

Artificial Intelligence Perspective of Indian Logic (in Special Reference To "ANUMĀN")

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Abstract

Representing knowledge is the fundamental requirement of inference and reasoning mechanism. Inference will prove efficient only when knowledge is represented and retrieved more naturally. In other words the pattern of knowledge representation to enable mimicking of human Inference. Every research in Artificial Intelligence (AI) had proposed striking advance in knowledge representing mechanism. One of the fundamental issues in AI is the problem of knowledge representation. Intelligent machines must be provided with a precise definition of the knowledge that they possess, in a manner, which is independent of procedural considerations, context-free, and easy to manipulate, exchange and reason about. Any comprehensive approach to knowledge representation has to take into account the inherently dynamic nature of knowledge. As new information is acquired, new pieces of knowledge need to be dynamically added to or removed from the knowledge base. For inferences, decision-making, dialogue-exchange or machine learning, the fundamental issue involved is the utilization of reasoning. Reasoning is the process of arriving at new conclusions. To reach a conclusion, we generally conclude certain investigations. Therefore, if the investigations are not formally represented using a knowledge representation language which is clear and user-friendly, performing reasoning shall become a daunting task. This paper discusses such as an aspect of knowledge representation adopted from Indian Philosophy in special reference to "Anuman(Inference)".

Key Words: Artificial Intelligence, knowledge representation, perception (pratyakṣa), inference(Anumāna), comparison(upmāna), verbal testimony(śabda), memory(smṛti), doubt (saṁśaya), error(viparyaya), hypothetical reasoning (tarka).

How will be easier knowledge representation

Knowledge representation cannot be defined in pure epistemological terms. Representation and reasoning are intertwined with knowledge representation. The attempt to deal with e-presentation as knowledge content alone leads to an incomplete conception where reasoning may be put aside. The use of a representation as a medium of expression and communication matters because we must be able to speak the language in order to use it. If we cannot determine how to say what we are thinking we cannot use the representation to communicate with the reasoning system. Several measures of a good knowledge representation may be listed as follows:

- Support to efficient reasoning.
- Expressivity- how expressive the knowledge is.
- Adequacy- is the represented knowledge adequate.

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- Satisfiability- role of knowledge which satisfies the goal.
- Quality- quality of knowledge within the knowledge representation.
- Uncertainty- how much certain the expressed knowledge is.
- Consistency - how much consistent the knowledge is.

Indian logical system

Indian logic has a long history. "*Ānvikṣikī*" started as the science of inquiry and has grown into the art of debate. It had its beginnings in the *Ātma Vidyā* or *Brahm Vidyā* (science of the soul or the divine science) pursued by the *Upaniṣads*. *Ānvikṣikī* differed from *Ātma Vidyā* as it dealt with two subjects: *ātma* is the soul and *hetu*, the theory of reasons. It later bifurcates into philosophy and logic. In the former aspect, it, evolved into *Hetu* (science of reasoning) or *tarka vidyā* (the art of debate). *Ānvikṣikī* has been held in high esteem in works such as Kautilya's *Arthashastra*. The technical terms of *Ānvikṣikī* may be found in texts such as *Aitareya Brahmana* and *Kathopanishad*. One can visualise a council conducting debates of learned men (*Samsad, samiti, sabha* or *parishad*), where discussions on true knowledge were taking place in the context of four valid means of obtaining the same:

1. Smṛiti (scripture),
2. Pratyakṣa (perception),
3. Eitihya (tradition),
4. Anumana (inference).

Indian logic somewhat covers the domains of two of the six schools (*darsanas*) of Indian philosophy, namely *Nyāya* and *Vaiśeṣika*. The generally accepted definition of Indian logic over the ages is the science which ascertains valid knowledge either by means of six senses or by means of the five members of the syllogism. In other words, perception and inference constitute the subject matter of logic. The science of logic evolved in India through three ages: the ancient, the medieval and the modern, spanning almost thirty centuries.

- The ancient school of Indian logic with the representative text, *Nyāya Sūtras* of Gautama (650 B.C.-100 A.D.).
- The Medieval school of Indian logic text, *Pramāṇa Samuccaya* of Dignāṅga (100 A.D.-1200 A.D.).
- The modern school with the representative text, *Tattva Cintāmaṇi* of Gaṅgesa (900 A.D. onwards).

Logical System of Nyāya:

Nyāya is the science of logic "प्रमाणैरर्थपरीक्षणं न्यायः (न्या. सू.)" *nyāya* (sanskrit word *ni-āyá*, literally "recursion", used in the sense of "syllogism" inference") is the name given to one of the six orthodox or *āstika* schools of Hindu philosophy- specially the school of logic. The *Nyāya* school of philosophical speculation is based on texts known as the *nyāya sūtras*, which were written by Gautam around the 2nd century.

The *Nyāya* epistemology considers knowledge (*jñāna*) or (*anubhava*). Knowledge may be valid or invalid. The *Naiyāyikas* (the *Nyāya* scholars) accepted four valid means (*Pramāṇa*) of obtaining valid knowledge (*prama*):

- Perception (*pratyakṣa*),
- Inference (*Anumāna*),
- Comparison (*upmāna*) and
- Verbal testimony (*śabda*).

Invalid knowledge includes:

- Memory (*smṛti*),
- Doubt (*saṃśaya*),
- Error (*viparyaya*) and
- Hypothetical reasoning (*tarka*).

AI perspective of Anumān or inference:

Anumāna (inference) is one of the most important contributions of the *Nyāya*. It can be of two types:-

- Inference for oneself (*Svārthānumāna*-where one does not need any formal procedure, and at the most the last three of their 5 steps),
- And inference for others (*Parāthānumāna*-which requires a systematic methodology of 5 steps).

Gautama gives three ways to infer -:

- *Purvavat* (inferring an unperceived effect from a perceived cause.
- *Sheshavat* (inferring an unperceived cause from a perceived effect) and,
- *Samanyatodriṣhta* (when inference is not based on causation but on uniformity of co-existence.

Jayanat gives the five process of inferring-

- Perception of reason,
- Remembrance of universal connivance,
- Judgment that the subject of inference contain sense concomitant with the object,
- Knowledge of the consequence and
- the judgment that consequence is worthy of being accepted or rejected.

Artificial Intelligence explanation of inference:

Inference is very important and strong point of predicate calculus-axioms-- theorems

new fact can be deducted from axioms using rules of inference similar once given by Gautam .

Gautam gives the three ways to infer-

- **purvavat(deduction):**
- Cause—effect
- cloud --rain

E.g. Gauri eats grass. (major term)

Gauri is a cow. (minor or middle term)

So all cows eats grass.

(inst gauri cow)

(for all X (if(inst X cow) (food x grass)

(food gauri grass)

- **Sesvat(Abduction)**
- process- explanation
- effect-- cause
- river is swollen-- there could have been rain
- Abduction has the following paradigms-

from :b

(if a is b)

infer: a

- abduction is not a legal Inference it can lead to false conclusion-
- from (feels nervous era)

(for all x (if (is sick x)

(feels nervous x)

Infer (is sick ire)

- **Samanyatodrst(induction)**
- Infer consequent from antecedent which is neither cause nor effect.
- while induction can take several forms the most common is
- from:(p a), (p b),
- infer :(for all (x) (P x))
- Although this not a sound inference but it is very useful in everyday life where it is more commonly known as learning.

Exp. if we see a lot of leaves of green color, we might infer that all that all leaves are green color.

From (if (inst leaf- 1 leaf) (color leaf_1 green)

(if (inst leaf- 2 leaf) (color leaf_2 green)

infer: for all(x)(if (inst X leaf) (color x green)

Use of Inference for easier to implement knowledge:

Second type of *Anumān "Pararthanuman"* inference for others which requires a systematic methodology of 5 syllogism sentence is a Impressive source for implement and understanding the knowledge . therefore it is very useful for knowledge representation.

There is fire on the hill (called *Pratijñā*, required to be proved)

Because there is smoke there (called *Hetu*, reason)

Wherever there is smoke, there is fire, e.g. in a kitchen (called *Udāhāraṇa*, example of *vyāpti*)

The hill has smoke that is pervaded by fire (called *Upanaya*, reaffirmation or application)

Therefore there is fire on the hill (called *Nigamana*, conclusion)

In *Nyāya* terminology for this example, the hill would be called as *pakṣa* (minor term) the fire is called as *sādhya* (major term), the smoke is called as *Hetu*, and the relationship between the smoke and the fire is called as *vyāpti* (middle term) *Hetu* further has five characteristics: (1) It must be present in the *pakṣa*, (2) It must be present in all positive instances, (3) It must be absent in all negative instances, (4) It must not be incompatible with the minor term or *pakṣa* and (5) All other contradictions by other means of knowledge should be absent.

Through this methodology of five syllogism sentences we can get all the goals of a knowledge representation or efficient reasoning.

Expressivity- how expressive the knowledge is.

Adequacy- is the represented knowledge adequate.

Satisfiability- role of knowledge which satisfies the goal.

Quality- quality of knowledge within the knowledge representation.

Certainty- how much certain the expressed knowledge is.

Consistency- how much consistent the knowledge

Conclusion

In this paper, we attempted to give a flavor of classical Indian logic as it evolved over more than thirty centuries. It can be said that India has a systematized tradition of logic and *Anumān* is so useful in knowledge representation. This paper discussed the *Nyāya* Logics or *Anumān* theory which is the most effective method to represent knowledge useful for inference and reasoning purposes. The methodology is more effective because it tackles inferences similar to the approach of human cognition. This paper also analyzed the issues in existing knowledge representation formalisms.

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