Artificial Intelligence – Final Exam Outline – Fall 2019

The following topics will be covered on the exam.
The exam will be closed-book and closed-notes.

Introduction
- Definition of AI
- Four approaches to AI
    - Acting humanly
    - Thinking humanly
    - Thinking rationally
    - Acting rationally
- Turing test

Intelligent Agents
- Agent, percept, action, rational agent
- PEAS description of task environment
    - Performance, Environment, Actuators, Sensors
- Task environment properties
    - Fully vs. partially observable
    - Deterministic vs. stochastic
    - Static vs. dynamic
- Types of agents
    - Reflex, Model-based, Goal-based, Utility-based, Learning
- Wumpus world

Search
- Problem-solving agent
- Five parts of search problem
    - Initial state, actions, transition model, goal test, path (step) cost
    - Examples: vacuum world, 8-puzzle, wumpus world
- State space, search tree, search graph, path, frontier
- Uninformed search (know algorithms)
    - Breadth-first, Depth-first, Iterative deepening
- Informed search (know algorithm)
    - A*, Hill-climbing
- Heuristic functions
    - Admissible heuristics
    - Designing good heuristics
    - Heuristics: city-block (Manhattan), straight-line (Euclidean)
- Adversarial search
    - Game tree
    - Minimax (know algorithm)
    - Alpha-beta pruning (know algorithm)
    - Games: tic-tac-toe, checkers, chess, go, backgammon, poker

Logic

- Knowledge-based agent
- First-order logic
    - Syntax and semantics
    - Properties of quantifiers
    - Closed-world assumption
    - Translate word problems to first-order logic
- Inference in first-order logic
    - Unification (know algorithm)
    - Conversion to CNF
    - Resolution proof by refutation (know algorithm)
- Application to Wumpus World

Planning

- Know the components of the PDDL planning language
- Know approaches to planning: forward and backward
- Know domains: Blocks, Cargo, Vacuum

Uncertainty

- Rational agent maximizes expected utility
- Probability
    - Axioms
    - Unconditional (prior) or conditional (posterior)
    - Random variable
    - Distribution
- Probabilistic inference
    - Using full joint probability distribution
    - Normalization
    - Independence and conditional independence
    - Bayes' rule
    - Naïve Bayes
- Application to Wumpus World

Probabilistic Reasoning

- Bayesian networks
    - Node, link, conditional probability table
    - Exact inference (execute)

Learning

- Learning agent: performance, critic, feedback, learning element, learning goals, problem generator
- Supervised learning
    - Terminology: target concept, hypothesis, classification, regression
    - Error: false positive, false negative

    - Underfitting and Overfitting
    - Probabilistic learning
        - Bayes classifier (execute)
        - Naive Bayes classifier (execute)
            - Independence assumption
            - Dealing with zero probabilities
    - Neural network
        - Perceptron classification, regression, training (execute)
        - Logistic function
        - Multilayer perceptron topology
        - Deep learning
- Unsupervised learning
    - k-means clustering (execute)
    - Choosing k
- Reinforcement learning
    - State, action, reward, policy
    - Discount factor
    - Utility-based agent
        - Utility
        - Utility estimation given action model (compute)
        - Temporal-difference utility estimation (compute)
    - Passive vs. active learning
    - Exploration function
    - Learning rate function
    - Q-learning agent (execute)
        - Q function
        - Utility based on Q function
        - Update Q values given action model
        - Update Q values using temporal difference
    - Application to wumpus world

Natural Language

- Language, grammar, syntax, semantics
- N-gram word models
    - How to compute and use models
- Text classification
    - How to classify documents using Bayes' rule
- Natural language for communication
    - Context-free grammar, augmented grammar, lexicon, parse tree
    - Parsing: Generate parse tree(s) of sentence given grammar and lexicon
    - Generating semantics using an augmented grammar
- Speech recognition
    - Phonemes
    - Acoustic model
        - Frame features from acoustic signal

        - Hidden Markov Model for phoneme recognition
        - Calculate probability of HMM given sequence of frame features
    - Language model
        - Hidden Markov Model for word recognition
        - Calculate probability of HMM given sequence of phonemes

*Nothing on Vision and Robotics*

Philosophical and Ethical Issues

- Weak AI: Definition, arguments for and against
- Strong AI: Definition, arguments for and against
- Ethical issues
    - AI used for illicit ends
    - AI responsibility
    - AI ending human race
    - AI/Robot rights