Communications of the IIMA

Manuscript 1441

Examining the Relevance of Indian Logical Traditions and Present-day AI Developments

Ramesh Subramanian

Follow this and additional works at: https://scholarworks.lib.csusb.edu/ciima

 Part of the Management Information Systems Commons

Examining the Relevance of Indian Logical Traditions and Present-day AI Developments

Ramesh Subramanian
Quinnipiac University
Hamden, Connecticut, USA 06518 rsubramanian@quinnipiac.edu

ABSTRACT

This paper is an essay on the differences between "formal" Western logic and Indian logical traditions and how the latter impacts present-day AI developments. Upon the colonization of India, Western philosophers often dismissed Indian logical constructs as being underdeveloped or clumsy. Others, however, saw such denigration as emanating from Western racial prejudice rather than objectivity. This debate has persisted. I discuss the salient aspects of this debate, and then focus on the inductive aspects of Indian logic. This is especially relevant to the present, when there is an explosion of artificial intelligence based applications. I discuss the salient features of the new developments in Generative AI, and then attempt to show how the models in Generative AI are connected to Indian logic with its focus on inductive reasoning rather then deductive reasoning. It is useful for students and researchers of present-day AI to be aware of alternate systems of logic, which may be useful in developing newer AI models and applications.

Keywords: Indian Logic; Generative AI; AI Development; Aristotelian logic; Nyaya sutra; Indian syllogism; AI Education

INTRODUCTION AND MOTIVATION

Artificial Intelligence is all the rage at the moment. AI applications abound in almost every sphere of human endeavor. Innovations in AI have led to a mushrooming of AI related startups. The global market size for AI applications was estimated by Bloomberg Business at around USD 500 Billion in 2022 and is expected to grow at a compound annual growth rate exceeding 38%, and is estimated to reach about USD 1.5 Trillion by 2030 (Catsaros, 2023). University courses in AI and Machine Learning are very popular across a wide spectrum of students. Newer and better models of AI, known as Generative AI are emerging. This has led to passionate discussions on the ethics of AI and ML, their impact on privacy, law, and society, among the sociological and legal community, such as the Yale Law School's "Information Society Project" in which the author is a Fellow.
This paper examines Indian logical traditions in comparison to Western logical traditions, and discusses how it is relevant to today's developments in AI, especially Generative AI. My motivation for this is as follows: To my knowledge, there is very little, if any, work done in examining the history of logical traditions from across the globe and then relating those traditions to present-day developments in AI. As a researcher interested in the history of technology, I am interested in the logical foundations of AI. As an academic, I am interested in what present-day students need to know about logic. I often ask to myself: Do students know enough about the history of logic that underlies the study of AI? If so, to what extent? If not, then what needs to be taught? What do application designers and analysts know about logic as a subject? This paper therefore addresses at least some of these questions on how logical traditions have developed in India in comparison to the West, and how one should understand and apply the Indian logical traditions, which I argue is primarily inductive rather than deductive, so that we can see how and where the Indian perspective becomes relevant when we study new developments in AI.

The paper is written in an essay format. It uses as sources published literature on topics of logic and well as modern developments in AI. It then compares the logical approaches, focusing on the main objective, which is to show how Indian logical traditions are relevant to today's AI. It is hoped that the contribution of this paper will be a deeper understanding of logical traditions as well as new developments in AI and show the relevance of alternative logical approaches such as Indian logical traditions in gaining a deeper understand for present-day AI.

GREEK VERSUS INDIAN LOGIC: COLONIAL PERCEPTIONS GREEK

Most discussions on the history of logic revert to the ancient Greeks, such as Aristotle, Plato, Diodorus, and Philo, to name a few (Bobzien, 2020). Aristotle and the development of syllogism is considered to be one of the best intellectual achievements of the period (Smith, 2022). But is that the only basis for logical thinking, or is there room for other versions of logic? When the West colonized the Indian sub-continent, the colonizers naturally sought to accentuate their intellectual superiority over the colonized. As philosopher Jonardon Ganeri noted with great precision, "the assumption that the West, and the West alone, had developed a science of reason was a fundamental axiom in the justification of the colonial enterprise as a civilizational process (Ganeri, 2004)."

As the process of colonization unfolded across the sub-continent, Western colonial scholars eagerly researched cultures of the colonized, to see if there were any similarities or "proofs" of intellectual growth. Imagine their surprise, when they discovered that the Indian sub-continent actually possessed a long and active history of logical thought! Upon discovering Indian or "Hindu" logic, these philosophers then sought to discredit it and prove its weaknesses compared to "Western" logical reasoning. The selective occlusion of Indian logic became prevalent among Western philosophers during the nineteenth century, as exemplified by Henry T. Colebrooke, who "discovered" Indian logic (or "Hindu syllogism") and presented it at the Royal Asiatic Society on February 21, 1824 (Colebrooke, 1824); and Heinrich Ritter, who discussed Hindu syllogism in his 1846 *History of Ancient Philosophy vol. 4. (Ritter, 1846)"*

These scholars zeroed in on the *Nyaya Sutras*, authored by the philosopher Aksapada Gautama anywhere from 600 BCE to 150 CE. This was a classic text on logical foundations that emerged from or existed in the Indian sub-continent. So here was something that they could compare with "Western logical foundations." They soon noticed that the *Nyaya Sutra* contained descriptions of syllogisms. But the syllogisms therein were different from Aristotle's in that they contained *five* members or parts, rather than Aristotelian syllogism that had *three* members. Thus, the syllogisms found in the Nyaya sutra consisted of: the *proposition*, the *reason*, the *instance*, the *application*, and the *conclusion* or *inference*. The most famous and oft-quoted example of this is the following presentation of "Indian syllogism:"

1. This hill is fiery:
2. For it smokes.
3. What smokes is fiery: as a culinary hearth.

4. Accordingly, the hill is smoking:
5. Therefore it is fiery.

The immediate reaction of the Western philosophers was: Aha! This is clumsy! To them, the *conclusion,* that the hill is on fire, should follow from just two premises, that the hill is smoky *(minor premise),* and that where there is smoke, there is fire *(major premise).* Syllogism could be formed by just using the first three, or the last three parts of the above form. Thus two parts were superfluous, or, as noted by Heinrich Ritter, ".in its exposition the Nyaya is tedious, loose and unmethodical. Indeed the whole form of this philosophy is a proof of the incapacity of its expositors to enter into the intrinsic development of ideas, whatever knowledge they may have possessed of the external laws of composition (Ritter, 1838)." Ritter based his conclusions on Colebrooke as well as Karl Windischmann, who published his *Die Philosophie im Fortgang der Weltgeschichte* between 1827 and 1834. In fact, Ritter quotes Windischmann thus: "Windischmann concludes that the Hindoos possessed only the fundamental principles of the logic which the Greeks cultivated." Another eminent logician, Sir William Hamilton referred to "Hindu syllogism" as "merely a clumsy agglutination of . .. counter-forms, being enounced, 1st, analytically, 2nd, synthetically" in his *Discussions on Philosophy (Appendix 1 'On Syllogism' page 604) (Hamilton, 1853).*

While the term "Hindu syllogism" was introduced to the West by Colebrooke, it was not as though Western philosophers were unaware of Indian syllogism until Colebrooke's talk in 1824. Max Muller, who wrote an Appendix to William Thomson's *Outline of the Laws of Thought* (Oxford, 1842), quotes the German historian Barthold Niebuhr as stating much earlier, that there were great similarities between Greek and Indian logic, and it was possible that these logical traditions borrowed concepts from each other. The British mathematician and logician Augustus De Morgan saw parallels between Grecian and Indian logic, and but remarked that they must have independently formed these systems of logic. There is some legitimacy to the assertion that Grecian and Indian logic are autochthonous. The ancient Buddhist text *Digha Nikaya Vol 1,* which translates to "long discourses" by Buddhas, some of them preceding Gautama Buddha, and dated at around 500 BCE, also contains syllogisms similar in structure to Aristotle's, as seen below (Vidyabhusana, 1920 pp500):

1. My being wrong is a hindrance to me
2. The sense of remorse is due to my being wrong.
3. The sense of remorse is a hindrance to me

This has even led some Indian scholars to debate whether Indian syllogism predates Aristotelian syllogism. In an interesting refutation of Colebrooke's "discovery" of Indian syllogism, logician George Boole's wife Mary Everest Boole, in an article titled "Indian thought and Western science in the nineteenth century (Mary Everest Boole, 1901)," noted that in addition to George Boole, other logicians such as De Morgan and Charles Babbage were certainly familiar with the Indian body of work in logic at the same time as Colebrooke. Given this, Colebrooke's motivation in claiming that he discovered India's logical traditions (or "Hindu syllogism") is questionable.

To be fair, it is apparent that there were certainly other Western philosophers and logicians in the nineteenth century who were aware of, and recognized that India indeed possessed a long history of reasoning and logic. However, in the late nineteenth century, this, however, just resulted in back-handed methods of acknowledging the same. In some instances, Western logicians found tedious ways to explain the need for five, rather than three parts, so as to make Indian logic look more like Aristotelian logic. These are discussed in great detail by Ganeri (Ganeri, 2004). I do not discuss these various attempts here, except to note that these attempts did not do much to lessen Western skepticism of Indian logic.

Other researchers simply avoided such explanations, and simply sought to portray Indian logic as some "other." A prime example is philosopher H. H. Price, who in a 1957 article on "The present relations between Eastern and Western philosophy" published in *Philosophy Today,* expressed his belief that a "vast chasm" separated the two traditions, in which one "looks outward and is concerned with logic and with the presuppositions of scientific knowledge; the other inward, into the 'deep yet dazzling darkness' of the mystical consciousness (Price, 1957)." Thus, while Indian philosophy was interesting and important, it could not be compared to Western systems of logical thought which were more scientific in nature. In this "othering," Price was apparently helped along by Indian philosophers such as Sarvepalli Radhakrishnan and the social reformist Swami Vivekananda.

They portrayed Indian philosophy more from its spiritual persuasions as embodied in Vedic texts such as the *Upanishads* and the *Brahmasutras* rather than from the logical constructs embedded within. The historian Tapan Raychaudhuri suggested that this selective veneration of the Hindu culture was done on purpose, in the background of emerging nationalist consciousness in India during the late 19th and early 20th centuries.

From the above, we see, not surprisingly, the persistence of Western cultural imperialism that sought to attribute more importance to Western logical systems, and that which seeks to "other" the development of logic in the East. The hierarchical superiority of deductive reasoning (i.e. through Aristotle-style syllogism) over inductive reasoning (i.e. a syllogistic style that uses examples as emphasis or explanation) is thus sought to be perpetuated.

HOW TO UNDERSTAND INDIAN LOGIC

This brings us to the question of how, or, more importantly, whether to judge the soundness of Indian logic. There are two avenues of thought on this. The first is that the original, oft-cited example of Indian syllogism, i.e. "There is fire on the hill, because there is smoke…" is simply a *rhetorical* exercise, and emanates from the ancient Indian culture of debate and argumentation. This was the view of Scottish orientalist James Ballantyne, who was also the first superintendent of the Sanskrit College in Benares started by the British government). Ballantyne, along with others with similar views proposed instead the following interpretation of the syllogism example in a debate format, as a debate between a questioner and responder (Ganeri, 2001, pp10):

(1) What is your thesis? That the hill has fire on it.
(2) Why? Because there is smoke there.
(3) So what? Where there is smoke, there is fire: e.g. the kitchen.
(4) And? The hill is such a smokey place.
(5) So? Therefore, it has fire.

In this form, the example is more akin to *rhetoric*, rather than formal *logic*. This form also seems to exemplify some of the debates between Hindu and Buddhist philosophers of the *Nyaya* period. Another influential analysis and interpretation of Indian *Nyaya* syllogism is due to Stanislaw Schayer, who studied both Indian and Western philosophies. Schayer saw Indian syllogism as really a proof that exploited *two* rules of inference. He represented the five steps as follows (excerpted from (Ganeri, 2001 pp25; Schayer, 2001):

1. thesis	Fa	There is fire on a (= on this mountain).
2. reason	Ga	There is smoke on a.
3. statement of pervasion	$(x)(Gx \rightarrow Fx)$	For every locus x: if there is smoke in x then there is fire in x.
4. application	$Ga \rightarrow Fa$	This rule also applies for $x = a$.
5. conclusion	Fa	Because the rule applies to $x = a$ and the statement Ga is true, the statement Fa is true.

Figure 1: Schayer's interpretation of Nyaya logic (Ganeri, 2001 pp25)

Seen from this perspective, Indian syllogism embodies more inductive reasoning rather than deductive reasoning.

In the next section, we move closer into how the study of logic has changed over time, and how the emergence of "Logical Relativism" helps to understand different systems of logic, and where especially Indian logic fits into this newer way of looking at logic, and how and where it fits into present-day AI developments.

EMERGENCE OF LOGICAL RELATIVISM

Starting in the middle of the 20th century, there has been gradual change in the approach to the examination of logical traditions. Led mostly by sociologists, this trend focuses on the notion that examination and understanding of logic has a *cultural* component. That is, logical reasoning is relative, and is predicated on its cultural context. A well-known and oft-cited example is the one by British sociologist David Bloor, who discussed the "Azande logic" in his 1976 book *Knowledge and Social Imagery."* In the book, Bloor uses the example of the Azande tribe in Central Africa who were studied by anthropologists. Members of this tribe believe that witchcraft is inherited. And since the tribe is small enough, the logical conclusion is that every member of the tribe possesses witchcraft. Yet, Bloor notes that members of the tribe sincerely believe that some members do not possess witchcraft, contrary to common logical assumptions, without in any way rejecting the original assumptions. Bloor cites the Azande logic as an example of how logic could be treated differently in different cultural contexts (Bloor, 1991). Bloor's book caused serious ripples among philosophers, sociologists, and historians of science, by challenging the established position and role of Western conceptualizations of logic.

It gave rise to a whole sub-field known as "Logical Relativism." Predictably, this development led to protests, and reasoned refutations by logicians, who asserted that Azande logic was just another form of, or could be folded into Aristotelian logic (Triplett, 1988).

Nevertheless, Logical Relativism has gained ground. It is seen as the answer to Western cultural imperialism, and the belief that other cultures may subscribe to alternate forms of logic. Sociologists Christian Greiffenhagen and Wes Sharrock characterize Logical Relativism into two sub-groups, "alternative logic" and "symmetric treatment." The Azande logic is an example of the former. Symmetric treatment, on the other hand, seeks to show how forms of classical logic does not apply in all cases. For example, if murderers are those who deliberately kill people, then bomber pilots are murderers, as they deliberately kill people. Yet, society does not consider them that way (even though it is quite conceivable that the Azande may not see a difference).

Similar discussions on alternative logic extend to the work of early Chinese philosophers. Some Western philosophers, such as Massimo Pigliucci of the City University of New York have argued that Eastern philosophers "do not attempt to argue for a position by using logic and evidence." This in turn has been refuted by philosophers and students of Chinese philosophy such as Brian Van Norden, who point to logical constructs prevalent the *Mohist School* founded by Mozi in the fifth century BCE in China (Cleary, 2016). This tension is ongoing.

Coming back to Indian logic, the approaches of Ballantyne and Schayer can be considered to fall within the realm of alternate considerations of logic. They seek to move away from strictly deductive reasoning. They posit that Indian logic is instead inductive in nature. Western philosophers who sought to compare Indian syllogism to Aristotelian syllogism, with the former's emphasis on deductive reasoning, naturally found it wanting. Deductive reasoning is truth-preserving, whereas inductive reasoning is empirical, as noted by Amin Afrouzi (A. Afrouzi, personal communication, February 16, 2023). It is important to note that one is not superior to the other. The efforts to undertake an exact comparison of Indian syllogism with Aristotelian syllogism, and finding the former wanting and ill-developed, is thus not useful, and perhaps disingenuous.

Studies in analyzing and interpreting the actual nature of Indian logic continues. More recently, philosophers such as Sibajiban Bhattacharyya, Bimal Krishna Matilal, and Jonardon Ganeri have proposed new alternative approaches to studying Indian logic.

Ganeri argues that Indian logic should be considered as a *theory of case-based reasoning*, rather than as one that aims towards providing a general rule. The *Nyaya Sutra* defines the rules of good debate. Thus, the interlocutors must (1) be able to draw upon a common and accepted body of information, and based on that (2) there is no need for the interlocutors to understand the underlying general rule in order to arrive at a conclusion (Ganeri, 2003). Both of these "conditions" seem to be aligned with the new developments in present day developments in AI, as discussed below.

HOW DOES THIS APPLY TO PRESENT DAY AI DEVELOPMENT

What we can see from the above is the changing nature of logic itself, or what is considered to be "logic." The logic of present-day AI is mostly inductive, not deductive. Interpretations change constantly, and are context-driven. We posit that the hierarchy of deductive versus inductive reasoning is changed by the way we develop present-day AI applications. The newest avatar of AI development, "Generative AI" is a case in point. It is briefly introduced below.

GENERATIVE AI: A BRIEF INTRODUCTION

In recent years AI Generated Content (AIGC) and applications have generated widespread interest. Products such as ChatGPT and DALL-E are much talked about and offer promise for the introduction of very innovative applications (McKinsey, 2023). AIGC refers to taking a given human content and instructions to complete a given task, using Generative AI (GAI) algorithms. The process involves two steps: the first is to extract *intent information* from human instructions, and the second is to generate content according to the extracted intentions (Cao et al., 2023). While this basic approach has existed for several years, recent advancements in computing processing power as well as newer modeling frameworks have caused major ripples. They have enabled the development of new training models, the ability to process vast amounts of training data, and development of very large "foundation models" that can then be used for processing new "prompts" or queries in real-time.

There are multiple families of generative AI models, such as Diffusion models, Variational Autoencoders (VAEs), and Generative Adversarial Networks (GANs) (AltexSoft, 2022). By combining two or more of these models, it has been demonstrated that better (i.e. more human-like) results can be produced. Large "foundation models" are built using trillions of human-generated data, with hundreds of contextual parameters that are then trained and retrained until they reach accuracy levels and performances that are close to human accuracy and performance (AltexSoft, 2022),(McKinsey, 2023). Thus there is constant learning and re-learning within these models. Examples of some foundation models are GPT, Llama, BLOOM, FLAN-T5, BERT, etc (Slashdot Media, 2023).

Interaction with these models typically involve:

- A *Prompt* (such as a question like "What is Titan?"), which is fed into
- A *Model* (such as the ones above), which processes the question and outputs
- A *Completion*, which is the response (such as "Titan is the largest moon of Saturn…")

This example uses a large language model (LLM). Generative AI applications using LLMs can be used to write essays, summarize text, translate sentences to other languages, translate text to machine code, extract information given the names of people, etc. The important point here is the training of these LLMs. That process involves trillions of data, each with billions of parameters which represent contexts, collected and trained over several months. The training typically uses a model known as the "Transformer Model," introduced by Google engineers in 2017 (Vaswani et al., 2017a). The model basically "learns" the strength of relationships between word-pairs in texts, using the concept of "attention weights," as well as positional encoding of the words. In this manner, the model is able to predict the "next word," given a prompt.

A more detailed discussion of the LLM models and the Transformer architecture is outside the scope of this paper. For interested readers, a good place to start is the 2017 seminal paper "Attention is all you need" by Ashish Vaswani et al (Vaswani et al., 2017b). However, the important takeaways from this discussion on Generative AI are the following:

- The "next word" that is predicted by the models is dependent on the *context,* and does not follow any hierarchical process of deduction
- This context is determined by how "close" a word is to other words in ndimensional space (i.e. with numerous parameters)
- Very large amounts of data, with large numbers of parameters are required for building and training these models

GENERATIVE AI AND THE INDIAN-LOGIC CONNECTION

Some experts have observed that India's inherent complexity, in terms of its varying cultural norms, religions, languages and scripts, positions it to be an ideal locational resource to develop large language models (Aggarwal, 2018). The data that can be collected is potentially vast, and the parameters that relate to or inter-connect the data points are numerous. The contextual reasoning that is an aspect of the Indian logical tradition is also aligned with Recurrent Neural Networks and the more recent Generative AI models.

Thus, today, as AI application development is at an inflection point, poised to take off, India is at the center of this development – not only from the point of view of its induction-oriented logical traditions, but also from the point of view of the trillions of data points that are required to develop large language models (LLMs). Along with the availability of technical manpower, this has led to a big impetus for developing AI models and applications in India. We can already see the result of this alignment in some of the research in AI vision. A case in point is the prevalent use of the "Mahalanobis Distance" in various image recognition systems used today. Mahalanobis, the Indian statistician and father of modern computing practices in India, developed this concept of measuring the distance between "groupings" – which is contextual in nature. He in turn based his work on ancient Indian mathematical and logical works (Mahalanobis, 1936).

CONCLUSION

In summary, in this paper I have first shown how Indian logical systems were dismissed by Western philosophers and scientists early on. Yet, as we have seen, these systems have persisted and are very relevant to today's AI development. I have discussed the debates between deductive and inductive logic, and how Indian logic falls under the latter. I have discussed the initial rejection of Indian logical systems by the several Western logicians, and some efforts by others to counter those rejections.

While that debate is bound to continue into the future without any clear "winner," I posit that India has a lot to offer in present-day Generative AI models, LLMs, and AI applications. I have tried to show how Indian systems of logic, with their strong emphasis on rhetoric, examples, and induction rather than formal deduction, offer a natural basis for new developments in AI. We can see the relevance of inductive logic in present-day AI systems, which depends on building very large models, such

as language models, that take into account numerous contexts and nuances that are present in natural language.

In the future, it would be useful to study other logical traditions to see what they can offer to these newer developments in AI. It would also be useful to investigate specific works of scientists and researchers who have have worked in the area of inductive logic and with respect to Generative AI applications. Finally, I hope that this paper will be useful for students and developers of AI and AI-based information systems. Learning about some of the histories and interpretations of logic in different cultural traditions will positively impact the applications that they develop, which will be deployed around the world and will impact all human development in the years to come.

REFERENCES

Afrouzi, A. (2023, February 16). *Personal interview* [Personal communication].

Aggarwal, V. (2018, August). *India's mess of complexity is just what AI needs*. MIT Technology Review. https://www.technologyreview.com/s/611478/indias-mess-ofcomplexity-is-just-what-ai-needs/

AltexSoft. (2022, October 13). Generative AI Models Explained. *AltexSoft*. https://www.altexsoft.com/blog/generative-ai/

Bloor, D. (1991). *Knowledge and Social Imagery* (2d edition, Ed.). University of Chicago Press. https://press.uchicago.edu/ucp/books/book/chicago/K/bo3684600.html

Bobzien, S. (2020). Ancient Logic. In E. N. Zalta (Ed.), *The Stanford Encyclopedia of Philosophy* (Summer 2020). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/sum2020/entries/logic-ancient/

Cao, Y., Li, S., Liu, Y., Yan, Z., Dai, Y., Yu, P. S., & Sun, L. (2023). *A Comprehensive Survey of AI-Generated Content (AIGC): A History of Generative AI from GAN to ChatGPT* (arXiv:2303.04226). arXiv. http://arxiv.org/abs/2303.04226

Catsaros, O. (2023, June 1). Generative AI to Become a $1.3 Trillion Market by 2032, Research Finds | Press | Bloomberg LP. *Bloomberg L.P.* https://www.bloomberg.com/company/press/generative-ai-to-become-a-1-3trillion-market-by-2032-research-finds/

Cleary, S. (2016, May 17). Chinese Philosophy in the English-Speaking World: Interview with Bryan Van Norden. *Blog of the APA*. https://blog.apaonline.org/2016/05/17/chinese-philosophy-in-the-englishspeaking-world-interview-with-bryan-van-norden/

Colebrooke, H. T. (1824). On the Philosophy of the Hindus. Part I. *Transactions of the Royal Asiatic Society of Great Britain and Ireland*, *1*(1), 19–43.

Ganeri, J. (2001). *Indian Logic—A Reader*. Routledge.

Ganeri, J. (2003). ANCIENT INDIAN LOGIC AS A THEORY OF CASE-BASED REASONING on JSTOR. *Journal of Indian Philosophy*, *31*(1), 33–45.

Ganeri, J. (2004). Indian Logic. In D. M. Gabbay, J. Woods, & A. Kanamori (Eds.), *Handbook of the History of Logic* (pp. 1–309). Elsevier.

Hamilton, S. W. (1853). *Discussions on Philosophy and Literature, Education and University Reform: Chiefly from the Edinburgh Review*. Longman, Brown, Green and Longman's.

Mahalanobis, P. C. (1936). On the generalized distance in statistics. *Sankhya*, *II*(1). https://insa.nic.in/writereaddata/UpLoadedFiles/PINSA/Vol02_1936_1_Art05.pdf

Mary Everest Boole. (1901). *Indian Thought and Western Science in the Nineteenth Century*. The Ceylon National Review.
http://archive.org/details/indianthoughtwes00bool

McKinsey, E. (2023, January). *What is ChatGPT, DALL-E, and generative AI? | McKinsey*.
https://www.mckinsey.com/featured-insights/mckinsey-explainers/what-isgenerative-ai

Price, H. H. (1957). The Present Relations Between Eastern and Western Philosophy. *Philosophy Today*, 1(1), 33–38.
https://doi.org/10.5840/philtoday195711/48

Ritter, H. A. (1838). *The History of Ancient Philosophy (Translated by A. J. Morrision)*. Kessignger Publishing , LLC. 2010.

Ritter, H. A. (1846). *The history of ancient philosophy / by Dr. Heinrich Ritter ; translated from the German by Alexander J.W. Morrison. v.4. Volume v.4 1846 [LEATHER BOUND] by Ritter Heinrich: New Leather Bound (2022) | Gyan Books Pvt. Ltd.*
https://www.abebooks.com/history-ancient-philosophy-Heinrich-Rittertranslated/31224527906/bd

Schayer, S. (2001, June 20). Studies in Indian Logic 1 and 2. *Materials of the International Seminar on Argument and Reason in Indian Logic*.

Slashdot Media. (2023). *Compare BERT vs. GPT-3 vs. LLaMA in 2023*.
https://slashdot.org/software/comparison/BERT-vs-GPT-3-vs-LLaMA/

Smith, R. (2022). Aristotle's Logic. In E. N. Zalta & U. Nodelman (Eds.), *The Stanford Encyclopedia of Philosophy* (Winter 2022). Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/win2022/entries/aristotle-logic/

Triplett, T. (1988). Azande Logic versus Western Logic? *The British Journal for the Philosophy of Science*, *39*(3), 361–366.

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., & Polosukhin, I. (2017a). Attention is All you Need. *Advances in Neural Information Processing Systems*, *30*. https://papers.nips.cc/paper_files/paper/2017/hash/3f5ee243547dee91fbd053c1c 4a845aa-Abstract.html

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, Ł., & Polosukhin, I. (2017b). Attention is All you Need. *31st Conference on Neural Information Processing Systems*.

Vidyabhusana, S. C. (1920). *A History of Indian Logic—Ancient, Mediaeval, and Modern Schools*. Motilal Banarsidass.