Artificial Intelligence
Joint class 5314 / 4320
Introduction

1 What is AI? informally

Our mental capacities are very important to us, as human beings. In particular,

- we don't understand exactly how we think and act;
- we feel limited.

The purpose of AI is to have a machine (or understand how we can): • perceive, • understand, • predict; • manipulate a world far larger and more complicated that itself (or us). Let us detail a little bit what these are.

- **Perceiving:**
  - receiving information, such as images, sound, all kinds of data,
  - and be aware of receiving information

  e.g., a human being can perceive a sound without to be able to tell what this sound is; but at least it is clear that a sound is perceived.
- **Understanding:**
  - be able to analyze incoming information[1]: what kind of sound? what does the sound say? distinguish the same landscape at different seasons.

  e.g., when someone speaks to you, you understand what this person says (provided you speak the same language.)
- **Predicting:**
  - smarter analysis of information

  e.g., next image (in movie repair, or compression for instance), meteorology, ball/spaceship trajectory
- **Manipulating:**
  - be able to perceive, understand and transform information

  e.g., making decision

[1] Let us note that understanding a surrounding environment can also be considered as understanding incoming information, since the surrounding environment has to be perceived in some way (such as from sensors).

2 What is AI? more formally

It is difficult to give a single definition of AI. Implementing the above-mentioned tasks (perceiving, understanding, predicting, manipulating) can be done in different ways, leading therefore to different definitions of what AI may be. Let us review the trends of AI.

Systems that think like humans	**Systems that think rationally**
"The exciting new effort to make computers think... machines with minds, in the full and litteral sense." (Haugeland, 1985)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985)
"[The automation of] activities that we associate with human thinking, activities such as decision-making, problem-solving, learning..." (Bellman, 1978)	"The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Systems that act like humans	**Systems that act rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990)	"Computational Intelligence is the study of the design of intelligent agents." (Poole et al., 1998)
"The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"AI... is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

- approaches on top: thought processes and reasoning
- bottom: behavior
- left: measure success in terms of fidelity to human performance
- right: measure against an ideal concept of intelligence, which is called rationality: a system is rational if it does the right thing, given what it knows

3 Different approaches in AI

3.1 Acting humanly

cf. the Turing test, proposed by Alan Turing (1950).

A computer able to pass the test should possess the following capabilities:

- **natural language processing:** successful communication
- **knowledge representation:** to store what it knows or hears
- **automated reasoning:** to use the stored information to answer questions, and to draw new conclusions
- **machine learning:** to adapt to new circumstances, and to detect and extrapolate patterns

The total Turing test is completed with vision and prehension abilities. Therefore a winning computer should also possess the following abilities:

- **computer vision:** to perceive objects
- **robotics:** to manipulate objects and move about

3.2 Thinking humanly

The main first question is: how humans think? After answering this question, it will be easier to define what we expect from a thinking computer.

→ **cognitive science**

cf. GPS (General Problem Solver), developed by Allan Newell and Herbert Simon: did not aim at solving problems exactly, but instead at solving them the way humans would solve them.

AI and cognitive science both evolved (separately), but they also contribute to each other, such as to enhance **vision**, by integrating both approaches from neurophysiological evidence and computational models.

3.3 Thinking rationally

initiated by Aristotle: "right thinking", reasoning processes, patterns that always yield correct conclusions when given correct premises.

Socrates is a man
All men are mortal
Therefore, Socrates is mortal

These laws of thought were supposed to govern the operation of the mind: their study intitiated the field called **logic**.

However, there are two main drawbacks to this approach:

- what if statements are not 100% certain?
- complexity may be prohibitive: even if problems can be solved in theory, turning to practice may be untractable

3.4 Acting rationally

We choose the rational agent approach.

An **agent** has the capacity of:

- acting
- operating under autonomous control
- perceiving their environment
- persisting over a prolonged period of time
- adapting to change
- being capable of taking on another's goal

A **rational agent** is therefore an agent that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

Making the correct action goes along with making the right decision, given the state of the world. Therefore, acting rationally is intimitely related to thinking rationally.

However, there are situations in which there is no proved correct thing to do. Therefore, should we just give up? Certainly not. Such situations require yet an action to be taken. In particular, this illustrates the fact that not every ation can be deduced rationally. For instance, reflexes are rational but may not result from inference.

4 AI in several different fields

In this section, we review a number of fields that are involved in AI, by contributing ideas, generating needs.

4.1 Philosophy

- can formal rules be used to draw valid conclusions?
- where does knowledge come from?
- how does knowledge lead to action?

4.2 Mathematics

- what are the formal rules to draw valid conclusions?
- what can be computed?
- how do we reason with uncertain information?

4.3 Economics

- how should we make decisions so as to maximize payoff?
- how should we do this when others may not go along?
- how should we do this when the payoff may be far in the future?

4.4 Neuroscience

- how do brains process information?

4.5 Psychology

- how do humans and animals think and act?

4.6 Computer engineering

- how can we build an efficient computer?

4.7 Control theory and cybernetics

- how can artifacts operate under their own control?

4.8 Linguistics

- how does language relate to thought?

5 State of the art in AI

In this section, we briefly review what AI can do today. This is obviously not an exhaustive list for AI is present in so many fields.

- **Autonomous planning and scheduling:** e.g., NASA's remote agent program
- **Game playing:** e.g., IBM's Deep Blue
- **Autonomous control:** e.g., ALVINN's computer vision system (98 % performance)
- **Diagnosis:** e.g., medical diagnosis
- **Logistics planning:** e.g., DART[2] during the 1991 Persian Gulf crisis.
- **Robotics:** robot assistants in microsurgery, e.g., HipNav + research at INRIA Sophia-Antipolis

[2]DART: Dynamic Analysis and Replanning Tool.

- **Language understanding and problem solving:** e.g., PROVERB that can solve crossword puzzles better than human
  example of its ability:
  from NICE STORY, it deduces ETAGE, because: its database includes a pair "Story in France/Etage", and because it recognizes that the patterns "Nice X" and "X in France" often have the same solution.
  Let us note that this way the machine can solve the puzzle, while it does not even know that Nice is a city in France

6 Assignments

1. Read the slides about an introduction to AI, available on my website http:www.cs.utep.edu/mceberio
2. Read Chapter 1 of your textbook.
3. Exercise 1.7 of your textbook (p. 31): choose four of the points and answer them.

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