

PYTHON AND CONTROL Solutions

COMPUTER SCIENCE MENTORS 61A

August 31–September 2, 2022

1 Intro to Python

1. What Would Python Display?

```
>>> 3

3

>>> "cs61a"

'cs61a'

>>> x = 3
>>> x

3

>>> x = print("cs61a")
cs61a
>>> x

None

>>> print(print(print("cs61a")))

cs61a
None
None

>>> def f1(x):
...     return x + 1
>>> f1(3)

4

>>> f1(2) + f1(2 + 3)
```

9

```
>>> def f2(y):  
...     return y / 0  
>>> f2(4)
```

ZeroDivisionError: division by zero

```
>>> def f3(x, y):  
...     if x > y:  
...         return x  
...     elif x == y:  
...         return x + y  
...     else:  
...         return y  
>>> f3(1, 2)
```

2

```
>>> f3(5, 5)
```

10

```
>>> 1 or 2 or 3
```

1

```
>>> 1 or 0 or 3
```

1

```
>>> 4 and (2 or 1/0)
```

2

```
>>> 0 or (not 1 and 3)
```

False

```
>>> (2 or 1/0) and (False or (True and (0 or 1)))
```

1

2. For the following expressions, simplify the operands in the order of evaluation of the entire expression

Example: `add(3, mul(4, 5))`

Order of Evaluation: `add(3, mul(4, 5))` \rightarrow `add(3, 20)` \rightarrow 23

(a) `add(1, mul(2, 3))`

```
add(1, mul(2, 3))  
add(1, 6)  
7
```

(b) `add(mul(2, 3), add(1, 4))`

```
add(mul(2, 3), add(1, 4))
add(6, add(1, 4))
add(6, 5)
11
```

(c) `max(mul(1, 2), add(5, 6), 3, mul(mul(3, 4), 1), 7)`

```
max(mul(1, 2), add(5, 6), 3, mul(mul(3, 4), 1), 7)
max(2, add(5, 6), 3, mul(mul(3, 4), 1), 7)
max(2, 11, 3, mul(mul(3, 4), 1), 7)
max(2, 11, 3, mul(12, 1), 7)
max(2, 11, 3, 12, 7)
12
```

2 Control

1. Write a function that returns `True` if a number is divisible by 4 and `False` otherwise.

```
def is_divisible_by_4(num):
    return num % 4 == 0
```

2. Write a function `find_max` that takes in three numbers, `x`, `y`, `z`, and returns the maximum of the provided values. Assume that `x`, `y`, and `z` are unique. Do not use Python's built-in `max` function.

```
def find_max(x, y, z):
```

```
    def find_max(x, y, z):
        if x > y and x > z:
            return x
        elif y > x and y > z:
            return y
        else:
            return z
```

3. Implement `pow_of_two`, which prints all the positive integer powers of two less than or equal to `n` in ascending order. This function should return `None`.

*Follow up question: What would you change about your solution if the question asked to print all the powers of two **strictly less than** `n`?*

```
def pow_of_two(n):
    """
    >>> pow_of_two(6)
    1
    2
    4
    >>> result = pow_of_two(16)
    1
    2
    4
    8
    16
    >>> result is None
    True
    """

    curr = 1
    while curr <= n:
        print(curr)
        curr *= 2 # equivalent to curr = curr * 2
```

Since we are multiplying `curr` by 2 on each iteration of the while loop, `curr` holds values that are powers of 2. Notice that since there is no return statement in this function, when Python reaches the end of the function, it automatically returns `None`.

The answer to the follow up question is that the condition of our while loop would change to `curr < n`. Walk through the code for `pow_of_two(16)` with both of the conditions to see why they produce different outputs!

Another way you could have written this function is by using **pow** or the `**` operator. That solution would look something like this where you would keep track of the exponent itself:

```
exponent = 0
while (2 ** exponent) <= n:
    print(2 ** exponent)
    exponent += 1
```

4. Complete the function `fact_limit`, which calculates factorials up to a specified limit. Specifically, `fact_limit` takes in two positive integers, `n` and `limit`, and calculates the product of `n`, `n-1`, `n-2`, etc., working downward until it attains the greatest product that doesn't exceed `limit`. If there is no product less than or equal to `limit`, `fact_limit` should return 1.

Hint: The output of `fact_limit` is always less than or equal to `limit`.

```
def fact_limit(n, limit):
    """
    >>> fact_limit(5, 20)
    20 # 5 * 4 = 20, but 5 * 4 * 3 = 60 > 20
    >>> fact_limit(5, 200)
    120 # 5 * 4 * 3 * 2 * 1 = 120 < 200
    >>> fact_limit(5, 3)
    1 # no partial product is less than 3
    """
    if _____:
        _____
    product = _____
    _____ = n - 1
    while _____:
        _____ = _____
        _____ = _____
    return _____
```

```
def fact_limit(n, limit):
    if n > limit:
        return 1
    product = n
    n = n - 1
    while product * n <= limit and n > 0:
        product = product * n
        n = n - 1
    return product
```