

CS & IT ENGINEERING

DISCRETE MATHS
SET THEORY



Lecture No. 3



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TOPICS TO BE COVERED

01 Basics of Functions

02 Terms in Functions

03 Number of Functions

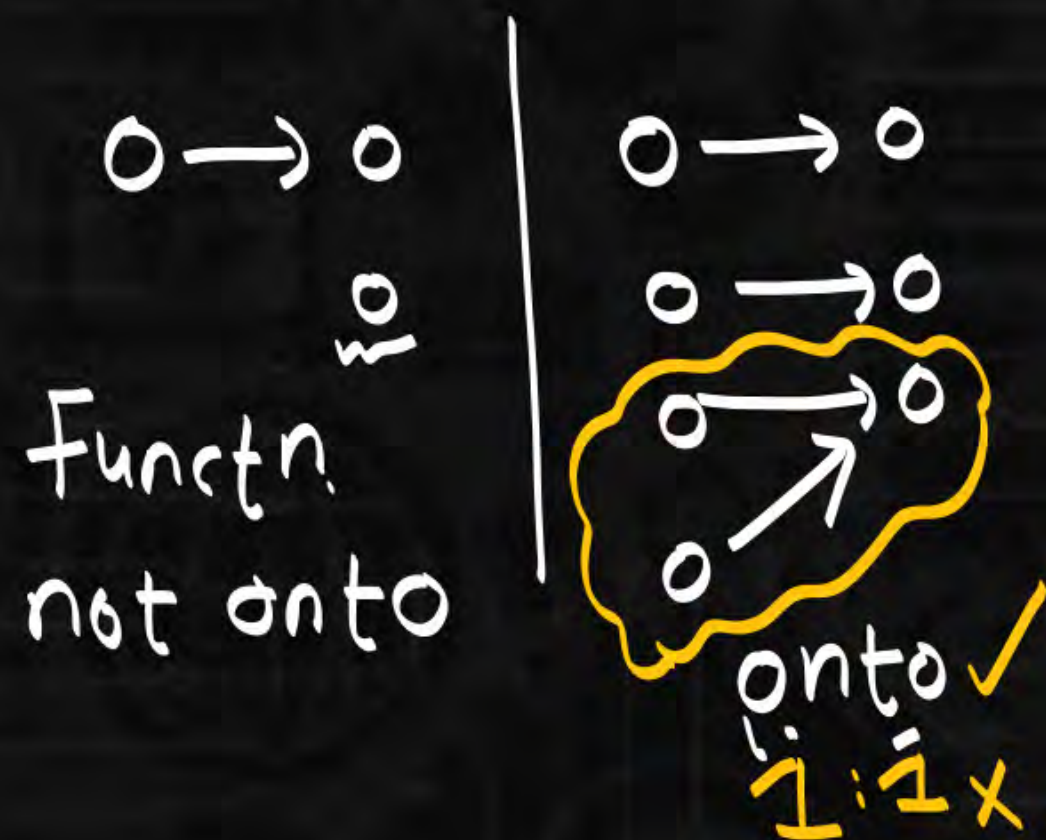
04 Types of Functions

05 Various Examples in Functions

Functions

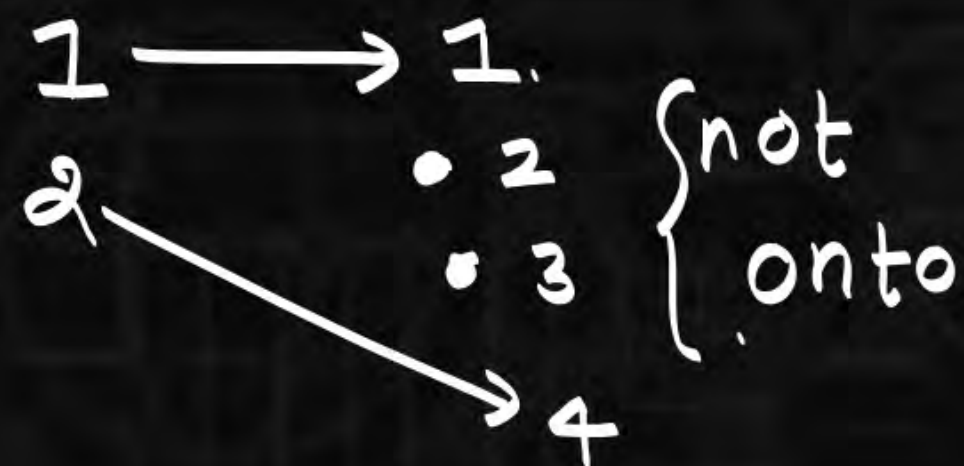
Onto (surjective)

- Range = codomain.
- Right side must be full.

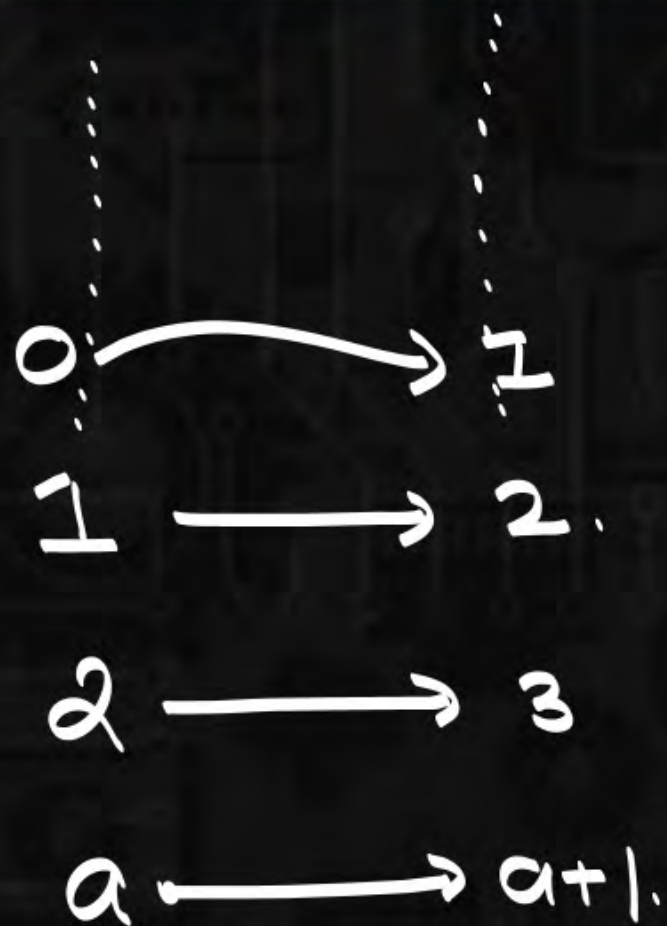


$$f(x) = x^2$$

$$f: \mathbb{Z} \rightarrow \mathbb{Z}$$



Functions



$$f(n) = n + 1$$

$$f: \mathbb{Z} \rightarrow \mathbb{Z}$$

$$w \in \mathbb{Z}$$

$$w-1 \in \mathbb{Z}$$



Functions

$(L.S < R.S) \rightarrow \text{not onto}$

○ \rightarrow ○

○ \rightarrow ○

○ \rightarrow ○

○

○

$(L.S \geq R.S) \rightarrow \text{onto} \cdot (\neg R.S \text{ must be Full})$

$f: A \rightarrow B$

$|A| = 4$ $|B| = 3$

○

○

○

○

○

○

○

onto = Total Functions
- non onto.

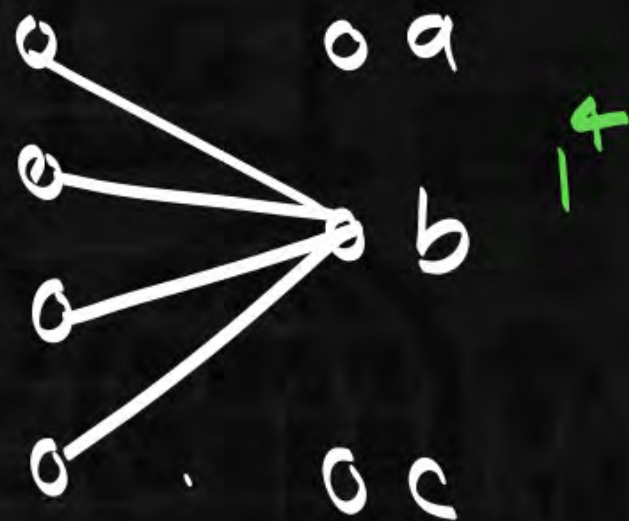
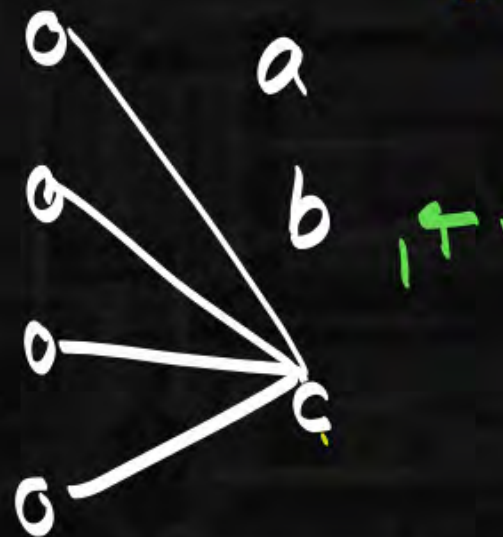
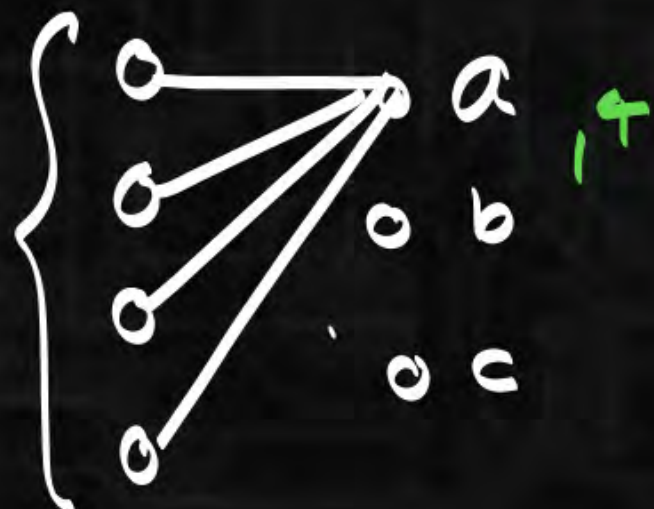
Functions

$$\underline{nC_2} = \underline{nC_{n-2}}$$

non onto:

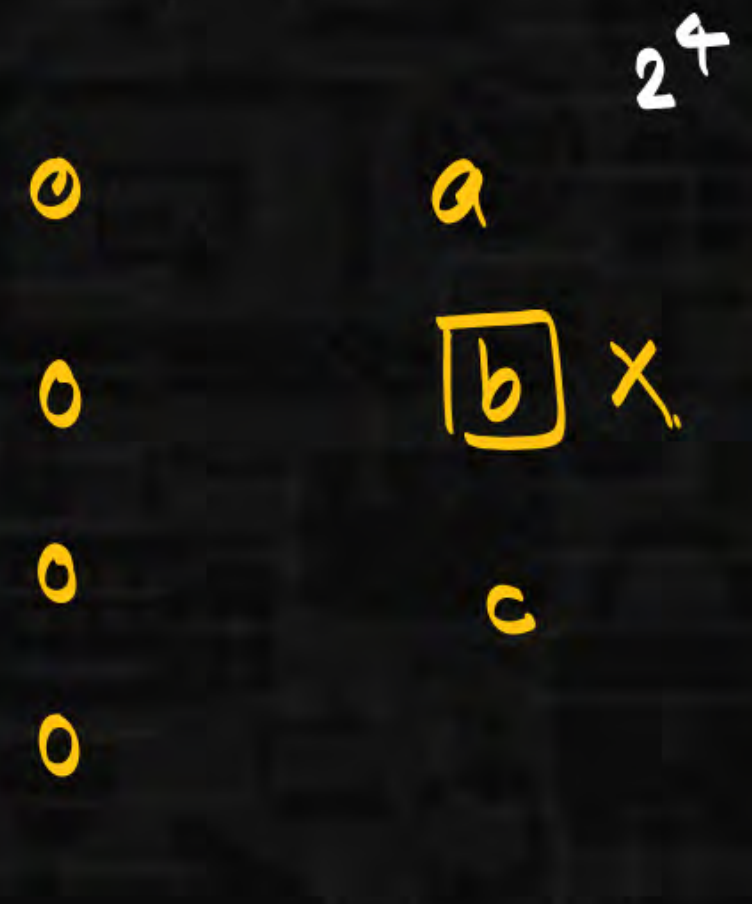
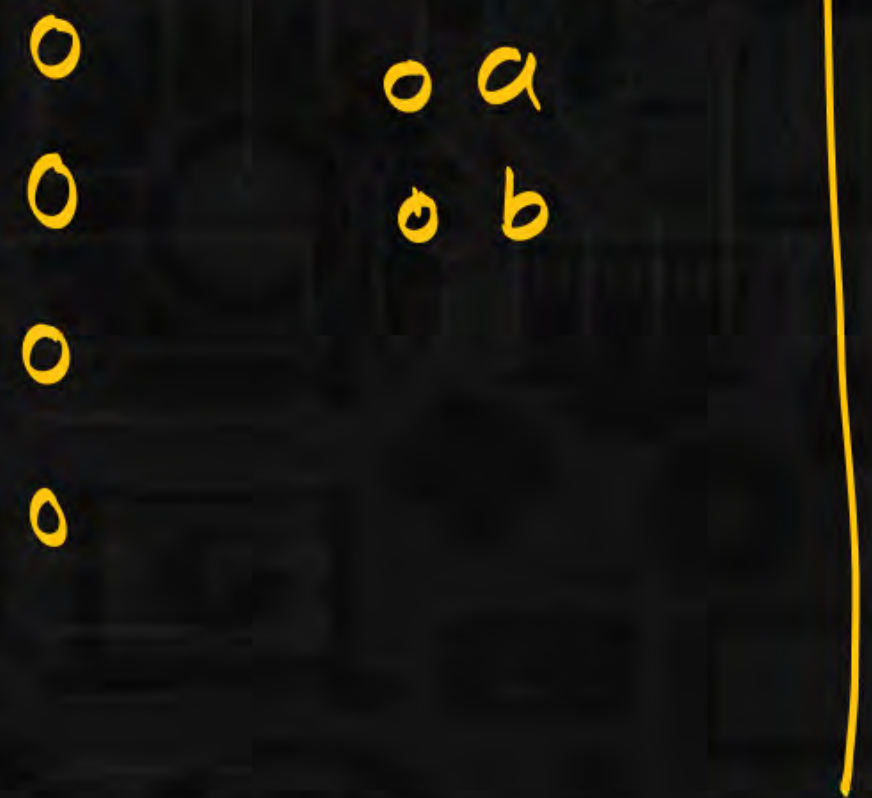
$$\underline{3C_2} = 3$$

Total ways to leave 2 elements.



Functions

non onto: 2^4



$3C_1 \rightarrow$ leaving 2 element.
 $3C_1 \times 2^4$



Functions

→ $f: A \rightarrow B$ $|A|=4$ $|B|=2$ Total Functions = $2^4 = (R.S)^{l.s.}$

non onto:

o	• a
o	• b
o	
o	c hide

Total Functions = 2^4 .

o	a
o	b hide.
o	
o	c

2^4 .

o	a hide
o	
o	b
o	
o	c

→ 2^4 .

Functions

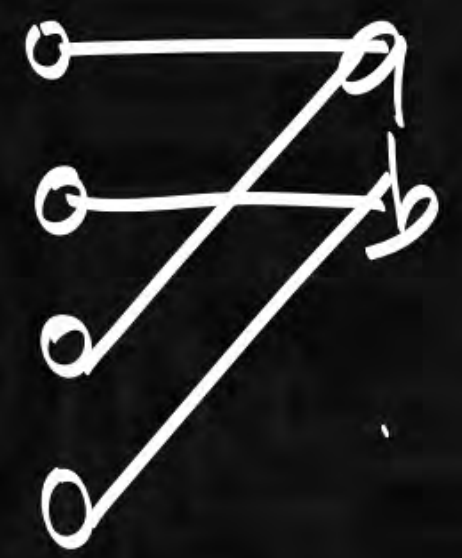
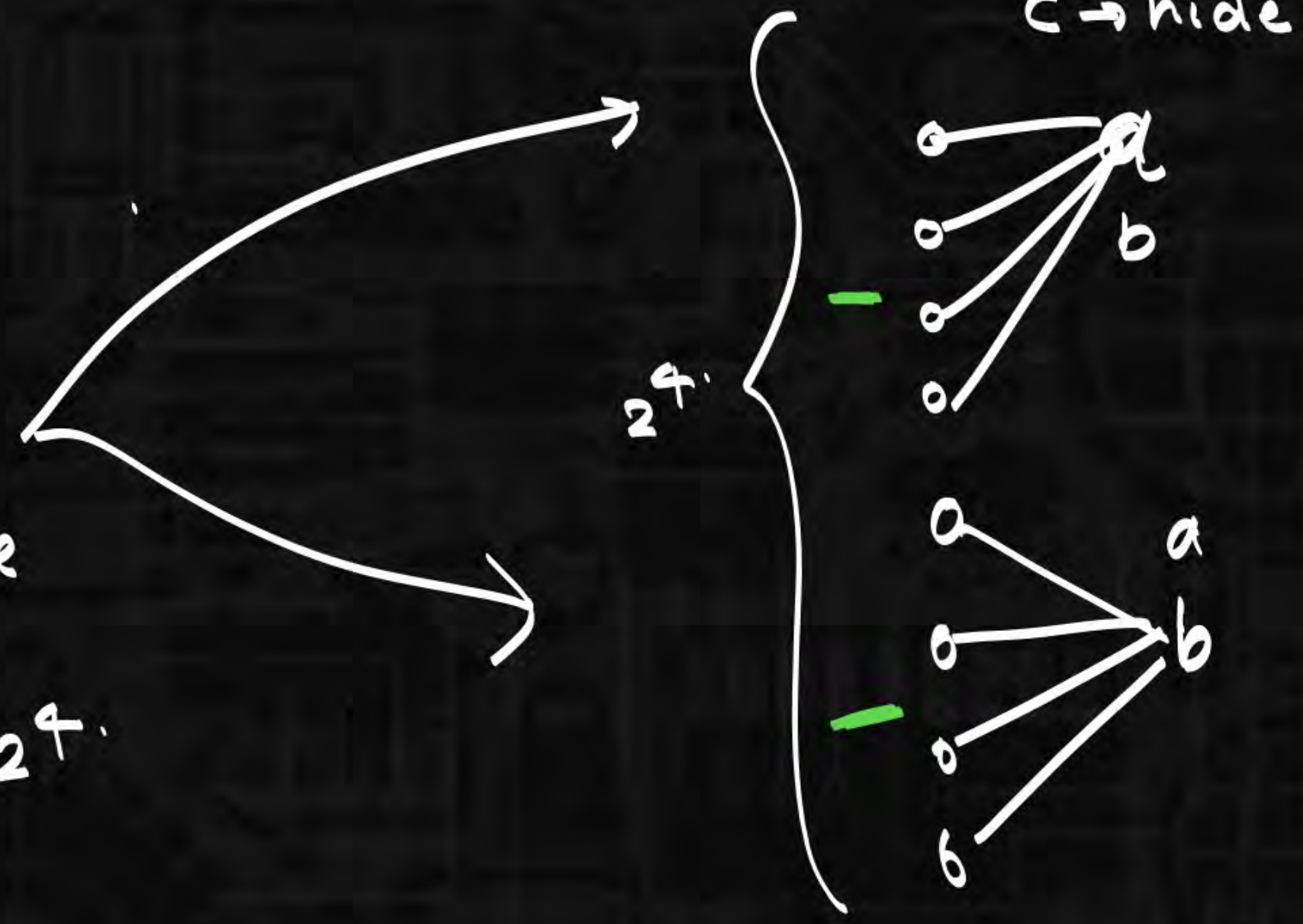
→ $f: A \rightarrow B$ $|A|=4$ $|B|=2$ Total Functions = $2^4 = (R.S)^{l.s.}$

non onto:

o • a
o • b
o
o

c hide

Total Functions = 2^4 .



Functions

$$|A| = 4 \quad |B| = 3$$

$$\text{Total onto} = \text{Total Function} - \text{Total non onto}$$

$$= 3^4 - \underbrace{3C_1}_{\text{total ways to leave 1 element}} \times 2^4 + \underbrace{3C_2}_{\text{Total ways to leave 2 elements}} \times 1^4$$



b
[c] hi
 [a] hi

hid

non onto:

o
o
o
o

a

b

c hide.



Total Function
= 2^4

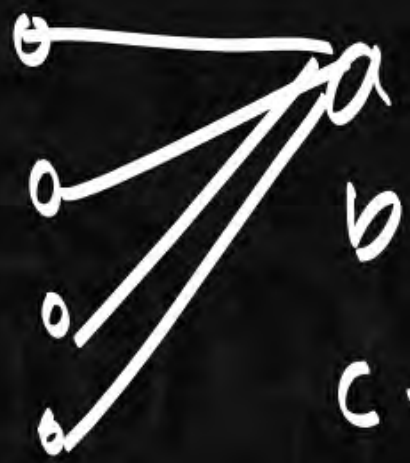
$- 2^4$

o
o
o
o

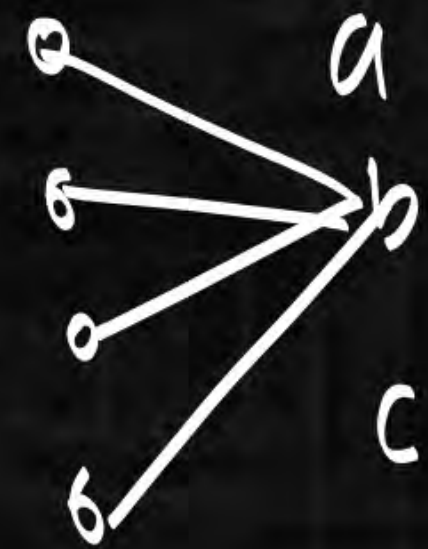
b hide

c.

a \rightarrow 2^4



c \rightarrow hide

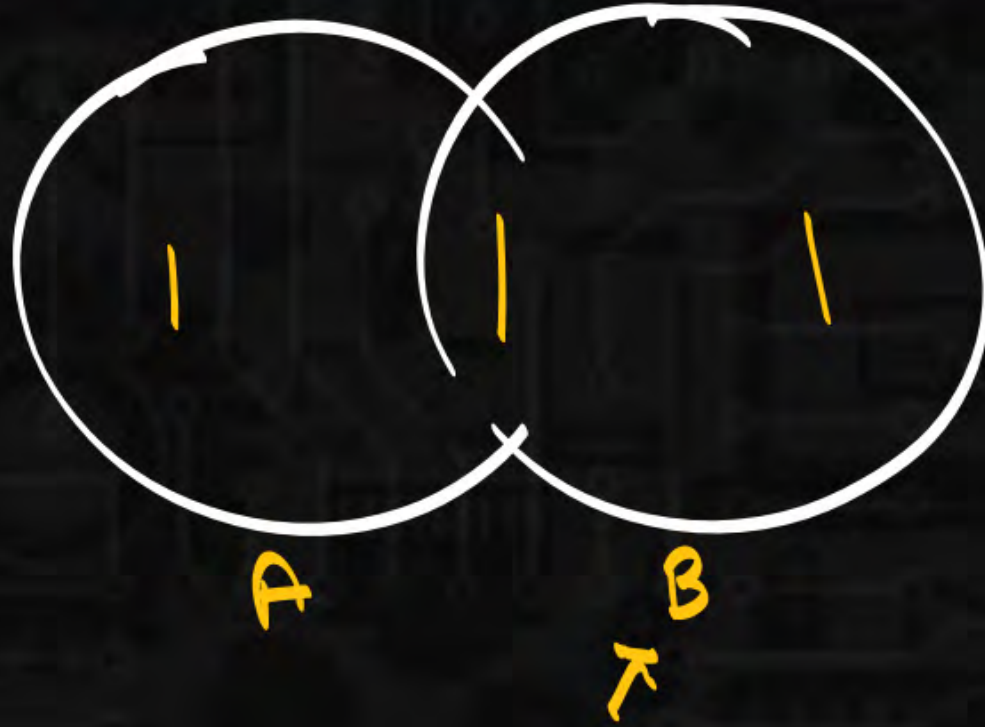


c hide



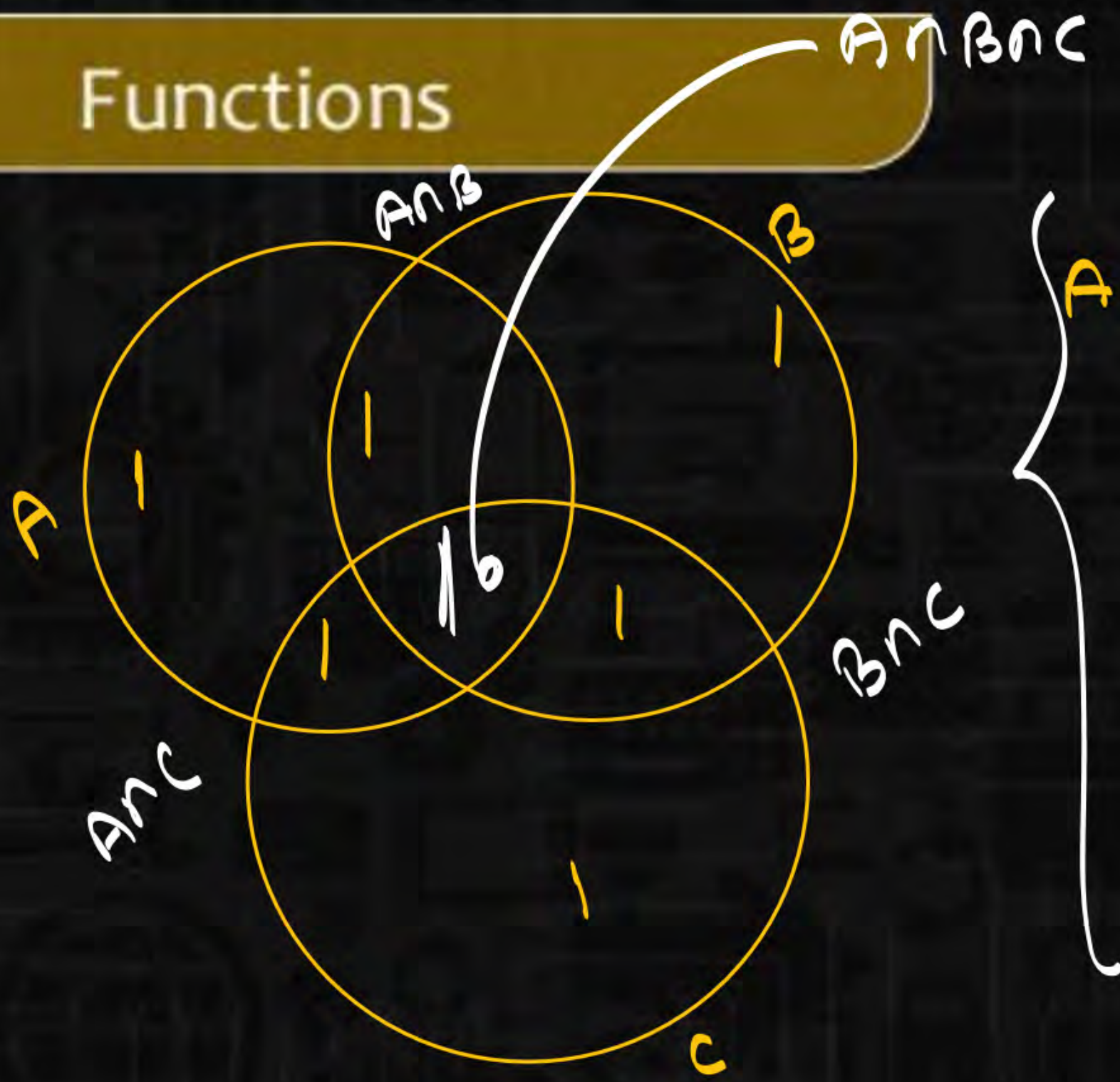
c \rightarrow hide.

Functions



$$A \cup B = A + B - A \cap B.$$

Functions



$$A + B + C - A \cap B - B \cap C - A \cap C + A \cap B \cap C.$$

Functions



$$\text{Total onto} = \text{Total Function} - \text{Total non onto}$$

$$= 3^4 - 3c_1 \cdot 2^4 + 3c_2 \cdot 1^4$$

$$= 3c_0 (3-0)^4 - 3c_1 (3-1)^4 + 3c_2 (3-2)^4$$

$$= n_{c_0} (n-0)^m - n_{c_1} (n-1)^m + n_{c_2} (n-2)^m - n_{c_3} (n-3)^m \dots$$

$$f: A \rightarrow B$$

$$\underline{|A| = m = 4}$$

$$\underline{|B| = n = 3}$$

Functions

$$= n c_0 (n-0)^3 - n c_1 (n-1)^3 + n c_2 (n-2)^3 - \dots$$

$$= \sum_{i=0}^n (-1)^i * n c_i * (n-i)^3$$

Functions

Total onto Functions: $f: A \rightarrow B$.

$$|A| = 7 \quad |B| = 4.$$

$$m = 7 \quad n = 4.$$

$$\sum_{i=0}^n (-1)^i \times nC_i (n-i)^m.$$

$$4C_0(4-0)^7 - 4C_1(4-1)^7 + 4C_2(4-2)^7 - 4C_3(4-3)^7 + \underbrace{4C_4(\underline{4-4})^7}$$

Functions



Onto \rightarrow combinatorics



7 quests 4 diff rooms

how many ways we can assign quests to Rooms
such that none of the rooms should be
empty

