

CS2030 Programming Methodology
Semester 1 2023/2024

18 & 19 October 2023

Problem Set #7

Variable Capture

1. Study the following program fragment.

```
1 abstract class A {
2     abstract void g();
3 }
4
5 class B {
6     int x = 1;
7
8     void f() {
9         int y = 2;
10
11         A a = new A() {
12             void g() {
13                 x = y;
14             }
15         };
16
17         a.g();
18     }
19 }
```

Now suppose the following is invoked:

```
B b = new B();
b.f();
```

Sketch the content of the stack and heap *just before* the statement in line 17 is executed. Label the values and variables/fields clearly. You can assume `b` is already on the heap and you can ignore all other content of the stack and the heap before `b.f()` is called.

2. You are given two functions $f(x) = 2 \times x$ and $g(x) = 2 + x$.
- (a) By creating an abstract class **Func** with a public abstract method **apply**, evaluate $f(10)$ and $g(10)$.
 - (b) The composition of two functions is given by $f \circ g(x) = f(g(x))$. As an example, $f \circ g(10) = f(2 + 10) = (2 + 10) * 2 = 24$. Extend the abstract class in question 2a so as to support composition, i.e. `f.compose(g).apply(10)` will give 24.
 - (c) Now re-implement the **Func** abstract class as generic abstract class **Func<T,R>** with the corresponding re-definitions of **apply** and **compose** methods.