

Factorials, Integers, and Multinomials for Algorithms

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Abstract: This paper presents an innovative theorem using factorials, integers, and multinomials. The theorems and its results can be used as an application in computing and cryptography to develop algorithms like RSA algorithm and Elliptic Curve Cryptography.

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1. Introduction

Binomials, multinomials, and combinatorial techniques [1-12] are used as powerful tools in artificial intelligence and machine learning for data analysis and cybersecurity for protection of the computing systems, devices, networks, programs and data from cyber-attacks. Also, the nonnegative integers play a crucial role in factorial functions or factorials [1-12] for building the theorems that are used for algorithms and software development. The results of factorials and binomial coefficients are used as strong applications without any vulnerability in artificial intelligence and cybersecurity.

The factorial of a non-negative integer n , denoted by $n!$, is the product of all positive integers less than or equal to n .

For example, $7! = 1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 = 5040$. Note that zero factorial is always one, that is, $0! = 1$.

2. Multinomial with Factorials

Multinomial is an expression or sum of more than two algebraic terms and binomial refers to sum of two algebraic terms.

Theorem: $\prod_{i=1}^k (n_i!)^r = \frac{1}{A^r} \left\{ \left(\sum_{i=1}^k n_i \right)! \right\}^r$, where $A = \prod_{i=1}^{k-1} a_i$ and $r \geq 1, a_i \geq 0$ are integers.

Proof. This theorem is proved by using the following theorem:

$\left(\sum_{i=1}^k n_i \right)! = A \prod_{i=1}^k n_i!$, where $A = \prod_{i=1}^{k-1} a_i$ and A & a_i are nonnegative integers.

$$\left(\sum_{i=1}^k n_i \right)! = A \prod_{i=1}^k n_i! \Rightarrow \left\{ \left(\sum_{i=1}^k n_i \right)! \right\}^r = \left(A \prod_{i=1}^k n_i! \right)^r = A^r \left(\prod_{i=1}^k n_i! \right)^r = A^r \prod_{i=1}^k (n_i!)^r.$$

From this expression we conclude that
$$\prod_{i=1}^k (n_i!)^r = \frac{1}{A^r} \left\{ \left(\sum_{i=1}^k n_i \right)! \right\}^r.$$

This idea can help to the researchers working in computer science, computational science, and cryptography for developing algorithms and software to solve the real-world problems.

3. Conclusion

In this article, an innovative theorem has been introduced using factorials, integers, and multinomials [1-12]. This theorem refers to a methodological advance which is useful for researchers working in working in computer science, computational science, and cryptography for developing algorithms and software to solve the most real life problems and meet today's challenges.

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