Artificial Intelligence and Expert Systems

Overview of Artificial Intelligence (1)
- Artificial intelligence (AI)
  - Computers with the ability 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

Overview of Artificial Intelligence (2)
- Intelligent behaviour
  - Learn from experience
  - 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
  - Use heuristics

Major Branches of AI (1)
- Perceptive system
  - A system that approximates the way a human sees, hears, and feels objects
- Vision system
  - Capture, store, and manipulate visual images and pictures
- Robotics
  - Mechanical and computer devices that perform tedious tasks with high precision
- Expert system
  - Stores knowledge and makes inferences

Major Branches of AI (2)
- Learning system
  - Computer changes how it functions or reacts to situations based on feedback
- Natural language processing
  - Computers understand and react to statements and commands made in a "natural" language, such as English
- Neural network
  - Computer system that can act like or simulate the functioning of the human brain

Schematic
Artificial Intelligence (1)

The branch of computer science concerned with making computers behave like humans. The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology. Artificial intelligence includes:

- games playing: programming computers to play games such as chess and checkers
- expert systems: programming computers to make decisions in real-life situations (for example, some expert systems help doctors diagnose diseases based on symptoms)
- natural language: programming computers to understand natural human languages

Artificial Intelligence (2)

- neural networks: Systems that simulate intelligence by attempting to reproduce the types of physical connections that occur in animal brains
- robotics: programming computers to see and hear and react to other sensory stimuli

Currently, no computers exhibit full artificial intelligence (that is, are able to simulate human behavior). The greatest advances have occurred in the field of games playing. The best computer chess programs are now capable of beating humans. In May, 1997, an IBM super-computer called Deep Blue defeated world chess champion Gary Kasparov in a chess match.

Artificial Intelligence (3)

Gary Kasparov in a chess match.

In the area of robotics, computers are now widely used in assembly plants, but they are capable only of very limited tasks. Robots have great difficulty identifying objects based on appearance or feel, and they still move and handle objects clumsily.

Natural-language processing offers the greatest potential rewards because it would allow people to interact with computers without needing any specialized knowledge. You could simply walk up to a computer and talk to it. Unfortunately, programming computers to understand natural languages has proved to be more difficult than originally thought. Some rudimentary translation systems that translate from one human language to another are in existence, but they are not nearly as good as human translators. There are also voice recognition systems that can convert spoken sounds into written words, but they do not understand what they are writing; they simply take dictation. Even these systems are quite limited -- you must speak slowly and distinctly.

Artificial Intelligence (4)

In the early 1980s, expert systems were believed to represent the future of artificial intelligence and of computers in general. To date, however, they have not lived up to expectations. Many expert systems help human experts in such fields as medicine and engineering, but they are very expensive to produce and are helpful only in special situations.

Today, the hottest area of artificial intelligence is neural networks, which are proving successful in a number of disciplines such as voice recognition and natural-language processing.

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Artificial Intelligence (6)

There are several programming languages that are known as AI languages because they are used almost exclusively for AI applications. The two most common are LISP and Prolog.
Overview of Expert Systems

- Can...
  - Explain their reasoning or suggested decisions
  - Display intelligent behavior
  - Draw conclusions from complex relationships
  - Provide portable knowledge

Expert system shell
  - A collection of software packages and tools used to develop expert systems

Limitations of Expert Systems

- Not widely used or tested
- Limited to relatively narrow problems
- Cannot readily deal with “mixed” knowledge
- Possibility of error
- Cannot refine own knowledge base
- Difficult to maintain
- May have high development costs
- Raise legal and ethical concerns

Capabilities of Expert Systems

- Strategic goal setting - Explore impact of strategic goals
- Planning - Impact of plans on resources
- Design - Integrate general design principles and manufacturing limitations
- Decision making - Provide advice on decisions
- Quality control and monitoring - Monitor quality and assist in finding solutions
- Diagnosis - Look for causes and suggest solutions

When to Use an Expert System (1)

- Provide a high potential payoff or significantly reduced downside risk
- Capture and preserve irreplaceable human expertise
- Provide expertise needed at a number of locations at the same time or in a hostile environment that is dangerous to human health

When to Use an Expert System (2)

- 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 of human experts with a large number of people

Components of an Expert System (1)

- Knowledge base
  - Stores all relevant information, data, rules, cases, and relationships used by the expert system
- Inference engine
  - Seeks information and relationships from the knowledge base and provides answers, predictions, and suggestions in the way a human expert would
- Rule
  - A conditional statement that links given conditions to actions or outcomes
Components of an Expert System (2)

- Fuzzy logic
  - A specialty research area in computer science that allows shades of gray and does not require everything to be simply yes/no, or true/false
- Backward chaining
  - A method of reasoning that starts with conclusions and works backward to the supporting facts
- Forward chaining
  - A method of reasoning that starts with the facts and works forward to the conclusions

Rules for a Credit Application

Mortgage application for a loan for $100,000 to $200,000

- If there are no previous credit problems, and
- If month net income is greater than 4x monthly loan payment, and
- If down payment is 15% of total value of property, and
- If net income of borrower is > $25,000, and
- If employment is > 3 years at same company

Then accept the applications

Else check other credit rules

Explanation Facility

- Explanation facility
  - A part of the expert system that allows a user or decision maker to understand how the expert system arrived at certain conclusions or results

Knowledge Acquisition Facility

- Knowledge acquisition facility
  - Provides a convenient and efficient means of capturing and storing all components of the knowledge base

Expert Systems Development

- Domain
  - The area of knowledge addressed by the expert system.
Participants in Expert Systems Development and Use

- **Domain expert**
  - The individual or group whose expertise and knowledge is captured for use in an expert system
- **Knowledge user**
  - The individual or group who uses and benefits from the expert system
- **Knowledge engineer**
  - Someone trained or experienced in the design, development, implementation, and maintenance of an expert system

Evolution of Expert Systems Software

- **Expert system shell**
  - Collection of software packages & tools to design, develop, implement, and maintain expert systems

Advantages of Expert Systems

- Easy to develop and modify
- The use of satisfying
- The use of heuristics
- Development by knowledge engineers and users

Expert Systems Development Alternatives

Applications of Expert Systems and Artificial Intelligence

- Credit granting
- Information management and retrieval
- AI and expert systems embedded in products
- Plant layout
- Hospitals and medical facilities
- Help desks and assistance
- Employee performance evaluation
- Loan analysis
- Virus detection
- Repair and maintenance
- Shipping
- Marketing
- Warehouse optimization