CS 1571 Introduction to AI
Lecture 1

Course overview

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Course administrivia

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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.*
Prentice Hall, 1995

New edition is expected at the end of the year

Other 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 requiring intelligence

• **Goals of AI:**
  – 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.

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

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.
**You:**

...
What is Artificial Intelligence?

Four different views on what constitutes 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

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

• The textbook 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
    \[ f : \text{Percepts} \ → \text{Actions} \]

• **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 of researchers interested in 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 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 model** (McCulloch and Pitts 1943).
  - Boolean model of the 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)

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, 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)
Knowledge-based system era. 70s.

• 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/Caduceus (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 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

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 model technology

**Adaptive speech systems**
- Adapt to the user (training)
- Continuous speech
- commercially available software (Dragon Systems, IBM)

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

<table>
<thead>
<tr>
<th>Autonomous rovers, intelligent probes</th>
<th>Telescope scheduling</th>
<th>Analysis of data</th>
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<tr>
<td><img src="image1" alt="Rover Image" /></td>
<td><img src="image2" alt="Telescope Image" /></td>
<td><img src="image3" alt="Data Analysis Image" /></td>
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<tr>
<td><img src="image4" alt="Satellite Image" /></td>
<td><img src="image5" alt="Telescope Image" /></td>
<td><img src="image6" alt="Data Analysis Image" /></td>
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<td><img src="image7" alt="Spacecraft Image" /></td>
<td><img src="image8" alt="Telescope Image" /></td>
<td><img src="image9" alt="Data Analysis Image" /></td>
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### AI applications: Medicine.

- **Medical diagnosis:**
  - Pathfinder. Lymph-node pathology.
  - QMR system. Internal medicine.

- **Medical imaging**
  - Image guided surgery (Grimson, MIT)
  - Image analysis and enhancement
AI applications: Transportation.

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

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

- **Route optimizations**

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 sequence 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

Time permitting:
– AI programming languages
– Natural language processing
– Image understanding
– Speech recognition