Static Type System

TFb

$\tau ::= \text{Bool} \mid \text{Int} \mid \tau \to \tau$

Approximation: a type is a set of values*

Types in grammar: ex. C++ `int x;` `int foo(int x);`

OCaml `let x : int = 42;;`

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

(most Fb exprs (not Let))

$v ::= \mathbb{Z} \mid \text{True} \mid \text{False}$
$\mid \text{Function } x : \tau \to e$

Let a : Int = 4 In
a + 2

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

gamma ↓

$\Gamma \vdash e : \tau$

Operational Semantics Relation

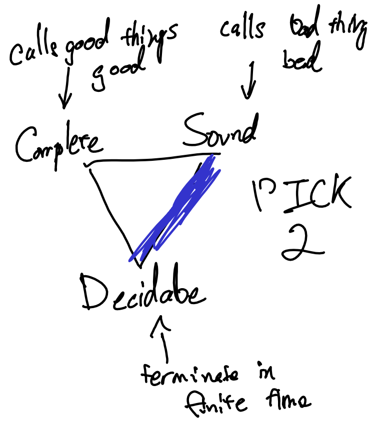
$e \Rightarrow v$

$1 + 1 \Rightarrow 2$

$1 + 3 \not\Rightarrow 5$

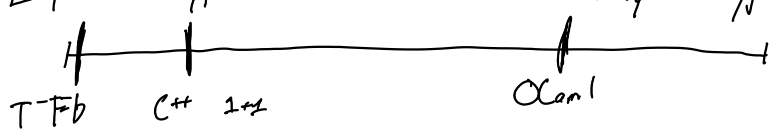
$\forall v.\ 1 + \text{True} \not\Rightarrow v$

$\langle S, e \rangle \Rightarrow \langle S, v \rangle$



Java — int+bool	—	static type system
Python, Javascript — call non-function	—	dynamic type system
C — stack overflow, array index check	—	no type system

Explicit Type-Declarations — Implicit Type Inference



$(1 : \text{Int})\ (+ : \text{Int} \to \text{Int} \to \text{Int})\ (1 : \text{Int})$

$$\frac{}{\Gamma \vdash \text{True} : \text{Bool}} \qquad \frac{}{\Gamma \vdash \text{False} : \text{Bool}} \qquad \text{Int}\ \frac{}{\Gamma \vdash \mathbb{Z} : \text{Int}} \qquad \Gamma \cup \{x : \tau\}$$

$$\text{Plus}\ \frac{\Gamma \vdash e_1 : \text{Int} \quad \Gamma \vdash e_2 : \text{Int}}{\Gamma \vdash e_1 + e_2 : \text{Int}} \qquad \text{And}\ \frac{\Gamma \vdash e_1 : \text{Bool} \quad \Gamma \vdash e_2 : \text{Bool}}{\Gamma \vdash e_1 \text{ And } e_2 : \text{Bool}} \qquad \text{Let}\ \frac{\Gamma \vdash e_1 : \tau \quad \Gamma, x : \tau \vdash e_2 : \tau'}{\Gamma \vdash \text{Let } x : \tau = e_1 \text{ In } e_2 : \tau'}$$

$$\text{Let}\ \frac{\text{Int}\ \frac{}{\emptyset \vdash 4 : \text{Int}} \quad \text{Plus}\ \frac{\text{Var}\ \frac{}{\{a : \text{Int}\} \vdash a : \text{Int}} \quad \text{Int}\ \frac{}{\{a : \text{Int}\} \vdash 2 : \text{Int}}}{\{a : \text{Int}\} \vdash a + 2 : \text{Int}}}{\emptyset \vdash \text{Let } a : \text{Int} = 4 \text{ In } a + 2 : \text{Int}}$$

$$\text{Var}\ \frac{(x : \tau) \in \Gamma}{\Gamma \vdash x : \tau}$$

$$\text{Fun}\ \frac{\Gamma, x : \tau \vdash e : \tau'}{\Gamma \vdash \text{Function } x : \tau \to e : \tau \to \tau'}$$

$$\text{Appl}\ \frac{\Gamma \vdash e_1 : \tau \to \tau' \quad \Gamma \vdash e_2 : \tau}{\Gamma \vdash e_1\ e_2 : \tau'}$$