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.*

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

Grading

- Lectures 15%
- Homework assignments 40%
- Midterm 20%
- Final 25%
Lectures

- 15% of the grade
- Attendance + short quizzes
- Short quizzes:
  - 10 minutes at the beginning of the lecture
  - Random
  - Short question(s) from previous lectures

Homework assignments

- Homework assignments:
  - 40% 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

- **Final**
  - 25 % of the grade
  - Cumulative exam

Academic honesty

- All the work in this course should be **done independently**.
- **Collaborations on homework assignments, quizzes and exams are not permitted.**
- Cheating and any other anti-intellectual behavior, including giving your work to someone else, will be dealt with severely.

- **Academic Integrity Code for the Faculty and College of Arts and Sciences:**
  - [http://www.fcas.pitt.edu/academicintegrity.html](http://www.fcas.pitt.edu/academicintegrity.html)
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 problems that require reasoning (intelligence)
• **Two aspects 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.
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:**
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)

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What is Artificial Intelligence?

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

- **Reasoning vs. Behavior**

  - [Diagram: Computational process vs. End-product]

  - 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)
### Some AI definitions

<table>
<thead>
<tr>
<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” (Haugeland, 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>Act</td>
<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 (Paracelcus, 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** 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)
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
  – **Adaline 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-specific 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 in 80s
• High expectations in very short time
• Computational complexity: some problems are intrinsically hard
• Modeling uncertainty
• Separation of connectionist - logic approaches.

90s. Moving ahead

• Modeling uncertainty (a breakthrough in late 80s)
  – Bayesian belief networks, graphical models.
  – Speech recognition.

• 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