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SIMPLE WAYS TO DIFFERENTIATE BETWEEN PERMUTATIONS AND COMBINATIONS IN COMBINATORICS

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Abstract

The article provides a simple and easy way to differentiate between permutations and combinations, which are rare in textbooks and manuals and difficult to work with.
Key words: permutations, combinations, factorial, “imaginary row”.

Introduction

Combinatorics is one of the branches of modern mathematics that is based on the integration of sciences and develops on the basis of real-life applications. The branch of mathematics that deals with the theory of finite sets is called combinatorics. Combinatorics deals with issues such as identifying all possible ways to place elements of a finite set or finding all ways to perform a particular action.

In other words, combinatorial problems are problems involving the formation of different groups (associations) from the elements of a finite set and the calculation of the number of all possible groups formed according to a rule.

Here are three basic types of combinations that can be used to solve combinatorics: permutations, factorial and combinations.

1. Permutations.

Given a finite set of n different elements.

Definition. As permutations n different elements taken $m \leq n$ elements at a time, all possible combinations containing m elements derived from a given n elements are said to differ from each other either in the order of the elements or in the composition of the elements.

The number of permutations from n different elements taken m without repetitions at a time is defined as A_m^n and is given by the following formula:

$$A_m^n = \frac{n!}{(n-m)!}.$$

2. Factorial.

Definition. Factorial of a non-negative integer n is the number of all combinations composed of n given elements and differing from each other in the order of the elements.

The number of factorial of a non-negative integer n is defined as P_n and is given by following formula:

$$P_n = n!$$

3. Combinations.

Definition. As combinations n different elements taken m elements at a time, all possible combinations containing m elements derived from a given n elements are said to differ from each other only the composition of the elements.

The number of combinations from n different elements taken m without repetitions at a time is defined as C_m^n and is given by the following formula:

$$C_n^m = \frac{n!}{m!\,(n-m)!}.$$

Simple ways to differentiate between permutations and combinations in Combinatorics

Often, students or teachers find it difficult to distinguish between permutations and combinations when solving combinatorial problems. Here is a "simple" solution to this problem:

Let's ask a question about permutation or combination formulas. In that case, of course, it is necessary to separate m elements from n elements. For example, 3 out of 10 students; 5 out of 20 flowers; 3 out of 7 numbers; 4 out of 12 books, etc. First, we separate the required m elements from these n elements and write these m elements in an "**imaginary row**" We replace any two elements of the resulting "row". If, according to the problem, a union is formed which is different from the union of the m elements which we originally separated, then the problem is a matter of permutations. Otherwise, the issue will be combinations.

It is relatively easy to distinguish factorial than permutations and combinations . Substitutions are generally performed on n given elements and no element is required to be separated.

To teach that the above concepts are based on the integration of sciences and their application in practice, we bring the following examples:

Example 1. Through this example, students feel the integration of geography and combinatorics.

There are 49 states in the USA, of which 3 optional states must be selected to conduct research among the population. How many different ways can this be done?

Solution.

First, we select an optional 3 states imaginatively. For instance, let them be Arizona, Hawaii, Michigan. Let's line up these states in "imaginary row":

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Arizona	***Hawaii***	***Michigan***

Then we replace the first and second elements of this “imaginary row”:

Hawaii	***Arizona***	***Michigan***

According to the term of the cases, these two rows do not differ from each other, i.e., they are the same. Thus, this example is a matter of combinations. We solve it using the following formula:

$$C_{49}^{3} = \frac{49!}{3! \cdot 46!} = 18424.$$

That is, there are a total of 18 424 different options.

Example 2. Through this example, students feel the integration of geometrics and combinatorics.

How many straight lines can be drawn from 9 points, if every three of which do not lie on the same straight line?

Solution.

As you know, we can always draw a straight line from two points that do not overlap. That is, the problem required to separate 2 out of 9 elements. We can separate any two points, for example, points A_1 and A_2, and draw a straight line from these two points:

Then swap the points to draw a straight line:

Obviously, the straight lines in both cases are the same. Thus this example is a matter of combinations. We solve it using the following formula:

$$C_{9}^{2} = \frac{9!}{2! \cdot 7!} = 36.$$

In general, the combinatorics department develops the functionality of mathematical concepts in students, while shaping students ’mathematical literacy and cognitive competence.

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