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#CMPT 340

ASSIGNMENT 1

(a) $\lambda x.\lambda y.(y\ x)\ \lambda y.\lambda x.(x\ y)\ \lambda x.\lambda y.(x\ y)$

Solution

$\lambda x.\lambda y.(y\ x)\ \lambda y.\lambda x.(x\ y)\ \lambda x.\lambda y.(x\ y)$
would evaluate the outermost application (using lazy evaluation)

$\Rightarrow \lambda y.(y\ \lambda y.\lambda x(x\ y))\ \lambda x.\lambda y.(x\ y)$

$\Rightarrow \lambda x.\lambda y(\cancel{x}\ y)\ \lambda y.\lambda x(x\ y)$

$\Rightarrow \lambda y(\lambda y.\lambda x(x\ y)\ y)$

$\Rightarrow \lambda x.\lambda y.(x\ y)$

So using Lazy evaluation: $\lambda x.\lambda y.(y\ x)\ \lambda y.\lambda x.(x\ y) \Rightarrow \underline{\lambda x.\lambda y.(x\ y)}$

(b) $\lambda z.(z\ z)\ \lambda x.(x\ x)$
would start here by evaluating the outermost application lazy evaluation

$\lambda z.(z\ z) \Rightarrow \lambda x.(x\ x)\ \cancel{\lambda x}(x\ x)$

it applies to itself; this applies the function input to itself and then it creates a fixed point & return a value

$\lambda z.(z\ z)\ \lambda x(x\ x)$

$\Downarrow$

$\Rightarrow \underline{\lambda x(x\ x)\ \lambda x(x\ x)}$

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(2.) Using the definitions of boolean constants and operators presented in class:-

and true(or false(not true))

Soln

and true(or false(not true))

true ⇒ λx.λy(x)

false ⇒ λx.λy.(y)

not ⇒ λv.λw.λx(v x w)

or ⇒ λv.λw(v v w)

and ⇒ λv.λw(v w v)

⇒ λv.λw(v w v) true(or false(not true))

⇒ λw(true w true)(or false(not true))

⇒ true(or false(not true)) true

⇒ λx.λy(x)(or false(not true)) true

⇒ or false(not true)

⇒ λv.λw(v v w) false(not true)

⇒ λw(false false w)(not true)

⇒ false false(not true)

⇒ λx.λy(y) false (not true)

⇒ (not true)

⇒ λv.λw.λx(v x w) true

⇒ λw.λx(true x w)

⇒ λw.λx(λx.λy.(x) x w)

⇒ λw.λx.(x)

⇒ λw.λx.(x)

⇒ **false**

(3) ite function using lambda expression

(a) the ite function would take three arguments as follows:-
(i) an expression to evaluate if the boolean is true
(ii) a boolean
(iii) Second expression to evaluate if the boolean is false

$\Rightarrow$ to evaluate if the boolean is true:
$\lambda x.\lambda y.(x)\ w\ a$
$\lambda y\,(w)\ a$

$\Rightarrow$ Evaluate if the boolean is false:-
$\Rightarrow \lambda x.\lambda y\,(y)\ w\ a$
$\lambda y\,(a)\ w$

$\Rightarrow$ the ite $\Rightarrow \lambda x.\lambda y.\lambda z.(x\ y\ z)$

$\Rightarrow \lambda x.\lambda y.\lambda z.(x\ y\ z)$

(3b) Write the lambda expression for a function iteite that takes five arguments:

$\Rightarrow \lambda x.\lambda y.\lambda z.\lambda v.\lambda w\,(x\ y\,(z\ v\ w)$ are iteite

here both v and x are booleans and y, z, w are expressions so when v is true then the expression w will run but if v is false then it will go into the function for the number a for number 3 $\Rightarrow$ (3a) then it will check if x is true and then the expression y will run otherwise vice versa

$\Rightarrow \lambda x.\lambda y.\lambda z.\lambda v.\lambda w\,(x.y\,(z\ v\ w))$

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④ Fibonacci series contain numbers 0, 1, 1, 2, 3, 5 .....

$fib(1) = 0$

$fib(2) = 1$

$fib(n) = fib(n-1) + fib(n-2)$

$Y \lambda f. \lambda n (\text{if then else} (ife) (n < 3) (n-1) (f(n-1) + f(n-2)))$

⑤ Consider a function compose4, which takes three function $f(x), g(x), h(x), i(x)$

compose4 in lambda $\Longrightarrow \lambda f. \lambda g. \lambda h. \lambda i. \lambda x (f(g(h(i(x)))))$

here the result of $i(x)$ would be used as an argument to h and $h(x)$ would be used as an argument to g and $g(h(i(x)))$ would be used as an an argument to f

$g(h(i(x)))$ would be used as an argument to f.