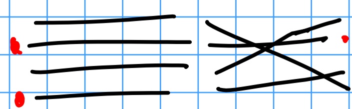
$|A| \geq |B|$ Onto = surjective = örten

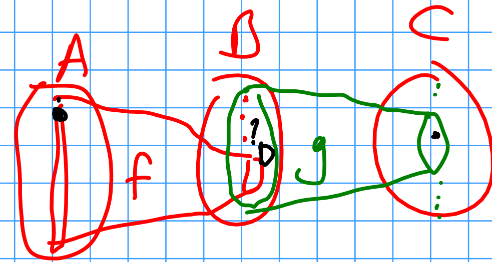
$|A| \leq |B|$ one to one = injective = birebir

bijective = birebir örten $|A| = |B|$

$f(x) = x^2 \qquad g(x) = x+3$

$\to f : ? \to ?\ B \to g : ?\ B \to ?$





$A = \{1, 2, 3\}$

$B = \{a, b\}$

	1	2	3
1	a	b	b
2	b	a	a
3	b	a	b

$g(f(x))$

$f(1,1) = a$

$f(2,1) = b$

$f(3,1) = b$..

The set of integers ($\mathbb{Z}$) is closed under addition

$f(x) = \sqrt{x} \quad f : \mathbb{C} \to \mathbb{C}$

add $f(5,2) = 7 \qquad mult(7,2) = 14$

div$(30, 17) =$ not int

$\mathbb{Z}$ is not closed under division

set under op

$f : \mathbb{Q} \setminus \{0\} \times \mathbb{Q} \setminus \{0\} \to \mathbb{Q} \setminus \{0\} \qquad f(a,b) = \frac{a}{b}$

$\mathbb{Q} \setminus \{0\}$ is closed under division

$f(7,2) = f(2,7)$

$7 \times 2 = 2 \times 7$

$f(a,b) = a - b$

$(5-3)-2 \qquad 5-(3-2)$

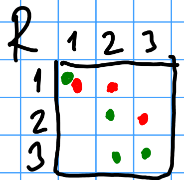
$0 \qquad 4$

$24/8/2$

$3/2$? ✗

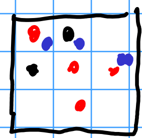
$A = \{1,2,3\}$ $\quad R: A \to A$

$R \subseteq A \times A$



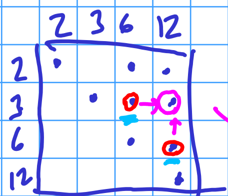
$R = \{(1,1), (1,2), (2,3)\}$ not reflexive

$R = \{(1,1), (2,2), (3,3), (3,2)\}$ is reflexive



✓ α

✓

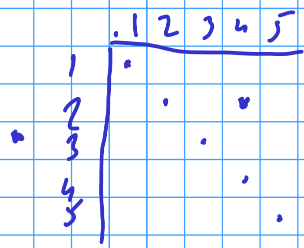


not sym.

trans.

$(2,2) \quad (2,4)$

$(a,b), (b,c) \quad (a,c)$

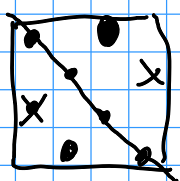


✓

$A = \{2,3,6,12\}$

$R = \{(2,2), (2,6), (2,12), (3,3), (3,6), (3,12), (6,12), (6,6)\}$

✓



"$\geq$" is an antisym. rel

$a \geq b \quad b \geq a \quad \to a = b$

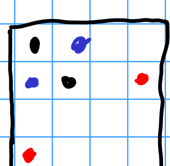
$7 \geq 5 \;.\; 5 \geq 7$

p	q
0	0
0	1
1	0
1	1

$p \to q$: 1, 1, 0, 1

a,b $\quad$ b,a

$\Rightarrow$



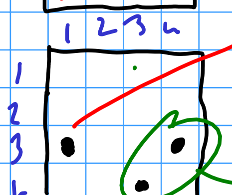
Sym ✓ & antisym ✗ at the same time ✓

✗ $\quad$ ✓

$R = \{(1,1), (2,2)\}$ ✓ ✓

$R = \{\}$

$\Rightarrow$



neither sym nor antisym.

$\Rightarrow R = \{(1,1), (4,3), (3,4)\}$

$5^{(1)} \geq 5^{(2)} \geq 2 \geq 1$

$5^{(2)} \geq 5^{(1)} \geq 2 \geq 1$

$\geq \quad \mathbb{Z}^+$

divisibility

$x \mid x$ ✓ refl.

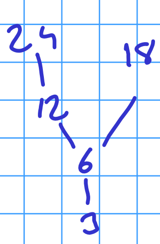
$x \mid y \wedge y \mid x \to y = x$ ant.

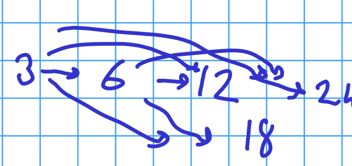
$x \mid y \wedge y \mid z \to x \mid z$ tra.

α

pos.

24 18 12 6 3





P.H.P. n: # of pigeons m: # p.holes

at least one p.h has $\left\lfloor \frac{n-1}{m} \right\rfloor + 1$ pigeons

$n = 32$ $m = 5$ $\frac{32-1}{5} + 1 = 7$ pigeons

min x

$\left\lfloor \frac{x-1}{28} \right\rfloor + 1 = 2$

$\left\lfloor \frac{82-1}{81} \right\rfloor + 1 = 2$

pigeons : people
pholes : cities

players : p.holes $22 + 6 = 28$
y. cards : pigeons.

$28 \to 29$ ✓

$\frac{24}{2} = 12$ p.h.

13.

$\left\lfloor \frac{13-1}{12} \right\rfloor + 1 = 2$

Rule of thumb keep pigeonholes exclusive. non-intersec

Pigeons : humans p.holes. cons. floors $(2n, 2n+1)$ for $n = 0, 1, \dots, 11$

$(25+1)(25+1)$

625
50
1
676

$\left(\frac{677-1}{676}\right) + 1$ ✓

pigeon: people 677
phole: initial comm. = 676