

## Chapter 6: Knowledge representation

### Introduction

Examples of artificial intelligence

- Honda (ASIMO)
- Sony(Aibo)
- IBM (Deep Blue)

Artificial Intelligence is a broad field, and means different things to different people. It is concerned with getting computers to do task that require human intelligence. E.g. robot that can walk, talk, see, move things.

AI techniques do not necessarily reproduce human thought process. Rather they seek to apply computers to problem solving tasks requiring intelligence.

These techniques need to produce results consistent with human activity if they are to be useful, however, they do not necessarily reproduce the reasoning of an expert in their analysis.

### Definition and Reasons for AI

Artificial Intelligence is the science of making machines do things that would require intelligence if done by humans

**Artificial Intelligence (AI)** is the activity of providing such machines as computers with the ability to display behaviour that would be regarded as intelligence if it were observed in humans

There are many activities that we might think require intelligence such as arithmetic – which computers can do very easily. While many tasks that people do even without thinking – such as recognising face – which are extremely complex to automate.

People want to automate human intelligence for a number of different reasons.

- Understand human better : build AI so that we can test human behaviour
- Develop smarter devices: with the assumption that human behaviours are most efficient.

### Branches of Artificial Intelligence development

- **Expert system** (knowledge-based system) is a computer program that attempts to represent the knowledge of human experts in the form of heuristics (good guessing) e.g. expert system that is used to diagnose infectious blood diseases.
- **Neural work**: simplified models of human nervous system. e.g. 3D computer processor.
- **Perceptive system**: use visual images and auditory signals to instruct computers ( automatic driving system, pedestrian alarming system)
- **Learning**: consist of activities that enable computers (or other devices) to acquire additional knowledge
- **Robotics**: devices that mimic the motor activities of humans e.g. robotics used in car manufacturing companies.
- **AI hardware**: physical devices that aid in AI application
- **Natural language processing**: enable users to communicate with the computer in natural languages i.e. computer can read/write/speak/listen to natural languages.

There is a great deal of overlap among areas. There is usually more than one area of application that is combined into one AI system and they support each other.

e.g. Perceptive system -> robotics  
Natural languages <-> learning  
AI hardware -> Robotics

### Is AI possible?

There are four positions that you can adopt:

- Computer will never even appear to be really intelligent, though they might do *a few useful tasks* that conventionally require intelligence
- Computers may eventually *appear* to be intelligent, but in fact they will just be simulating intelligent behaviour and are not really intelligent i.e. passing Turin test.
- Computers will eventually be really intelligent
- Computers will not only be intelligent, they will be *conscious* and have *emotions*.

Computers can clearly behave intelligently in performing certain limited tasks, full intelligence is a very long way off and hard to imagine.

AI research assumes that human intelligence can be reduced to and represented by a manipulation of symbols i.e. can be modelled and processed by a computer.

#### Turin test (Turin):

If a human doesn't know that whether a human or a computer is communicating with him then the computer appears intelligent.

#### Chinese room (Searle):

Human can look up a huge book of Chinese rules and can understand Chinese. If computer is intelligent then it must be able to do the same.

E.g. IBM developing a device that can read and translate Chinese into English but it is far from being as good as human.

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### Expert System

#### Knowledge representation

How to represent knowledge in artificial intelligence is crucial as in order to solve a simple problem may require a lot of knowledge.

e.g. "It's President Clinton" It doesn't mean much if we don't know that today is the Election Day.

There are two questions to ask for knowledge representation:

- How & What knowledge should be captured
- How knowledge should be represented

E.g. How to assess the financial strength of a company by examining its financial ratios and other factors.

Financial ratios: ROI, debt to equity ratio, inventory ratio, profit, profit growth, etc.

Knowledge must be represented *efficiently*: selecting most relevant knowledge to be included. More than often, there is too much knowledge that is relevant, but deciding what are most relevant is difficult.

Knowledge must be represented *meaningfully*: so that we know how it relates back to the real world.

#### Expert system

**Expert systems** (knowledge-based system) is a computer program that attempts to represent the knowledge of human experts in the form of heuristics (good guessing)

#### Differences between an Expert system and a DSS

**DSS**: DSS is a tool or process whose utility is related to its ability to support decision making in the real world situation and not provide the solution itself.

An expert system is very similar to DSS that both are intended to provide a high level of problem-solving support to their users.

However there are 2 major differences:

- DSS is constraint to the manager's style and capabilities. While ES offer opportunities to make decisions that exceed the managers' capabilities
- Ability of the expert system to explain its line of reasoning in reaching a particular solution. (more complete than DSS)

#### An expert system model

- User interface: for communicating input and out between users and the machine. It may be menus, natural language or any other style of interaction.
- Knowledge base: contains facts that describe problem area, and also knowledge presentation techniques that describe how the facts fit together in a logical manner, typically represented as IF-THEN rule
- Inference machine: perform reasoning by using contents of the knowledge base in a particular sequence i.e. determines when and how to apply the rules.
- Development engine: tools used to create the expert system.

#### Knowledge base

Rules: The most popular knowledge representation techniques. Rules define how facts fit together in a logical manner. A rule consists of two parts: condition and action.

e.g. *If profit > 100000 and average profit growth of the last five years > 20% then financial strength = 'excellent'* (rule)  
*If traffic light = red then action = brake.*

All rules contained in an expert system are called the rule set. A rule set can have thousands of rules.

Rules are linked in a network of rules.

#### Inference machine

e.g. 5, 3, 2

Forward reasoning

Backward reasoning (reverse reasoning)

Comparing backward and forward reasoning:

- Backward reasoning is faster as it doesn't have to examine all rules.
- Most appropriate when there are multiple goal variables.
- There are many rules
- All or most all of the rules do not have to be examined in the progress of reaching a solution.

Advantages and Disadvantages of expert systems to the firm.

Advantages:

- Consider more alternatives (i.e. improving productivity): e.g. a stock broker can monitor more stock accounts with a financial expert system, in stead of few stock accounts as before.
- Apply higher level of logics: users are able to apply logic of experts in to solving problems.
- More time to evaluate decision results: as solutions can be easily and quickly provided, more time is available for choosing the best solutions.
- More consistent solutions
- Maintain control over the firm's knowledge: firms can capture the knowledge of experience staff and represented it in an expert system. The system then can be used for training by new staff.

Disadvantages:

- Can not handle inconsistent knowledge: Many business problems are not consistent in conditions of the problems. Expert systems may not be able to provide the most appropriate solutions to those problems.

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- Can not apply judgement and intuition: especially in solving unstructured problems.