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

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
```  

```python
>>> 6 or 1 or "a" or 1 / 0
6
```  

```python
>>> 6 and 1 and "a" and 1 / 0
Error
>>> print(print(4) and 2)
4
None
>>> not True and print("a")
```
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
    ...
```

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

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
    ...
```

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

*Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.*
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/rZuzaM](https://goo.gl/rZuzaM)

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](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

>>> 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
```

*Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.*)
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 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
```

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

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
5 Extra Questions

Questions

5.1 Define a function, ordered_digits, which takes in a positive integer, x, and returns True if the (base 10) digits of x are in non-decreasing order, and False otherwise.

```python
def ordered_digits(x):
    ...
    >>> ordered_digits(5)
    True
    >>> ordered_digits(11)
    True
    >>> ordered_digits(127)
    True
    >>> ordered_digits(1357)
    True
    >>> ordered_digits(21)
    False
    >>> result = ordered_digits(1375) # Return, don't print
    >>> result
    False
    ...

    last = x % 10
    val = x // 10
    while x > 0 and last >= x % 10:
        last = x % 10
        x = x // 10
    return x == 0
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
5.2 Define a function, `cycle`, which takes in three functions, `f1`, `f2`, `f3`, and returns a function that takes in an integer `n` and returns a function that takes in an integer `x`, and returns the result of `f1(x)` the first time it’s called, `f2(x)` the second time it’s called, `f3(x)` the third time it’s called, and then cycles back to `f1(x)` the fourth time it’s called, and so on.

```python
def cycle(f1, f2, f3):
    """Returns a function that is itself a higher-order function.
    >>> def add1(x):
    ...     return x + 1
    >>> def times2(x):
    ...     return x * 2
    >>> def add3(x):
    ...     return x + 3
    >>> my_cycle = cycle(add1, times2, add3)
    >>> identity = my_cycle(0)
    >>> identity(5)
    5
    >>> add_one_then_double = my_cycle(2)
    >>> add_one_then_double(1)
    4
    >>> do_all_functions = my_cycle(3)
    >>> do_all_functions(2)
    9
    >>> do_more_than_a_cycle = my_cycle(4)
    >>> do_more_than_a_cycle(2)
    10
    >>> do_two_cycles = my_cycle(6)
    >>> do_two_cycles(1)
    19
    """

    def ret_fn(n):
        def ret(x):
            i = 0
            while i < n:
                if i % 3 == 0:
                    x = f1(x)
                elif i % 3 == 1:
                    x = f2(x)
                else:
                    x = f3(x)
                i += 1
            return x
        return ret
    return ret_fn
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.
5.3 Define a function, is_palindrome, which takes in an integer, n, and returns True if n is a palindrome and False otherwise.

```python
def is_palindrome(n):
    """
    Fill in the blanks '_____' to check if a number is a palindrome.
    >>> is_palindrome(12321)
    True
    >>> is_palindrome(42)
    False
    >>> is_palindrome(2015)
    False
    >>> is_palindrome(55)
    True
    """
    x, y = n, 0
    f = lambda: _________________________________
    while x > 0:
        x, y = _____________, f()
    return y == n

x, y = n, 0
f = lambda: y * 10 + x % 10
while x > 0:
    x, y = x // 10, f()
return y == n
```

Note: This worksheet is a problem bank—most TAs will not cover all the problems in discussion section.