

Linguagens de Programação 2016/2017

Cálculo Lambda

– Soluções –

1. (a) 4 variáveis: x ligadora, y ligadora, x ligada, y ligada, x ligadora, x ligada, y livre
(b) $(\lambda a.\lambda b.a\ b)(\lambda c.c\ y)$
(c) $\lambda b.b\ y$
2. (a) i. 5 variáveis: x ligadora, y ligadora, y ligada, x ligada, y livre, x ligadora, x ligadora, x ligada, x ligada (-1)
ii. $(\lambda a.\lambda b.b\ (b\ a))\ y\ (\lambda c.(\lambda d.d)\ c)$
iii. y
(b) i. 3 variáveis: a ligadora, a ligada, a ligada, a ligadora, b ligadora, a ligada, b ligada
ii. $\lambda c.\lambda e.c\ e$
3. (a) $(\lambda f.f\ (f\ 1))\ (\lambda x.x * 2 + 1)$
(b) $(1 * 2 + 1) * 2 + 1$
4. (a) $(\lambda f.(\lambda g.f\ 2 + g\ 2)(\lambda x.f\ x + f\ x))$
(b) $(2 * 2) + ((2 * 2) + (2 * 2))$
5. (a) $(\lambda f.(\lambda g.f\ (3 + g\ 2))(\lambda x.f\ x + f\ x))(\lambda x.x * x)$
(b) $(3 + ((2 * 2) + (2 * 2))) * (3 + ((2 * 2) + (2 * 2)))$
6. (a) $(\lambda f.(\lambda g.g\ (f\ 2))(\lambda x.f\ x + f\ x))(\lambda x.x * x)$
(b) $((2 * 2) * (2 * 2)) + ((2 * 2) * (2 * 2))$
7. (a) $(\lambda f.(\lambda g.f\ (g\ 5))(\lambda x.f\ x))(\lambda y.y * y)$
(b) $((5 * 5) * (5 * 5)) = 25 * 25$
8. (a) $(\lambda f.(\lambda g.(\lambda h.h\ 3)(g\ f))(\lambda f.\lambda x.f\ x + 1))(\lambda x.x + x)$
(b) $((3 + 3) + 1)$
9. (a) $(\lambda c.(\lambda h.c\ h\ h\ y)(\lambda x.x + 1))(\lambda f.\lambda g.\lambda x.f\ (g\ x))$
(b) $(y + 1) + 1$