

What is the definition of Multinomial Coefficient and what are some examples of its use?

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The Multinomial Coefficient is a mathematical term used to describe the number of ways a set of objects can be divided into different groups. It is denoted by the symbol $\binom{n}{k_1, k_2, \dots, k_r}$ and is calculated by the formula $n! / (k_1! k_2! \dots k_r!)$, where n is the total number of objects and k_1, k_2, \dots, k_r represent the number of objects in each group. This coefficient is commonly used in combinatorics and probability to solve problems involving the distribution of objects into various categories. For example, it can be used to calculate the number of possible outcomes in a dice game where the dice are rolled multiple times, or to find the probability of drawing a specific combination of cards from a deck. It is also used in statistics to analyze data with multiple categories. Overall, the Multinomial Coefficient plays a crucial role in various fields of mathematics, making it an important concept to understand.

Multinomial Coefficient: Definition & Examples

A multinomial coefficient describes the number of possible partitions of n objects into k groups of size n_1, n_2, \dots, n_k .

The formula to calculate a multinomial coefficient is:

$$\text{Multinomial Coefficient} = n! / (n_1! * n_2! * \dots * n_k!)$$

The following examples illustrate how to calculate the multinomial coefficient in practice.

Example 1: Letters in a Word

How many unique partitions of the word ARKANSAS are there?

Solution: We can simply plug in the following values

into the formula for the multinomial coefficient:

n (total letters): 8

n1 (letter "A"): 3

n2 (letter "R"): 1

n3 (letter "K"): 1

n4 (letter "N"): 1

n5 (letter "S"): 2

Multinomial Coefficient = $8! / (3! * 1! * 1! * 1! * 2!) = 3,360$

There are 3,360 unique partitions of the word ARKANSAS.

Example 2: Students by Grade

A group of six students consists of 3 seniors, 2 juniors, and 1 sophomore. How many unique partitions of this group of students are there by grade?

n (total students): 6

n1 (total seniors): 3

n₂ (total juniors): 2

n₃ (total sophomores): 1

Multinomial Coefficient = $6! / (3! * 2! * 1!) = 60$

There are 60 unique partitions of these students by grade.

Example 3: Political Party Preference

Out of a group of ten residents in a certain county, 3 are Republicans, 5 are Democrats, and 2 are Independents. How many unique partitions of this group of residents are there by political party?

Solution: We can simply plug in the following values into the formula for the multinomial coefficient:

n (total residents): 10

n₁ (total Republicans): 3

n₂ (total Democrats): 5

n₃ (total Independents): 2

Multinomial Coefficient = $10! / (3! * 5! * 2!) = 2,520$

There are 2,520 unique partitions of these residents by political party.

The multinomial coefficient is used in part of the formula for the multinomial distribution, which describes the probability of obtaining a specific number of counts for k different outcomes, when each outcome has a fixed probability of occurring.

Bonus: You can use the Multinomial Coefficient Calculator to easily calculate multinomial coefficients.