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)

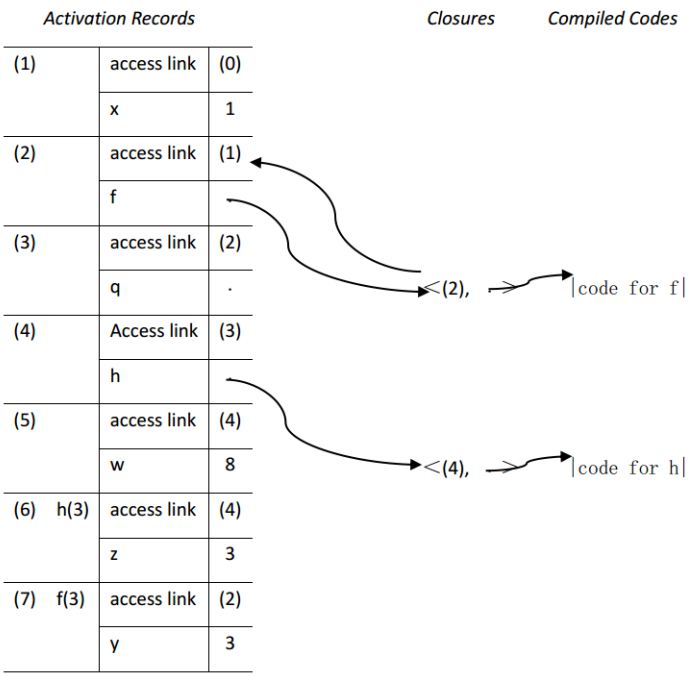
$$
\begin{aligned}
& < x = (x = x + 3) + (x = x + 5), \sigma > \\
\rightarrow & < x = (x = 1 + 3) + (x = x + 5), \sigma > \\
\rightarrow & < x = (x = 4) + (x = x + 5)\sigma > \\
\rightarrow & < x = 4 + (x = x + 5), Put(\sigma, x, 4) > \\
\rightarrow & < x = 4 + (x = 4 + 5), \sigma' > \\
\rightarrow & < x = 4 + (x = 9), \sigma' > \\
\rightarrow & < x = 4 + 9, Put(\sigma', x, 9) > \\
\rightarrow & < x = 13, \sigma'' > \\
\rightarrow & < 13, Put(\sigma'', x, 13) >
\end{aligned}
$$

problem 6

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

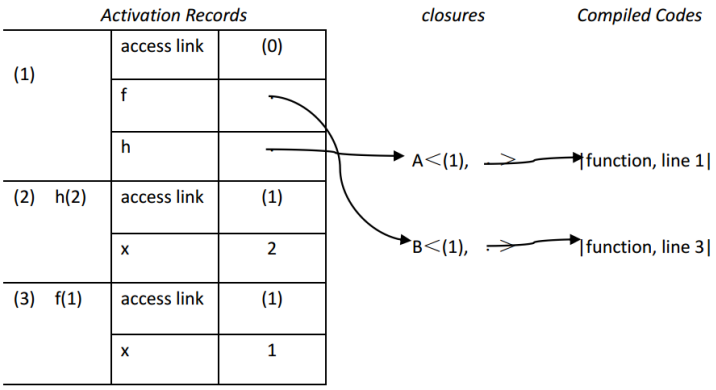
problem 7

(a) $\omega = 8$
(b)



problem 8

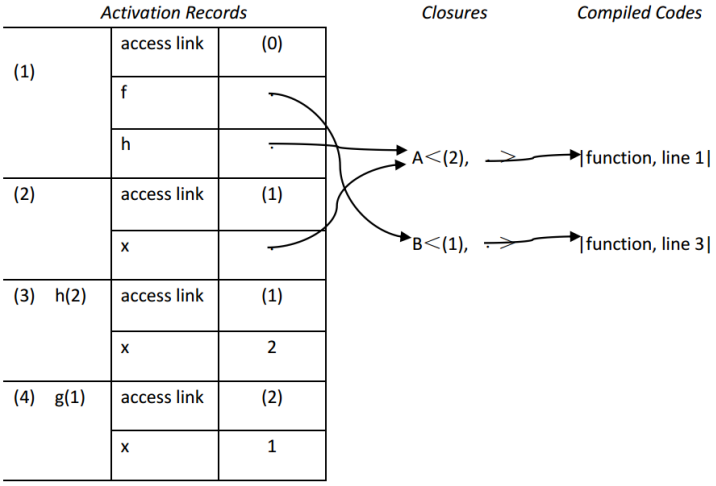
(a)



(b) B

(c) When calling function $h(2)$ after line 2, first function $f_1(2)$ will be called, then function $f_1(1)$; When calling function $h(2)$ on line 4,function $f_1(2)$ will be called firstly,then $f_3(1)$ will be called because on line 3 f is modified be point to function f_3.

(d)



(e)$h(2) = 2$. $g(2)$ is called firstly, then $g(1)$.