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# A New Symmetrical Numeric Pattern with Analytical Features Based on Palindromic Numbers and the Palindrome Diamond

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**Abstract:** ***In the realms of discrete mathematics, number theory, and algorithm analyses, palindromes, which are numbers that read the same backwards as forwards, have long been a subject of interest. Although earlier research was dominated by palindromic primes, symmetry of digits, and ways of calculation to obtain palindromes, structured presentations of palindromic sequences in multi-dimensional plots have yet to be completely investigated. In this paper, we discuss and mathematically analyze the newly proposed numerical structure known as the Palindrome Diamond. Palindrome Diamond is a symmetrical diamond structure consisting of palindromic numbers arranged in a diamond pattern; this pattern is determined by the central number n. In Palindrome Diamond, each row consists of an palindromic pattern that gradually approaches the center and then retreats symmetrically towards the sides. The proposed structure is fully symmetrical in the horizontal and vertical planes. Further formulae are also provided to determine the overall quantity of numbers and summation of all Palindrome Diamonds based on a specific center number n. Applications involving the Palindrome Diamond include mathematical visualization, algorithm design, and teaching discrete mathematics via connections between geometric symmetry, numerical palindromes, and combinatorial pattern generation.***

**Keywords:** Palindrome Numbers; Numerical Symmetry; Discrete Structures; Palindromic Sequences; Pattern Formation; Mathematical Visualization.

## 1. Introduction

**Palindrome Number**
Palindromic number means that the number reads the same both forward and backward. In other words, the number remains the same even after reversing the digits of the number.

***Basic Idea of a Palindrome Number***
Palindrome is a translation of the words "running back again." The term palindrome is used in mathematics to describe a number if its digits are symmetric.

Examples:
121, 1331, 7 are palindrome numbers.
123, 120 are not palindrome numbers.

***Properties of Palindrome Numbers***

All **single-digit numbers (0–9) are palindromes**
There is only one digit, so reversal does not change the number.

Leading **zeros are not allowed**
For example, 101 is a palindrome, but 010 is not considered a valid number representation.

Symmetry **of digits**
The first digit equals the last digit, the second equals the second-last, and so on.

Palindromes **can be even or odd in length**
- Odd length: 121, 12321
- Even length: 1221, 3443

*Mathematical Importance*
1) **Pattern recognition**
   Palindromes are useful in understanding symmetry and the patterns of numbers.
2) **Number theory**
   Palindromes can be found in recreational mathematics and digit problems.
3) **Special problems**
   - Largest palindrome made from the product of two numbers
   - Palindromic primes (numbers that are both prime and palindrome, e.g., 131

*Real-Life Application*
- **Computer Science:** String and number manipulation problems
- **Cryptography:** Pattern detection
- **Competitive Exams:** Frequently asked in aptitude and coding tests
- **Education:** Helps students understand reversal logic and loops

## 2. Research Area

***Palindrome Diamond***
Research of a **New pattern** of Palindrome No.

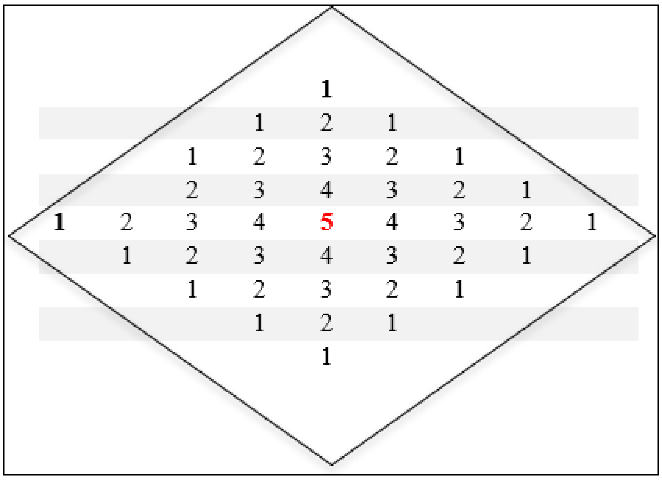


**Figure 1**

This pattern is an example (Fig.1) is Palindrome Diamond, as because this pattern looks like a diamond shape of center "**5**", which is called CENTRAL NUMBER.

A **Palindrome Diamond** is a number arrangement in the shape of a **diamond**, where:

- Numbers increase toward the **centre**
- Numbers decrease symmetrically away from the centre
- Each row reads the same **from left to right and right to left**, making it a **palindrome**

The entire figure is symmetric **horizontally and vertically**.

***Central Number:***

The Central number is the number in the center of the diamond pattern. This number indicates the largest number discovered in the pattern. For instance, in fig 1, every number progresses from 1-5 and then returns to 1.

**General Palindrome Diamond**

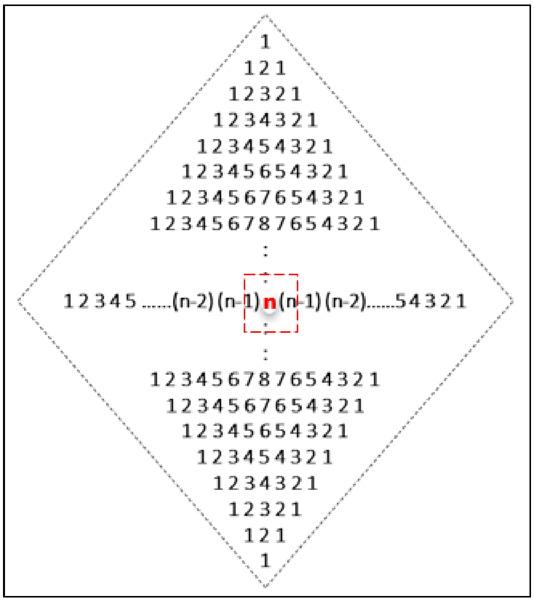


**Figure 2**

This diagram represents the general diagram of Palindrome Diamond with CENTRAL NUMBER "n"

***Properties of the PALINDROME DIAMOND***

1) No of the terms: 2n (n-1) + 1, (where "n" is the CENTRAL NUMBER)
2) Summation of all terms: $\frac{1}{3}$ n ($2n^2$+1), (where "n" is the CENTRAL NUMBER)

Proof:

1) No. of the terms:

If the central number is "n" then the no. of terms is = $n^2$ + $(n-1)^2$

= $n^2 + n^2 - 2n + 1$

= $2n^2 - 2n + 1$

= **2n (n-1) + 1**

2) Summation of the all terms:

If the central number is "n" then the summation of terms is =

$$\sum_{n=1}^{n} n^2 + \sum_{n=1}^{n} (n-1)^2$$

$$= \sum_{n=1}^{n} [\, n^2 + (n-1)^2 ]$$

$$= \sum_{n=1}^{n} [n^2 + n^2 - 2n + 1\,]$$

$$= \sum_{n=1}^{n} [2n^2 - 2n + 1\,]$$

$$= \sum_{n=1}^{n} 2n^2 - \sum_{n=1}^{n} 2n + \sum_{n=1}^{n} 1$$

$$= 2\sum_{n=1}^{n} n^2 - 2\sum_{n=1}^{n} n + \sum_{n=1}^{n} 1$$

$$= 2.\frac{1}{6}n(n+1)(2n+1) - 2.\frac{n(n+1)}{2} + n$$

$$= \frac{n(n+1)(2n+1) - 3n(n+1) + 3n}{3}$$

$$= \frac{n(2n^2+n+2n+1) - 3n^2 - 3n + 3n}{3}$$

$$= \frac{2n^3+n}{3}$$

$$= \frac{1}{3}\,\mathbf{n\,(2n^2+1)}$$

## 3. Conclusion

One beautiful mathematical pattern, aptly named Palindrome Diamond, predominantly uses numbers, symmetry, and geometry. The top number is used as the summit, while all surrounding numbers form a palindrome. Easy to comprehend, yet very helpful in developing pattern recognition skills.