COMP 302 - Classtest 3 Problem Set

Capture-Avoiding Substitutions

For each expression, identify the bound variables and the free variables. Which variables will be renamed? What does the expression evaluate to? These are also implemented in the OCaml file.

(a)

```
[1/y, 5/b, 3/a, (a+b)/x] let x = y in let y = x in x + y
```

(b)

```
[z/x] let x = 1 in let x = 2 in let x = 3 in x + x
```

(c)

```
[0/x] let y = x in if y < x then x else y
```

(d)

```
[7/y, 2/z, 3/x] let x = y in let y = x in let z = x + (x + y) + z in z
```

Subtyping

1. Decide whether the following subtyping judgment holds:

$$\texttt{int} \leq \texttt{float}$$

2. Decide whether:

$$\texttt{int} \times \texttt{int} \leq \texttt{float} \times \texttt{float}$$

3. Decide whether:

$$\texttt{float} \to \texttt{int} \leq \texttt{int} \to \texttt{float}$$

4. Decide whether:

$$(\texttt{even} \times \texttt{int}) \to \texttt{int} \leq (\texttt{int} \times \texttt{int}) \to \texttt{float}$$

5. Decide whether:

$$(\texttt{int} \to \texttt{int}) \to \texttt{bool} \leq (\texttt{float} \to \texttt{int}) \to \texttt{bool}$$

6. Decide whether:

$$\texttt{int ref} \leq \texttt{float ref}$$

7. Decide whether:

$$(\texttt{int} \to \texttt{bool}) \times \texttt{even} \leq (\texttt{int} \to \texttt{bool}) \times \texttt{int}$$