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Comparative Study of Forward and Backward Chaining in Artificial Intelligence

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Abstract: ***An artificial intelligence system is capable of elucidating and representing knowledge along with storing and manipulating data. Knowledge could be a collection of facts and principles build up by human. It is the refined form of information. Knowledge representation is to represent knowledge in a manner that facilitates the power to draw conclusions from knowledge. Knowledge representation is a good approach as conventional procedural code is not the best way to use for solving complex problems. Frames, Semantic Nets, Systems Architecture, Rules, and Ontology are its techniques to represent knowledge. Forward and backward chaining are the two main methods of reasoning used in an inference engine. It is a very common approach for "expert systems", business and systems. This paper focus on the concept of knowledge representation in artificial intelligence and the elaborating the comparison of forward and backward chaining.***

Keywords: Artificial Intelligence, Knowledge Representation, Forward Chaining, Backward Chaining.

1. Introduction

Refined form of information is considered as knowledge which is really necessary to work with the concept of artificial intelligence [1]. Artificial Intelligence is concerned with getting computers doing things smartly like human beings. It is the concept of reading that how a human brain thinks, learn, take decisions, and act while trying to find solution of the provided situation, and then in the same way we use such results of the reading and understandings for developing intelligent and smart machines. While analyzing the power and capacity of the computer systems, a developer always wonders that is it possible for a machine to think. Knowledge provides wonderful power. This power is used to take various important decisions and controlling machines. A knowledge based system must have access to this power. The Artificial Intelligence programs that achieve expert- level intelligence for solving problems in specific task areas are termed as knowledge based systems [2]. Knowledge base systems include tasks, tasks domain, and knowledge engineer to represent knowledge in a proper manner. Knowledge-representation focuses on designing computer representations that capture information about the world that can be used to solve difficult and complex problems. It is used because conventional procedural code is not the best way to use to solve complex problems. Knowledge representation makes complex software easier to define and maintain than procedural code and can be used in expert systems. Logic is applied to take better decisions. Logic is the study of reasoning. It is a study of methods and principles used to differentiate valid and invalid reasoning. It is supposed to elaborate the laws of thought in a detail and sound manner with proper support of reasons. It is applied to prove things, whether mathematical, philosophical, or scientific. It is the basis for a branch of computer programming used in artificial intelligence [3]. It can be applied to perform software verification as well.

2. Knowledge Representation in AI

Highly technical and specialized Research associated with artificial intelligence is the main area of interest of artificial intelligence involves programming systems in few particular following disciplines such as: learning, Planning, knowledge, logical reasoning, capacity of manipulation, ability to rotate and move particles, problem solving and perception. Concept of knowledge engineering is considered as the heart of artificial intelligence [4-5]. It is considered that a knowledge base system in AI must have the following features:

- High Performance
- Good Response Time
- Reliable
- Understandable
- Flexible and many more.

Artificial intelligence has capability to access different objects, classes, procedures, categories, interactions, functions, attributes, links, algorithms and association between all among them to elaborate and understand the concept of "Knowledge Engineering". It means that having information which can be processed into useful knowledge, we are able to develop artificial humans. How exciting this subject is as it will provide us the knowledge of new concepts and opportunity to know a lot about ourselves [6]. While simulating natural thinking power that is "Common Sense", thinking ability and problem-solving power in machines is a difficult task. "Machine learning" is also one of the interesting and important parts of Artificial Intelligence [7].

"Learning" is the ability to learn new things from the surrounded environment. Learning is of various types.

1. Supervised Learning
2. Unsupervised Learning
3. Reinforcement Learning
4. Induced Learning

5. Auditory Learning
6. Episodic Learning
7. Motor Learning
8. Observational Learning
9. Perceptual learning
10. Relational Learning
11. Stimulus Response Learning

Frames, Semantic Nets, Systems Architecture, Rules and Ontology are various techniques to represent knowledge in a better way. Knowledge itself is of various types to attain the objective of artificial intelligence subject [8]. The following is various types of knowledge which is used in artificial intelligence to act and think like humans.

- Meta Knowledge
- Heuristic Knowledge
- Procedural Knowledge
- Structural Knowledge
- Declarative Knowledge

The above list of knowledge represents special type of knowledge .It consist of knowledge of knowledge, knowledge about some particular domain, show paths to perform task and shows relationship among objects [9-10]. A representation should be capable of doing the following tasks.

1. It should be able to express the knowledge needed to solve the problem.
2. It should be as close to the problem as possible. It should be compact and maintainable.
3. It should be easy to see the relationship between the representation and the domain.
4. It should be able to acquire knowledge from people, data and past experiences.

3. Issues Related to Knowledge Representation

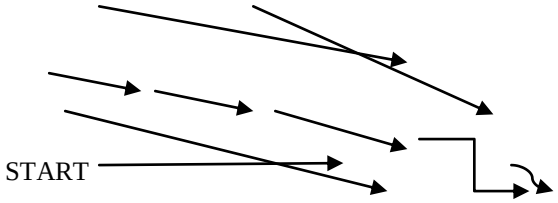
Artificial Intelligence claims to the concept of solving problems related to difficult tasks and ultimate puzzles. Artificial Intelligence is one of the wonderful and impressive disciplines. These are very difficult questions to answer, but the researchers and scientists in the field of artificial intelligence are having strong proofs that impossible also states about its possibility. All the researchers have to do is look them in the mirror to see wonderful example of an intelligent system. During 1985, Ron Brahnam highlights few issues in concern with representation of knowledge which was needed to be focused for the future of artificial intelligence. These core issues of primitives, Meta representation, definitions vs. facts, reasoning and incompleteness. Frames and Rules are important primitives in representing knowledge. Frame languages had various methods for expressing and enforcing constraints on frame data. Frames are further divided into slots and all data in frames are stored in slots. First Order Logic (FOL) is another technique to represent knowledge in AI [11]. Knowledge Representation binds facts and rules and justifies them using proper logic called predicate or propositional logic. Incompleteness is another important issue which is often faced when information is represented in knowledge base.

4. Forward and Backward Chaining

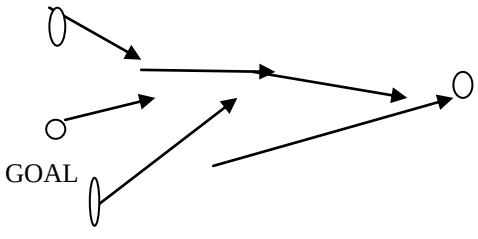
Forward chaining starts with the available data. This is an initial data and uses inference rules. It helps in extracting more data until a goal is reached. An inference engine using forward chaining searches the inference rules until it finds one. Here the antecedent is known to be true. Whenever such a rule is found, the engine can conclude results. An inference engine using forward chaining searches the inference rules until it finds solution. Here the "IF" clause is known to be true. When found it can conclude. It may infer the "THEN" clause. It will result in the addition of new information to the dataset. It means that it starts with some facts and applies rules to find all possible conclusions. Therefore, it is also known as "Data Driven Approach". Backward chaining approach starts with the desired conclusion and works backward to find supporting facts. An inference engine using "Backward Chaining" would search the inference rules until it finds one which has a "THEN clause" that matches a desired goal. If the "IF clause" of that inference rule is not known to be true. At the very next step, it will add to the list of goals. In other words, this approach starts with the desired conclusion and works backward to find supporting facts. Therefore, it is also known as "Goal-Driven Approach". They do this by finding rules that can conclude the information needed by the goal. It tries to make the If parts of those rules satisfied. It works as follows:

It will check the conclusions of the rules. This is used to find all rules that can satisfy the top goal on the stack. You need to process these rules one at a time. One has to evaluate the conditions in the rules. It may be possible that the condition is currently unknown. Simply you have to push a goal to make that condition known. At last, one has to recursively invoked the system. It might be possible that the condition which is known to be unsatisfied. We have to continue with the loop till the last. It might be possible that it is difficult to determine whether the condition was satisfied, continue with the loop. If all the conditions in the selected rule are satisfied. Then we can add to Working Memory. After that pop the goal off the stack. Finally, return from this invocation of the system. The system will terminate with success when the goal stack is empty. It will terminate with failure if the system runs out of rules.

Forward Chaining



Backward Chaining



5. Comparison of Forward and Backward Chaining

The concept of comparison can be understood with the help of an example of day to day life. Every day, due to a lot of reasons we have to visit hospitals for medical consultation. What logic is applied for the treatment of a person? There are two approaches can be used by the physician. One method is of forward chaining process and second one is of backward chaining method [12]. A physician usually begins to diagnose a patient by asking him about the symptoms he or she suffers from, such as high blood pressure, temperature, headache, sore throat, coughing and many other symptoms. After the analysis and discussion, information is collected for the starting process of treatment. The physician uses this information to draw a reasonable conclusion or to establish a hypothesis to explore further. This way of reasoning is done in a knowledge base system which is called forward-chaining [13]. On the contrast, a physician may suspect some problems with patient. After checkup, he attempts to prove by looking for certain symptoms of the disease which illustrates the concept of backward chaining. Table No. 1 shows the comparative study of chaining methods of artificial intelligence.

Forward Chaining	**Backward Chaining**
It starts with new data.	It starts with some goal or hypothesis.
It asks few questions.	It asks many questions.
It examines all rules.	It examines some rules.
Slow approach.	Fast approach.
Gather larger information from small amount of data.	It produce small amount of information from available data.
Forward Chaining is primarily data driven.	Backward Chaining is primarily Goal Driven.
It uses its input. It searches rules for answers.	It proves the considered hypothesis.
It is a form of Top-Down reasoning.	It is a form of bottom up reasoning.
Works forward to find conclusions from facts.	Works backward to find facts that support the hypothesis.
It tends to breath – first.	It tends to depth – first.
Forward Chaining is suitable for problems that start from data collection; e.g. planning, monitoring and control.	Backward Chaining is suitable for problems that start from hypothesis, e.g. diagnosis.
This type of chaining is non-focused because it infers all conclusions, may answer unrelated questions.	This type of chaining is focused to prove the goal and search as only the part of knowledge base that is related to the problem.
Explanation is not facilitated in Forward Chaining.	Explanation is facilitated in Backward Chaining
All data is available.	Data must be acquired interactively (i.e. on demand)
It deals with less number of initial states and many results.	It deals with less starting goals and many facts.
Forming a goal is difficult in case of Forward Chaining.	Forming a goal is easy in case of Backward Chaining.

6. Conclusion

This paper discusses the concept of knowledge and its importance in Artificial Intelligence. The Knowledge base acquires its contents from various sources, organize them and utilize them to take a decision and solve a difficult and complex problem. Knowledge plays an important role in designing AI supported systems. Different kinds of Knowledge and their sources have been elaborated and the then concept of

forward and backward chaining is rose out with their comparison. Recent progress in research and simulation of the artificial intelligence concepts are going hand to hand of researchers with enhancements in the abilities of real systems. Further research and development programs are simultaneously carried out for betterment in technology and it is necessary to understand the basic theoretical concepts in order to seek further knowledge.

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