



FUNCTIONS

Relations

$$f(x) = \sqrt{x}$$

domain

co-domain

total

surject

functional

inject

2 Binary Relations

① $<$ y

\leq

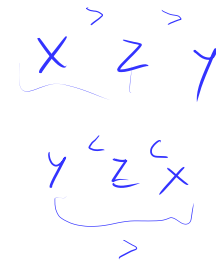
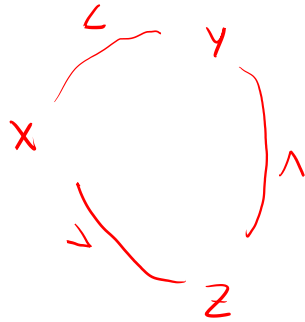
$=$

\neq

defin. predicat 2 arg

function-like 1 arg, 1 result

graph set of pairs



$(x,x) \in R$
 $R(x) = x$
 $\forall x. x R x$
 $R(x,x)$
 reflexive

$\forall x. \neg R(x,x)$
 irreflexive

Binary Relation

$\forall x,y. R(x,y) \rightarrow R(y,x)$

Transitive
 $\forall x,y,z. (R(x,y) \wedge R(y,z)) \rightarrow R(x,z)$

Symmetric
 $\forall x,y. R(x,y) \rightarrow \neg R(y,x)$
 asymmetric \subset antisymmetric
 $x \neq y \rightarrow$

every value relates to itself

| | reflexive | irreflexive | Transitive | Symmetric | antisymmetric |
|--|-----------|-------------|------------|-----------|---------------|
| < | | ✓ | ✓ | | ✓ |
| ≤ | ✓ | | ✓ | | |
| = | ✓ | | ✓ | ✓ | |
| ≠ | | ✓ | | ✓ | |
| x has y as a digit D(3,3) → D(10,10) | | | | | ✓ |
| Parent | | ✓ | | | ✓ |
| Sibling | | ✓ | ✓ | ✓ | |

Ref

irref

Trans

Symm

$\forall x, y. (x \neq y) \rightarrow (R(x, y) \rightarrow \neg R(y, x))$
antisym

Parent

Ancester

Sibling

Step-sibling

Cousin

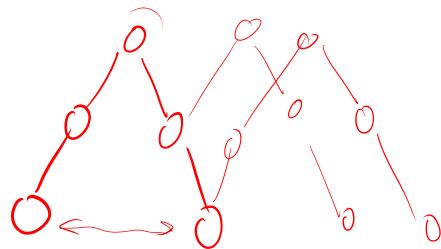
Friend

enemy

✓

✗

✓



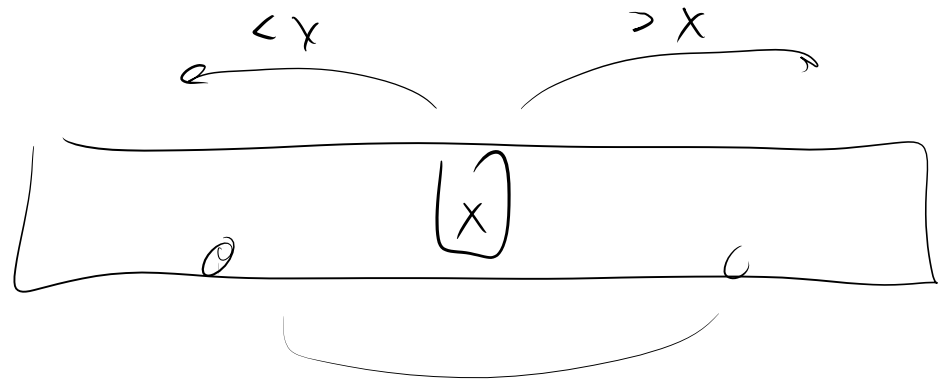
asymmetric = irreflexive \wedge antisymmetric

$$(A \rightarrow B) \wedge (B \rightarrow C)$$

$$\models A \rightarrow C$$

Transitive property
of \rightarrow

ancestor



$$1 < 2$$

$$2 < 3$$

$$1 < 3$$