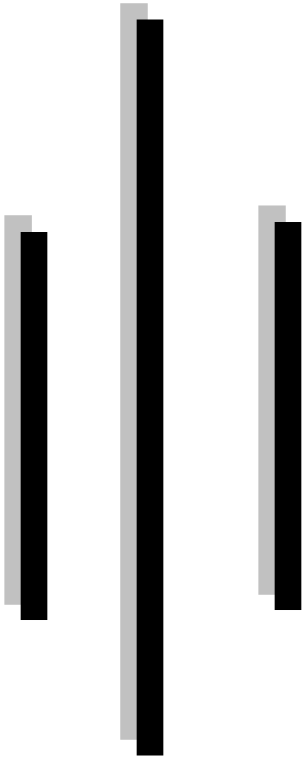
Pokhara University

Bachelor of Computer Engineering



Lecture Notes

In

Artificial Intelligence

1.Introduction to AI

Intelligence

Intelligence is:

– The ability to reason

– The ability to understand

– The ability to create

– The ability to Learn from experience

– The ability to plan and execute complex tasks

The intelligent behavior may include

– Everyday tasks: recognize a friend, recognize who is calling, translate from one language to another, interpret a photograph, talk, and cook a dinner

– Formal tasks: prove a logic theorem, geometry, calculus, play chess, checkers, or Go

– Expert tasks: engineering design, medical designers, financial analysis

Artificial Intelligence

AI is the branch of computer science concerned with making computers behave like humans. In other words, AI is the science and engineering of making intelligent machines, especially intelligent computer programs. The process may include

- Learning (Gaining of information and rules for using the information)
- Reasoning (Using the rules to reach approximate or definite conclusions)
- Self-Correction

According to Barr and Feigenbaum:

"Artificial Intelligence is the part of computer science concerned with designing intelligence computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior."

According to Elaine Rich:

"AI is the study of how to make computers do things at which, at the moment, people are better"

An AI system should have

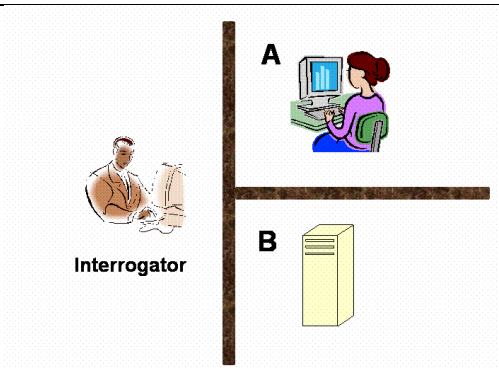
- Capability to provide reason about something
- Capability of natural language processing
- Capability of learning past experience
- Capability of self-correction

Views of AI fall into four categories

Thinking humanly	Thinking rationally
Acting humanly	Acting rationally

- **Acting humanly:** *The Turing Test approach*

  The Turing Test is a method for determining whether or not a computer is capable of thinking like a human. The test is named after Alan Turing, an English mathematician who pioneered artificial intelligence during the 1940s and 1950s, and who is credited with devising the original version of the test. According to this kind of test, a computer is deemed to have artificial intelligence if it can mimic human responses under specific conditions.

Consider the following setting. There are two rooms, A and B. One of the rooms contains a computer. The other contains a human. The interrogator is outside and does not know which one is a computer. He can ask questions through a teletype and receives answers from both A and B. The interrogator needs to identify whether A or B are humans. To pass the Turing test, the machine has to fool the interrogator into believing that it is human.	

To pass a Turing test, a computer must have following capabilities:

- Natural Language Processing: Must be able to communicate in English successfully
- Knowledge representation: To store what it knows and hears.
- Automated reasoning: Answer the Questions based on the stored information.
- Machine learning: Must be able to adapt in new circumstances.

- **Thinking humanly:** *The cognitive modeling approach*
  - Make the machines with mind.
  - **Cognition**: The action or process of acquiring knowledge and understanding through thought, experience and senses.
  - How do humans think?

    Requires scientific theories of internal brain activities (cognitive model).

    Once we have precise theory of mind, it is possible to express the theory

as a computer program.

- Two ways of doing this is:

  Predicting and testing human behavior (cognitive science)

  Identification from neurological data (Cognitive neuroscience)

- **Thinking rationally:** *The "laws of thought approach"*
  - Aristotle was one of the first who attempt to codify the right thinking that is irrefutable reasoning process. He gave Syllogisms that always yielded correct conclusion when correct premises are given.
  - For example:

    Ram is a man

    Man is mortal

    i.e. Ram is mortal

    These laws of thought were supposed to govern the operation of the mind; their study initiated a field called **logic.** The logistic tradition in AI hopes to create intelligent systems using logic programming.

- **Acting rationally :** *The rational agent approach*
  - An **agent** is something that acts.
  - Computer agent is expected to have following attributes:
    - Autonomous control
    - Perceiving their environment
    - Persisting over a prolonged period of time
    - Adapting to change
    - And capable of taking on another's goal
  - Rational behavior: doing the right thing
  - The right thing: that which is expected to maximize goal achievement, given the available information
  - Rational Agent is one that acts so as to achieve the best outcome or, when there is uncertainty, the best expected outcome.

  In this approach the emphasis is given to correct inferences.

AI and related fields

Different fields have contributed to AI in the form of ideas, viewpoints and techniques.

***Philosophy*:**

Logic, reasoning, mind as a physical system, foundations of learning, language and rationality.

***Mathematics*:**

Formal representation and proof algorithms, computation, undesirability, intractability, probability.

***Psychology*:**

Adaptation, phenomena of perception and motor control.

***Economics*:**

Formal theory of rational decisions, game theory.

***Linguistics*:**

Knowledge representation, grammar

***Neuroscience*:**

Physical substrate for mental activities

***Control theory*:**

Homeostatic systems, stability, optimal agent design

Brief History of AI

The term "Artificial Intelligence" was used for the first time in 1956 by an American scientist John McCarthy who is referred to as the Father of AI. McCarthy also come up with a programming language called LISP (i.e. List-Processing), which is still used to program computer in AI that allow the computer to learn.

Further, the major achievements can be listed as below:

1943	First electronic computer "Colossus" was developed.
1949	First commercial stored program computer was developed.
1950	- Alan Turing proposes the Turing test as a measure of machine intelligence. - Claude Shannon published a detail analysis of chess playing as search. - Isaac Asimov published his three laws of Robotics.
1951	The first working AI programs were written to run on the Ferranti Mark machine of the University of Manchester; a checkers-playing program written by Christopher Stavechey and a chess-playing program is written by Dietrich Prinz
1955	The first Dartmouth college summer AI conference is organized by John McCarthy, Marvin Minsky, Nathan Rochester of IBM and Claude Shannon.

1956	- The name artificial intelligence is used for the 1st time as the topic of the second Dartmouth Conference, organized by John McCarthy. - The first demonstration of the Logic Theorist (LT) written by Allen Newell, J.C. Shaw and Merbart Simon pus is called the first AI program
1957	The general problem Solver (GPS) demonstrated by Newell, Shaw and Simon
1958	John McCarthy at MIT invented the Lisp Programming Language.
1959	- John McCarthy and Marvin Minsky founded the MIT AI Lab. - First industrial robot company, animation was established.
1972	Prolog programming language was developed by Alain Colmerauer
1980	First National Conference of the American Association for Artificial Intelligence (AAAI) was held at Stratford.
Mid 1980's	Neural networks become widely used with the Back propagation algorithm.
1994	AI system exist in real environments with real sensory inputs (i.e. Intelligent Agents)
1997	First time AI system controlled a spacecraft named "Deep Space II"
2007	Checkers is solved by a team of researchers of the University of Alberta.
Present	Programmers are still trying to develop a computer which can successfully pass the "Turing Test".

Importance and Application of AI

Artificial intelligence has been used in a wide range of fields including medical diagnosis, stock trading, robot control, law, remote sensing, scientific discovery and toys. Many thousands of AI applications are deeply embedded in the infrastructure of every industry. In the late 90s and early 21st century, AI technology became widely used as elements of larger systems, but the field is rarely credited for these successes.

Game Playing

Machines can play master level chess. There is some AI in them, but they well against people mainly through brute force copulation, looking at hundreds of thousands of positions.

Speech Recognition

It is possible to instruct some computers using speech. In 1990s, computer speech recognition reached a practical level for limited purposes.

Understanding Natural Language

To perform many natural language processing tasks such as machine translation, summarization, information extraction, word sense disambiguation need the AI in machine.

Computer Vision

Computer vision is concerned with the theory behind artificial system that extract information from images. The image data can take many forms such as videos sequences views from multiple cameras and data from a medical scanner. Application range from simple tasks such as industrial machine, vision system which count bottles speeding by on a production line to research into artificial intelligence and computers or robots that can comprehended the world around them.

Expert System

Expert system need the AI to perform its task. One of the first expert system was MYCIN in 1974 which diagnosis bacterial infections of the blood and suggests treatments. It did better that makes medical students practicing doctors provided to limitations were observed.

Finance

Financial institutions have long used artificial neural network systems to detect charges or claims outside of the norm, flagging these for human investigation. Use of AI in banking can be tracked back to 1987 when Security Pacific National Bank in USA set-up a Fraud Prevention Task force to counter the unauthorized use of debit cards.

Hospitals and medicine

Artificial neural networks are used as clinical decision support systems for medical diagnosis, such as in Concept Processing technology in EMR software.

Other tasks in medicine that can potentially be performed by artificial intelligence include:

- Computer-aided interpretation of medical images. Such systems help scan digital images, *e.g.* from computed tomography, for typical appearances and to highlight conspicuous sections, such as possible diseases. A typical application is the detection of a tumor.
- Heart sound analysis
- Companion robots for the care of the elderly

Heavy industry

Robots have become common in many industries. They are often given jobs that are considered dangerous to humans. Robots have proven effective in jobs that are very repetitive which may lead to mistakes or accidents due to a lapse in concentration and other jobs which humans may find degrading. Japan is the leader in using and producing robots in the world. In 1999, 1,700,000 robots were in use worldwide.

Online and telephone customer service

Artificial intelligence is implemented in automated online assistants that can be seen as avatars on web pages. It can avail for enterprises to reduce their operation and

training cost. A major underlying technology to such systems is natural language processing.

Toys and games

The 1990s saw some of the first attempts to mass-produce domestically aimed types of basic Artificial Intelligence for education, or leisure. This prospered greatly with the Digital Revolution, and helped introduce people, especially children, to a life of dealing with various types of Artificial Intelligence. AI has also been applied to video games, for example video game bots, which are designed to stand in as opponents where humans aren't available or desired

Music

The evolution of music has always been affected by technology. With AI, scientists are trying to make the computer emulate the activities of the skillful musician. Composition, performance, music theory, sound processing are some of the major areas on which research in Music and Artificial Intelligence are focusing.

Aviation

The Air Operations Division (AOD) uses AI for the rule based expert systems. The AOD has use for artificial intelligence for replacement operators for fighting and training simulators, mission management aids, support systems for tactical decision making, and post processing of the simulator data into symbolic summaries.

Knowledge and Learning

Knowledge is the information about a domain that can be used to solve problems in that domain. To solve many problems requires much knowledge, and this knowledge must be represented in the computer. As part of designing a program to solve problems, we must define how the knowledge will be represented.

A representation scheme is the form of the knowledge that is used in an agent. A representation of some piece of knowledge is the internal representation of the knowledge. A representation scheme specifies the form of the knowledge. A knowledge base is the representation of all of the knowledge that is stored by an agent.

A good representation scheme is a compromise among many competing objectives. A representation should be

- Rich enough to express the knowledge needed to solve the problem.
- Willing for efficient computation
- Able to be acquired from people, data and past experiences.

Knowledge is the body of facts and principles. Knowledge can be language, concepts, procedures, rules, ideas, abstractions, places, customs, and so on. (Study of knowledge is called Epistemology)

Types of knowledge

The types of knowledge include procedural knowledge, declarative knowledge and heuristic knowledge.

- **Meta Knowledge**

It is a knowledge about a knowledge and how to gain them.

- **Procedural knowledge**

Procedural knowledge is compiled or processed form of information. Procedural knowledge is related to the performance of some task. For example, sequence of steps to solve a problem is procedural knowledge.

- **Declarative knowledge**

Declarative knowledge is passive knowledge in the form of statements of facts about the world. For example, mark statement of a student is declarative knowledge.

- **Heuristic knowledge**

Heuristics knowledge are rules of thumb or tricks. Heuristic knowledge is used to make judgments and also to simplify solution of problems. It is acquired through experience. An expert uses his knowledge that he has gathered due to his experience and learning.

- **Structural Knowledge**

Describes what relationship exists between concepts/ objects.

Learning:

Learning is acquiring new or modifying existing knowledge, behaviors, skills, values and may involve synthesizing different types of information.

Machine learning, a branch of AI, is a scientific discipline concerned with the design and development of algorithms that allow computers to evolve behaviors based on empirical data such as from sensor data or database.

Inferential Knowledge

Natural language understanding requires inference i.e., assumptions about what is typically true of the objects or situations under consideration. Such information can be coded in structures known as frames.

- **Need of Frames**

Frame is a type of diagram used in many AI applications including vision and natural language processing. Frames provide a convenient structure for representing objects that are typical to a conventional situations. The

situations to represent may be visual scenes, structure of complex physical objects, etc.

A frame is similar to a record structure and corresponding to the fields and values are slots and slot fillers. Frame systems usually have collection of frames connected to each other. Value of an attribute of one frame may be another frame.

A frame for a book is given below.

Slots	Fillers
publisher	Thomson
title	Expert Systems
author	Giarratano
edition	Third
year	1998
pages	600

Intelligent agents and its type and performance measures

An Intelligent Agent perceives it environment via sensors and acts rationally upon that environment with its effectors (actuators). Hence, an agent gets percepts one at a time, and maps this percept sequence to actions.

Properties

– Autonomous

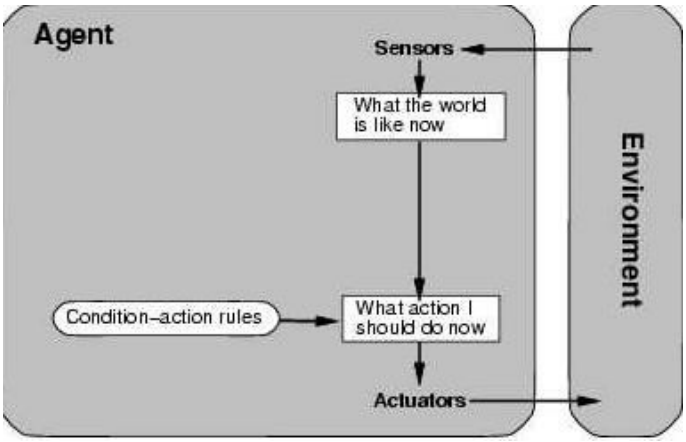
– Interacts with other agents plus the environment

– Reactive to the environment

– Pro-active (goal- directed)

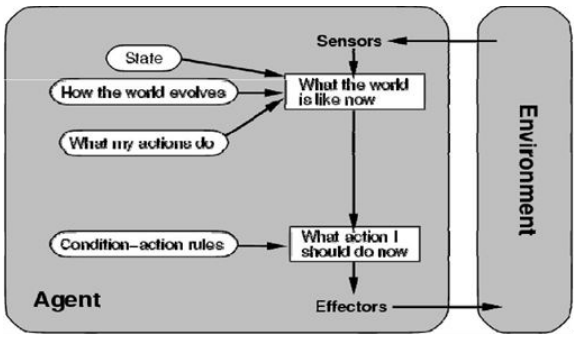
Types of Agent

- **Simple Reflex Agent**



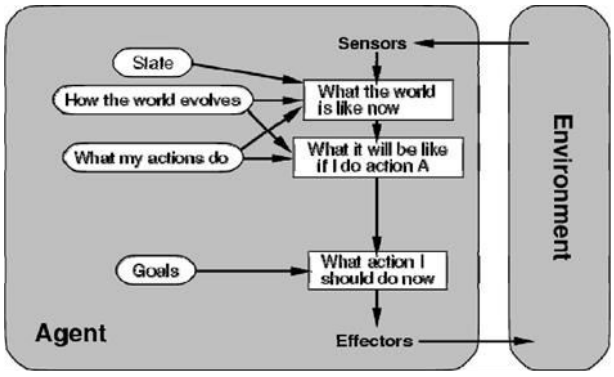
  - They choose actions only based on the current percept.
  - They are rational only if a correct decision is made only on the basis of current precept.
  - Their environment is completely observable

- **Model Based Agents (Reflex Agent with Internal State)**



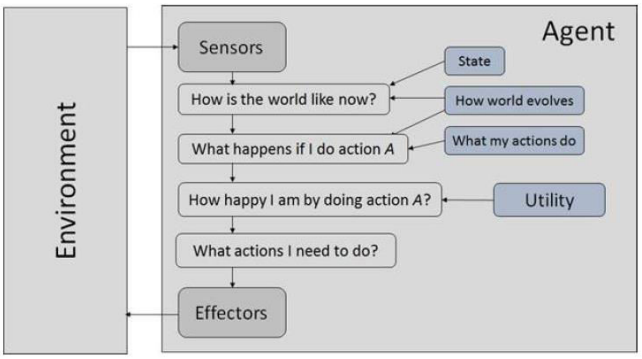
  - They use a model of the world to choose their actions. They maintain an internal state.
  - **Model** − the knowledge about how the things happen in the world.
  - **Internal State** − It is a representation of unobserved aspects of current state depending on percept history.

- **Goal Based Agents**



  They choose their actions in order to achieve goals. Goal-based approach is more flexible than reflex agent since the knowledge supporting a decision is explicitly modeled, thereby allowing for modifications.

- **Utility Based Agents**



  - They choose actions based on a preference *utility* for each state. Goals are inadequate when −There are conflicting goals, out of which only few can be achieved.
  - Goals have some uncertainty of being achieved and you need to weigh likelihood of success against the importance of a goal.

PEAS

To design a rational agent we must specify its task environment. Standing for performance, environment, actuators and sensors, PEAS define task environments about formulating the performance of intelligent agents.

Q. Point out the task of designing an automated taxi driver according to PEAS description.

- Performance measure: Safe, fast, legal, comfortable trip, maximize profits
- Environment: Roads, other traffic, pedestrians, customers
- Actuators: Steering wheel, accelerator, brake, signal, horn

- Sensors: Cameras, sonar, speedometer, GPS, odometer, engine sensors and keyboard

Q. Point out the task of designing a Medical diagnosis system according to PEAS description

- Performance measure: Healthy patient, minimize costs, lawsuits
- Environment: Patient, hospital, staff
- Actuators: Screen display (questions, tests, diagnoses, treatments, referrals)
- Sensors: Keyboard (entry of symptoms, findings, patient's answers)

Q. Machines can be made intelligent artificially but ultimately persons make the machines. So who is more intelligent - the artificial machine or the person? Discuss

Ans: Human have done considerable work in designing a machine but the machine may not need to do very much to operate well. An example is, thermostat. It is difficult to design a thermo stat so that it turns on and off at exactly the right temperature but the thermostat itself does not have to do more computations.

All the logic behind making the machine specifies what needs to be mechanized and how to be machinated but not in vice versa. The AI reasoning in human involves all the possibilities to determine how to make a complete machine. The natural intelligence of human made the AI which may not cope on real time. Hence, the above point are supportive on the favor of the humans.

What can AI systems do and don't do

Today's successful AI systems operate in well-defined domains and employ narrow, specialized knowledge. Common sense knowledge is needed to function in complex, open-ended worlds. Such a system also needs to understand unconstrained natural language. However these capabilities are not yet fully present in today's intelligent systems.

What can AI systems do	What can AI systems NOT do yet?
Today's AI systems have been able to achieve limited success in some of these tasks. • In Computer vision, the systems are capable of face recognition • In Robotics, we have been able to make vehicles that are mostly autonomous. • In Natural language processing, we have systems that are capable of simple machine translation. • Today's Expert systems can carry out medical diagnosis in a narrow domain • Speech understanding systems are capable of recognizing several thousand words continuous speech	• Understand natural language robustly (e.g., read and understand articles in a newspaper) • Surf the web • Interpret an arbitrary visual scene • Learn a natural language • Construct plans in dynamic real-time domains • Exhibit true autonomy and intelligence