Module 10: Knowledge management, artificial intelligence, and information systems issues

Overview

Information systems and their applications in business are being increasingly affected by developments in the areas of knowledge management and artificial intelligence (AI). The goal of artificial intelligence is to develop information systems that can react to the environment and function like a human being, including physical functions such as seeing, walking, talking, and listening, as well as intellectual functions such as thinking and reasoning. The ultimate objective for artificial intelligence development is to give machines the ability to learn and to solve problems. Because of these diverse goals, artificial intelligence systems can be broadly grouped into two categories: robotics (machines that exhibit human physical functions) and expert systems (systems that exhibit human intellectual functions).

In this module, you will study the various types of artificial intelligence systems and how they are designed. You will also learn about the various applications of artificial intelligence in real-world situations. It concludes with a number of issues and solutions related to the use of computers, including waste, mistakes, crime, the work environment, and ethics.

Test your knowledge

Begin your work on this module with a set of test-your-knowledge questions designed to help you gauge the depth of study required.

Topic outline and learning objectives

10.1 Basic concepts of knowledge management and artificial intelligence
    Define knowledge management, artificial intelligence, and the characteristics of intelligent behaviour, and compare the performance of natural and artificial intelligence systems for each of the characteristics defined. (Level 2)

10.2 Major branches of artificial intelligence
    List the major branches of artificial intelligence. (Level 2)

10.3 Intelligent agents/bots
    Describe the potential uses of intelligent agents. (Level 3)

10.4 Expert systems
    Describe an expert system. (Level 2)

10.5 Components of expert systems
    Describe the components of an expert system. (Level 2)

10.6 Expert systems development
    Describe the steps for developing an expert system. (Level 2)

10.7 Applications of ES and AI
    Explain the applications of artificial intelligence. (Level 2)

10.8 Virtual reality
    Define "virtual reality" and provide examples of its applications. (Level 2)

10.9 Other specialized systems
    Identify and describe other specialized systems. (Level 2)

10.10 Computer waste.
    Describe waste and mistakes in the IS environment. (Level 1)
Computer crime Describe the types and effects of computer crime. (Level 1)

Preventing computer crime Describe options for preventing computer crime and its effects. (Level 1)

Health and environment issues List the effects of computers on the work environment, and identify actions to ensure the health and safety of employees. (Level 2)

Ethical issues Identify ethical issues and describe codes of ethics related to computer systems. (Level 1)

Module summary

Print this module
Module 10: Test your knowledge

1. Chapter 11, Review question 6, page 466

   Solution

2. Chapter 11, Review question 10, page 466

   Solution

3. Veratex Corporation, a Detroit, Michigan-based distributor of medical and dental products, is a good example of a company that's not afraid to use the best that AI technology has to offer. Among other applications it employs, Veratex has deployed neural networks and expert system-based sales support systems running on their IBM AS/400 minicomputer.

   Veratex has a unique approach to marketing its products. The company mails unsolicited catalogues to physicians and dentists. When a customer makes a buy from the catalog, his/her name is added to a customer database. Veratex's team of 40 telemarketers then call the names in that database regularly for reorders.

   The company's problem was that before long, huge numbers of "dormants" - customers who had not made reorders for significant lengths of time - would accumulate without a phone call. Veratex's small telemarketing force is not trained to prospect for new sales, and the portion of the telemarketers' time allotted to calling dormants is typically limited to 20%. Given that Veratex's database contains 44,000 customer names, that adds up to a lot of lost yet relatively accessible business. In addition, the credibility of older data as a whole was called into question more and more as time went on.

   The company had to verify its older data and then decide to which members of the dormant pool it would assign limited marketing time. Veratex contracted with Churchill Systems of Troy, Michigan, to build a neural network that would help identify the dormants with the highest probability of being the "best" customers - the ones likely to place reorders. Similarly, the network would be trained to weed out the customers less likely to reorder from the "good" ones. The telemarketers would take it from there, making the most of their available time to contact the best customers thus identified by the network.

   Built with a neural network utility, the neural network inputs comprised various statistical and demographic data culled from Dun & Bradstreet and other sources. The network was then applied against Veratex's accounts to get a numerical output - a "rating" - for each customer. These ratings were then plugged directly into the customer records, which were sorted down to the best accounts. The result for each account is a rating relative to the "best" Veratex customer.

   According to Harve Light, president of Churchill Systems, following the network's installation two years ago, "More Veratex accounts were reopened in five months than in similar periods (that didn't have the benefit of the network)." In addition, he said, the patterns and interrelationships uncovered by the neural network proved to be an extremely valuable resource for Veratex's marketing analysts.

   The company also uses many expert systems, but one of the most successful is designed to support sales representatives while they're taking orders. Like many marketing-related companies, Veratex has a high turnover in its sales force. Because of the nature of the business and its products, most new representatives spend several months picking up terminology. New reps will frequently miss the opportunity to pitch products that are associated in some way with
the customer's order. For example, if a dentist orders x-ray film, a new sales representative may not know that such an order probably requires x-ray holders as well and so loses the additional sale.

Veratex's expert system - which boasts a less-than-one-second response time per screen - has a knowledge base that captures complete product and inventory information. It follows the progress of a telephone sale and prompts sales representatives to pitch their customers for more orders. Consequently, the sales representatives learn to see "the big picture" of every customer order, pick up terminology more quickly, and make more sales.

According to Light, sales climbed 17% in a 30-day period following the system's deployment. As another benefit, Light adds that "Implanting an expert system into an existing program really invigorates old code."

a. What is the difference between an expert system and a neural network?

b. Why did Veratex use a neural network to solve a marketing database problem and an expert system to solve a sales problem?

c. Could neural networks be used to solve other business problems?


Solution

4. Chapter 11, Review question 11, page 466

Solution

5. Chapter 11, Discussion question 11, page 467

Solution

6. Chapter 14, Review question 7, page 610

Solution

7. Chapter 14, Review question 14, page 610

Solution
10.1 Basic concepts of knowledge management and artificial intelligence

Learning objective

- Define knowledge management, artificial intelligence, and the characteristics of intelligent behaviour, and compare the performance of natural and artificial intelligence systems for each of the characteristics defined. (Level 2)

Required reading

- Chapter 11, pages 430-447

LEVEL 2

One example of using AI techniques is Ask, a consumer and corporate web search device at Ask.com, which allows users to ask questions in English about products and services. It also provides corporations with customer service and has a database of information about companies. It is one of the most visited sites on the Web, handling over three million questions a day. It can help users solve complex problems about buying goods, and it has a large knowledge base plus links to partners. It attempts to understand questions and does so interactively; it captures language used and questions asked to improve its ability to answer questions. These are practical applications of artificial intelligence, which has been undergoing intense research for the past four decades.

Artificial intelligence can have a profound impact on today's businesses. Programmed trading systems, which have rudimentary built-in artificial intelligence, were partly blamed for the stock market crash on "Black Monday" (October 17, 1987). Some of these systems are programmed to detect general market trends and to execute sell orders under certain conditions. Some investment firms have been attempting to use artificial intelligence to forecast stock market indexes and to guide stock trading.

The application of artificial intelligence ranges from controlling simple appliances to maintaining complicated aircraft engines. The use of fuzzy logic in cameras and video equipment, refrigerators, ovens, and small appliances by Japanese manufacturers illustrates a commercial application of artificial intelligence.

Although we have not reached the stage of AI as described in science fiction and movies such as The Terminator, the use of AI is growing in industry, manufacturing, computer design, medicine, research, accounting, and many other fields.

What is knowledge management?

A knowledge management system (KMS) is an organized collection of people, procedures, software, databases, and devices used to create, store, share, and use the organization's knowledge and experience. A KMS can involve explicit and tacit knowledge.

Explicit knowledge is objective and can be measured and documented in reports and rules. Determining if a person qualifies for a bank loan based on the company's rules is an example of explicit knowledge.

Tacit knowledge is harder to measure and document and is typically not objective or formalized. Knowing the best way to negotiate a complex labour dispute would utilize tacit knowledge. Many organizations attempt to convert tacit knowledge to explicit knowledge to make the knowledge easier to measure, document, and share with others through knowledge management systems.
IBM's Lotus Notes/Domino and Microsoft's Digital Dashboard are examples of software designed to support knowledge management. In addition to software tools, artificial intelligence and special-purpose technologies and tools can be used in a knowledge management system.

**What is artificial intelligence?**

On a theoretical level, **artificial intelligence (AI)** can be defined in many ways. John McCarthy proposed the term in 1956 to describe computers with the ability to mimic or duplicate the functions of the human brain.

**Artificial intelligence systems** are the people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that demonstrate characteristics of human intelligence. The purpose is to replicate human decision making and so help an organization achieve its goals.

**Nature of intelligence**

In order to develop machines with **intelligent behaviour**, you must understand the characteristics of intelligent behaviour. These are:

- **Learn from experience and apply the knowledge acquired from experience.** The ability to learn from experience must be programmed in, such as in chess games. While humans naturally apply what they have learned to other situations, this is difficult to program into computers.

- **Handle complex situations.** Even human experts make mistakes in dealing with the complexities of multi-faceted decisions, so imagine the difficulty in programming this characteristic into a computer.

- **Solve problems with important information missing.** People have to deal with uncertainty and missing data constantly, and for an AI system, it is not acceptable to just say "insufficient data."

- **Determine what is important.** Human decision makers have to ignore unimportant data and base their decision on what is important, and this ability has to be programmed into AI.

- **React quickly to a new situation.** This is not the way computers generally work, so tricky programming is necessary.

- **Understand visual images.** Think of how many visual images we must interpret in our daily activities, such as driving a car, or moving through a room. Machines that can do this must have an extension of understanding of visual images, called a **perceptive system**.

- **Process and manipulate symbols.** People deal with symbols and three-dimensional objects constantly, but machines deal best with numbers, a problem that is being addressed but with limited success.

- **Be creative and imaginative.** Some people are able to turn negative situations into success stories by being inventive and creative. In the field of information systems and management, people are encouraged to look for innovative solutions to problems and not be held back by self-imposed constraints. However, creativity and imagination, the capability of inventing something new, are not characteristics of machines or computers.

- **Use heuristics.** People develop rules of thumb developed from experience, mainly by trial and error or even guessing. Some computer systems can do this today.

The problem with all definitions of AI is that we cannot pinpoint what "human intelligence" is. To create computer systems that can simulate the reasoning process, we need to understand the exact process of human reasoning. Unfortunately, to date, the secret of how human beings think and reason has not been unlocked. Thus, no definition of artificial intelligence is yet satisfactory.
Difference between natural and artificial intelligence

Scientists have struggled with, and disagreed with, the difference between natural and artificial intelligence, or life between carbon-based life (human or animal) and silicon-based life (silicon chip). There are differences, but they are diminishing. Much research continues into how humans think, and it is amazing how the results of neurological research show similarities in memory and linkages in the brain that compare to how computers are designed. Ultimately, the key to designing AI computers is believed to be our actual thought and reasoning processes.

Many computer systems claim to have artificial intelligence, yet it is almost impossible to argue for or against such claims. The only generally accepted test is the Turing test, proposed in 1948 by Alan Turing, a British computer scientist. The Turing test avoids the problems arising from the imprecise definition of artificial intelligence, as well as the issue of whether a computer system claiming to have artificial intelligence really possesses human intelligence or understanding. It simply requires the computer system to be able to mimic human behaviour to the extent that it can fool a human evaluator into believing that he or she is interacting with another human being, not a computer system. To date, very few computer systems have passed the Turing test. Nonetheless, since its proposal, the Turing test has become the standard by which artificial intelligence systems are measured.
10.2 Major branches of artificial intelligence

Learning objective

- List the major branches of artificial intelligence. (Level 2)

Required reading

- Chapter 11, pages 440-447

LEVEL 2

On a practical level, the lack of a precise definition has not deterred the pursuit of artificial intelligence. AI is a collection of several disciplines:

- expert systems
- robotics
- vision systems (perceptive systems)
- natural language processing
- learning systems
- neural networks
- genetic algorithms

Expert systems

An expert system is a key area of artificial intelligence application, consisting of hardware and software, which stores knowledge and makes inferences in a manner similar to a human expert.

Robotics

Robotics is the technology of designing and using robots with artificial intelligence and computer-controlled humanlike motor abilities, such as dexterity, tactility, and vision. Unlike traditional machines, robotics permits the robots to be quickly reprogrammed by software, and the robots can be trained to solve specific types of problems.

The most significant development in robotics is its application in manufacturing. Robotics is attractive because robots do not go on strike, never get sick, do not take vacations, and require no supervision. They can also perform repeated operations precisely and consistently for hours on end. A further advantage is that robots can be used for hazardous tasks considered too dangerous for human workers, like firefighting, undersea exploration, rescue in mine disasters, and the handling of nuclear and other hazardous wastes.

Besides being used extensively in computer-aided manufacturing, robotics is applied to a broad range of activities including scientific research, medical procedures, and space exploration.

While the brain in today's advanced industrial robot works at about 10 million instructions per second (MIPS), it must reach at least 100 trillion MIPS to come even close to the human brain.

Vision systems

Vision systems allow computers to capture, store, and manipulate visual images. Current important applications are fingerprint and retina scanning. Vision systems are still under development in such areas as extending the capabilities of robots. The ability to see in colour and draw conclusions from images, as do humans, appears to lie in the distant future.
Natural language processing

Natural language processing allows computers to understand statements or commands made in a “natural” language, such as English. There are three levels of voice recognition:

- **Command** recognizes dozens to hundreds of words.
- **Discrete** recognizes dictated speech with pauses.
- **Continuous** recognizes natural speech.

This technology has been with us for at least 20 years, but the early forms were limited. For example, in the 1980s, the Director of Information Systems for the City of Toronto hired blind programmers, who used the command level as well as Braille keyboards. There are many applications of this technology, with more expected in the future. Several packages already exist, and the technology is improving. For example, voice recognition is used by brokerage houses.

Learning systems

Learning systems in this context means systems that use feedback to change how the computer functions or reacts to situations.

Neural networks

Neural networks are perhaps the most innovative branch of AI. Instead of rule-based expert systems, neural networks mimic the learning and reasoning behaviour of the human brain. To train a neural network, the system is fed an example and the correct result. Example 10.1 illustrates the workings of a simple neural network.

A key in neural networks is their ability to recognize patterns and, in the more sophisticated neural networks, to program themselves to solve related problems on their own. The specific features of neural networks are the ability to

- retrieve information even if some of the neural nodes fail
- modify stored data quickly as a result of new information
- discover relationships and trends in large databases
- solve complex problems for which not all the information is present

An area of research offers promise for those with disabilities, using neural networks to drive artificial limbs. While this has long been a subject for science fiction, the research indicates that it is achievable, despite obstacles.

Genetic algorithms

**Genetic algorithms (GA)** were formally introduced in the 1970s by John Holland at the University of Michigan. The major impetus to the development of GA comes from the continuing price/performance improvements of computers in the early 1970s. GA problems require an extensive amount of computer power to solve, and without the advances in computing power, GA would not be affordable.

To use a genetic algorithm, a solution to your problem is represented as a genome (or chromosome). The genetic algorithm then creates a population of solutions and applies genetic operators such as mutation and crossover to evolve the solutions in order to find the best one.

Genetic algorithms require a set of population members, usually between 20 and 100. Each population member represents a trial solution to a given problem. The inputs are often called genes, chromosomes, or genomes. Typically, there are a number of different inputs. The output is commonly called the **fitness**, since it describes how “fit” the trial solution is. The trial solution is tested by an evaluation function, which calculates the quality of the trial solution.
Suppose the problem is to optimize factory profits. The fitness function is designed to calculate the factory’s profit. The input variables, or genes, may consist of material costs, labour costs, overtime charges, and other process variables. The population is made up of a unique combination of genes (values for the input variables). Each population member has an identical number of genes, or input variables.

Genetic algorithms work by starting with relatively poor trial solutions, that is, population members with poor fitness. Three basic processes are then allowed to occur: mating, mutation, and selection. The mating process involves an exchange of information between population members. When population members mate, they cross gene values (input variables) over to their partner. This rearranges the information in the gene values of the population members, creating new and diverse "offsprings" that combine potentially beneficial features of their parents.

Hybrid systems

A hybrid AI system is one that combines different AI technologies. Examples of hybrid systems include one that combines expert system techniques with GA, or one that combines neural networks with fuzzy logic. The combination provides a more powerful system for problem solving.

GA and hybrid systems have been used in a variety of applications, including shipping cargo, designing engines, and describing criminal suspects by crime witnesses.

Development of artificial intelligence

Two approaches are used in the development of artificial intelligence: the bottom-up approach and the top-down approach.

The bottom-up approach concentrates on developing a physical analog to the human brain. In other words, it tries to replicate the workings of the human brain using computer circuits. Cybernetics, the study of the control and communications functions in machines, animals, and human beings, is an example of the bottom-up approach. The term "cybernetics" was coined in 1948 by Norbert Wiener, an American mathematician, and is derived from a Greek word meaning to steer or control. According to Wiener, the chief common characteristic of people and machines is the use of feedback. The concept of feedback has become one of the key tenets of the bottom-up approach to artificial intelligence.

The top-down approach, on the other hand, concentrates on the development of a logical analog to simulate the workings of the human brain. In other words, this approach concentrates on replicating the logic of human thinking. The most well-known applications are game programs, such as computer chess or Go. Early versions of these programs use a “tree searching” technique. For example, a chess program playing against a human player would look ahead several moves and “play out” the consequences of these moves to determine the next best move to make. Although the chess program can mimic a human player, this is not how most human players play chess. Computer scientists later introduced heuristic rules (guidelines to aid in decision making) based on pattern-matching techniques to better mimic the way actual chess masters play. Expert systems represent the latest refinement of the top-down approach.

Application software

There is increasing interest to build some intelligence into application software, with mixed success so far.
10.3 Intelligent agents and bots

Learning objective

- Describe the potential uses of intelligent agents. (Level 3)

Required reading

- Chapter 11, page 445

LEVEL 3

On the Internet, an intelligent agent is a program that gathers information or performs some other service without the user’s presence. The user sets certain parameters, and the intelligent agent searches all or part of the Internet to gather the relevant information, on a daily basis or on demand. There is a class of agents called bots (short for robots). A bot is a software version of a mechanical robot. Early bots are more like their mechanical counterparts, guided by pre-programmed rules of behaviour. However, the newer generation of bots is endowed with artificial intelligence and is able to make heuristic decisions.

Different names are used for bots: daemons, agents, and softbots. A common form of daemons that most Internet users have experienced is mailer daemons that return undeliverable e-mails. Here are some common forms of bots:

- **Webbots** map and index the vast quantities of information available through the World Wide Web. Many of the search engines use webbots to create the indexes used to perform searches.

- **Searchbots** perform search functions. Regular search engines are not smart enough, typically yielding a large amount of irrelevant information. The user is required to sift through the results returned by search engines to find the desired information.

- **Mailbots** filter electronic mail, preventing junk mail and spam from clogging up e-mail boxes.

- **Chatterbots** carry on whimsical conversations in online, real-time text environments, such as chat rooms. Eliza, written by Joseph Weizenbaum in 1966, is perhaps the grandmother of chatterbots. It was constructed to talk like a human psychotherapist and is the first to pass the Turing AI Test, fooling humans into thinking that they are talking with a real human psychotherapist. Julia, written by Michael Mauldin in 1990, is generally considered to be the first intelligent agent. It could chat like a human and provide factual answers to questions on specific subjects.

- **Gamebots** are popular computer game environments with believable characters and wily foes.

- **Spambots**, perhaps the most hated form of bots, automatically search out e-mail addresses from websites and create mailing lists for spammers.

Applying genetic algorithms to construct intelligent agents and bots promises a bold new world in which computer programs can *mutate* and *breed* without any intervention by their human creators. Intelligent agents and bots can be designed to either help their human masters or cause problems. Already, some macro viruses can *mate* and *mutate* in the "wild," making them very hard to detect.
10.4 Expert systems

Learning objective

- Describe an expert system. (Level 2)

Required reading

- Chapter 11, pages 447-448

LEVEL 2

Expert systems can be applied to almost any human endeavour that requires expertise. They are a natural outgrowth of heuristics-based chess-playing programs in which the expertise of chess masters was incorporated into the programs. Computer scientists began to use the same technique in other areas of human knowledge that require expert knowledge, such as medicine, engineering, and law. In the field of medicine, expert systems using the diagnostic skills of physicians can be designed to analyze the symptoms of a patient and to diagnose medical problems.

Notice that expert systems are limited to narrow and specific disciplines. Unlike human beings, they do not possess general problem-solving capabilities and cannot tackle problems outside the specific expertise.

An expert system is made up of data and the software that manages the data. The data is stored in a knowledge base. The software is built especially for the expert system by knowledge engineers and experts in that field. Example 10.2 describes how an expert system designed to play chess defeated the world champion.

Example 10.2

IBM's Deep Blue upsets world's chess champion

On February 10, 1996, an IBM supercomputer equipped with an expert system defeated the world chess champion, Garry Kasparov, in the first game of a chess match using standard tournament rules. The IBM supercomputer named "Deep Blue" can consider a billion chess moves per second. Deep Blue was designed specifically to play chess using an expert system. In the 13th exchange of the first game, the expert system in Deep Blue made a move that stumped the world's reigning chess champion. The move of knight to B5 was completely off-the-wall and defied normal playing conventions. This move sealed the fate of the match; in 10 more exchanges, Deep Blue defeated Kasparov. However, Kasparov recovered from the first game setback and beat Deep Blue in game 2, drawing games 3 and 4, and defeating Deep Blue in games 5 and 6 in this first match.

A rematch between Kasparov and IBM's Deep Blue was scheduled in early May 1997. Kasparov opened with a first game victory. In the second game, Deep Blue stunned the audience and particularly the watching Grandmasters by playing a seamless strategic game and defeating Kasparov. The third, fourth, and fifth games were draws. By game 6, Kasparov was emotionally drained. In a shocking finale that lasted barely more than an hour, World Champion Garry Kasparov resigned 19 moves into game 6, handing a historic victory to Deep Blue. The win gave the IBM supercomputer a 3.5-2.5 victory in the six-game rematch. It is the first time a current world champion has lost a match to a computer opponent under tournament conditions. May 11, 1997 will be remembered as the day a computer won the world chess championship.

Q: What is the significance of this victory by Deep Blue?
Types of expert systems

There are actually several types of expert systems. Each type is used in different ways: 1

- **Intelligent assistants** are the simplest forms of expert systems that help users to analyze small but difficult problems. Typically, such systems relieve users from having to memorize a large amount of information required to solve the problem, thus enabling organizations to use less trained people to perform the work.

- **Expert support systems** are systems designed to provide interactive aids to experts. Unlike the intelligent assistant types of expert systems, expert support systems do not require all the relevant knowledge and rules in the system. Experts rely on these systems because of their reasoning skills and the wealth of knowledge they store. It is the human expert, however, who determines the problem-solving direction as well as carries knowledge not incorporated in the system. The human experts can both control and inspect an expert support system's problem-solving process.

- **Embedded expert systems** are embedded in conventional information systems. An example is intelligent business forms, where the expert system assists people in providing information to the system by filling out forms. In such a case, the expert system acts as the front-end to a conventional information system. This type of expert system is often used when the needed information is either voluminous or involves complex regulations or rules. Some water and waste treatment systems have been designed to help operators manage the treatment plant with expert systems embedded in the operational system. The embedded expert systems are designed to assist operators to deal with unusual circumstances that the operational system is not programmed to handle.

Characteristics of an expert system

The following are characteristics of an expert system:

- *Can explain their reasoning or suggested decisions.* Users can understand how and why a conclusion was reached.

- *Can display “intelligent” behaviour.* It proposes new ideas from the data.

- *Can draw conclusions from complex relationships.* This is the ability to evaluate relationships to solve problems.

- *Can provide portable knowledge.* When a human expert leaves an organization, the expert's knowledge and methods for problem solving are generally no longer available. An expert system can capture that expert's knowledge and approach to problem solving.

- *Can deal with uncertainty.* An expert system uses probability and heuristics to cope with incomplete data.

Limitations

Although expert systems have remarkable characteristics, other characteristics such as control, complexity, and cost limit their usefulness. The application of expert systems to accounting, auditing, and taxation has been slow in Canada. The major hurdle is the large amount of resources and time, not to mention expertise, required to construct an expert system. The following are some key limitations of expert systems:
- **Not widely used or tested.** There isn't much empirical data because few corporations actually use expert systems.

- **Difficult to use.** Some systems require technical or other expertise to use, which limits their usefulness to users such as decision makers.

- **Limited to relatively narrow problems.** The narrower the scope of the problem, the easier it is to design an expert system for it. Many expert systems are narrow in scope and are therefore not particularly useful to business management.

- **Cannot deal readily with “mixed” knowledge.** These systems are designed to work in certain ways, such as with defined rules or by comparison to cases, but have difficulty if data contains both rules and cases.

- **Possibility of error.** The main sources of potential errors are the knowledge bases of the human expert and programming by human beings.

- **Cannot refine own knowledge base.** First, the knowledge base has to be input by a programmer. Also, many systems are unable to refine their knowledge base for such inconsistencies as redundant or contradictory rules.

- **Difficult to maintain.** It is usually difficult to update expert systems as complex relationships change. Skilled programming is generally required.

- **High development costs.** Most expert systems are costly to develop. Expert system shells, which are software packages and tools designed to develop expert systems, can be used to help reduce the costs of development and maintenance. Nevertheless, the cost is still high.

- **Raise legal and ethical concerns.** There are both legal and ethical issues that are unresolved. An example is a doctor using an expert system to make a wrong diagnosis that harms the patient. On the legal side, there is the question of liability for damages. Who is liable - the doctor who used the system, the system developer, the human expert whose knowledge was used, the person who fed data to the system, the patient who perhaps did not disclose all pertinent facts, or the people who failed to make direct observations of the patient? And the ethical issue - whether a machine should be used as a substitute for a human being - is still a concern. Because of these issues, expert systems are often used as an assistant or advisor, with a human being making the actual decision. You might want to think about these issues in regard to the criminal justice system as well.

- **Lengthy development time.** It takes a long time to develop an expert system to handle complex problems and relationships, and to impart a complex human knowledge base to the system. While this development is going on, the real world is changing and new knowledge is being discovered.

- **Resource requirements.** Expert systems with a large knowledge base require a huge amount of storage space and computing capability. Investing in the expensive hardware needed to run an expert system may not be the best use of an organization's resources.

- **Risk.** It may be risky to rely solely on expert systems to make human choices, and a human expert is needed to evaluate its recommendations. Compared to the relative ease of communicating with human experts, it is difficult to establish “rapport” with an expert system, and thus difficult to assess the validity of its recommendations. It is also difficult and may even be impossible for an expert system to explain the logic of its recommendations. Indeed, expert systems that can explain their own reasoning are a leading area of research.

- **Lack of real intelligence.** Expert systems are not truly intelligent. They cannot learn new concepts by themselves. They cannot address problems that lack focus and careful definition.
10.5 Components of expert systems

Learning objective

- Describe the components of an expert system. (Level 2)

Required reading

- Chapter 11, pages 448-451

LEVEL 2

An expert system has five basic components:

- a knowledge base
- an inference engine
- an explanation facility
- a knowledge acquisition facility
- a user interface

Knowledge base

The knowledge base is unique in each application and goes far beyond the databases found in other systems. It stores relations, rules (such as “if-then-else” statements), and cases.

Purpose of a knowledge base. The overall purpose is to hold all relevant facts and information, similar to the sum of a human expert’s knowledge and experience.

Assembling human experts. This is not as easy as it sounds because the objective is to integrate the expertise of several human experts and experts often disagree on relationships or methods of solving problems. Developers therefore have problems in deciding which rules and relationships should be put into the knowledge base.

Use of fuzzy logic. Most computer systems need precise and specific data, where inputs are clear and decisions are yes/no or true/false, but in expert systems, relationships are not necessarily precise or exact.

Fuzzy logic was first invented by Lordi Zadeh at the University of California at Berkeley in 1965. Fuzzy logic is designed to simplify complex systems. It is ideally suited to control very complex systems that cannot be easily represented by “if-then” rules. Instead of assessing specific conditions or values, fuzzy logic processes the large number of variables into a small number of membership sets, called fuzzy sets. Example 10.3 illustrates a simple use of fuzzy logic.

Fuzzy logic is used in many products, such as autofocus cameras, photocopiers, washing machines, elevators, subway trains, and automobiles. It can also be used in many types of processing plants, database retrieval systems, and other operational systems. In addition, it can be paired up with other expert systems to assist in decision making by such systems.

Use of rules. A rule is a statement that links given conditions to actions or outcomes, as described in connection with decision tables and “if-then-else” statements. Most expert systems prevent users from entering contradictory rules.

Use of cases. Expert systems rely on finding problems or situations that are similar to the problem that needs
to be solved, and modifying them or adapting the solution. **Case-based reasoning (CBR)** draws inferences by comparing a current case with hundreds or thousands of past cases stored in the database. CBR is increasingly used in expert systems to make them more flexible.

**Inference engine**

The purpose of the inference engine is to search the knowledge base for appropriate information and relationships to provide solutions or answers as would a human expert. This is a complex task. The inference engine in the expert system shell uses either forward reasoning or backward reasoning to search the rules in the knowledge base to arrive at a conclusion.

- **Backward chaining** starts with the conclusion or end result and works backward to find facts that support that conclusion.
- **Forward chaining** starts with facts and comes to a conclusion.

Forward chaining reaches a conclusion faster than backward chaining, but entails more processing and sophistication. Some systems use **mixed chaining**, which is a combination of forward and backward chaining.

**Explanation facility**

The explanation facility tells the user how the conclusion was reached, and what facts and rules were used. Thus a professional user can evaluate the approach for its logic and correctness.

**Knowledge acquisition facility**

Creating, developing, and updating the knowledge bases have been a very time-consuming and expensive activity, using highly-experienced programmers. Today, this problem has been alleviated by the development of specialized software that allows users to create and update the knowledge base through the knowledge acquisition facility.

**User interface**

The user interface facilitates the development and use of an expert system by users through specialized user interface software, which is generally text-oriented.
10.6 Expert systems development

Learning objective

- Describe the steps for developing an expert system. (Level 2)

Required reading

- Chapter 11, pages 451-453

LEVEL 2

Expert systems have a process for development, as follows:

1. Determine requirements.
2. Identify experts.
3. Construct expert system components.
4. Implement the results.
5. Maintain and review the system.

The development process

The process is reasonably well defined, but finding the right people to form the development team can be difficult and costly, especially getting the expert.

Participants

The following are the key participants in developing an expert system:

Domain expert. Generally, this is a group that, for a specific area of knowledge, or domain, can fully understand the situation, how to solve problems in that field of expertise, and articulate/explain the thought processes and procedures to others. It is the expertise of the domain expert that must be captured by the system.

Knowledge engineer. The knowledge engineer has the skills to develop and maintain an expert system, including experience with expert system shells.

Knowledge users. The knowledge user is the individual or group who benefits from the system, and needs no previous training in computers or expert systems.

Tools and techniques

Although virtually any programming language could be used to develop an expert system, this is not the best way to do so. In the early stages, high-level languages were in fact used to develop expert systems, and special languages such as LISP and PROLOG were developed for AI applications. All these languages required highly skilled programmers. Starting in the 1990s, expert system products such as shells are being developed to allow non-programmers to develop expert systems.

Expert system shells and products

An expert system shell is a collection of software packages and tools used to design, develop, and maintain expert systems. Different shells exist for various sizes of systems, from PCs to mainframes.
Advantages of expert system shells and products

The newer shells and products have many advantages over the traditional methods, which are expensive and time-consuming:

- **Easy to develop and modify.** Updating in particular is simplified.

- **The use of satisficing.** Rather than find the best or optimal solution, a good (but not best) solution that satisfies the decision maker is found for much less time and cost.

- **The use of heuristics.** Heuristics can handle imprecise relationships and find reasonable solutions.

- **Development by knowledge engineers and users.** Rather than requiring the domain expert and users to communicate to analysts and programmers what the system should do and how, knowledge engineers and users can use system cells to do the development and maintenance with considerable savings of time and money.

Expert system development alternatives

Each expert system application is unique, so the choice between expert system shell versus expert system package needs to be evaluated by comparing the benefits with the cost, control, and complexity of each alternative.

- **In-house development: develop from scratch.** This approach generally costs more to develop and maintain and is often complex, but offers the most control and customization.

- **In-house development: develop from a shell.** The shell can be used for more than one system and is cheaper to develop and maintain, but it is not as customized and there is less control.

- **Off-the-shelf purchase: use existing packages.** This is undoubtedly the cheapest and fastest method, as well as easiest to maintain. The downside is that a package may not fit your organization's unique requirements.
10.7 Applications of ES and AI

Learning objective

- Explain the applications of artificial intelligence. (Level 2)

Required reading

- Chapter 11, pages 453-456

LEVEL 2

Capabilities of expert systems

Expert systems are particularly useful in the following areas:

- **Strategic goal setting.** Top decision makers can use expert systems to explore possible strategic goals.

- **Planning.** Expert systems assist decision makers to assess the impact of strategic goals and objectives.

- **Design.** Some expert systems have been developed to assist in designing new products.

- **Decision making.** Expert systems assist in possible alternatives and in approaches to decision making.

- **Quality control and monitoring.** There are several ways in which expert systems can help in both monitoring and suggesting solutions.

- **Diagnosis.** Diagnosis often results from monitoring, as an expert system analyzes the results of monitoring and suggests possible causes of problems.

When to use expert systems

Because of the cost to develop expert systems, it is important to ensure that the benefits are worth the expenditure. Expert systems are often used in the following circumstances:

- to achieve substantial cost savings or significantly reduce downside risk

- to capture and preserve irreplaceable human expertise

- to capture the knowledge of an expert and serve as an expert consultant in place of a real expert. If the expert system combines the expertise of several experts from one or more fields, it can be superior to a single human expert.

- to perform tasks that are complex and difficult for human operators to be able to perform consistently and accurately

- to perform more consistently than human experts, who can be affected by sickness, stress, or distracted by undesirable environmental conditions
to provide expertise in several locations

- to operate in environments or situations where the human operator's safety may be in jeopardy, and in hostile or hazardous environments in which human experts may not be able to work, such as in outer space, in deep ocean, or in nuclear plants
- to provide expert knowledge when experts are either hard to find or very expensive
- to make decisions in an extremely short timeframe or under extreme pressure, when expert knowledge is required to make the correct decision
- to provide expertise needed for training and development, and to share the knowledge and experience with a large number of people
- to make decisions that are infrequent yet extremely important. In such cases, expert systems can replace or assist the human decision maker who has not got enough practice to develop and retain expertise for that type of decision.
- to make rapid yet vital decisions. The decision must be made in a hurry, but the result of the decision affects human life, such as in emergency wards. Expert systems can be used to help people make better decisions.
- to be called on to perform around the clock tirelessly, unlike their human counterparts who need sleep, food, and breaks
- can be replicated quite inexpensively once an expert system is built

Applications of expert systems and artificial intelligence

Applications for EI and AI include the following:

- credit granting
- information management and retrieval: assist managers and decision makers
- games — for entertainment purposes
- legal profession — provide advice to lawyers based on case law
- embedded in products — used in many everyday appliances such as antilock brakes
- plant layout — provide best location for equipment and facilities; some use fuzzy logic
- hospitals and medical facilities — for a range of medical diagnosis
- help desks and assistance — provide customer support and free up staff
- employee performance evaluation — provide advice in reviews and career development
- loan analysis — determine appropriate amount of reserve funds
- virus detection — detects and eradicates "boot sector" viruses
- repair and maintenance — maintenance diagnostics
- shipping — find the best shipping route to save time and/or money
- marketing — extract and analyze information and write reports in findings
- warehouse optimization — inventory optimization

Applications of expert systems in business operations

Like all other applications of technology, the development of an expert system may be subject to cost-benefit analysis. The following lists some possible applications of expert systems along with various business operations, summarizing the potential benefits:

- manufacturing — optimize the development and packaging of manufactured goods
- forestry — optimize tree harvesting and log cutting
• tax planning — assist accountants in structuring clients' affairs to result in the lowest taxes

• maintenance — help field service representatives in diagnosing problems and repairing complex machinery or engines

• insurance and estate planning — assist insurance agents in tailoring insurance plans for clients, taking into account the clients' financial and estate planning needs

• specialized insurance — some types of insurance risks are quite complex and difficult to calculate, such as marine insurance, but an expert system can analyze multiple conditions to suggest rates for different types of ships, trips, and cargo

• portfolio management — assist investment advisors to optimize clients' investment portfolio, taking into account the clients' specific financial circumstances and level of risk tolerance

• credit checking and authorization — assist sales personnel in assessing the credit worthiness of customers to determine risks for credit authorization based on past history and similar credit cases

Example 10.4 illustrates how a credit card company uses an expert system to help conduct its credit approval process.

Example 10.4

American Express uses an expert system

Authorizer's Assistant (AA) is an expert system built by American Express (AMEX) to assist human credit authorizers in approving large purchases by a cardholder. The system is perhaps one of the best-known and most successful expert systems. AA helps AMEX to provide better service to customers by providing faster credit approvals. Because AMEX has no preset spending limits, it is difficult for its credit authorizers to determine the appropriate credit limit for a particular AMEX cardholder. When an AMEX cardholder makes a large purchase, the merchant phones up a credit authorization centre for authorization. With the assistance of AA, the credit authorizer searches several databases for information on the customer, including his spending and payment history. The expert system then makes a judgment call, using knowledge and heuristics provided by credit authorization experts, and suggests an appropriate action to take, all within seconds. AA not only enables AMEX to provide faster and more consistent service to merchants, it also saves AMEX huge amounts of money by avoiding bad judgment calls from inexperienced or tired credit authorizers.

This expert system incorporates the expertise of five top authorizers from American Express and contains hundreds of rules about credit authorization.

Q: If Authorizer's Assistant is so efficient, why does AMEX still use human credit authorizers? Why doesn't AMEX let merchants dial up AA directly, with AA making the credit-granting decision automatically?

Solution

Application of artificial intelligence to basic business systems

Artificial intelligence has many potential applications for business systems. For example, AI can be applied to stock trading systems, particularly for investors who use some form to chart the financials (called "technical analysis"), rather than analyzing the financials (called "fundamental analysis"). Most charting techniques (working with price trends) involve looking for a pattern to predict stock prices, and buy-and-sell decisions are made based on such predictions. This type of investment strategy lends itself to automated trading systems with built-in artificial intelligence.
The tax preparation software currently on the market (for example, CANTAX) has no built-in intelligence. It is, however, entirely possible to build expert systems that can guide the taxpayer through the maze of tax regulations. CCH Canadian Limited has been working at developing specific expert systems for tax planning purposes for some time. It is quite conceivable that a tax planner and preparation software with a built-in tax expert system will be available in the near future.

Inventory management is another example of a business information system that can benefit significantly from expert systems. Currently, inventory control systems are designed only to track inventory, with minimal capability to predict and manage inventory. It is possible that expert systems can be incorporated into inventory control systems so that they can predict inventory requirements months in advance, using information on sales activities, economic forecasts, and other relevant factors.

Accounting and audit firms are often asked to assess the risk of a firm that might become insolvent. Expert systems have been developed to analyze financial data, ratios trends, and performance measures, and to come to conclusions concerning potential insolvency. Similarly, expert systems can advise accountants on risks in specific strategies.

**Integrating expert systems**

Expert systems can be integrated with other systems such as a TPS, wherein the TPS collects and stores the data and an expert system performs analysis and decision-support functions.
10.8 Virtual reality

Learning objective

- Define “virtual reality” and provide examples of its applications. (Level 2)

Required reading

- Chapter 11, pages 457-461

LEVEL 2

A virtual reality system enables one or more users to move and react in a computer-simulated environment.

The term originally referred to immersive virtual reality, where the user is totally immersed in a three-dimensional world that is wholly generated by the computer along the lines of the holodeck in the Star Trek television series and movies. Through various interfaces, the user feels part of the simulated environment. The user can communicate with the computer and interact with the simulation.

Interface devices

An important aspect of feeling part of the simulation is seeing the environment, and several devices have been developed to do this. Perhaps most familiar to you is the head-mounted display (HMD) that has a screen for each eye and sensors to tell the computer where you are looking and how your head is moving. Users often found the HMD uncomfortable and awkward, so alternatives were developed, such as the BOOM (Binocular Omni-Orientation Monitor) and the CAVE, which is an actual room with stereo projections on the walls. The sense of hearing is simulated through the use of earphones. The sense of touch is conveyed through the haptic interface, via a glove and position trackers. This is still under development and difficult to simulate properly.

Immersive virtual reality

An immersive virtual reality system presents the simulated environment in full scale in proportion to the size of the user.

Other forms of virtual reality

Non-immersive forms of virtual reality can take a variety of forms, including mouse-controlled movement through graphics, views of real environments with superimposed virtual objects, and telepresence that captures a real world by video cameras and allow the user to manipulate objects in it.

Useful applications

There are many applications of virtual reality. They include the following fields:

- **Medicine.** Closed-chest heart surgery is an example of operations using tiny cameras and a computer that simulates the surgeon's movements. You may have seen operations using these techniques on television documentaries and news stories.

- **Education.** Simulation of real-world situations is an example of how virtual reality can be applied in the classrooms for educational and training purposes.
• **Real estate marketing.** Whether on the Web or on a computer, prospective buyers can walk through properties without leaving their homes, which saves them time and allows real estate firms to offer improved services to prospective clients.

• **Computer-generated images.** There are many examples of this in movies or in television documentaries. The technique is at least three decades old, but it has improved enormously over the years.
10.9 Other specialized systems

Learning objective

- Identify and describe other specialized systems. (Level 2)

Required reading

- Chapter 11, pages 461-462

LEVEL 2

Although the focus so far in this module has been primarily on AI, expert systems, and virtual reality, there are other specialized systems under development or are in use:

- **Radio frequency identification (RFID)** tags contain information about products.
- "**Smart containers**" use communications systems that enable containers to broadcast information about themselves, including their location.
- **Game theory** is used to develop competitive strategies.
- **Informatics** combines computer systems and technology with a traditional discipline such as medicine (bioinformatics).

The list of specialized systems will continue to grow.
10.10 Computer waste, mistakes, and security measures

Learning objective

- Describe waste and mistakes in the IS environment. (Level 1)

Required reading

- Chapter 14, pages 574-580

LEVEL 1

The basic principles of computer security are that: 1) there is often emphasis on physical security while invisible security is neglected, 2) the majority of breaches are committed by insiders unaffected by firewalls, and 3) expenditure on security should be based on the risk probability and the impact of a breach. You have already seen how computer systems are vulnerable to a variety of risks and the procedures to limit risk by prevention, detection, and recovery.

There are some social and ethical issues with respect to information systems, specifically:

- computer waste and mistakes
- computer crime
- privacy
- health concerns
- ethical issues
- patent and copyright violation

These issues should be recognized when reviewing existing systems and developing new ones, not only by the systems personnel but also by management. As a professional accountant, you will be expected to understand and address these issues, whether your role is that of a business analyst, key user, auditor, or the chief financial officer of a company. Many CGAs have the role of chief financial officer of small to medium-sized companies and are frequently expected to be responsible for computers and information systems.

Computer waste

There are two major areas of computer waste, and both can be substantial. The first is the rush to discard systems or components that have a value and/or a use. If a company takes the client/server approach, the thin clients require virtually no processing capacity. Many organizations upgrade everything rather than evaluating the cost-benefit for each unit or department, believing that it will save time and effort, or that it will reduce maintenance and support costs. By contrast, considerable savings can be achieved by buying second-hand equipment that is only a year old, as some smaller organizations are doing.

The second area of waste is the resources and time spent on activities and data that are not work-related (such as junk e-mail and excessive personal use). Even for work-related activities, resources and time can be saved if groups or public areas can be established on one or more servers, where documents that are relevant to particular groups or the whole organization are available for viewing only if and when needed.

Computer-related mistakes

There are many ways in which computer-related mistakes can occur, ranging from incorrect programming (and inadequate testing), to input errors that seriously affect outputs ("garbage in, garbage out" or GIGO), to simply not following proper procedures or taking simple precautions.
Preventing computer waste and mistakes

The key to preventing waste and mistakes is for management to establish and enforce effective policies, procedures, and standards. It is essential that everyone, from the top down, understand the importance of policies, procedures, and standards to cost-effective information systems development and operation, as well as the consequences, to themselves and to the organization, of failing to follow established policy and procedures.

Establishing policies and procedures

Prevention of waste begins with policies and procedures that cover the use and acquisition of equipment and systems, including formal justification for acquisition and enhancement, as well as the implementation of standards.

Prevention of mistakes begins with the identification of the most common types of errors.

Many suggested policies to eliminate waste and mistakes involve controls. One key policy is proper testing of programs and systems.

Policies and procedures must be fully documented. They include both overall corporate policies and procedures such as standards, formal project approvals, and specific procedures for particular applications.

Implementing policies and procedures

The key to successful implementation of policies and procedures lies in education and training. Everyone in an organization should be educated in regard to the use of computers and the related policies. This includes top management, who must be seen to support and promote these policies. Training of users must not be neglected or rushed in order to save money, because mistakes can cost much more than any savings in training. Specialized and intense training is often needed for key users of new applications and for users involved in the development of applications.

Monitoring policies and procedures

The purpose of monitoring policies and procedures is to ensure that procedures are comprehensive and are being followed. Two groups are often involved in this process - the IS department and the internal audit group. External audits routinely include activities that check whether policies and procedures exist and are being followed.

Reviewing policies and procedures

The company needs to ensure that policies and procedures are still relevant to the current and future information systems environment. Technology and systems are changing constantly, so procedures effective in the recent past may not be adequate for the direction the company is taking. Sometimes a detailed review is triggered by the results of monitoring. Sometimes it is triggered by outside events, such as an external crisis that stimulates a company to review its own policies and procedures or contingency plans. An example is the Sarbanes-Oxley Act, which is U.S. legislation that requires companies to establish certain IT practices.
10.11 Computer crime

Learning objective

- Describe the types and effects of computer crime. (Level 1)

Required reading

- Chapter 14, pages 580-591

LEVEL 1

You all know that computer crime exists, but you may not be aware of the extent to which it exists. Statistics are available, but since most breaches of security go undetected and companies are unwilling to admit the extent of financial losses, the statistics may be just the tip of the iceberg.

While some people may not be concerned about computer crime because it is non-violent, every one of us is paying for it, whether in higher insurance rates, bank fees, and increased costs of products and services. This is because the organizations that are the victims of computer crimes pass on their security costs and actual losses to their customers. Furthermore, if people are generally worried about the security of information they provide to companies over the Internet, it will have a serious effect on e-commerce. Notice that many computer crimes are directed at individuals.

Computer as a tool to commit crime

Credit card fraud, where a criminal uses stolen credit card numbers to access someone's line of credit, is on the increase. Social engineering is when the criminal talks someone into disclosing a password to access a personal or company system. Dumpster diving is another method where criminals go through garbage for information that will give them access or enough information to gain access to computers. Cyberterrorism is a growing concern for governments.

Identity fraud, where the criminal obtains enough information about you to obtain documents such as health cards and credit cards in your name but with someone else's signature and address, is increasing rapidly. The criminal then uses those documents to run up large accounts in your name or to cash cheques in your name and conduct fraudulent transactions, such as obtaining mortgage loans. All of these are charged to you and affect your credit rating. Identity fraud is easier now because so many transactions are online and handled using data without face-to-face interaction or identification.

The computer has facilitated the forgery of currency, causing governments (including the Canadian government) to develop bank notes with security features. Criminals may also use stolen information about you to obtain or forge documents such as passports for criminal activities.

Computer as an object of crime

Computers may be the objects of crime as opposed to the tools for committing it. The following describes some of these crimes.

Illegal access and use

Hackers are people who love technology and know a lot about computers. A criminal hacker (cracker) is someone who gains unauthorized or illegal access to computer systems and records, sometimes just for the challenge of doing it, and sometimes with criminal or malicious intent. These people are often hard to find and
prosecute, because they often use the Internet and cellular phones, or attack through a convoluted trail that crosses international borders. **Script kiddies** are people who want to be hackers but lack the technical ability, so they simply download programs (scripts) that enable them to break into systems. **Insiders** are employees who, for whatever reason, work to compromise corporate systems. A major problem in all computer systems is that programmers love to include a code that is not in the requirements. Sometimes it is just a message that lets people know who they are, but sometimes it is a "back door" to the system that allows them access in a manner that overrides security.

**Data alteration and destruction**

Data and information are valuable assets. Destruction of data can cost a company dearly. Alteration of data can have worse consequences than the destruction of data. If a company knows that data has been destroyed or lost, it can take appropriate actions. If a company operates with altered data, it can lose customers, operate incorrectly or illegally, and even go bankrupt.

**Malware**

**Malware** is software deliberately designed to attack other programs and files in computers. A **virus** attaches itself to files and has a built-in mechanism to reproduce itself. A **worm** replicates itself but does not infect other computer files. Some viruses, just like their biological namesakes, can mutate and change their form and behaviour, making them even more difficult to detect.

A virus can be *benign* (only playing practical jokes on the host machine) or *malignant* (destroying data and files). Certain viruses alter applications so that they no longer work, or work in totally unexpected ways. For example, when the "Alabama" virus infects a computer, it executes the DISKCOPY command, causing the hard disk to be formatted and destroying all existing data.

A virus does not always destroy its host machine immediately after entering it. Typically, a virus would use the host machine as a springboard to infect other machines through jump drives, or through telecommunications connections to other machines. Some viruses would destroy the host machine only after they have replicated themselves, or when a specific condition is met. Some viruses never destroy their host machine; instead, they play havoc on the machine's operations.

Malware that attacks computers can be categorized into seven groups (and are generally known as viruses even when they are technically not viruses):

- application viruses/file infectors
- system viruses/boot sector infectors
- macro viruses
- stealth viruses
- worms
- Trojan horses
- logic bombs

**Antivirus programs**

Antivirus programs have been developed for most operating systems and range in price from no charge freeware to several hundred dollars. While viruses are being created faster than the antivirus software can be updated, the incorporation of "nature-based code" that looks for unusual computer code in programs may overcome this problem in future antivirus programs.

**Information and equipment theft**

Data and information have value to the organization, but may also be valuable to others, and thus may be stolen. To steal information by copying or downloading it, criminals need access and passwords. **Password sniffers** are small programs hidden in a computer system that records identification numbers and passwords. **Keystroke loggers** are another means of stealing passwords or other user-entered data. These come in the
form of software or hardware and are programmed to send a list of keystrokes typed by a user to a malicious person at defined times or after a certain number of keystrokes.

Equipment is an asset that is frequently stolen. There are many cases of laptops stolen out of cars or elsewhere. More serious to a company than the loss of the equipment is the loss of the information and programs on the computer.

**Software and Internet piracy**

Software piracy is the illegal copying of software programs. Internet piracy is a growing concern. It takes many forms, including access to data without paying for it by using someone else's password with or without their permission, and sending an applet to a user's machine and using it. This is called **MIPs-sucking**.

**Computer-related scams**

Many computer scams have been around for decades, but the computer and Internet have enabled swindlers to reach huge numbers of people quickly and cheaply. Some scams are pure fraud but most play on the greed of the mark (victim). Example 10.5 illustrates such a scam.

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**Example 10.5**

**The Nigerian Advanced Fee Scam**

This scam has been around for many years, with different variations. In one version, the owner or CEO of a small to medium-sized business receives an e-mail or fax purporting to come from an official in an African country, who represents a group that needs to get illegal profits or bribes related to government purchases out of the country. The business owner is recommended as trustworthy and probably interested in assisting in the scheme by an associate who does not want to be identified. The monies to be transferred are substantial. In the case received by this course author, it was US$21 million. In return for helping the African official, the business owner is entitled to keep 30% of the money. All he has to do is to use one of his company's existing accounts or open a new bank account in his own name or the name of the business, then provide the account number and identification number to the sender of the fax/e-mail with a means of identification, and the US$21 million would be transferred to him within a few days. If there are any questions, a telephone number and an e-mail address (in this case, in the United States) where his representative could be contacted are provided.

Q: Why is this scam successful? What is the purpose of the scam?

**Solution**

There are often secondary objectives of this type of scam. For example, the information could be used to access other accounts of the business or person and remove funds. In one variation of the scheme, the criminals persuade the businessperson to put up some funds purportedly to speed up the transaction or to bribe other officials or a third party as a sign of good faith. If a greedy person sees an opportunity to get $6 million, a few thousand dollars don't seem like much. Still another variation tells the victim that the scheme has been discovered and the government is going to prosecute the victim, but someone can be bribed to forget about it if the victim sends money.

Q: Has anyone fallen for this scam?

**Solution**

In a case such as this, the best action to take in Canada is to take the document received to your local police station, who can connect to the Fraud Squad and both national and international police forces.
Other scams may not be so obvious. Most of the tips to help you avoid becoming a victim are just common sense, and they apply to materials received through the mail or by telephone, as well as via e-mail and computer sources. The National Fraud Information Center provides information on online solicitation or for reporting a scam. In Canada, you can check with your local police and the Better Business Bureau.
10.12 Preventing computer crime

Learning objective

- Describe options for preventing computer crime and its effects. (Level 1)

Required reading

- Chapter 14, pages 591-604  
  (Note: Pages 597-604 previously assigned in Topic 1.11)

LEVEL 1

The rules of safe computing

The following are some rules of safe computing:

1. **Install a virus scanner and run it often.** Many programs scan your system whenever you boot up, and many have other features. Use antivirus software to test all software before installing it on your machine, particularly those downloaded via the Internet. However, commercial software purchased in original packaging should also be tested because there have been cases where well-known software manufacturers have inadvertently included viruses in their commercial packages. Always use antivirus software to scan e-mail attachments before opening the attachment. If the document should not contain any macros, when asked if you want to allow macros to be executed from within such a document, always select No.

2. **Update the virus scanner often.** New viruses are created constantly, at the rate of more than 500 a month, and antivirus software developers constantly add protection to their programs. You can usually update from the Internet. Where possible, use the memory-resident protection offered by these programs to guard your computer at all times.

3. **Scan all data jump drives or CDs before copying or running programs from them.** It is safer to operate from the temporary storage devices rather than copying the files to your hard disk if the files are not often used.

4. **Install software only from a sealed package or a secure website of a known software company.** Do not install software that has been opened. Never accept any software from resellers or vendors that is not in its original shrink-wrapped packaging. Never accept free software from a bulletin board operated by an unknown source.

5. **Follow careful downloading practices.** If you download software, check your system for viruses immediately after the transmission.

6. **If you detect a virus, take immediate action.** Most antivirus software asks what you want to do when they discover a virus. You can simply delete the file, or you may wish to have the software attempt to clean it (remove the virus). Do so immediately, and you may be able to prevent damage to your system or files.

7. **Do not open e-mail from an unknown source, or an attachment, unless you know what it is.** Many viruses spread via e-mail.

8. **Back up your files regularly on CDs or DVDs.** Perform virus scanning prior to backing up to ensure
that the back-up copies are virus-free.

9. Protect your computer from unauthorized use by means of power-on passwords or other forms of security systems. Do not let anyone use your computer unsupervised. Do not allow your friends to load programs or data onto your machine. Do this yourself, after confirming that the programs are virus-free.

**Pitfalls of antivirus software**

Two serious problems with antivirus software are false alarms and a false sense of security.

**False alarms**

Antivirus software may signal a probable virus attack from the normal activities of legitimate application programs. This is particularly true if the memory-resident portion of the antivirus software is loaded and active. Attempts by the computer system to write to the boot sector or partition table of the hard disk will be reported as a probable virus attack.

**False sense of security**

All antivirus software programs are equipped to detect specific virus signatures. Therefore, it is possible that a machine is reported to be clean when a new virus not recognized by the antivirus software has in fact attacked it. Therefore, antivirus software does not provide complete protection against virus attacks. Your best defence is to keep the antivirus software current. Antivirus software should not be used as the only defence against viruses. To prevent virus attacks on your computers, you must practise safe computing.

**Preventing computer-related crime**

Computer crime is on the increase and the impact is growing. Government agencies, corporations, businesses, and individuals are aware of this and have been making individual and group efforts to prevent or limit computer crime.

**Crime prevention by governments**

The efforts of federal and state governments in the United States to pass legislation and prosecute computer criminals is on-going. Canada lags behind the United States, so many computer criminals base operations in Canada for that reason. For example, because stock, vacation, lottery, and other scams can be conducted from a simple room with telephones, computers, and cellular phones, which can be moved at short notice, it is difficult to locate the criminals. Also in Canada, obtaining a search warrant is not as easy as it is in the United States, so by the time enough evidence is gathered to obtain a warrant, the operation has moved.

**Crime prevention by corporations**

Corporations are concerned about computer crime, and most are taking measures to protect themselves. The key to protection is to prevent access by unauthorized users. The trend is towards biometrics, using fingerprints and face recognition, which are cost-effective approaches.

The prevention efforts will be more effective when the corporation recognizes how computer crimes are committed.

Corporations face the continuing dilemma of wanting clients, suppliers, and other business associates to be able to interact with their computer systems easily so as to be more cost effective, while at the same time making the system difficult or impossible to access by criminals. One approach is to have separate servers that contain data for access by users outside the organization, so that outside access is limited to certain types of information. Some organizations have separate servers for e-mail because this is a common entry route for criminals and viruses.
Intrusion detection software (IDS)

By monitoring networks, IDS can provide a valuable warning to IS personnel, but it can also trigger false alarms.

Managed security service providers (MSSPs)

MSSPs offer a method for small and medium-sized organizations. By outsourcing network security, these organizations can acquire the security expertise that they do not have.

Internet laws for libel and protection of decency

There is very little legislation anywhere specifically aimed at the Internet with respect to libel and indecency. The laws of libel and indecency are far from standard, and one of the problems is that material is available on the Internet from sources that may be legal in their own countries. The ISP and communication software developers are usually not legally responsible for material that is accessed by their users. In Canada, a distributor of pornographic material can be prosecuted, but it is difficult to prosecute a person successfully for the possession of such material, even child pornography. See Example 10.6 for a related case.

Parents can protect their children with software that filters what information a child can receive, or even send, especially to chat rooms, which are a valuable source of information for predators.

Security issues

In the name of security, much is done that raises controversial issues. For example, for some years, England has large listening stations that use satellites to monitor all voice and data transmissions. Computers screen the data collected for key words such as "bomb" and others that are unknown to us. The data is turned over to U.S. intelligence agencies. A congressional committee is still studying the question of balancing an individual's right to privacy against national security. Obviously, after September 11, 2001, national security became paramount, but the monitoring activities did not prevent the attack.

The movement of data and computers into the United States with its high security measures raises privacy issues for Canadians. U.S. Customs officers are allowed to search and confiscate laptops and other storage devices. Whether or not this is an effective way of improving national security is open to discussion, but it does present problems for Canadian professionals including lawyers, physicians, and accountants who have confidential client or patient information on their laptops or storage devices when they enter the U.S. A further problem arises with respect to the transfer of confidential Canadian data such as health records to the U.S., or the storage of such data in the U.S. Questions have also been raised about whether U.S. computer subsidiaries working in Canada are subject to U.S. law. The U.S. Patriot Act makes it a crime for the U.S. recipient of such data to report to clients that U.S. law enforcement agencies have accessed these records. This means that Canadians whose confidentiality was compromised by U.S. authorities would not know that their private data have been accessed or would not be able to challenge this in the courts.

Privacy issues

E-mail usage raises many questions about privacy, whether at home or at work. The key point to remember about using an employer's e-mail is that any data belong to the company and the employee should have no expectation of privacy. There are many privacy issues concerning the use of the Internet and steps that you can take to protect your own privacy.
10.13 Health and environment issues

Learning objective

- List the effects of computers on the work environment, and identify actions to ensure the health and safety of employees. (Level 2)

Required reading

- Chapter 14, pages 604-606

LEVEL 2

The work environment

Technology and process reengineering have created stress in the workforce but these technological changes have created new positions and opportunities as well. The speed of technological change has put tremendous pressure on employees to continue learning and training. Employees cannot be expected to do their normal workload and learn new technology within office hours. A number of solutions are being considered to solve this dilemma. Some employers pay for professional training on employees’ own time or offer employees sabbatical leave at reduced salary to enable them to upgrade their skills. Some employees even spend their own time and money to upgrade their skills. Workers who are unwilling or unable to continue to learn may soon lose their jobs to better-qualified workers.

Union organizations, which traditionally were able to provide some protection to employees, will gradually find that they are powerless to protect their members if the choice is between the survival of the company or employment benefits to employees. In the past few years, in both Canada and the United States, many unions have agreed to concessions in order to ensure the survival of the companies and thus protect the jobs of their members.

Canada faces a special people challenge with knowledge workers. Because of the significantly higher level of personal income tax, combined with fewer opportunities and lower compensation, Canada has been losing many of its high-calibre knowledge workers, such as computer scientists, IS professionals, doctors, surgeons, accountants, and other knowledge workers to the United States. Out of 100 new computing science graduates from a typical Canadian university, the majority will move to the United States within five years of their graduation. Universities themselves are not exempt from this problem. Increasingly, Canadian universities are finding it more difficult to attract the calibre of professors they need.

Health concerns

Mental stress resulting from new technology is common, but there are physical problems as well. The most common problems are repetitive motion disorder or repetitive stress injury (RSI), and carpal tunnel syndrome (CTS).

Avoiding health and environmental problems

The need to design equipment that minimizes health problems gave rise to ergonomics. Good posture is the key to avoiding RSI and CTS. Corporations and individuals can use special medical software for computers. You can also go to the Internet for medical information, but make sure that the site is professional and valid.
10.14 Ethical issues

Learning objective

- Identify ethical issues and describe codes of ethics related to computer systems. (Level 1)

Required reading

- Chapter 14, pages 606-607

LEVEL 1

There are codes of ethics for the Association of Information Technology Professionals (A/TP), formerly known as the Data Processing Management Association (DPMA), and for the professional responsibilities developed by the Association for Computing Machinery (ACM). These and other codes of ethical behaviours, including your CGA professional code, are moral codes that you, as a professional, follow. They are not legal codes, which are made by legislators and judges. One may act legally (within the law) but not necessarily morally (according to a code of ethics).

While technology may seem overwhelming, do not be discouraged. After all, people are the most important component of a computer-based information system.
Module 10 summary

Knowledge management, artificial intelligence, and information systems issues

Information systems and their applications in business are being increasingly affected by developments in the area of knowledge management and artificial intelligence. In this module, you study the various types of artificial intelligence systems and how they are designed. You also learn about the various applications of artificial intelligence in real-world situations.

The module concludes with issues and solutions related to the use of computers, including waste, mistakes, crime, the work environment, and ethics.

Define knowledge management, artificial intelligence, and the characteristics of intelligent behaviour, and compare the performance of natural and artificial intelligence systems for each of the characteristics defined.

- A knowledge management system (KMS) is an organized collection of people, procedures, software, databases, and devices used to create, store, share, and use the organization’s knowledge and experience. A KMS can involve explicit and tacit knowledge.

- Artificial intelligence is the study and creation of machines that exhibit humanlike qualities, including the ability to reason.

- Some of the characteristics of human intelligence are
  - learn from experience
  - handle complex situations
  - use heuristics

- The Turing test is a test devised by Alan Turing to determine how well a computer emulates human intelligence.

List the major branches of artificial intelligence.

- Artificial intelligence can be classified into
  - expert systems
  - robotics
  - vision systems (perceptive systems)
  - natural language processing
  - learning systems
  - neural networks
  - genetic algorithms

Describe the potential uses of intelligent agents.

- An intelligent agent is a set of software programs that works in the background to automate specific, repetitive, and predictable tasks.

- Intelligent agents are commonly used on the Internet for searching or for handling undelivered mail.
A group of intelligent agents are called “web bots.” They are of different types, including search bots, mail bots, chatter bots, and spam bots.

Describe an expert system.

- An expert system is a software application that seeks to capture expertise in limited domains of knowledge and experience and to apply this expertise to solving problems. Expert systems are limited to narrow and specific disciplines.

- Some limitations of ES include the following:
  - The space required to store a large knowledge base may be too costly.
  - It is risky to rely solely on expert systems to make choices.
  - Expert systems can only solve problems that have rules already defining the solutions. They cannot learn new concepts by themselves.
  - Difficult legal and ethical issues exist when using expert systems to suggest solutions such as medical diagnoses. In many situations, a human operator must make the final decision.

Describe the components of an expert system.

- Components of an expert system are:
  - a knowledge base consisting of rules, semantic nets, or frames
  - an inference engine, which is an explanation facility that tells the user how the conclusion was reached, and what facts and rules were used
  - a development team consisting of experts who have the expertise to solve the problem, and knowledge engineers who translate this expertise into the knowledge base
  - an AI shell, which is the programming environment of an expert system. The shell often has an inference engine that uses a forward reasoning strategy or a backward reasoning strategy to search through the rule base in an expert system.
  - the user interface that facilitates the development and use of an expert system by users through specialized user interface software, which is generally text-oriented
  - a knowledge acquisition facility that allows users to create and update the knowledge base

Describe the steps for developing an expert system.

- The expert systems development process is as follows:
  1. Determine requirements.
  2. Identify experts.
  3. Construct expert system components.
  4. Implement the results.
  5. Maintain and review the system.

Explain the applications of artificial intelligence.

- AI can be applied to stock trading systems, particularly for investors who chart the financials (called “technical analysis”), rather than analyzing the financials (called “fundamental analysis”). Most charting techniques involve looking for a pattern to predict stock prices, and buy-and-sell decisions are made based on such predictions. This type of investment strategy lends itself to automated trading systems with built-in artificial intelligence.

- It is possible to build expert systems that can guide the taxpayer through the maze of tax regulations.

- Inventory management is another example of a business information system that can benefit
significantly from expert systems.

- Expert systems have been developed to analyze financial data, ratio trends, and performance measures, and to come to conclusions concerning potential insolvency.

**Define the term virtual reality and provide examples of its applications.**

- A virtual reality system enables one or more users to move and react in a computer-simulated environment.

- An important aspect of feeling part of the simulation is seeing the environment, and several devices have been developed to do this.

- There are many applications of virtual reality, including the following fields:
  - medicine
  - real estate
  - computer-generated images
  - education

**Identify and describe other specialized systems.**

Other specialized systems under development or in use:

- Radio frequency identification (RFID) tags contain information about products.

- "Smart containers" use communications systems that enable containers to broadcast information about themselves, including their location.

- Game theory is used to develop competitive strategies.

- Informatics combines computer systems and technology with a traditional discipline such as medicine (bioinformatics).

**Describe waste and mistakes in the IS environment.**

- Two major areas of computer waste are
  - the rush to discard systems or components that have a value and/or a use
  - the waste of resources and time on activities and data that are not work-related (such as junk e-mail and excessive personal use)

- Ways in which computer-related mistakes can occur are
  - incorrect programming (and inadequate testing)
  - input errors that can have a serious effect on outputs ("garbage in, garbage out" or GIGO)
  - not following proper procedures or taking simple precautions

- The key to preventing waste and mistakes is for management to insist on establishing and using effective policies, procedures, and standards.

**Describe the types and effects of computer crime.**

- Computer systems are vulnerable in many ways, including
  - software failure
  - hardware malfunction
  - telecommunications blackout
  - user errors
vandalism
- computer virus attacks
- unauthorized tampering
- theft of information and equipment
- hackers and computer viruses, which are growing threats to IS because of the upsurge in networked computing

- Computer systems can be used to commit crime, particularly with the advent of the Internet. This causes people to lose confidence in computer systems. Some types of crime are
  - scams
  - credit card fraud
  - identity fraud or theft
  - currency forgery

- International crime is an increasing problem, especially since laws differ from country to country. There is very little legislation anywhere specifically aimed at the Internet. The laws of libel and indecency are far from standard, and material is available on the Internet from sources that may be legal in their own countries. The ISP and communication software developers are usually not legally responsible for material that is accessed by their users.

**Systems viruses**

- Computer viruses can be classified as file infectors, boot sector infectors, Trojan horses, stealth viruses, macro viruses, and worms.

- Having an antivirus software does not provide absolute security. New viruses introduced may not be detected by older antivirus software. The best safeguard is to update antivirus software continuously and to practise safe computing.

- Software errors and data that are inaccurate, outdated, or incomplete are major causes of malfunctions in IS.

**Describe options for preventing computer crime and its effects.**

Options for preventing computer crime:

- Establish policies and procedures
- Implement policies and procedures
- Review policies and procedures
- Acquire and update virus protection
- Implement and monitor security measures and policies
- Follow the rules for safe computing
- Prevention by governments
- Prevention by corporations
- Intrusion detection software
- Managed security service providers
- Internet laws
- Privacy issues

**List the effects of computers on the work environment, and identify actions to ensure the health and safety of employees.**

- Technology and process reengineering has created stress in the work force. Employees have to learn new technology, often during office hours.

- Physical problems resulting from technology include
  - repetitive motion disorder or repetitive stress injury (RSI)
- carpal tunnel syndrome (CTS)

- The need to design equipment that minimizes health problems gave rise to ergonomics.

**Identify ethical issues and describe codes of ethics related to computer systems.**

- Ethical issues deal with what is generally considered right or wrong.

- IS professionals have more job satisfaction when top management enforces ethical behaviour.

- IS organizations with codes of ethics include
  - The Association of Information Technology Professionals (AITP)
  - The Association for Computing Machinery (ACM)
  - CGA-Canada's *Code of Ethical Principles and Rules of Conduct*
Solution 1

A learning system is a combination of hardware and software that allows the computer to change how it functions or reacts to situations based on the feedback it receives. A learning system could be used in strategic planning for an organization. It could also be used to learn and become competitive in chess matches.
The basic components of an expert system are:

- **Explanation facility** - provides a description of knowledge extracted for end-user.
- **Knowledge base** - stored repository of relevant facts and information.
- **Inference engine** - software that extracts knowledge based on user criteria.
- **Knowledge base acquisition facility** - software that allows addition of knowledge to expert systems.
- **User interface** - provides access to expert system for end-user.
- Sometimes the expert (source of knowledge) and users (destination of knowledge) are also considered parts of the expert system.
Solution 3

a. An expert system uses a knowledge base and an inference engine to reach conclusions. A neural network uses a network of processors that can be trained with old data to reach similar conclusions when confronted with new data.

b. The marketing database problem involved very imprecise decision rules, which would have been difficult to capture in a knowledge base. The sales problem involved more definable rules, and thus was much easier to model with a knowledge base. Also, fast response time is important for the sales problem.

c. Neural network systems could be used with any problems in which decisions are difficult to formulate precisely but for which old data with definite decision patterns are available.
Fuzzy logic is an AI-like technology that allows computer systems to capture and represent inexact knowledge and relationships. Unlike binary logic used in many computer-based decisions, fuzzy logic relies on the use of "shades of gray" or fuzzy sets which represent answers and possible answers in probabilistic terms. This allows computers to use rules of thumb (heuristics) to evaluate imperfect or incomplete sets of data and still arrive at reasonable answers.
**Solution 5**

The haptic interface is the least developed one. It relays the sense of touch and other physical sensations in the virtual world. Currently it uses a glove and tracker to allow the user to insert their hand into the virtual world and handle objects. It is a difficult interface because of the range of sensations and movement that are possible by a human. Potentially every nerve on a body would need to be "wired" to the system for true virtual immersion.
Solution 6

A virus is a program that attaches itself to other programs. It will often destroy software or data, interrupt processing, or damage computing applications. Worms are independent programs that will replicate until they destroy other systems and programs or interrupt the operation of networks and computer systems.
Solution 7

Ergonomics is the science of designing machines, products, and systems to maximize the safety, comfort, and efficiency of the people who use them. Ergonomics is applied to office workers through the use and positioning of the equipment and the workers' bodies, such as feet should be flat on the ground with keyboard positioned at elbow height.
Example 10.1

A neural network to evaluate credit applications

Suppose you want to design a neural network to evaluate bank customers' credit applications. In the simplest form, such a neural network would have several neurons, each representing one of the criteria required to distinguish good credit risks from bad ones. For example, the good neurons might be high salary, home ownership, married, and working spouse, while the bad neurons might be prior bankruptcy, divorced, less than one year in current job, and renting with frequent moves.

An example of a good credit risk with ratings on each of the criteria is fed to the system. The neurons all have an equal vote (the system is being taught). The correct result is fed into the system, and the system learns to suppress the votes from the bad neurons and increase the votes from the good neurons. An example of a bad credit risk with the correct result is fed into the system, and the system learns to suppress the votes from the good neurons and increase the votes from the bad neurons in this case. Through many examples, the neural network learns to correctly deal with each credit application.

Actual neural networks are much more complex than the simple neural network just described, but the underlying construct is basically the same.
Deep Blue's victory proved that it is possible to design expert systems that can be as good as or better than human experts. No human endeavour is exempted from competition by computer systems. If an expert system can be designed to beat a human champion, surely it is possible to design expert systems that can dispense expert tax advice or medical opinion.
Example 10.3

Fuzzy logic controls room temperature

Traditional systems require a specific definition or value for a characteristic. For example, 5° Celsius is cold but 20° is warm and 30° is hot. Think of a thermostat used to control room temperature. If the thermostat is set to 20°, the heater would kick in at about 18° and kick out at about 22° if it is controlled by a traditional system, resulting in room temperatures that are overly hot or cold.

Fuzzy logic, on the other hand, can keep the room at a more constant temperature. For a fuzzy logic system, each temperature setting is a member of four fuzzy sets of temperature - cold, cool, warm, or hot. The 20° setting, for example, could be assigned a 50% membership in the cool set and a 20% membership in the warm set, with 0% in the cold and hot sets. The fan speed and the size of furnace fire are controlled by these membership percentages. Thus, for a temperature of 20°, the fan speed may result in 44 rpm at a low fire. When the temperature in the room changes, the membership percentages also change, resulting in small adjustments to the size of the fire and fan speed. The result is a more constant room temperature.
Although the expert system may contain numerous rules about credit authorization, it cannot anticipate every situation. Thus, if the expert system encounters a credit inquiry that cannot be solved using the knowledge base, the result may be inappropriate. Human operators are needed to ensure that the recommendations from the expert system are appropriate under the circumstances. Indeed, the AA system permits human credit authorizers to override the expert system's recommendation if it does not seem logical in the particular situation.