

IMPACT OF INDIAN NUMBER SYSTEMS AND MATHEMATICS ON ARTIFICIAL INTELLIGENCE

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Abstract

Artificial Intelligence (AI), Generative AI are the most talked about technologies of today and have a very bright future. The development of AI relies very heavily on number systems specially the decimal system and the invention of 'ZERO' (Sunya). India has a very rich mathematical heritage. The Indian number system has made significant contribution in the development of AI.

This paper aims to study the impact of Indian number systems on AI. Through rigorous examination of primary sources, empirical studies, and contemporary applications, this paper offers insights into the foundational influence of Indian mathematics on AI algorithms and computational methods. This exploratory research makes an attempt to describe the interdisciplinary intersections between Indian mathematical number systems and AI.

Keywords: Indian Number Systems, Artificial Intelligence, Mathematics

INTRODUCTION

Artificial intelligence (AI) leverages computers and machines to mimic the problem-solving and decision-making capabilities of human mind; this is how (IBM, n.d.) explains AI. However, the development of AI relies very heavily on number systems specially the decimal system and the invention of 'ZERO' (Sunya). India has a very rich mathematical heritage. The mathematicians of Ancient India and the Indian number system have made significant contribution in the development of AI.

Empirical studies indicate that algorithms inspired by Indian mathematical principles, such as place value and zero, exhibit enhanced computational efficiency in AI applications (Russell & Norvig, 2021). The synergy between Indian mathematical algorithms and AI has led to the development of novel computational methods, optimization techniques, and data representation schemes (Joseph, 2000)

RESEARCH OBJECTIVES

- 1) To explore the foundational influence of Indian number systems and the contributions of Ancient Indian Mathematicians on AI algorithms and computational language and methods.
- 2) To study the interdisciplinary intersections between Indian mathematical number systems and AI.
- 3) To study the impact of Indian number systems and mathematics on AI.

LITERATURE REVIEW

(Mahadevan, Bhat, & Nagendra, 2023) in their book, Introduction to Indian Knowledge Systems they, very systematically explain the concepts of IKS along with its applications in today's modern world. Knowledge about Indian number systems, mathematics and its use in computer-based technology has quite well been integrated.

(Russell & Norvig, 2021) This book on Artificial Intelligence (AI) provides guidance towards the theoretical and practical aspects of AI. Through intuitive explanations a nontechnical language they first introduce the major concepts of AI, later they go into the algorithmic and mathematical details.

(Joseph, 2000) This book discusses the various aspects of mathematics for various countries like native America, ancient Egyptians, mathematics of Mesopotamia and Chinese Mathematics. Three chapters in this book discuss Indian Mathematics ;which forms an integral part in developing computational methods and algorithms.

(Briggs, 1985) in his article on knowledge representation in our ancient language Sanskrit and AI, he talks about Sanskrit as a living spoken language with literature of great value. The long philosophical and grammatical tradition, the method for paraphrasing natural languages is identical not only in essence but in form with works of AI. This article in the AI magazine demonstrates that a natural language like Sanskrit can serve as an artificial language also, and much work in AI can be done through Natural Language Processing to convert human ideas and language into machine understandable language for further generation of AI.

RESEARCH METHODOLOGY

This research paper is exploratory and descriptive in nature. To study the interlinkages between our Indian number systems , Mathematics, Sanskrit and AI, several secondary sources like books, journals and web-based research articles have been used.

REVEALING THE IMPACT OF INDIAN NUMBER SYSTEMS AND MATHEMATICS ON ARTIFICIAL INTELLIGENCE

The Indian Knowledge System is an infinite treasure of “Gyan” and scholarly research. Our Vedic Texts from the time period of around 3000 BCE or even earlier has recorded mathematical knowledge, number systems, Pythagorean type triplets; decimal number systems and the concept of “Shunya” and infinity (Mahadevan, Bhat, & Nagendra, 2023).

The Indian numeral system has a long history as is evident from the historical artifacts and archaeological evidence. The origin and the evolution of the numbers could be traced from the time of the Vedic period. A number of archaeological excavations and linguistic evidence provided by the early writers indicate the maturity and supremacy of the Indian mathematical foundations.

Mathematics referred to as “Ganita” is an integral part of our ancient times and texts of profound knowledge. Several concepts of “Ganita” have formed the basis of the birth, development and evolution of Artificial Intelligence. This paper studies the foundational influence of Indian number systems, the various Mathematical concepts contributed by Ancient Indian Mathematicians on AI algorithms and computational methods.

BINARY NUMBER SYSTEM

The role of Binary number systems and combinatorial problems has contributed to a great extent in computer programming languages and coding. A binary sequence is a sequence composed of the number 1 and 0. For example, in binary number system of length 4; 0,0,1,0 represents the number 5 and the mathematical number 9 is represented by the binary number system of length 4 by 0,0,0,1. Such binary arrays and their processes are there in the Chandah-Sastra of Pingala (300 BCE). The metres in Sanskrit (chandas) were investigated by means of two kinds of syllables, laghu (L), and guru (G) from a prosody (patterns of rhythm and sound used in poetry) perspective. Any syllabic metre (varna-vrta) is therefore characterised by a sequence of laghu (L) and (G) guru. If we replace the (L) laghu with the number ‘1’ and (G) guru with the number ‘0’, then the metrical pattern of the ancient times transforms into our current binary sequence. (Mahadevan, Bhat, & Nagendra, 2023)

THE DECIMAL SYSTEM

The Indian decimal system which is based on the fundamentals of place value, dates back to “Pauranik” (ancient) times. The Indian decimal system, originating from ancient civilizations such as the Indus Valley and flourishing during the Gupta period, laid the groundwork for modern numerical representation and arithmetic operations (Joseph, 2000). The Vedic texts and Jaina Mathematical works contributed to the development of Decimal systems. The Decimal number system originated in India much before its use in the Western countries. This Indian decimal system provided a robust framework for numerical computations.

INVENTION OF ZERO

The conceptualization of ‘ZERO’ , a pivotal innovation in Indian mathematics, revolutionized numerical computations, algebraic methodologies, and theoretical frameworks (Ifrah, 2000).

The concept of zero, which has a pivotal role in today’s computer programming and binary systems, was established in India during the period 500-300 BCE and was fully developed by 600 CE (Mahadevan, Bhat, & Nagendra, 2023).

Brahmagupta, in his work Brahma-sphuta-siddhanta gives a good description of working with the fractions, calculations with positive, negative numbers, and with zero. Chandah-Sastra introduces some mathematical concepts including a formal definition of the word “Sunya” to denote zero, in the Indian number system. Zero, both as a numerical symbol and a concept meaning the absence of any quantity allows us to perform calculus , solve complicated equations and to have invented computer operations using binary digits. An inscription on a

temple wall in Gwalior (India), dating back to the 9th century CE, is considered to be the oldest recorded example of a Zero.

PLACE VALUE SYSTEM

The method of using a limited set of numerals but assigning them unique names depending on which place they occupy in the number system is an age-old practice in India. Place value of numerals is a concept in which a symbol/ numeral is used and has a unique meaning and value. With this arrangement, it will be possible to represent any conceivable number systematically.

Aryabhata's well known book Aryabhatiyam, discussed below, has elaborately talked about the Indian Place Value system. Laplace, a French mathematician and astronomer who developed the theory of probability remarked, "The ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost amongst useful inventions" (Irfah, 2004).

SULBA-SUTRAS

During the time period of 800-600 BCE, Sulba-sutras contributed to the earliest texts of Geometry, approximated value of the square root of two and pie (π). Exact procedures for the construction and transformation of squares, trapezia, rectangles etc., was also a part of it which contributes to the development of computer technology.

SANSKRIT IN NLP

The very ancient language Sanskrit has certain inherent advantages in its structure and grammar. Due to this it is a very attractive contender for NLP (Natural Language Processing) and AI related work (Briggs, 1985). Natural Language Processing is a branch of linguistics mainly concerned with the processing of natural language data using computer and programming techniques. NLP is widely used in computer science and AI, to make natural languages understandable to computers so that computers can carry out actions based on the instructions given in a natural language.

BUDDHA MATHEMATICAL WORKS

From about 500 BCE to 500 CE, Buddha mathematical works gave to the world multi-valued logic. Their discussion on concepts of indeterminate and infinite numbers was of significant importance to the Indian Number systems.

PANINI (ASTADHYAYI or ASTAKA)

In 500 BCE, the well-known Sanskrit grammarian, should be alleged of as the forerunner of the modern formal computer language theory. The used of Sanskrit language for scientific and later mathematical use was greatly enhanced as an outcome of the detailed systemisation of the Sanskrit grammar by Panini. His ancient knowledge is now used in Algorithmic approaches; originator of the Backus-Naur Form (BNF), used in the syntax of programming languages today.

PINGALA (CHANDAH-SASTRA)

Acharya Pingala was an ancient mathematician and Indian poet. In 300 BCE his contribution to binary sequences; conversion of Binary to Decimal system and vice versa is of great importance in the construction of AI. 'Meru Prastara' (Pascal's triangle), optimal algorithms to calculate powers and use of Zero as a symbol are some of his salient contributions (Mahadevan, Bhat, & Nagendra, 2023). He has analysed a host of problems related to handling binary sequences. The concepts developed during 200-300 BCE are relevant for the modern-day computations involving binary numbers.

In the Indian Number system, while dealing with mathematical concepts and numbers; poetry is freely used as a medium of communication. Unique methods to represent numbers were developed for this so that the number systems could be easily memorised and applied.

ARYABHATA

The renowned ancient mathematician and astronomer of India, Aryabhata wrote several books in the Sanskrit language. Among his several works Aryabhatiyam (476-550 CE) must have a special mention for its concise verses on , Algorithm for square root, cube root, place value system, geometry, various types of equations, trigonometry and several mathematical concepts very useful in the development of AI. Aryabhatiyam, the book gives a good indication that ancient Indians had a well-developed algorithmic approach to problem-solving and were able to utilise recursive algorithms (Mahadevan, Bhat, & Nagendra, 2023).

BHASKARA- I

Bhaskara's name generally appears along with or after Aryabhata's name. From 600-680 CE, Bhaskara-I expanded Aryabhata's works on Integer solution for indeterminate equations, approximate formula for the sine function and planetary Astronomy.

The above study clearly brings forth the interdisciplinary intersections between Indian mathematical “Gyan”, our number systems and AI. The contributions of ancient Indian knowledge, the development of mathematical concepts laid the foundation for great technological and scientific discoveries both within India and the world at large is very significant. Ancient Indians developed a systematic approach to the number-names that they developed to describe larger numbers, which later proved to be a great contributor in the development of AI.

CONCLUSIONS

Thus, this research paper provides a curtain riser view of the Indian mathematical traditions, our Indian number systems and its contribution to the development of science , digital engineering and AI technology. The Indian Mathematical concepts and number systems found in the Vedic texts, Buddhist and Jain works clearly reveal that logical used of “Ganit Gyan”; it was this “Ganit Gyan” which formed the basis of the development and evolution of various algorithm and computer programmes, which then and now provided the basis of AI.

The Ancient Indians, few of whom are studied above, developed several concepts of mathematics primarily because they needed to solve a lot of real-life problems that they were facing even during the Vedic periods. Their real-life problem-solving techniques were so systematic , scientific and logical that they are used to solve real life problems of today through simulations by AI.

The Indian number systems are complete and well defined. The effective and scientific place value system of numbers is at the foundation of mathematics. This enables easy arithmetic computations, facilitating scientific analyses and promotes unambiguous and effective communication. The Indian Number systems and various mathematical concepts taught through Sanskrit were so well defined, systematic and logical that the development of AI and generative AI credits its evolution to them. Hence, we can truly conclude that there is significant, systematic, logical and scientific impact of our Indian Number systems and Mathematics on Artificial Intelligence.

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