Fall 2014 – OOP evaluation

1. (12 points) Class Hierarchy

For each row below, write the output displayed by the interactive Python interpreter when the expression is evaluated. Expressions are evaluated in order, and **expressions may affect later expressions.**

Whenever the interpreter would report an error, write ERROR. You *should* include any lines displayed before an error. *Reminder*: The interactive interpreter displays the `repr` string of the value of a successfully evaluated expression, unless it is `None`. Assume that you have started Python 3 and executed the following:

```
class Worker:
    greeting = 'Sir'
    def __init__(self):
        self.elf = Worker
    def work(self):
        return self.greeting + ', I work'
    def __repr__(self):
        return Bourgeoisie.greeting
class Bourgeoisie(Worker):
    greeting = 'Peon'
    def work(self):
        print(Worker.work(self))
        return 'My job is to gather wealth'
class Proletariat(Worker):
    greeting = 'Comrade'
    def work(self, other):
        other.greeting = self.greeting + ' ' + other.greeting
        other.work() # for revolution
        return other
jack = Worker()
john = Bourgeoisie()
jack.greeting = 'Maam'
```

Expression	Interactive Output
`5*5`	25
`1/0`	ERROR
`Worker().work()`	
`jack`	
`jack.work()`	

Expression	Interactive Output
`john.work()[10:]`	
`Proletariat().work(john)`	
`john.elf.work(john)`	

Fall 2014 - OOP authoring

4. (8 points) Tree Time

(a) (4 pt) A `GrootTree` g is a binary tree that has an attribute `parent`. Its parent is the `GrootTree` in which g is a branch. If a `GrootTree` instance is not a branch of any other `GrootTree` instance, then its `parent` is `BinaryTree.empty`.

`BinaryTree.empty` should not have a `parent` attribute. Assume that every `GrootTree` instance is a branch of at most one other `GrootTree` instance and not a branch of any other kind of tree.

Fill in the blanks below so that the `parent` attribute is set correctly. You may not need to use all of the lines. Indentation is allowed. You *should not* include any `assert` statements. Using your solution, the doctests for `fib_groot` should pass. The `BinaryTree` class appears on your study guide.

Hint: A picture of `fib_groot(3)` appears on the next page.

```
class GrootTree(BinaryTree):
    """A binary tree with a parent."""

    def __init__(self, entry, left=BinaryTree.empty, right=BinaryTree.empty):
        BinaryTree.__init__(self, entry, left, right)


        ------------------------------------------------------------------------


        ------------------------------------------------------------------------


        ------------------------------------------------------------------------


        ------------------------------------------------------------------------


        ------------------------------------------------------------------------


        ------------------------------------------------------------------------

def fib_groot(n):
    """Return a Fibonacci GrootTree.

    >>> t = fib_groot(3)
    >>> t.entry
    2
    >>> t.parent.is_empty
    True
    >>> t.left.parent.entry
    2
    >>> t.right.left.parent.right.parent.entry
    1
    """
    if n == 0 or n == 1:
        return GrootTree(n)
    else:
        left, right = fib_groot(n-2), fib_groot(n-1)
        return GrootTree(left.entry + right.entry, left, right)
```

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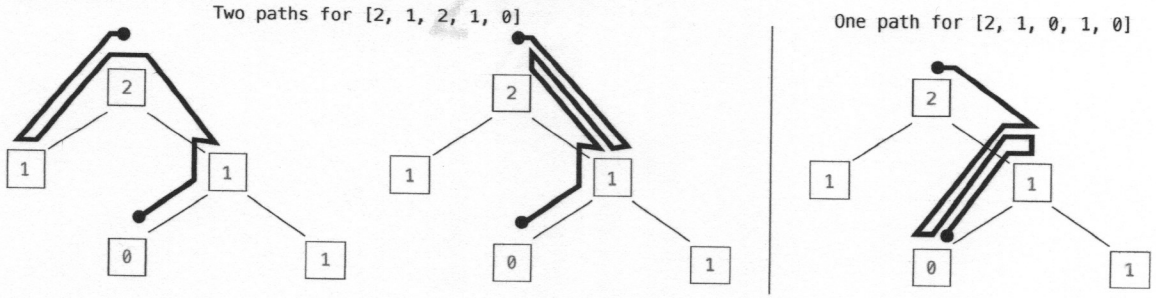
(b) **(4 pt)** Fill in the blanks of the implementation of `paths`, a function that takes two arguments: a `GrootTree` instance `g` and a list `s`. It returns the number of paths through `g` whose entries are the elements of `s`. A path through a `GrootTree` can extend either to a branch or its `parent`.

You may assume that the `GrootTree` class is implemented correctly and that the list `s` is non-empty.

The two paths that have entries `[2, 1, 2, 1, 0]` in `fib_groot(3)` are shown below (left). The one path that has entries `[2, 1, 0, 1, 0]` is shown below (right).




```
def paths(g, s):
    """The number of paths through g with entries s.

    >>> t = fib_groot(3)
    >>> paths(t, [1])
    0
    >>> paths(t, [2])
    1
    >>> paths(t, [2, 1, 2, 1, 0])
    2
    >>> paths(t, [2, 1, 0, 1, 0])
    1
    >>> paths(t, [2, 1, 2, 1, 2, 1])
    8
    """
    if g is BinaryTree.empty _____:
        return 0
    elif _____:
        return 1
    else:
        xs = [_____]
        return sum([ _____ for x in xs])
```

Spring 2018 Exam Prep 6 - 006

2. **Interpretation (Fa14 Mock Final Q5e)**

```
def g(n):
    if n % 2 == 0 and g(n + 1) == 0:
        return 0
    return 5
```

Circle the correct order of growth for a call to `g(n)`:

$\Theta(1)$ $\Theta(\log n)$ $\Theta(n)$ $\Theta(n^2)$ $\Theta(n^3)$ $\Theta(b^n)$

3. **Not with a fizzle, but with a bang (Su13 Midterm 2 Q2b)** Consider the following linked list functions:

```
def boom(n):
    if n == 0:
        return "BOOM!"
    return boom(n - 1)

def explode(n):
    if n == 0:
        return boom(n)
    i = 0
    while i < n:
        boom(n)
        i += 1
    return boom(n)
```

Circle the correct order of growth for a call to `explode(n)`:

$\Theta(1)$ $\Theta(\log n)$ $\Theta(n)$ $\Theta(n^2)$ $\Theta(n^3)$ $\Theta(2^n)$

4. **Not with a fizzle, but with a bang (Su13 Midterm 2 Q2c)** Consider the following linked list functions:

```
def dreams(n):
    if n<= 0:
        return n
    if n > 0:
        return n + dreams(n // 2)
```

Circle the correct order of growth for a call to `dreams(n)`:

$\Theta(1)$ $\Theta(\log n)$ $\Theta(n)$ $\Theta(n^2)$ $\Theta(n^3)$ $\Theta(2^n)$

Spring 2018 Exam Prep 6-006

5. **Various Programs (Sp14 Final Q5c)** Give worst-case asymptotic bounds, in terms of `m` and `n`, for the running time of the following functions.

```
def a(m, n):
    for i in range(m):
        for j in range(n // 100):
            print("hi")
```

Bound:

```
def b(m, n):
    for i in range(m // 3):
        print("hi")
    for j in range(n * 5):
        print(bye")
```

Bound:

```
def d(m, n):
    for i in range(m):
        j = 0
        while j < i:
            print("hi")
            j = j + 100
```

Bound:

6. **OOG Potpourri** What is the order of growth of each of the following functions?

a. Weighted

```
def weighted_random_choice(lst):
    temp = []
    for i in range(len(lst)):
        temp.extend([lst[i]] * (i + 1))
    return random.choice(temp)
```

Order of Growth:

b. Iceskate

```
def ice(n):
        skate = n
        def rink(n):
                nonlocal skate
                print(n)
                if skate > 0:
                        skate -= 1
                        rink(skate)
                return skate
        return rink(n//2)
```

Order of Growth:

Summer 2015 - 006

(d) (2 pt) Consider the following linked list functions:

```
def append(link, value):
    """Mutates link by adding value to the end of link."""
    if link.rest is Link.empty:
        link.rest = Link(value)
    else:
        append(link.rest, value)

def extend(link1, link2):
    """Mutates link1 so that all elements of link2 are added to the end
    of link1.
    """
    while link2 is not Link.empty:
        append(link1, link2.first)
        link2 = link2.rest
```

Circle the order of growth that best describes the runtime of calling **append**, where n is the number of elements in the input `link`.

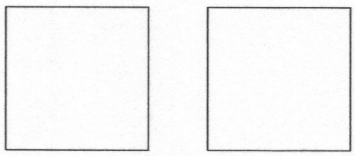
$O(1)$ $O(\log n)$ $O(n)$ $O(n^2)$ $O(2^n)$

Assuming the two input linked lists to **extend** both contain n elements, circle the order of growth that best describes the runtime of calling **extend**.

$O(1)$ $O(\log n)$ $O(n)$ $O(n^2)$ $O(2^n)$

6. (0 points) A second chance

In each of the two boxes below, write a positive integer. If one of the numbers you pick is the lowest unique integer in the class, you get one extra credit point. In other words, you get two chances to write the smallest positive integer that you think no one else will write.



Spring 2015 - linked list manipulation

(d) (6 pt) Implement `double_up`, which mutates a linked list by inserting elements so that each element is adjacent to an equal element. The `double_up` function inserts as few elements as possible and returns the number of insertions. The `Link` class appears on the midterm 2 study guide.

```
def double_up(s):
    """Mutate s by inserting elements so that each element is next to an equal.

    >>> s = Link(3, Link(4))
    >>> double_up(s) # Inserts 3 and 4
    2
    >>> s
    Link(3, Link(3, Link(4, Link(4))))
    >>> t = Link(3, Link(4, Link(4, Link(5))))
    >>> double_up(t) # Inserts 3 and 5
    2
    >>> t
    Link(3, Link(3, Link(4, Link(4, Link(5, Link(5))))))
    >>> u = Link(3, Link(4, Link(3)))
    >>> double_up(u) # Inserts 3, 4, and 3
    3
    >>> u
    Link(3, Link(3, Link(4, Link(4, Link(3, Link(3))))))
    """
    if s is Link.empty:

        return 0

    elif s.rest is Link.empty:

        ____________ = ____________________________________________________

        return ____________________________________________________________

    elif ____________________________________________________________________:

        return double_up(_____________________________________________________)

    else:

        ____________ = ____________________________________________________

        return ____________________________________________________________
```