Fall 2020

CS 370-101: Intro to Artificial Intelligence

Theodore Nicholson

Artificial Intelligence

Syllabus

Instructor

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Course Description

This course introduces concepts, approaches and techniques of artificial intelligence, and focuses on materials that are fundamental and have a broad scope of applications. Topics include Problem Solving, Search, Knowledge and Reasoning, Logical Agents, First-Order Logic and Inference, Uncertain Knowledge and Reasoning, Quantifying Uncertainty, Probabilistic Reasoning, Perception, Pictorial Knowledge Representation, and Search in Frequency and Spatial Domains. Additional topics include Machine Learning, Neural Computation, Evolutionary Computation, and Robotics.

Textbook

S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, Prentice Hall, 2010.
S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th edition, Prentice Hall, 2020.

Grading Scheme

Midterm	40%
Project I	10%
Project II	30%
Homework	20%

Topics (Tentative)

1. Introduction
    - AI Fundamentals: Knowledge & Search, Cognitive Science, Turing Test, Ancient Philosophers (Logic)
    - Programming Languages: Lisp, Prolog, C/C++, Java, Matlab
    - Related Fields: Machine Learning, Neural Networks, Evolutionary Computation, Computer Vision
    - AI History: Symbolism (Expert Systems) vs. Connectionism (MP model, Perceptron, BP Algorithm)
2. Problem Solving

- Intelligent Agent: Sensors, Actuators, Agent Program
- Solving Problems by Searching: problem-solving agent
- Blind Search Strategies: Breadth-first Search, Depth-first Search (completeness, optimality, complexity)
- Informed Search Strategies: Greedy Best-first Search, A* Search (completeness, optimality, complexity)

3. Knowledge and Reasoning - Logical Agents
   - Knowledge Base, Models, and Knowledge-Based Agents
   - Propositional Logic Knowledge Representation Language, Syntax and Semantics
   - Logical Reasoning: Entailment and Inference (soundness, completeness)
   - Propositional Theorem Proving: Validity, Satisfiability, Reduction to Absurd
   - MP Inference Rule, Resolution Inference Rule, Horn Form, CNF
4. Knowledge and Reasoning - First-Order Logic
   - Propositional Logic vs. First-Order Logic: objects, relations (unary, n-ary), functions
   - First-Order Logic: Syntax and Semantics (predicates, variables, quantifiers)
   - First-Order Logic Knowledge Representation Language, Model, Interpretation
   - First-Order Logic Knowledge Base
5. Knowledge and Reasoning - Inference in First-Order Logic
   - Universal Instantiation, Existential Instantiation
   - Substitution and Unification
   - Generalized MP Rule, Soundness of GMP
   - Resolution Inference Rule, CNF
   - Logic Programming - Prolog
6. Uncertain Knowledge and Reasoning - Quantifying Uncertainty
   - Acting under Uncertainty
   - Probability (model, atomic event, conditional), Random Variables (propositional, discrete, continuous)
   - Syntax and Semantics: probability distribution, joint probability distribution
   - Inference by Enumeration, Normalization
   - Independence, Conditional Independence, and Bayes' Rule
7. Uncertain Knowledge and Reasoning - Probabilistic Reasoning
   - Representing Knowledge in an Uncertain Domain
   - Bayesian Networks
   - Optimal Feature Representation Methods and Search
   - Optimal Feature Classification Methods and Search
8. Perception - Pictorial Knowledge Representation
   - Digital Image Fundamentals
   - Image Formation
   - Digital Image Formats/Protocols (JPEG, PNG, TIFF, PGM, PPM)
   - Digital Video Fundamentals (CAV; NTSC/PAL/SECAM; S-Video)
9. Perception - Search in Frequency Domain
   - FT/FFT
   - Lowpass and Highpass Filtering
   - Convolution, Correlation, and Autocorrelation Theorems
   - Pictorial Information Search using FFT Features
10. Perception - Search in Spatial Domain
    - Geometric Feature Representation
    - Edge Detection (Canny, Zero-crossing, LOG, Prewitt, etc.)
    - Line and Curve Detection (Hough Transform)
    - Pictorial Information Search using Geometric Features
11. Learning - Machine Learning

    - Inductive Learning
    - Decision Tree Learning
    - Unsupervised Learning
    - Supervised Learning
12. Neural Computation (optional)
    - Multilayer Perceptrons and BP Algorithm
    - Radial-Basis Function Networks
13. Evolutionary Computation (optional)
    - Genetic Algorithms (GA)
    - Evolutionary Strategy (ES)
    - Evolutionary Programming (EP)
14. Robotics (optional)
    - Sensors and Vision
    - Path Planning
    - Moving and Control

Cheating Policy

Cheating on a programming assignment results in zero credit for all students involved. Programming assignments may **NOT** be solved in collaboration, unless specifically stated in the assignment. Cheating on an exam will result in an "F" in the course.
You may discuss problems with each other. Where does discussion end and cheating start? You may **NOT** copy lines of code from anybody or anywhere. You may **NOT** use code in your assignments that you did not write. As a general rule: If you don't understand the code and can't explain the code, you can't use the code.
Please familiarize yourself with the NJIT Honor Code. Violations of the honor code will be dealt with seriously and reported immediately to the Dean of Students.

Late Policy

To receive full credit all programming assignments must be handed in on time at the beginning of class. Assignments will not be accepted after the due date.

Prerequisites

CS 114 and (Math 226 or CS 241)

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