Lesson Proper for Week 14

Introduction

This chapter opens with a summary of the background to the development of computer intelligence and explains the differences between AI and expert systems. This short history is intended to show how the grand ideas of intelligent machines have developed into devices that simply exhibit intelligent behavior, and that claims of intelligence in respect to computing are overplayed. To illustrate this point we present the main arguments for and against intelligent computing summarized by the Turing Test, and the Chinese Room Scenario.

We then give some contemporary examples of intelligent devices and their uses, and move on to discuss how these devices are designed to either benefit the user, or inhibit certain activities. From this discussion, we will see that intelligent systems act on choices made on behalf of the user. We ask what programming rules advise the choices, on what information the choices are made, and the wider implications of many agents operating over the Internet. It follows that certain issues should be taken into consideration during the design of the application.

Subsequently, we discuss various social implications, which are summarized in the story of Joseph Weizenbaum. We consider whether there are some applications of intelligent systems that should not be developed. Secondly, the legal aspects are considered, together with the difficult issues of agent responsibility, responsibilities of the designer, the programmer, the provider and the user.

Finally, we look at issues relevant to the computing professional in the areas of design, implementation and management and, as with other chapters, outline an 'ethical dilemma'.

Origins of AI and expert systems

Interest in artificial intelligence (AI) can be said to have begun when it was realized that computers could perform problem-solving activities and, moreover, that they could perform certain functions in a faster, more reliable, way than humans. In other words, they could be used to replace some human mental operations.

Two areas of research emerged, one trying to achieve some replication of human intelligence (i.e. artificial intelligence), and the other trying to use human intelligence (in the form of expert knowledge) combined with computation to provide fast and reliable information (expert systems).

Intelligent machines

Academics working in the field of AI could see similarities between the computational aspects of the human mind and the way these machines worked. From that point it was just a short step for visionary thinkers to conceive the idea of 'intelligent machines'. The reasoning behind the idea of intelligent computers runs something like this:

· **Step 1**

1. Logic and rationality are properties of human thought

AND

2. Logical arguments are properties of computation

THEREFORE

3. Human 'thinking' can be replicated by computational methods.

· **Step 2**

4. Human thinking is equated with 'intelligence'

AND

5. Computers can replicate human thinking

THEREFORE

6. Computers can be 'intelligent'.

Expert systems

So far we have been discussing only one aspect of machine intelligence – that is, where computers are used to replicate aspects of intelligent behavior. A second approach is to 'put' intelligence into computers. Rather than trying to get computers to exhibit intelligence (a task fraught with tremendous difficulties), developers concentrated on creating knowledge-based systems. The idea is simple – obtain expert knowledge from, for example, a doctor or lawyer, and put that knowledge into a database. The best properties of computation (speed, search, pattern matching) can then be utilized to maximum advantage. So, for example, a medical diagnosis can be generated from a database of signs, symptoms and example cases – but who gets the blame when mistakes are made?

The debate on computer intelligence

Naturally, if computer scientists are to try to replicate intelligence they need to have some idea of what would be considered 'intelligent'. Two opposing points of view are given below: the first is a test of computer intelligence, and the second denies that computers can be intelligent at all.

One of the most influential tests of computer intelligence came from Alan Turing, a British mathematician. Put simply, he suggested that if a person could be fooled into thinking they were having a conversation with another person, when in fact they were conversing with a machine, then the machine could be said to exhibit intelligence. His idea took shape in what later became known as the Turing Test. This particular idea influenced research and debate for many years.

One program that was written to interact with a human operator and simulate conversation was called ELIZA, created by Joseph Weizenbaum. With this program, a person could sit at a computer terminal and engage in a fairly realistic conversation with the machine. The design of the program meant that the type of interaction it allowed was similar to the interaction between a psychologist or therapist and a client. Further research went into producing computers that could play chess, based on the assumption that 'clever people can play chess, therefore if a computer can beat a world-class chess player, then the computer must be intelligent'. The philosopher John Searle argued against these ideas of computer intelligence – he claimed that computers are simply 'symbol manipulators' and cannot be said to exhibit intelligence at all. He explained his position by using an example, now commonly known as the 'Chinese Room Scenario'. (Searle, (1994).)

An explanation of Searle's Chinese Room Scenario

Suppose that a man is inside a room, which has a gap under the door; through this gap, he receives sheets of paper from someone outside. No other form of communication is possible. The sheets of paper have Chinese symbols written on them and the task before this individual is to translate these symbols into some other language, such as English. To do this, he simply looks up a table on the wall and writes down the equivalent of the Chinese symbol in the required language. He then passes these under the door to the person waiting outside.

Searle's claim is that, although the man in the room has manipulated symbols so that Chinese language has been ‘translated’ into English words, in no sense could the man be said to understand Chinese. He has simply followed rules in order to change one particular input format into a desired output format, and this is essentially what digital computers do. Hence, any claim that rule-governed symbol manipulation can allow a computer to understand language or, more broadly, exhibit intelligence, is totally without foundation. Humans may manipulate symbols, but in communicating or demonstrating intelligence in other ways they must be doing additional things as well.

Thinking about what defines intelligence continues to baffle philosophers. The essential abilities for intelligence as indicated by Hofstadter (1979) are summarized in Figure 9.1.

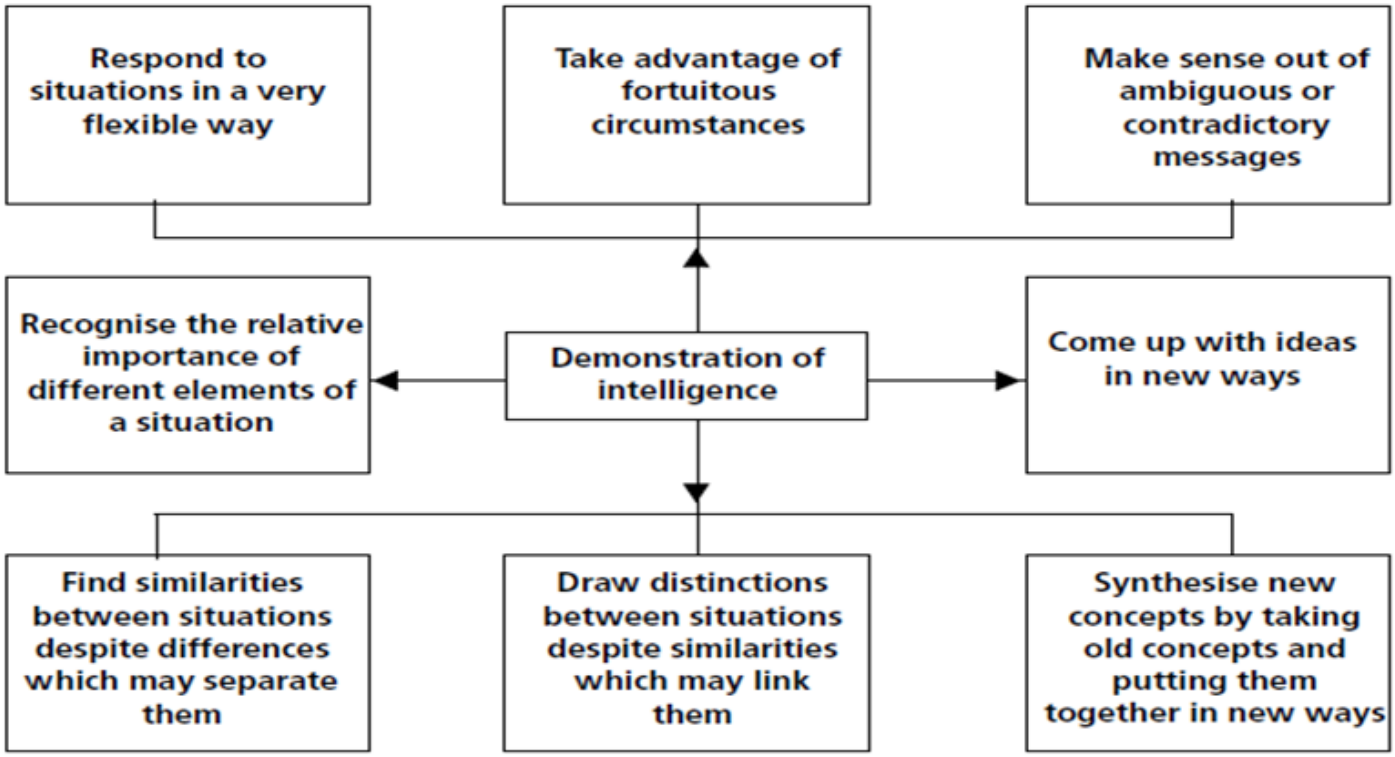

Figure 9.1: A summary of essential abilities for intelligence as indicated by Hofstadter (1979)

Applying intelligence

In the above sections, we have looked at the development of AI and expert systems, from attempts to replicate intelligence to the more practical aspects of capturing knowledge in expert systems. These different approaches give rise to differing concepts of AI. In the first instance, AI is concerned with producing applications that developers may claim 'do' intelligent things (for example, gather information, make judgements, and respond flexibly to the environment). In the second instance, AI is concerned with producing programs that deliver information based on prior knowledge gained from experts. In simplistic terms we could say that the concept behind AI is that systems respond to changing external circumstances, and the concept behind expert systems is the delivery of output based on internally stored information. As we shall discuss later in the chapter, these different approaches raise substantially different ethical questions.

Applications

We only have to look at media reports, advertisements and current news items to see that the quest for machine intelligence has not diminished, and has resulted in a proliferation of 'intelligent' and 'smart' devices. The results of search engines alone show their application, not just in the list of results to a query, but also in the lists of associated 'useful' websites (for example, 'if you're interested in ... then you're likely to be interested in ....'). The commercial advantages of cheap and fast information processing leading to information delivery has resulted in a trend for 'intelligent' computing.

When intelligent devices are designed to act independently, they are called agents. An agent may operate singly, or in conjunction with other agents. Clearly, since the advent of the Internet and the World Wide Web, the context for the application of intelligent programs has changed from individual systems to globally connected systems. Wireless networks and Bluetooth technologies have also extended the range of application – 'intelligence' has moved into the environmental, domestic and personal sphere. This convergence of technology, and intelligent applications, has resulted in the term 'ambient intelligence', which may be defined thus:

....ambient intelligence: people living easily in digital environments in which the electronics are sensitive to people's needs, personalized to their requirements, anticipatory of their behavior and responsive to their presence.

Applications in the environment

One of the early aims of applying artificial intelligence was in the field of robotics, and in particular to use robots to carry out work that is either dangerous or inaccessible to humans. This aim was realized when robots were used from 11 September to 2 October 2001 in the rescue operation at the site of the collapse of the World Trade Center. They were used to pass through areas where there was no breathable air, and went into spaces too small for humans to pass through.

On a more everyday level, most people are familiar with in-car navigation systems which have been in use for some time – offering suggestions on the most efficient route a driver can take to get from 'A' to 'B'. Intelligent in-car systems that are not yet in the public domain, but are predicted to be in use before too long, are devices that control the speed of the car in relation to the speed limit in effect on particular sections of the road. Intelligent speed adaptation (ISA) technology and its adoption is seen as 'virtually inevitable in the car industry ... either through increased legislation or voluntary use'. (*IEE Review*, February 2004) ETC...Trials using ISA systems in specially adapted cars have begun in the UK.

'The MIRA-designed ISA system uses a GPS receiver to continuously identify the position of the vehicle and match its location with a digital map of permitted speeds. The speed limit is displayed inside the car and also sent to the throttle. When the driver reaches the speed limit, the ISA system will intervene so that however hard the driver presses on the accelerator pedal, the engine produces no further power.' (*IEE Review*, February 2004)

'Smart' homes

Bringing intelligent devices into the home is the vision of the future, and research into 'smart' homes is the latest trend. A number of projects are under way using technologies that learn user preferences, and that can respond to changing circumstances. One of these projects – 'The Aware Home' – uses technology to support elderly people living in their own homes. The following is an example of how the technology can be applied, and is part of a project called 'The Aware Home Research Initiative' (AHRI) at the Georgia Institute of Technology:

- Software which automatically constructs family albums from video pictures collected in the house
- An intercom system which uses voice recognition to allow people to speak to one another by saying their name
- Software that telephones a person when their photograph is spoken to

- Electronic tagging of easily mislaid items such as keys
- Reminders about appointments.

Social, legal and professional issues

In this section we look more closely at the social, legal and professional issues associated with the use of intelligent systems.

Social issues

Some of the social issues raised by artificial intelligence have been documented by Whitby [1996] as:

- Loss of employment due to replacement of jobs
- Dangers in safety-critical applications
- Centralization of power
- Dehumanizing effects of AI
- Unrealistic expectations due to sensationalizing the capabilities of AI.

In the early days of artificial intelligence, when the prospect of being able to simulate human intelligence was considered by some to be viable, the computer scientist Joseph Weizenbaum became very concerned about how AI would be applied. As we described earlier, Weizenbaum had developed a program (ELIZA) that could emulate conversation – the test for intelligence that Turing had suggested. Using the ELIZA program, a person could sit at a computer terminal and engage in a fairly realistic conversation with the machine. The design of the program meant that the type of interaction it allowed was similar to the interaction between a psychologist or therapist and a client. Weizenbaum was horrified by the suggestion that a program such as this could be used instead of using human counsellors, and this inspired him to write the book *Computer Power and Human Reason*. He wrote:

...there are some human functions for which computers ought not to be substituted. It has nothing to do with what computers can or cannot be made to do. Respect, understanding and love are not technical problems.

He gives three specific areas where computers should not be applied:

- Applications 'whose very contemplation ought to give rise to feelings of disgust in every civilized person'. This comment refers to the connection of animals to computers, specifically in areas of visual and brain research
- 'All projects that propose to substitute a computer system for a human function that involves interpersonal respect, understanding and love in the same category.' This is in reference to the substitution of therapists by a 'conversing' machine as mentioned above

· Anything which 'can be seen to have irreversible and not entirely foreseeable side effects', especially when there is 'no pressing human need for such a thing'. This refers to the research being conducted in speech recognition devices.

Interestingly, and with amazing foresight, he refers specifically to voice recognition devices: '... such listening machines, could they be made, will make monitoring of voice communication very much easier than it now is ...And, Perhaps the only reason that there is very little government surveillance of telephone conversations in many countries of the world is that such surveillance takes so much manpower ... speech-recognizing machines could delete all 'uninteresting' conversations and present transcripts of only the remaining ones to their masters.

We only have to read the news, or look at organizations protecting privacy rights (such as the Electronic Frontier Foundation – **www.eff.org**) to realize the visionary nature of Weizenbaum's observations, which date back to 1976.

Legal issues

There are two issues that we will consider here – one concerns the use of agents to implement and enforce the law, and the second is the issue of responsibility. In Section 9.4 we briefly outlined a system used to implement the law: the MIRA Intelligent Speed Adaptation system. The issue of responsibility raises many complexities. If the program or device goes wrong, or acts illegally, who should be held responsible? For example:

· The person or organization that commissioned the system

· The requirements or specification designer

· The programmer

· The provider

· The user – whether an individual or an organization.

For example, consider the MIRA system. A child runs out into the road in front of a car. Despite the speed control enforcement, there is insufficient space for the car to stop. The only course that the driver can take is to swerve and accelerate. The car swerves, but the speed control system prevents a brief period of acceleration. An accident ensues. Who is to be blamed?

A wider issue, and one that has been discussed a number of times in this book, is that of national versus international law, together with the problems of enforcing such laws in a global context.

As we have already seen, there are many different areas of application for AI and expert systems – in the home, in dangerous environments, and in safety-critical situations. Another major area of development, now and in the future, is e-commerce. The following extract describes how intelligent systems (also called software agents) can be used on the Internet:

The long term vision is of legally compliant agent mediated electronic commerce over public global networks, perhaps on the semantic web, involving multi-agent systems or societies. Agents will represent different participants and services and interact to create legally binding agreements, enforceable both on and offline. Negotiation and compliance processes will relate to all legal aspects of a commercial relationship (privacy, intellectual property, contract, consumer protection, tax, etc.), with various agents providing the appropriate processes and taking on functions of privacy protector, consumer protection monitor, contracting assistants, security protocol management (e.g. digital signature mechanism) trust, auditing and recording. (Subirana & Bain, 2004)

In other words, what these authors foresee are intelligent agents communicating between themselves over a global network such as the Internet. These agents will negotiate with each other to reach agreements on contracts, and to make sure legal requirements are met.

For example, if personal information is required in a contract the agent should make sure that the information given, and the way it will be used, complies with any data protection legislation. Another agent could be looking after intellectual property interests. So, for example, if someone tried to sell you illegal software your agent would refuse it.

According to Subirana & Bain, particular areas of difficulty when using intelligent agents in this context are:

- The allocation of responsibility (where agents are used in a contract situation)
- Compliance with consumer protection regulations (notifications, confirmations, contracting procedures)
- Privacy risks (for example, notifying users of privacy risks, and gaining consent for personal data processing)
- Creating legally valid agent-based digital signatures.

Other difficulties of complying with the law, especially in a global context such as that provided by the Internet, are where intelligent agents are used to access content such as video clips, music and written reports. In this instance, compliance with intellectual property rights will be another issue. Where agents are acting on our behalf, as for example gaining access to music, or negotiating our privacy requirements, it is important that they act within the law. For those involved in developing, managing, or using intelligent agents, key questions are 'does your agent obey the law?', and if so, 'whose law is it obeying?'.

Professional issues

In the previous sections we have given examples of applications for intelligent devices and have summarized a number of key implications. As we have indicated, these devices can be designed to be of benefit to the user, or can inhibit what the user does. We could of course say the same about any computer application. However, we have also seen from the previous discussions that intelligent devices may be required to make decisions, interact with

other intelligent applications, and obey the law. Computer professionals have a responsibility not only to consider the usability of the device, but also to consider the wider effects of its decision-making capabilities, and the extent of the interaction with other devices.

Where intelligent devices are used in a social context (as in the examples given earlier) the issues to be considered are:

· Reliability

· Trustworthiness – both in the functioning, and the limits of decision making

· Privacy issues – where data is stored, such as user preferences, this information should meet privacy requirements

· Security issues – information should be secure, and so to should the ownership of the device.

· Burden on the user – is there a burden on the user in respect of managing the device?

· Identity verification – can anyone else impersonate the user?

· Decision-making procedures – can they, or should they, be controlled by the user?

· Is it legal?

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System Integration And Architecture 2

Courses

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