

## Combinatorics about Some Formulas

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### Abstract:

In this work, the methods of finding the number of combinations obtained from at least one element in each of the sums that do not have a common element and the number of combinations obtained from each of at least one element and the total obtained in different ways are shown.

**Keywords:** Set, Cartesian multiplication, power of set, combination, finite set.

$m$  ta elemental  $A$  collection and  $n$  ta element  $B$  collections given they are do not cross. Add according to the rule according to  $A$  or  $B$  to the collection belongs to to be one element choose opportunities to number  $(m+n)$ . is equal. It is also called "Or" rule this the rule content the following theorem express also through can

**Theorem 1.** *If arbitrary finite  $A_1, A_2, \dots, A_n$  (bu yerda  $\forall A_i \cap A_j = \emptyset, i \neq j$ ) let be the sets  $A_1 \cup A_2 \cup \dots \cup A_n$  from the collection one element choose combinations the number  $n(A_1 \cup A_2 \cup \dots \cup A_n) = n(A_1) + n(A_2) + \dots + n(A_n)$  is equal to*

Hence, by the addition rule, non-intersecting  $n$  the power of the union of sets is equal to the sum of the powers of these sets.

**Theorem 2.** *If for arbitrary finite  $A_1, A_2, \dots, A_n$  sets*

$$n(A_1 \cup A_2 \cup \dots \cup A_n) = n(A_1) + n(A_2) + \dots + n(A_n) - n(A_1 \cap A_2) - n(A_2 \cap A_3) - \dots - n(A_{n-1} \cap A_n) + n(A_1 \cap A_2 \cap A_3) + \dots + (-1)^{n-1} n(A_1 \cap A_2 \cap \dots \cap A_n)$$

is equal to

Therefore, according to the rule of addition,  $n$  the power of the union of sets is equal to the difference of the power of the set formed by their intersection from the sum of the powers of these sets.

**the multiplication rule**, the number of all  $m$  ( $a \in A, b \in B$ ) tuples (pairs)  $m \cdot n$  that can be formed from the elements  $\langle a, b \rangle$  of  $m$ -element set  $A$  and  $n$ -element set  $B$  is equal to  $m \cdot n$ .

If  $m_1$  has element  $a \in A_1$  and  $m_2$  has element  $b \in A_2$  and last  $m_n$  has element  $e \in A_n$  the number of all  $(a, b, \dots, e)$  tuples (pairs)  $m_1 m_2 \dots m_n$  that can be formed from the elements of the sets  $\langle a, b, \dots, e \rangle$  is equal to  $m_1 m_2 \dots m_n$ . This rule is also called **the "and" rule**. It can also be expressed as the following theorem.

**Theorem 3.** The equality holds for  $|A \times B| = |A| \cdot |B|$  arbitrary finite  $A$  and finite sets  $B$ .

**Theorem 4.** The equality holds for arbitrary finite  $A_1, A_2, \dots, A_n$  sets  $|A_1 \times A_2 \times \dots \times A_n| = |A_1| \cdot |A_2| \cdot \dots \cdot |A_n|$ .

Therefore, according to the multiplication rule,  $n$  the power of the Cartesian product of an arbitrary finite set is equal to the product of the powers of these sets.

**Theorem 5.** If  $A_1$  in the collection  $m_1$   $A_2$  in the collection  $m_2$  so...  $A_n$  in the collection  $m_n$  There is an element let it be The number of combinations obtained from at least one element from each set

$$\sum_{k_1+k_2+\dots+k_n \leq t} C_{m_1}^{k_1} C_{m_2}^{k_2} \dots C_{m_n}^{k_n} \quad (1)$$

is equal to Since the total number of sets here  $n$  is  $t$  and each set has at least one element  $\forall k_i \geq 1$

and  $\forall m_i \geq k_i, i = 1 \dots n$  total elements the number  $\sum_{i=1}^n m_i = t$ .

**Example 1.** In the first container there are 3 different colored apples, in the second container there are 2 different colored cherries and in the third container there are 2 different colored pears. How many combinations can be obtained from at least one from the fruit received combinations find the number

Solving. Total containers 3 in number and each one from the vessel at least get one element condition that it was to formula (1) for according to  $m_1 = 3, m_2 = 2, m_3 = 2 \quad \forall k_i \geq 1 \text{ va } k_i \leq m_i$  total

fruits the number  $\sum_{i=1}^3 m_i = 7$

$$\begin{aligned} \sum_{k_1+k_2+k_3 \leq 7} C_{m_1}^{k_1} C_{m_2}^{k_2} C_{m_3}^{k_3} &= C_3^1 C_2^1 C_2^1 + C_3^2 C_2^1 C_2^1 + C_3^3 C_2^1 C_2^1 + C_3^1 C_2^2 C_2^1 + C_3^2 C_2^2 C_2^1 + \\ &+ C_3^3 C_2^2 C_2^1 + C_3^1 C_2^1 C_2^2 + C_3^2 C_2^1 C_2^2 + C_3^3 C_2^1 C_2^2 + C_3^1 C_2^2 C_2^2 + C_3^2 C_2^2 C_2^2 + C_3^3 C_2^2 C_2^2 = \\ &= 12 + 12 + 4 + 6 + 6 + 2 + 6 + 6 + 2 + 3 + 3 + 1 = 63 \end{aligned}$$

**Example 2.**  $X = \{1, 2, 3, 4\}, Y = \{a, b, c\}$  collections given let it be one from the collection at least one from the element received part collections find the number

Solving. Two collection given and each from the collection at least get one element condition that it was to formula (1) for according to  $m_1 = 4, m_2 = 3 \quad \forall k_i \geq 1 \text{ va } k_i \leq m_i$  total fruits the number

$$\sum_{i=1}^2 m_i = 7$$

$$\sum_{k_1+k_2 \leq 7} C_{m_1}^{k_1} C_{m_2}^{k_2} = C_4^1 C_3^1 + C_4^2 C_3^1 + C_4^3 C_3^1 + C_4^4 C_3^1 + C_4^1 C_3^2 + C_4^2 C_3^2 + C_4^3 C_3^2 + C_4^4 C_3^2 + C_4^1 C_3^3 + C_4^2 C_3^3 + C_4^3 C_3^3 + C_4^4 C_3^3 = 12 + 18 + 12 + 3 + 12 + 18 + 12 + 3 + 4 + 6 + 4 + 1 = 105$$

**Theorem 6.** If  $A_1$  in the collection  $m_1$  to  $A_2$  in the collection  $m_2$  so...  $A_n$  in the collection  $m_n$  There is an element let it be Har one from the collection at least from one received combinations the number  $N$

$$N = \prod_{i=1}^n (2^{m_i} - 1)$$

to equal to Here  $n$  collections the number

Example 3. In the first container there are 3 different colored apples, in the second container there are 2 different colored cherries and in the third container there are 2 different colored pears. Har one from the vessel at least one from the fruit received combinations find the number

$$N = \prod_{i=1}^3 (2^{m_i} - 1) = (2^3 - 1)(2^2 - 1)(2^2 - 1) = 7 \cdot 3 \cdot 3 = 63$$

**Theorem 7 .** If  $A_1$  in the collection  $m_1$  to  $A_2$  in the collection  $m_2$  so...  $A_n$  in the collection  $m_n$  There is an element let it be It is the number of combinations in which there is at least one element from each set when each element is taken from the sets  $t$

$$\sum_{k_1+k_2+\dots+k_n \leq t} C_{m_1}^{k_1} C_{m_2}^{k_2} \dots C_{m_n}^{k_n} \tag{1}$$

is equal to Since the total number of sets here  $n$  is ta and each set has at least one element  $\forall k_i \geq 1$

and  $\forall m_i \geq k_i, i = 1 \dots n$  total elements the number  $\sum_{i=1}^n m_i \geq t$ .

Example 4. In the first container there are 3 different colored apples, in the second container there are 2 different colored cherries and in the third container there are 2 different colored pears. 4 each one from the vessel at least one from the fruit received combinations find the number

Solving . Total containers 3 in number and each one from the vessel at least get one element condition that it was to formula (1) for according to  $m_1 = 3, m_2 = 2, m_3 = 2 \quad \forall k_i \geq 1 \text{ va } k_i \leq m_i$  total fruits the number

$$\sum_{k_1+k_2+k_3 \leq 4} C_{m_1}^{k_1} C_{m_2}^{k_2} C_{m_3}^{k_3} = C_3^1 C_2^1 C_2^1 + C_3^2 C_2^1 C_2^1 + C_3^1 C_2^2 C_2^1 + C_3^1 C_2^1 C_2^2 = 12 + 12 + 6 + 6 = 24$$

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