

Tipos

Manejo de memoria: ¿Que número de bits necesito para almacenar la información?

Número --> 32 bits (integer)

--> 64 bits (long)

--> 128 bits (long long)

Double --> 32 bits (float)

--> 64 (double)

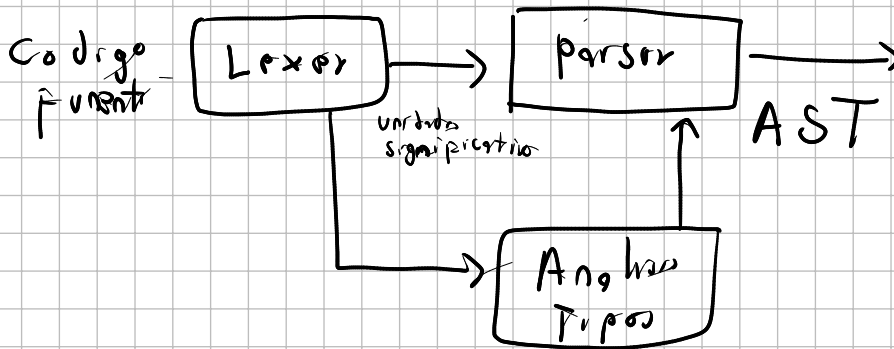
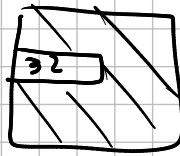
--> 128 (double de doble precisión)

}
Figura

Tipado + Compilado: más rápido { C++
Java

var a = 8;
a = "HolaF"
↓
8

} 32 bits
40 bits



Reglas Tipos

primitivo { + int * int → int and bool * bool → bool
> int * int → bool

condicion { if <test-exp>
then <true-exp>
false <false-exp>

<test-exp> := bool
<true-exp> = <false-exp>

$$\text{proc} \left\{ \begin{array}{l} t_1 * t_2 * t_3 * \dots * t_n \rightarrow t \\ \text{proc}(\underbrace{\hspace{2cm}}_{n \text{ variables}}) \end{array} \right.$$

$$\text{app-exp} \left\{ \begin{array}{l} (F \overbrace{t_1' t_2'}) \\ t_F = t_1 * t_2 * t_3 * \dots * t_n \rightarrow t \\ \underline{t_1 = t_1' \quad t_2 = t_2' \quad t_n = t_n'} \\ t \end{array} \right.$$

$$\text{let} \left\{ \begin{array}{l} f = \text{proc}(\text{int } n, \text{int } m) \\ \quad \text{if } >(n, m) \\ \quad \text{then } t(n, m) \\ \quad \text{else } -(n, m) \end{array} \right. \\ \text{in } (f \ 2 \ 3)$$

$$\begin{array}{l} t_F = \text{int} * \text{int} \rightarrow \text{int} \\ \downarrow \\ (f \ 2 \ 3) \\ \downarrow \quad \downarrow \\ t_F = \text{int} * \text{int} \rightarrow \text{int} \\ \uparrow \quad \uparrow \\ \textcircled{2 = \text{int}} \quad \textcircled{3 = \text{int}} \\ \hline \text{int} \end{array}$$

$$\text{basics} \left\{ \begin{array}{l} \langle \text{int} \rangle = \text{int} \\ \langle \text{bool} \rangle = \text{bool} \end{array} \right.$$

$$\text{let} \left\{ \begin{array}{l} \text{let} \\ \text{in } \textcircled{\langle \text{exp} \rangle} \end{array} \right. \quad T_{\text{exp}}$$

let
 $f = \text{proc}(x, y)$
 if $x > y$
 then x else y
in
 $(f \ 2 \ 3)$

Inferencia de tipos

Chequeo de tipos

let
 $f = \text{proc}(\text{int } x, \text{int } y)$
 if $x > y$
 then x else y
in $(f \ 2 \ 3)$

$f = \text{proc}(\text{? } x, \text{int } y)$

in

$(f \ 2 \ 3)$

retor

args

$[\text{int}, \text{int}]$

$\text{int} \times \text{int} \rightarrow \text{int}$

1. Realice chequeo de tipos en la siguiente expresión:

```
let
  j = proc(int x, (int->bool) y)
    if (y 2) then +(x,2) else -(x,3)
  t = proc((int*int->bool) k, int a, int b, int c)
    (k + (a,b) c)
  s = proc(int w) >(w,6)
in
  let
    p = proc((int->(bool->int))*int*int->int) m, int->(bool->int) n)
      (m n 1 3 s)
  in
    (p t j)
```

$t_j = \text{int} * (\text{int} \rightarrow \text{bool}) \rightarrow \text{int}$

$t_t = (\text{int} * \text{int} \rightarrow \text{bool}) * \text{int} * \text{int} * \text{int} \rightarrow \text{bool}$

$t_s = \text{int} \rightarrow \text{bool}$

$t_p = \text{int} \rightarrow (\text{bool} \rightarrow \text{int}) * \text{int} * \text{int} \rightarrow \text{int}$

$* \text{int} \rightarrow (\text{bool} \rightarrow \text{int}) \rightarrow \text{int}$

Verifique esta expresión, si hay errores de tipo indique cuales son.

2. Escriba expresiones de tipo que cumplan:

- $(\text{int} * (\text{int} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{int} \rightarrow \text{bool})$
- $(\text{int} * \text{bool} * (\text{int} \rightarrow \text{int}) * \text{int} \rightarrow (\text{bool} \rightarrow \text{int})) \rightarrow (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))$
- $(\text{int} * (\text{bool} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{bool} \rightarrow \text{int})$

t_p
 t_t

$\text{int} * \text{int} \rightarrow \text{bool}$
 $\text{int} \rightarrow (\text{bool} \rightarrow \text{int})$

2. Escriba expresiones de tipo que cumplan:

- $(\text{int} * (\text{int} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int})) \rightarrow (\text{int} \rightarrow \text{bool}))$
- ■ $(\text{int} * \text{bool} * (\text{int} \rightarrow \text{int}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))$
- $(\text{int} * (\text{bool} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{bool} \rightarrow \text{int})$

let
 f = proc (int x
 (int → bool) y,
 (int → (bool → int) z)
 if (y x)
 then proc (int m)
 > (x, m)
 else proc (int n)
 > ((z n) true), n)
 in f

$\underbrace{\text{bool} \rightarrow \text{int}}_{\text{int}}$

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- ■ $(\text{int} * \text{bool} * (\text{int} \rightarrow \text{int}) * \text{int} \rightarrow (\text{bool} \rightarrow \text{int})) \rightarrow (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))$
- $(\text{int} * (\text{bool} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{bool} \rightarrow \text{int})$

let
 f = proc (int x, bool y, (int → int) z, (int → (bool → int)) w)
 if and(y, >(x, (z 10)))
 then w
 else
 proc (int a)
 proc (bool b)
 ((w x) y)
 in f

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- $(\text{int} * \text{bool} * (\text{int} \rightarrow \text{int}) * \text{int} \rightarrow (\text{bool} \rightarrow \text{int})) \rightarrow (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))$
- $(\text{int} * (\text{bool} \rightarrow \text{bool}) * (\text{int} \rightarrow (\text{bool} \rightarrow \text{int}))) \rightarrow (\text{bool} \rightarrow \text{int})$

let

```
f = proc(int x, (bool->bool) y, (int->(bool->int)) z)
  proc (bool a)
    if (y true)
    then ((z x) true)
    else ((z +(x,2)) false)
```

in f

(30 puntos) Indique expresiones dentro del lenguaje visto en el curso que sean de tipo

- $(\text{int} * (\text{int} \rightarrow \text{bool})) \rightarrow (\text{int} \rightarrow \text{int})$
- $(\text{int} * \text{int}) \rightarrow ((\text{int} \rightarrow \text{bool}) \rightarrow \text{int})$

a)

let

```
f = proc(int x, (int->bool) y)
  proc (int b)
    if (y x) then x else *(x,2)
in f
```

b)

let

```
f = proc(int x, int y)
  proc (int->bool) a)
    if (a x)
    then x
    else y
```

in f

En un ambiente de tipos inicial $\text{env}_0 = [j \rightarrow \text{int}, m \rightarrow \text{bool}]$.

```
let fun1 = proc (int * (int → bool) → (int → bool) g,
  bool t, bool s, int x, int → bool h)
  if and(t, s) then (g x h)
  else (g * (x, 2) h)
fun3 = proc (int w)
  proc (int a)
    > (w, a)
in
let fun2 = proc (int x, int → bool q)
  if > (x, 3) then proc (int z)
    (q z)
  else (fun3 x)
fun4 = proc (int k)
  < (+ (k, 5), 9)
in
(fun1 fun2 m true j fun4)
```

$T_{F_1} = ((\text{int} * (\text{int} \rightarrow \text{bool}) \rightarrow (\text{int} \rightarrow \text{bool}))$
 $* \text{bool} * \text{bool} * \text{int} * (\text{int} \rightarrow \text{bool}))$
 $\rightarrow (\text{int} \rightarrow \text{bool})$

$T_{F_3} = (\text{int} \rightarrow (\text{int} \rightarrow \text{bool}))$

$T_{F_2} = (\text{int} * (\text{int} \rightarrow \text{bool})$
 $\rightarrow (\text{int} \rightarrow \text{bool}))$

$T_{F_4} = (\text{int} \rightarrow \text{bool})$

$T_{F_4} =$

if <test-exp>
then <true-exp>
else <false-exp>

<test-exp> = (bool)
<true-exp>
= <false-exp>

cond
([<test-exp> <answer-exp>]*)
else
 <else-exp>

(cond
 [>(x, 3) 10]
 [<(x, 5) 20]
 [>(y, 10) 10]
 else 5)

bool

int f(—)