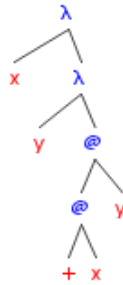


Linguagens de Programação

Inferência de Tipos

– Soluções –

1. (a) `fun f1 x y = x + y;`
`f1 : int → int → int`



- (b) `fun f2 x y = f1 x y;`
`f2 : int → int → int`



- (c) `fun f3 x = f1 x;`
`f3 : int → int → int`
- (d) `fun id x = x;`
`id : 'a → 'a`
- (e) `fun apply (f, x) = f x;`
`apply : ('a → 'b) * 'a → 'b`
- (f) `fun applyc f x = f x;`
`applyc : ('a → 'b) → 'a → 'b`



(g) `id applyc;`
`id applyc : ('a \rightarrow 'b) \rightarrow 'a \rightarrow 'b`



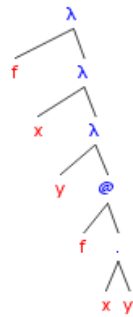
(h) `applyc id;`
`applyc id : 'a \rightarrow 'a`



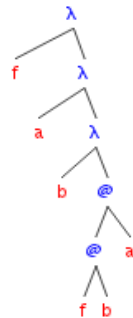
- (i) `apply (f1, 5);`
`apply (f1, 5) : int → int`



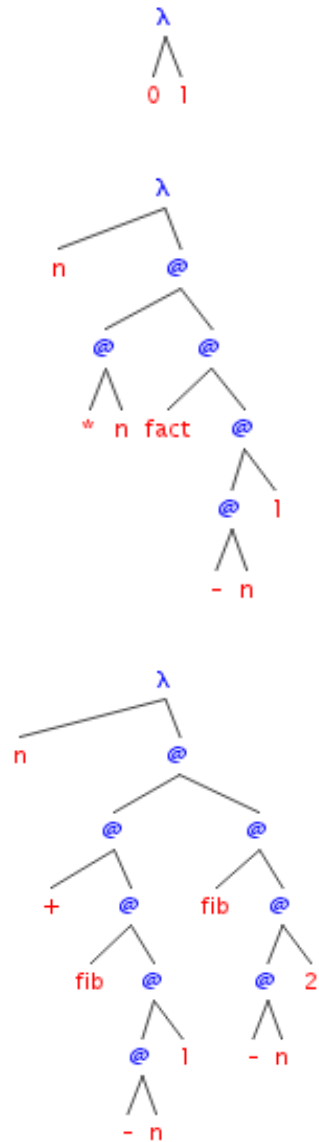
- (j) `fun curry f x y = f (x, y);`
`curry : ('a * 'b → 'c) → 'a → 'b → 'c`



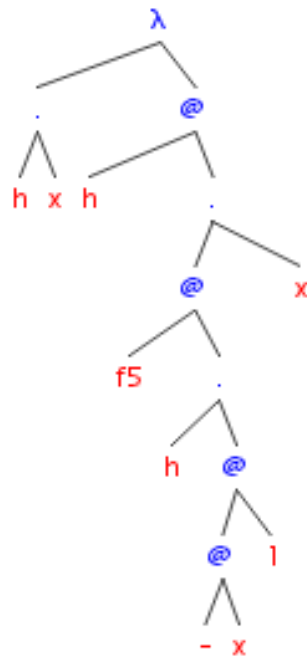
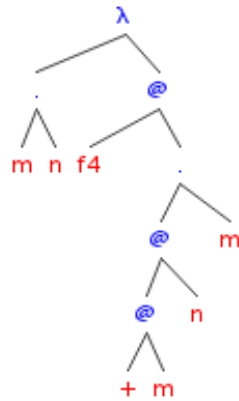
- (k) `fun flip f a b = f b a;`
`flip : ('a → 'b → 'c) → 'b → 'a → 'c`



- (l) `fun fact 0 = 1`
`| fact n = n * fact (n - 1);`
`fact : int → int`
- (m) `fun fib n = fib (n - 1) + fib (n - 2);`
`fib : int → int`
- (n) `fun f4 (m, n) = f4 (m + n, m);`
`f4 : int * int → 'a`

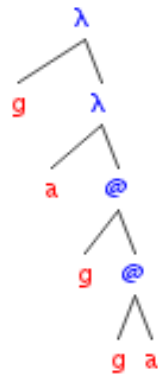
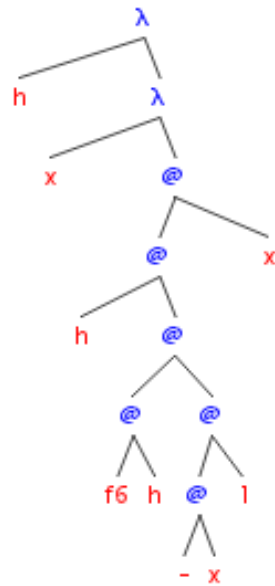


- (o) `fun f5 (h,x) = h (f5 (h, x - 1), x);`
`f5 : ('a * int → 'a) * int → 'a`
- (p) `fun f6 h x = h (f6 h (x - 1)) x;`
`f6 : ('a → int → 'a) → int → 'a`
- (q) `fun f7 g a = g (g a);`
`f7 : ('a → 'a) → 'a → 'a`
- (r) `fun e1 f = f (e1 0);`
erro de tipos!!!
- (s) `fun e2 f = f f + 2;`

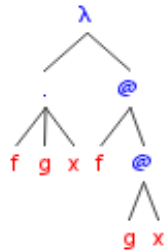


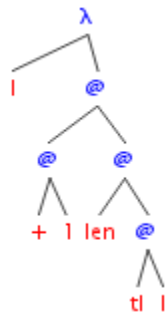
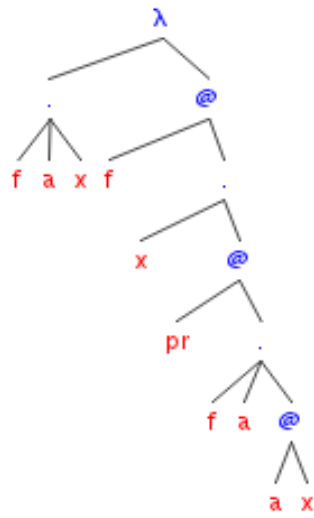
erro de tipos!!!

- (t) `fun o f g x = f (g x);`
`o : ('a → 'b) → ('c → 'a) → 'c → 'b`
- (u) `fun ou (f, g, x) = f (g x);`
`ou : ('a → 'b) * ('c → 'a) * 'c → 'b`
- (v) `fun pr (f, a, x) = f (x, pr (f, a, a x));`
`pr : ('a * 'b → 'b) * ('a → 'a) * 'a → 'b`
- (w) `fun len l = if l = [] then 0 else 1 + len (tl l);`
`len : 'a list → int`



(x) `fun ape l m = if l = [] then m else ape (tl l) m;`
 Como $\text{ape} : 'a \text{ list} \rightarrow 'b \rightarrow 'b$
 e $\text{ape} : 'a \text{ list} \rightarrow 'b \rightarrow 'c$
 Temos que $\text{ape} : 'a \text{ list} \rightarrow 'b \rightarrow 'b$



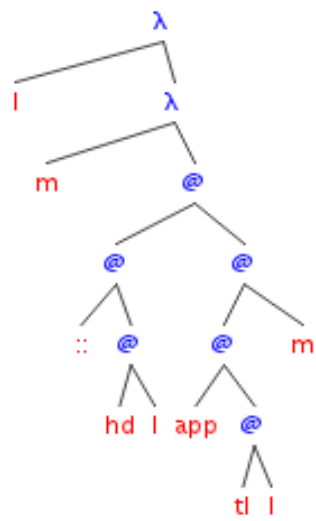
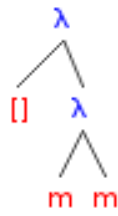
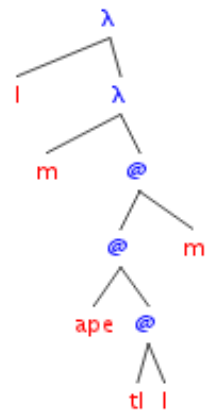


Teremos então $(\lambda f.f \ 4 \ 5)(\lambda x.\lambda y.(\lambda g.g \ (x-1))(\lambda x.3*x+y))$

(b) $3 * (4 - 1) + 5 = 3 * 3 + 5 = 14$

(c) $f : int \rightarrow int \rightarrow int$

3. (a) Árvore Sintáctica:



(b) $f: ('a * 'b \rightarrow 'b) * 'a \rightarrow 'b$

