UNIT 1

Introduction to Artificial Intelligence

Instructor's Data

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Text Book

- **Text Book:**

Artificial intelligence: structures and strategies for complex problem solving.

- **Author:**

George F. Luger.

- **Publisher:**

Pearson Education, Inc

Course Assessment

ITEM	DATE	MARK
First Exam		20
Second Exam		20
Project	Throughout the whole semester	20
Final Exam	Set by the college	40
Total		100

Course Objectives

- Develop an appreciation of the role of intelligent systems in the contemporary context.
- Develop a deep understanding of fundamental theoretical and practical concepts about intelligent systems.
- Develop several applications employing different intelligent system paradigms

What's Artificial Intelligence (AI)

- Artificial intelligence (AI) is the branch of computer science concerned with making computers behave like humans (Computers with the ability to mimic or duplicate the functions of the human brain).

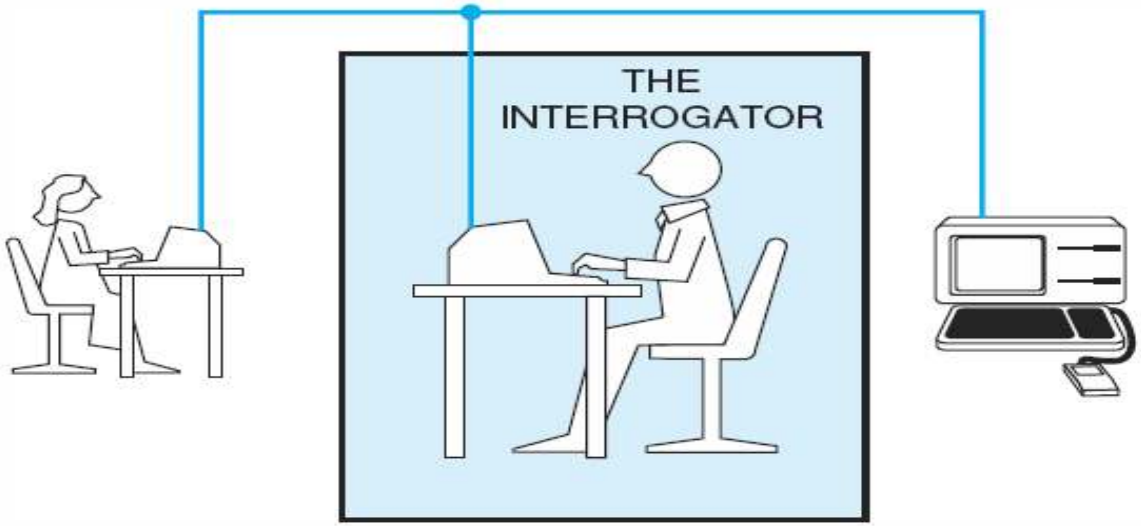
- The term was coined in 1956 by John McCarthy at the Massachusetts Institute of Technology (MIT).

The Turing Test

- Alan Turing in 1950 wrote a paper entitled “Computing machinery and intelligence”
- This paper is one of the earliest papers to address the question of machine intelligence specifically in relation to the modern digital computer
- The Turing test is a test of machine’s ability to exhibit an intelligent behaviour.
- The Turing test (called the imitation game) measures the performance of an intelligent machine against that of a human being.
- The test places the machine and a human counterpart in rooms apart from a second human being, referred to as the interrogator.

The Turing Test (ii)

- The interrogator is asked to distinguish the computer from the human being solely on the basis of their answers to questions asked over this device.
- If the interrogator cannot distinguish the machine from the human, then, Turing argues, the machine may be assumed to be intelligent.



Artificial Intelligence Systems

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

Artificial Intelligence Behavior

- **Intelligent behavior:**
  - 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

Important Features of AI

- The use of computers to do reasoning, pattern recognition, learning, or some other form of inference.
- A focus on problems that do not respond to algorithmic solutions. This underlies the reliance on heuristic search (as rules for choosing those branches in a state space that are most likely to lead to an acceptable problem solution) as an AI problem-solving technique.
- A concern with problem-solving using inexact, missing, or poorly defined information and the use of representational formalisms that enable the programmer to compensate for these problems.
- Reasoning about the significant qualitative features of a situation.
- An attempt to deal with issues of semantic meaning as well as syntactic form.
- Answers that are neither exact nor optimal, but are in some sense “sufficient”. This is a result of the essential reliance on heuristic problem-solving methods in situations where optimal or exact results are either too expensive or not possible.
- The use of large amounts of domain-specific knowledge in solving problems. This is the basis of expert systems.

Techniques used in AI

- **Problem Representation (Knowledge Representation):** is a science of translating actual knowledge into a format that can be used by the computer

- **Search:** a technique to choose the optimal solution from many possible solutions.

- **Automated Reasoning:** a process of achieving a specific goal based on the given knowledge.

- **Planning:** the ability to decide on a good sequence of actions to achieve our goals.

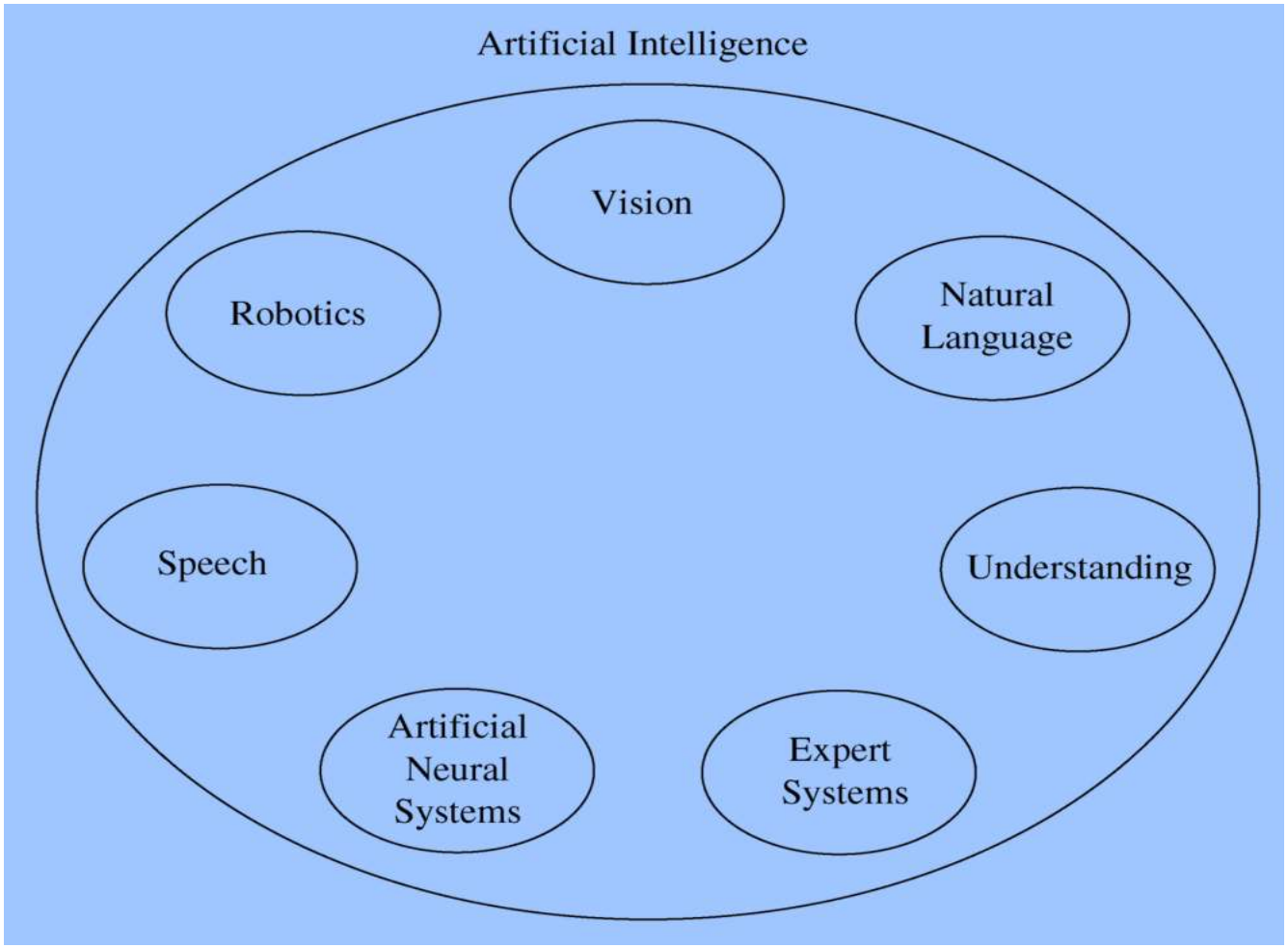
Overview of AI applications

- The two most fundamental concerns of AI researchers are:
  - **Knowledge representation:** it addresses the problem of capturing in a language (predicate calculus), suitable for computer manipulation
  - **Search:** is a problem-solving technique that systematically explores a space of problem state (successive and alternative stages in the problem-solving process) for solution space.
- Like most sciences, AI is decomposed into a number of sub disciplines that, while sharing an essential approach to problem solving, have concerned themselves with different applications.

Important Research and Application Areas of AI

- Game playing
- Automated reasoning and theorem proving
- Expert systems
- Natural language understanding and semantic modelling
- Modelling human performance
- Planning and robotics
- Languages and environments for AI
- Machine learning
- Alternative representations: neural nets and genetic algorithms

Areas of Artificial Intelligence



Areas of Artificial intelligence

Robotics

Vision systems

Learning systems

Natural language processing

Neural networks

Expert systems

(i) Game playing

- Game playing involves programming computers to play games such as chess and checkers .

- Most games are played using a well-defined set of rules: this makes it easy to generate the search space and frees the researcher from many of the ambiguities and complexities inherent in less structured problems.

- As games are easily played, testing a game-playing program presents no financial or ethical burden.

(ii): Automated reasoning & theorem proving

- Automated theorem-proving research was responsible for much of the early work in formalizing search algorithms and developing formal representation languages such as the predicate calculus and the logic programming language Prolog.

(iii): Expert Systems

- Expert systems involves programming computers to make decisions in real-life situations (for example, some expert systems help doctors diagnose diseases based on symptoms) .

- Expert systems are constructed by obtaining this knowledge from a domain expert (a person who has deep knowledge (of both facts and rules) and strong practical experience in a particular domain) and coding it into a form that a computer may apply to similar problems.

- Expert knowledge is a combination of a theoretical understanding of the problem and a collection of heuristic problem-solving rules that experience has shown to be effective in the domain.

(iv): Natural Language Understanding

- Natural language understanding involves programming computers to understand natural human languages like Arabic.
- Understanding natural language involves much more than parsing sentences into their individual parts of speech and looking those words up in a dictionary.
- Real understanding depends on extensive background knowledge about the domain of discourse and the idioms used in that domain as well as an ability to apply general contextual knowledge to resolve the omissions and ambiguities that are a normal part of human speech.

(v): Modeling Human Performance

- Many AI programs are engineered to solve some useful problems without regard for their similarities to human mental architecture.

- In fact, programs that take nonhuman approaches to solving problems (e.g. chess) are often more successful than their human counterparts. Still, the design of systems that explicitly model aspects of human performance is a fertile area of research in both AI and psychology.

- Human performance modeling, in addition to providing AI with much of its basic methodology, has proved to be a powerful tool for formulating and testing theories of human cognition.

(vi): Planning and Robotics

- **Planning** is the ability to decide on a good sequence of actions to achieve our goals.
- Research in planning began as an effort to design robots that could perform their tasks with some degree of flexibility and responsiveness to the outside world.
- Briefly, planning assumes a robot that is capable of performing certain atomic actions. It attempts to find a sequence of those actions that will accomplish some higher-level task, such as moving across an obstacle-filled room.
- Planning is a difficult problem for a number of reasons, not the least of which is the size of the space of possible sequences of moves. Even an extremely simple robot is capable of generating a vast number of potential move sequences.

(vii): Languages and Environments of AI

- Some of the most important by-products of artificial intelligence research have been advances in programming languages and software development environments.
- Programming environments include knowledge-structuring techniques such as object-oriented programming.
- High-level languages, such as Lisp and Prolog, help manage program size and complexity.
- Trace packages allow a programmer to reconstruct the execution of a complex algorithm and make it possible to unravel the complexities of heuristic search.
- Without such tools and techniques, it is doubtful that many significant AI systems could have been built.

(viii): Machine Learning

- Learning is one of the most important components of intelligent behavior.

- An expert system may perform extensive and costly computations to solve a problem. However, unlike a human being, if it is given the same or a similar problem a second time, it usually does not remember the solution. It performs the same sequence of computations again.

(ix): Neural Nets and Genetic Algorithms

- Computer system that can act like or simulate the functioning of the human brain

- Most of the techniques in AI (and in this course) use knowledge and search algorithms to implement intelligence.

- An alternative approach seeks to build intelligent programs using models that parallel the structure of neurons in the human brain or the evolving patterns found in genetic algorithms and artificial life.

Major Branches of AI

- **Perceptive system:**

A system that approximates the way a human sees, hears, and feels objects

- **Vision system:**

Captures, stores, and manipulates visual images and pictures

- **Robotics:**

Mechanical and computer devices that perform tedious tasks with high precision

- **Expert system:**

Stores knowledge and makes inferences

- **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" languages, such as English

- **Neural network:**

Computer system that can act like or simulate the functioning of the human brain

Artificial intelligence = Software that acts intelligently

- AI centers on methods using Booleans, conditionals, and logical reasoning, with numbers used as needed.
- AI software need not work like people do, but people can provide clues as to methods. For instance, aircraft don't fly by imitating birds.
- AI means deep (not superficial) understanding of how to do something (e.g. language understanding versus table lookup). Example: Query "picture of west wing of white house" for Google.
- AI will become increasingly common in the future, as computers do increasingly complex tasks.
- Many developments in AI have been "exported" to other areas of computer science (e.g. object-oriented programming and data mining).
- AI programs that are too slow today may get used eventually as computers increase in speed (e.g. speech understanding).

What is AI good for?

- AI is not precisely defined, but generally it's for:
  - Problems needing "common sense", like recognizing building types in aerial photos
  - Problems requiring many different kinds of knowledge, like automatic translation of English text
  - Problems only a few experts can solve, like treating rare diseases
  - Hard problems without any good known algorithms, like playing chess

Some history of AI

- **1950s: The first programs**
  - First speculation about AI (Turing test)
  - Dartmouth Conference: organized by John McCarthy and colleagues for starting a new area in studying computation and intelligence.
  - John McCarthy introduced the term “artificial intelligence” in the conference.
  - Game-playing
  - Heuristic search methods

- **1960s: Major progress**
  - Lisp programming language by McCarthy
  - Development of symbolic reasoning methods using logical constraints
  - The first natural language and vision programs

- **1970s: Many successes**
  - Appearance of expert systems
  - Prolog programming language and various other AI software
  - Symbolic learning is popular

- **1980s: Faddishness**
  - Suddenly AI is faddish and gets much media coverage
  - Lots of AI startup companies, most fail
  - Lots of standalone AI applications, lots of expert systems
  - Neural networks become popular

- **1990s: Maturity of AI**
  - AI no longer a fad, but used more than ever (e.g. the Web)
  - AI is embedded in larger systems (like on the Web and in simulations)
  - Genetic algorithms and artificial life are popular
  - Statistical language processing is popular, including speech understanding

- **2000s: AI is back in fashion**
  - Data mining is popular
  - Simulations and games using AI are popular

Artificial intelligence today

- Programs that use artificial-intelligence techniques are usually just pieces of a larger system (like Java classes).
- "Artificial-intelligence techniques" emphasize conditional statements and logical constructs (like "and", "or", and "not").
- Artificial-intelligence code often contains many small pieces, to provide flexible reasoning.
- Journals with current AI trends: IEEE Intelligent Systems and AI Magazine. More technical are IEEE Transactions on Knowledge and Data Engineering and Artificial Intelligence.

Options for implementing AI

- Use an AI programming language
- Use an AI software package
- Do AI directly in your favorite programming language

Options for implementing AI:
(i) Use an AI programming language

- **Prolog and Lisp are two programming languages; both have standards.**
  - **Both emphasize programming in small pieces.**
  - **Both use emphasize linked lists and recursion.**
  - **Lisp uses functions, Prolog predicate calculus.**
  - **Prolog has automatic backtracking and flexible variable binding.**

Options for implementing AI: (ii) Use an AI software package

- Many software packages are available:
  - CLIPS is a popular standalone system
  - JESS is a popular Java package.
  - Packages have better support facilities (e.g. graphics) than languages
- Languages have standards, shells don't.
- Packages may be too rigid for your application.
- Some packages don't support variables (e.g. neural nets).

Options for implementing AI:
(iii) Do AI directly in your favorite programming language

- This is the most popular way today.
- Libraries and predefined classes for AI methods are available.
- It's more work to do it yourself, but many AI ideas aren't hard to implement.

Key difficulties in doing AI

- Successes get exported, and people forget the ideas came from AI.
- Thorough testing is necessary to show an AI system works. Don't trust quick demos.
- Methods that cannot be tested easily (e.g. genetic algorithms and fuzzy sets) tend to be overvalued because people can't see when they're wrong. Methods that can show obvious errors (e.g. logical inferences) tend to be undervalued.