CS 1571 Introduction to AI
Lecture 1

Course overview

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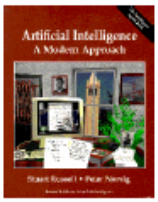
Course web page:
http://www.cs.pitt.edu/~milos/courses/cs1571/

Textbook

Course textbook:



Stuart Russell, Peter Norvig.
Artificial Intelligence: A modern approach.
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. Nillson: 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

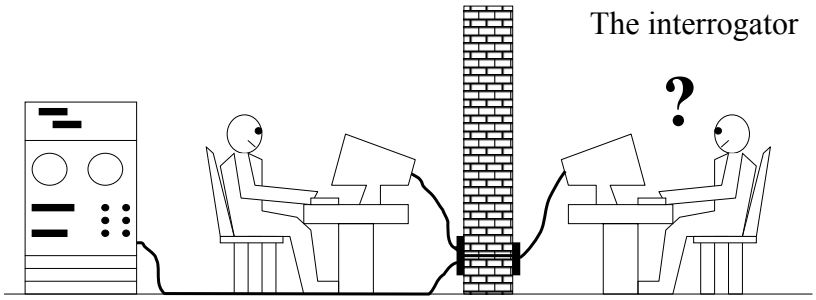
Intelligence and machines

- **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 is 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**
- **Info:**
  - **http://web.mit.edu/STS001/www/Team7/eliza.html**

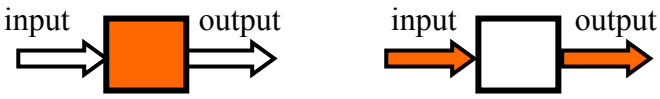
Eliza program. Sample dialogue.

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.
…

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)

Some AI definitions

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

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

$$f : Percepts \rightarrow Actions$$

- **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 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 (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, 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.
  - Hidden Markov models. Advances in 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

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/)

AI applications: Speech recognition.

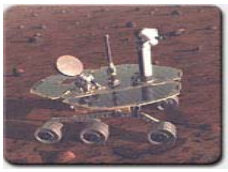
- **Speech recognition systems:**
  - Hidden Markov model technology

- **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.

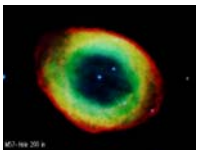
Applications: Space exploration

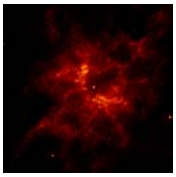
Autonomous rovers, intelligent probes



Telescope scheduling

Analysis of data

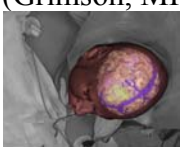




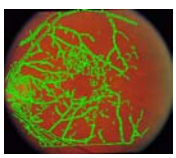
AI applications: Medicine.

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

  http://www.ai.mit.edu/projects/medical-vision/
  - Image guided surgery (Grimson, MIT)



  - Image analysis and enhancement



AI applications: Transportation.

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

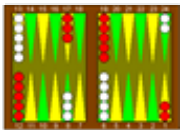
- **Vision systems:**
  - Automatic plate recognition

  - 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