CS 1571 Introduction to AI
Lecture 1

Course overview

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Course web page:
http://www.cs.pitt.edu/~milos/courses/cs1571/
Textbook

Course textbook:
Stuart Russell, Peter Norvig.  
*Artificial Intelligence: A modern approach.*  

Other widely used AI textbooks:
Dean, Allen, Aloimonos: Artificial Intelligence.  
P. Winston: Artificial Intelligence, 3rd ed.  
N. Nilsson: Principles of AI.

Grading

- Lectures  10%  
- Homeworks  45%  
- Midterm  20%  
- Final  25%
Lectures

• 10 % of the grade
• Attendance + short quizzes
• Short quizzes:
  – 10 minutes at the beginning of the lecture
  – Random: ~ once per week
  – Short question(s) from previous lectures

Homeworks

• Homeworks:
  – 45 % of the grade
  – Weekly assignments
  – A mix of pencil and paper, and programming assignments
  – No extensions. Homework due dates are strict.

• Collaborations:
  – No collaborations on homework assignments

• Programming language:
  – C/C++
  – g++ compiler under UNIX
Exams

• **Midterm**
  – 20 % of the grade
  – In-class
  – Before the withdrawal day

• **Final**
  – 25 % of the grade
  – Covers whole semester

Artificial Intelligence

• The field of **Artificial intelligence:**
  – The design and study of computer systems that behave intelligently
• **AI programs:**
  – Go beyond numerical computations and manipulations
  – Focus on reasoning tasks that require intelligence
• **Objectives of AI research:**
  – Engineering
    • solving of hard problems
  – Cognitive
    • Understanding the nature of human intelligence
Intelligence and machines

- **Symbolic system hypothesis** (Newell and Simon)
  - Intelligence is substrate neutral;
  - A physical symbol system has necessary and sufficient means for general intelligent action.

- **Biological substrate only** (John Searle, philosopher).
  - Intelligence is substrate dependent. The material humans are made of is fundamental for our intelligence. Thinking is possible only in special machines – living ones made of proteins.

- Other researchers believe that **sub-symbolic processing** (signal processing) may be needed to replicate intelligence.

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Turing test

**How to test the “intelligence” of a program?**

- **Behavioral view of intelligence**
  - A behavior capable of fooling a human interrogator

- Acting humanly is sufficient to pass the test.
- Is it necessary the AI system also thinks humanly?
Eliza program

- **Eliza, the computer therapist**, created by Joseph Weizenbaum in 1966 at MIT, is one of the most famous early AI programs.
- Eliza functions by "twisting the statements of her 'patients' back at them in the classic manner of a non-directive psychotherapist."
- The fact that it understands the subject's statements is an illusion. Surprisingly, many users were taking its performance quite seriously.
- **You can run Eliza at:**
  - [http://www-ai.ijs.si/eliza/eliza.html](http://www-ai.ijs.si/eliza/eliza.html)
- **Info:**

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Eliza program. Sample dialogue.

Eliza: Hello. I am ELIZA. How can I help you?
You: I am frustrated by the traffic I have to face every morning.
Eliza: How long have you been frustrated by the traffic you have to face every morning?
You: For about a year now.
Eliza: Please go on.
You: Why should I go on? Give me some advice.
Eliza: Can you elaborate on that?
You: Why? Give me some solution.
Eliza: Can you elaborate on that?
You: It is obvious you cannot pass the Turing test
Eliza: Oh, i cant pass the turing test.
You: That is correct.
Eliza: Please go on.
…

Try it yourself at: [http://www-ai.ijs.si/eliza/eliza.html](http://www-ai.ijs.si/eliza/eliza.html)
What is Artificial Intelligence?

Four different views on what makes an AI system!! Depends on what matters more in the evaluation.

- **Reasoning vs. Behavior**
  - the computational process or the end-product matters

- **Human performance vs. Rationality**
  - Compare against human model (with its weaknesses) or a normative “ideal” model (rational system)

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**Some AI definitions**

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<th>Think</th>
<th>Human</th>
<th>Rational</th>
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<td>“The exciting new effort to make computers think … machines with minds, in the full and literal sense” (Hugeland, 1985)</td>
<td>“The study of mental faculties through the use of computational models” (Charniak and McDermott, 1985)</td>
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<td>“[The automation of] activities that we associate with human thinking, activities such as decision-making, problem-solving, learning …” (Bellman, 1978)</td>
<td>“The study of the computations that make it possible to perceive, reason, and act” (Winston, 1992)</td>
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<td>“The art of creating machines that perform functions that require intelligence when performed by people” (Kurzweil, 1990)</td>
<td>“A field of study that seeks to explain and emulate intelligent behavior in terms of computational processes” (Schalkoff, 1990)</td>
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<td>“The study of how to make computers do things at which, at the moment, people are better” (Rich and Knight, 1991)</td>
<td>“The branch of computer science that is concerned with the automation of intelligent behavior” (Luger and Stubblefield, 1993)</td>
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Rational agents

- The textbook we use adopts the rational agent perspective
  - **How to design a rational agent?**

- **Agent:** an entity that perceives and acts
  - On abstract level the agent maps percepts to actions
    \[ f : Percepts \rightarrow Actions \]

- **Design goal:** for any given environment find the agent that performs the best

- **Caveat:** The design may be limited by resources: memory, time
  - Find agents with best resource-performance trade-off

History of AI

- **Artificial Intelligence** – name adopted at Dartmouth conference in 1956

- “Contemporary” AI starts in 20th century (1940s), But the origins go back many years.

**Two sources motivating AI:**
- **Artificial people.**
  - Beings or devices capable of substituting or replacing humans in various activities.
- **Mathematical models of reasoning.**
  - Formal models of thought and reasoning.
Before AI. Artificial people.

Beings or devices capable of substituting or replacing humans in various activities

• **Legends, stories:**
  – **Androids** (artificial people):
    • Android constructed by Albert the Great (13-th century)
    • Golem: made from clay, household chores (14-th century)
  – **Homunkulus** – a human-like being created in other than natural way (Paraceleus, 16-th century)

• **Mechanical people** capable of writing, drawing, playing instruments (18-th century)

• **Kempelen’s chess machine** (18-th century). Fraud: a chess player hidden inside the machine.

• **Robots.** Drama R.U.R. by K. Capek (early 20th century)

Before AI. Models of reasoning.

• Philosophers and mathematicians worked on models of reasoning and thought.

**Timeline:**

• **Aristotle** (384-322 B.C), ancient Greece, philosopher
  – Tried to explain and codify certain types of deductive reasoning, that he called syllogisms.

• **George Boole** (1854)
  – Foundations of **propositional logic**.
    • Formal language for making logical inferences.

• **Gottlieb Frege** (end of 19-th century).
  – **First order logic.**
The beginnings of AI (40s-50s).

Two streams:

• **Neural network approach** (McCulloch and Pitts 1943).
  – Boolean model of a human brain.

• **Programs capable of simple reasoning tasks:**
  – chess programs (Shannon 1950, Newell, Shaw & Simon 1958)
  – checkers (Samuel 1959)
  – Theorem prover in geometry (Gelernter 1959)
  – Logic Theorist (Newell, Shaw & Simon 1957). Used propositional logic to prove theorems.

• Dartmouth meeting (1956), the name **Artificial Intelligence** adopted (due to John McCarthy)

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60s.

Developments in the two streams:

• **Neural network models for learning and recognition**
  – Build on McCulloch and Pitts’ work (1943)
  – **Objective:** replicate self-organization and subsequently phenomenon intelligence
  – **Adalines networks** (Widrow, Hoff 1960)
  – **Perceptrons** (Rosenblatt 1961)
  – Minsky and Papert (1969) – strong critique of perceptrons, it killed the area for a decade

• **Symbolic problem solvers:**
  – **General problem solver** (Newell, Simon) – think humanly
  – **LISP** - AI programming language
  – **Micro-worlds** – focus on problem-solving in restricted worlds (e.g. blocks world)
70s. Knowledge-based system era.

- Early AI systems did not scale-up well to large applications
- The need for background knowledge

Edward Feigenbaum: “knowledge is the power”
Power of the system derived from the knowledge it uses
- Expert systems: obtain the knowledge from experts in the field, and replicate their problem-solving

Examples of KB systems:
- **Dendral** system (Buchanan et al.). Molecular structure elicitation from mass spectrometer readings.
- **Mycin.** Diagnosis of bacterial infections.
- **Internist** (Pople, Myers, Miller). Medical diagnosis.

80s. AI goes commercial.

AI becomes an industry
- Many tools for the design of KB systems were developed

Revival of neural network (connectionist) approach.
- **Multi-layer neural networks**
  - Modeling and learning of non-linear functions.
  - Back-propagation algorithm (learning)

Failure of AI
- High expectations in very short time
- Computational complexity: some problems are intrinsically hard
- Separation of connectionist - logic approaches.
90s. Moving ahead

- **Modeling uncertainty** (a breakthrough in late 80s)
  - Bayesian belief networks, graphical models.

- **Machine learning and data mining**
  - Analysis of large volumes of data
  - Finding patterns in data
  - Learning to predict, act

- **Autonomous agents** with intelligence:
  - Software agents
  - Robots

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AI today (where are we?)

AI is more rigorous and depends strongly on: applied math, statistics, probability, control and decision theories

**Recent theoretical advances and solutions:**
- Methods for dealing with uncertainty
- Planning
- Learning
- Optimizations

**Applications:**
- Focus on partial intelligence (not all human capabilities)
- Systems with components of intelligence in a specific application area; not general multi-purpose intelligent systems
AI applications: Software systems.

**Diagnosis of software**, technical components

**Adaptive systems**
- Adapt to the user

**Examples:**
- **Intelligent interfaces**
  (http://www.research.microsoft.com/research/dtg/)
- **Intelligent helper applications**, intelligent tutoring systems
- **Web agents:**
  - crawlers
  - softbots, shopbots (see e.g. http://www.botspot.com/)

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AI applications: Speech recognition.

**Speech recognition systems:**
- Hidden Markov models

**Adaptive speech systems**
- Adapt to the user (training)
- continuous speech
- commercially available software (e.g. IBM http://www-3.ibm.com/software/speech/)

**Multi-user speech recognition systems**
- Restricted (no training)
- Used often in the customer support
  - Airline schedules, baggage tracking;
  - Credit card companies.
Applications: Space exploration

Autonomous rovers, intelligent probes    Telescope scheduling    Analysis of data

AI applications: Medicine.

- Medical diagnosis:
  - Pathfinder. Lymph-node pathology.
  - QMR system. Internal medicine.
- Medical imaging
  http://www.ai.mit.edu/projects/medical-vision/
  - Image guided surgery (Eric Grimson, MIT)
  - Image analysis and enhancement
AI applications: Transportation.

- **Autonomous vehicle control:**
  - ALVINN (CMU, Pomerleau 1993).
    - Autonomous vehicle;

- **Vision systems:**
  - Automatic plate recognition
  - Pedestrian detection (Daimler-Benz)
  - Traffic monitoring

- **Route optimizations**

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AI applications: Game playing.

- **Backgammon**
  - TD-backgammon
    - a program that learned to play at the championship level (from scratch).
    - reinforcement learning

- **Chess**
  - Deep blue (IBM) program beats Kasparov.

- **Bridge**

- **Etc.**
AI applications.

• Robotic toys
  – Sony’s Aibo
    (http://www.us.aibo.com/)

• Humanoid robot
  – Honda’s ASIMO
    (http://world.honda.com/robot/)

Other application areas

• Bioinformatics
  – Gene expression data analysis
  – Prediction of protein structure

• Text classification, document sorting:
  – Web pages, e-mails
  – Articles in the news

• Video, image classification

• Music composition, picture drawing

• Entertainment 😊
Topics to be covered in the course

**Five main areas:**

- Problem solving and search
- Logic and knowledge representations
- Planning
- Uncertainty
- Learning