Lesson Proper for Week 16

An Overview of Artificial Intelligence

What is artificial intelligence? **Artificial intelligence** (AI) is a field of science and technology based on disciplines such as computer science, biology, psychology, linguistics, mathematics, and engineering. The goal of AI is to develop computers that can simulate the ability to think, as well as see, hear, walk, talk and feel.

The Domains of Artificial Intelligence

Note that AI **applications** can be grouped under three major areas: cognitive science, robotics and natural interfaces, though these classifications do overlap each other, and other classifications can be used. Also note that expert systems are just one of many important AI applications.

Cognitive Science. This area of artificial intelligence is based on research in biology, neurology, psychology, mathematics, and many allied disciplines. It focuses on researching how the human brain works and how humans think and learn. The results of such research in *human information processing* are the basis for the development of a variety of computer-based applications in artificial intelligence.Applications in the cognitive science area of AI include the development of expert systems and other *knowledge-based systems* that add a knowledge base and some reasoning capability to information systems. Also included are *adaptive learning systems* that can modify their behaviors based on information they acquire as they operate. Chess-playing systems are primitive examples of such applications, though many more applications are being implemented. *Fuzzy logic* systems can process data that are incomplete or ambiguous, that is, *fuzzy data*. Thus, they can solve semistructured problems with incomplete knowledge by developing approximate inferences and answers, as humans do. *Neural network* software can learn by processing sample problems and their solutions. As neural nets start to recognize patterns, they can begin to program themselves to solve such problems on their own. *Genetic algorithm* software uses Darwinian (survival of the fittest), randomizing, and other mathematics functions to simulate evolutionary processes that can generate increasingly better solutions to problems. And *intelligent agents* use expert system and other AI technologies to serve as software surrogates for a variety of end user applications.

Robotics. AI, engineering, and physiology are the basic disciplines of robotics. This technology products robot machines with computer intelligence and computer-controlled, humanlike physical capabilities. This area thus includes applications designed to give robots the powers of sight, or visual perception; touch, or tactile capabilities; dexterity, or skill in handling and manipulation; locomotion, or the physical ability to move any terrain; and navigation, or the intelligence to properly find one's way to a destination.

Natural Interfaces. The development of natural interfaces is considered a major area of AI applications and is essential to the natural use of computers by humans. This involves research and development in linguistics, psychology, computer science, and other disciplines. Other natural interface research applications include the development of multisensory devices that use a variety of body movements to operate computers.

Expert Systems

One of the most practical and widely implemented applications of artificial intelligence in business is the development of expert systems and other knowledge-based information systems. A knowledge-based information system (KBIS) adds a knowledge base to the major components found in other types of computer-based information system. An expert system (ES) is a knowledge-based information system that uses its knowledge about a specific, complex application area to act as an expert consultant to end users. Expert systems provide answers to questions in a very specific problem area by making humanlike inferences about knowledge contained in a specialized knowledge base.

Components of an Expert System

The components of an expert system include a knowledge base and software modules that perform inferences on the knowledge in the knowledge base and communicate answers to a user's questions.

·	**Knowledge Base**. The knowledge base of an expert system contains (1) facts about a specific subject area (for example, John is an analyst) and (2) heuristics (rule of thumb) that express the reasoning procedures of an expert on the subject (for example, IF John is an analyst. THEN he needs a workstation).

·	**Software Resources**. An expert system software package contains an inference engine and other programs for refining knowledge and communicating with users. The inference engine program processes the knowledge (such as rules and facts) related to a specific problem. It then makes associations and inferences resulting in recommended courses of action for a user. User interface programs for communicating with end users are also needed, including an explanation program to explain the reasoning process to a user if requested. Knowledge acquisition programs are not part of an expert system, but are software tools for knowledge base development, as are *expert system shells*, which are used for developing expert systems.

Expert System Applications

Expert systems are being used for many different types of applications, and the variety of applications is expected to continue to increase. However, you should realize that expert systems typically accomplish one or more generic uses. Expert systems now help diagnose illnesses, search for minerals, analyze compounds, recommend repairs, and do financial planning.

Benefits of Expert Systems

An expert system captures the expertise of an expert or group of experts in a computer-based information system. Thus, it can outperform a single human expert in many problem situations. That's because an expert system is faster and more consistent, can have the knowledge of several experts, and does not get tired or distracted by overwork or stress. Expert systems also help preserve and reproduce the knowledge of experts. They allow a company to preserve the expertise of an expert before she leaves the organization. This expertise can then be shared by reproducing the software and knowledge base of the expert system.

Limitations of Expert Systems

The major limitations of expert systems arise from their limited focus, inability to learn, maintenance problems, and developmental cost. Expert systems excel only in solving specific types of problems in a limited domain of knowledge. Expert systems may also be difficult and costly to develop and maintain. The costs of knowledge engineers, lost expert time, and hardware and software resources may be too high to offset the benefits expected from some applications. Also, expert systems can't maintain themselves. That is, they can't learn from experience, but must be taught new knowledge and modified as new expertise is needed to match developments in their subject areas.

Developing Expert Systems

The easiest way to develop an expert system is to use an **expert system shell** as a developmental tool. An expert system shell is a software package consisting of an expert system without its kernel, that is, its knowledge base. This leaves a *shell* of software (the inference engine and user interface programs) with generic inferencing and user interface capabilities. Other development tools (such as rule editors and user interface generators) are added in making the shell a powerful expert system development tool.

Knowledge Engineering

A knowledge engineer is a professional who works with experts to capture the knowledge (facts and rules of thumb) they possess. The knowledge engineer then builds the knowledge base (and the rest of the expert system fi necessary), using an iterative, prototyping process until the expert system is acceptable. Thus, knowledge engineers perform a role similar to that of systems analysts in conventional information systems development.

Neural Networks

Neural Networks are computing systems modeled after the brain's meshlike network of interconnected processing elements, called *neurons*. Of course, neural networks are a lot simpler in architecture (the human brain is estimated to have over 100 billion neuron brain cells!). However, like the brain, the interconnected processors in a neural network operate in parallel and interact dynamically with each other. This enables the network to "learn" from data it processes. That is, it learns to recognize patterns and relationships in this data. The more data examples it receives as input, the better it can learn to duplicate the results of the examples it processes. Thus, the neural network will change the strengths of the interconnections between the processing elements in response to changing patterns in the data it receives and the results that occur.

Fuzzy Logic Systems

In spite of the funny name, **fuzzy logic** systems represent a small but serious application of AI in business. Fuzzy logic is a method of reasoning that resembles human reasoning since it allows for approximate values and inferences (fuzzy logic) and incomplete or ambiguous data (fuzzy data) instead of relying only on crisp data, such as binary (yes/no) choices.

Genetic Algorithms

The use of **genetic algorithms** is a growing application of artificial intelligence. Genetic algorithm software uses of Darwinian (survival of the fittest), randomizing, and other mathematical functions to simulate an evolutionary process that can yield increasingly better solutions to a problem.

Virtual Reality

Virtual Reality (VR) is a computer-simulated reality. Virtual reality is a fast-growing area of artificial intelligence that had its origins in efforts to build more natural, realistic, multisensory human-computer interfaces.

VR applications

Current applications of virtual reality are wide-ranging and include computer-aided design (CAD), medical diagnostics and treatment, scientific experimentation in many physical and biological sciences, flight simulation for training pilots and astronauts, product demonstrations, employee training, and entertainment, especially 3-D video arcade games. CAD is the most widely used industrial VR application. VR becomes *telepresence* when users who can be anywhere in the world use VR systems to work alone or together at a remote site. Typically, this involves using a VR system to enhance the sight and touch of a human who is remotely manipulating equipment to accomplish a task.

Intelligent Agents

Intelligent agents are growing in popularity as a way to use artificial intelligence routines in software to help users accomplish many kinds of tasks in e-business and e-commerce. An intelligent agent is a software surrogate for an end user or a process that fulfills a stated needs or activity. An

intelligent agent uses its built-in and learned knowledge base about a person or process to make decisions and accomplish tasks in a way that fulfills the intentions of a user.