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

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

Table 7.1: A Comparison of Natural and Artificial Intelligence

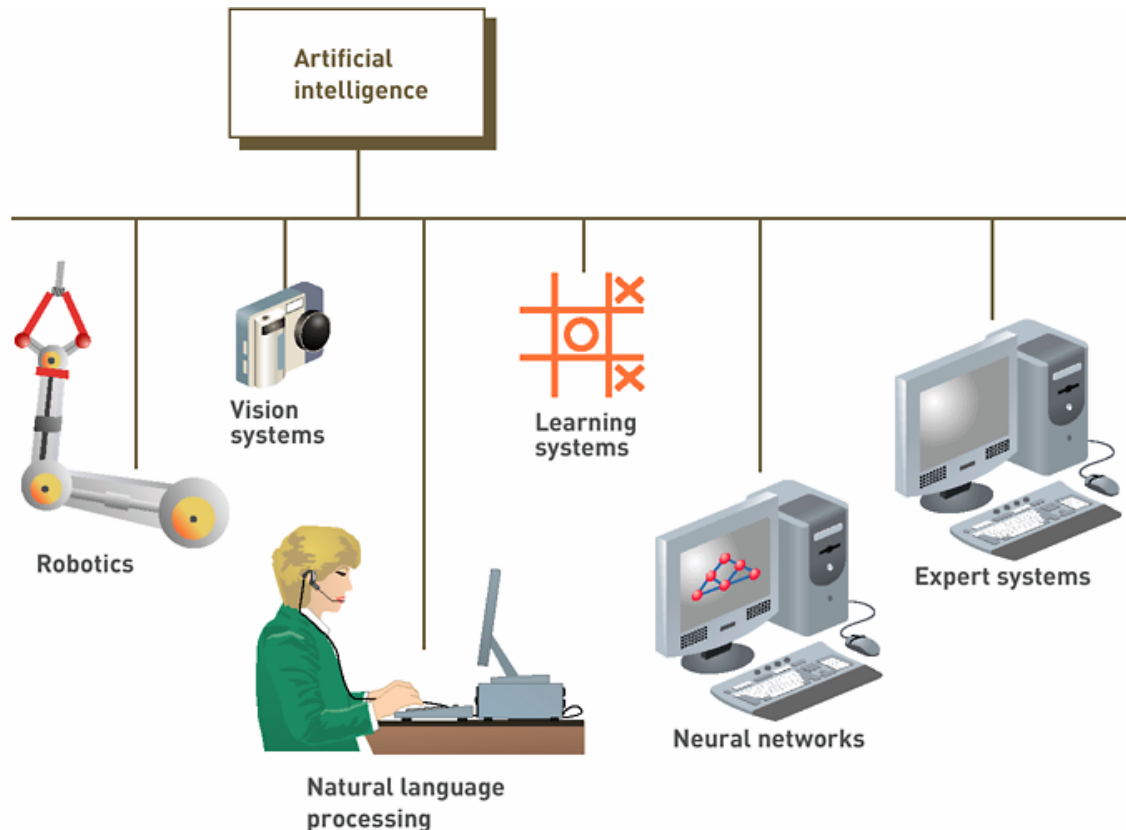# The Major Branches of Artificial Intelligence

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

Robotics (continued)

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.
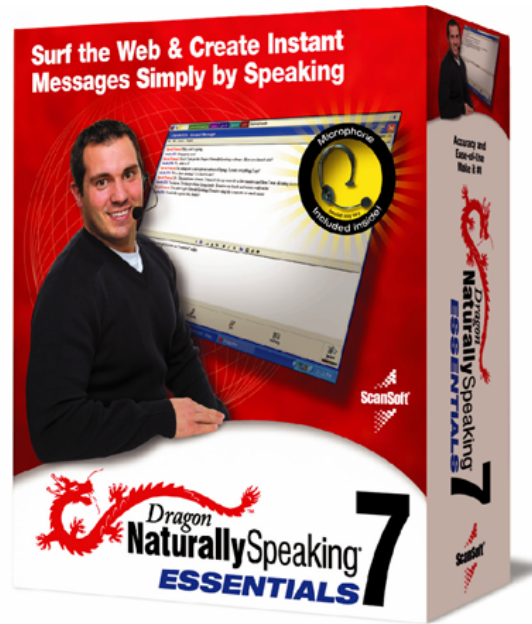
Vision Systems

- 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

Natural Language Processing (continued)

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

An Overview of Expert Systems: Characteristics and Limitations of an Expert System

- 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
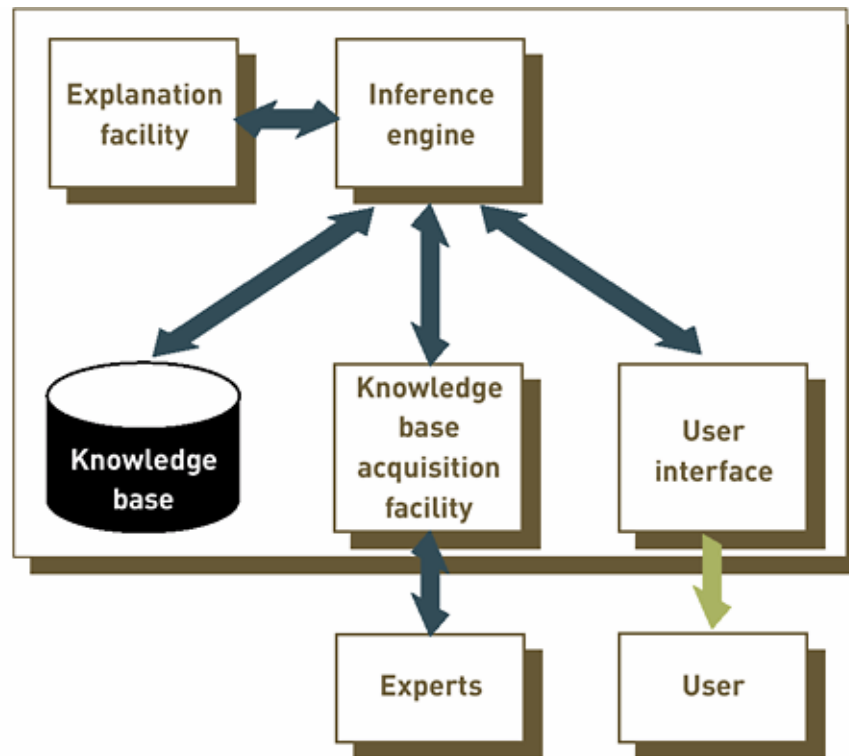
Components of Expert Systems

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)

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
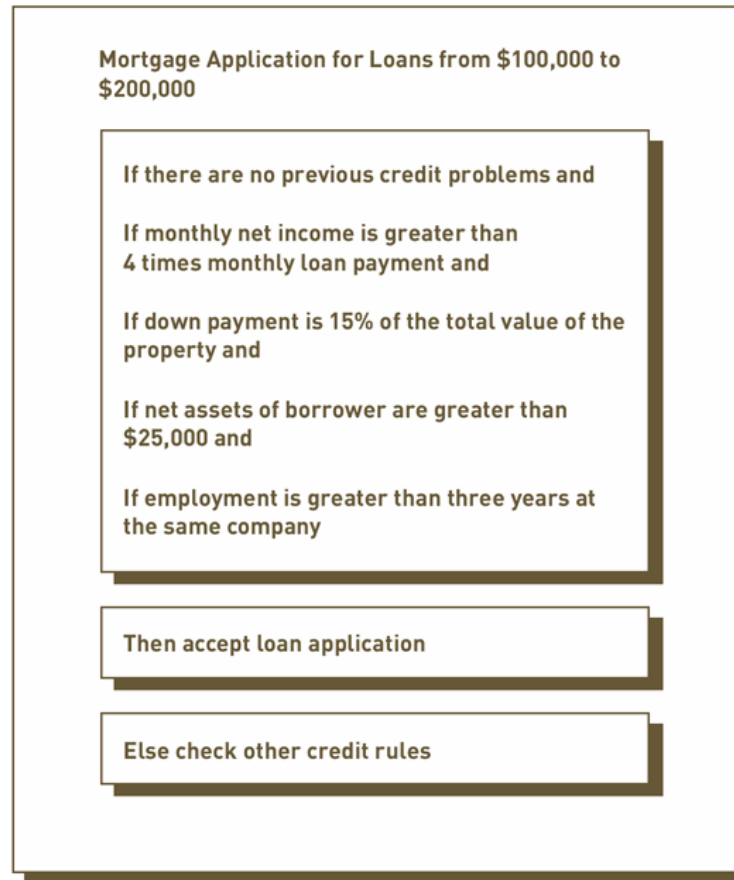
Else check other credit rules

Figure 7.4: Rules for a Credit Application

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

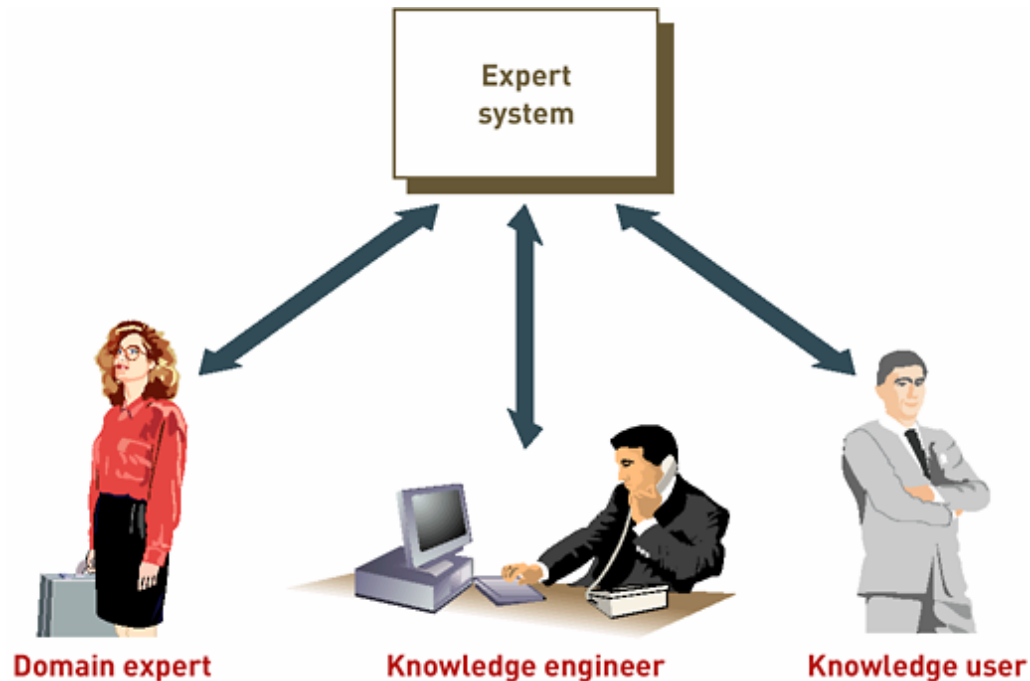# Participants in Developing and Using Expert Systems (continued)

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

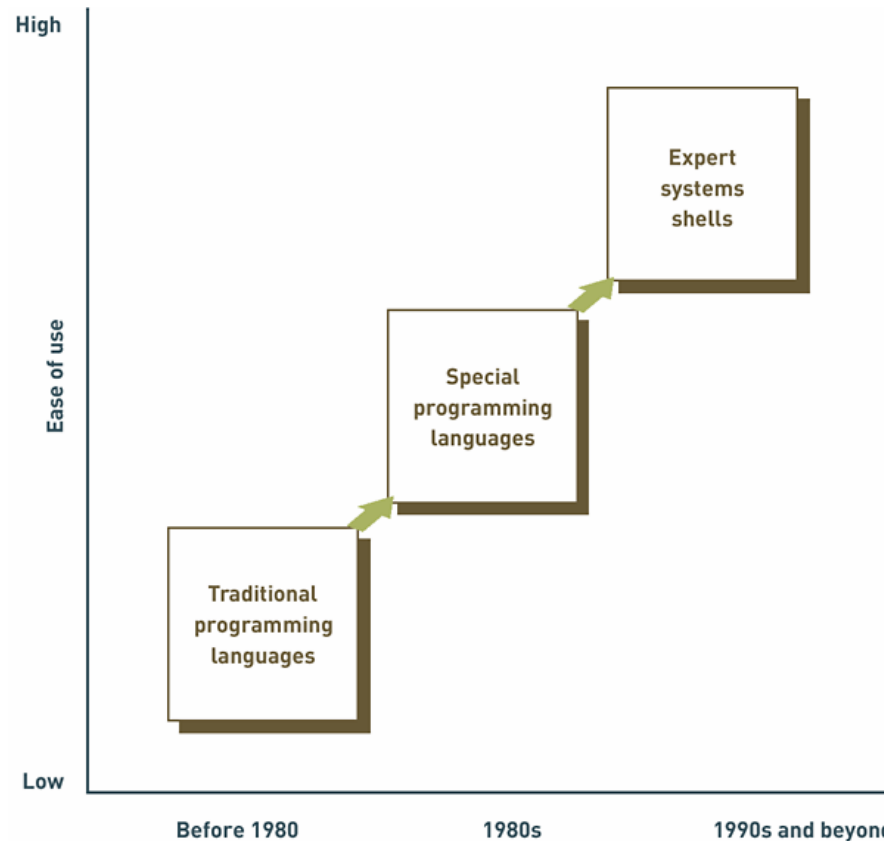# Expert Systems Development Tools and Techniques (continued)

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

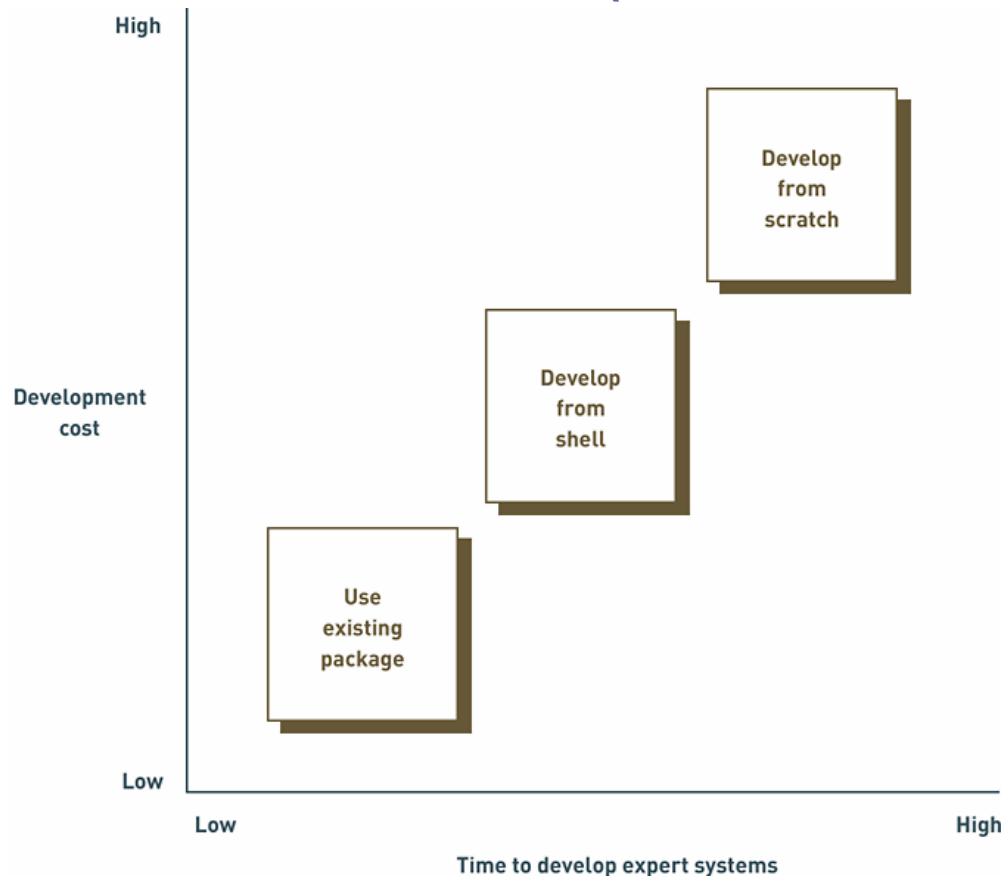# Expert Systems Development Alternatives (continued)

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