Compiler Construction
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Quiz 5
November 10, 2010

Name: _____

This exam has 3 questions, for a total of 10 points.

1. [2 points] What is the output of the following program?

```
x = 1
y = 2

def f(y):
    z = x + y
    def g(w):
        v = w + y
        return v
    return g

print (f(3))(4)
```

Solution:

```
7
```

2. [2 points] What is the output of the following program?

```
def m():
    x = [0]
    def f():
        x[0] = x[0] + 1
    def g():
        return x[0]
    return (f,g)

a = m()[1]
b = m()
b[0]()
print a()
b[0]()
b[0]()
print b[1]()
```

Solution:

```
0
3
```

3. [6 points] Translate the Python program in question 1 to an equivalent Python program in which functions are only defined at the global (top-level) scope and that do not have any free variables. That is, apply heapification and closure conversion to the program. Do not perform any other transformations (such as optimizations).

Solution:

```
def lambda_0(fvs, w):
  y = fvs[0]
  v = w + y[0]
  return v

def lambda_1(fvs, y_0):
  x = fvs[0]
  y = [y_0]
  z = x[0] + y[0]
  g = (lambda_0, [y])
  return g

x = [0]
x[0] = 1
y = 2
f = (lambda_1, [x])
tmp = f[0](f[1], 3)
print tmp[0](tmp[1], 4)
```