ENGLISH FOR ACADEMIC PURPOSES SERIES

General Editor: C. Vaughan James

COMPUTER SCIENCE

Tricia Walker

Oxford Polytechnic,
England

ENGLISH LANGUAGE TEACHING

Prentice Hall

New York London Toronto Sydney Tokyo Singapore

CONTENTS

ARTIFICIAL INTELLIGENCE

UNIT 3

A. Understanding a printed text (1)

This extract introduces the critically important issue of **Artificial Intelligence**. Read it through, trying to get the **gist**.

The following practical tasks and questions will help you focus on the main features of the text. Bear the questions in mind as you read and as soon as you have finished reading, write down your responses. Please write in complete sentences.

1. The author talks about:
   knowledge *intelligence*
   information and *wisdom*.
   Rank these in order, from highest to lowest.
2. Whose test led to a definition of artificial intelligence? When was it devised?
3. Name an important technique of knowledge representation.
4. Game playing programs have made an important contribution to certain fields of artificial intelligence. Can you suggest in what ways?
5. When was the Four Colour Theorem proved conclusively, and by what means?
6. Name the aspects of natural language which can be understood, in a limited context, by computers.

NOTIONS OF INTELLIGENCE

1 It is quite possible to set out an approximate scale of intelligence: most people are more intelligent than most chimpanzees, a word processor is a more intelligent machine than a typewriter, etc. Nevertheless there is no scientific definition of intelligence. Intelligence is related to the ability to recognise patterns, draw reasoned conclusions, analyse complex systems into simple elements and resolve contradictions, yet it is more than all of these. Intelligence is at a higher level than information and knowledge, but below the level of wisdom. It contains an indefinable 'spark' which enables new insights to be gained, new theories to be formulated and new knowledge to be established.

2 Intelligence can also be examined from the point of view of language. Information can easily be represented as words, numbers or some other symbols. Knowledge is generally expressed in a language or as mathematics. Intelligence is at the upper limit of language: instances of patterns or deductive reasoning can be written down, and certain general principles can be stated. However, the creative 'spark' of intelligence is almost impossible to express in language.

3 The only widely accepted definition of artificial intelligence is based on a test devised by Alan Turing in 1950:

> **Suppose there are two identical terminals in a room, one connected to a computer, and the other operated remotely by a person. If someone using the two terminals is unable to decide which is connected to the computer, and which is operated by the person, then the computer can be credited with intelligence.**

4 The definition of artificial intelligence which follows from this test is:

> **Artificial intelligence is the science of making machines do things that would require intelligence if done by people.**

5 No computer system has come anywhere near to passing the Turing test in general terms. Nevertheless, progress has been made in a number of specific fields. It would take a very good chess player in the 1980s to be able to tell whether he or she were playing against a computer or a human opponent. Most car drivers are unaware which parts of their cars have been assembled by robots, and which by manual workers.

How knowledge is represented

6 Conventional data processing is based on information; artificial intelligence is based on knowledge. A central problem for artificial intelligence is an adequate representation of knowledge on a computer. On the one hand, the representation must be 'rich' enough to be of practical use. On the other hand, it must be simple enough for processing by a computer.

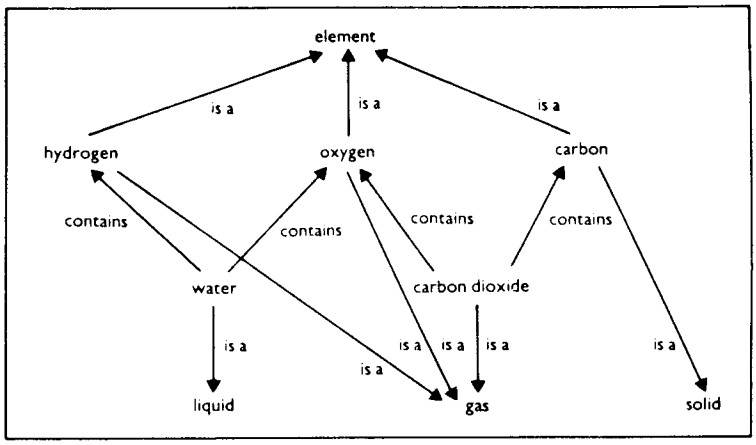


Figure 7.1
A semantic network

Semantic networks

7 A technique of knowledge representation which is widely used is **semantic networks**. As shown in Figure 7.1, a semantic network shows a set of relationships between objects. It is a flexible method of representation, allowing new objects and new relationships to be added to a knowledge base. Accordingly, semantic networks are often used in computer systems which have some form of learning capacity.

Game Playing Programs

8 Much of the progress in artificial intelligence has come through work on game playing programs. Games such as chess have the advantage of being simple enough to represent on a computer, while requiring a high level of intelligence on the part of the player. A number of successful strategies for playing games have been worked out. They are all based on searching a large number of possible moves and counter-moves, and selecting the best one to make. In some games, such as noughts and crosses, it is possible to search right through to the end of the game for each possible next move. In other games, notably chess, this is not possible, as the number of moves is too large even for the most powerful computer. The best chess programs achieve the right balance between the breadth of the search (the number of possible moves investigated), the depth of the search (the number of consequent moves investigated for each possibility) and the way of assessing the favourability of the moves.

9 Many of the methods used for game playing programs are being transferred to other fields of artificial intelligence.

10 Reasoning programs have been used to solve the kind of pattern recognition problems found in intelligence tests, and to solve problems in formal logic. An example of programs of this sort is the use of a computer to assist in the proof of the **Four Colour Theorem**. It has been known for centuries that no more than

four colours are needed to colour in any map, so that no two adjacent zones have the same colours. See Figure 7.3. This theorem was finally proved with the aid of a computer program in 1976.

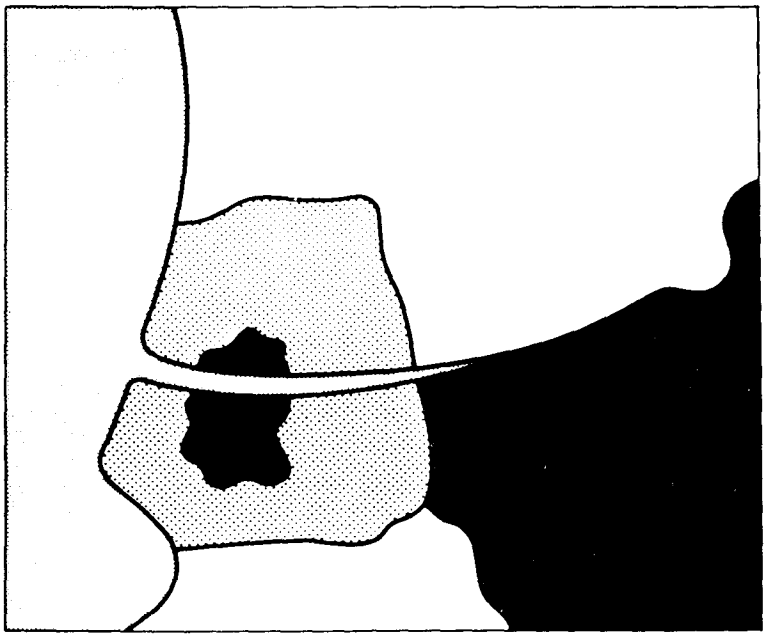


Figure 7.3
The Four Colour Theorem

11 Computers cannot interpret continuous passages in a natural language. Nevertheless, computers can cope with individual words and phrases, and longer passages of natural language in specific topics. A major topic of artificial intelligence research has been the recognition of natural language by computer. There are two aspects of this work: **syntax** and **semantics**.

12 Natural languages are composed of structures such as sentences, which are constructed according to rules of syntax. For example, the sentence:

```
The boy stood on the burning deck
```

can be analysed (or parsed) as:

```
<subject> <verb> <object>
```

where <subject> ('the boy') can be further parsed as

```
<article> <noun> etc.
```

The problem with syntax analysis is that the rules for sentence construction are very complex, there are many exceptions, and the rules are gradually modified as languages evolve.

13 In order to understand a passage in a natural language, the **semantics** or meaning of the piece must be studied. This depends on the context and what has been said before, as well as the meanings of individual words. Semantics is very difficult. In some cases an alternative interpretation of a single word can alter the meaning of a whole passage.

14 Computer programs have been devised which will cope with the syntax and semantics of complete sentences, but only within limited contexts. Even for these restricted situations, the programs are very complex. However, if current research into fifth generation computers is successful, systems with a much more powerful natural language capability will be available during the 1990s.

B. Check your understanding

If you have been through the answers in A (perhaps with your teacher/tutor) you now have a good general understanding of this important topic. With your dictionary to hand, you are now ready to tackle the passage in greater depth. Take your time and stick close to the text.

1. In which ways, according to the text, can information be represented?
2. Describe the Turing test and say if any computer is likely to pass it at the moment.
3. Name a job traditionally done by people which can be equally well done by robots today.
4. What is the fundamental difference between conventional data processing and artificial intelligence?
5. To be effective, representation of knowledge must have two characteristics. What are they?
6. Which technique of knowledge representation is diagramatically expressed here?
7. • Which games lend themselves to representation on computers?
   • What do they have in common?
   • What are the special characteristics of the best chess programs?
8. What kind of programs can solve problems in formal logic?
9. What do you understand by the term 'natural language'?
10. Which two aspects of natural language are computers known to cope with at the moment? What improvements are hoped for in the future?

C. Increase your vocabulary

In the opening paragraph there are some highly specific verbs which you need to be able to use accurately. It is important that you learn their meanings as their correct use will save you a dozen everyday English words to achieve the same effect.

Try to match up the verbs in column A with the nouns in column B to form meaningful phrases. The first is done for you.

NB: This is quite a difficult exercise as there may be more than one possible answer. Perhaps if you do a little dictionary work first the relationships may suggest themselves more easily.

COLUMN A	COLUMN B
recognise	principles
draw	patterns
analyse	knowledge
resolve	systems
gain	information
formulate	theories
establish	conclusions
represent	contradictions
express	insights
state	problems

1. draw conclusions
2. _____ _____
3. _____ _____ and so on . . .

D. Check your grammar

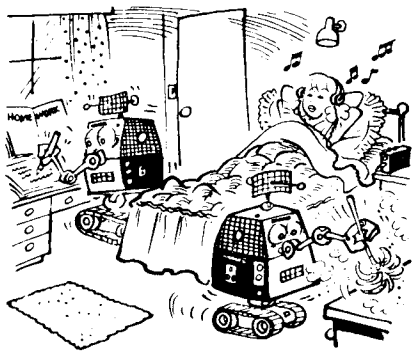
1. Using the semantic network diagram in Fig. 7.1, write simple sentences following the typical English pattern of Subject — Verb — Object as demonstrated in paragraph 12. Remember to follow the arrows and make whatever grammatical adjustments are necessary.
e.g.: 1. Carbon is a solid.
2. ——— – – ———
3. ——— – – ———

2. Look at paragraph 6. We learn that representation of knowledge on a computer must be *rich enough* to be of practical use but *simple enough* for processing. . . .
simple enough / not difficult
not simple enough / too difficult
Agree with the following statements by re-casting the sentences in the following manner:
This program is too short.
Yes, it isn't long enough, is it?
This chair is too hard.
Yes, it isn't soft enough, is it?

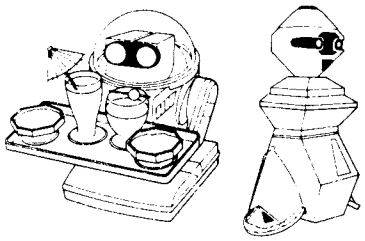
- This textbook is too difficult.
  Yes, ...
- This explanation is too complicated.
  Yes, ...
- This computer centre opens too late.
  Yes, it doesn't ..... *does it?*
- This printer is too slow.
  Yes, ...
- This screen is too dark.
  .....
- This word processor is too expensive.
  .....
- This computer game is too boring.
  .....
- This software is too old-fashioned.
  .....

E. Understanding a lecture

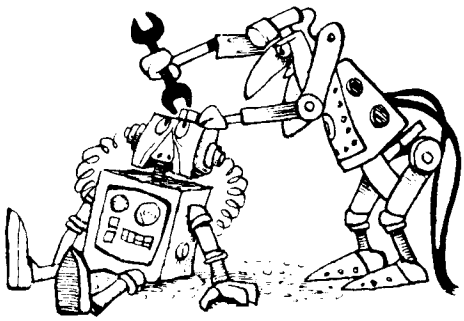
1. Listen to the lecture on robots. As you do, number the pictures in the order the lecturer mentions them.



A. _____



C. _____



B. _____

2. Listen a second time. Below each picture write a sentence describing the function of the robot.

3. Write notes on the advantages and disadvantages of robots.

_____

_____

_____

_____

_____

_____

_____

_____

_____

F. Understanding a printed text (2)

Read the following carefully. An expert system is one very special application of artificial intelligence. In particular, make sure you can explain the case study.

EXPERT SYSTEMS

An expert system is a computer system which is able to draw reasoned conclusions from a body of knowledge in a particular field, and communicate to the user the line of reasoning by which it has reached a conclusion.

Objectives of Expert Systems

The aims of expert systems

The purpose of an expert system is to provide reasoned advice at a comparable level to that provided by a human expert. This capability has two main aims: to enhance the abilities of leading experts in certain fields, and to make a high level of expertise available to less highly qualified practitioners.

The first aim takes note of the fact that some areas of human expertise, such as the diagnosis and treatment of cancer, are so complex that even the leading experts can benefit from the systematic, logical approach provided by a computer. A computer system will take into consideration all the knowledge at its disposal in the consideration of every case, and will follow known lines of reasoning exhaustively, no matter how complex they are. These capabilities complement the skills of a human expert, which are generally based on a mixture of knowledge, experience, insight and intuition.

The second aim attempts to raise the level of skill of professionals who are not themselves leading experts. A large number of medical practitioners fall into this category, particularly in developing countries. When expert systems become widely available, the skills of these practitioners should be significantly enhanced.

In some expert systems, the expert knowledge is fixed into the system when it is constructed. In others, there is a built-in ability to learn from experience, including from mistakes made by the system.

Applications of Expert Systems

A small number of expert systems are in use at present. These are mainly in the following fields:

Some uses of expert systems

- Medicine: Expert systems are in use for diagnosis and the planning of treatment in specialised fields. These include certain types of cancer, kidney diseases and some viral infections. Expert systems are also used to plan and monitor experiments, particularly in genetics. Expert systems for use by general practitioners in diagnosis and treatment are under investigation, but none are in widespread use at present.
- Geological Prospecting: Expert systems have already proved their worth in oil prospecting, and are now being used for other minerals.
- Designing Computer Configurations: Digital Equipment Corporation uses an expert system to design the computer configuration required when an order for a VAX minicomputer is placed. The expert system ensures that a compatible set of equipment is delivered, which meets the requirements of the customer.
- Chemistry: The analysis of chemical structures from mass spectrometer data is often done with the aid of an expert system.
- Legal Advice: Expert systems which give general legal advice, and assist in such matters as making Social Security claims, are at present under development.

Case Study 1: Mycin

The expert system **Mycin** was developed at Stanford University in the USA to assist doctors with advice on diagnosis and treatment of infectious diseases. The body of medical knowledge is stored in a form which includes a certainty value. This is a number in the range −1 to +1, where −1 means a negative association, and +1 means a definite positive association. A value near zero means that no correlation is known. For example:

Aids HTLV 3 1.0

which means that the virus HTLV 3 is associated with the disease Aids, with a certainty factor of 1.0.

The knowledge is processed by a set of **production rules** of the form:

if <condition> then <action>

At the start of a diagnosis, many of the items of knowledge are incomplete, or the certainty factors in them are near zero. During a diagnosis, additional knowledge is accumulated, and certainty factors move towards −1 or +1. The process is interactive. The physician enters background information and symptoms, and is then asked to give further information by the computer, as it requires it. At the end of the diagnosis, the conclusions are displayed, together with their certainty factors. At any stage, the line of reasoning and intermediate conclusions may be examined by the physician.

G. Check your understanding

1. The following phrases, which appear in the text, are expressed slightly differently elsewhere in the passage. Can you identify these? It is useful for you to learn as many ways as possible of saying the same thing in order to avoid repetition:

- objective (2 possibilities)
- takes into consideration
- be significantly enhanced
- raise the level of skill (3 possibilities)
- built in
- widely available

2. Answer the following questions:

- How does an expert system benefit a leading 'human expert'?
- What are its advantages to less highly qualified practitioners?
- We are told that the expert system will 'follow known lines of reasoning *exhaustively*'. What do you understand by the word in italics?
- What two main areas of medical work are assisted by expert systems?
- Why have expert systems 'proved their worth' to geologists? What do you think the phrase means?
- Which field of knowledge does the passage say is currently developing expert systems?
- In what way is the expert system 'Mycin' said to be 'interactive'?

H. Understanding discourse

Listen to Kaleni, whom you met in Unit 2, helping her friend Tariq identify numbers in English. Write down every number you hear *in the correct form*.