CIS 425 Assignment 2

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1. Example of a variable occurs both bound and free.

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

In above lambda expression, the variable y occurs both bound and free. The first y is the binding occurrence, the second y is bound because it is in the scope of λy, the second y is free because it is not in the scope of λy.

2. Give the free variables and bound variables of there terms:
(a). $\lambda x.(\lambda y.xy)y$
Bound variable: x, y
Free variable: y.
The second x is in the scope of λx, the second y is in the scope of λy. So they are bound variable.
The third y is not in the scope of λy, it is free variable. So y is both free and bound variable.

(b). $\lambda k.k(\lambda f.hf)(qf)$
Bound variable: k, f
Free variable: f
The variable k is in the scope of λk, the second f is in the scope of λf, so they are bound variable.
The third variable f is not in the scope of λf, it is free variable. So f is both free and bound variable.

3. Give the result of performing the following substitutions:

a.$[(\lambda y.xy)/x](x(\lambda x.yx))$
$= ((\lambda y.xy)(\lambda x.yx))$
The "x" in $\lambda x.yx$ is a bounded variable to λx(inside expression), so we can not replace it when doing the outside expression substitution.

b. $[(\lambda x.xy)/x](\lambda y.x(\lambda x.x))$
$= (\lambda y.(\lambda x.xy)(\lambda x.x))$