

Wolaita Sodo University

School of Informatics

Department of Information Systems

Module Title: Intelligent Systems(Includes AI,ML and KM courses)

Prepared and Compiled by: Samuel B.

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Wolaita Sodo University, Ethiopia

About the Module

This module provides general knowledge on three courses namely fundamentals of artificial intelligence, introduction to machine learning and knowledge management system which are included under intelligent system module. It would come to a great help for graduate class students to be effective in exit exam. We try to overview the main concepts of intelligent system.

Audience

This module is prepared for Graduate class students who will take Exit Exam to guide the main ideas of intelligent system.

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Module I
Fundamentals of Artificial Intelligence



Overview of AI

Since the invention of computers or machines, their capability to perform various tasks went on growing exponentially. Humans have developed the power of computer systems in terms of their diverse working domains, their increasing speed, and reducing size with respect to time.

A branch of Computer Science named *Artificial Intelligence* pursues creating the computers or machines as intelligent as human beings.

What is Artificial Intelligence?

According to the father of Artificial Intelligence John McCarthy, it is *"The science and engineering of making intelligent machines, especially intelligent computer programs".*

Artificial Intelligence is a way of **making a computer, a computer-controlled robot, or a software think intelligently**, in the similar manner the intelligent humans think.

AI is accomplished by studying how human brain thinks, and how humans learn, decide, and work while trying to solve a problem, and then using the outcomes of this study as a basis of developing intelligent software and systems.

Philosophy of AI

While exploiting the power of the computer systems, the curiosity of human, lead him to wonder,

‖Can a machine think and behave like humans do?‖

Thus, the development of AI started with the intention of creating similar intelligence in machines that we find and regard high in humans.

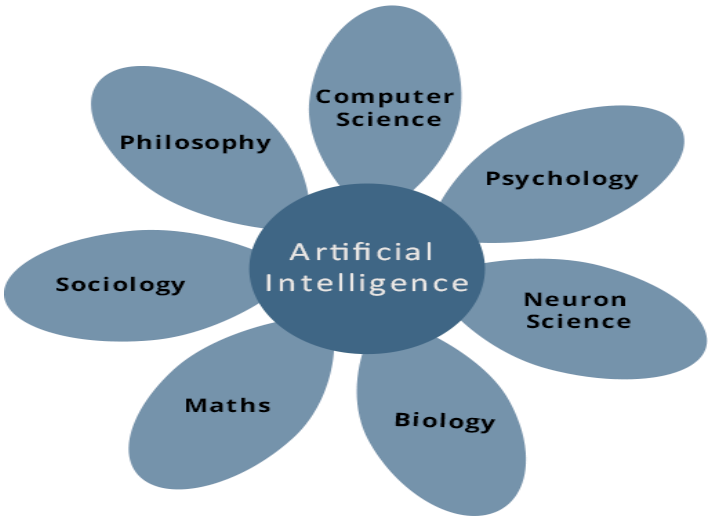
Goals of AI

- **To Create Expert Systems:** The systems which exhibit intelligent behavior, learn, demonstrate, explain, and advice its users.
- **To Implement Human Intelligence in Machines:** Creating systems that understand, think, learn, and behave like humans.

What Contributes to AI?

Artificial intelligence is a science and technology based on disciplines such as Computer Science, Biology, Psychology, Linguistics, Mathematics, and Engineering. A major thrust of AI is in the development of computer functions associated with human intelligence, such as reasoning, learning, and problem solving.

Out of the following areas, one or multiple areas can contribute to build an intelligent system.



Programming Without and With AI

The programming without and with AI is different in following ways:

Programming Without AI	Programming With AI
A computer program without AI can answer the **specific** questions it is meant to solve.	A computer program with AI can answer the **generic** questions it is meant to solve.
Modification in the program leads to change in its structure.	AI programs can absorb new modifications by putting highly independent pieces of information
	together. Hence you can modify even a minute piece of information of program without affecting its structure.
Modification is not quick and easy. It may lead to affecting the program adversely.	Quick and Easy program modification.

What is AI Technique?

In the real world, the knowledge has some unwelcomed properties:

- Its volume is huge, next to unimaginable.
- It is not well-organized or well-formatted.
- It keeps changing constantly.

AI Technique is a manner to organize and use the knowledge efficiently in such a way that:

- It should be perceivable by the people who provide it.
- It should be easily modifiable to correct errors.
- It should be useful in many situations though it is incomplete or inaccurate.

Applications of AI

AI has been dominant in various fields such as:

- **Gaming**

  AI plays crucial role in strategic games such as chess, poker, tic-tac-toe, etc., where machine can think of large number of possible positions based on heuristic knowledge.

- **Natural Language Processing**

  It is possible to interact with the computer that understands natural language spoken by humans.

- **Expert Systems**

  There are some applications which integrate machine, software, and special information to impart reasoning and advising. They provide explanation and advice to the users.

- **Vision Systems**

  These systems understand, interpret, and comprehend visual input on the computer. For example,

  - A spying aeroplane takes photographs which are used to figure out spatial information or map of the areas.
  - Doctors use clinical expert system to diagnose the patient.
  - Police use computer software that can recognize the face of criminal with the stored portrait made by forensic artist.

- **Speech Recognition**

  Some intelligent systems are capable of hearing and comprehending the language in terms of sentences and their meanings while a human talks to it. It can handle different accents, slang words, noise in the background, change in human‘s noise due to cold, etc.

- **Handwriting Recognition**

  The handwriting recognition software reads the text written on paper by a pen or on screen by a stylus. It can recognize the shapes of the letters and convert it into editable text.

- **Intelligent Robots**

Robots are able to perform the tasks given by a human. They have sensors to detect physical data from the real world such as light, heat, temperature, movement, sound, bump, and pressure. They have efficient processors, multiple sensors and huge memory, to exhibit intelligence. In addition, they are capable of learning from their mistakes and they can adapt to the new environment.

Intelligent Systems

While studying artificially intelligence, you need to know what intelligence is. This chapter covers Idea of intelligence, types, and components of intelligence.

What is Intelligence?

The ability of a system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize, and adapt new situations.

Types of Intelligence

As described by Howard Gardner, an American developmental psychologist, the intelligence comes in multifold:

Intelligence	Description	Example
Linguistic intelligence	The ability to speak, recognize, and use mechanisms of phonology (speech sounds), syntax (grammar), and semantics (meaning).	Narrators, Orators
Musical intelligence	The ability to create, communicate with, andunderstand meanings made of sound,understanding of pitch, rhythm.	Musicians, Singers, Composers
Logical-mathematical intelligence	The ability of use and understand relationships in the absence of action or objects. Understanding complex and abstract ideas.	Mathematicians, Scientists

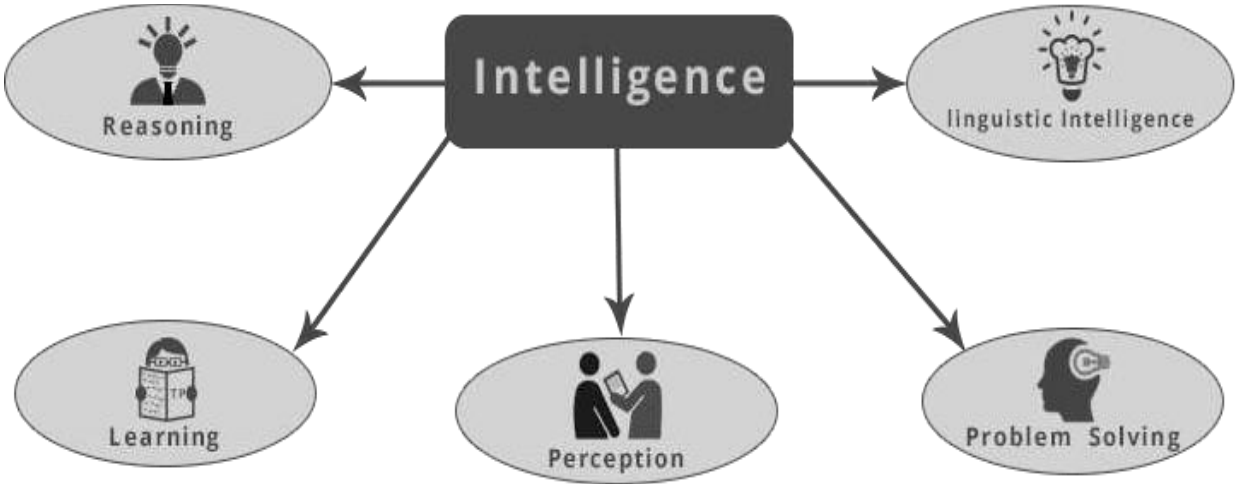
Spatial intelligence	The ability to perceive visual or spatial information, change it, and re-create visual images without reference to the objects, construct 3D images, and to move and rotate them.	Map readers, Astronauts, Physicists
Bodily-Kinesthetic intelligence	The ability to use the complete or part of the body to solve problems or fashion products, control over fine and coarse motor skills, and manipulate the objects.	Players, Dancers
Intra- personal intelligence	The ability to distinguish among one‘s own feelings, intentions, and motivations.	Gautam Buddha
Inter-personal intelligence	The ability to recognize and make distinctions among other people‘s feelings,beliefs, and intentions.	Mass Communicators, Interviewers

You can say a machine or a system is **artificially intelligent** when it is equipped with at least one and at most all intelligences in it.

What is Intelligence Composed of?

The intelligence is intangible. It is composed of:

1. Reasoning
2. Learning
3. Problem-Solving
4. Perception
5. Linguistic Intelligence



Let us go through all the components briefly:

1. **Reasoning:** It is the set of processes that enables us to provide basis for judgement, making decisions, and prediction. There are broadly two types:

Inductive Reasoning	**Deductive Reasoning**
It conducts specific observations to makes broad general statements.	It starts with a general statement and examines the possibilities to reach a specific, logical conclusion.
Even if all of the premises are true in a statement, inductive reasoning allows for the conclusion to be false.	If something is true of a class of things in general, it is also true for all members of that class.
Example: –Nita is a teacher. All teachers are studious. Therefore, Nita is studious.‖	Example: "All women of age above 60 years are grandmothers. Shalini is 65 years. Therefore, Shalini is a grandmother."

2. **Learning:** It is the activity of gaining knowledge or skill by studying, practicing, being taught, or experiencing something. Learning enhances the awareness of the subjects of the study.

The ability of learning is possessed by humans, some animals, and AI-enabled systems. Learning is categorized as:

- **Auditory Learning:** It is learning by listening and hearing. For example, students listening to recorded audio lectures.
- **Episodic Learning:** To learn by remembering sequences of events that one has witnessed or experienced. This is linear and orderly.
- **Motor Learning:** It is learning by the precise movement of muscles. For example, picking objects, Writing, etc.
- **Observational Learning:** To learn by watching and imitating others. For example, child tries to learn by mimicking her parent.
- **Perceptual Learning:** It is learning to recognize stimuli that one has seen before. For example, identifying and classifying objects and situations.
- **Relational Learning:** It involves learning to differentiate among various stimuli on the basis of relational properties, rather than absolute properties. For Example, Adding ‗little less' salt at the time of cooking potatoes that came up salty last time, when cooked with adding say a tablespoon of salt.
- **Spatial learning:** It is learning through visual stimuli such as images, colors, maps, etc. For Example, A person can create roadmap in mind before actually following the road.
- **Stimulus-Response Learning:** It is learning to perform a particular behavior when a certain stimulus is present. For example, a dog raises its ear on hearing doorbell.

3. **Problem solving:** It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.

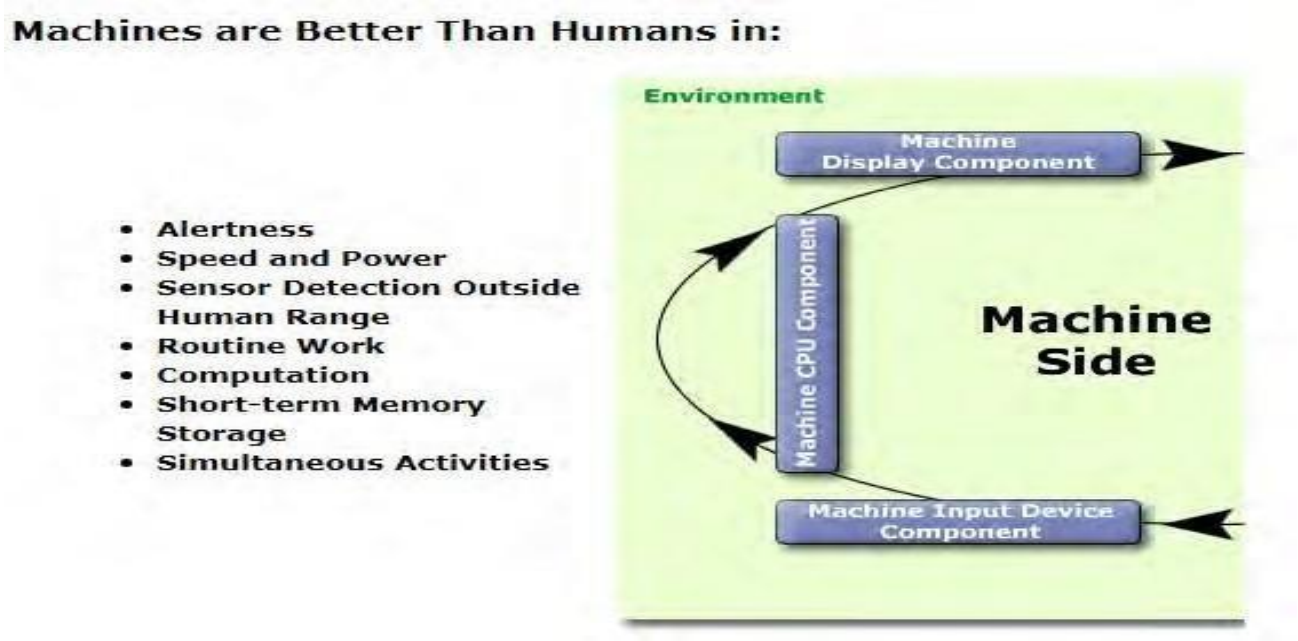
Problem solving also includes **decision making,** which is the process of selecting the best suitable alternative out of multiple alternatives to reach the desired goal are available.

4. **Perception**: It is the process of acquiring, interpreting, selecting, and organizing sensory information. Perception presumes **sensing**. In humans, perception is aided by sensory organs. In the domain of AI, perception mechanism puts the data acquired by the sensors together in a meaningful manner.

5. **Linguistic Intelligence:** It is one's ability to use, comprehend, speak, and write the verbal and writtenlanguage. It is important in interpersonal communication.

Difference between human and machine intelligence

- Humans perceive by patterns whereas the machines perceive by set of rules and data.
- Humans store and recall information by patterns, machines do it by searching algorithms. Forexample, the number 40404040 is easy to remember, store and recallas its pattern is simple.
- Humans can figure out the complete object even if some part of it is missing or distorted; whereas the machines cannot correctly.



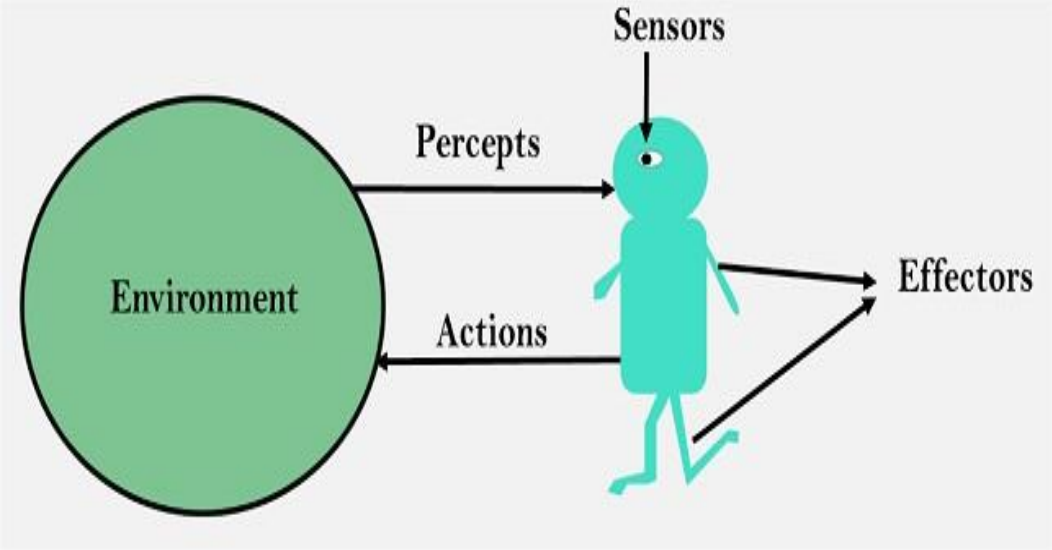
Agents and Environments

An AI system is composed of an agent and its environment. The agents act in their environment. The environment may contain other agents.

What are Agent and Environment?

An **agent** is anything that can perceive its environment through **sensors** and acts upon that **environment** through **effectors**.

- A **human agent** has sensory organs such as eyes, ears, nose, tongue and skin parallel to thesensors, and other organs such as hands, legs, mouth, for effectors.
- A **robotic agent** replaces cameras and infrared range finders for the sensors, and various motors and actuators for effectors.
- A **software agent** has encoded bit strings as its programs and actions.



Agents Terminology

- **Performance Measure of Agent:** It is the criteria, which determines how successful an agentis.
- **Behavior of Agent:** It is the action that agent performs after any given sequence of percepts.
- **Percept**: It is agent‘s perceptual inputs at a given instance.
- **Percept Sequence:** It is the history of all that an agent has perceived till date.
- **Agent Function:** It is a map from the precept sequence to an action.

Rationality

Rationality is nothing but status of being reasonable, sensible, and having good sense of judgment. Rationality is concerned with expected actions and results depending upon what the agent has perceived. Performing actions with the aim of obtaining useful information is an important part of rationality.

What is Ideal Rational Agent?

An ideal rational agent is one, which is capable of doing expected actions to maximize its performance measure, on the basis of:

- Its percept sequence
- Its built-in knowledge base

Rationality of an agent depends on the following:

1. The **performance measures**, which determine the degree of success.
2. Agent‘s **Percept Sequence** till now.
3. The agent‘s **prior knowledge about the environment**.
4. The **actions** that the agent can carry out.

A rational agent always performs right action, where the right action means the action that causes the

agent to be most successful in the given percept sequence. The problem the agent solves is characterized by Performance Measures, Environment, Actuators, and Sensors(PEAS).

The Structure of Intelligent Agents

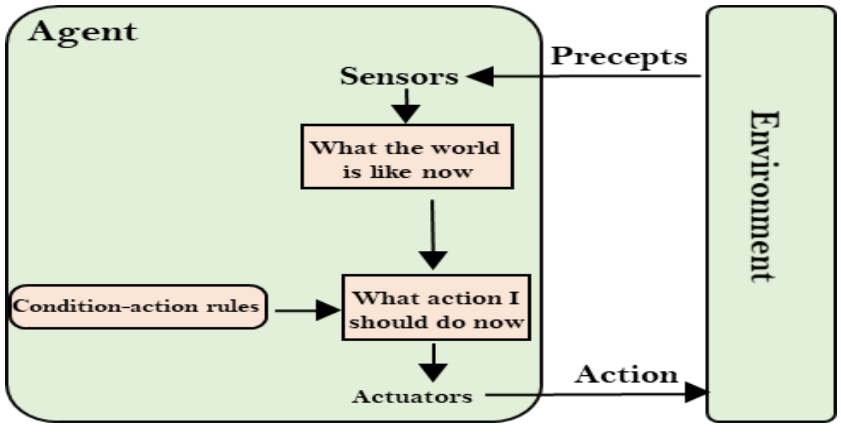
Agent‘s structure can be viewed as:

- Agent = Architecture + Agent Program
- Architecture = the machinery that an agent executes on.
- Agent Program = an implementation of an agent function.

Simple Reflex Agents

- 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.

Condition-Action Rule – It is a rule that maps a state (condition) to an action.



Model-Based Reflex Agents

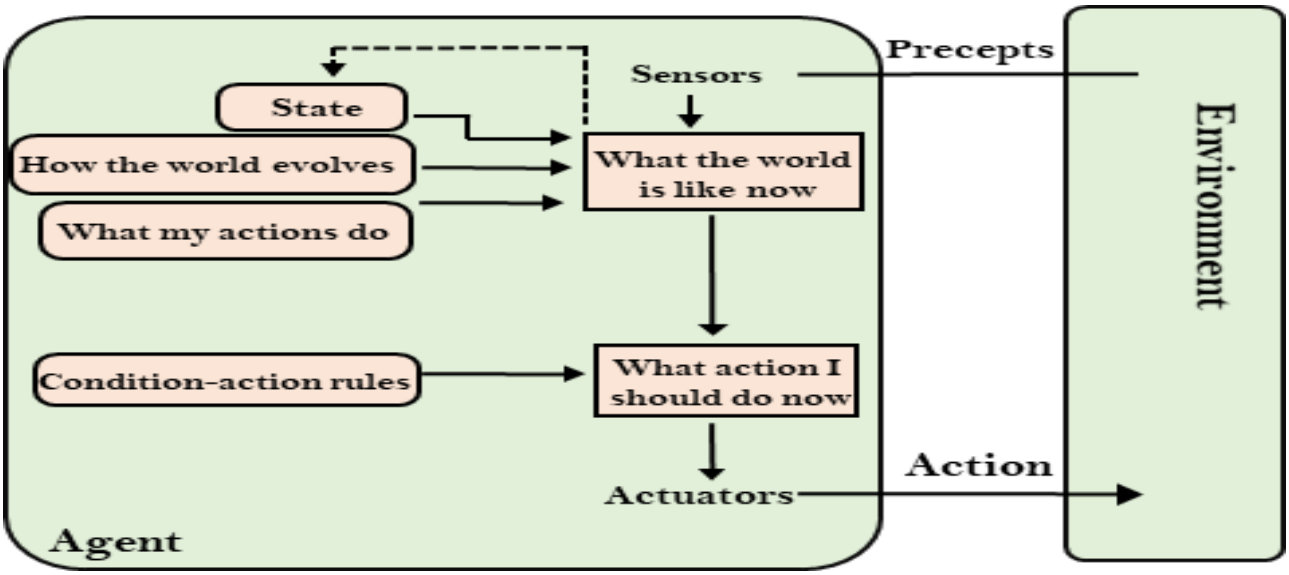
They use a model of the world to choose their actions. They maintain an internal state.

Model: 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.

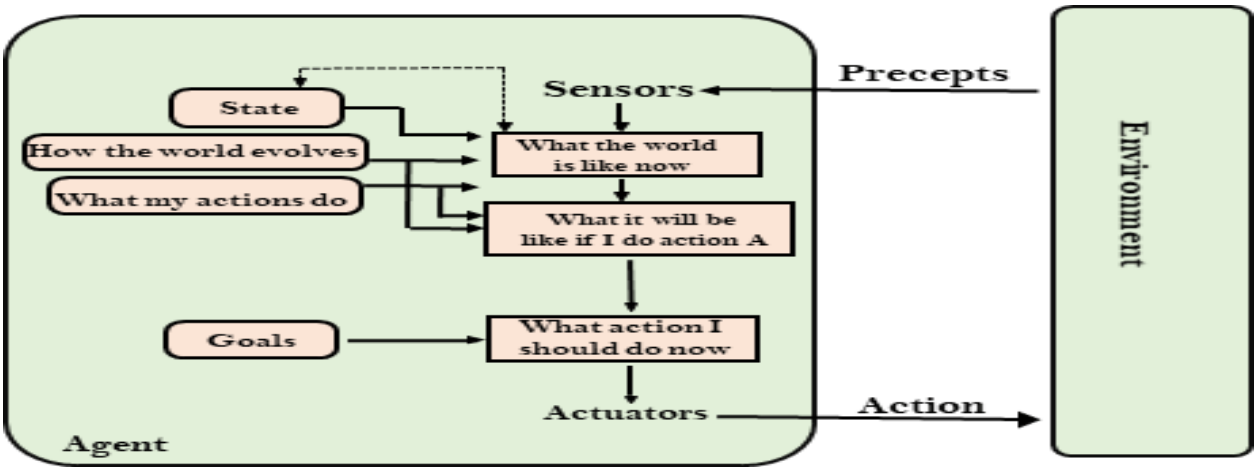
Updating state requires the information about

- How the world evolves.
- How the agent‘s actions affect the world.



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.



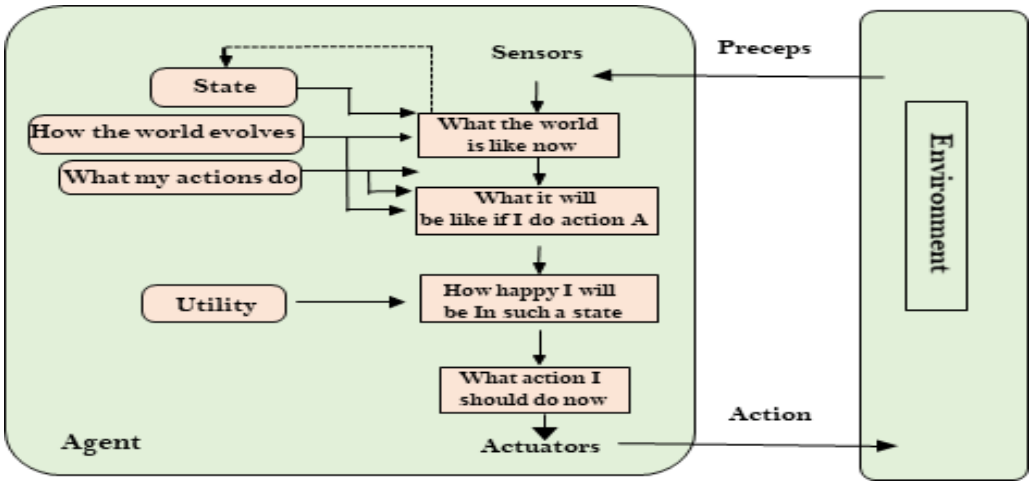
Goal: It is the description of desirable situations.

Utility-Based Agents

They choose actions based on a preference (utility) for each state.

Goals are inadequate when:

- There are conflicting goals only some of which can be achieved.
- Goals have some uncertainty of being achieved and one needs to weigh likelihood of successagainst the importance of a goal.



The Nature of Environments

Some programs operate in the entirely **artificial environment** confined to keyboard input, database, computer file systems and character output on a screen.

In contrast, some software agents (software robots or softbots) exist in rich, unlimited softbots domains. The simulator has a **very detailed, complex environment.** The software agent needs to choose from a long array of actions in real time. A softbot designed to scan the online preferences of the customer and show interesting items to the customer works in the **real** as well as an **artificial** environment.

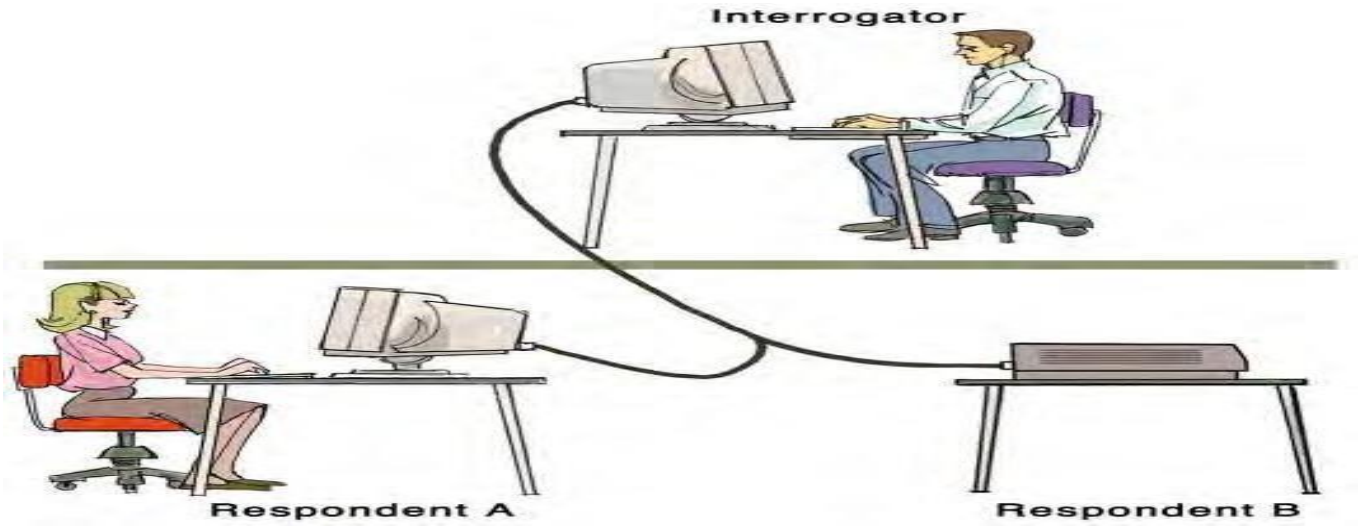
The most famous **artificial environment** is the **Turing Test environment**, in which one real and other artificial agents are tested on equal ground. This is a very challenging environment as it is highly difficult for a software agent to perform as well as a human.

Turing Test

The success of the intelligent behavior of a system can be measured with Turing Test.

Two persons and a machine to be evaluated participate in the test. Out of the two persons, one plays the role of the tester. Each of them sits in different rooms. The tester is unaware of who is machine andwho is a human. He interrogates the questions by typing and sending them to both intelligences, to which he receives typed responses.

This test aims at fooling the tester. If the tester fails to determine machine‘s response from the human response, then the machine is said to be intelligent. In the Turing test, the interrogator must determine which respondent is a computer and which is a human.



Figure

Properties of Environment

The environment has multifold properties:

- **Discrete / Continuous:** If there are a limited number of distinct, clearly defined, states of the environment, the environment is discrete (For example, chess); otherwise it is continuous (Forexample, driving).
- **Observable / Partially Observable**: If it is possible to determine the complete state of the environment at each time point from the percepts it is observable; otherwise itis only partially observable.
- **Static / Dynamic**: If the environment does not change while an agent is acting, then it is static;otherwise it is dynamic.
- **Single agent / Multiple agents**: The environment may contain other agents which may be of the same or different kind as that of the agent.
- **Accessible vs. inaccessible**: If the agent‘s sensory apparatus can have access to the complete state of the environment, then the environment is accessible to that agent.
- **Deterministic vs. Non-deterministic**: If the next state of the environment is completely determined by the current state and the actions of the agent, then the environment is deterministic; otherwise it is non-deterministic.
- **Episodic vs. Non-episodic**: In an episodic environment, each episode consists of the agent perceiving and then acting. The quality of its action depends just on the episode itself. Subsequent episodes do not depend on the actions in the previous episodes. Episodic environments are much simpler because the agent does not need to think ahead.

PopularSearch Algorithms

Searching is the universal technique of problem solving in AI. There are some single-player games such as tile games, Sudoku, crossword, etc. The search algorithms help you to search for a particular position in such games.

Single agent path finding problems

The games such as 3X3 eight-tile, 4X4 fifteen-tile, and 5X5 twenty four tile puzzles are single-agent-path-finding challenges. They consist of a matrix of tiles with a blank tile. The player is required to arrange the tiles by sliding a tile either vertically or horizontally into a blank space with the aim of accomplishing some objective.

The other examples of single agent pathfinding problems are Travelling Salesman Problem, Rubik‘s Cube, and Theorem Proving.

Search terminologies

Problem Space: It is the environment in which the search takes place. (A set of states and set of operators to change those states)

Problem Instance: It is Initial state + Goal state

Problem Space Graph: It represents problem state. States are shown by nodes and operators are shown by edges.

Depth of a problem: Length of a shortest path or shortest sequence of operators from Initial State togoal state.

Space Complexity: The maximum number of nodes that are stored in memory.

Time Complexity: The maximum number of nodes that are created.
Admissibility: A property of an algorithm to always find an optimal solution.
Branching Factor: The average number of child nodes in the problem space graph.
Depth: Length of the shortest path from initial state to goal state.

Brute-Force Search Strategies

They are most simple, as they do not need any domain-specific knowledge. They work fine with small number of possible states.

Requirements –

- State description
- A set of valid operators
- Initial state
- Goal state description

Breadth-First Search

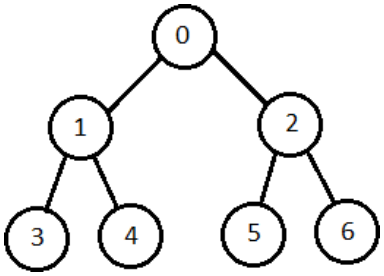
It starts from the root node, explores the neighboring nodes first and moves towards the next level neighbors. It generates one tree at a time until the solution is found. It can be implemented using FIFO queue data structure. This method provides shortest path to the solution.

If **branching factor** (average number of child nodes for a given node) = b and depth = d, then number of nodes at level d = b^d.

The total no of nodes created in worst case is $b + b^2 + b^3 + \ldots + b^d$.

Disadvantage: Since each level of nodes is saved for creating next one, it consumes a lot of memory space. Space requirement to store nodes is exponential.

Its complexity depends on the number of nodes. It can check duplicate nodes.



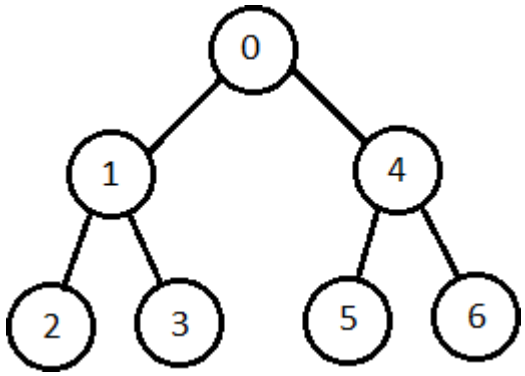
Depth-First Search

It is implemented in recursion with LIFO stack data structure. It creates the same set of nodes as Breadth-First method, only in the different order.

As the nodes on the single path are stored in each iteration from root to leaf node, the space requirement to store nodes is linear. With branching factor *b* and depth as *m*, the storage space is *bm*.

Disadvantage: This algorithm may not terminate and go on infinitely on one path. The solution to this issue is to choose a cut-off depth. If the ideal cut-off is *d*, and if chosen cut- off is lesser than *d*, then this algorithm may fail. If chosen cut-off is more than *d*, then execution time increases.

Its complexity depends on the number of paths. It cannot check duplicate nodes.



Bidirectional Search

It searches forward from initial state and backward from goal state till both meet to identify a common state.

The path from initial state is concatenated with the inverse path from the goal state. Each search is done only up to half of the total path.

Uniform Cost Search

Sorting is done in increasing cost of the path to a node. It always expands the least cost node. It is identical to Breadth First search if each transition has the same cost.

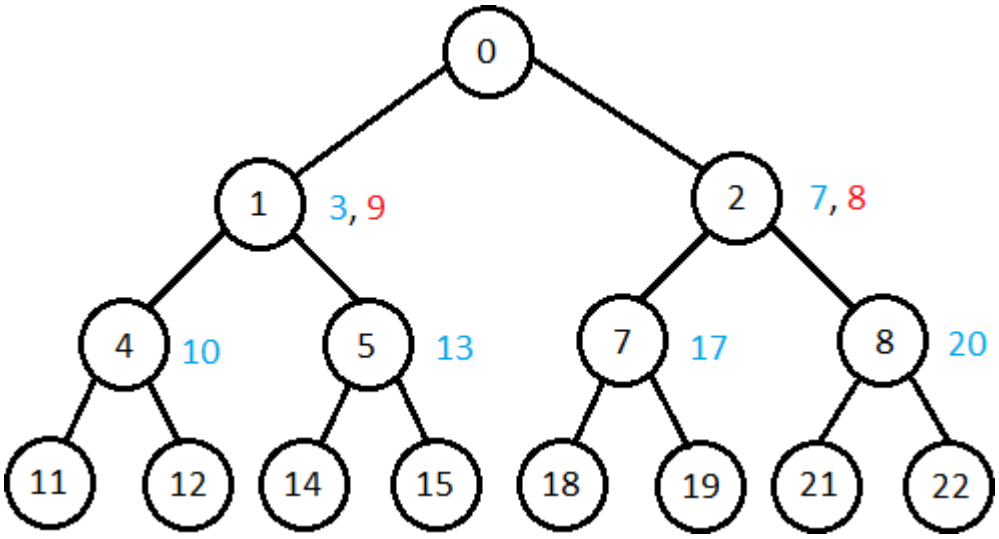
It explores paths in the increasing order of cost.

Disadvantage: There can be multiple long paths with the cost ≤ C*. Uniform Cost search must explore them all.

Iterative Deepening Depth-First Search

It performs depth-first search to level 1, starts over, executes a complete depth-first search to level 2, and continues in such way till the solution is found.

It never creates a node until all lower nodes are generated. It only saves a stack of nodes. The algorithm ends when it finds a solution at depth *d*. The number of nodes created at depth *d* is b^d and atdepth d-1 is b^{d-1}.



Informed(Heuristic) Search Strategies

To solve large problems with large number of possible states, problem-specific knowledge needs to be added to increase the efficiency of search algorithms.

Heuristic Evaluation Functions

They calculate the cost of optimal path between two states. A heuristic function for sliding- tiles games is computed by counting number of moves that each tile makes from its goal state and adding these number of moves for all tiles.

Pure Heuristic Search

It expands nodes in the order of their heuristic values. It creates two lists, a closed list for the already expanded nodes and an open list for the created but unexpanded nodes.

In each iteration, a node with a minimum heuristic value is expanded, all its child nodes are created and placed in the closed list. Then, the heuristic function is applied to the child nodes and they are placed in the open list according to their heuristic value. The shorter paths are saved and the longer ones are disposed.

A* Search

It is best-known form of Best First search. It avoids expanding paths that are already expensive, but expands most promising paths first.

f(n) = g(n) + h(n), where

- g(n) the cost (so far) to reach the node
- h(n) estimated cost to get from the node to the goal
- f(n) estimated total cost of path through n to goal. It is implemented using priority queue byincreasing f(n).

Greedy Best First Search

It expands the node that is estimated to be closest to goal. It expands nodes based on f(n) =h(n). It is implemented using priority queue.

Disadvantage: It can get stuck in loops. It is not optimal.

Local Search Algorithms

They start from a prospective solution and then move to a neighboring solution. They can return a valid solution even if it is interrupted at any time before they end.

Hill-Climbing Search

It is an iterative algorithm that starts with an arbitrary solution to a problem and attempts to find a better solution by changing a single element of the solution incrementally. If the change produces a better solution, an incremental change is taken as a new solution. This process is repeated until there are no further improvements.

Disadvantage: This algorithm is neither complete, nor optimal.

Local Beam Search

In this algorithm, it holds *k* number of states at any given time. At the start, these states are generated randomly. The successors of these k states are computed with the help of an objective function. If any of these successors is the maximum value of the objective function, then the algorithm stops.

Otherwise, the (initial *k* states and *k* number of successors of the states = 2*k*) states are placed in a pool.The pool is then sorted numerically. The highest *k* states are selected as new initial states. This processcontinues until a maximum value is reached.

Expert Systems

What are Expert Systems?

The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

Characteristics of Expert Systems

- High performance
- Understandable
- Reliable
- Highly responsive

Capabilities of Expert Systems

The expert systems are capable of:

- ✓ Advising
- ✓ Instructing and assisting human in decision making
- ✓ Demonstrating
- ✓ Deriving a solution
- ✓ Diagnosing
- ✓ Explaining
- ✓ Interpreting input
- ✓ Predicting results
- ✓ Justifying the conclusion

They are incapable of:

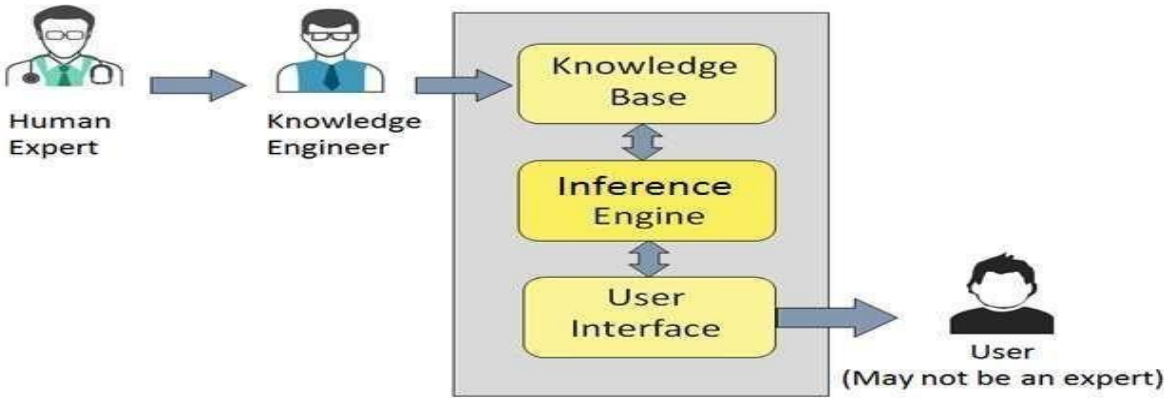
- Substituting human decision makers
- Possessing human capabilities
- Producing accurate output for inadequate
- knowledge baseRefining their own knowledge

Components of Expert Systems

Major components of ES include:

- Knowledge Base
- Inference Engine
- User Interface

Let us see them one by one briefly:



Knowledge Base

It contains domain-specific and high-quality knowledge.

Knowledge is required to exhibit intelligence. The success of any ES majorly depends upon the collection of highly accurate and precise knowledge.

What is Knowledge?

The data is collection of facts. The information is organized as data and facts about the task domain.

Data, **information**, and **past experience** combined together are termed as knowledge.

Components of Knowledge Base

The knowledge base of an ES is a store of both, factual and heuristic knowledge.

- **Factual Knowledge** – It is the information widely accepted by the Knowledge Engineers and scholars in the task domain.
- **Heuristic Knowledge** – It is about practice, accurate judgment, one‘s ability of evaluation, and guessing.

Knowledge representation

It is the method used to organize and formalize the knowledge in the knowledge base. It is in the form of IF-THEN-ELSE rules.

Knowledge Acquisition

The success of any expert system majorly depends on the quality, completeness, and accuracy of the information stored in the knowledge base.

The knowledge base is formed by readings from various experts, scholars, and the **Knowledge Engineers**. The knowledge engineer is a person with the qualities of empathy, quick learning, and case analyzing skills.

He acquires information from subject expert by recording, interviewing, and observing him at work, etc. He then categorizes and organizes the information in a meaningful way, in the form of IF- THEN-ELSE rules, to be used by interference machine. The knowledge engineer also monitors the development of the ES.

Inference Engine

Use of efficient procedures and rules by the Inference Engine is essential in deducting a correct, flawless solution.

In case of knowledge-based ES, the Inference Engine acquires and manipulates the knowledge fromthe knowledge base to arrive at a particular solution.

In case of rule based ES, it:

- Applies rules repeatedly to the facts, which are obtained from earlier rule application.
- Adds new knowledge into the knowledge base if required.
- Resolves rules conflict when multiple rules are applicable to a particular case

To recommend a solution, the inference engine uses the following strategies:

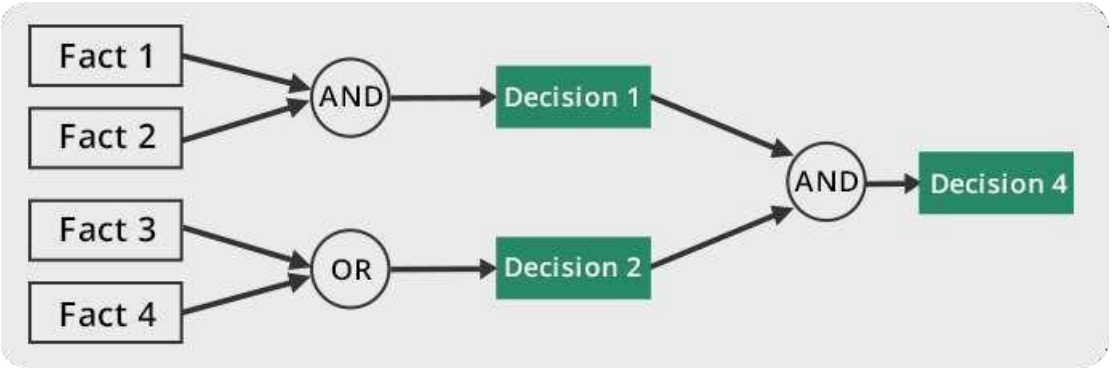
- Forward Chaining
- Backward Chaining

Forward Chaining

It is a strategy of an expert system to answer the question, **"What can happen next?"**

Here, the inference engine follows the chain of conditions and derivations and finally deduces the outcome. It considers all the facts and rules, and sorts them before concluding to a solution.

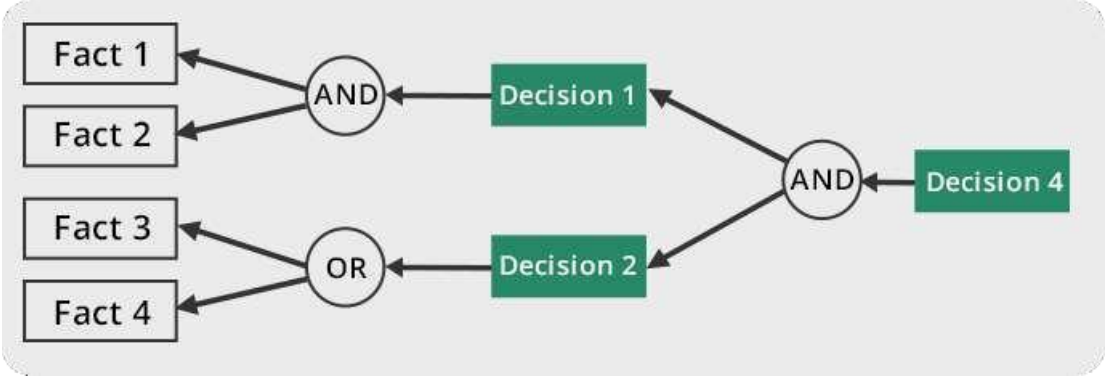
This strategy is followed for working on conclusion, result, or effect. For example, prediction of share market status as an effect of changes in interest rates.



Backward Chaining

With this strategy, an expert system finds out the answer to the question, **"Why this happened?"** On the basis of what has already happened, the inference engine tries to find out which conditions could have happened in the past for this result. This strategy is followed for finding out cause or reason.

For example, diagnosis of blood cancer in humans.



User Interface

User interface provides interaction between user of the ES and the ES itself. It is generally Natural Language Processing so as to be used by the user who is well-versed in the task domain. The user of the ES need not be necessarily an expert in Artificial Intelligence.

It explains how the ES has arrived at a particular recommendation. The explanation may in the following forms:

- Natural language displayed on screen
- Verbal narrations in natural language
- Listing of rule numbers displayed on the screen.

The user interface makes it easy to trace the credibility of the deductions.

Requirements of Efficient ES User Interface

- ❖ It should help users to accomplish their goals in shortest possible ay.
- ❖ It should be designed to work for user‘s existing or desired work practices.
- ❖ Its technology should be adaptable to user‘s requirements; not the other way round.
- ❖ It should make efficient use of user input.

Expert Systems Limitations

No technology can offer easy and complete solution. Large systems are costly, require significant development time, and computer resources. ESs have their limitations which include:

- Limitations of the technology
- Difficult knowledge acquisition
- ES are Difficult to maintain
- High Development costs

Applications of Expert System

The following table shows where ES can be applied.

Application	Description
Design Domain	Camera lens design, automobile design.
Medical Domain	Diagnosis Systems to deduce cause of disease from observed data, conduction medical operations onhumans.
Monitoring Systems	Comparing data continuously with observed system or with prescribed behavior such as leakage monitoring in long petroleum pipeline.
Process Control Systems	Controlling a physical process based on monitoring.
Knowledge Domain	Finding out faults in vehicles, computers.
Finance/Commerce	Detection of possible fraud, suspicious transactions, stock market trading, Airline scheduling, cargo scheduling.

Module II

Introduction to Machine Learning

Introduction to Machine Learning

The phrase ‘machine learning’ dates back to the middle of the last century where Arthur Samuel in 1959 defined machine learning as “the ability to learn without being explicitly programmed.” Machine learning is a type of AI that helps a computer’s ability to learn and essentially teach itself to evolve as it becomes exposed to new and ever-changing data. For example, Facebook’s news feed uses machine learning in an effort to personalize each individual’s feed based on what they like.

Today‘s Artificial Intelligence (AI) has far surpassed the hype of blockchain and quantum computing. This is due to the fact that huge computing resources are easily available to the common man. The developers now take advantage of this in creating new Machine Learning models and to re-train the existing models for better performance and results. The easy availability of high-Performance Computing (HPC) has resulted in a sudden increased demand for IT professionals having Machine Learning skills.

The journey of AI began in the 1950's when the computing power was a fraction of what it is today. AI started out with the predictions made by the machine in a fashion a statistician does predictions using his calculator. Thus, the initial entire AI development was based mainly on statistical techniques.

Statistical Techniques

The development of today‘s AI applications started with using the age-old traditional statistical techniques. You must have used straight-line interpolation in schools to predict a future value. There are several other such statistical techniques which are successfully applied in developing so-called AI programs. We say ―so-called‖ because the AI programsthat we have today are much more complex and use techniques far beyond the statistical techniques used by the early AI programs.

Some of the examples of statistical techniques that are used for developing AI applications in those days andare still in practice are listed here:

- Regression
- Classification
- Clustering
- Probability Theories
- Decision Trees

Here we have listed only some primary techniques that are enough to get you started on AI without scaring you of the vastness that AI demands. If you are developing AI applications based on limited data, you would be using these statistical techniques.

However, today the data is abundant. To analyze the kind of huge data that we possess statistical techniques are of not much help as they have some limitations of their own. More advanced methods such as deep learning are hence developed to solve many complex problems.

As we move ahead in this tutorial, we will understand what Machine Learning is and how it is used for developing such complex AI applications.

Categories of Machine Learning

Machine Learning is broadly categorized under the following headings:

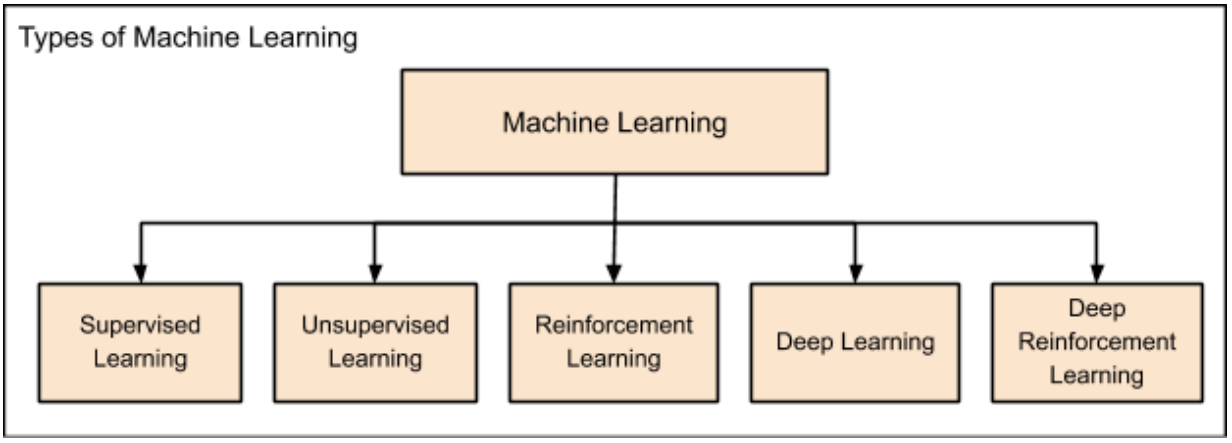


Figure Types of machine learning

Machine learning evolved from left to right as shown in the above diagram.

- Initially, researchers started out with Supervised Learning. This is the case of housing price prediction discussed earlier.
- This was followed by unsupervised learning, where the machine is made to learn on its own without any supervision.
- Scientists discovered further that it may be a good idea to reward the machine when it does the job the expected way and there came the Reinforcement Learning.
- Very soon, the data that is available these days has become so humongous that the conventional techniques developed so far failed to analyze the big data and provide us the predictions.
- Thus, came the deep learning where the human brain is simulated in the Artificial Neural Networks (ANN) created in our binary computers.

- The machine now learns on its own using the high computing power and huge memory resources that are available today.
- It is now observed that Deep Learning has solved many of the previously unsolvable problems.

- The technique is now further advanced by giving incentives to Deep Learning networks as awards and there finally comes Deep Reinforcement Learning.

Supervised Learning

Supervised learning is analogous to training a child to walk. You will hold the child‘s hand,show him how to take his foot forward, walk yourself for a demonstration and so on, untilthe child learns to walk on his own.

Regression

Similarly, in the case of supervised learning, you give concrete known examples to the computer. You say that for given feature value x1 the output is y1, for x2 it is y2, for x3 it is y3, and so on. Based on this data, you let the computer figure out an empirical relationship between x and y.

Once the machine is trained in this way with a sufficient number of data points, now you would ask the machine to predict Y for a given X. Assuming that you know the real valueof Y for this given X, you will be able to deduce whether the machine‘s prediction is correct.

Thus, you will test whether the machine has learned by using the known test data. Once you are satisfied that the machine is able to do the predictions with a desired level of accuracy (say 80 to 90%) you can stop further training the machine.

Now, you can safely use the machine to do the predictions on unknown data points, or askthe machine to predict Y for a given X for which you do not know the real value of Y. This training comes under the regression that we talked about earlier.

Classification

You may also use machine learning techniques for classification problems. In classification problems, you classify objects of similar nature into a single group. For example, in a set of 100 students say, you may like to group them into three groups based on their heights such as short, medium and long. Measuring the height of each student, you will place them in a proper group.

Now, when a new student comes in, you will put him in an appropriate group by measuring his height. By following the principles in regression training, you will train the machine to classify a student based on hisfeature – the height. When the machine learns how the groups are formed, it will be able to classify any unknown new student correctly. Once again, you would use the test data to verify that the machine has learned your technique of classification before putting the developed model in production.

Supervised Learning is where the AI really began its journey. This technique was applied successfully in several cases. You have used this model while doing the hand-written recognition on your machine. Several algorithms have been developed for supervised learning.

Algorithms for Supervised Learning

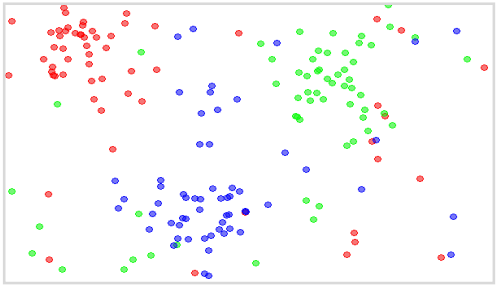
There are several algorithms available for supervised learning. Some of the widely used algorithms of supervised learning are as shown below:

- k-Nearest Neighbours
- Decision Trees
- Naive Bayes
- Logistic Regression
- Support Vector Machines

As we move ahead in this chapter, let us discuss in detail about each of the algorithms.

k-Nearest Neighbours

The k-Nearest Neighbours, which is simply called kNN is a statistical technique that can be used for solving for classification and regression problems. Let us discuss the case of classifying an unknown object using kNN. Consider the distribution of objects as shown in the image given below:



Decision Trees

You would write a code to classify your input data based on this flowchart. The flowchart is self- explanatory and trivial. In this scenario, you are trying to classify an incoming email to decide when to read it.

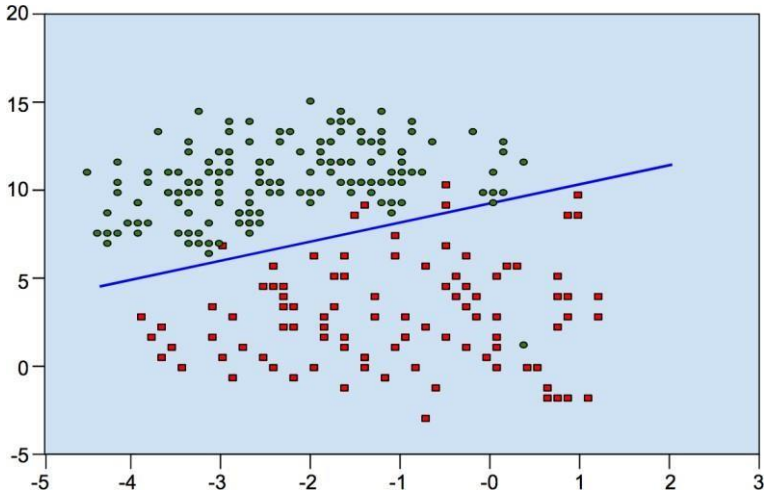
In reality, the decision trees can be large and complex. There are several algorithms available to create and traverse these trees. As a Machine Learning enthusiast, you need to understand and master these techniques of creating and traversing decision trees.

Naïve Bayes

Naive Bayes is used for creating classifiers. Suppose you want to sort out (classify) fruits of different kinds from a fruit basket. You may use features such as color, size and shape of a fruit, For example, any fruit that is red in color, is round in shape and is about 10 cm in diameter may be considered as Apple. So to train the model, you would use these features and test the probability that a given feature matches the desired constraints. The probabilities of different features are then combined to arrive at the probability that a given fruitis an Apple. Naive Bayes generally requires a small number of training data for classification.

Logistic Regression

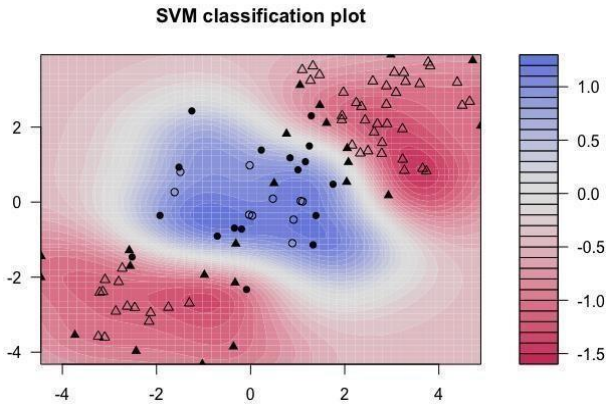
Look at the following diagram. It shows the distribution of data points in XY plane.



From the diagram, we can visually inspect the separation of red dots from green dots. You may draw a boundary line to separate out these dots. Now, to classify a new data point, you will just need to determine on which side of the line the point lies.

Support Vector Machines(SVM)

Look at the following distribution of data. Here the three classes of data cannot be linearly separated. The boundarycurves are non-linear. In such a case, finding the equation of the curve becomes a complex job.



The Support Vector Machines (SVM) comes handy in determining the separation boundaries in such situations.

Unsupervised Learning

In unsupervised learning, we do not specify a target variable to the machine, rather we ask machine –What can you tell me about X?‖. More specifically, we may ask questions such as given a huge data set X, –What are the five best groups we can make out of X?‖ or –What features occur together most frequently in X?‖. To arrive at the answers to suchquestions, you can understand that the number of data points that the machine would require to deduce a strategy would be very large. In case of supervised learning, the machine can be trained with even about few thousands of data points. However, in case of unsupervised learning, the number of data points that is reasonably accepted for learning starts in a few millions. These days, the data is generally abundantly available. The data ideally requires curating. However, the amount of data that is continuously flowing in a social area network, in most cases data curation is an impossible task.

Algorithms for Unsupervised Learning

Let us now discuss one of the widely used algorithms for classification in unsupervised machine learning.

k-means clustering

The 2000 and 2004 Presidential elections in the United States were close — very close. The largest

percentage of the popular vote that any candidate received was 50.7% and the lowest was 47.9%. If a percentage of the voters were to have switched sides, the outcome of the election would have been different.

There are small groups of voters who, when properly appealed to, will switch sides. These groupsmay not be huge, but with such close races, they may be big enough to change the outcome of the election.How do you find these groups of people? How do you appeal to them with a limited budget? The answer is clustering.

Let us understand how it is done.

- First, you collect information on people either with or without their consent: any sort of information that might give some clue about what is important to them andwhat will influence how they vote.
- Then you put this information into some sort of clustering algorithm.
- Next, for each cluster (it would be smart to choose the largest one first) you craft a message that will appeal to these voters.
- Finally, you deliver the campaign and measure to see if it‘s working.

Clustering is a type of unsupervised learning that automatically forms clusters of similar things. It is like automatic classification. You can cluster almost anything, and the more similar the items are in the cluster, the better the clusters are. In this chapter, we are going to study one type of clustering algorithm called k-means. It is called k-means because it finds ‗k‘ unique clusters, and the center of each cluster is the mean of the values in that cluster.

Cluster Identification

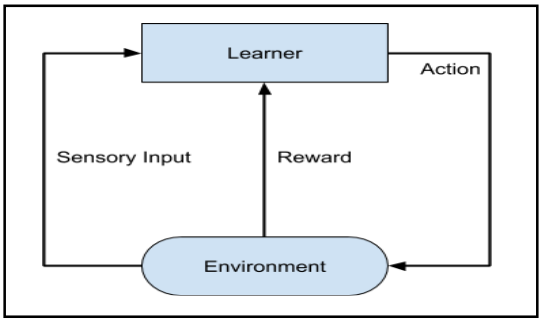
Cluster identification tells an algorithm, ―Here‘s some data. Now group similar things together and tell me about those groups.‖ The key difference from classification is that in classification you know what you are looking for. While that is not the case in clustering.

Clustering is sometimes called unsupervised classification because it produces the same result as classification does but without having predefined classes. Now, we are comfortable with both supervised and unsupervised learning.

Reinforcement Learning

Consider training a pet dog, we train our pet to bring a ball to us. We throw the ball at a certain distance and ask the dog to fetch it back to us. Every time the dog does this right,we reward the dog. Slowly, the dog learns that doing the job rightly gives him a reward and then the dog starts doing the job right way every time in future. Exactly, this concept is applied in ‑Reinforcement‖ type of learning. The technique was initially developed for machines to play games. The machine is given an algorithm to analyze all possible moves at each stage of the game. The machine may select one of the moves at random. If the move is right, the machine is rewarded, otherwise it may be penalized. Slowly, the machine will start differentiating between right and wrong moves and after several iterations would learn to solve the game puzzle with a better accuracy. The accuracy of winning the game would improve as the machine plays more and more games.

The entire process may be depicted in the following diagram:



This technique of machine learning differs from the supervised learning in that you need not supply the labelled input/output pairs. The focus is on finding the balance between exploring the new solutions versus exploiting the learned solutions.

Deep Learning

The deep learning is a model based on Artificial Neural Networks (ANN), more specifically Convolutional Neural Networks (CNN)s. There are several architectures used in deep learning such as deep neural networks, deep belief networks, recurrent neural networks, and convolutional neural networks.

These networks have been successfully applied in solving the problems of computer vision, speech recognition, natural language processing, bioinformatics, drug design, medical image analysis, and games. There are several other fields in which deep learning is proactively applied. The deep learning requires huge processing power and humongous data, which is generally easily available these days.

Applications of Deep Learning

Deep Learning has shown a lot of success in several areas of machine learning applications.

Self-driving Cars: The autonomous self-driving cars use deep learning techniques. Theygenerally adapt to the ever changing traffic situations and get better and better at drivingover a period of time.

Speech Recognition: Another interesting application of Deep Learning is speech recognition. All of us use several mobile apps today that are capable of recognizing our speech. Apple‘s Siri, Amazon‘s Alexa, Microsoft‘s Cortena and Google‘s Assistant – all these use deep learning techniques.

Mobile Apps: We use several web-based and mobile apps for organizing our photos. Facedetection, face ID, face tagging, identifying objects in an image – all these use deep learning.

What is Required for Achieving More Using Deep Learning?

To use deep learning, supercomputing power is a mandatory requirement. You need bothmemory as well as the CPU to develop deep learning models. Fortunately, today we have an easy availability of HPC – High Performance Computing. Due to this, the development of the deep learning applications that we mentioned above became a reality today and in the future too we can see the applications in those untapped areas that we discussed earlier.

Now, we will look at some of the limitations of deep learning that we must consider beforeusing it in our machine learning application.

Deep Learning-Disadvantages

Some of the important points that you need to consider before using deep learning are listed below:

- Black Box approach
- Duration of Development
- Amount of Data
- Computationally Expensive

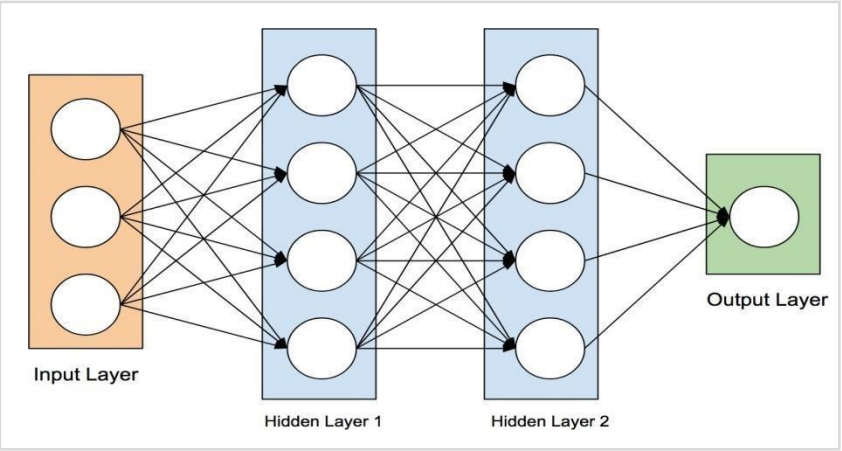
Deep Reinforcement Learning

The Deep Reinforcement Learning (DRL) combines the techniques of both deep and reinforcement learning. The reinforcement learning algorithms like Q-learning are now combined with deep learning to create a powerful DRL model. The technique has been with a great success in the fields of robotics, video games, finance and healthcare. Many previously unsolvable problems are now solved by creating DRL models. There is lots of research going on in this area and this is very actively pursued by the industries.

So far, you have got a brief introduction to various machine learning models, now let us explore slightly deeper into various algorithms that are available under these models.

Artificial Neural Networks

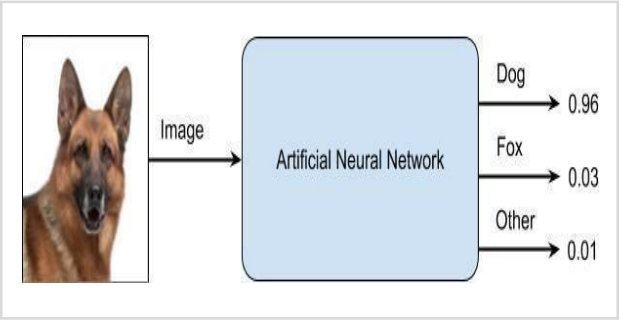
The idea of artificial neural networks was derived from the neural networks in the human brain. The human brain is really complex. Carefully studying the brain, the scientists and engineers came up with an architecture that could fit in our digital world of binary computers. One such typical architecture is shown in the diagram below:



There is an input layer which has many sensors to collect data from the outside world. Onthe right hand side, we have an output layer that gives us the result predicted by the network. In between these two, several layers are hidden. Each additional layer adds further complexity in training the network, but would provide better results in most of the situations.

Black Box approach

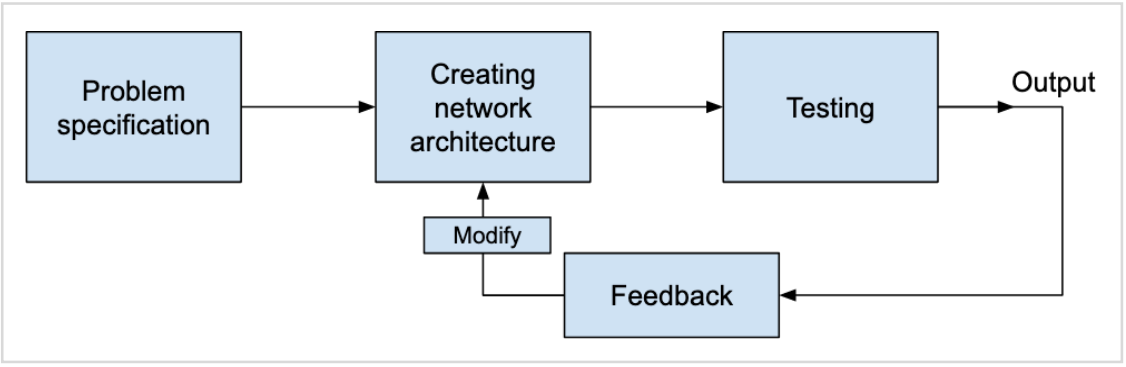
An ANN is like a black box. You give it a certain input and it will provide you a specific output. The following diagram shows you one such application where you feed an animal image to a neural network and it tells you that the image is of a dog.



Why this is called a black-box approach is that you do not know why the network came upwith a certain result. You do not know how the network concluded that it is a dog? Now consider a banking application where the bank wants to decide the creditworthiness of a client. The network will definitely provide you an answer to this question. However, will you be able to justify it to a client? Banks need to explain it to their customers why the loan is not sanctioned?

Duration of Development

The process of training a neural network is depicted in the diagram below:



You first define the problem that you want to solve, create a specification for it, decide on the input features, design a network, deploy it and test the output. If the output is not as expected, take this as a feedback to restructure your network. This is an iterative process and may require several iterations until thetime network is fully trained to produce desired outputs.

Implementing Machine Learning

To develop ML applications, you will have to decide on the platform, the IDE and the language for development. There are several choices available. Most of these would meet your requirements easily as all of them provide the implementation of AI algorithms discussed so far.

If you are developing the ML algorithm on your own, the following aspects need to be understood carefully:

The language of your choice – this essentially is your proficiency in one of the languages supported in ML development.

The IDE that you use – This would depend on your familiarity with the existing IDEs and your comfort level.

Development platform – There are several platforms available for development and deployment. Most of these are free-to-use. In some cases, you may have to incur a licensefee beyond a certain amount of usage. Here is a brief list of choice of languages, IDEs andplatforms for your ready reference.

Language Choice

Here is a list of languages that support ML development:

- Python
- R
- Matlab
- Octave

This list is not essentially comprehensive; however, it covers many popular languages used in machine learning development. Depending upon your comfort level, select a language for the development, develop your models and test.

IDEs

Here is a list of IDEs which support ML development:

- R Studio
- Pycharm
- iPython/Jupyter Notebook
- Julia
- Spyder
- Anaconda
- Rodeo
- Google –Colab

The above list is not essentially comprehensive. Each one has its own merits and demerits. The reader is

encouraged to try out these different IDEs before narrowing down to a single one.

Platforms

Here is a list of platforms on which ML applications can be deployed:

- IBM
- Microsoft Azure
- Google Cloud
- Amazon
- Mlflow

Module III

Knowledge Management System

INTRODUCTION

Knowledge management is the systematic management of an organization's knowledge assets for creating value and meeting tactical & strategic requirements. It consists of the initiatives, processes, strategies, and systems that sustain and enhance the storage, assessment, sharing, refinement, and creation of knowledge.

Each enterprise should define knowledge management in terms of its own business objectives. Knowledge management is all about applying knowledge in new, previously overburdened or novel situations.

Knowledge Management is a Continuous Cycle

Knowledge management is currently seen as a continuous cycle of three processes, namely:

- Knowledge creation and improvement
- Knowledge distribution and circulation
- Knowledge addition and application

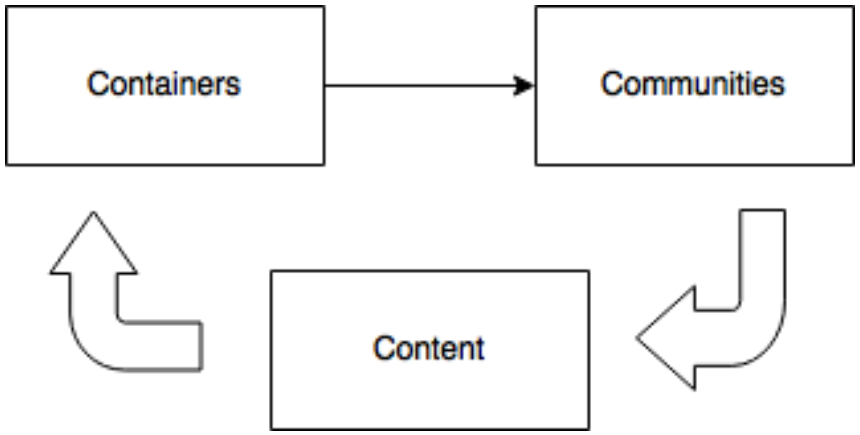
Knowledge management expresses a deliberate, systematic and synchronized approach to ensure the full utilization of the company‘s knowledge base, paired with the potential of individual skills, competencies, thoughts, innovations, and ideas to create a more efficient and effective company.

In simple words, knowledge management incorporates both **holding and storing** of the knowledge perspective, with respect to the intellectual assets.

It is the deliberate and systematic collaboration of an organization‘s people, technology, processes, style and structure in order to add value through reuse and innovation.

Knowledge Management Theory

There are three distinct perspectives on Knowledge Management which leads to a different estimation and a different definition.



The Components of Knowledge Management

Knowledge management is a business activity with two primary aspects:

- Executing the knowledge component of business activities as an explicit concern of businessin strategy, policy, and practice at all levels of the organization.

- Maintaining a direct link between an organization‘s intellectual assets both explicit (recorded) and tacit (personal know-how) and positive business results.

What Cognitive Science or Knowledge Science Perspective Says?

Knowledge management is the transformation of knowledge in the form of insights, understandings, and practical know-how that we all possess in other manifestations like books, technology, practices, and traditions within organizations of all kinds and in society in general.

According to the Process/Technology Perspective

Knowledge management is the concept under which information is changed into actionable knowledge and made available effortlessly in a usable form to the people who can leverage it

according to their needs.

Why Knowledge Management?

Application of Knowledge Management (KM) lie in the below four key areas

- **Globalization of Business**: Organizations today are more universal i.e., they are operating in multiple sites, multilingual, and multicultural in nature.

- **Leaner Organizations**: Organizations are adopting to a lean strategy where they understand customer value and focus on key processes to continuously increase it. The ultimate goal is to provide perfect value to the customer through a perfect value creation process that has zero waste.

- **Corporate Amnesia**: We are freer as a workforce, which creates issues regarding knowledge continuity for the organization and places with continuous learning demands from knowledge worker. We no longer expect to spend our entire work life with the same organization.

- **Technological Advances**: The world is more connected with the advent of websites, smart phones and other latest gadgets. Advancements in technology has not only helped in better connectivity but also changed expectations. Companies are expected to have online presence round the clock providing required information as per the customer needs.

Knowledge Management serves as one of the major response to the challenge of trying to handle this complex, information overloaded work environment. As such, Knowledge management is perhaps best clustered as a science of complexity.

MODELS OF KM CYCLE

Knowledge management cycle is a process of transforming information into knowledge within an organization. It explains how knowledge is captured, processed, and distributed in an organization. In this chapter, we will discuss the prominent models of knowledge management cycle.

Till date, four models have been selected based on their ability to meet the growing demands. The four models are the Zack, from Meyer and Zack (1996), the Bukowitz and Williams (2000), the McElroy (2003), and the Wiig (1993) KM cycles.

Zack	Bukowitz &Williams	WIIG	McElroy
Acquisition	Get	Creation	Learning
Refinement	Use	Sourcing	Validation
Store	Learn	Compilation	Acquisition
Distribution	Contribute	Transformation	Integration
Presentation	Assess	Application	Completion

Figure: The Four Major Models of Knowledge Management

Zack Knowledge Management Model

The Zack model is extracted from work on the design and development of information products. In Meyer and Zack‘s approach, the network between each stage is designed to be logical and standardized.

In this cycle, the major developmental stages of a knowledge repository are analyzed and mapped to the stages of a KM cycle.

The stages are acquisition, refinement, storage/retrieval, distribution, and presentation/use. This cycle is also known as the ―refinery.‖

Acquisition of Data or Information

Acquisition deals with issues regarding origin of raw materials such as scope, breadth, depth, credibility, accuracy, timeliness, relevance, cost, control, and exclusivity.

The guiding principle is the well- known proverb of ‑garbage in, garbage out.‖ That is, highest quality source data is required, else the intellectual products produced downstream will be lower.

Refinement

Refinement may be physical (like migrating from one medium to another) or logical (like restructuring, relabeling, indexing, and integrating.)

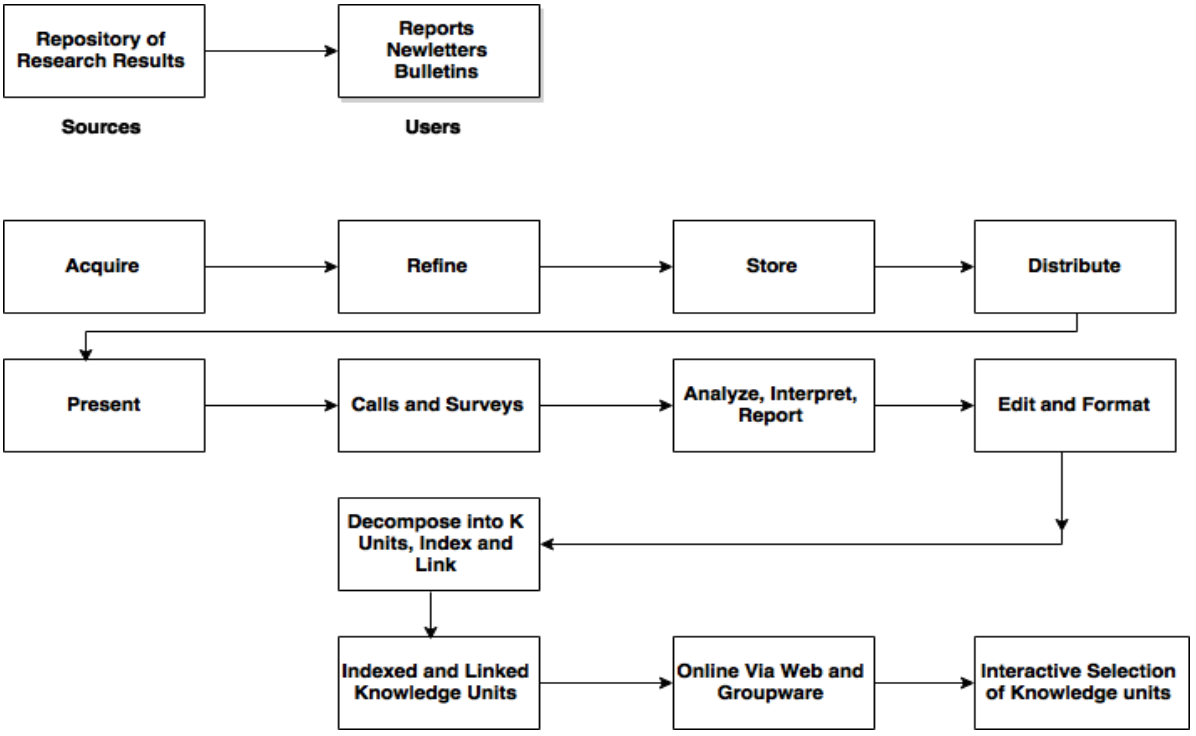


Figure: Zack Model

Refining also defines cleaning up (like sanitizing content so as to ensure complete anonymity of sources and key players involved) or standardizing (like conforming to templates of a best practice or lessons learned as used within that particular organization).

This stage also adds up to the value by creating more readily usable knowledge objects and by storing the content more flexibly for future use.

Storage / Retrieval

Storage or Retrieval forms a bridge between the upstream addition and refinement stages that feed the repository and downstream stages of product generation. Storage can be physical (file folders, printed information) as well as digital (database, knowledge management software).

Distribution

Distribution defines how the product is to be delivered to the end-user (like fax, print, e- mail) and encloses not only the medium of delivery but also its timing, frequency, form, language, and so on.

Presentation

Context plays an important role in Presentation or Application stage. The performance of each of the preceding value-added steps is evaluated here – for example, does the user have enough context to be able to make use of this content? If not, the KM cycle has failed to deliver value to the individual and ultimately to the company.

The repository and the ―refinery‖ combined enable the management of valuable knowledge of a firm. In this cycle, there is also an impression of having to continually renew the repository and the refinery in order to avoid elimination.

The Meyer and Zack model is one of the most complete picture of the key elements engaged in the knowledge management model. To be specific the notion of refinement is a crucial stage in the KM cycle and one that is often neglected.

Bukowitz and Williams Model

Bukowitz and Williams portray a knowledge management process framework that outlines ―how organizations generate, maintain and expand a strategically correct stock of knowledge to create value‖.

In this framework, knowledge includes knowledge repositories, relationships, information technologies, communications infrastructure, functional skill sets, process know-how, environmental responsiveness, organizational intelligence, and external sources.

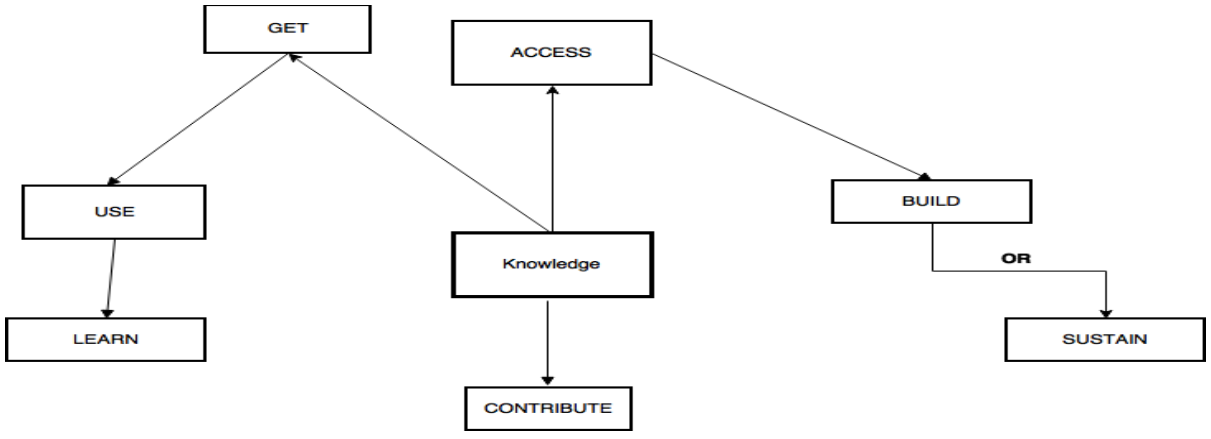


Figure: Bukowitz & Williams Model

These stages aim on more long-range processes of matching intellectual capital to strategic needs.

- **Get Stage** is the first stage, it consists of seeking out information required in orderto make decisions, solve problems, or innovate.

- **Use Stage** is the next stage, and it deals with how to combine information in new and interesting ways in order to foster organizational innovation. The spotlight is primarily on individuals and then on groups.

- **The Learn Stage** points to the formal process of learning from experiences as a means of creating competitive gain. Learning in enterprises is important because it serves the transition step between the application of ideas and the generation of new ones.

- **The Contribute Stage** of the Knowledge Management cycle deals with encouraging employees to post what they have learnt to the communal knowledge base (like a repository). Only in this way, can individual knowledge be made visible and available to theentire organization, where and when appropriate.

McElroy Model

McElroy outlines a knowledge life cycle that consists of the processes of knowledge production and knowledge integration, with a series of feedback loops to organizational memory, beliefs, and claims and the business-processing environment.

- Problem claim formulation is an attempt to learn and state the specific nature of the detected knowledge gap.
- Knowledge claim formulation acts as a response to approved problem claims via information acquisition and individual and group learning.
- New knowledge claims are tested and examined through knowledge claim evaluation processes.
- Evaluation of knowledge claims results in surviving knowledge claims that will be integrated as new organizational knowledge or falsified/undecided knowledge claims.

Experience gained from the application of knowledge in the organizational knowledge base leads tonew claims and resulting beliefs, triggering the cycle to begin all over again.

In knowledge production, the primary processes are individual and group learning. Knowledge claim formulation, information acquisition; codified knowledge claim and knowledge claim evaluation.

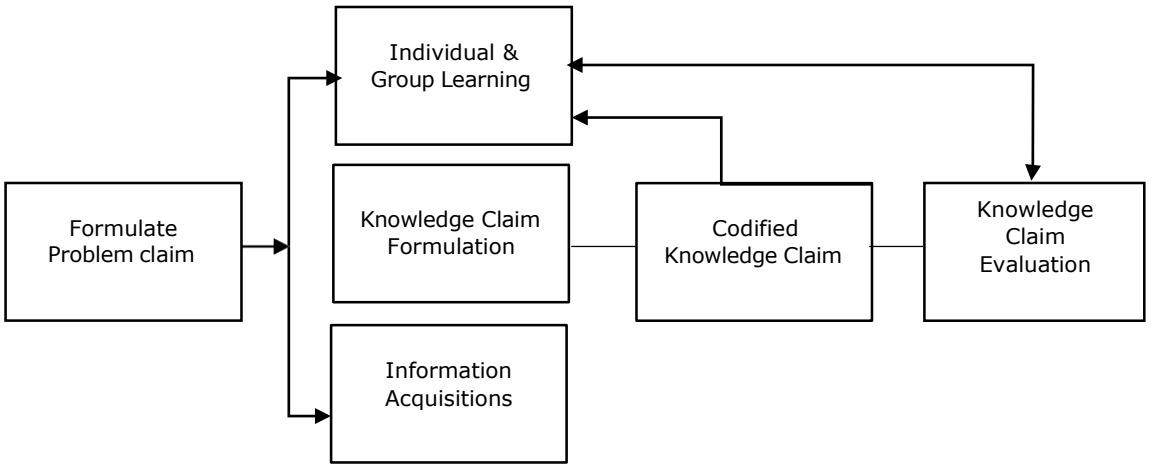


Figure: McElroy Model

These knowledge production processes can be briefed as:

- Individual and group learning marks the first step in organizational learning.
- Knowledge claim validation includes codification at an organizational level.
- A formalized procedure is essential for the receipt and codification of individual and group innovations.

- Information addition is the process by which an organization deliberately or serendipitously acquires knowledge claims or information produced by others, usually external to the company. This stage plays a basic role in formulating new knowledge claims at the organizational level.

Knowledge integration is the process by which an organization announces new knowledge claims to its operating environment and retires old ones. It includes all knowledge transmission such as teaching, knowledge sharing, and other social activities that either connects an understanding of previously produced organizational knowledge to knowledge workers or accommodate newly minted knowledge.

One of the advantages of the McElroy cycle is the clear description of how knowledge is examined and a conscious decision is made as to whether or not it will be included in to the organizational memory. The authorization of knowledge is a step that clearly differentiates knowledge management from document management. The KM cycle aims at processes to identify knowledge content that is of value to the organization and its employees.

WIIG Model

WIIG highlights the three conditions that need to be present for an organization to conduct its business successfully

- ✓ It must have a business (commodities/services) and customers.
- ✓ It must have resources (people, budget, and facilities).
- ✓ It must have the strength to act.

WIIG marks the major purpose of KM as an effort ‒to make the organization intelligent- acting by facilitating the creation, accumulation, deployment and use of quality knowledge.‖ WIIG‘s KM cycle shows how knowledge is built and used as individuals or as organizations.

The following figure shows the four major steps of the WIIG model.

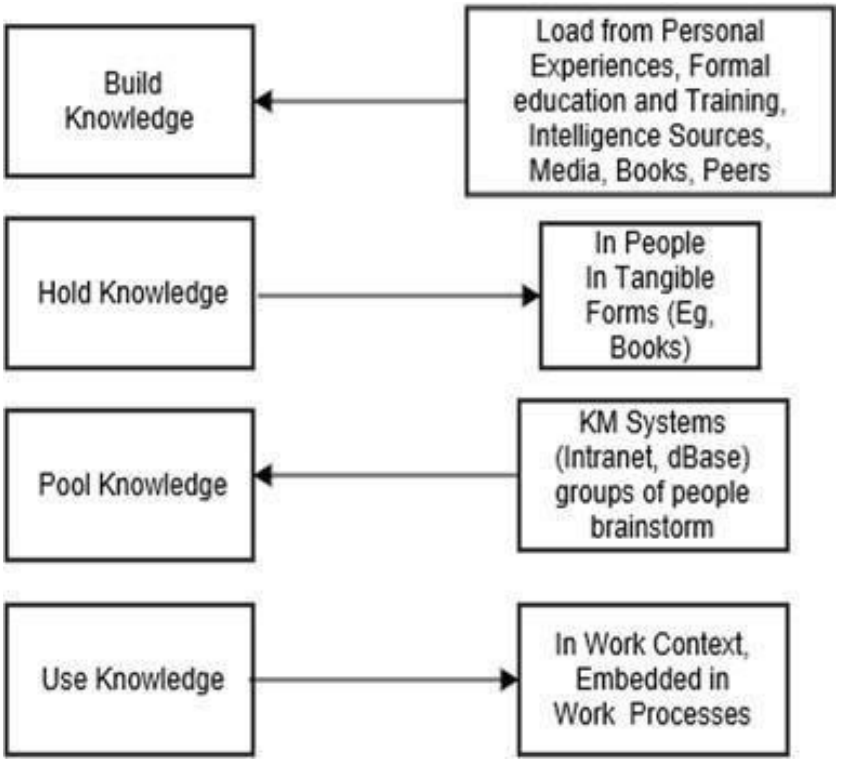


Figure: WIIG Model

- **Building knowledge**: From external and internal knowledge sources
- **Holding knowledge**: Storing the information in a particular form
- **Pooling knowledge**: Through intranets and knowledge management portals
- **Applying knowledge**: In the context of work embedded in process

Integrated Cycle

The following are the three major stages of integrated cycles of knowledge management strategy when introduced in any organization:

- Knowledge capture and/or creation
- Knowledge sharing and dissemination
- Knowledge acquisition and application

Knowledge Capture states the identification and frequent codification of existing (usually previously unnoticed) internal knowledge and know-how within the organization and/or external knowledge from the environment.

Knowledge Creation is the advancement of new knowledge and know-how innovations that did not have a previous existence within the organization.

Once, it is clear that the newly identified content is of sufficient value, the next step is to contextualize this content. This involves maintaining a connection between the knowledge knowledge and those knowledgeable about that content.

Contextualization also indicates identifying the key elements of the content in order to better match to a variety of users. Finally, contextualization succeeds to when the new content is firmly, precisely yet seamlessly, embedded in the business processes of the enterprise.

The knowledge management cycle is then rechecked as users understand and decide to make use of content.

The users will update usefulness, and they will signal when it becomes out of date or when this knowledgeis not applicable.

KNOWLEDGE MANAGEMENT MODELS

All the Knowledge Management models described in this chapter attempt to address knowledge management from a universal and broader perspective.

Von Krogh and Roos Model

The von Krogh and Roos model of organizational epistemology (1995) is the first model that precisely differentiates between individual knowledge and social knowledge.

This model, analyzes the following aspects

- Why and how the knowledge gets to the workers of a company
- Why and how the knowledge arrives at the organization
- What does knowledge mean for the workers as well as the organization
- What are the barriers of organizational knowledge management

In their organizational model, knowledge is to be found both in the mind of the people and in thelinks between them.

This model examines the nature of knowledge management from the perspective of:

- Staff members
- Communication and connection
- Organizational structure and layout
- Network between members and
- Management of human resources

The above five factors create issues that can prevent knowledge management strategies.

Nonaka and Takeuchi model

The Nonaka and Takeuchi model of KM has its base in a universal model of knowledge creation and the management of coincidence.

There are four different modes of knowledge conversion in the Nonaka and Takeuchi model of knowledge conversion:

- Socialization (tacit to tacit) i.e. Indirect way,
- Externalization (tacit to explicit) i.e. Indirect to Direct way,
- Combination (explicit to explicit) i.e. Direct way, and
- Internalization (explicit to tacit) i.e. Direct to indirect way.

Socialization is the technique of sharing tacit knowledge through observation, imitation, practice, and participation in formal and informal communities and groups. This process is basically preempted by the creation of a physical or virtual space where a given community can interact on a social level.

Externalization is the technique of expressing tacit knowledge into explicit concepts. As tacit knowledge is highly internalized, this process is the key to knowledge sharing and creation.

Combination is the technique of integrating concepts into a knowledge system. Some examples or cases would be a synthesis in the form of a review report, a trend analysis, a brief executive summary, or a new database to organize content.

Internalization is the technique of embodying explicit knowledge into tacit knowledge.

Choo Sense-Making KM Model

The Choo Sense-Making KM Model (1998) focuses on

- Sense Making
- Knowledge Creation
- Decision making skills

These three highly interconnected processes play a major role in the unfoldment of the organization‘s knowledge vision, it‘s potential to knowledge creation and its commitment into taking knowledge creation to the utmost consequences.

Sense Making: Its long-term aim is the warranty that organizations will adapt and continue to prosper in a dynamic and complex environment through activities of prospecting and interpretation of suitable information enabling it to understand changes, trends and scenarios about clients, suppliers, competitors and other external environment actors.

Knowledge Creation: It is a process that allows a company to create or acquire, organize and process information in order to generate new knowledge through organizational learning. The new knowledge obtained, allows company to develop new abilities and capabilities, create new products

and new services, improve the existing ones and redesign its organizational processes.

Decision Making: The Company must choose the best option among those that are plausible and presented and pursue it based on the organization‘s strategy. Decision making process in companies is constrained by the bounded rationality principle.

This model focuses on how informational elements are selected and fed into organizational actions.

WIIG Model

Karl Wiig KM model (1993) marks the basic principle which says, in order for knowledge to be useful and valuable, it must be organized and synchronized.

Some essential dimensions in the WIIGS KM model are:

- Completeness
- Connectedness
- Congruency and
- Perspective and purpose

Completeness: It describes how much relevant knowledge is available from a given source. Sources vary from human minds to knowledge bases (like, tactic or explicit knowledge).

First of all, we have to make sure, that the knowledge is complete if all the information available on the subject is there but if no one knows of its existence, they cannot make use of this knowledge.

Connectedness: It briefs about the well-understood and well-defined relations between the different knowledge objects. Most knowledge objects are connected to each other, the more connected a knowledge base is then the more consistent the content and the greater its value.

Congruency: A knowledge base congruent when all the facts, concepts, perspectives, values, judgments, and relational links and connections between the objects are consistent. Most knowledge content do not meet such ideals.

Perspective and Purpose: It is a technique through which we know something but from a particular point of view for a specific purpose. We organize much of our knowledge applying to the dual dimensions of perspective and purpose.

This model attempts to define different levels of internationalization of knowledge and therefore

could be seen as a further refinement of the fourth Nonaka and Takeuchi quadrant of internalization.

Boisot Model

This model is based on the key concept of information which is good and that is different from a physical asset.

Boisot differentiates information from data by emphasizing that information is what an observer will extract from data as a function of his or her expectations or prior knowledge.

Boisot's model can be seen as three dimensional cube with the following dimensions:

- From uncodified to codified
- From concrete to abstract
- From undiffused to diffused

He proposes a Social Learning Cycle (SLC) that adopts the I-Space to model the dynamic flow of knowledge through a series of six phases:

- **Scanning**: Wisdom is gained from generally available or diffused data.
- **Problem-Solving**: Problems are solved offering structure and coherence to these insights as knowledge becomes codified.
- **Abstraction**: The newly codified wisdom is generalized to a wide range of situations as knowledge becomes more abstract.
- **Diffusion**: the new wisdom are shared with a target population in a codified and abstract form as knowledge becomes diffused.
- **Absorption**: The newly codified insights are applied to a variety of situations generating new learning experiences as knowledge is absorbed and produces learnt behavior and so becomes uncodified or tacit.
- **Impacting**: Abstract knowledge becomes fixed in concrete practices, for example in artifacts, rules or behavior patterns as knowledge becomes concrete.

Complex Adaptive System Models

According to the ICAS (Intelligent Complex Adaptive Systems) theory, an organization is seen as an adaptive, complex system.

Complex adaptive systems includes many independent agents that interact with one another locally and their combined behavior gives rise to complex adaptive phenomena.

These models contain a series of functions that makes sure that the viability of any living system in general and of organizations, in particular.

ICAS systems are based on cybernetics principles, which uses communications and control mechanisms in order to understand, describe and predict what a viable organization should do.

Adaptive systems involve lots of independent agents which are interacting. Their behavior makes possible the appearance of some complex circumstances of adaptation. A general model of a complex behavior is the result of all the interactions. Inside the adaptive model, the intelligent elements are made of people whoare self-organized, but who can remain as a part of general hierarchies of the organizations.

The challenge is to use the advantage offered by the force of the people when they cooperate, keeping a global sense of unity. Organizations solve issues by creating options, using resources, both internal and external, that can add value over the initial input.

KNOWLEDGE MANAGEMENT TOOLS

Knowledge acquisition and application

Knowledge acquisition is the process used to describe the rules and ideologies required for a knowledge-based system. It is the process of extracting knowledge from experts and structuring this knowledge into a readable form.

Some techniques used in the process of extracting information are Interviewing, Observations, Protocol Analysis, and Brainstorming.

It is ideally driven by strategies – for example, an organization decides what knowledge is needed, what it has, and then fills in the gap by developing new knowledge or acquiring it. Knowledge acquisition has several applications that we will be discussing in this chapter.

Codifying explicit knowledge

Converting unspoken knowledge to a categorical form by way of codifying, and to acquire this tacitknowledge as explicit meta-knowledge (knowledge about knowledge).

This is basically a directory which knows what and how to contact them. The aim of the codification is to make it easy to organize, locate, share, store, and use the knowledge.

Common material including codified knowledge are manuals, spreadsheets, decision support systems and procedures.

Anyhow, the codification process is generally expensive and it is difficult to code for universal understanding too.

Creation of Tools

Knowledge creation is all about continuous transfer, combination, and conversion of the different types of knowledge, as users practice, interact, and learn.

Content creation and management tools are essential to structure and organize knowledge content foreach retrieval and maintenance. It consists of the following tools:

- Authoring Tools
- Annotation Tools
- Data Mining and Knowledge Discovery
- Templates

Authoring Tools

Authoring tools include the software that allow users to create web page or multimedia applications. These are tools by which various media elements are brought together to structure and flow.

Authoring tools align with the aim of capturing the author's tacit knowledge and helping structure that knowledge into an explicit form.

Annotation Tools

Annotation tools help in the addition of explanatory comments to a document after it has been created. The comments can be public as well as private. Tools like track changes in MS Word is an example of annotation tools. This tool also helps with the goal of capturing tacit knowledge by allowing authors to connect their expertise to a certain document.

Data Mining and Knowledge Discovery

Data mining pioneers new or hidden patterns in data that resides in multiple databases. It includes statistical analysis to discover relations, correlation, and market related analysis.

Various analysis tools are approached in data mining such as statistical analysis tools e.g. SAS, datamining suites, and data visualization tools.

This tool accomplishes the goal of creating new knowledge by being able to analyze existing data and making something useful out of it. It also helps in predicting future occurrence and forecast expected outcomes.

Templates

It includes designing or patterning of an item that acts as a guide for designing or constructing similar items. This tool is helpful to organize knowledge in a systematic manner, by following an established design.

Blogs

These are webpages that typically focus on a specific subject. They can be like personal pages that are much like personal diaries which are periodically updated and accessible publicly. This web tool fits with the aim to elicit knowledge, by authors being able to express their unique ideas and opinions.

Sharing and Dissemination tools

It includes groupware and collaborative tools. These tools acts as enablers of knowledge flow and knowledge-sharing activities among personnel.

Groupware invokes class of software (programs) that allows to work together while located remotely from each other.

Here, collaboration is mainly referred as groupware, or work group productivity software. For example – LAN (Local Area Network)

Typically, a groupware supports the following operations:

- Password Protection of document
- Schedule meeting and allocate resources
- File distribution
- Electronic newsletter
- Email (Electronic mail)
- Group Calendars
- Collaborative writing system
- Video Communication System
- Chat Systems
- Wikis

KNOWLEDGE MANAGEMENT STRATEGY

Knowledge management strategy is a general, issue-based approach to define operational strategy and objectives with specialized KM principles and approaches. It helps in addressing questions like:

- Which knowledge management approach, or set of approaches, will bring the most value tothe company?
- How can a company prioritize alternatives, when any one or several of the alternatives are appealing and resources are limited?

A good Knowledge Management strategy possesses the following components:

- **A Stated Business Strategy and Objectives:** It should have products or services, target customers, referred distribution or delivery channels, characterization of regulatory environment, mission or vision statement.
- **A Description of Knowledge-Based Business Issues:** Need for collaboration, need to level performance variance, need for innovation, and need to address information overload.
- **An Inventory of Available Knowledge Resources:** Knowledge capital, social capital, infrastructure capital.
- **An Analysis of Recommended Knowledge Leverage:** Points that briefs what can be done with the above-identified knowledge and knowledge artifacts and lists Knowledge management projects that can be undertaken with the intent to maximize ROI and business value.

Knowledge Audit

A knowledge audit service marks the core information knowledge requirements and uses in an organization. It also outlines the gaps, duplications, and flows and how they contribute to business goals as well as the owners, users, uses, and key attributes of core knowledge assets.

It produces the following types of results:

- Identification of core knowledge assets and flows like who creates, who uses.
- Identification of gaps in information and knowledge required to manage the business effectively.
- Areas of information policy and ownership that needs progress. Opportunities to minimize information-handling costs.
- Opportunities to improve coordination and access to commonly required information.

A better understanding of the contribution of knowledge to business results.

GAP Analysis

This involves establishing the current and desired states of knowledge resources and KM levels. Specific projects further defined in order to address specific gaps that were identified and agreed upon as high-priority areas.

A good gap analysis addresses the following points:

- ✓ The major differences between the current and desired KM states of the organization.
- ✓ Enlist barriers to KM implementation like culture where ―knowledge is power‖ or where individual possession of knowledge is consistently rewarded.
- ✓ Enlist KM leverage points or enablers like existing initiatives that could be built upon. Identify opportunities to collaborate with other business initiatives like combine knowledge continuity goals with succession planning initiatives in Human Resources.
- ✓ Conduct a risk analysis like knowledge that will soon ―walk out the door‖ due to imminent retirements or knowledge that is at risk because only a few individuals are competent in this area and very little of their expertise exist in coded or tangible knowledge assets.
- ✓ Redundancies within the organization like the case of the right hand not knowing what the left hand is doing.
- ✓ Presence of knowledge silos like groups, departments, or individuals that hoard knowledge or block fluid knowledge flows to other groups, departments, or colleagues.
- ✓ This analysis is further used to list and prioritize KM objectives to be addressed by the organization.

KNOWLEDGE MANAGEMENT METRICS

Intellectual assets are generally categorized as human capital (like the know-how of knowledge workers that is ―rentedǁ by an organization), structural capital (like the policies, procedures, and applications that the organization ―ownsǁ), and customer or relationship capital (like the value of customer relationships and loyalty that has been built up over the years).

A variety of fairly sophisticated KM measurement techniques are available now that can help assess how well an organization is progressing. These involve benchmarking, the balanced scorecard method, and the house of quality matrix.

Before introducing any metric-based system, we have to be clear regarding what we want themetrics to answer. Metrics generally helps us to answer several questions, such as:

- Is Knowledge management working as required? And if not, what needs to be fixed?Is execution on track, and if not, what needs to be fixed?
- Are people doing what they are assigned to do? Who is doing well, who is not doing well?Are we delivering value? If we aren't, let's stop, or find a better way.

Measuring KM Implementation

The first thing to be done is probably wanting to measure, and how well we are managing to implement KM.

When we run your assessment at the start of KM implementation, we will develop some baselinemetrics which you can measure the improvement against.

A KM assessment protocol measures various aspects of knowledge flow within an organization, and allows you to identify blockers and obstacles to knowledge flow. Re-running the assessment later allows you to measure progress.

Measuring KM Compliance

Let us assume that an employee named Steve has introduced a knowledge management frameworkto the organization, with some clear accountabilities and clear expectations in the form of KM policies and standards.

At this stage, Steve might want to measure whether people are complying with these

expectations,by using dashboarding and analytical tools to track his project members in an organization. Similar dashboards will be required in other functions of an organization.

Measuring KM Activity

It is also useful to introduce some activity based metrics to track different elements of yourKnowledge management system.

Measuring Business Outcome

It is generally believed that, knowledge management leads to continuous performance improvement. As knowledge improves, so does the efficiency and results of an organization. Therefore, the more we deploy these methods and implement them, the better will be business performance.

Benchmarking

Benchmarking is the hunt for industry wide best practices that leads to superior performance. It is a fairly straightforward Knowledge Management metric that represents a good starting point.

Benchmarking basically consists of a study of similar companies to determine how things are done best in order to adapt these methods for their own use. This approach is best summed up by the Hindu proverb: ‑know the best to become the best.

There are two general types of benchmarking:

- **Internal benchmarking –** Comparisons against other units within the same company or a comparison of a single unit over different time periods.

- **External benchmarking** – Comparison with other companies.

Balanced Scorecard

A Balanced Scorecard method (BSC) is a judgment and management system that enables enterprises toclarify their vision and strategy and which translates them into action. It offers feedback on both the internal business processes and external results in order to continuously improve strategic performance and results.

Balanced Scorecard is a conceptual framework for converting an organization‘s vision into a set of performance indicators distributed among four dimensions:

- **Financial Dimension** – Involves measures such as operating income, return on capital employed, and economic value added.
- **Customer Dimension** – It is associated with such measures as customer satisfaction, retention,and market share in targeted segments.
- **Internal Business Processes** – Consists of measures such as cost, throughput, and quality.
- **Learning and Growth** – addresses measures such as worker's satisfaction, retention, and skillsets.

Reference

1. Chowdhary, K. R. Fundamentals of artificial intelligence. New Delhi: Springer India, 2020.
2. Ivanov, Stanislav, and Craig Webster. "Economic fundamentals of the use of robots, artificial intelligence, and service automation in travel, tourism, and hospitality. Emerald Publishing limited, 2019.
3.Stamp, Mark, Introduction to machine learning with applications in information security. CRC Press, 2022.
4. Neapolitan, Richard E., and Xia Jiang. Artificial intelligence: With an introduction to machine learning. CRC Press, 2018.
5. Becerra-Fernandez, Irma, and Rajiv Sabherwal. Knowledge management: Systems and processes. Routledge, 2014.