19/11/18 :

Artificial Intelligence (R-16)

→ AI is a branch of Computer science concerned with the study and creation of computer systems that exhibit some form of Intelligence:

1) systems that learn new concepts & tasks
2) " that can reason & draw useful conclusion about the world around us
3) " that can understand a natural lang or perceive and comprehend a visual scene
4) " that can perform other types of fact that require human types of Intelligence or in other words

"AI is the study of mental faculties through the use of computational models".
Charnaik & Mc. Dermott 1985

→ Understanding of AI requires Intelligence, knowledge, reasoning, through cognition learning and a no. of computer related terms.

Intelligence — Ability to acquire, understand and apply knowledge
(or)
Capability to learn and solve problems

→ Foundation of AI was laid with development of Boolean Theory & principles by a mathematician named Boole and others researchers.

→ Since the invention of the 1st computer in 1943, AI has been of Interest to the researchers as they have always aimed to make machines more Intelligent than humans & tried to simulate Intelligent behaviour.

→ Over the last six decades, AI has grown substantially, starting from simple program to Intelligent ~~behaviour~~ programs such as programs for playing games, expert systems, Intelligent robots.

→ AI researchers generally use one of the two basic approaches namely bottom-up and top-down for creating Intelligent m/c.

→ Bottom-up approach belief is to achieve AI by building replicas of the human brain which is a complex n/w of neurons

→ Top-down approach, mimic the behaviour of brain with computer programs.

→ AI currently comprises of a huge variety of sub-fields ranging from general-purpose areas such as perception, logical reasoning, to specific tasks such as game playing, theorem proving & diagnosing diseases, etc.

→ Scientists of other fields use tools of AI to systematize & automate the intelligent tasks of their fields.

→ This field is truly multi-disciplinary field and is based on the work done in different ~~locations~~ disciplines such as logic, cognition, linguistics, philosophy, psychology anthropology, computing etc.

→ AI application problems can be found in all disciplines from SE to film Theory.

→ AI program tend to be large, and it would have not been possible to work unless there is great advancement in speed and memory of computers.

→ AI is one of the newest sciences. work started in ~~early~~ earnest soon after world war II, and the name itself was coined in 1956.

→ AI is regularly cited as the "field I would most like to be in" by scientists in other disciplines.

Ex:- A student in physics might reasonably feel that all good ideas have already been taken by Galileo, Newton Einstein and the rest.

AI on the other hand still has openings for several full-time Einsteins.

→ "Rationality" - A system is rational if it does the "right thing" given what it knows

→ systems that think like humans

→ " act like humans

→ systems that think rationally

→ " act rationally

A Rationalist approach involves a combination of mathematics & Engineering.

→ "Natural lang processing" to enable it communicate successfully in english

→ "knowledge representation" to store what it knows or hears

→ "Automated reasoning" to use the stored info to answer questions and to draw new conclusions.

Challenges to AI

- ✓ perception - perceive the environment via sensors
- ✓ computer vision - (perception via Images/video)
  process visual Info,
  object identification, face recognition, motion tracking)
- ✓ Knowledge representation
- ✓ learning
- ✓ Reasoning / problem solving
- ✓ Robotics

[Heuristics :- Allowing students to learn by discovering things themselves and learning from their own experiences rather than by telling them things.]

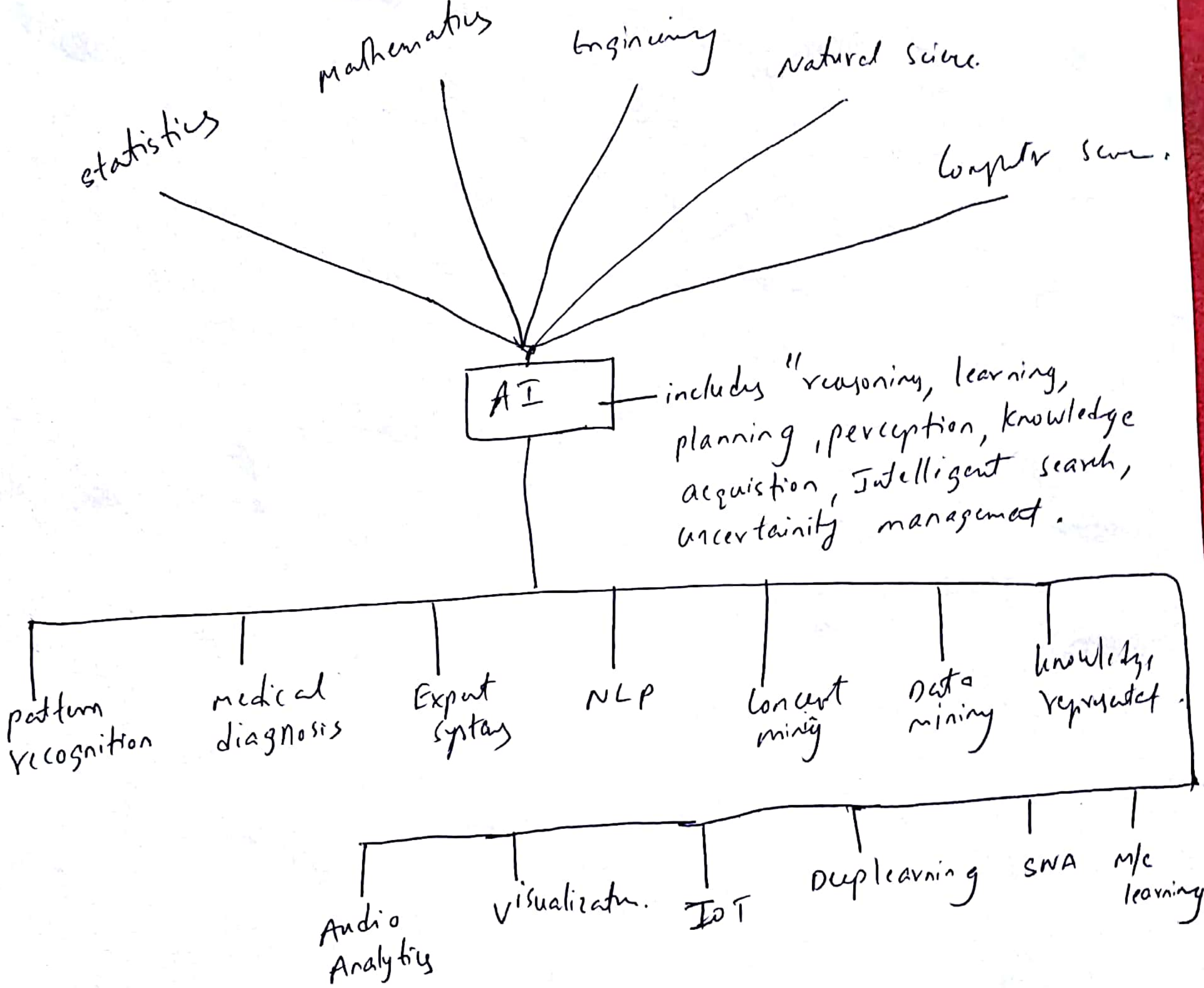
Goals of AI

To create Expert systems - The system which exhibit intelligent behaviour, learn, demonstrate, explain and advice its users

→ AI without programming Vs AI with programming

Applications of AI :-

1) Gaming - AI plays role in strategic games such as chess, poker, tic-tac-toe etc, where machine can think of large no of possible positions based on heuristic knowledge
2) NLP - It is possible to interact with the computer that understands Natural lang spoken by humans
3) Expert systems - It is a computer program that is designed to emulate and mimic human intelligence skills or behaviour.
4) Vision systems -
5) Speech recognition, Robots.
6) machine learning - It is an application of AI that provides systems the ability to automatically learn without being explicitly programmed.


statistics
mathematics
Engineering
Natural Science
Computer Science.
AI
includes "reasoning, learning, planning, perception, knowledge acquistion, Intelligent search, uncertainity management.
pattern recognition
medical diagnosis
Expert systems
NLP
Concept mining
Data mining
knowledge representation.
Audio Analytics
visualization.
IoT
Deeplearning
SNA
M/c learning

History of A.I:-

1950 - No relation b/w human intelligence & machine

1956 - John MC-Carthy arranged conference coined name A.I

1957 - Ist version of AI new program GPS was developed and tested. program developed by Newell and Simon

1958 - Mc.Carthy announced his new development called List processing Language

"Marvin Minsky" of MIT - Computer programs could solve spatial and logic problems.

late 1960 - Another program named "STUDENT" was developed during late 1960 which could solve "algebra".

1960 - Fuzzy set and logic was developed by L.Zadeh that had unique ability to make decisions under uncertain conditions.

Also NN were considered as possible ways of achieving AI.

During the same time, the system named "SHRDLU" was developed by Terry Winograd at the MIT, AI lab as a part of micro worlds project, consisting of research and programming in small words.

"SHRDLU" was a program that carried out a simple dialouge (via teletype) with a user in english, about small world of objects and this program was written in MACLISP.

1970- Frame theory was one of the new methods developed by minsky during 1970 in the development of AI for storing structural knowledge to be used by AI programs.

1970- Another development during the same time was the PROLOG language that was initially proposed by R.Kowalski of Imperial College, London.

1970- Advent of "expert systems" appeared in 1970 when expert systems were designed and developed to predict the probability of a solution under set conditions.

An expert system is a program that uses logical rules that are derived from the knowledge of experts to answers the questions/ solves the problem about the specific domain of knowledge.

Since then various expert systems for applications such as forecasting the stock market, aiding doctors with the ability to diagnose discuss and instracting miners to promising mineral locations were developed

These would have been possible because of large storage capacity at the time and ability to store conditional rules and info.

1980- Research organizations and corporate sector during 1980 started developing AI systems at faster pace. Expert systems were in particular demand because of their efficiency.

Companies such as Digital Electronics were using XCON, an expert system designed to program the large VAX computers. DuPont, General Motors, and Boeing relieved heavily on expert systems.

* New Theories about machine vision was proposal by "David Marr", where it was possible to distinguish an image based on basic info such as shapes, colour, edge, texture and shading of an image.

1985- By 1985, over a hundred companies offered machine vision systems in the U.S.

1986- Work on simulating human brain started from 1986 onwards.
Neural network's were used to simulate brain functioning.

* More recently, work of AI has started from agent point of view.
* Agents are viewed to be entities that receive percepts constantly from dynamic environment and perform actions.
* Agents can be used in solving any problems which requires intelligence.

* Understanding of problem and situations is embedded in agents and the problem is solved.

Intelligent systems:-

As already mentioned earlier, AI is a combination of Computer science, Physiology and philosophy. AI is a broad topic, consisting of different fields, from m/c vision to expert systems.

✓ "John Mc. Carthy" was one of the founders of AI field who stated that AI is the science & engineering of making intelligent m/c's, especially intelligent computer programs.

✓ Different people think of AI differently and there is no unique definition.

✓ AI as the study of making computers do things intelligently.

✓ AI programs must have capability & characteristics of intelligence such as learning, reasoning, inferencing, perceiving and comprehending information

Understanding of AI:-

→ It requires an understanding of related terms such as intelligence, knowledge, reasoning, cognition, learning and a no of other computer-related terms.

→ AI techniques and ideas seems to be harder to understand than most things in computer science.

→ AI programs like human are usually not perfect, and even make mistakes. As people cannot handle numbers well and need not necessarily provide the best solution.

→ AI programs also can be treated as non-numeric (common sense) ways of solving problems.

Two views of AI goals:-

1) The first view is that AI is about duplicating what the (human) brain does (cognitive science).
2) The second view is that AI is about duplicating what the (human) brain SHOULD do, that is, doing things logically/rationally.

→ There are lot of challenges in building systems that mimic the behaviour of the human brain which is made up of billions of neurons.

→ Inorder to classify systems as intelligent, it is necessary to define intelligence.

→ The earliest method to guage the intelligence of a system was the "turing test" was proposed by "Alan Turing" in 1950.

→ It was designed to provide a satisfactory operational definition of intelligence.

→ "Alan Turing" defined intelligent behaviour as the ability to achieve human-level performance in all cognitive tasks, sufficient to fool an interrogator. He said that a system is called intelligent if it has an ability to pass the turing test which is defined informally ~~det~~ as follows.

> A system is said to have passed turing test if a human questioner is unable to determine from repeated questions of any kind, whether he/she is talking to another person or to a machine system.

* The very first so called "Intelligent systems" which was named "ELIZA" passed the Turing test which was written by "Joseph weizenbaum" during the period from 1964 to 1966.

ELIZA:-

ELIZA was a program that conversed with user in English. People were amazed to see this program. The program was able to converse about any subject, because it stored subject information in data banks. The imp feature of ELIZA was has an ability to pick up speech patterns from user's questions and provite responses using those patterns.

The following passage contains dialouse b/w Eliza and a girl. The system indicates the conversation marked as > and user's responses are marked as *.

Conversation

> Hello, I am Eliza
* Can you help me?
> Don't you believe that I can help you?
* Yes
> I see
* I feel depressed
> How long have been feeling depressed?
* Since last month
> That is quite interesting
* What is interesting in this?
> Have you asked anyone else?
* No
> Are you saying no just to be negative?
* No I did not ask anyone
> Why no?
* I do not believe other people
> Say, do you have any psychological problems?
* I do not know
> Tell me more

Characteristics of ELIZA:-

① **Simulation of Intelligence:** Eliza programs are not intelligent at all in real sense. They do not understand the meaning of utterance. Instead these programs simulate Intelligent behaviour quite effectively by recognizing keywords & phrases.

② **Quality of Response:-** It is limited by the sophistication of the ways in which they can process the i/p text at a syntactic level.

③ **Coherence:-** The earlier version of the system imposed no structure on the conversation. Each statement was based entirely on the current i/p and no context info was used. more complex versions of Eliza can do a little better.

④ **Semantics:-** Such systems have no semantic representation of the content of either the user's i/p or the reply. That is why we say that it does not have intelligence of understanding of what we are saying.

Categorization of Intelligent Systems:-

1. Systems that think like humans
2. " " act like humans
3. " " thinks rationally
4. " " act rationally

① **Thinking humanly**: (The cognitive modeling Approach)

we need to get inside actual working of the human mind.

(a) Through introspection - trying to capture our own thoughts as they go by
(b) Through psychological experiments

Allen Newell and Herbert Simon, who developed GPS - General problem solver, tried to trace the reasoning steps to trace of human ~~objects~~ subjects solving the same problems. The interdisciplinary field of cognitive science brings together computer models from AI and experimental techniques from psychology to try to construct precise and testable theories of the workings of human mind.

② **Acting Humanly**: ~~The~~ (The Turing Test Approach)

Already written in previous page - pls refer

To pass the complete turing Test, the computer will need

* Computer Vision - To perceive the objects
* Robotics - to manipulate objects and move about.

③ **Thinking rationally**: (The laws of thought approach)

"Aristotle" was one of the first to attempt to codify "right thinking" that is irrefutable reasoning process. His syllogism provided patterns for argument structures that always yielded correct conclusions when given correct premises.

Ex:- Socrates is a man; all men are mortal; Therefore Socrates is mortal.

④ **Acting rationally:** (The rational agent approach)

An agent is something that acts. Computer agents are not mere programs, but they are expected to have the following attributes also.

① operating under autonomous control
② perceiving their environment
③ persisting over a prolonged time period
④ Adopting to change

A rational agent is one that acts ~~as~~ so as to achieve best outcome.

Foundations of AI:-

Commonly used AI techniques and theories are rule-based, fuzzy logic, neural networks, decision theory, statistics, probability theory, genetic algorithms. etc. Since AI is interdisciplinary in nature, foundations of AI are in various fields such as.

- ✓ Mathematics
- ✓ Neuroscience
- ✓ Control theory
- ✓ Linguistics

1) **Mathematics:-** AI systems use formal logical methods and Boolean logic (Boole, 1847), analysis of limits to what can be computed, probability theory, uncertainity that forms the basic for most modern approaches to AI, fuzzy logic etc.

2) **Neuroscience:-** This science of medicine helps in studying the functioning of brains. In early studies, injured and abnormal people were used to understand what parts of brain work. Now recent studies use accurate sensors to correlate brain activity to human thought. By monitoring individual neuron, monkeys can now control a computer mouse using thought alone. Moore's law states that the computers will have as many gates as human have neurons in the year 2020. Researchers are working to know as to how to have a mechanical brain. Such systems will requires parallel computation, remapping & interconnections to a large extent.

3) Control Theory :- Machines can modify their behaviour in response to the environment (sense/action loop).
Ex:- water-flow regulator.

This theory of stable feedback systems helps in building systems that transition from initial state to goal state with minimum energy.

4) Linguistics:- Speech demonstrates so much of human intelligence. Analysis of human language reveals thought taking place in ways not understood in other settings. children can create sentences they have never heard before. Languages and thoughts are believed to be tightly interwined.

Sub-areas of AI:-

Each one of these field is an area of research in AI itself. Some of these are listed below.

- ✓ Natural language processing - Google New feature - speech Recognition, automatic voice o/p.
- ✓ Expert systems - Ex: flight tracking systems, clinical systems
- ✓ Neural networks - Ex:- pattern recognition sys such as face recognition,
- ✓ Robotics - Ex:- Industrial robots for moving, spraying, painting, etc
- ✓ Computer Vision - Ex: object recognition, image understanding
- ✓ Data mining - Ex: Fraud detection, Trend Analysis
- ✓ Machine learning - Ex:- decision tree learning, version space learning

Applications of AI:-

AI finds applications in almost all areas of real-life applications. Broadly speaking, business, engineering, medicine, education and manufacturing are the main areas

(1) Business: financial strategies, give advice
(2) Engineering: check design, expert system for all applications
(3) Manufacturing: assembly, inspection and maintenance
(4) medicine: monitoring, diagnosing and prescribing
(5) Education: In teaching
(6) Fraud detection
(7) object Identification
(8) Space Shuttle Scheduling
(9) Information retrieval

Artificial Intelligence(AI)

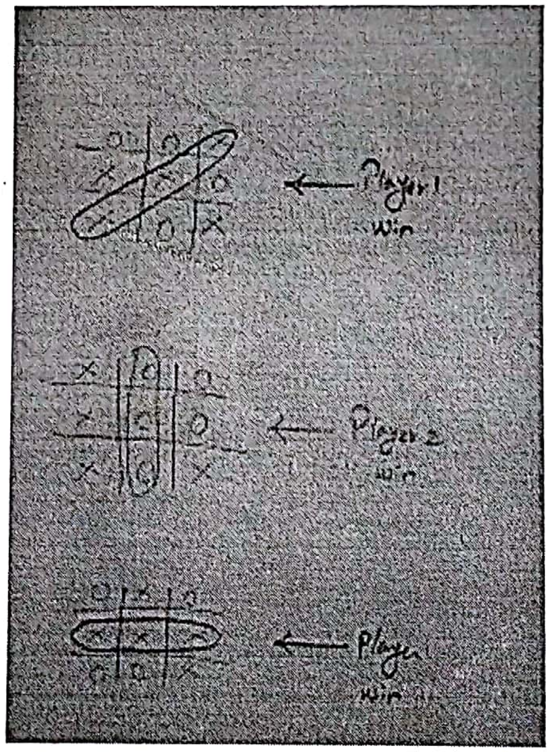
CS6659 - AI Notes

Introductory Problem-Tic Tac Toe

The game **Tic Tac Toe** is also known as **Noughts** and **Crosses** or **X**s and **O**s ,the player needs to take turns marking the spaces in a 3x3 grid with their own marks,if 3 consecutive marks (**Horizontal, Vertical,Diagonal**) are formed then the player who owns these moves get won. We present here three approaches to play this game which increases in a) complexity b) use of generalization c) clarity of their knowledge d) Extensibility of their approach.

Assume ,

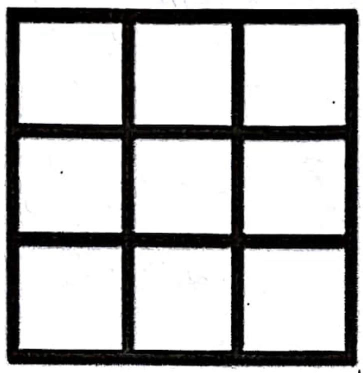
Player 1 - X
Player 2 - O



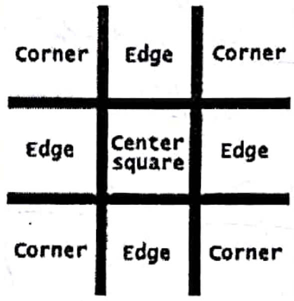
So,a player who gets 3 consecutive marks first,they will win the game .

Let's have a discussion about how a board's data structure looks and how the Tic Tac Toe algorithm works.

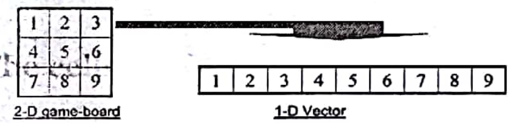
Board's Data Structure:



The cells could be represent as Center square,Corner,Edge as like below



Number each square starts from 1 to 9 like following image



Consider a Board having nine elements vector.Each element will contain

- 0 for blank
- 1 indicating X player move
- 2 indicating O player move

Computer may play as X or O player. First player is always X.

Move Table

It is a vector of 3^9 elements, each element of which is a nine element vector representing board position.

Total of 3^9(19683) elements in move table

Move Table

Index	Current Board position	New Board position
0	000000000	000010000
1	000000001	020000001
2	000000002	000100002
3	000000010	002000010

* The entries of the table are carefully designed manually in advance keeping in mind that computer should never lose.

* Each entry is indexed by decimal representation of current board position digits.

* Initially board is empty

* All the possible Board positions are stored in "Current Board position" column along with its corresponding next best possible board position in "New board position column".

* once the table is designed, the computer programs has to simply do the table lookup. let us write algorithm for the version of a program as follows

Algorithm

To make a move, do the following:

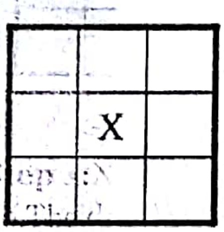
1. View the vector (board) as a ternary number and convert it to its corresponding decimal number.
2. Use the computed number as an index into the move table and access the vector stored there.
3. The vector selected in step 2 represents the way the board will look after the move that should be made. So set board equal to that vector.

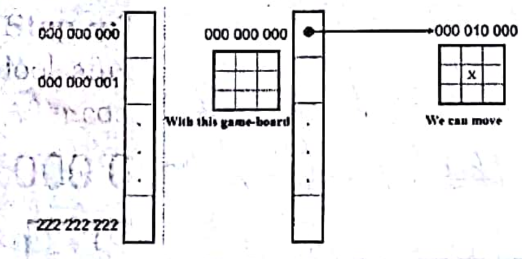
Let's start with empty board

Step 1: Now our board looks like **000 000 000 (**tenary number**)** convert it into decimal no.The decimal no is **0**

Step 2: Use the computed number ie **0** as an index into the move table and access the vector stored in
New Board Position.
The new board position is **000 010 000**
Step 3: The vector selected in step 2(**000 010 000**) represents the way the board will look after the move that should be made. So set board equal to that vector.
After complete the 3rd step your board looks like\

000 010 000





This process continues until the player get win or tie.

Disadvantages:-

This version of the program is very efficient in terms of time but has several disadvantages.

① It requires lot of memory space to store the move table

② To specify entries in move table manually, lot of work is required

③ Creating move table is highly error prone as data to be entered is voluminous

④ This approach cannot be extended to 3D tic-tac-toe. In this 3^{27} board position are to be stored.

⑤ This program is not intelligent at all as it does not meet any of AI requirements.

Let us develop 2nd version of the program using approach 2 which makes use of human style of playing game. Here again the board is represented by 9 element vector. We hard code the fact that initially computer at its chance plays in the center, if possible otherwise tries the various non-corner squares.

Approach - 2

The board B[1 --- 9] is represented by a nine-element vector. In this case we choose the following digits to represent blank, X player and O player moves. The Choice of these digits will be clear in the strategy part given below.

2 - Representing blank position
3 - indicating X player move
5 - indicating O player move

All 9 moves represented by an integer 1 (first move) to 9 (last move). we will use the following three sub procedures.

* Go(n) → using this function Computer can make a move in square n
* Make_2 → This function helps the Computer to make Valid 2 moves.
* PossWin(P) → If player P Can win in the next move then it returns the index from (1 to 9) of the square that constitutes a winning move, otherwise it returns 0.

strategy:-

The strategy applied by human for this game is that if human is winning in the next move then he/she plays in the desired square. else if, human is not winning in the next move then one checks if the opponent is winning. If so then block the square, otherwise try making valid two in any row, Column or diagonal.

The function "PossWin" operates by checking, one at a time, for each of rows/columns and diagonals.

✓ If PossWin(P) = 0, then P cannot win. Find whether opponent can win. If so then block it. This can be achieved as follows.

~~If (3*3*2=18)~~

→ If $(3 \times 3 \times 2 = 18)$ then X player can win as there is one blank square in row, column or diagonal

→ If $(5 \times 5 \times 2 = 50)$ then O player can win.

Let us represent computer by C and human by H. The player who is playing first will called X player. Since computer can be first or second player, Table 1.2 consists of rules to be applied by computer for all nine moves. If C is the first player (playing X), then odd moves are to be choosen otherwise, if C is playing as second player (playing O) then even moves are the ones to be followed by C.

Comments in the Rules are enclosed in { }

P.T.O

Rules for Nine Moves

(C plays X, H plays O)	(H Plays X, C plays O)
1 move: Go(5) / Go(1)	2 move: If B[5] is blank, then Go(5) else Go(1)
3 move: If B[9] is blank then Go(9) else {make 2} Go(3)	4 move: {By now human (playing X) has played 2 moves}: If PossWin(X) then {block X} Go(PossWin(X)) else {make 2} Go(Make_2)
5. move {By now both have played 2 moves}: If PossWin(X) then {X wins} Go(PossWin(X)) else if PossWin(0) {block(0)} then Go(PossWin(0)) else if B[7] is blank then Go(7) else Go(3)	6: move: {By now Computer has played 2 moves}: If PossWin(0) then {0 wins} Go(PossWin(0)) else if PossWin(X) {block(X)} then Go(PossWin(X)) else Go(Make_2)

7 & 9 moves:

{By now human (playing O) has played 3 chances}

```
If PossWin(X)
then
    {X wins}
    Go(PossWin(X))
else ~~if~~
    {block O}
~~If~~If PossWin(O)
then
    Go(PossWin(O))
else
    Go(Anywhere)
```

8 move:-

{By now computer has played 3 chances}:

```
If PossWin(O)
then
    {O wins}
    Go(PossWin(O))
else
    {block X}
If PossWin(X)
then
    Go(PossWin(X))
else
    Go(Anywhere)
```

This version of the program is memory efficient and easier to understand as complete strategy has been determined in advance but has several disadvantages as listed below. It applies heuristics (thumb rules), so can be treated as one step towards AI approach.

Dis-adv:-

1) Not as efficient as 1st one with respect to time. Several conditions are checked before each move.
2) still cannot generalize to 3-D.

Approach 3

In this approach, we choose board position to be a magic square of order 3; blocks numbered by magic number. The magic square of order n consists of n^2 distinct numbers (from 1 to n^2), such that the numbers in all rows, all columns, and both diagonals sum to the same constant. It is generated using the following method if n is odd. There might be various other methods for generating magic square. The one we have used is defined below:

→ It begins by placing 1 in middle of top row, then incrementally placing subsequent numbers in the square diagonally up and right. If a filled square is encountered, move vertically down one square instead, then continue as before. The counting is wrapped around, so that falling off the top returns on the bottom and falling off the right returns on the left. One can easily show that the sum must be $n[(n^2+1)/2]$ for each row, column, and diagonal.

→ The magic square of order 3 is shown in the table 1.3. Sum of each row, column, and both diagonals is 15

Table 1.3 Magic Square of Order 3

8	1	6
3	5	7
4	9	2

In this approach, we maintain a list of the blocks played by each player. For the sake of convenience, each block is identified by its number. The following strategy for possible win for a player is used. Obviously in our case, we are considering a computer to be player for which the strategy is suggested as follows:

- Each pair of blocks a player owns is considered.
- Difference D between 15 and the sum of the two blocks is computed.
  - If $D<0$ or $D>9$, then these two blocks are not collinear and so can be ignored; otherwise if the block representing difference is blank (i.e., not in either list) then player can move in that block.
- This strategy will produce a possible win for a player.

→ It should be noted that first few moves are fixed as given in Table 1.2. To illustrate the method, consider the lists of both the players; say after seventh move assuming that the first player represented by 'X' is human (Table 1.4). Now it is the turn of computer at eighth move.

We choose a convention such that 'eigth block' refers to the block containing the number 08, that is, the first block of magic square.

Table 1.4 Status of both lists after seventh move.

Player					
Player-X (Human)	8	1	4	2	
Player O (Computer)	5	6	3	↓	

At this turn, computer checks if it can win. This checking is done by considering pair-wise blocks from its last and find a block which is collinear. Here $D = 15-(5+3) = 7$ and since seventh block is not in either of the lists, computer can play in this block and declare itself as won. Let us see the execution of program from the start and the strategy used by a computer. (16)

Execution of a program3:- Assume that human is the first player.

→ Turn 1 : suppose H plays in the eigth block

→ Turn 2 : C plays in fifth block (fixed move, see Table 1.2).

→ Turn 3 : H plays in first block

→ Turn 4 : C checks if H can win or not

- Compute sum of blocks played by H
  - S = 8+1 = 9
  - Compute D = 15-9 = 6
- The sixth block is a winning block for H and not there on either list. So, C blocks it and plays in sixth block. The sixth block is recorded in the list of computer.

→ Turn 5: H plays in the fourth block.

→ Turn 6: C checks if C can win as follows:

- compute sum of blocks played by C
  - S = 5+6 = 11
  - compute D = 15-11 = 4; Discard this block as it already exists in X list
- Now C checks whether H can win
  - compare sum of pair of squares from the list of H which have not been used earlier
  - S = 8+4 = 12
  - compute D = 15-12 = 3
- Block 3 is free, so C plays in this block. The third block is recorded in the list of computer.

→ Turn 7 : If H plays in second or ninth block; the computer wins. Let us assume that H plays in second block.

→ Turn 8 : C checks if it can win as follows:

- compute sum of blocks played by C which has not been used earlier
  - S = 5+3 = 8;
- compute D = 15-8 = 7
- Block 7 is free, so C plays in seventh block and wins the game.
- If H plays in seventh block at its Turn 7, then there is a draw

⇒ The program will require much more time than other two as it must search a tree representing all possible move sequences before making each move. But the advantage is that this approach could be extended to handle three-dimensional tic-tac-toe. It could also be extended to handle games more complicated than tic-tac-toe.

Development of AI languages:-

→ AI languages have traditionally been those which stress on knowledge representation schemes; pattern matching, flexible search and programs as data.

→ The typical examples of such languages are LISP, POP-2, ML and Prolog.

→ LISP is a functional language based on lambda Calculus, and Prolog is a logic language based on first-order predicate logic.

→ Both languages are declarative languages where one is concerned about 'what to compute' and not 'how to compute'.

→ Pop-2 (later extended to Pop11) is a stack-based language providing greater flexibility and has some similarity to LISP.

→ POP 11 is embedded in AI programming Environment called Poplog. It permits the mixed use of logic and functional languages like Prolog, LISP & ML provides flexible implementation support.

→ other hybrid ~~pgra~~programming environments exists which focus on the domain level as opposed to the implementation level.

→ For Ex the KLONE family languages support modelling at the knowledge level.

→ Environments such as KEE, ART and CLIPS provide a variety of knowledge representation schemes which helps the AI programmer to integrate object oriented representations with ones based on logic.

Current Trends in AI:-

→ Conventional Computing (Hard Computing) is based on the concept of precise modelling and analyzing to yield accurate results.

→ Hard Computing techniques Work well for simple problems.

→ Furthermore, Soft Computing may be viewed as foundation Components for the emerging field of Conceptual intelligence.

→ Generally, soft Computing techniques resemble biological process more Closely than traditional techniques which are largely based on formal logical systems.

→ The Role model for soft Computing is the human mind

→ Soft Computing a formal Computer Science area of study from the early 1990s refer to a Collection of Computational techniques in Computer Science, m/c learning and Some engineering disciplines, which study, model and analyze very Complex phenomena.

→ Components of Soft Computing include, Neural n/w's, Fuzzy systems, Evolutionary algorithms, Swarm intelligence

→ Neural Networks have been developed based on functioning of the human brain. Attempts to model the biological neuron have led to the development of the field called artificial Neural n/w These Systems have been developed inorder to facilitate predicting features in advance based on the previous details available.

→ Evolutionary techniques mostly involve meta-heuristic optimization algorithms such as evolutionary algorithms (Comprising genetic algorithms, evolutionary programming etc) and swarm intelligence (Comprising ant colony optimization and particle swarm optimization)

→ Genetic algorithms based on Darwin theory of evolution were developed mainly by emulating the nature and behaviour of biological Chromosome. Genetic algorithms are favoured for search problems which require the identification of a global optimal solution without getting stuck in local minima/maxima.

→ "Ant colony algorithms" was developed to emulate the behaviour of real ants and found suitable applications in multi-agents systems to solve difficult combinatorial optimization problems. An ant algorithm is one in which a set of artificial ants (agents) cooperate to find the solution of a problem by exchanging information via phermone deposited on graph edges.

→ "swarm intelligence" is the idea of coordinating massive numbers of individual technology entities to work together. It is a fundamental concept in IT that has been useful and interesting, as well as bit threatening throught the ~~modern~~ development of modern technological progress

→ Emergence of Agent Technology as a sub-field of AI is a significant Paradigm shift for s/w development & break through as a new revolution.

→ Agents are generally situated in some environment and are capable of taking autonomous decisions while solving a problem.

→ There are a wide variety of applications that range from industrial, commercial to medical fields.