Mathematical Foundations for Computer Applications

Permutations

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Mathematical Foundations for Computer Applications

Permutations

- The concept of permutation is used for the **arrangement of objects** in a specific order i.e. whenever the **order is important**, permutation is used.
- The total number of permutations on a set of n distinct objects is given by **n!** and is denoted as

$$^{n}P_{n} = n!$$

- The total number of permutations on a set of **n** objects taken **r** at a time is given by $^{n}P_{r} = n!/(n-r)!$

  (Non repeating r elements)

Permutations-Example

If 6 letters are given , How many 3 letter words can be formed without repetition of the letter?

=6 *5 *4 =120 (by product Rule)

OR

$^{n}P_{r} = n!/ (n-r)!$

Here n=6 , r=3

=6! / (6-3)! = 6! /3!

= 6*5*4

=120

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Permutations-Example

If repetition is allowed --Possible arrangement is n^r

Eg--If 6 letters are given , How many 3 letter words can be formed with repetition of the letter?

$$n^r = 6^3$$

$$=6*6*6$$

$$=216$$

Permutations

- A permutation is an ordered arrangement of the elements of some set *S*
  - Let *S* = {a, b, c}
  - c, b, a is a permutation of S
  - b, c, a is a *different* permutation of S
- An *r*-permutation is an ordered arrangement of *r* elements of the set
  - A♦, 5♥, 7♣, 10♠, K♠ is a 5-permutation of the set of cards
- The notation for the number of *r*-permutations: $P(n,r)$

Permutations

$$P(n,r) = n(n-1)(n-2)\ldots(n-r+1)$$

- If n and r are integers with $0 \le r \le n$,

then $P(n, r) = \dfrac{n!}{(n-r)!}$

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Permutation formula proof

- There are n ways to choose the first element
  - n-1 ways to choose the second (n-2+1)
  - n-2 ways to choose the third (n-3+1)
  - …
  - n-r+1 ways to choose the r^{th} element

- By the product rule, that gives us:

  $p(n,r) = n(n-1)(n-2)\ldots(n-r+1)$

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Permutation formula proof

$$p(n,r) = n(n-1)(n-2)\ldots(n-r+1)$$

- Multiply and divide by (n-r)(n-r-1)(n-r-2)….3.2.1 = (n-r)!

$$p(n,r) = n(n-1)(n-2)\ldots(n-r+1) \cdot (n-r)(n-r-1)(n-r-2)\ldots.3.2.1 / (n-r)(n-r-1)(n-r-2)\ldots.3.2.1$$

Therefore, **p(n,r) = n! / (n-r)!**

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Permutations-Problems

1. Determine the number of 4 digit decimal number that contain no repeated digit.

First Digit: The first digit of a four-digit number cannot be 0. Therefore, there are 9 possible choices for the first digit (from 1 to 9).

Second Digit: There are 9 remaining choices for the second digit (from the 10 available digits, excluding the one used). Third Digit: 8 , Fourth Digit: 7 remaining choices.

Total Number=9*9*8*7 =4536

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Permutations-Problems

1. Determine the number of 4 digit decimal number that contain no repeated digit.

Total Number=9*9*8*7 =4536

OR

Required number=Total 4 digit number – “4” digit number “0” in the beginning

$$= {}^{10}P_4 - {}^{9}P_3$$

$$=5040 - 504$$

$$= \mathbf{4536}$$

THANK YOU

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