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# Unveiling the relevance of Vedic mathematics in the age of artificial intelligence

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***Abstract***— *In the context of AI, where optimization and rapid processing are paramount, Vedic Mathematics presents a valuable set of tools that can enhance algorithmic performance. The methods inherent to Vedic Mathematics—such as pattern recognition, digit manipulation, and modular arithmetic—align with the principles of algorithmic efficiency and computational optimization critical to AI systems. This paper investigates how Vedic techniques can be integrated into modern computational frameworks to improve algorithmic processes, reduce computational overhead, and accelerate problem-solving. We analyze the core Sutras and their applications in comparison with contemporary computational techniques, highlighting how these ancient methods can be adapted to optimize data processing, enhance numerical accuracy, and contribute to algorithmic innovation. By drawing parallels between Vedic Mathematics and current AI methodologies, this study elucidates the potential synergies and practical applications of these historical techniques in advancing the field of artificial intelligence.*

***Keywords***— ***Artificial Intelligence, Decimal system, Vedic Mathematics, Vedic Sutras***

## I. INTRODUCTION

In the era of Artificial Intelligence (AI) where complex algorithms and machine learning models dominate the technological landscape, the ancient Indian system of Vedic Mathematics emerges as a surprisingly relevant and potent tool (Kumar,2024,pp.1-8). Despite being thousands of years old, Vedic Mathematics offers a fresh perspective and efficient methods that align well with the principles of AI. In this article, we'll analyze the importance of Vedic Mathematics in the generation of AI, along with examples and refer sources to elucidates its applicability in modern computational standards.(Jokhi, 2024, pp.31-34).

Vedic Mathematics, an ancient mathematical system with origin in the Atherva Veda, has demonstrated renewed significance in the contemporary scientific landscape, particularly within the domain of artificial intelligence (AI). Vedic Mathematics was recollected by Jagadguru Sankaracharya Sri Bharati Krishna Tirthaji Maharaj between 1911 and 1918; this system comprises Sutras and numerous sub-Sutras that encapsulate a range of computational techniques (Tirtha, 1992).These techniques, which simplify arithmetic operations through systematic methods, offer notable advantages in terms of speed and computational efficiency.

***UNDERSTANDING VEDIC MATHEMATICS*:** Vedic Mathematics, a system of mathematics propounded by ancient Indian scholars, is established on sixteen sutras (aphorisms) and thirteen sub-sutras. These sutras provide a systematic and coherent approach to solving mathematical problems, emphasizing simplicity, flexibility and efficiency. Unlike conventional methods, Vedic Mathematics focuses on mental calculations, which makes it inherently suitable for applications in AI where speed and efficiency are crucial.

***VEDIC PERIOD*:** The Veda means knowledge or wisdom, also called Sruti (puranavedas.com). The Veda are four in number i.e., Rig-Veda, Yajurveda, Samveda, Artharvaveda. Apart from Vedas, there are four upveda (literally means sub Veda or smaller than Veda) by Caranvyuta, and six types of vedangas (literally mean the

limbs of the Vedas). The Rig-Veda is the oldest among them; its origin is about 1600 BC (Acharya, 2015, pp.41-47).

| S. No. | Veda | Upveda | Vedangas |
|---|---|---|---|
| **1.** | Rig-veda | Ayurveda (Medicine) | Shiksha (pronunciation) |
| **2.** | Sama-veda | Gandharvaveda (Music and Sacred dance) | Kalpa (Ritual) |
| **3 .** | Yajur-veda | Dhanurveda (Archey) | Vyakarana (Grammar) |
| **4.** | Atharva-veda | Atharshastra ( Economics) | Nirukta (Etymology) |
| **5.** | | | Chandas (Meter) |
| **6.** | | | Jyotisha (Astronomy) |

## II. HISTORY AND EVOLUTION OF VEDIC MATHEMATICS

Ancient Indian civilizations provide origin and evolution of numbers, various methods in many fields like Science, technology to solve various problems (Tirtha, 1992).

Vedic Civilization (2000-600 BC) It belongs to the northern and northwestern parts of the Indian subcontinent in the second and first millennia BC continuing up to the 6th century BC. Vedanga Jyotisa deals with various features of time and seasons and to calculate lunar months, solar months including lunar leap month of Adhimasa. It also provides information n twenty-seven constellations, eclipses, seven planets and 12 signs of the zodiac. In the 8th century BC, Baudhayana, an Indian mathematician produces Sulba Sutra to make rules and solve problems to give important mathematical results for the constructions of altars. His findings include square root of two and Pythagorean Theorem (Tandon, 2019, pp. 3-26). In 6$^{th}$ century BC Sushruta Samhita, which also mentions cataract surgery (Leproscopy) should only be used when necessary with the help of a tool called the Jabamukhi Salaka a curved needle was used to loosen the lens and push the cataract out of the field of vision. Further warm butter and bandaged was used to soaked the eyes and it fully recover. It also mentions various records of veterinary and human medicine in the Vedic period. Before 5$^{th}$ century BC, many discoveries being made in the field of phonetics, phonology and morphology by Panini, metal currency was also invented by silver and copper figuring animal and plants symbols on them (Sarkar, 2011,pp.8-14).

1. ***Binary Number System*** (Jokhi, 2024, pp.31-34):

Acharya Pingala was scholar of mathematics and father of binary system in 2nd century BCE (Kak, 2011, pp. 111-119)

- **Chandas (Sanskrit Prosody):** He wrote Chhandshastra (circa 200BCE), analyzing meters in Sanskrit poetry based on short (laghu) and long (guru) syllables. This book provides the musical structure of poetry and mathematics (Goonatilake, 1998)
- **Binary Number System**: His methods of counting different combinations of long and short syllables provided the knowledge of binary number system. He created the principles of type, quantity, calculus, number theory etc. His number theories, mathematical and equation methods were also developed in modern mathematics. This binary system is foundational to modern computing and also plays a role in Vedic Mathematics' algorithms for mental calculation and number representation.
- **Pascal's Triangle** (known as **Meru Prastara** in Pingala's system): These combinations can be mathematically represented through binomial coefficients and recursive structures, such as those seen in. The sums of the diagonals in this triangle yield the **Fibonacci sequence**, which connects Pingala's work to broader mathematical structure (Plofker, 2012, pp. 45-53)

In the 17th century Gottfried Wilhelm Leibniz, reorganized Acharya Pingala's presentation of binary system and presents as the basis for modern computing. Pingala is the origin of the Fibonacci sequence, denoted by $\{F_n\}n\sum N$,where N is the set of non-negative integers {0, 1,2…}. In the Initial stage meters in Classical Sanskrit poetry was used as Fibonacci sequence in the South Asia region before Common Era.

Acharya Pingala was given a name Maathra Meru for the Fibonacci sequence, methods of the development of binary numbers, Pascal's triangle in his book Chandshatra (Kulkarni, A. ,2023, pp.96-102)(Bhaduri A, Das A, 2024) (Mahesh K, Kolachana A, Ramasubramanian K, 171–81).

There were many scholars discovered again and formulate the Fibonacci sequence like Acharya Bharata (c.100 B.C.-350 A.D.) prepared a Sanskrit Treatise in performing arts, called Natya-Sastra. In the Seventh century A.D. Virahanka was given a clear view of the Fibonacci sequence but his works was lost only a

quotation of his work was presented by Gopla in 1130-1140 A.D. (P. Singh, 1985, pp. 229-244) and Hemchandra (c.1150 A.D) also provide some knowledge on Fibonacci sequence(Livio, 2008).

Leonardo Fibonacci of Pisa (1180–1240) contributed and making efforts to use Indian decimal systems. He worked on many systems of calculations but noticed less useful as compared to Indian system "quasi errorem computavi respectu modi indorum" (Datta,1935).His work was written in the book Liber Abaci (1202). In 1228 he again rewrites his book based on Indian decimal system and computation application using Indian numerals. Many thinkers in Europe adopted the method. One of the illustrations in 1503, Margarita Philosophica of Gregor Reisch representing a Pythogoras with a counting board using Indian numerals .In 1550, Hans Sebald Beham also used Indian numerals on the counting board (Dutta,2015,pp.1-14). In the nineteenth century, Édouard Lucas used the term Fibonacci sequence, the focal point and studied in a variety of domain to understand its applications (Bergum, 1998) (Koshy, 2019). Sharma, S., Tomar, A., & Padaliya, S. K. (2025). On the evolution and importance of the Fibonacci sequence in visualization of fractals. Chaos, Solitons & Fractals, 191, 115851.

2. ***The Decimal system***

The word "decimal" is evolved from the Latin decimalis, very much identical to the Sanskrit word das´ama (tenth) (Tiwari).

The Rigveda showed evidence of decimal system, nine numerals comes many times, power of ten like das´a (ten), s´ata (hundred) and sahasra (thousand); ayuta (ten thousand) seen in a few hymns. In Regveda times, for making a verbal decimal terminology, powers of ten were joined together with the names of nine numerals to form the compound numbers (Dutta, 2002,pp. 4-19) (Dutta,2016,pp.1-20).

In the Rigveda, decimal enumeration is an application and rules of nominal composition later developed by Panini in Vedic age. The verbal decimal terminology was used as the grammatical principles of Vedic Sanskrit.

There are various Ancient Sanskrit treatises, Vedic Samhita and Brahmaṇa showed the decimal system, decimal taxonomy in India. It includes Sanskrit words for the primary numbers: eka (1), dvi (2), tri (3), catur(4), pan˜ca (5),ṣaṭ (6),sapta (7), aṣṭa (8) and nava (9); when multiplies by first nine numbers with ten and formed: das´a (10), viṁs´ati (20), triṁs´at (30), catvāriṁs´at (40), pan˜cās´at (50), ṣaṣṭi (60), saptati (70), as´īti (80) and navati (90); and terms for powers of ten. The Rigveda, the oldest literature in the Vedic time used decimal system in a few hymns (Dutta, 2016, pp.1-20) (Al Homsi, 2018).

In the mathematical principle of any counting number can be imagining as a algebraic expressions of the sum $10^n\ a_n, \ldots + \cdots + 100a_2 + 10a_1 + a_0$ , where $a_0, a_1, \ldots, a_n$ numbers between 0 and 9.This are is the basic method of application. In the binary representation, numbers can also be described in bases other than ten. It can be used in computers; numbers are recognized in the form of $2^n\ a_n + \cdots + 2a_1 + a_0$, where $a_i$ is either 0 or 1. This representation associates unchanging methods of the division algorithm that infuse later in Greek, Indian and modern mathematics.

The Brahmagupta (628 CE) and Madhava (14 CE) developed analogous algebra of polynomials with power series expansions of trigonometric function (Suryanarayan,1996,pp. 30-39).After Brahmagupta, Isaac Newton (1671) highlighted that the arithmetic number systems gave a effective method for expanding the arithmetic applications on the algebraic expressions ( Suryanarayan,1998,pp.34-42).

The Indus valley civilization, the decimal system was used. In the famous epic tale Mahabharata used decimal and nine digits for the calculation (III.134.16), there is a phrase nava yogo gaṇanāmeti s´as´vat. During the narration of the epic tale the decimal place value notation will occurs (III.132–134) (Tiwari, D). The Vedic era famous ancient names like Uddālaka, Śvetaketu, Aṣṭāvakra, Janaka etc were popular in the Brahmana phase. The saga used the word s´as´vat (perpetual) has the suggestion of "from immemorial time" (Tripathi, 2021) (Black, 2011, pp. 136-161).

There are various proofs of decimal notation inscriptions like in 595 CE a copper plate from Gujarat illustrating a number (Black, 2020). Other countries like Cambodia and Indonesia used their Śaka dates 605, 606 and 608 in decimal notation like India. The King Bhojadeva 870 C.E. of Gwalior represents the decimal notation and zero digits in the numbers 50 and 270. There are more examples of decimal notations using zero mentioned in( 690 CE), 30 number in Trilingi plates , Khandela inscription (807 CE). Āditya Sena at Shahpur, (Bihar), 672 CE showed zero by a small dot (Dutta, 2015, pp.1-14).

3. ***Invention of zero***:

Brahmagupta: The approach of zero as a number was discovered by many civilizations, including the ancient Babylonians, Mayans, and Indians. The Indian mathematician and astronomer, Brahmagupta was introduced the term zero first time in A.D.628 He wrote Brahmasphutasiddhanta which means Opening of the Universe and by applying zero and negative numbers

making rules for arithmetic calculation (Dutta, 2015, pp.1-14). He elucidates rules of subtraction, addition, multiplication, fractions, and calculations with positive, negative numbers. The calculation of zero and negative number in addition is negative; sum of a positive number and zero is positive; addition of zero and zero is zero (Al Homsi, 2018). Likewise he provides the correct rules for subtraction and multiplication, but in division methods gave incorrect rules (Divakaran, 2018, pp. 978-981).

The concept of zero was very valuable in mathematics and had plays a very important role on fields such as algebra, calculus, and computer science. It is helpful in the development of modern mathematical apprehensions and calculations (sakalindiafoundation.com).

- Bhaskara: After 500 years Bhaskara tried to find out division methods but failed. He correctly mention other properties, such as square of zero is zero and square root of zero is also zero (Nath, 2012).
- Aryabhatt: Aryabhatt a famous mathematician and astronomer of Gupta period use algebra was fully developed by 600 CE, gave the knowledge of zero but it was earlier outlined by Brahmagupta. He wrote the book 'Aryabhatiya', based on the principles of mathematics and astrology consist of arithmetic, algebra, simple trigonometry, spherical trigonometry, fractions, quadratic equations, sums of power series etc (Sahu, 2021). The concept of zero is very important in computer programming. Chandah-Sastra established various mathematical ideas and defines of sunya. A temple wall in Gwalior (India), dating in 9th century CE, is the oldest recorded example of a Zero (Tewari, 2023).

In the Rig-Veda time two very familiar words are sunya and Kha. In India Zero signify by a dot or small circle. Zero has been denoted in India by a dot or a small circle (Dutta, 2015, pp.1-14). Sunya and Kha are two common Sanskrit words in Indian mathematics for zero. In Ṛigveda, the word kha means the hole in the nave of a wheel. Its meanings include “cavity”, “hollow”, “aperture”, “vacuity”, “empty space”, “sky”, the “great Void”. The word sunya appears to have been derived means “hollowness”, “emptiness”, “deficient state”, “zero state”. Its synonyms includes ambara, abhra, gagana, antarikṣa (resemblance of the sky and the vastness of space), purna (whole, full, complete) and ananta (infinite). Shakespeare and the American mathematician G. B. Halsted highlighted the place value of zero with this philosophical significance. The sunya and kha has yet to be formed or created (Divakaran, 2018, pp. 978-981).

4. ***Sulba Sutras*****:** The word Sulba means ropes used to make measurement. The World oldest civilization, Indus Valley civilization developed its own mathematical system. It meant for the measurement and construction of altars and arenas (Osborn, 2010). It gives instructions for constructing various fire-altars, temple base or building base etc (Dutta, 2002, pp. 4-19).

In 800–500 BCE Sulba Sutras by Maharshi Baudhayan (Father of Geometry). The Sulba Sutra is a part Shrauta Sutras and source of knowledge of Indian Mathematics from ancient times (wikiless.copper.dedyn.io/wiki/Shulba_Sutras?) .The Sulba-sutras of Baudhayana is the oldest mathematical text and after that Apastamba and Katyayana comes in later Vedic age. The sutra recommended that if we draw a rectangle and then form a square using the lengths of its two diagonals, the sum of the squares will be equal to area formed on the sides of the original rectangle.The Sulba Sutras contain geometric principles that Modern Science concepts, especially in the field of geometry, example Pythagorean Theorem and geometric constructions, showcasing advanced mathematical understanding in ancient India (Joshi, 2017).

***Vedic Mathematics***:

The Veda is a Storehouse of all knowledge. The “Vedic Mathematics” emerged from “Atharva Vedas”. It serves various fields like Science, Engineering, Mathematics and Medicine. Vedic mathematics is a combination of Arithmetic and Algebraic operations. It is a very simple tool to solve mathematical problems faster than conventional mathematical techniques (Agarwal, 2013). Through applying these simple methods of Vedic mathematics- multiplication, division, square roots, cube roots, decimals and fractions can be easily solved (Ganesh,2018, pp.820-830). The Jyotish Shastra is an ancient methods and a small part of Vedangas. (Sriskandarajah, 2003).

The Vedic mathematics was studied by Jagadguru Swami Bharathi Krishna Tirtha Ji of Govardhan Peeth, Puri Jaganath (1884-1960) and again reproduced various methods to simplify large calculation in simple form (Tirthaji, 1965). He was a scholar of Sanskrit, Mathematics, History and Philosophy and provides a set of 16 sutras and 13 sub sutras from Atharva-Vedas (The concept of Vedic Maths, 2015).

**Sixteen Sutras**: The Sutras and sub sutras are related to many parts of Mathematics. The sutras gave short cut solution, are easy to remember and apply. It can solve complex problems, save lots of time and efforts (Bajaj, 2005). It can be used effectively for solving addition, subtraction, multiplication, divisions, squares and square roots, cubes and cube roots, factorization, fractions,

Pythogorus Theorem, Apollonius Theorem etc (Bose, 2015).

For example, **Ekadhikena Purvena** teaches a division method that involves taking one more than the previous number, simplifying division processes. **Nikhilam Navatascaramam Dasatah** is a multiplication technique based on subtracting from 9 or 10, particularly useful in certain cases of multiplication. **Urdhva-tiryagbhyam** is a powerful method for multiplication, where vertical and crosswise techniques are employed, making it highly efficient for multiplying large numbers. **Paravartya Yojayet** is used in dividing polynomial equations by transposing and adjusting terms, demonstrating its applicability in algebra. **Sunyam Samyasamuccaye** is a sutra that equates to zero when the sums (samuchchaya) on both sides are the same, which is useful in solving equations where the terms balance out. **(Anurupye) Sunyamanyat** helps in proportional problems by stating that if one value is in a certain ratio, the other will be zero. **Sankalana-vyavakalanabhyam** refers to simplifying calculations through addition and subtraction, often used when expanding algebraic expressions. **Puranapuranabhyam** deals with the completion or non-completion of sequences, which is relevant in certain types of calculations. **Calana-Kalanabhyam** applies to calculus and emphasizes the understanding of rates of change, which is critical in continuous functions and their derivatives. **Yavadunam** is focused on working with deficiencies or differences in numbers, guiding how to deal with the “missing” part of a number. **Vyastisamastih** is used for calculating averages, applying both specific and general principles to simplify complex problems. **Sesanyankena Caramena** involves finding remainders based on the last digit, providing an easy method for modular arithmetic. **Sopantyadvayamantyam** guides finding the ultimate and twice the penultimate values in a sequence, useful in certain series and pattern recognition. **Ekanyunena Purvena** is a method where one less than the previous value is used, providing a simpler approach to certain calculations. **Gunitasamuccayah** refers to the product of the sum of coefficients in factors, crucial for solving algebraic multiplication problems. Finally, **Gunakasamuccayah** technique useful for solving multiplication problems efficiently. These sutras demonstrate the radiance of Vedic mathematics, enabling rapid and intuitive calculation methods that have stood the test of time, often eliminating the need for long division or multiplication techniques.

***Sub sutras*:** These are the extension of main sutras and divided into thirteen parts. It provides various techniques to solve complex mathematical problems. A**nurupyena** means "proportionately," and it is a method used for solving problems involving proportional relationships, where quantities are in a constant ratio. **Sityate Sesasanfitah** refers to the fact that the remainder remains constant, useful in division problems or when working with remainders across different divisions. **Adyamadyenantyainantyena** suggests a method of multiplying the first digit by the first and the last by the last, which simplifies the calculation when working with certain types of numerical problems. **Kevalalh Saptakan Gunyat** specifically deals with the number 7, where the multiplicand should be 143 in certain multiplication problems involving multiples of 7. **Vestanam** refers to "by osculation," a term related to an approximation method in mathematical operations, particularly in geometrical problems or estimations. **Yavadunam Tavadunam** translates as "lessen by the deficiency," which means reducing a number by the deficiency, often applied when solving problems involving difference or excess. **Yavadunam Taradunikrtya Varganca Yojayet** suggests that whatever the extent of a deficiency, it should be reduced further by the same extent and also the square of that deficiency should be accounted for in the solution. **Antyayordasake'pt** deals with numbers whose last digits add up to 10 and whose preceding parts are identical, providing a shortcut for handling such numbers in calculations. **Antyayoteva** emphasizes working with only the last terms of a series or number, simplifying certain types of arithmetic operations that focus on the final values. **Samuccayaguaitah** refers to "the sum of the coefficients in the product," a concept used in algebraic expansions and simplifications when multiplying polynomials. **Lopanasthapandbhyam** involves alternate elimination and retention, a method for solving equations or simplifying expressions by systematically eliminating or keeping terms. **Vilokanam** simply means "by observation," suggesting that patterns or solutions may be found by recognizing certain visual or numerical trends. Finally, **Gunitasamuccayah Samuccayagunitah** is a principle that states that the product of the sum of the coefficients in the factors equals the sum of the coefficients in the product, a valuable rule for dealing with polynomial multiplication and expansion.

These sutras from Vedic mathematics demonstrate the efficiency and elegance of ancient methods for dealing with a wide range of mathematical problems, emphasizing intuition, pattern recognition, and simplifying complex calculations. By applying these principles, one can solve equations and perform arithmetic operations much more quickly and with less computational effort.

***Characteristic/ Features*** (Tirtha , 1992)

1. Vedic Mathematics mainly focuses on Vedas, which has storage capacity of all information (Dutta, 2016).
2. Vedic mathematics deals with spiritual, informative guidelines and direction in full details logically.
3. Vedanges are the inherent parts and subjects of Vedic study (Kapoor, 2006).
4. We can apply sutras in all parts of the mathematics.
5. The Sutras are simple to apply, recall and store the information in the mind.
6. Vedic Mathematics is symmetrical, adaptable in nature and it improves mental power creatively (Yadaw, 2020, pp.62-67).
7. It is applicable for everyone and it is, efficient and fast and time saving.
8. Vedic mathematics is the understanding of human skills and knowledge.
9. It is the faster method with simple formulas and easy to remember (Vaidya, 2019).
10. MAC, ALU are some of the main application.
11. Urdhva-Triyagbhyam method is one of the best for the multiplication.
12. Vedic mathematics calculation makes pleasurable and fascinating.
13. Complex problems can be sort out easily without using lengthy methods.
14. Vedic Mathematics requires logical thinking, improves mental ability (Sumathi, 2016).

***Importance of Vedic Mathematics***:

**1**. It is definitely exceptional and coherent in its methodology.

**2**. It helps to carry out laborious and functional mathematical calculations.

**3**. It transformed conventional Math's into a joyful activity.

**4**. It lessens, "Maths fear".

**5**. The validity of a problem can be determined easily.

**6**. It is fast methods than our classrooms methods.

**7**. Mental calculations

## III. BENEFITS OF VEDIC MATHEMATICS

**1. Enhanced Speed and Accuracy in Competitive Examinations:** **V**edic Mathematics (Joshi, 2017) significantly improves performance in high-stakes competitive examinations as well as various engineering and banking entrance tests. The techniques facilitate rapid calculation and problem-solving, offering a strategic advantage to candidates by reducing time constraints and enhancing accuracy (Shukla, 2017).

**2. Broad Applicability across Disciplines (**Anjali, 2022)**:** The versatility of Vedic Mathematics extends across numerous academic disciplines. Students in fields such as Mathematics, Physics, Engineering, and Computer Science find that its methods simplify complex problems and improve computational efficiency. This cross-disciplinary applicability underscores the system's broad utility.

**3. Support in Software Development (**Krishna, 2012)**:** In the domain of software development, Vedic Mathematics offers valuable techniques for optimizing algorithms and improving performance. Its methodologies can be applied to enhance the efficiency of code, particularly in algorithmic design and numerical computation, contributing to more effective software solutions (Rajasekar, 2016, pp. 3025-3036)

**4. Mental Calculation and Method Selection** (Bose, 2015)**:** Vedic Mathematics enhances mental calculation abilities, allowing students to select the most efficient methods for specific problems. This mental agility is beneficial for mastering complex concepts and performing calculations without reliance on electronic tools, thereby fostering a deeper understanding of mathematical principles (Mathews, 2022).

**5. Acceleration of Mathematical Calculations (**Solanki, 2021, pp.160-163)**:** The techniques of Vedic Mathematics expedite calculations in various areas, including Arithmetic, Algebra, Trigonometry, and Geometry. By simplifying traditionally cumbersome processes, these methods enable quicker and more accurate problem-solving.

**6. Time Efficiency and Confidence Building (**Garg, 2023, pp. 2079-2086): The ability to solve problems quickly using Vedic Mathematics techniques not only enhances time efficiency but also builds self-confidence among students. The competence gained from rapid problem-solving contributes to greater confidence in mathematical tasks and examinations (Raikhola, 2020).

**7. Quick and Valuable Calculations (**Tirtha, 1992)**:** Vedic Mathematics is instrumental in achieving swift and valuable calculations. Its methods streamline computational processes, making it an essential tool for both academic and practical applications where time and accuracy are critical (Makholia).

**8. Cognitive Benefits and Mental Fitness (**Chowdhury, 2023): Regular use of electronic devices such as calculators and computers can adversely affect cognitive abilities (Day-ongao, 2022, pp.237-248). Vedic Mathematics promotes mental fitness by engaging the mind in manual calculations, thereby enhancing cognitive skills and problem-solving capabilities (Shastri, 2017, pp. 53-62).

**9. Institutional Adoption in Western Countries:** Prominent educational institutions in England and the United States have begun incorporating Vedic Mathematics into their curricula, highlighting its effectiveness and international relevance (Dani, 1993, pp. 90-92). This adoption reflects the system's capability to improve mathematical proficiency and computational skills (Staal, 1999, pp. 105-127)

**10. Application in Advanced Research:** NASA scientists have explored the application of Vedic Mathematics principles in artificial intelligence research (Bhardwaj, 2012, pp. 23-24). The integration of these techniques into AI development demonstrates their potential to enhance computational models and algorithms, contributing to advancements in the field (Kandasamy, 2006).

**Relevance of Vedic Mathematics**

Key components of machine learning include:

1. **Data**: It is an information or fact of observations or measurements can be used in machine-learning. Data are arrange in the form of structured data (e.g., tables), unstructured data (e.g., text, images, videos), and semi-structured data (e.g., JSON).
2. **Machine learning algorithms**: It refers to highlight the data. These algorithms are of following types: there are mainly four types of machine learning techniques.
   - **Supervised Machine learning:** The raw data sets are designed to train and classifying data or predicting outcomes accurately. It is mainly used in predictive analysis, image segmentation or classification, fraud detection, spam detection, automatic sequence processing, pattern detection (javatpoint.com).
   - **Unsupervised Machine Learning:** In this method clustering algorithms used to make dataset. Without specific supervision it uncovers hidden patterns and structures in unlabelled data. To examine and form the group of unlabelled data and find out unseen patterns in data without any human disruption. It is useful in automatic labeling, object segmentation, similarity detection, and recommendation engines.
   - **Semi-Supervised Machine Learning**: This method is used in labelled and unlabelled data to execute specific learning functions. This technique very useful when labelled data is very expensive, insufficient amount of data available, like computer-aided diagnosis, drug discovery and part-of-speech tagging etc. when unlabelled data provides relevant information to improve classification method (Van Engelen, 2020, pp. 373-440)
   - **Reinforcement Learning:** This technique is used apply to evaluate and improve efficiency in terms of optimal behavior of the environment (Bonaccorso, 2018) . It is usually based on the feedback provide by the environment to evaluate the positive or negative actions. Sometimes feedback is called reward and penalty (Kaelbling, 1996, pp. 237–85). It helps for the training of AI models can help expand computerization or to increase the operating function such as robotics, independent driving assignment, producing and providing chain logistics (Mohammed, 2016). Reinforcement learning, together with supervised and unsupervised learning, is the fundamental machine learning pattern**.** This theory has already found applications in many interdisciplinary areas such as information theory, marketing business and game based applications, and many more (simplilearn.com).
3. **Training**: There are numbers of different approaches to training. Through an interactive process models adjust its framework to reduce the forecast and identify to, machine learning models are trained.
4. **Evaluation**: After training, data models are calculated to evaluate their presentation and derive capability. It depends upon certain functions like correctness, recollect, F1-score and aims of the model.
5. F**eature Engineering:** Feature engineering refers to determine, modify, and generate significant characteristics to improve the tasks of various machine learning models. It can affect the functions of various models.
6. **Model Selection and Tuning**: To optimize model performance, it chooses exact algorithms for their typical job and hyper parameters. They used two methods such as cross-validation and grid search.
7. **Deployment**: After training and evaluation, these models are arranged into production, forecast on the new, unseen data. Deployment involves adaptation such as scalability, performance, reliability, and security.

***Application of Vedic Mathematics to Machine Learning****:*

Vedic mathematics principles and methods may not be meant for machine learning. It can be useful to various factors of machine learning. Following are the applications

1. **Algorithm Design**: Vedic mathematics can help to identified, created, pattern recognition and giving solutions to the various problems. By the use of Vedic mathematics techniques, new algorithm design is formed to execute machine learning tasks (Babu, 2024).

2. **Improving mathematical methods:** Vedic mathematics contains methods to finding and improving solutions to problems and training models and tuning hyper parameters. Vedic Mathematic technique is a collection of arithmetic rules can be used to improve the speed and achievement of optimization algorithms. So with the help of fast and efficient computational techniques to accomplished various responsibilities like -data processing, data analysis cryptography, and optimization problems.
3. **Feature Engineering or creating new techniques:** Vedic Mathematics mainly focus and support mental calculation, manipulating numbers, pattern recognition. It convert raw data into more relevant model for machine learning algorithms, signal processing and image analysis area are the examples of feature engineering (Jain, 2014,pp. 7458-7459).
4. **Error Evaluation and Debugging:** Vedic Mathematics uses mental calculation methods to find out error quite easily and improve model and its functions. It is very important in debugging machine learning models, improve model.
5. **Education and Outreach**: There are no direct techniques available for machine learning in Vedic Mathematics. It enhanced mathematical intuition and complex problem solving skills of the students to develop machine learning algorithms. Its techniques when fuse together with machine learning can give various methods to improve machine learning models (Tularam, G. A. 2010).

***The application of Machine learning to Vedic mathematics***

1. **Automate calculation**: Machine learning algorithm understands, instruct and resolve large amount of mathematical problems. In Vedic mathematics all calculations are processed in the mind. Machine learning use huge amount of Vedic mathematics axioms and formulas to solve many complex problems.
2. **Vedic mathematical techniques**: By using Vedic mathematical formulas students learning ability will be improved. It also provides new techniques of recognizing, applying and teaching in today's education system.
3. **Unique learning methods**: To investigate students learning process, speed weakness and strength machine learning algorithm, adjust problem and solution of particular exercise.
4. **Detection of mistake and correction:** Machine learning algorithms techniques use to find out mistake and provide suggestion and rectifying the solutions. It support and reply student's queries to enhanced learning system.
5. **Pattern recognition:** The main centre point of Vedic Mathematics and AI algorithm is pattern recognition. The Vedic mathematics sutra "by one more the one before" helps in identifying pattern and sequences to provide accurate predictions and groups. It is useful in image and natural language processing. The neural network process is the part of Machine learning process to identify pattern to solve latest problem solving methods of the Vedic mathematics.
6. **Experimental Data Analysis:** Machine learning techniques investigate; remove pattern, correlations and observation to provide methods, relationship and knowledge of huge amount of data in Vedic mathematics.
7. **Forecast results:** By examine old data and pattern, Machine learning techniques provides solution in advance.
8. **Speed and productivity:** Vedic Mathematics techniques used simple steps fast mental calculations to solve difficult problems. It is useful in AI application where huge amount of data processed quickly like matrix multiplication and convolution operations in neural networks.
9. **Flexibility and Adaptability:** Due to the flexible nature of Vedic mathematics it provides alternative methods to perform specific tasks, for example "Nikhilam Navatashcaramam Dashatah" guide AI developers various methods to upgrade algorithms to perform certain functions. In AI system adaptability is very important criteria to accomplishing optimal tasks.

## IV. CONCLUSION

This exploration underscores the untapped potential of Vedic Mathematics in the realm of artificial intelligence. By integrating its time-tested principles with modern computational methods, we can unlock new avenues for algorithmic efficiency and innovation. The alignment between Vedic techniques and AI optimization strategies not only enhances performance but also introduces alternative approaches to problem-solving that are both elegant and effective. As AI continues to evolve, revisiting and reimagining ancient mathematical frameworks may offer valuable insights for the next generation of intelligent systems.

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