$$\forall a, b.\ \mathrm{eats}(a,b) \rightarrow \mathrm{is}(a,b)$$

$\therefore$ Frogs are flies

$$\underbrace{f(x) = x+1}$$

$$\{(0,1), (1,2), (17,18), (\pi, \pi+1), \ldots\}$$

answers: what is $x+1$? $\rightarrow$ function

$\forall f \in$ functions.

$\exists r \in$ relations.

f and r have the same graph

Y/N: is $\underbrace{y} = \underbrace{x+1}$? $\rightarrow$ relation

funct $\rightarrow$ relation

$f(x)$

$y = f(x)$

$$x < y$$

$$\{(3, 111), (-11.2, 13), (0.00001, 0.0001), \dots\}$$

Predicate w/ 2 arg is called a relation

$$L(x,y) : x < y$$

default $a \in$ domain
$b \in$ codomain

graph of relation $R \equiv \{(a,b) \mid \boxed{a,b \in \_\_} \wedge R(a,b)\}$

the set of xs for which $R(x,y)$ is defined is called its Domain

the set .. y .... $R(x,y)$ ..... is called its codomain

$$S(x,y) : x > y^2$$

are neg in dom(S)? yes

are there boolean in dom(S)? no

$\underbrace{\qquad\qquad\qquad}_{\text{course}}$ is taught by $\underbrace{\qquad\qquad\qquad}_{\text{person}}$

{("2102-001", "Sullivan"), (2102-002, Tychoniewich), (2102-003, Sullivan)}

Symbols

$R(x,y)$

is a relation a function?

$\boxed{\text{only one}}$ y per x

at most

$x < y$

what is less than y?

$f(x) = \frac{1}{x}$

$f(x) = \sqrt{x}$ positive sq. root

a function is $\boxed{\text{invertable}}$ if

at most 1 y per x

at most 1 x per y

$\boxed{\text{Total}}$ = defined all of domain

partial = not total

inverse Relation

$R(x,y) : x < y$ $(2,3)$

$R^{-1}(x,y) : y < x$ $(3,2)$

graph of $R^{-1} = \{ (y,x) \mid (x,y) \in \text{graph of } R \}$

image

image of $\underset{\text{set}}{\underline{\hspace{3em}}}$ under $\underset{\text{function}}{\underline{\hspace{6em}}}$ is $\underset{\text{set}}{\underline{\hspace{4em}}}$

$\{1, 3, 7\}$ $\qquad f(x) = x + 1 \qquad$ $\{2, 4, 8\}$

image of S under f is $\{f(x) \mid x \in S\}$

Types

int
float

What is the type of sqrt

function

static function
double / float
String
array of bits

$y = sqrt(x)$

static double sqrt(double

type checker

prove types make sense

$$\text{sqrt} : \mathbb{R} \to \mathbb{R}$$

Curry - Haskell Isomorphism

$$(\mathbb{R} \times \mathbb{R}) \to \mathbb{R}$$

$$\mathbb{R} \to (\mathbb{R} \to \mathbb{R})$$