. Factors
IV. Sampling
    A. Prior Sampling
    B. Rejection Sampling

C. Likelihood Weighting
D. Gibbs Sampling

Rational Decisions

I. Rational Preferences
II. Utility
    A. Assessment of Human Utility
III. Decision Networks
    A. Decision Node
    B. Chance Node
    C. Utility Node
IV. Value of Information

Machine Learning

I. Learning Agents
    A. Architecture
    B. Learning Element
    C. Supervised/Unsupervised Learning
II. Inductive Learning
    A. Approximate f(x) with h(x)
    B. Overfitting
    C. Generalization
    D. Structural Representations
        1. Decision Trees
        2. Rules
    E. Algorithms
        1. Decision Trees – Information Theory / Entropy
        2. Rules – Instance Covering
III. Artificial Neural Networks
    A. History
    B. Model
        1. Parameters
            a. Pattern of connections between layers
            b. Learning rule
            c. Activation function
    C. Training
        1. Backpropagation
        2. Mean Squared Error (MSE)
        3. Error surface
    D. Applications

Robotics - Omar
Genetic Algorithms - Jesse
Swarm Intelligence - Andrew
Philosophical and Ethical Issues – Nathan
Intelligent Agent Societies - Kenny