1 Functions

Questions

1.1 Determine what the Python interpreter will output given the following lines of code.

```python
>>> from operator import add, mul

>>> mul(add(5, 6), 8)
88

>>> print('x')
x

>>> y = print('x')
x

>>> print(y)
None

>>> print(add(4, 2), print('a'))
a
6 None
```

1.2 Determine what the Python interpreter will output given the following lines of code.

```python
>>> def foo(x):
    print(x)
    return x + 1

>>> def bar(y, x):
    print(x - y)

>>> foo(3)

3
4

>>> bar(3)
```
2 Functions, Control, Environments, HOFs

>>> bar(6, 1)
-5
>>> bar(foo(10), 11)
10
0

2 Control

Questions

2.1 Which numbers will be printed after executing the following code?

```python
def bar(a, b):
    return a - b

n = 0
if n:
    print(1)
elif n < 2:
    print(2)
else:
    print(3)
print(4)
```

2
4

2.2 WWPD (What would Python Display) after evaluating each of the following expressions?

```python
>>> 0 and 1 / 0
0
>>> 6 or 1 or "a" or 1 / 0
6
>>> 6 and 1 and "a" and 1 / 0
Error
>>> print(print(4) and 2)
4
None
>>> not True and print("a")
```
2.3 Define a function, `count_digits`, which takes in an integer, `n`, and counts the number of digits in that number.

```python
def count_digits(n):
    count = 0
    while n > 0:
        count += 1
        n = n // 10
    return count
```

```python
>>> count_digits(4)
1
>>> count_digits(12345678)
8
>>> count_digits(0)
0
```

2.4 Define a function, `count_matches`, which takes in two integers `n` and `m`, and counts the number of digits that match.

```python
def count_matches(n, m):
    matches = 0
    while n > 0 and m > 0:
        if n % 10 == m % 10:
            matches += 1
            n, m = n // 10, m // 10
    return matches
```

```python
>>> count_matches(10, 30)
1
>>> count_matches(12345, 23456)
0
>>> count_matches(121212, 123123)
2
>>> count_matches(111, 11)  # only one’s place matches
2
>>> count_matches(101, 10)  # no place matches
0
```
3 Environment Diagrams

Questions

3.1 Draw the environment diagram for evaluating the following code

```python
def f(x):
    return y + x
y = 10
f(8)
```

Solution: https://goo.gl/rZnzaM

3.2 Draw the environment diagram for evaluating the following code

```python
def dessef(a, b):
    c = a + b
    b = b + 1

b = 6
dessef(b, 4)
```

Solution: https://goo.gl/4m3NRD
3.3 Draw the environment diagram for evaluating the following code

```python
def foo(x, y):
    foo = bar
    return foo(bar(x, x), y)

def bar(z, x):
    return z + y

y = 5
foo(1, 2)
```

Solution: https://goo.gl/7Kcx6n

3.4 Draw the environment diagram for evaluating the following code

```python
def spain(japan, iran):
    def world(cup, egypt):
        return japan-poland
    return iran(world(iran, poland))

def saudi(arabia):
    return japan + 3

japan, poland = 3, 7
spain(poland+1, saudi)
```

Solution: https://goo.gl/iddW49
3.5 Draw the environment diagram for evaluating the following code

cap = 9
hulk = 3

```python
def marvel(cap, thor, avengers):
    marvel = avengers
    iron = hulk + cap
    if thor > cap:
        def marvel(cap, thor, avengers):
            return iron
    else:
        iron = hulk
    return marvel(thor, cap, marvel)

def iron(man):
    hulk = cap - 1
    return hulk

marvel(cap, iron(3), marvel)
```

Solution: https://goo.gl/sofcq2
4 Higher Order Functions

Questions

4.1 What do lambda expressions do? Can we write all functions as lambda expressions? In what cases are lambda expressions useful?

Lambda expressions create functions. When a lambda expression is evaluated, it produces a function. We often use lambdas to create short anonymous functions that we won’t need for too long.

We can’t write all functions as lambda expressions because lambda functions all have to have `return` statements and they can’t contain very complex multi-line expressions.

4.2 Determine if each of the following will error:

```python
>>> 1/0
Error

>>> boom = lambda: 1/0

No error, since we don’t evaluate the body of the lambda when we define it.

>>> boom()
Error
```

4.3 Express the following lambda expression using a `def` statement, and the `def` statement using a lambda expression.

```python
pow = lambda x, y: x**y

def pow(x, y):
    return x**y

def foo(x):
    def f(y):
        def g(z):
            return x + y * z
        return g
    return f

foo = lambda x: lambda y: lambda z: x + y * z
```
4.4 Draw Environment Diagrams for the following lines of code

\[
\text{square} = \lambda x: x \times x \\
\text{higher} = \lambda f: \lambda y: f(f(y)) \\
\text{higher}(\text{square})(5)
\]

Solution: https://goo.gl/LATqV9

\[
\text{a} = (\lambda f, a: f(a))(\lambda b: b \times b, 2)
\]

Solution: https://goo.gl/TyriuP
4.5 Write `make_skipper`, which takes in a number n and outputs a function. When this function takes in a number x, it prints out all the numbers between 0 and x, skipping every nth number (meaning skip any value that is a multiple of n).

```python
def make_skipper(n):
    """
    >>> a = make_skipper(2)
    >>> a(5)
    1
    3
    5
    """

def skipper(x):
    for i in range(x + 1):
        if i % n != 0:
            print(i)
    return skipper
```

4.6 Write a function that takes in a function `cond` and a number `n` and prints numbers from 1 to n where calling `cond` on that number returns True.

```python
def keep_ints(cond, n):
    """Print out all integers 1..i..n where cond(i) is true

    >>> def is_even(x):
    ...     # Even numbers have remainder 0 when divided by 2.
    ...     return x % 2 == 0
    ...     return x % 2 == 0
    >>> keep_ints(is_even, 5)
    2
    4
    """

i = 1
while i <= n:
    if cond(i):
        print(i)
    i += 1
```

Video walkthrough
4.7 Write a function similar to keep_ints like before, but now it takes in a number \( n \) and returns a function that has one parameter \( \text{cond} \). The returned function prints out numbers from 1 to \( n \) where calling \( \text{cond} \) on that number returns True.

```python
def make_keeper(n):
    """Returns a function which takes one parameter \( \text{cond} \) and prints out all integers 1..i..n where calling \( \text{cond}(i) \) returns True."

    >>> def is_even(x):
    ...     # Even numbers have remainder 0 when divided by 2.
    ...     return x % 2 == 0
    >>> make_keeper(5)(is_even)
    2
    4
    """

def do_keep(cond):
    i = 1
    while i <= n:
        if cond(i):
            print(i)
        i += 1
    return do_keep
```

Video Walkthrough