

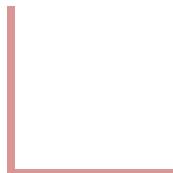
# Mathematical Foundations for Computer Applications

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## Permutations

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# Mathematical Foundations for Computer Applications

## Permutations

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- 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)**

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## Permutations-Example

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

$$=6 *5 *4 =120 \text{ (by product Rule)}$$

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

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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?

$$n^r = 6^3$$

$$=6*6*6$$

$$=216$$

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## Permutations

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- 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
  - $A\spadesuit, 5\heartsuit, 7\clubsuit, 10\spadesuit, K\spadesuit$  is a 5-permutation of the set of cards
- The notation for the number of  $r$ -permutations:  $P(n,r)$

# Mathematical Foundations for Computer Applications

## Permutations

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

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

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

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## Permutation formula proof

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- 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  $r^{\text{th}}$  element
- By the product rule, that gives us:  
$$p(n,r) = n(n-1)(n-2)\dots(n-r+1)$$

# Mathematical Foundations for Computer Applications

## Permutation formula proof

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

- Multiply and divide by  $(n-r)(n-r-1)(n-r-2)\dots3.2.1 = (n-r)!$

$$p(n,r) = n(n-1)(n-2)\dots(n-r+1) \cdot (n-r)(n-r-1)(n-r-2)\dots3.2.1 / \\ (n-r)(n-r-1)(n-r-2)\dots3.2.1$$

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

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## Permutations-Problems

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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=** $9*9*8*7 = 4536$

# Mathematical Foundations for Computer Applications

## Permutations-Problems

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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

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

$$=5040 - 504$$

$$= \mathbf{4536}$$



**THANK YOU**

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