CHAPTER 7

Specialized Information Systems:
Artificial Intelligence, Expert Systems, Virtual Reality, and Other Systems

Fundamentals of Information Systems
Third Edition
Principles and Learning Objectives

• Artificial intelligence systems form a broad and diverse set of systems that can replicate human decision making for certain types of well-defined problems.
  – Define the term *artificial intelligence* and state the objective of developing artificial intelligence systems.
  – List the characteristics of intelligent behavior and compare the performance of natural and artificial intelligence systems for each of these characteristics.
  – Identify the major components of the artificial intelligence field and provide one example of each type of system.
Principles and Learning Objectives (continued)

• Expert systems can enable a novice to perform at the level of an expert but must be developed and maintained very carefully.
  – List the characteristics and basic components of expert systems.
  – Identify at least three factors to consider in evaluating the development of an expert system.
  – Outline and briefly explain the steps for developing an expert system.
  – Identify the benefits associated with the use of expert systems.
Principles and Learning Objectives (continued)

• Virtual reality systems have the potential to reshape the interface between people and information technology by offering new ways to communicate information, visualize processes, and express ideas creatively.
  – Define the term *virtual reality* and provide three examples of virtual reality applications.
Principles and Learning Objectives (continued)

• Specialized systems can help organizations and individuals achieve their goals.
  – Discuss examples of specialized systems for organizational and individual use.
An Overview of Artificial Intelligence

- **Artificial intelligence (AI):** the ability of computers to mimic or duplicate the functions of the human brain
- **Artificial intelligence systems:** the people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that demonstrate the characteristics of intelligence
The Nature of Intelligence

- Learn from experiences and apply knowledge acquired from experience
- Handle complex situations
- Solve problems when important information is missing
- Determine what is important
- React quickly and correctly to a new situation
The Nature of Intelligence (continued)

- Understand visual images
- Process and manipulate symbols
- Be creative and imaginative
- Use heuristics
### The Difference Between Natural and Artificial Intelligence

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Natural Intelligence (Human)</th>
<th>Artificial Intelligence (Machine)</th>
</tr>
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<tbody>
<tr>
<td>The ability to use sensors (eyes, ears, touch, smell)</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>The ability to be creative and imaginative</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>The ability to learn from experience</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>The ability to be adaptive</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>The ability to afford the cost of acquiring intelligence</td>
<td>High</td>
<td>Low</td>
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<tr>
<td>The ability to use a variety of information sources</td>
<td>High</td>
<td>High</td>
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<tr>
<td>The ability to acquire a large amount of external information</td>
<td>High</td>
<td>High</td>
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<tr>
<td>The ability to make complex calculations</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>The ability to transfer information</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>The ability to make a series of calculations rapidly and accurately</td>
<td>Low</td>
<td>High</td>
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Table 7.1: A Comparison of Natural and Artificial Intelligence
The Major Branches of Artificial Intelligence

Figure 7.1: A Conceptual Model of Artificial Intelligence
Expert Systems

• Hardware and software that stores knowledge and makes inferences, similar to a human expert
• Used in many business applications
Robotics

- Mechanical or computer devices that perform tasks that either require a high degree of precision or are tedious or hazardous for humans
- Contemporary robotics combines high-precision machine capabilities with sophisticated controlling software
- Many applications of robotics exist today
- Research into robots is continuing
Robots can be used in situations that are hazardous or inaccessible to humans. The Rover was a remote-controlled robot used by NASA to explore the surface of Mars.
Vision Systems

• The hardware and software that permit computers to capture, store, and manipulate visual images and pictures
• Used by the U.S. Justice Department to perform fingerprint analysis
• Used for identifying people based on facial features
Natural Language Processing

• Processing that allows the computer to understand and react to statements and commands made in a “natural” language, such as English

• Three levels of voice recognition
  – Command: recognition of dozens to hundreds of words
  – Discrete: recognition of dictated speech with pauses between words
  – Continuous: recognition of natural speech
Dragon Systems’ Naturally Speaking 7 Essentials uses continuous voice recognition, or natural speech, allowing the user to speak to the computer at a normal pace without pausing between words. The spoken words are transcribed immediately onto the computer screen.
Learning Systems

- A combination of software and hardware that allows the computer to change how it functions or reacts to situations based on feedback it receives.
- Learning systems software requires feedback on the results of actions or decisions.
- Feedback is used to alter what the system will do in the future.
Neural Networks

• A computer system that can simulate the functioning of a human brain
• The ability to retrieve information even if some of the neural nodes fail
• Fast modification of stored data as a result of new information
• The ability to discover relationships and trends in large databases
• The ability to solve complex problems for which all the information is not present
Other Artificial Intelligence Applications

- **Genetic algorithm:** an approach to solving large, complex problems in which a number of related operations or models change and evolve until the best one emerges
- **Intelligent agent:** programs and a knowledge base used to perform a specific task for a person, a process, or another program

- Can explain its reasoning or suggested decisions
- Can display “intelligent” behavior
- Can draw conclusions from complex relationships
- Can provide portable knowledge
- Can deal with uncertainty
Characteristics and Limitations of an Expert System (continued)

- Not widely used or tested
- Difficult to use
- Limited to relatively narrow problems
- Cannot readily deal with “mixed” knowledge
- Possibility of error
Characteristics and Limitations of an Expert System (continued)

- Cannot refine its own knowledge
- Difficult to maintain
- May have high development costs
- Raises legal and ethical concerns
When to Use Expert Systems

• Provide a high potential payoff or significantly reduce downside risk
• Capture and preserve irreplaceable human expertise
• Solve a problem that is not easily solved using traditional programming techniques
• Develop a system more consistent than human experts
When to Use Expert Systems (continued)

• Provide expertise needed at a number of locations at the same time or in a hostile environment that is dangerous to human health
• Provide expertise that is expensive or rare
• Develop a solution faster than human experts can
• Provide expertise needed for training and development to share the wisdom and experience of human experts with a large number of people
Components of Expert Systems

Figure 7.2: Components of an Expert System
The Knowledge Base

- Stores all relevant information, data, rules, cases, and relationships used by the expert system
- Assembling human experts
- Use of fuzzy logic
- Use of rules
- Use of cases
The Inference Engine

- Seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions the way a human expert would
- Backward chaining
- Forward chaining
- Comparison of backward and forward chaining
The Inference Engine (continued)

Figure 7.4: Rules for a Credit Application

Mortgage Application for Loans from $100,000 to $200,000

If there are no previous credit problems and
If monthly net income is greater than 4 times monthly loan payment and
If down payment is 15% of the total value of the property and
If net assets of borrower are greater than $25,000 and
If employment is greater than three years at the same company

Then accept loan application

Else check other credit rules
The Explanation Facility

- Allows a user or decision maker to understand how the expert system arrived at certain conclusions or results
- For example: it allows a doctor to find out the logic or rationale of the diagnosis made by a medical expert system
The Knowledge Acquisition Facility

• Provides convenient and efficient means of capturing and storing all the components of the knowledge base
• Acts as an interface between experts and the knowledge base
The User Interface

• Specialized user interface software is employed for designing, creating, updating, and using expert systems

• The main purpose of the user interface is to make the development and use of an expert system easier for users and decision makers
Expert Systems Development

Figure 7.6: Steps in the Expert System Development Process
Participants in Developing and Using Expert Systems

- **Domain expert**: individual or group that has the expertise or knowledge one is trying to capture in the expert system
- **Knowledge engineer**: an individual who has training or experience in the design, development, implementation, and maintenance of an expert system
- **Knowledge user**: individual or group that uses and benefits from the expert system
Participants in Developing and Using Expert Systems (continued)

Figure 7.7: Participants in Expert Systems Development and Use
Expert Systems Development Tools and Techniques

• Traditional programming languages
• Special programming languages
• Expert system shells
  – An expert system shell is a collection of software packages and tools used to design, develop, implement, and maintain expert systems
• Off-the-shelf expert system shells
Figure 7.8: Software for expert systems development has evolved greatly since 1980, from traditional programming languages to expert system shells.
Expert Systems Development
Alternatives

• In-house development: develop from scratch
• In-house development: develop from a shell
• Off-the-shelf purchase: use existing packages
Expert Systems Development Alternatives (continued)

Figure 7.9: Some Expert System Development Alternatives and Their Relative Cost and Time Values
Applications of Expert Systems and Artificial Intelligence

- Credit granting and loan analysis
- Catching cheats and terrorists
- Information management and retrieval
- AI and expert systems embedded in products
Applications of Expert Systems and Artificial Intelligence (continued)

- Plant layout and manufacturing
- Hospitals and medical facilities
- Help desks and assistance
- Employee performance evaluations
Applications of Expert Systems and Artificial Intelligence (continued)

- Virus detection
- Shipping
- Marketing
Virtual Reality

• **Virtual reality system**: enables one or more users to move and react in a computer-simulated environment

• **Immersive virtual reality**: user becomes fully immersed in an artificial, three-dimensional world that is completely generated by a computer
Interface Devices

• Head-mounted display (HMD)
• Binocular Omni-Orientation Monitor (BOOM)
• CAVE
• Haptic interface
Interface Devices (continued)

The BOOM, a head-coupled display device
Interface Devices (continued)

Viewing the Detroit Midfield Terminal in an immersive CAVE system
Forms of Virtual Reality

- Immersive virtual reality
- Mouse-controlled navigation through a three-dimensional environment on a graphics monitor
- Stereo projection systems
- Stereo viewing from the monitor via stereo glasses
Virtual Reality Applications

- Medicine
- Education and training
- Real estate marketing and tourism
- Entertainment
Other Specialized Systems

• Segway
• A microchip that might be able to help quadriplegics perform tasks they could not perform otherwise
• Radio-frequency identification (RFID) tags
Other Specialized Systems (continued)

- “Smart containers” for ships, railroads, and trucks
- Game theory
- Informatics
Summary

• Artificial intelligence (AI): ability of computers to mimic or duplicate the functions of the human brain

• Artificial intelligence systems: the people, procedures, hardware, software, data, and knowledge needed to develop computer systems and machines that demonstrate the characteristics of intelligence

• Expert system: computer system that stores knowledge and makes inferences, similar to a human expert
Summary (continued)

- Robotics: mechanical or computer devices that perform tasks that either require a high degree of precision or are tedious or hazardous for humans
- Vision system: computer system that permits computers to capture, store, and manipulate visual images and pictures
- Natural language processing: allows the computer to understand and react to statements and commands made in a “natural” language, such as English
Summary (continued)

- **Learning system**: computer system that allows the computer to change how it functions or reacts to situations based on feedback it receives.
- **Neural network**: computer system that can simulate the functioning of a human brain.
- **Virtual reality system**: enables one or more users to move and react in a computer-simulated environment.