# Relevance of Nyāya Philosophy to Modern Life

G. S. MAHALAKSHMI AND T. V. GEETHA

Nyāya is the philosophy of logic. *Vāda*, the variety of argumentation style is of prime importance in Nyāya system of argumentation. The idea of identifying reason fallacies (*hetvābhāsha*) from the proposed arguments in order to qualify the argument to be defective is very promising. The methodology of syllogistic reasoning and inferencing performed through the *tarka-vāda* process, guides us through a systematic understanding of the procedure of inference. These age-old traditions of Nyāya find interesting applications in modern discipline, especially in artificial intelligence. In this paper, we have attempted to throw a light on key applications to which Nyāya philosophical traditions could be applied.

The school of reasoning, Nyāya, concerns with the nature of inferential reasoning and constructed a system of rules for conducting debates. *Tarka-vāda* is a special class of debate which can be applied to knowledge sharing. The benefit of *tarka* methodology is that, the arguments exchanged between the arguers are seen as a means for sharing valid knowledge which can be achieved through proper reasoning.

Acquisition of new knowledge by performing reasoning might lead to situations which conflict the old beliefs. This situation is generally known as non-monotonic reasoning, where, revising the old beliefs is required. Procedural reasoning or *tarka* stated in Nyāya of Indian philosophy follows a five-membered inference pattern which tries to associate other knowledge elements around the revised belief, questions it and analyses the consequences of the surrounding knowledge more meaningfully.

The importance of Nyāya tradition in Indian philosophy has its significance particularly in rational debate and clear, logical argumentation. Analysis of inferential reasoning was central in establishing the proper rules for scholastic debate, a prominent practice of Indian philosophy. The hypothetical reasoning or rational critique (*tarka or tarka-vāda*) [16], is the exchange of arguments between the proponent and opponent with the objective of attaining valid knowledge. The purpose is to test the validity of inferential reasoning by demonstrating the absurd consequences that follow from an opponent's position and therefore eliminate doubt in the mind of the enquirer. The nature of inference for others, as applicable in traditional debates, is discussed in Nyāya Shāstra.

## Nyāya inference

According to Nyāya Shāstra, an inferential proof is made up of the following members:

- The statement, premise, thesis or proposition—a declaration of that which is to be established;
- The cause or reason for the statement—the supporting evidence which strengthens the proof;
- The example—a similar case that has occurred prior to the statement. It can be homogeneous or heterogeneous;
- The application of that example—a

summing up with reference to the example of what was sought to be established;

- The conclusion—consists in re-stating the proposition after mentioning the reason.

The difference between the thesis and the conclusion lies in the fact that the thesis simply states what is to be established in the locus, but the conclusion states how it is to be established in the locus [15].

On the employment of five sentences there arises, at first, knowledge from each of them separately. Then arises collective knowledge from the five sentences combined together. Therefore, according to ancient Nyāya logic, the proper formulation of inference utilizes the above-mentioned five-membered syllogism. To test the validity of inferential reasoning, Nyāya incorporates the unique property of invariable concomitance or *vyāpti*, the relation of simultaneous existence that binds any two concepts, of *probans and probandum.*

The order of a five-membered syllogism is not in accordance with the process of getting inferential cognition. An inferer must first comprehend the invariable concomitance between probans and probandum, before starting to infer about the probandum. At a later stage, when the inferer wants to prove the existence of probandum over the subject, he remembers the invariable concomitance comprehended already at a previous situation. Finally he obtains the inferential cognition to prove the proposition.

This inferential cognition (*anumiti*) is the effect of certain other cognitions. The Nyāya philosophers have defined the inferential cognition in terms of its causal conditions [14] in terms of *parāmarsha* and *pakshatā.*

The instrument for generating this cognition is the knowledge of the invariable concomitance. This knowledge is assumed to be available as part of the common-sense knowledge. Whether the enquirer infers this relation by the co-presence or co-absence of both probans and probandum lies in the formal definition of invariable concomitance. Parāmarsha is the cognition of the presence of the probans pervaded by the probandum in the locus of the inference. *Pakshatā* is the absence of certainty about the probandum in the locus or the desire to infer the probandum in the locus [14]. An effect always follows its cause. Inferential cognition is the effect, of which both *parāmarsha* and *pakshatā* are causal conditions.

According to the Nyāya, the Vaisheshika, and some other systems, the mental perception of a cognition is to be accepted in order to reveal a cognition [12, 13]. In this context it is to be noted that among Indian philosophers there are three views about how a cognition is to be revealed (or cognized). These three views are as follows:

- A cognition reveals itself (or is self-revealing);
- A cognition is to be inferred from the probans, (or the inferential mark), namely the property of being cognised;
- A cognition is the object of a mental perception.

We go by the second view of cognition as defined by the Indian philosophers. *Vyāptijnāna* is the cognition of invariable concomitance between the probans and the probandum. The Nyāya philosophers have classified inferences into three types depending upon the nature of the invariable concomitance (*vyāpti*) between the probans and the probandum. Again, the probantia (*hetus*) have been divided into three types depending upon the nature of the invariable concomitance.

If the rule of invariable concomitance used in an inference takes the form of agreement in presence of the probans with the probandum, then the inference is called '*anvayi*' ('agreement in presence'). If this rule takes the form of agreement in absence, then the inference is called *vyatireki* ('agreement in absence'). And if the rule takes both the forms, then the inference is called '*anvaya-vyatireki*' ('agreement in presence and absence'). Both the examples of agreement in presence and agreement in absence are to be stated in support of this rule of invariable concomitance. The observation of the presence of the probans and the probandum in some loci and the non-observance of the presence of the probans and the absence of the probandum in some other loci are required for the cognition of the rule of invariable concomitance between the probans and the probandum.

In our work, we go on to explain and follow only the plain definition of invariable concomitance relation between the probans and probandum (agreement in presence), according to the second view as stated in Nyāya Shāstra [1], thus ignoring the internal variations [12, 13].

The process of determining the nature of existence of invariable concomitance in the proponent's argument starts by exploration of argument in light of various reason fallacies over the elements of argument. This exploration further results in identifying the possible defects in the proposition, for which the nature and definition of invariable concomitance is utilized. Syllogistic interactions are a measure to resolve knowledge inconsistencies through argument analysis by which defects are thoroughly explored. It is this perspective which motivated us to apply this to knowledge sharing.

### Argument gaming

Western philosophical perspectives of argumentative reasoning deal with variety of argumentation schemes which tell how the argument is fallacious or defective. However, the analysis of internal semantic content of the argument is secondary and therefore, there is no rule for identifying argument fallacies out of the proposed arguments. It has to be a trial and error process, or, in other words, every argumentation scheme could be developed only by attempting at more examples of argumentation which carry such argument fallacies.

However, in this paper, we have discussed the methodology behind utilizing the idea of reason fallacies present in the proposed arguments, which formed a motivation to knowledge sharing.

The reason fallacies or *hetvābhāsha* are the fallacies present in the *hetu* or *probans* or 'reason' component of the submitted argument. According to Shaw [15] the fallacies are due to the defect of probantia. The 'reason' supports the claim of *probandum* or 'object of inference' over the 'subject' or *paksha*. The reason fallacies present in the proposed argument (with respect to the interpreter's knowledge base) is referred to as 'defect' which is identified by defect exploration methodologies [3]. The defects are invalid knowledge units supplied in the arguments and therefore, need to be opposed by refutations. Through refutations, the contradictions of the proposed argument are identified [4], which result in appropriate counter-arguments.

This strict alternation of arguments and counter-arguments as moves and counter-moves, in a gaming fashion is called 'argument gaming' [3, 4]. From the perspective of knowledge sharing, the major task in the argument gaming context is the discovery of knowledge contradiction, ie holes or gaps in the knowledge base of one of the proponents, and the removal of the contradictions by putting forth suitable justifications [3, 4]. This would enable effective knowledge sharing.

### Applications of argument gaming

The purpose of argument gaming is generally twofold: to resolve contradictions, and to attain a mutual consensus. The focus is on rational interactions between the participating entities involved in practical reasoning. By rational, we mean, giving and receiving of reasons or explanations. In such a co-operative, non-monotonic argument scenario, the participating entities or gaming agents swap arguments with each other as an attempt to attack the opponent's argument. The focus is on the amount of knowledge shared as a result of the set of arguments exchanged. Higher, the sharing of conceptual knowledge, greater, the rewards harvested. Increased rewards qualify the discussion entities for further participations.

Because the knowledge exchange has to be rational, allowing certain amount of partial observability tends to preserve the rational exchange of arguments between the participating entities. The key idea is to have volunteers that teach unknown information (or concept) to interested volunteers in a rational conversation environment. Two crucial components of argument gaming are defect analysis and refutation [3, 4].

The process of defect exploration [3] actually entails analysing the ontological elements of submitted arguments and populates them into a defect set. The defect set can then be utilized by the participant for designing appropriate defeat strategies, which help in generation of associated counter-arguments. It is this property of argument gaming motivated by Nyāya, which finds interesting application to intelligent systems. The following sections portray various applications that take inspirations from Nyāya.

### Requirements engineering

In traditional software project development, system analysts interact with the customer to identify suitable requirements for the software package under question. There is an issue associated in this context, due to employing human personnel as system analysts to tap the initial set of requirements. The obstacle lies in the biased approach of the system analyst in interpreting the customer requirements, if they are very much aware of the problem domain. Besides, the domain expertise applied in the previous projects, which resulted in parts of reusable models, would go unnoticed if untrained or fresh human personnel are employed. Application of argumentative reasoning to automate the knowledge sharing process during the early stages of software life cycle might benefit in gathering valid and essential software requirements. The requirements from stakeholders shall be analysed [6] for defects with respect to preconceived notion of that particular domain ontology (for which the company is assumed to have already completed atleast one project earlier). There may be more than one defects present in the response of the stakeholder, in which case, the defect or flaw with the highest score is projected at the output. The stakeholder is expected to resolve the flaw in the following response. Defects explored in this fashion shall be put forth as counter-questions recursively to the stakeholders until the requirements ontology customized to the stakeholder's need is visualized.

Under the circumstances of presence of invariable relation between two concepts, the stakeholder is expected to provide information about only one of the concepts because, the other is assumed by default, and any further answers that violate the invariableness is just ignored. Absence of invariableness projects the necessity of taking a response from the stakeholder. Thus, the knowledge represented in Indian logic-based ontology provides every benefit of analysing the natural language requirements.

### Military robotics

Knowledge sharing through argumentation shall be applied for autonomous robots which are associated with unmanned vehicles. In such a scenario, robots wander along the surface with the objective of marching towards the enemy battalion. The autonomous robots may exchange certain information regarding the enemies or the landscape, in order to facilitate easy navigation of the battalion behind. Instead of devising just an interaction and querying mechanism, argumentation-based knowledge sharing motivated us to enable the robots to do little procedural reasoning and inferencing. This might improve the systematic thinking of robots and will stimulate better reasoning and inferencing by analysing every argument proposed to them. Since there would not be any human commandant present to control the navigation of robots, the robots eventually will arrive at intermediate conclusions which will lead them to march safely in such an emergency situation.

With respect to this application, the notion of argument-gaming-based knowledge sharing entity shall be interpreted as 'an unmanned military robot' [7]. The initiator is allowed to propose arguments and others tend to listen and reply to that argument. We assume that the swarm of military robots has already located the target and the robots plan to march towards the target in clusters, under the leadership of the initiator. The military region is split into grids. To march towards the target, an initiator is selected from the cluster based on trust. Initiator marches towards the target laying the encrypted pheromone.

The robot cluster decides the pheromone encryption before the initiator leaves the cluster. The cluster head communicates with initiator and organizes the cluster to move in the path in which the initiator has laid the pheromone. Other robots of the cluster decrypt the pheromone and move in the path planned by the initiator. Within cluster, the robots communicate and share knowledge with each other by argument gaming. This procedural communication has to be based on trust derived for that particular state. The knowledge gained is passed to other robots so that the cluster could take a more intelligent decision.

The evaluation of arguments follows a thorough exploration of belief-based search to which rewards are assigned. Robots with identical or approximately equal trust values is assumed to have proportional knowledge bases ie, such robots can interpret and communicate among themselves much faster because they possess similar conceptual knowledge bases. The knowledge base is in the form of Indian logic-based ontology. This makes easier for the robots to infer information on a large-scale while communicating in emergency situations.

**Semantic Wiki-s**

Indian logic plays a vital role in interpreting and conducting argumentative discussions. Presenting a flawless argument is one of the prime criterions to convince others during argumentation. Indian logic proposes various reason fallacies and argument fallacies which are to be avoided while constructing an argument. Fallacies of thesis as explained in *Nannool*, the famous Tamil treatise, also discusses similar thought. Fallacious arguments get weaker rewards and have the chance of getting rebuked by the opponent. It is this idea which inspired us to apply it to evaluation of Wiki pages, when a naïve user browses over Wikipedia.

Wikipedia is a collection of Wiki pages which discusses various ideas and supporting explanations, annotations and references for those discussed ideas. But, there is no credibility in the information content of Wiki page. However, the credibility of a Wiki page varies with respect to the supporting definitions and inter-Wiki references and other related stuff which that Wiki page contains. By altering or re-arranging the abovementioned references and supporting explanations for a sample Wiki page, and still, ontologically maintaining the Wiki page to be tagged under the same node of the ontology as before, one shall realize that the trust level of Wiki page increases or decreases accordingly, which shall be recommended to any naive or experienced user.

We propose our idea for evaluation of Wiki thus: Every Wiki page is to be represented into an Indian logic-based argument interchange format. Argument interchange formats for semantic web exist in the literature [2, 8]; however, they lack the treatment of arguments as like Indian logic. In Indian logic, every argument is seen in terms of three concept components: subject, object to be proved and reason, apart from the relation components which exist between them. Therefore, representation of Wiki pages into Indian logic-based argument interchange format will facilitate identification of reason fallacies in arguments. In other words, every Wiki page is mapped as a composite argument which consists of various argument elements, which shall be explored for reason fallacies as recommended by Indian logic.

Though we need to map the internal descriptions of the Wiki page into concept ontology, the structure of ontology also follows NORM model [5] recommended by Nyāya Shāstra's classification scheme, which facilitates extraction and exploration of fallacies present in Wiki arguments. After a thorough analysis for presence of fallacies and refutations [11] in Wiki arguments, the Wiki page is evaluated for credibility. Wiki pages evaluated in the above style are reranked according to the degree of trust and the information granularity and various other parameters, which provide a trustable Wiki document to the users.

## E-learning

Nyāya performs an analytical investigation of the subject through the process of logical reasoning, which can be applied to teaching-learning scenario. The methodological reasoning involving a critical investigation can be obtained from the five-membered scheme of syllogistic expression of Nyāya thought and from the ideas proposed in Nyāya *sutra*. The framework of teaching learning system shall be thought to be based on blooms taxonomy [17] reasoned with Nyāya logic.

Knowledge level reasoning with Nyāya attribute is obtained from verbal testimony and perception. Verbal testimony defines the characteristic of the text. Perception is defined as the knowledge obtained from the association of the text to the object. Blooms taxonomy at comprehension level deals with understanding of information and to translate it to a new context. Comprehensive reasoning in Nyāya deals with comparison (*upamāna*) and through analogical reasoning. *Upamāna* is defined as the knowledge of the object derived from its similarity to another object previously well known. The five membered syllogism contributes to finding a similar and dissimilar example through analogical reasoning.

Application level of blooms taxonomy deals with using methods, concepts and theories in new situation. Nyāya reasoning in this level deals with application (*upanaya*) which is the comparison and change in loci. The five membered syllogism also contributes to mapping existing example to different loci.

Blooms taxonomy in analysis level deals with ability to discover and differentiate component parts. This shall be achieved through Nyāya's contributions like doubt (*samshaya*) and mark (*linga*) at analysis level. *Samshaya* is defined as the conflicting judgement made with character of the object consisting of recognition of common properties, recognition of not common properties, conflicting testimony, and irregularity of perception and irregularity of non-perception. Mark is threefold consisting of purely positive, purely negative and positive with negative. Nyāya at synthesis level which deals with ability to adapt old ideas to create new ones contributes to assembling all the five members discussed during the inference pattern to obtain a valid conclusion.

## Conclusion

In this work, we emphasized the relevance of various features of Nyāya like reason fallacies, *tarka-vāda*, to theories of modern *life*. In addition, the epistemological classification of Nyāya also contributes to efficient storage and organization of universal knowledge around us, which could be thought of to be applicable in search engines [9, 10]. In future, we have plans to develop a dream application which is more like an interactive tutor based on argumentation, as an aid for naive lecturers, to regulate the flow of lecture delivery. ■

## NOTES AND REFERENCES


1 Gautama (1930). 'The Nyaya Sutras', translated by S. C. Vidyabhusana, edited by Nanda Lal Sinha, Sacred Book of Hindus, Allahabad, 1930. Reprinted in 1990. Delhi: Motilal Banarsidass

2 Iyad Rahwan, Fouad Zablith and Chris Reed (2007), 'Towards Large Scale Argumentation Support on the Semantic Web', Association for the Advancement of Artificial Intelligence, pp. 1446-1451.

3 G. S. Mahalakshmi and T. V. Geetha (2007), Navya-Nyàya Approach to Defect Exploration in Argument Gaming for Knowledge Sharing, In proceedings of International Conference On Logic, Navya-Nyàya & Applications-A Homage To Bimal Krishna Matilal (ICLNNA '07), Jadavpur University, Calcutta, India, pp. 171-182.

4 G. S. Mahalakshmi and T. V. Geetha (2008), Modeling Uncertainty in Refutation Selection—A POMDP based approach, Journal of Uncertain Systems-special issue on 'Advances in uncertain theory and its applications', Vol. 2, No. 3, pp. 223-240.

5 G. S. Mahalakshmi and T. V. Geetha (2008), Reasoning and Evolution of consistent ontologies using NORM, IJAI: Sp. Issue on theory and applications of soft computing, Indian Society for Development & Environment Research, Vol. 2, No. S09, pp. 77-94.

6 G. S. Mahalakshmi and T. V. Geetha (2009), Requirements Elicitation by Defect Elimination: An Indian Logic Perspective, International Journal of Software Science and Computational Intelligence, IGI publications, 1(2), 73-90, April-June 2009.

7 G. S. Mahalakshmi and T. V. Geetha (2009), Multi-Robot Learning using Nondeterministic Argument Games, International Journal of Autonomous and Adaptive Communication Systems (IJAACS), Inderscience Publishers (in press)

8 Michel Buffa, Fabien L. Gandon, Guillaume Ereteo, Peter Sander and Catherine Faron (2008), 'Sweet Wiki: A semantic wiki', Web Semantics: Science, Services and Agents on World Wide Web, pp. 84-97.

9 S. N. Rajasekar, G. S. Mahalakshmi, S. Sendhilkumar and T. V.Geetha (2008), Indian logic Ontology Based Automatic Query Refinement, IJAI sp. issue on Theory and Applications to soft computing, Indian Society for Development and Environment Research, Vol. 8, No.A 08, pp. 111-132.

10 S. Sendhilkumar, G. S. Mahalakshmi. and S. N. Rajasekar. (2009), 'Ontology based Automatic Query Refinement', International Journal of Artificial Intelligence and Soft Computing, Inderscience Publishers (in press).

11 U. Ve. SaaminaathaIyer (1995), 'Pavanandhi munivar iyatriya Nannool moolamum, Mayilainaathar uraiyum', Dr U. Ve. SaaminaathaIyer, Noolnilaiyam, Chennai.

12 J. L. Shaw. (1996), 'Cognition of Cognition', Part I, *Journal of Indian Philosophy*, vol 24, pp 165–207.

13 J. L. Shaw (1996), 'Cognition of Cognition', Part II, *Journal of Indian Philosophy*, vol 24, pp 231–264.

14 J. L. Shaw (2002), 'Causality: Samkhya, Bauddha, and Nyàya', *Journal of Indian Philosophy*, Kluwer Academic Publishers, Holland, June, pp 213-270.

15 J. L. Shaw, (2009), 'The Nyàya on Inference and Fallacies in book series' "Studies in Logic" edited by Mihir K. Chakraborty, Benedikt Löwe, Madhabendra Nath Mitra, and Sundar Sarukkai, College Publications, London (in press).

16 Swami Virupakshananda (1994), *Tarka Samgraha*, Sri Ramakrishna Math, Madras.

17 Bloom's Taxonomy


---


* G. S. Mahalakshmi and T. V. Geetha are associated with the Department of Computer Science and Engineering, Anna University, Chennai.