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)
```
Functions, Control, Environments, HOFs

Error
>>> 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
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_digits(4)
    1
    >>> count_digits(12345678)
    8
    >>> count_digits(0)
    0
    ...

    count = 0
    while n > 0:
        count += 1
        n = n // 10
    return count
```

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):
    ...
    >>> 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
    ...

    matches = 0
    while n > 0 and m > 0:
        if n % 10 == m % 10:
            matches += 1
        n, m = n // 10, m // 10
    return matches
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

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
```

```python
>>> boom = lambda: 1/0
No error, since we don’t evaluate the body of the lambda when we define it.
```

```python
>>> 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
```

```python
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

```python
square = lambda x: x * x
higher = lambda f: lambda y: f(f(y))
higher(square)(5)
```

Solution: https://goo.gl/LATqV9

```python
a = (lambda f, a: f(a))(lambda b: b * 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 \(n\)th 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 \(\text{cond}\) and a number \(n\) and prints numbers from 1 to \(n\) where calling \(\text{cond}\) 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