HIGHER-ORDER FUNCTIONS, ENVIRONMENT DIAGRAMS, & FUNCTIONAL ABSTRACTION

COMPUTER SCIENCE MENTORS 61A

February 3 – February 7, 2025

1   Environment Diagrams

1. Give the environment diagram and console output that result from running the following code.

```python
def swap(x, y):
    x, y = y, x
    return print("Swapped!", x, y)

x, y = 60, 1
a = swap(x, y)
swap(a, y)
```

2. Draw the environment diagram that results from running the following code.

```python
def funny(joke):
    hoax = joke + 1
    return funny(hoax)

def sad(joke):
    hoax = joke - 1
    return hoax + hoax

funny, sad = sad, funny
result = funny(sad(2))
```

2 Higher-Order Functions

1. What are higher-order functions? Why and where do we use lambda and higher-order functions? Can you give a practical example of where we would use a HOF?

2. Give the environment diagram and console output that result from running the following code.

```
x = 20
def foo(y):
    x = 5
    if y == 5:
        return lambda y: x + y
    else:
        print('hello!')

y = foo(5)
x = y(7)
z = foo(7)
```

3. Implement compose.

```
def compose(f, g):
    """
    >>> a = compose(lambda x: x * x, lambda x: x + 4)
    >>> a(2)
    36
    """
```

4. Write a function, `whole_sum`, which takes in an integer, `n`. It returns another function which takes in an integer, and returns `True` if the digits of that integer sum to `n` and `False` otherwise.

```
def whole_sum(n):
    """
    >>> whole_sum(21)(777)
    True
    >>> whole_sum(142)(10010101010)
    False
    """
    def check(x):

        _____

        while _____:

            last = _____

            _____

            _____

        return _____

    return _____
```

5. Implement `make_alternator` which takes in two functions and outputs a function. The returned function takes in a number `x` and prints out all the numbers from 1 to `x`, applying `f` to the odd numbers and applying `g` to the even numbers before printing.

```
def make_alternator(f, g):
    """
    >>> a = make_alternator(lambda x: x * x, lambda x: x + 4)
    >>> a(5)
    1
    6
    9
    8
    25
    """
```