

## Homework 2

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### problem 1

$$\begin{aligned} & (\lambda p. \lambda q. \lambda r. p \ q \ r)(\lambda p. \lambda q. p \ q \ r) \\ \rightarrow & (\lambda s. \lambda t. \lambda u. s \ t \ u)(\lambda p. \lambda q. p \ q \ r) \\ \rightarrow & \lambda t. \lambda u. (\lambda p. \lambda q. p \ q \ r) t \ u \\ \rightarrow & \lambda t. \lambda u. (\lambda q. t \ q \ r) u \\ \rightarrow & \lambda t. \lambda u. t \ u \ r \\ \rightarrow & r \end{aligned}$$

*If we don't rename bound variables, free variable  $r$  be bound. So rename bound variables so that all bound variables are different from each other and different from all of the free variables.*

### problem 5

(a)

$$< x + y, \sigma > \rightarrow < 2 + y, \sigma > \rightarrow < 2 + 3, \sigma > \rightarrow < 5, \sigma >$$

(b)

$$< x = x + 3, \sigma > \rightarrow < x = 1 + 3, \sigma > \rightarrow < x = 4, \sigma > \rightarrow < 4, Put(\sigma, x, 4) >$$

(c)

$$< (x = 3) + x, \sigma > \rightarrow < 3 + x, Put(\sigma, x, 3) > \rightarrow < 3 + 3, \sigma' > \rightarrow < 6, \sigma' >$$

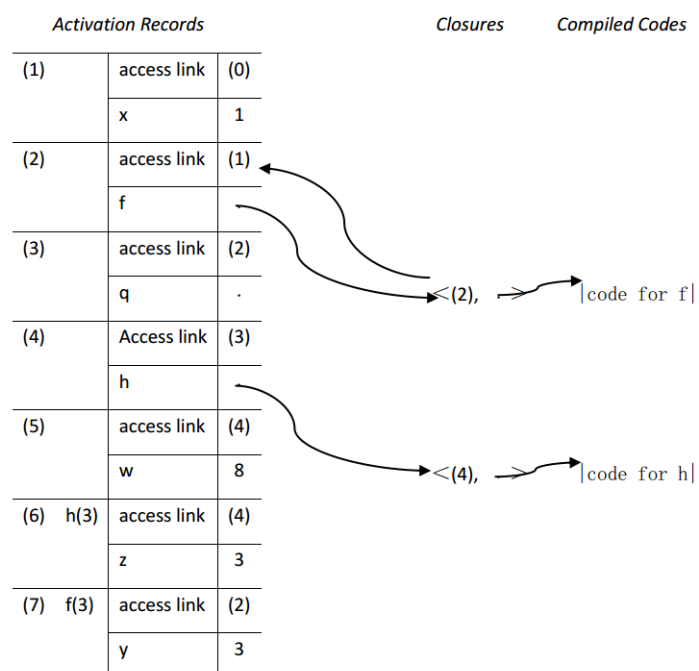
(d)

$$\begin{aligned}
& \langle x = (x = x + 3) + (x = x + 5), \sigma \rangle \\
& \rightarrow \langle x = (x = 1 + 3) + (x = x + 5), \sigma \rangle \\
& \rightarrow \langle x = (x = 4) + (x = x + 5), \sigma \rangle \\
& \rightarrow \langle x = 4 + (x = x + 5), Put(\sigma, x, 4) \rangle \\
& \rightarrow \langle x = 4 + (x = 4 + 5), \sigma' \rangle \\
& \rightarrow \langle x = 4 + (x = 9), \sigma' \rangle \\
& \rightarrow \langle x = 4 + 9, Put(\sigma', x, 9) \rangle \\
& \rightarrow \langle x = 13, \sigma'' \rangle \\
& \rightarrow \langle 13, Put(\sigma'', x, 13) \rangle
\end{aligned}$$
**problem 6**

(a) 2 (b) 4 (c) 3

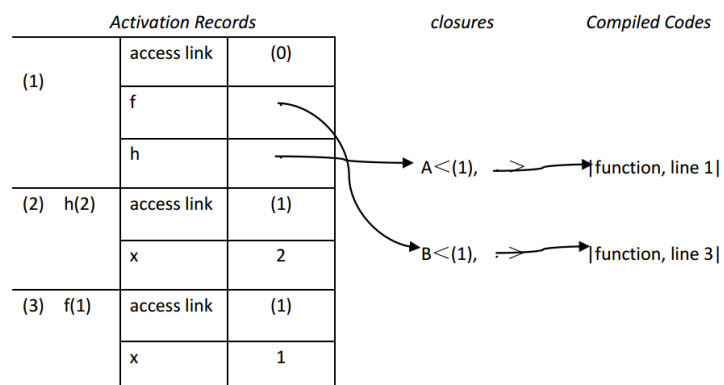
**problem 7**(a)  $\omega = 8$ 

(b)



## problem 8

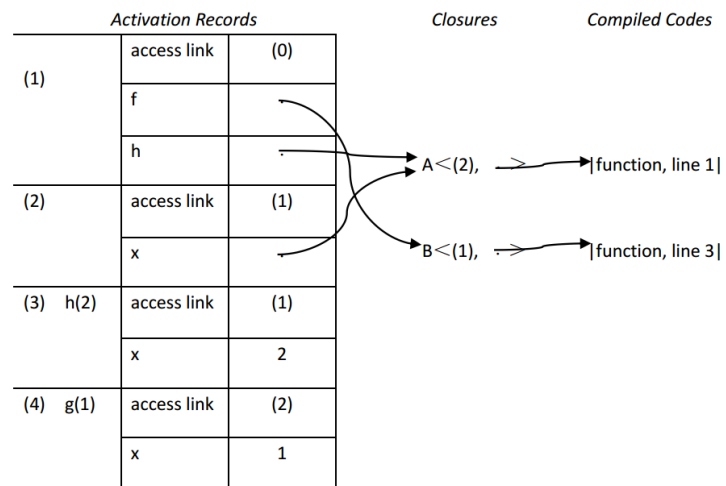
(a)



(b) B

(c) 第二行之后调用  $h(2)$  会调用  $f_1(2)$  然后再调用  $f_1(1)$ ; 而第四行调用  $h(2)$  时,  $f$  已经被修改并指向  $f_3()$ , 所以会先调用  $f_1(2)$  再调用  $f_3(1)$ .

(d)

(e)  $h(2) = 2$ . 先调用  $g(2)$  再调用  $g(1)$ .