

Fb Expression

5

$3 + 7$

If True Then 5 Else 3

Function $a \rightarrow a + 2$

(Function $a \rightarrow \text{Not } a$) True

(Function $a \rightarrow \text{If } a \text{ Then } 4 \text{ Else True}$)

Function $a \rightarrow b$

Type

Int

Int

Int

Function

$\text{Int} \rightarrow \text{Int}$

Bool

$\text{Bool} \rightarrow (\text{Bool} \mid \text{Int})$

dependent
type

$a: \text{Bool} \rightarrow \frac{\text{Bool} \mid a=\text{False}}{\text{Int} \mid a=\text{True}}$

NO

Type System

logical system of rules which relate expressions to types

$\frac{\text{break}}{\tau} \quad \frac{\text{latin}}{t}$

TFb

values $v ::= \text{Nil} \mid \text{True} \mid \text{False} \mid \text{Function } x: \tau \rightarrow e$

expressions $e ::= \dots \mid \text{Let } x: \tau = e \text{ In } e$

types $\tau ::= \text{Bool} \mid \text{Int} \mid \tau \rightarrow \tau$

environments $\Gamma ::= \{x: \tau, \dots\}$

$\rightarrow$ is right-associative

$\tau_1 \rightarrow \tau_2 \rightarrow \tau_3 = \tau_1 \rightarrow (\tau_2 \rightarrow \tau_3)$

$\tau_1 \rightarrow \tau_2 \rightarrow \tau_3 \neq (\tau_1 \rightarrow \tau_2) \rightarrow \tau_3$

TFb type system defines a relation $\boxed{\Gamma} \vdash \boxed{e} : \boxed{\tau}$

TFb type system defines a relation $\Gamma \vdash e : \tau$

$$\frac{}{\Gamma \vdash \text{True} : \text{Bool}} \quad \frac{}{\Gamma \vdash \text{False} : \text{Bool}} \quad \frac{v \in \mathbb{Z}}{\Gamma \vdash v : \text{Int}}$$

$$\frac{\Gamma \vdash e : \text{Bool}}{\Gamma \vdash \text{Not } e : \text{Bool}} \quad \frac{\Gamma \vdash e_1 : \text{Int} \quad \Gamma \vdash e_2 : \text{Int}}{\Gamma \vdash e_1 + e_2 : \text{Int}}$$

$$\frac{\Gamma \vdash e_1 : \text{Bool} \quad \Gamma \vdash e_2 : \tau \quad \Gamma \vdash e_3 : \tau}{\Gamma \vdash \text{If } e_1 \text{ Then } e_2 \text{ Else } e_3 : \tau} \quad \frac{\Gamma \vdash e_1 : \tau_0 \rightarrow \tau_1 \quad \Gamma \vdash e_2 : \tau_0}{\Gamma \vdash e_1 e_2 : \tau_1}$$

$$\frac{\Gamma \{x:\tau\} \vdash e : \tau'}{\Gamma \vdash (\text{Function } x:\tau \rightarrow e) : \tau \rightarrow \tau'} \quad \frac{(x:\tau) \in \Gamma}{\Gamma \vdash x : \tau}$$

$$\frac{\Gamma \vdash e_1 : \tau \quad \Gamma \{x:\tau\} \vdash e_2 : \tau'}{\Gamma \vdash (\text{Let } x:\tau = e_1 \text{ In } e_2) : \tau'}$$

$$\Gamma ::= \{x:\tau, \dots\}$$

$$\text{Let } \overset{x}{\text{let}} \overset{\tau}{\text{Int}} = \overset{e_1}{3+1} \text{ In } \overset{e_2}{\text{let}+1}$$

$$\Gamma \{x:\tau\} = \Gamma \text{ without any prev } x \text{ mapping and with } x:\tau$$

Dynamic

		Static	
		checked ✓	unchecked X
Dynamic	checked ✓	OCaml Java	Python Javascript
	unchecked X	C++ C	assembly

