# Basic Counting Principle

## Combinatorics

Bongobondhu Sheikh Mujibur Rahman Science and Technology University

14 April, 2020

# Fulfilment

1. 5.1
2. 5.2

# Now we on. . .

1. 5.1
2. 5.2

# Two Basic Counting Principle

1. Product Rule

# Two Basic Counting Principle

1. Product Rule
2. Sum Rule

# Two Basic Counting Principle

1. Product Rule
2. Sum Rule

**Product Rule:** Suppose that a procedure can be broken down into a sequence of two tasks. If there are $n_1$ ways to do the first task and for each of these ways of doing the first task, there are $n_2$ ways to do the second task, then there are $n_1 n_2$ ways to do the procedure.

# Two Basic Counting Principle

1. Product Rule
2. Sum Rule

**Product Rule:** Suppose that a procedure can be broken down into a sequence of two tasks. If there are $n_1$ ways to do the first task and for each of these ways of doing the first task, there are $n_2$ ways to do the second task, then there are $n_1 n_2$ ways to do the procedure.

**Sum Rule:** If a task can be done either in one of $n_1$ ways or in one of $n_2$ ways, where none of the set of $n_1$ ways is same as the any of set $n_2$ ways. Then there are $n_1 + n_2$ ways to do the task.

# Inclusion-Exclusion Principle

Suppose that a task can be done in $n_1$ ways or in $n_2$ ways, but that some of the set of $n_1$ ways is same as some of the set of $n_2$ ways.
To correctly count the ways to do the two task:
We add

- The number of ways to do it in one way

then subtract.

So. . .
The number of ways to do the task in a way that is both among the set of $n_1$ ways and the set of $n_2$ ways.
This technique is called **Inclusion-Exclusion**.

# Inclusion-Exclusion Principle

Suppose that a task can be done in $n_1$ ways or in $n_2$ ways, but that some of the set of $n_1$ ways is same as some of the set of $n_2$ ways.
To correctly count the ways to do the two task:
We add

- The number of ways to do it in one way
- The number of ways to do it in another way

then subtract.

So...

The number of ways to do the task in a way that is both among the set of $n_1$ ways and the set of $n_2$ ways.
This technique is called **Inclusion-Exclusion**.

# Now we on. . .

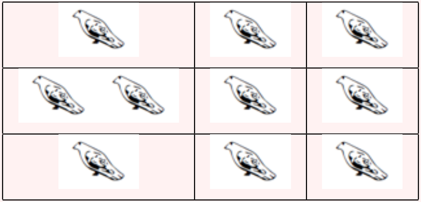
1. 5.1
2. 5.2

# The pigeonhole principle

Let's consider that, there are 10 pigeon and 9 pigeonhole at your home. So, there must a hole that contains two pigeon.

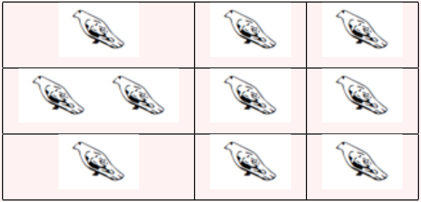
# The pigeonhole principle

Let's consider that, there are 10 pigeon and 9 pigeonhole at your home. So, there must a hole that contains two pigeon.



# The pigeonhole principle

Let's consider that, there are 10 pigeon and 9 pigeonhole at your home. So, there must a hole that contains two pigeon.



**Principle:**

$k$ is a positive integer. There are $n$ objects ($n > k$) placed in $k$ boxes, then there are at least one box containing two or more objects.

### Corollary 1

A function $(f)$ from set with $k+1$ of more elements to a set of $k$ elements, not $one - to - one$.

**Proof:** We can proof this by pigeonhole principle. Suppose elements of $x$ is pigeon(Domain), $y$ elements are pigeonhole(Co-domain). Then there are at least one pigeonhole(Co-domain) that contains more than one element. That's mean, the function is not $one - to - one$.

# Generalized Pigeonhole Principle

If $N$ objects are placed into $K$ boxes, then there is at least one box that containing at least $ceil(N/K)$ elements.

# Generalized Pigeonhole Principle

If $N$ objects are placed into $K$ boxes, then there is at least one box that containing at least $ceil(N/K)$ elements.