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Research Article

Effortless Calculations of Arithmetic Progression Through Vedic Sutras

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Abstract. To finding the nth term and the sum of n terms in Arithmetic Progression is very easy if the number of term's small but the it is bulky if the number of term's are lager and so its take's larger time and also take our large affects and difficulties. On the other hand, the Vedic Mathematics work's opposite as the modern mathematics so if we using the Vedic Mathematics sutra [3]Urdhwatiryagbhyam, sutra [7]sankalan-vyavkalanabyam, Up-sutra [9]Antyyoravto finding the nth term and the sum of n terms in Arithmetic Progression it takes our large affects reduced around 60-65% and also take's small time comparatively modern mathematics. The arithmetic pattern is one of the easiest series to study. It contains adding or subtracting from a common difference (d), for generating a string of the numbers that are interrelated to each other. Thus, in this document we present the comparison to find the nth term and the sum of n terms in Arithmetic Progression by using the modern mathematics and Vedic mathematics.

Keywords. Arithmetic Progression (AP), Mean, Sutra 03 Urdhwatiryagbhyam, Sutra 07 Sankalan-Vyavkalanabyam, Up-sutra 09 Antyayoreva

Mathematics Subject Classification (2020). 97Axx

1. Introduction

Vedic mathematics offers a comprehensive framework for resolving both basic and complex mathematical issues, and it is based on this rich legacy. Numerous mathematical topics, including as arithmetic, algebra, geometry, and calculus, are covered in the 16 Sutras and 13 Sub-Sutras. By using these techniques in the classroom, we may make learning easier while also giving children confidence and excitement, turning mathematics from a scary topic to one that they find fascinating. The applications of the Sutras of Vedic Mathematics are extensive and include sections on arithmetic, algebra, geometry, calculus, and conics. They provide sophisticated answers to issues that, when handled using traditional techniques, could otherwise appear insurmountable. For example, Vedic methods can be used to analyse and solve the Arithmetic Progression (AP), which is a series of numbers with a constant difference between successive terms. The importance of Vedic mathematics can be explained in a number of ways. Numerical difficulties can be simplified by Vedic mathematics much faster than by modern computational methods (Yadav *et al*. [9]). Complex mathematical computations are now routinely carried out in modern culture using computers and calculators (Yadav *et al*. [8]). Illustrates how modern mathematics differs from Vedic mathematics. Numerous uses of the Vedic formula can be found in simple mathematical computations. In many respects, Vedic mathematics is superior than contemporary mathematics (Kumari [7]). One of the key ideas of Vedic mathematics, Meru Prastar (Kumar *et al*. [6]), makes it simple to answer many expansions, such as binomial expansion. Numerous contemporary mathematical technologies, including the inverse and linear equation systems, can be readily resolved using crucial formulas like "Vertically and cross wise" (Kumar *et al*. [5]). There are certain problems that are associated with vedic mathematics; however, no field is complete without the use of mathematics (Khare [2]). One method for doing the task faster is to use mathematical operations.

1.1 Arithmetic Progression

A sequence is a function whose domain is the set N of natural numbers and range a subset of real numbers or complex number. By adding or subtracting the terms of a sequence. We obtain a series. In the terms of sequence follow certain pattern, then the sequence is called a progression. There are various types of sequences which are universally accepted, but the one which we are going to study right now is the Arithmetic Progression. A succession of a number is said to be in Arithmetic Progression (AP) if the difference between any term and the term preceding it is constant throughout. this constant is called the common difference of AP. In an AP, we usually denote first term 'a', the common difference 'd' and the nth term 't_n'. Thus, we can say that $d = t_n - t_{n-1}$. Hence AP can be written as $a, a+d, a+2d \dots a+(n-1)d$.

1.2 Historical Evolution of Arithmetic Progression

Ancient Indian mathematics is where Arithmetic Progression (AP), a series of numbers where the difference between successive terms is constant, first appeared. The idea was widely accepted and methodically used in a variety of disciplines, including geometry, astronomy, and ritualistic acts.

I. *Classical Indian and Vedic Contributions*:

- The Sulba Sutras, between 800 and 500 BCE: Implicit references to arithmetic sequences can be found in these ancient books, which are connected to Vedic ceremonies. This is particularly true when discussing geometric constructs and altar designs. For instance, symmetrical constructions are created by increasing the dimensions of succeeding brick layers in accordance with arithmetic progressions.

- Aryabhata (499 CE): Aryabhata employed mathematical progressions in his foundational book Aryabhatiya to compute sums of series, particularly for astronomical applications such as determining the total number of celestial body revolutions.
- Brahmagupta (628 CE): Brahmagupta gave precise formulas for the sum of arithmetic series in Brahmasphutasiddhanta and used them to solve real-world issues.
- Bhaskaracharya (1114–1185 CE): In Lilavati, a mathematical work, Bhaskara II expounded on arithmetic progressions, addressing issues pertaining to sums of sequences and their useful applications in measurements and commerce.

II. *Applications in Indian Context*:

- *Astronomy*: Indian astronomers used AP to calculate planetary positions and time intervals.
- *Architecture*: AP was used in the proportional scaling of structures and altars.
- *Cultural Practices*: Ritualistic timings and patterns often adhered to arithmetic sequences.

Indian contributions, particularly in the works of Aryabhata and Bhaskara II, were highly influential and were transmitted to other cultures through translations, significantly enriching the global understanding of arithmetic progressions.

1.3 Finite Arithmetic Sequence

The number of terms in this sequence is countable or finite then it has a limit. So, if the number of terms in an AP has a limit, they are called *Finite Sequences*. A finite sequence has a finite number of terms and the AP is called Finite AP.

Example 1.1. $3, 6, 9, 12$ (it is Finite AP because sequence has 4 numbers).

1.4 Infinite Arithmetic Sequence

The number of terms in this sequence is uncountable or infinite then it has a no limit. So, if the number of terms in an AP has no limit, they are called *Infinite Sequences*. Such a sequence which contains the infinite number of terms is known as an Infinite Sequence the AP is called Infinite AP.

Example 1.2. $3, 6, 9, 12, \dots$ (it is Infinite AP because sequence does not have limited number of terms).

1.5 nth Term of Arithmetic Progression

We assume that the terms $a, (a+d), (a+2d), \dots, (a+nd)$ are in AP. If the first term is 'a' and its common difference is 'd'. Then, the terms can also be explained as following:

2nd term $a_2 = a_1 + d = a + d = a + (2-1)d$

3rd term $a_3 = a_2 + d = (a+d) + d = a + 2d = a + (3-1)d$

as well as nth term $a_n = a + (n-1)d$

Therefore, we can get the nth term of an AP by using this formula, $a_n = \{a + (n-1)d\}$, a_n is called the general nth term of an Arithmetic Progression (AP).

1.6 Sum of n Term of Arithmetic Progression

We assume that the terms $a, (a+d), (a+2d), \dots, (a+nd)$ are in AP. If the first term is 'a' and its common difference is 'd'. Then, the Arithmetic Progression (AP) defined as:

$$a, a+d, a+2d, a+3d, \dots \{a+(n-1)d\}.$$

Sum of two terms $= a + (a+d) = 2a + d = \frac{2}{2}\{2a + (2-1)d\}$.

Sum of three terms $= a + (a+d) + (a+2d) = 3a + 3d = \frac{3}{2}\{2a + (3-1)d\}$ as well as the sum of n terms $s_n = \frac{n}{2}\{2a + (n-1)d\}$.

Therefore, we can get the sum of n terms of an Arithmetic Progression (AP) by using this formula, $s_n = \frac{n}{2}\{2a + (n-1)d\}$, s_n is called the general sum of n terms of an Arithmetic Progression (AP).

1.7 Arithmetic Mean

If we have a set of positive numbers $a_1, a_2, a_3, \dots, a_n$ then the Arithmetic Mean (AM) is AM $= \frac{a_1 + a_2 + a_3 + \dots + a_n}{n}$.

So, we can say that AM for two positive integers a and b is AM $= \frac{a+b}{2}$.

As well as we can find AM for the finite terms of AP.

2. Introduction of Vedic Up-sutra [9]Antyayoreva

Antyayoreva means - only the last terms. Sequential Progression steps of upsutra-09

1	2	3	4	5	6	7	8	9	10	11
अ	न्	त्	य्	अ	य्	ओ	र्	ए	व्	अ

The Antyayoreva is a technical term whose meaning its composition which admits split-up as अन्त्य् + अय् + ओर + एव which on its chase would mean the (अन्त्य्) end on its reverse (अय्) orientation (ओर) leads too (एव). Feature of this sutra "end point" of sequential set. As that there happens reverse orientation for continuation of further leads (sequential progression). In this feature of chase which become the basic feature of organization format of this phase and stage of Ganita Upsutra-9.

2.1 Methodology

If terms $a, (a+d), (a+2d), \dots (a+nd)$ are in AP. If the first term is 'a' and its common difference is 'd'. Then,

I: Arithmetic Mean

$$\text{AM} = \frac{a+(a+d)+(a+2d)+\cdots+\{a+(n-1)d\}}{n}$$

$$\Rightarrow \quad \underline{x} = \frac{\frac{n}{2}[2a+(n-1)]}{n}$$

$$\Rightarrow \quad \underline{x} = \frac{2a+(n-1)d}{2}$$

By Vedic Mathematics up-sutra [9]Antyayoreva

$$\underline{x} = \frac{I^{\text{st}}+n^{\text{th}}}{2} = \frac{a+(a+(n-1)d)}{2}$$

$$\underline{x} = \frac{2a+(n-1)d}{2}$$

II: *n*th term

$$a_n = a+(n-1)d$$

By Vedic Mathematics Sutra [7]Sankalan-Vyavkalanabyam

$$a_n = 2\underline{x} - I^{\text{st}} \ \text{(term)}$$

$$\Rightarrow \quad a_n = 2\underline{x} - a$$

III: Sum of *n* term

$$s_n = \tfrac{n}{2}\{2a+(n-1)d\}$$

By Vedic Mathematics Sutra

$$a_n = \underline{x} \times n^{\text{th}} \ \text{(term)}$$

$$\Rightarrow \quad a_n = \underline{x} \times n$$

Example 2.1. If terms $a, a+d, a+2d, a+3d, a+4d, \dots$ are in AP. Then, find 16^{th} term of the series and the sum of first 16 terms of the series.

Solution. The first term is 'a' and its common difference is 'd' and $n = 16$. Then,

I: Arithmetic Mean

$$\text{AM} = \frac{a+(a+d)+(a+2d)+\cdots+\{a+(16-1)d\}}{16}$$

$$\Rightarrow \quad \underline{x} = \frac{\frac{16}{2}[2a+(16-1)d]}{16}$$

$$\Rightarrow \quad \underline{x} = \frac{2a+15d}{2}$$

By Vedic Mathematics up-sutra [9]Antyayoreva

$$\underline{x} = \frac{I^{\text{st}}+n^{\text{th}}}{2} = \frac{a+(a+15d)}{2}$$

$$\Rightarrow \quad \underline{x} = \frac{2a+15d}{2}$$

II: 16^{th} term

$$a_n = a+(n-1)d$$

$$\Rightarrow \quad a_{16} = a+(16-1)d$$

$$\Rightarrow \quad a_{16} = a+15d$$

By Vedic Mathematics Sutra [7]Sankalan-Vyavkalanabyam

$$a_n = 2\underline{x} - I^{\text{st}} \ \text{(term)}$$

$$\Rightarrow \quad a_{16} = 2\tfrac{2a+15d}{2} - a$$

$$\Rightarrow \quad a_{16} = 2a+15d-a$$

$$\Rightarrow \quad a_{16} = a+15d$$

$$\Rightarrow \quad a_n = 2\underline{x} - a$$

III: Sum of 16 terms

$$s_n = \frac{n}{2}\{2a+(n-1)d\}$$
$$\Rightarrow \quad s_{16} = \frac{16}{2}\{2a+(16-1)d\}$$
$$\Rightarrow \quad s_{16} = 8\{2a+15d\}$$
$$\Rightarrow \quad s_{16} = 16a+120d$$

By Vedic Mathematics Sutra

$$s_n = \underline{x} \times n^{\text{th}} \text{ (term)}$$
$$\Rightarrow \quad s_{16} = \frac{2a+15d}{2} \times 16$$
$$\Rightarrow \quad s_{16} = (2a+15d) \times 8$$
$$\Rightarrow \quad s_{16} = 16a+120d$$

Example 2.2. If terms $5, 10, 15, 20, \dots$ are in AP. Then, find 20^{th} term of the series and the sum of first 20 terms of the series.

Solution. The first term is '5' and its common difference is '5' and $n = 20$. Then,

I: Arithmetic Mean

$$\text{AM} = \frac{5+10+15+\cdots+5\times 20}{20}$$
$$\Rightarrow \quad \underline{x} = \frac{\frac{20}{2}[2\times 5+(20-1)5]}{20}$$
$$\Rightarrow \quad \underline{x} = \frac{10+19\times 5}{2}$$
$$\Rightarrow \quad \underline{x} = \frac{10+95}{2}$$
$$\Rightarrow \quad \underline{x} = \frac{105}{2}$$

By Vedic Mathematics up-sutra [9]Antyayoreva

$$\underline{x} = \frac{I^{\text{st}}+n^{\text{th}}}{2} = \frac{5+100}{2}$$
$$\Rightarrow \quad \underline{x} = \frac{105}{2}$$

II: 20^{th} term

$$a_n = a+(n-1)d$$
$$\Rightarrow \quad a_{20} = 5+(20-1)5$$
$$\Rightarrow \quad a_{20} = 5+95\times 5$$
$$\Rightarrow \quad a_{20} = 5+95$$
$$\Rightarrow \quad a_{20} = 100$$

By Vedic Mathematics Sutra [7]Sankalan-Vyavkalanabyam

$$a_n = 2\underline{x} - I^{\text{st}} \text{ (term)}$$
$$\Rightarrow \quad a_{20} = 2\frac{105}{2} - 5$$
$$\Rightarrow \quad a_{20} = 105-5$$
$$\Rightarrow \quad a_{20} = 100$$
$$\Rightarrow \quad a_n = 2\underline{x} - a$$

III: Sum of 20 terms

$$s_n = \frac{n}{2}\{2a+(n-1)d\}$$
$$\Rightarrow \quad s_{20} = \frac{20}{2}\{2\times 5+(20-1)5\}$$
$$\Rightarrow \quad s_{20} = 10\{10+19\times 5\}$$
$$\Rightarrow \quad s_{20} = 10\{10+95\}$$
$$\Rightarrow \quad s_{20} = 1050$$

By Vedic Mathematics Sutra

$$s_n = \underline{x} \times n^{\text{th}} \text{ (term)}$$
$$\Rightarrow \quad s_{20} = \frac{105}{2} \times 20$$
$$\Rightarrow \quad s_{20} = 105 \times 10$$
$$\Rightarrow \quad s_{20} = 1050$$

3. Conclusion

A series of numbers where the difference between terms stays constant is called an Arithmetic Progression (AP). This mathematical idea is often applied to tackle problems we commonly face in our daily lives and to generalise trends. In this essay, we examine and contrast the Vedic and contemporary approaches to calculating the sum of an AP's first n terms. Our results show that compared to the effective and simple solutions offered by Vedic Mathematics, tackling such issues with contemporary approaches frequently takes more time and effort. In addition to improving computation speed and accuracy, we may greatly lessen students' phobia of mathematics by utilising Vedic formulas. These techniques, which have their roots in traditional Indian knowledge, provide an intuitive manner that makes learning mathematics more interesting and approachable while also encouraging a greater level of confidence and interest in the topic.

Competing Interests

The author declares that she has no competing interests.

Authors' Contributions

The author wrote, read and approved the final manuscript.

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