

Chap-07, Specialized Information Systems

Principles and Learning Objectives

- **Artificial intelligence (AI)** 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 AI 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 AI field and provide one example of each type of system.
- **Expert systems** can enable a novice, with knowledge in a field, 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.
- **Virtual reality** systems have the potential to reshape the interface between people and 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.
- **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 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 characteristics of intelligence

• **The Nature of Intelligence [for Natural/Human Intelligence and for Artificial 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	Understand visual images
Process and manipulate symbols	Be creative and imaginative
Uses heuristics (trial & error, 'rules of thumb', estimates)	

• **The Difference Between Natural and Artificial Intelligence**

{see page 6, Table 7.1 in lecture notes}

• **The Major Branches 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

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. [New Passport rule: Cannot smile for photo]

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

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 [Computer systems that can simulate the functioning of a human brain.]

Some specific features of Neural Networks:

- 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

An Overview of Expert Systems:

Characteristics of an Expert System

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|--|------------------------------------|
| 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 | |

Limitations of an Expert System

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|--|---------------------------------------|
| Difficult to use | Not widely used or tested |
| Cannot readily deal with “mixed” knowledge | Limited to relatively narrow problems |
| Cannot refine its own knowledge | Possibility of error |
| May have high development costs | Difficult to maintain |
| | 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
- 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

The Knowledge Base

Stores all relevant information, data, rules, cases, etc used by the expert system	Assembling human experts
Use of fuzzy logic (see def.inition - page 5)	Use of rules
Use of cases	

The Inference Engine

The inference engine provides a mechanism for retrieving the stored knowledge.

- Seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions the way a human expert would.
- Forward chaining:** The process of starting with the facts and working forward to the conclusions
- Backward chaining:** The process of starting with conclusions and working backward to the supporting facts

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 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

Participants in Developing and Using Expert Systems

- Domain expert:** individual(s) with expertise or knowledge of the subject of 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

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

Expert Systems Development Alternatives

- In-house development: develop from scratch
- In-house development: develop from a shell
- Off-the-shelf purchase: use existing packages

• 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
Plant layout and manufacturing	Hospitals and medical facilities
Help desks and assistance	Employee performance evaluations
Virus detection	Shipping
Marketing	

Virtual Reality

- Virtual reality systems enable 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

Virtual reality systems require special interface devices that transmit the sights, sounds, and sensations of the simulated world to the user. These devices can also record and send the speech and movements of participants to the simulated world. This means that users are able to move and react in a virtual environment and manipulate virtual objects much as they would those in the real world.

Head-mounted display (HMD)	Binocular Omni-Orientation Monitor (BOOM)
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•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 to help quadriplegics perform tasks they could not perform otherwise
- Radio-frequency identification (RFID) tags
- “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
- 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
- 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

Key Terms

- **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 characteristics of intelligence
- **Backward chaining:** The process of starting with conclusions and working backward to the supporting facts
- **Domain:** The area of knowledge addressed by the expert system
- **Domain expert:** The individual or group that has the expertise or knowledge one is trying to capture in the expert system
- **Expert system:** Hardware and software that stores knowledge and makes inferences, similar to a human expert
- **Expert system shell:** A collection of software packages and tools used to develop expert systems
- **Explanation facility:** The component of an expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results
- **Forward chaining:** The process of starting with the facts and working forward to the conclusions
- **Fuzzy logic:** A special research area in computer science that allows shades of gray and does not require everything to be simple black or white, yes/no, or true/false
- **Game theory:** The use of information systems to develop competitive strategies for people, organizations, or even countries
- **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
- **If-then statements:** Rules that suggest certain conclusions
- **Inference engine:** Part of the expert system that seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions the way a human expert would
- **Informatics:** A specialized system that combines traditional disciplines, such as science and medicine, with computer systems and technology
- **Intelligent agent:** Programs and a knowledge base used to perform a specific task for a person, a process, or another program; also called intelligent robot or bot
- **Intelligent behavior:** The ability to 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, understand visual images, process and manipulate symbols, be creative and imaginative, and use heuristics
- **Knowledge acquisition facility:** The part of the expert system that provides convenient and efficient means of capturing and storing all the components of the knowledge base
- **Knowledge base:** A component of an expert system that stores all relevant information, data, rules, cases, and relationships used by 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:** The individual or group who uses and benefits from the expert system
- **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

- **Natural language processing:** Processing that allows the computer to understand and react to statements and commands made in a “natural” language, such as English
- **Neural network:** A computer system that can act like or simulate the functioning of a human brain
- **Perceptive system:** A system that approximates the way a human sees, hears, and feels objects
- **Robotics:** Mechanical or computer devices that perform tasks requiring a high degree of precision or that are tedious or hazardous for humans
- **Rule:** A conditional statement that links given conditions to actions or outcomes
- **Virtual reality system:** A system that enables one or more users to move and react in a computer-simulated environment
- **Vision systems:** The hardware and software that permit computers to capture, store, and manipulate visual images and pictures

The Difference Between Natural and Artificial Intelligence

The table below (7.1) provides a comparison of natural and artificial intelligence.

Attributes	Natural Intelligence (Human)	Artificial Intelligence (Machine)
The ability to use sensors (eyes, ears, touch, smell)	High	Low
The ability to be creative and imaginative	High	Low
The ability to learn from experience	High	Low
The ability to be adaptive	High	Low
The ability to afford the cost of acquiring intelligence	High	Low
The ability to use a variety of information sources	High	High
The ability to acquire a large amount of external information	High	High
The ability to make complex calculations	Low	High
The ability to transfer information	Low	High
The ability to make a series of calculations rapidly and accurately	Low	High