ARTIFICIAL INTELLIGENCE (Practical – 3 Units)

Aim: This course is designed to introduce the learner to fundamental concepts and understanding of Artificial Intelligence.

Objectives
By the end of the course the student should be able to:

- To expose the students to the evolution of artificial intelligence and applications
- To introduce students to knowledge representation concepts
- To introduce students to AI programming
- To introduce students to search algorithms.

Expected Learning Outcomes
By the end of the course, the learner should be able to:

- Explain the basic techniques and principles of AI;
- Describe the applications of AI; and
- Apply AI programming skills to problem solving.
- Explain search algorithms as used in AI.

Course Content
Introduction and scope. Overview of main areas. History of AI: The Turing Test; The Chinese Room. Social impact of artificial intelligence. Criticism of AI. Applications of AI:. Man-Machine Interface (MMI): design criteria for MMI, input and output devices, the eye and vision, the ear and hearing. Knowledge Representation: Symbolic and Non-symbolic. Natural language processing. Knowledge representation. Learning systems: Artificial Neural networks, evolutionary systems. Artificial intelligence programming. Expert system development and tools. Search strategies: heuristic, best-first, breadth-first, depth first, A* techniques. Natural Language Processing PROLOG programming language. Intelligent Agents, Future of AI.

Mode of Delivery
This is a practical course and delivery shall be by lectures and lab work.

Assessment
Continuous Assessment Tests (CATs): 30%
End of Semester Written Examinations: 70%

Learning Materials
Core reading Material
Nilsson, N. J. (2014). *Principles of artificial intelligence*. Morgan Kaufmann.

Recommended Reference material
Anderson, J. R. (1986). *Machine learning: An artificial intelligence approach* (Vol. 2). R. S. Michalski, J. G. Carbonell, & T. M. Mitchell (Eds.). Morgan Kaufmann.

ARTIFICIAL INTELLIGENCE - LECTURE 1

Intelligence is the computational part of the ability to achieve goals in the world. It involves mental processes such as creativity, solving problems, pattern recognition, classification, learning, optimization, language processing and knowledge.
The progress of complexity of the terms associated with information is as follows:-
Data > Information> Knowledge > intelligence

Artificial Intelligence:-

- A branch of computer science that studies and develops intelligent machines and software.
- AI is the study and design of intelligent agents, where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.
- It is similar to the task of using computers to mimic human intelligence.
- Artificial Intelligence is a branch of Science which deals with helping machines find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence, and applying them as algorithms in a computer friendly way.

The *goals* of AI research include **reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects.** Artificial Intelligence aims to improve machine behavior in tackling such complex tasks.
The **philosophy of artificial intelligence** attempts to answer such questions as:

- Can a machine act intelligently?
- Can it solve any problem that a person would solve by thinking?
- Are human intelligence and machine intelligence the same?
- Is the human brain essentially a computer?
- Can a machine have a mind, mental states and consciousness in the same sense humans do?
- Can it feel how things are?

Limitations

- All the traits of human intelligence have not been captured and applied together to generate an intelligent artificial creature. Currently, Artificial Intelligence seems to focus on specific applications, which do not necessarily require the full extent of AI capabilities. This limit of machine intelligence is known to researchers as *narrow intelligence.*
- There is little doubt among the community that artificial machines will be capable of intelligent thought in the near future. The machines may be pure silicon, quantum computers or hybrid combinations of manufactured components and neural tissue. Expect great things to happen within this century.
- The entire foundation of artificial intelligence is based on informatic procedures - that means to circumscribe the intelligent behavior of a human being.
- *The two pillars of computer science, "0" and "1" together with the truth values "True" and "False" are major borders in artificial intelligence.* Any intelligent information procedure is decomposed eventually in strings of "0" and "1", which leads us to the fundamental objection that intelligent machines will never be like humans. We have to consider that bio-systems also work with intermediary values.
- *Artificial intelligence is based very much on symbolic logic, and has not succeeded in involving so-called affective logic*. In **affective** logic, combinations of truth values may lead to different evaluations. A possible solution could be obtained by using affective computing, which undertakes to model affective behavior in various situations. **Symbolic logic** is a way to represent logical expressions by using symbols and variables in place of natural language, such as English, in order to remove vagueness. Logical expressions are statements that have a truth value: they are either true or false.

Generally AI research aims to create AI that can replicate human intelligence completely.
AI gives four possible goals to pursue:-

- Systems that think like humans
- Systems that think rationally
- Systems that act like humans
- Systems that act rationally

Most AI work falls in the **Laws of thought** and **rational agents**.

General AI Goal
- Replicate human intelligence
- Solve knowledge intensive tasks
- Make an intelligent connection between perception and action
- Enhance human-human, human-computer and computer-computer interaction

Engineering based AI goal
- Develop concepts, theory and practice of building intelligent machines.
- Emphasis in systems building

Science based AI goals
- Develop concepts, mechanisms and vocabulary to understand biological intelligent behavior.

Branches of AI
- **Logical AI -** What a program knows about the world in general the facts of the specific situation in which it must act, and its goals are all represented by sentences of some mathematical logical language.
- **Search -** AI programs often examine large numbers of possibilities, e.g. moves in a chess game or inferences by a theorem proving program. Discoveries are continually made about how to do this more efficiently in various domains.
- **Pattern recognition -** When a program makes observations of some kind, it is often programmed to compare what it sees with a pattern. For example, a vision program may try to match a pattern of eyes and a nose in a scene in order to find a face.
- **Representation -** Facts about the world have to be represented in some way. Usually languages of mathematical logic are used.
- **Inference –** From some facts, others can be inferred. For example, when we hear of a bird, we man infer that it can fly, but this conclusion can be reversed when we hear that it is a penguin.
- **Common sense knowledge and reasoning -** This is the area in which AI is farthest from human-level.
- **Learning from experience -** Programs can only learn what facts or behaviors their formalisms can represent, and unfortunately learning systems are almost all based on very limited abilities to represent information.
- **Planning -** Planning programs start with general facts about the world (especially facts about the effects of actions), facts about the particular situation and a statement of a goal. From these, they generate a strategy for achieving the goal.
- **Epistemology -** This is a study of the kinds of knowledge that are required for solving problems in the world.
- **Ontology -** Ontology is the study of the kinds of things that exist. In AI, the programs and sentences deal with various kinds of objects, and we study what these kinds are and what their basic properties are.
- **Heuristics -** A heuristic is a way of trying to discover something or an idea imbedded in a program. *Heuristic functions* are used in some approaches to search to measure how far a node in a search tree seems to be from a goal. *Heuristic predicates* compare two nodes in a search tree to see if one is better than the other,
- **Genetic programming -** Genetic programming is a technique for getting programs to solve a task by selecting the fittest in millions of generations.

AI involves:-

- How knowledge is acquired, represented and stored.
- How intelligent behavior is generated and learned.
- How motives, emotions and priorities are developed and used.
- How sensory signals are transformed into symbols.
- How symbols are manipulated to perform logic, to reason about the past and plan the future.
- How mechanisms of intelligence produce the phenomena of illusion, belief, hope, fear, dreams, kindness and love.

There are two thoughts of AI:

1. **Strong AI** is artificial intelligence that matches or exceeds human intelligence — the intelligence of a machine that could successfully perform any intellectual task that a human being can.

Strong AI refers to a machine that approaches or supersedes human intelligence,
If it can do typically human tasks,
If it can apply a wide range of background knowledge and
If it has some degree of self-consciousness.

2. **Soft or Weak AI** refers to the use of software to study and accomplish specific problem solving or reasoning tasks that do not encompass the full range of human cognitive abilities – it does not achieve self-awareness.
Weak AI does not achieve self-awareness; it demonstrates wide range of human-level cognitive abilities; it is merely an intelligent, a specific problem-solver.

Advantages & Disadvantages of Artificial Intelligence

Like everything else, artificial intelligence comes with its own share of advantages and disadvantages.

Advantages

- Tireless performance of tasks makes for one of the biggest advantages of artificial intelligence. Unlike humans who need to take a break, a machine can get a particular job done quickly.
- With artificial intelligence ‘copying’ becomes that much easier. Copying here refers to the training of an artificial mind to perform a particular task. Training an artificial mind to do some task is a slightly more feasible that training human.
- With an artificial mind it is about making logical and feasible decisions and so much lesser about giving into emotions. Maybe this is because an artificial mind feels no real emotions to speak of.
- Artificial intelligence finds applications in space exploration. Intelligent robots can be used to explore space. They have the ability to endure the hostile environment of the interplanetary space.
- Intelligent robots can be programmed to reach the Earth's core. They can be used to dig for fuels. They can be used for mining purposes. The intelligence of machines can be harnessed for exploring the depths of oceans. These machines serve human so well especially where human intelligence has serious limitations.
- Intelligent machines can do certain laborious tasks. Painstaking activities, which have long been carried out by humans can be taken over by the robots.
- Intelligent machines can be employed to do certain dangerous tasks. Machines equipped with artificial intelligence can be made to thoughtfully plan towards the fulfillment of tasks and accordingly adjust their parameters such as their speed and time. They can be made to act quickly, unaffected by anything like emotion and take the tasks towards perfection.

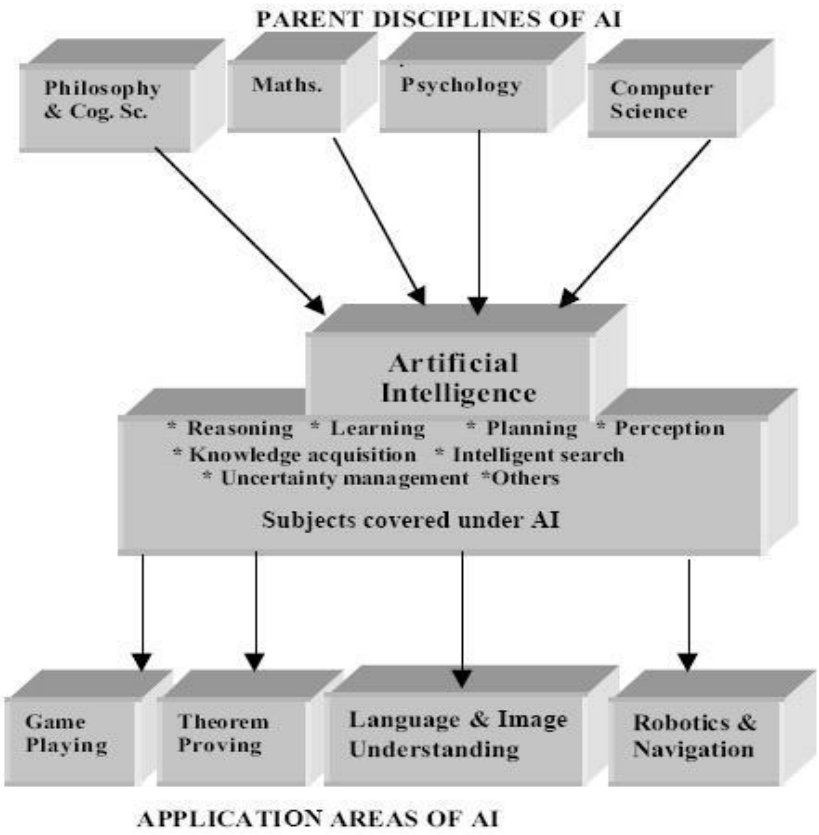
Disadvantages

- The risk of a breakdown - Artificial intelligence is all about the effortless performance of a job, but in the event of a breakdown, the whole picture can turn shady.
- The imminent risk of a loss of data. In certain cases, due to the malfunction of certain components, a machine can fail to keep within its memory the files that it should have.

- Computer systems or artificial minds need to be shut down on a regular basis for maintenance work. This can be a deterrent to productivity and to the general welfare of the organization in question.
- If robots start replacing human resources in every field, we will have to deal with serious issues like unemployment in turn leading to mental depression, poverty and crime in the society. Human beings deprived of their work life may not find any means to channelize their energies and harness their expertise.
- There are many jobs that require the human touch. Intelligent machines will not be able to substitute for the caring behavior of hospital nurses or the promising voice of a doctor. Intelligent machines may not be the right choice for customer service.
- We might be able to make intelligent machines think. But will we be able to make them feel? Intelligent machines will definitely be able to work for long hours. But will they do it with dedication? Will they work with devotion?
- There are chances that intelligent machines overpower human beings. Machines may enslave human beings and start ruling the world.
- Some thinkers consider it ethically wrong to create artificial intelligent machines. Intelligence is God's gift to mankind. It is not correct to even try to recreate intelligence. It is against ethics to create replicas of human beings.

Applications of AI

- **Game playing -** There is some AI in game programs which play well against people mainly through brute force computation--looking at hundreds of thousands of positions.
- **Speech recognition -** while it is possible to instruct some computers using speech, most users have gone back to the keyboard and the mouse as still more convenient.
- **Understanding natural language -** Just getting a sequence of words into a computer is not enough. The computer has to be provided with an understanding of the domain the text is about, and this is presently possible only for very limited domains.
- **Computer vision -** The world is composed of three-dimensional objects, but the inputs to the human eye and computers' TV cameras are two dimensional. full computer vision requires partial three-dimensional information. At present there are only limited ways of representing three-dimensional information directly, and they are not as good as what humans use.
- **Expert systems -**A ``knowledge engineer'' interviews experts in a certain domain and tries to embody their knowledge in a computer program for carrying out some task. The usefulness of current expert systems depends on their users having common sense.
- **Heuristic classification -** One of the most feasible kinds of expert system given the present knowledge of AI is to put some information in one of a fixed set of categories using several sources of information. An example is advising whether to accept a proposed credit card purchase. Information is available about the owner of the credit card, his record of payment and also about the item he is buying and about the establishment from which he is buying it (e.g., about whether there have been previous credit card frauds at this establishment).



AI Approaches

The approaches followed are defined by choosing goals of the computational model, and basis for evaluating performance of the system.
Cognitive Science: Think human-like is an exciting new effort to make computers think that it is, the machines with minds, in the full and literal sense. The focus is not just on behavior and I/O, but looks at reasoning process, Computational model as to how results were obtained.
The goal is not just to produce human-like behavior but to produce a sequence of steps of the reasoning process, similar to the steps followed by a human in solving the same task..
An **agent** is an entity that perceives and acts.

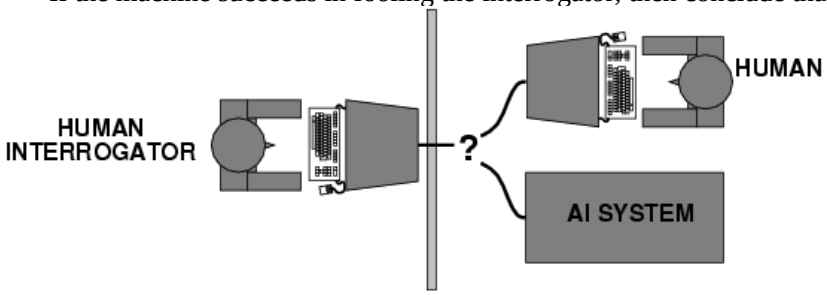
Laws of Thought: Think Rationally

The study of mental faculties through the use of computational models; that it is, the study of the computations that make it possible to perceive, reason and act.
Develop systems of representation to allow inferences to be like “Socrates is a man. All men are mortal. Therefore Socrates is mortal.”
The goal is to formalize the reasoning process as a system of logical rules and procedures for inference.
The issue is, not all problems can be solved just by reasoning and inferences.

Turing Test : Act Human-like
The art of creating machines that perform functions requiring intelligence when performed by people; that it is the study of, how to make computers do things which at the moment people do better.
Focus is on action, and not intelligent behavior centered around representation of the world.
A Behaviorist approach is not concerned with how to get results but to the similarity to what human results are.

Example: Turing Test

- 3 rooms contain: a person, a computer, and an interrogator.
- The interrogator can communicate with the other 2 by teletype (to avoid the machine imitate the appearance or voice of the person).
- The interrogator tries to determine which is the person and which is the machine.
- The machine tries to fool the interrogator to believe that it is the human, and the person also tries to convince the interrogator that it is the human.
- If the machine succeeds in fooling the interrogator, then conclude that the machine is intelligent.



Goal is to develop systems that are human-like.

To pass the Turing test, a computer would need at least the following skills:

- Intelligent Environment: Environment for a system is intelligent
- Environment may include other intelligent systems
- Intelligent Interaction: Interaction, between a system and its environment (including other systems), is intelligent

The suggested major components of AI: *knowledge, reasoning, language understanding and learning.*

CAT 1

1. Semantic networks are an alternative to predicate logic as a form of knowledge representation. Design a network to represent the following logic:-[6 MKS]

Robin is a cat.
Robin caught a bird.
Robin is owned by John.
Robin is ginger in colour.
Cats like cream.
The cat sat on the mat.
A cat is a mammal.
A bird is an animal.
All mammals are animals.
Mammals have fur.

2. Develop a direct Prolog representation that can be used, with classes represented by predicates for the solution in a above. [8 MKS]
3. Explain the following algorithms, in each indicate whether its state of being either complete and optimal. [16MKS]
    a. breadth-first search
    b. depth-first search
    c. depth-limited search
    d. iterative deepening search