AI

Lecture 1: Introduction to AI - II

Course Syllabus

1. Introduction to AI
2. Environment & agent types.
3. Logic programming
4. Problem Solving & Search
5. Knowledge and inference

Introduction

- Can machines think?
- And if so, how?
- And if not, why not?
- And what does this say about human beings?
- And what does this say about the mind?

Basic Concepts of AI

1. Definition

- **AI (Ability):** The ability of a machine (device) to perform functions that are normally associated with human intelligence, such as reasoning, planning, recognition, perception, cognition, learning, understanding, and problem-solving.

- **AI (Discipline):** A branch of computer science that deals with the research, design and application of the intelligent computer. Its major objective is to develop and use a machine to imitate some intellectual capabilities of human brain and to develop the related theories and techniques.

Perspectives of AI definition

- **What is artificial intelligence?**

  It is the science and engineering of making intelligent machines, especially intelligent computer programs. (John McCarthy)

- **Yes, but what is intelligence?**

  Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines.

Intelligence

- **Intelligent Machine**: A kind of machine that can perform various anthropomorphic tasks in an environment by learning autonomously or interactively.
- **Intelligent System**: A system that can drive (operate) intelligent machine to reach its goal.
- **Intelligent Science**: A discipline that **studies** the essences of the human-being intelligent behavior, **simulates** the intelligence of human and living beings, and **realizes** various intelligent systems.

What is intelligence?

- Intelligence:
  - “the capacity to learn and solve problems” (Websters dictionary)
  - in particular,
    - *the ability to solve novel problems*
    - *the ability to act rationally*
    - *the ability to act like humans*
- Isn't there a solid definition of intelligence that doesn't depend on relating it to human intelligence?

  Not yet. The problem is that we cannot yet characterize in general what kinds of computational procedures we want to call intelligent. We understand some of the mechanisms of intelligence and not others.

What's involved in Intelligence?

- Ability to interact with the real world
  - to perceive, understand, and act
    - e.g., speech recognition and understanding and synthesis
    - e.g., image understanding
    - e.g., ability to take actions, have an effect
- Reasoning and Planning
  - modeling the external world, given input
  - solving new problems, planning, and making decisions
  - ability to deal with unexpected problems, uncertainties
- Learning and Adaptation
  - we are continuously learning and adapting
  - our internal models are always being "updated"
    - e.g., a baby learning to categorize and recognize animals

AI Objectives

- Make machines *smarter* (primary goal)
- Understand what *intelligence* is (Nobel Laureate purpose)
- Make machines more *useful* (entrepreneurial purpose)

Signs of Intelligence

- *Learn* or *understand* from experience
- Make sense out of ambiguous or contradictory messages
- Respond quickly and successfully to new situations
- Use *reasoning* to solve problems

More Signs of Intelligence

- Deal with perplexing situations
- *Understand* and *infer* in ordinary, rational ways
- Apply *knowledge* to manipulate the environment
- *Think* and *reason*
- Recognize the relative importance of different elements in a situation

Turing Test for Intelligence

- A computer can be considered to be *smart* only when a human interviewer, “conversing” with both an unseen human being and an unseen computer, can not determine which is which
- The Turing test is a one-sided test. A machine that passes the test should certainly be considered intelligent, but a machine could still be considered intelligent without knowing enough about humans to imitate a human. (Alan Turing's)

History of AI

- 1943: early beginnings
  - McCulloch & Pitts: Boolean circuit model of brain
- 1950: Turing
  - Turing's "Computing Machinery and Intelligence‟
- 1956: birth of AI
  - Dartmouth meeting: "Artificial Intelligence‟ name adopted
- 1950s: initial promise
  - Early AI programs, including
  - Samuel's checkers program
  - Newell & Simon's Logic Theorist
- 1955-65: “great enthusiasm”
  - Newell and Simon: GPS, general problem solver
  - Gelertner: Geometry Theorem Prover
  - McCarthy: invention of LISP

- 1966—73: Reality dawns
  - Realization that many AI problems are intractable
  - Limitations of existing neural network methods identified
    - Neural network research almost disappears

- 1969—85: Adding domain knowledge
  - Development of knowledge-based systems
  - Success of rule-based expert systems,
    - But were brittle and did not scale well in practice

- 1986-- Rise of machine learning
  - Neural networks return to popularity
  - Major advances in machine learning algorithms and applications

- 1990-- Role of uncertainty
  - Bayesian networks as a knowledge representation framework

- 1995-- AI as Science
  - Integration of learning, reasoning, knowledge representation
  - AI methods used in vision, language, data mining, etc

Can we build hardware as complex as the brain?

- How complicated is our brain?
  - a neuron, or nerve cell, is the basic information processing unit
  - estimated to be on the order of 10^{12} neurons in a human brain
  - many more synapses (10^{14}) connecting these neurons
  - cycle time: 10^{-3} seconds (1 millisecond)

- How complex can we make computers?
  - 10^{8} or more transistors per CPU
  - supercomputer: hundreds of CPUs, 10^{12} bits of RAM
  - cycle times: order of 10^{-9} seconds

- Conclusion
  - YES: in the near future we can have computers with as many basic processing elements as our brain, but with
    - far fewer interconnections (wires or synapses) than the brain
    - much faster updates than the brain
  - but building hardware is very different from making a computer behave like a brain!

Important Features of Artificial Intelligence

1. The use of computers to do reasoning, pattern recognition, learning, or some other form of inference.
2. A focus on problems that do not respond to algorithmic solutions. This underlies the reliance on heuristic search as an AI problem-solving technique.
3. A concern with problem-solving using inexact, missing, or poorly defined information and the use of representational formalisms that enable the programmer to compensate for these problems.
4. Reasoning about the significant qualitative features of a situation.
5. An attempt to deal with issues of semantic meaning as well as syntactic form.

Important Features of Artificial Intelligence

6. Answers that are neither exact nor optimal, but are in some sense “sufficient”. This is a result of the essential reliance on heuristic problem-solving methods in situations where optimal or exact results are either too expensive or not possible.
7. The use of large amounts of domain-specific knowledge in solving problems. This is the basis of expert systems.
8. The use of meta-level knowledge to effect more sophisticated control of problem-solving strategies. Although this is a very difficult problem, addressed in relatively few current systems, it is emerging as an essential area of research.

Intelligent Systems in Your Everyday Life

- **Post Office**
  - automatic address recognition and sorting of mail
- **Banks**
  - automatic check readers, signature verification systems
  - automated loan application classification
- **Customer Service**
  - automatic voice recognition
- **The Web**
  - Identifying your age, gender, location, from your Web surfing
  - Automated fraud detection
- **Digital Cameras**
  - Automated face detection and focusing
- **Computer Games**
  - Intelligent characters/agents
- **ETC**

Research & Application Fields of AI (What Can Be Done by AI)

1. **Problem-solving**

   IBM Deep Blue in 1997

2. **Logic Reasoning & Automatic Theorem Proving**

   Prove theorem by operating the fact data-base

   - Natural deduction
   - Theorem proving
   - Computer-Aided proving

3. Natural Language Understanding

It deals with voice understanding and language translation. This is a very difficult task, a very complex encoding and decoding problem. For do so, we need:

- do voice analysis, semantics understanding and syntax structure
- make frequency-spectrum analysis and recognition
- establish knowledge base of specialized knowledge and common knowledge as well as the context

4. Automatic Programming

For mobile robots/vehicles working in space, underwater or on land, they have to sense and adapt their environment, to execute the assigned tasks and to design the most suitable program automatically.

Automatic programming is related to automatic theorem-proving and robotics, it has the following research area:

· Program synthesis: According to the initial description of a given problem, then produce automatically a program to satisfy the requirement of the task.

· Program verify: It uses the “old” program to verify the “new” program.

5. Machine Learning

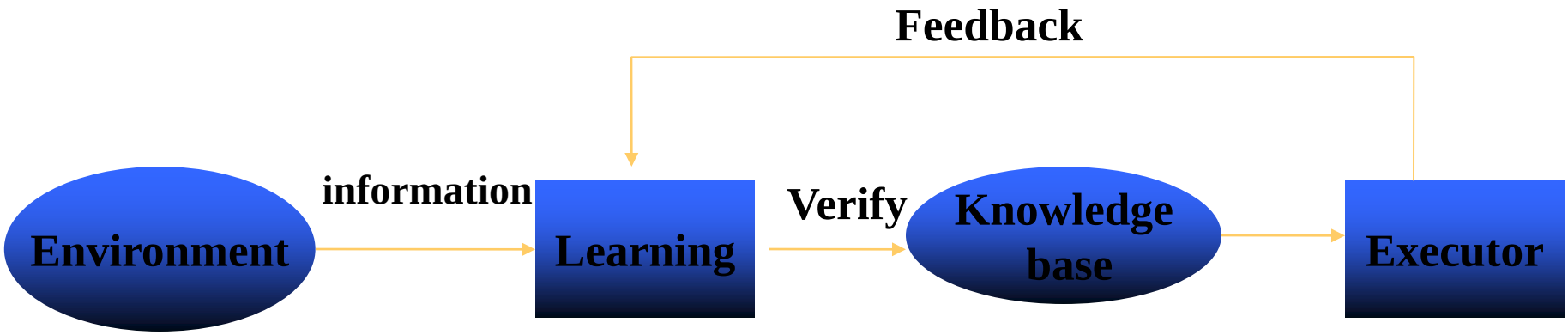

Fig.1 Model of Machine Learning

Based on large quantity of knowledge and knowledge base system.

New branch- Data Mining & Knowledge Discover

6. Expert System

ES is an important and most active application area of AI. ES is an intelligent computer programming system in which there exists knowledge and experience of specialized area in quantity in expert level, and can use the expert knowledge to handle and solve the problem in the specified domain.

ES can be used to medicine, industry, agriculture, business and military.

7. Artificial Neural Network(ANN)

ANN has been applied into the Pattern Recognition, Image Process, Automation Control, Information Process, Robotics and other AI areas.

8. Robotics

An interested research area of AI. The AI & Robotics promote each other. The development of Intelligent Robots needs the guidance of the principles and techniques of AI, and Robotics can provide AI a suitable test-bed. Many function of AI can be used and tested in Robotics, such as sensing, planning, decision-making and autonomous programming.

There are different kinds of intelligent robot:

- interactive robot
- sensory robot
- autonomous robot

9. Pattern Recognition

Pattern Recognition is to recognize the imitate sample of a given object. The “pattern” can be an object, a graph, a voice, a character and/or light signal.

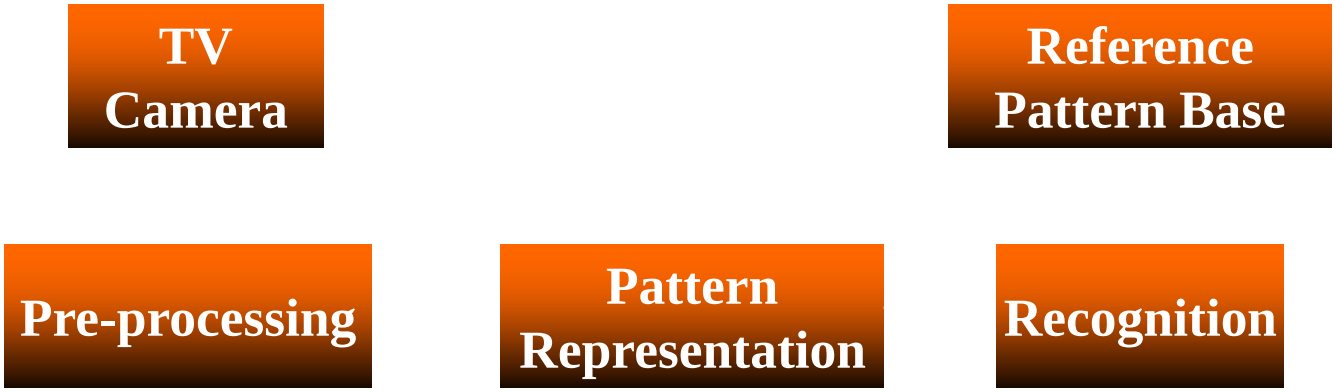

Fig. 2 A Pattern Recognition Process

10. Computer Vision

Research topics of Computer Vision:

· real-time parallel processing

· active and qualitative vision

· dynamic and time-varying vision

· modeling & recognition of 3-dimension scenes

· compression, transmission and retrieval of real-time images

· processing and explanation of multi-spectrum and color image

Applications: robot assembly, processing of satellite images, monitoring of industrial process, tracking and guiding of flying objects and broadcasting of live TV.

11. Intelligent Control

Techniques: quantitative mathematics analysis+ qualitative knowledge-based method.

Six kinds of IC: hierarchical control, expert control, fuzzy control, learning control, neuro-control and evolutionary control etc.

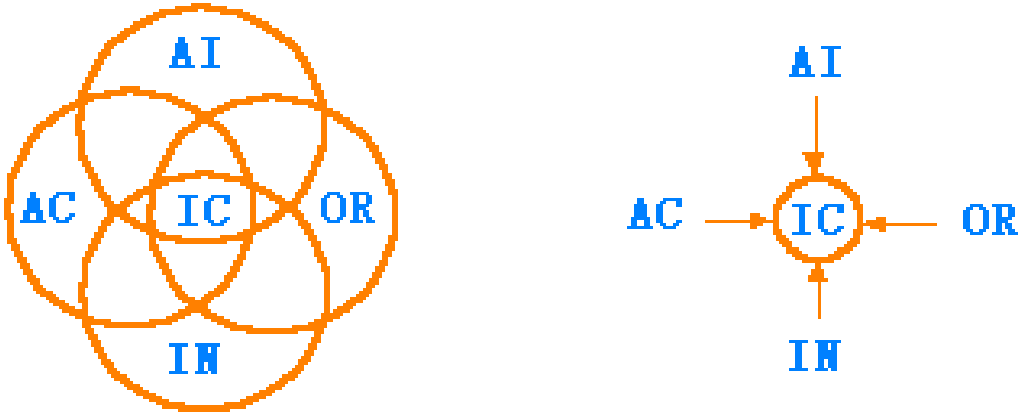

Fig 3. The Structure of Four-element intersection