



Lecture 0 of 42

Artificial Intelligence: Course Organization and Survey

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KSOL course page: <http://snipurl.com/v9v3>
Course web site: <http://www.kddresearch.org/Courses/Fall-2007/CIS730>
Instructor home page: <http://www.cis.ksu.edu/~bhsu>

Reading for Next Class:
Chapter 1, Russell and Norvig 2nd edition
Syllabus and Introductory Handouts



Course Outline

- **Overview: Intelligent Systems and Applications**
- **Artificial Intelligence (AI) Software Development Topics**
 - * **Knowledge representation**
 - ⇒ Logical
 - ⇒ Probabilistic
 - * **Search**
 - ⇒ Problem solving by (heuristic) state space search
 - ⇒ Game tree search
 - * **Planning: classical, universal**
 - * **Machine learning**
 - ⇒ Models (decision trees, version spaces, ANNs, genetic programming)
 - ⇒ Applications: pattern recognition, planning, data mining and decision support
 - * **Topics in applied AI**
 - ⇒ Computer vision fundamentals
 - ⇒ Natural language processing (NLP) and language learning survey
- **Practicum (Short Software Implementation Project)**





Course Administration

- Official Course Page (KSOL): <http://snipurl.com/v9v3>
- Class Web Page: <http://www.kddresearch.org/Courses/Fall-2007/CIS730>
- Instructional E-Mail Addresses
 - * CIS730TA-L@listserv.ksu.edu (always use this to reach instructor)
 - * CIS730-L@listserv.ksu.edu (this goes to everyone)
- Instructor: William Hsu, Nichols 213
 - * Office phone: (785) 532-7905; home phone: (785) 539-7180
 - * IM: AIM/YIM/MSN [hsuw](#) & [rizanabsith](#), ICQ [28651394](#) & [191317559](#)
 - * Office hours: after class Mon/Wed/Fri; other times by appointment
- Graduate Teaching Assistant: TBD
 - * Office location: Nichols 124
 - * Office hours: to be announced on class web board
- Grading Policy
 - * Midterm: 20% (in-class, closed-book); final (open-book): 30%; quiz: 3%
 - * Machine problems, problem sets (8 of 10): 16%; term project: 26%
 - * Class participation: 5% (3% attendance, 1% questions, 1% answers)



How To Get an A in This Course

- A Story from Dr. Gerard G. L. Meyer, Johns Hopkins University
- Ask Questions
 - * Ask for (more) examples, another explanation, etc. if needed (“don’t be shy”)
 - * All students (especially remote students): post in class web board
 - ⇒ Unclear points – bring to class as well
 - ⇒ “When will X happen”?
 - * Fastest way to reach instructor: instant messaging (ICQ, MSN Messenger)
 - * Notify TA, KDD system administrators of any computer problems
- Be Aware of Resources
 - * Check with instructor or GTA about
 - ⇒ Handouts, lectures, grade postings
 - ⇒ Resources online
 - * Check with classmates about material from missed lecture
- Start Machine Problems (and Problem Sets) Early
 - * How to start virtuous (as opposed to vicious) cycle
 - * Don’t cheat



Homework Assignments: Problem Sets and Machine Problems

- PS1 assigned Wed 23 Aug 2006, due Wed 06 Sep 2006
- MP2 assigned Wed 06 Sep 2006, due Fri 22 Sep 2006
 - * Submit using K-State Online
 - * HW page: <http://www.kddresearch.org/Courses/Fall-2006/CIS730/Homework>
- Model solutions: 2 class days after due date
- Graded assignments: ≤ 7 days after due date
- Machine Problem: Search
 - * Problem specifications to be posted on homework page before 06 Sep 2006
 - * Languages: C/C++ & Java
 - * MP guidelines
 - ⇒ Work individually
 - ⇒ Generate standard output files and test against partial standard solution
 - ⇒ No late submissions except with documented excusal (medical, etc.)
 - * See also: state space, constraint satisfaction problems



Questions Addressed

- **Problem Area**
 - * What are intelligent systems and agents?
 - * Why are we interested in developing them?
- **Methodologies**
 - * What kind of software is involved? What kind of math?
 - * How do we develop it (software, repertoire of techniques)?
 - * Who uses AI? (Who are practitioners in academia, industry, government?)
- **Artificial Intelligence as A Science**
 - * What is AI?
 - * What does it have to do with intelligence? Learning? Problem solving?
 - * What are interesting problems to which intelligent systems can be applied?
 - * Should I be interested in AI (and if so, why)?
- **Today: Brief Tour of AI History**
 - * Study of intelligence (since classical age), AI systems (1940-present)
 - * Viewpoints: philosophy, math, psychology, engineering, linguistics





What is AI? [1]

- **Four Categories of Systemic Definitions**
 - * 1. Think like humans
 - * 2. Act like humans
 - * 3. Think *rationally*
 - * 4. Act *rationally*
- **Thinking Like Humans**
 - * *Machines with minds* (Haugeland, 1985)
 - * Automation of “decision making, problem solving, learning...” (Bellman, 1978)
- **Acting Like Humans**
 - * *Functions that require intelligence when performed by people* (Kurzweil, 1990)
 - * Making computers do things *people currently do better* (Rich & Knight, 1991)
- **Thinking Rationally**
 - * Computational models of mental faculties (Charniak & McDermott, 1985)
 - * Computations that make it possible to *perceive, reason, and act* (Winston, 1992)
- **Acting Rationally**
 - * Explaining, emulating intelligent behavior via computation (Schalkoff, 1990)
 - * Branch of CS: automating intelligent behavior (Luger, 2005)



What is AI? [2] Thinking and Acting Like Humans

- **Concerns: Human Performance (Figure 1.1 R&N, Left-Hand Side)**
 - * **Top:** thought processes and reasoning (learning and inference)
 - * **Bottom:** behavior (interacting with environment)
- **Machines With Minds**
 - * **Cognitive modelling**
 - ⇒ Early historical examples: problem solvers (see R&N Section 1.1)
 - ⇒ Application (and one driving force) of cognitive science
 - * **Deeper questions**
 - ⇒ What is intelligence?
 - ⇒ What is consciousness?
- **Acting Humanly: The Turing Test Approach**
 - * **Capabilities required**
 - ⇒ Natural language processing
 - ⇒ Knowledge representation
 - ⇒ Automated reasoning
 - ⇒ Machine learning
 - * **Turing Test:** can a machine appear indistinguishable from a human to an experimenter?



What is AI? [3] Viewpoints on Defining Intelligence

- **Genuine versus Illusory Intelligence**
 - * Can we tell?
 - ⇒ If so, how?
 - ⇒ If not, what limitations do we postulate?
 - * The *argument from disability* (“a machine can never do X”)
- **Turing Test Specification**
 - * Objective: develop intelligent system “indistinguishable from human”
 - ⇒ Blind interrogation scenario (no direct physical interaction – “teletype”)
 - ⇒ 1 AI system, 1 human subject, 1 interrogator
 - ⇒ Variant: total Turing Test (perceptual interaction: video, tactile interface)
 - * *Is this a reasonable test of intelligence?*
 - * Details: Section 26.3, R&N
 - * See also: Loebner Prize page
- **Searle’s Chinese Room**
 - * Philosophical issue: is (human) intelligence a pure artifact of symbolic manipulation?
 - * Details: Section 26.4, R&N
 - * See also: consciousness in AI resources



What is AI? [3] Thinking and Acting Rationally

- **Concerns: Human Performance (Figure 1.1 R&N, Right-Hand Side)**
 - * Top: thought processes and reasoning (learning and inference)
 - * Bottom: behavior (interacting with environment)
- **Computational Cognitive Modelling**
 - * Rational ideal
 - ⇒ In this course: rational agents
 - ⇒ Advanced topics: learning, utility theory, decision theory
 - * Basic mathematical, computational models
 - ⇒ Decisions: automata (Chomsky hierarchy – FSA, PDA, LBA, Turing machine)
 - ⇒ Search
 - ⇒ Concept learning
- **Acting Rationally: The Rational Agent Approach**
 - * **Rational action:** *acting to achieve one’s goals, given one’s beliefs*
 - * **Agent:** entity that perceives and acts
 - * Focus of next lecture
 - ⇒ “Laws of thought” approach to AI: correct inferences (reasoning)
 - ⇒ Rationality not *limited to* correct inference





What is AI? [4] A Brief History of The Field

- **Philosophy Foundations (400 B.C. – present)**
 - * Mind: dualism (Descartes), materialism (Leibniz), empiricism (Bacon, Locke)
 - * Thought: syllogism (Aristotle), induction (Hume), logical positivism (Russell)
 - * Rational agency (Mill)
- **Mathematical Foundations (c. 800 – present)**
 - * Early: algorithms (al-Khowarazmi, 9th century mathematician), Boolean logic
 - * Computability (20th century – present)
 - ⇒ Cantor diagonalization, Gödel's incompleteness theorem
 - ⇒ Formal computational models: Hilbert's Entscheidungsproblem, Turing
 - ⇒ Intractability and NP-completeness
- **Computer Engineering (1940 – present)**
- **Linguistics (1957 – present)**
- **Stages of AI**
 - * Gestation (1943 – c. 1956), infancy (c. 1952 – 1969)
 - * Disillusioned early (c. 1966 – 1974), later childhood (1969 – 1979)
 - * "Early" (1980 – 1988), "middle" adolescence (c. 1985 – present)



Why Study Artificial Intelligence?

- **New Computational Capabilities**
 - * Advances in uncertain reasoning, knowledge representations
 - * Learning to act: robot planning, control optimization, decision support
 - * Database mining: converting (technical) records into knowledge
 - * Self-customizing programs: learning news filters, adaptive monitors
 - * Applications that are hard to program: driving, speech recognition
- **Better Understanding of Human Cognition**
 - * Cognitive science: theory of knowledge acquisition (e.g., through practice)
 - * Performance elements: reasoning (inference) and *recommender* systems
- **Time is Right**
 - * Recent progress in algorithms and theory
 - * Rapidly growing volume of online data from various sources
 - * Available computational power
 - * Growth of AI-based industries (e.g., data mining, robotics, web search)





Artificial Intelligence: Some Problems and Methodologies

- **Problem Solving**
 - * Classical search and planning
 - * Game-theoretic models
- **Making Decisions under Uncertainty**
 - * Uncertain reasoning, decision support, decision-theoretic planning
 - * Probabilistic and logical knowledge representations
- **Pattern Classification and Analysis**
 - * Pattern recognition and machine vision
 - * Connectionist models: artificial neural networks (ANNs), other graphical models
- **Data Mining and Knowledge Discovery in Databases (KDD)**
 - * Framework for optimization and machine learning
 - * Soft computing: evolutionary algorithms, ANNs, probabilistic reasoning
- **Combining Symbolic and Numerical AI**
 - * Role of knowledge and automated deduction
 - * Ramifications for cognitive science and computational sciences



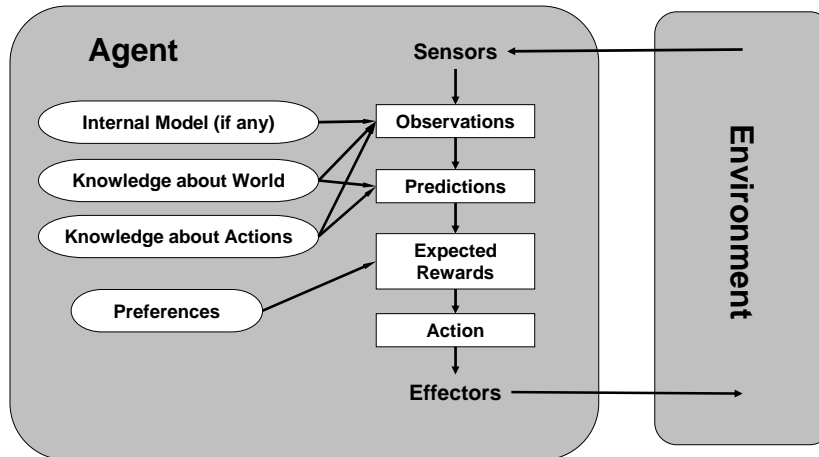
Intelligent Agents: Overview

- **Agent: Definition**
 - * Any entity that perceives its environment through sensors and acts upon that environment through effectors
 - * Examples (class discussion): human, robotic, software agents
- **Perception**
 - * Signal from environment
 - * May exceed sensory capacity
- **Sensors**
 - * Acquires percepts
 - * Possible limitations
- **Action**
 - * Attempts to affect environment
 - * Usually exceeds effector capacity
- **Effectors**
 - * Transmits actions
 - * Possible limitations





A Generic Intelligent Agent Model



Term Project Topics Fall 2006

- **1. Game-playing Expert System**
 - * "Borg" for Angband computer role-playing game (CRPG)
 - * <http://www.thangorodrim.net/borg.html>
- **2. Trading Agent Competition (TAC)**
 - * Supply Chain Management (TAC-SCM) scenario
 - * <http://www.sics.se/tac/page.php?id=13>
- **3. Knowledge Base for Bioinformatics**
 - * Evidence ontology for genomics or proteomics
 - * <http://bioinformatics.ai.sri.com/evidence-ontology/>



Term Project Guidelines

- **Due: 17 Nov 2006**
 - * Project milestones: initial (plan), interrim (interview), final (presentation)
 - * Presentations, peer review outside class
- **Individual Projects**
 - * Topic selection due Fri 01 Sep 2006
 - * First draft of project plan due Fri 08 Sep 2006
- **Grading: 260 points (out of 1000)**
 - * Proposal: 20 points
 - * Interview: 20 points
 - * Presentation: 20 points
 - * Project content: 160 points
 - ⇒ Originality: 40 points
 - ⇒ Functionality: 40 points
 - ⇒ Development effort: 40 points
 - ⇒ Completeness: 40 points
 - * Writeup: 40 points



Related Online Resources

- **Research**
 - * KSU Laboratory for Knowledge Discovery in Databases
<http://www.kddresearch.org> (see especially Group Info, Web Resources)
 - * KD Nuggets: <http://www.kdnuggets.com>
- **Courses and Tutorials Online**
 - * At KSU
 - ⇒ CIS732 *Machine Learning and Pattern Recognition*
<http://www.kddresearch.org/Courses/Fall-2005/CIS732>
 - ⇒ CIS830 *Advanced Topics in Artificial Intelligence*
<http://www.kddresearch.org/Courses/Spring-2005/CIS830>
 - ⇒ CIS690 *Implementation of High-Performance Data Mining Systems*
<http://ringil.cis.ksu.edu/Courses/Summer-2005/CIS690>
 - * Other courses: see KD Nuggets, www.aaai.org, www.auai.org
- **Discussion Forums**
 - * Newsgroups: comp.ai*
 - * Recommended mailing lists: *Data Mining*, *Uncertainty in AI*
 - * KDD Group Mailing List (KDD-L@listserv.ksu.edu)





Terminology

- **Artificial Intelligence (AI)**
 - * **Operational definition:** study / development of systems capable of “thought processes” (reasoning, learning, problem solving)
 - * **Constructive definition:** expressed in artifacts (design and implementation)
- **Intelligent Agents**
- **Topics and Methodologies**
 - * **Knowledge representation**
 - ⇒ Logical
 - ⇒ Uncertain (probabilistic)
 - ⇒ Other (rule-based, fuzzy, neural, genetic)
 - * **Search**
 - * **Machine learning**
 - * **Planning**
- **Applications**
 - * Problem solving, optimization, scheduling, design
 - * Decision support, data mining
 - * Natural language processing, information retrieval and extraction (IR/IE)
 - * Pattern recognition and robot vision



Summary Points

- **Artificial Intelligence: Conceptual Definitions and Dichotomies**
 - * **Human** cognitive modelling vs. rational inference
 - * Cognition (thought processes) versus behavior (performance)
 - * Some viewpoints on defining intelligence
- **Roles of Knowledge Representation, Search, Learning, Inference in AI**
 - * Necessity of KR, problem solving capabilities in intelligent agents
 - * Ability to reason, learn
- **Applications and Automation Case Studies**
 - * Search: game-playing systems, problem solvers
 - * Planning, design, scheduling systems
 - * Control and optimization systems
 - * Machine learning: pattern recognition, data mining (decision support)
- **More Resources Online**
 - * Home page for AIMA (R&N) textbook
 - * CMU AI repository
 - * KSU KDD Lab (Hsu): <http://www.kddresearch.org>
 - * comp.ai newsgroup (now moderated)