ENVIRONMENT DIAGRAMS AND HOFS

COMPUTER SCIENCE MENTORS

February 1 - February 3, 2021

1 Environment Diagrams

1. When do we make a new frame in an environment diagram?

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

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

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

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

```
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))
```

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2 Higher-Order Functions

1. Why and where do we use lambda and higher-order functions?

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

```
x = 20
def foo(y):
    x = 5
    def bar():
        return lambda y: x - y
    return bar

y = foo(7)
z = y()
print(z(2))
```

3. Draw the environment diagram that results from running the code.

```
apple = 4
def orange(apple):
    apple = 5
    def plum(x):
        return lambda plum: plum * 2
    return plum

orange(apple)("hiii")(4)
```

4. Fill in the blanks (*without using any numbers in the first blank*) such that the entire expression evaluates to `9`.

```
(lambda x: lambda y: ____________________)(______)(lambda z: z*z)()
```

5. Write a function, `print_sum`, that takes in a positive integer, `a`, and returns a function that does the following:
(1) takes in a positive integer, `b`
(2) prints the sum of all natural numbers from 1 to `a*b`
(3) returns a higher-order function that, when called, prints the sum of all natural numbers from 1 to `(a+b)*c`, where `c` is another positive integer.

```
def print_sum(a):
    """
    >>> f = print_sum(1)
    >>> g = f(2) # 1*2 => 1 + 2
    3
    >>> h = g(4) # (1+2)*4 => 1 + 2 + ... + 11 + 12
    78
    >>> i = h(5) # (3+4)*5 => 1 + 2 + ... + 34 + 35
    630
    """
    def helper(b):

        i, total = ___________________________________

        while ___________________________________:

            ___________________________________

            ___________________________________

        print(___________________________________)

        return ___________________________________

    return ___________________________________
```

6. Write a higher-order function that passes the following doctests.

   Challenge: Write the function body in one line.

```
def mystery(f, x):
    """
    >>> from operator import add, mul
    >>> a = mystery(add, 3)
    >>> a(4) # add(3, 4)
    7
    >>> a(12)
    15
    >>> b = mystery(mul, 5)
    >>> b(7) # mul(5, 7)
    35
    >>> b(1)
    5
    >>> c = mystery(lambda x, y: x * x + y, 4)
    >>> c(5)
    21
    >>> c(7)
    23
    """
```

7. What would Python display?

```
>>> foo = mystery(lambda a, b: a(b), lambda c: 5 + square(c))
>>> foo(-2)
```