International Journal of Sanskrit Research 2024; 10(6): 17-19

International Journal of Sanskrit Research

अनन्ता

ISSN: 2394-7519
IJSR 2024; 10(6): 17-19

www.anantaajournal.com
Received: 24-08-2024
Accepted: 29-09-2024

B Santhi
School of Arts, Sciences, Humanities & Education
SASTRA Deemed University, Thanjavur, Tamil Nadu, India

Corresponding Author:
B Santhi
School of Arts, Sciences, Humanities & Education
SASTRA Deemed University, Thanjavur, Tamil Nadu, India

Exploring Mathematical Roots: From Pingala's Chandashastra to Fibonacci

B Santhi

Abstract
This paper sets out to uncover the wisdom of ancient India, especially in Chandashastra by Pingala. We want to showcase the important ideas of Pingala, who was an exceptional mathematician, and bring to light the valuable aspects of our heritage that may have been ignored or misunderstood in today's world. The paper highlights Pingala's insights and their significant influence on computing. Our vision is to establish a lasting legacy for traditional knowledge and find new ways to put it into practical use.

Keyword: Chandashastra, pingala, mathematics, traditional knowledge, computing

1. Introduction
This study identifies the roots of important math concepts like the Fibonacci sequence, Pascal's triangle, Binary system, and Binomial coefficients, all found in Pingala's detailed Chandashastra. By tracing the origins of these ideas, we not only unveil their historical roots but also highlight the lasting significance of Indian mathematical philosophy. Pingala's contributions form the basis for these mathematical concepts, connecting the past to the present and offering valuable insights into the development of mathematical knowledge.

2. Pingala's Contribution to Combinatorial Mathematics in Chandashastra
In his significant text Chandashastra, the ancient Indian mathematician Pingala laid the groundwork for a detailed study of poetic meters. Pingala focused on organizing short (laghu) and long (guru) syllables, which is the main topic of this thorough investigation. His work delves into the numerical arrangement of these syllables within a verse, pioneering what we now recognize as combinatorial mathematics in Chandashastra. Objective of this paper is to dig into ancient Indian wisdom, particularly focusing on Chandashastra by Pingala. Vision is to establish a lasting legacy for traditional knowledge and pave the way for its practical use in new ways.

A. Systematic Framework for Syllabic Sequences
Pingala's thorough investigation goes beyond simply recognizing syllabic patterns. He introduces a methodical framework for creating various sequences based on a specified number of syllables, with each sequence carefully named and categorized. Demonstrating the depth of his research, Pingala concludes his work with a set of guidelines that help to generate all possible combinations of laghu and guru (L and G) in a verse containing 'n' syllables. These guidelines cover listing combinations, determining laghu-guru combinations for a given index, and calculating the total number of potential n 'LG' syllable combinations.

B. Pingala's Exploration of Combinatorial Mathematics in Meters
Basically, Pingala's study in Chandashastra is a groundbreaking exploration of what we can call the 'mathematics of combinations' in poetry. This work aims to uncover Pingala's deep insights, exploring the mathematical details that not only explain how poems are structured but also connect to important math ideas like the Fibonacci sequence, Pascal's triangle, the Binary system, and Binomial coefficients. The following parts will reveal Pingala's contributions and how they continue to influence our understanding of both poetic styles and mathematical principles.

3. Exploration of Algorithms in Chapter 8 of Chandashastra

In Pingala's Chandashastra, an old Indian book about poetic metrics, the eighth chapter is very important. This chapter, made up of 35 sutras, especially from 8.20 to 8.35, delves into algorithms connected with combinatorial mathematics. In this mathematical exploration, the attention is on analyzing poetic meters, wherein two fundamental types of syllables, namely 'laghu' and 'guru,' play a pivotal role.

A. Syllabic Classifications in Chanda Analysis

In chanda analysis, these syllabic labels, 'laghu' for 'light' and 'guru' for 'heavy,' represent the duration of one beat and two beats in poems. This unique classification is crucial for creating patterns in ancient Indian poetry. The careful arrangement of 'laghu' and 'guru' syllables, each with a specific duration, forms the basis for the intricate patterns explored in the eighth chapter of Chandashastra.

B. Algorithms and Combinatorial Mathematics in Chapter 8 of Chandashastra

As we delve into the algorithms delineated in the final 16 sutras of Chapter 8, we uncover Pingala's profound insights into the combinatorial mathematics underpinning the metrics of poetic compositions. The interplay of light and heavy syllables, as guided by the principles of 'laghu' and 'guru,' not only shapes the rhythmic cadence of verses but also forms the basis for the development of intricate patterns that transcend the boundaries of poetry into the realm of mathematical elegance. This harmonious convergence of linguistic expression and mathematical precision exemplifies the enduring legacy of Pingala's contributions to both poetic and mathematical discourse.

4. Maatra Meru

Table 1: Maatra Meru

Maatra	Possible Patterns	Count
1.	L	1
2.	LL / G	2
3.	LLL / LG / GL	3
4.	LLLL / LLG / LGL / GLL / GG	5
5.	LLLLL / LLLG / LLGL / LGLL / GLLL / LGG / GLG / GGL	8

In this Table 1, 'L' represents 'laghu,' and 'G' represents 'guru.' The "Possible Patterns" column outlines the various combinations of 'laghu' and 'guru' syllables for each row, while the "Count"column indicates the total count of distinct patterns for the corresponding total number of maatra.This 'Count' column representing the Current Fibonacci Sequence.

5. Pingala's algorithms: Six pratyayas

Table 2: Six Pratyayas

Algorithm	Description
Prastaara	Lists, Spread Systematically all possible forms of a meter with given number
Nashtam	To recover the lost/missing row in the matrix; (Decimal to Binary conversion)
Uddishtam	To get the row index of a given row in the matrix; (Binary to Decimalconversion)
Lagakriya	To compute *nCr*, where *n* is the total number of syllables, and *r* is the number of laghus (gurus).
Sankhya	To get the total number of n-bit combinations; equivalent to computation of 2^n
Adhvayoga	Computes the total space required

A. Prastaara Expansion

A. One Syllable (akshara)

The expansion of 'one syllable (akshara)' in Prastaara may consist of either of two elements, namely 'G or L'.

- G
- L

B. Two Syllables

- Blend the 'GL' of one-syllable Prastaara with itself, resulting in a sequence where 'GL' is combined with 'G' and followed by another instance where 'GL' is mixed with 'L'.
- G G
- L G
- G L
- L L

C. Three Syllables

- Generating patterns for 3 syllables:
- GG G
- LG G
- GL G
- LL G
- GG L
- LG L
- GL L
- LL L

D. Four Syllables

- Generating patterns for 4 syllables:
- GG G G
- LG G G
- GL G G
- LL G G
- GG L G
- LG L G
- GL L G
- LL L G
- GG G L
- LG G L
- GL G L
- LL G L
- GG L L
- LG L L
- GL L L
- LL L L

E. Binary Number Generation

For getting binary number system, we need to replace G with 0, L with 1 in the above patterns and get the mirror image. Thus we will get current binary numbers.

F. Method to Get Row Pattern

Give the row number and get the pattern in that row. For example, consider row number 5. If the given number is divisible by two without any remainder, designate it as 'L'; otherwise, add one, halve the result, and denote it as 'G'. For instance, to obtain the 'laghu-guru' combination in the row 5 of the 3 akshara matrix, commence with 5. As 5 is an odd number, add 1 to make it 6 and designate it as 'G'. After dividing 6 by 2, yielding 3, which is also odd, add 1 and label it as 'G'. Subsequent division of 4 by 2 results in 2, an even number, prompting the designation 'L'. The process concludes once the desired number of bits, in this case, 3, is achieved. Pattern in the row 5 is GGL.

G. Method to get row number from pattern

Given pattern GGLL. Assign from left to right 1,2,4,8 to the top of GGLL. Add the top values over L and add 1 to it. Here 4 + 8 + 1 = 13. So this pattern 'GGLL' is in the row 13.

6. Maatra Meru

From Maatra Meru, adding shallow diagonal entries we will form the sequence 1, 1, 2, 3, 5, 8, 13, etc. Here the first row labelled as 0. Pingala's process involves systematically combining laghu and guru to create a sequence of patterns.Method to get the binomial coefficients for each n, the values in the inner boxes obtained by the sum of the values of two boxes in the previous row. When we add up the numbers in all the boxes of the fifth row, it gives us the 'sankhya' for the prastaara of 4 syllables. Consider the coefficients in the fourth row are (1, 4, 6, 4, 1). We have the following inference from these row entries. 1 pattern with 4 Gurus; 4 patterns with 3 Gurus; 6 patterns with 2 Gurus; 4 patterns with 1 Guru; 1 pattern with no Guru (i.e, all 4 are Laghus). We can find sum of that coefficients. Add all the values in the fourth row, we will get $16(2^4)$. $S4 = 1 + 4 + 6 + 4 + 1 = 16 = 2^4$

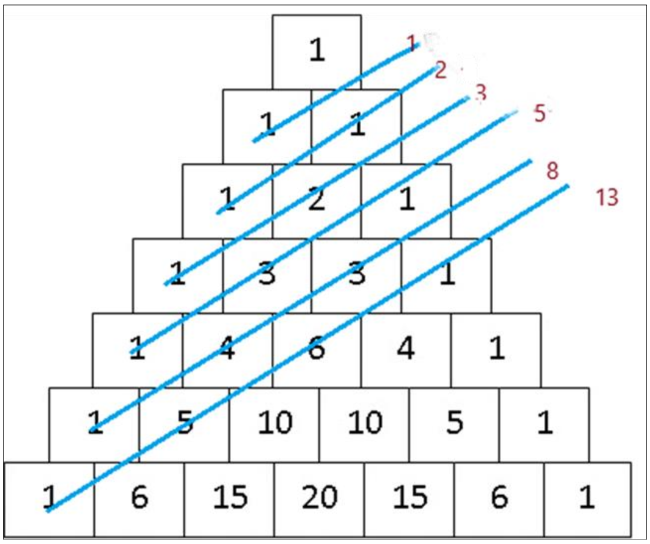

Fig 1: Meru Prastaara(Pascal Triangle)

$(x + y)^1 = x + y$
$(x + y)^2 = x^2 + 2xy + y^2$ - (1,2,1) - 2^2
$(x + y)^3 = x^3 + 3x^2y + 3xy^2 + y^3$ - (1,3,3,1) - 2^3

Thus it is possible to get the sum of the coefficients as 2^n. Row 4, box values are (1, 4, 6, 4, 1) which is now called as binomial coefficients. View this as number 14641, which is 11^4. Each row values are viewed as a number. If two digits in a single box, keep one digit and other digit should be added with the left side box and keep the single digit. We now represent this as 11^n. Row 5, values are (1, 5, 10, 10, 5, 1). Here from right to left, 3rd box 10, keep 0 and add 1 to the left value 10; we have 11 now in 4th box. Keep 1 and add 1 to the left box, we will have 6. Hence, need to view this as number 161051, which is 11^5. From this Meru Prastaara (Pingala's triangle) we got Fibonacci sequence (shallow diagonal sum), Binomial coefficients (values in boxes). Meru Prastaara commonly recognized as Pascal's Triangle, was actually introduced by Pingala more than 1800 years before Pascal.

7. Conclusion

This study explores the deep interconnection between the ancient wisdom found in Pingala's Chandashastra and fundamental mathematical principles. Pingala's thorough examination of laghu and guru syllables serves as the foundation for the mathe-matical aspects of poetry, subtly impacting important mathematical concepts and underlining the intricate relationship between art and science. The goal is to stimulate curiosity, urging young minds to explore the richness of traditional Indian knowledge and understand its relevance in contemporary applications.

8. References

1. Sharma A. Pingalacharya Pranītam Chanda Shastram. Delhi: Parimal Publications; 2001.
2. Chandashastra of Pingala with Sanskrit commentary Mrtasanjivani of Halayudha. Sharma A, editor. Delhi: Parimal Publications; 2007.
3. Sridharan R. Sanskrit Prosody, Pingala Sutras, and Binary Arithmetic. In: Emch GG, Sridharan R, Srinivas MD, editors. Contributions to the History of Indian Mathematics. 2005.
4. https://archive.nptel.ac.in/courses/111/101/111101080/