CHAPTER – 4

LEARNING

WHAT IS 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 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.

TYPES OF LEARNING:

1. *Rote Learning:*

Rote learning is the memorization of information based on repetition. Examples of rote learning include memorizing the alphabet, numbers, and multiplication tables. Some consider rote learning to be a necessary step in learning certain subjects. Memorization isn't the most effective way to learn, but it's a method many students and teachers still use. A common rote learning technique is preparing quickly for a test, also known as

cramming. For example: When a learner learns a poem or song by reciting or repeating it, without knowing the actual meaning of the poem or song.

Advantages of Rote Learning

- Ability to quickly recall basic facts
- Helps develop foundational knowledge

Disadvantages of Rote Learning

- Can be repetitive
- Easy to lose focus
- Doesn't allow for a deeper understanding of a subject
- Doesn't encourage the use of social skills
- No connection between new and previous knowledge
- May result in wrong impression or understanding a concept

While being able to quickly recall pieces of information is helpful, to understand information on a deeper level students must use a different method of learning: meaningful learning.

2. Learning From Example (Induction Learning):

Induction learning is carried out on the basis of supervised learning. In this learning process, a general rule is induced by the system from a set of observed instance. However, class definitions can be constructed with the help of a classification method.

Supervised learning, in the context of artificial intelligence (AI) and machine learning, is a type of system in which both input and desired output data are provided. Input and output data are labelled for classification to provide a learning basis for future data processing. Supervised learning systems are mostly associated with retrieval-based AI but they may also be capable of using a generative learning model.

Training data for supervised learning includes a set of examples with paired input subjects and desired output (which is also referred to as the supervisory signal). In supervised learning for image processing, for example, an AI system might be provided with labelled pictures of vehicles in categories such as cars and trucks. After a sufficient amount of observation, the system should be able to distinguish between and categorize unlabeled images, at which time training can be said to be complete.

Supervised learning models have some advantages over the unsupervised approach, but they also have limitations. The systems are more likely to make judgments that humans can relate to, for example, because humans have provided the basis for decisions. However, in the case of a retrieval-based method, supervised learning systems have trouble dealing with new information. If a system with categories for cars and trucks is presented with a bicycle, for example, it would have to be incorrectly lumped in one category or the other. If the AI system was generative, however, it may not know what the bicycle is but would be able to recognize it as belonging to a separate category.

3. Explanation Based Learning (EBL):

An Explanation-based Learning (EBL) system accepts an example (i.e. a training example) and explains what it learns from the example. The EBL system takes only the relevant aspects of the training. This explanation is translated into particular form that a problem solving program can understand. The explanation is generalized so that it can be used to solve other problems.

An EBL accepts 4 kinds of input:

a. **A Training Example:** What the learning *sees* in the world.
b. **A Goal Concept:** A high level description of what the program is supposed to learn.
c. **An Operational Criterion:** A description of which concepts are usable.
d. **A Domain Theory:** A set of rules that describe relationships between objects and actions in a domain.

From this EBL computes a generalization of the training example that is sufficient not only to describe the goal concept but also satisfies the operational criterion.

This has two steps:

1. **Explanation:** The domain theory is used to prune away all unimportant aspects of the training example with respect to the goal concept.
2. **Generalization:** The explanation is generalized as far possible while still describing the goal concept.

This type of learning usually requires a substantial number of training instances but there are two difficulties in this:

i. It is difficult to have such a number of training instances.
ii. Sometimes, it may help us to learn certain things effectively, especially when we have enough knowledge.

Hence, it is clear that instance-based learning is more data-intensive, data-driven while EBL is more knowledge-intensive, knowledge-driven.

4. Learning by Analogy (Similarity):

Analogy is a powerful inference tool. Our language and reasoning are laden with analogies. Consider the following sentences:

- Last month, the stock market was a roller coaster.
- Bill is like a fire engine.

Underlying each of these examples is a complicated mapping between what appear to be dissimilar concepts. For example, to understand the first sentence above, it is necessary to do two things:

1. Pick out one key property of a roller coaster, namely that it travels up and down rapidly.
2. Realize that physical travel is itself an analogy for numerical fluctuations (in stock prices).

This is no easy trick. The space of possible analogies is very large. We do not want to entertain possibilities such as "the stock market is like a roller coaster because it is made of metal."

An Artificial Intelligence program that is unable to grasp analogy will be difficult to talk to and, consequently difficult to teach. Thus, analogical reasoning is an important factor in learning by advice taking. It is also important to learn in problem solving. The difficulty comes in determining what things are similar and what things are not. Two methods of analogical problem solving that have been studied in Artificial Intelligence are:

1. Transformational Analogy:

Transformational analogy is a problem-solving technique in which a pre-selected plan is modified to solve a new problem. By looking for a similar solution and copying it to the new situation, making suitable substitutions where appropriate, transformational analogy transforms it into the target solution.

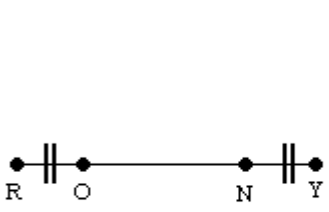
Possible modifications to the plan include:

- Removing step(s) from the plan
- Adding new step(s) to the plan
- Changing the parameter(s) of the steps in the plan (binding constraints)
- Addition/removal of ordering/contiguity constraints in the plan

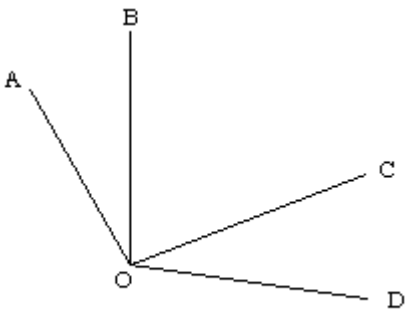
To illustrate the idea better, consider the following example.

E.g. Geometry.

If we know about lengths of line segments and a proof that certain lines are equal then we can make similar assertions about angles.



(a) Old Proof



(b) New Proof

Transformational Analogy Example

- We know that lines *RO* = *NY* and angles *AOB* = *COD*
- We have seen that *RO* + *ON* = *ON* + *NY* - additive rule.
- So we can say that angles *AOB* + *BOC* = *BOC* + *COD*
- So by a transitive rule line *RN* = *OY*
- So similarly angle *AOC* = *BOD*

Carbonell [1983] describes one method for transforming old solutions into new solutions. Whole solutions are viewed as states in a problem space called T-Space. T-operators prescribe the methods of transforming solutions (states) into other solutions.

Reasoning by analogy becomes search in T-spaces: starting with an old solutions, we use means ends analysis or some other method to find a solution to the current problem.

2. Derivational Analogy:

Transformational analogy does not look at *how* the old problem was solved, it only looks at the *final* solution. Often the twists and turns involved in solving an old problem are relevant to solve a new problem. The detailed history of a problem solving episode is called its *derivation*. Analogical reasoning that takes these histories into account is called derivational analogy.

Carbonell (1986) showed that derivational analogy is a necessary component in the transfer of skills in complex domains:

- In translating Pascal code to LISP, a line by line translation is not appropriate but we will have to *reuse* the major structural and control decisions.
- One way to do this is to *replay* a previous derivation and modify it when necessary.
- If initial steps and assumptions are still valid copy them across.
- Otherwise alternatives need to found for this we can apply best first search fashion.