Data C88C
Fall 2024

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Midterm

Solutions last updated: Friday, November 1st, 2024

Print Your Name: ____

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You have 110 minutes. There are 6 questions of varying credit (100 points total).

Question:	1	2	3	4	5	6	Total
Points:	15	32	15	23	15	0	100

For questions with **circular bubbles**,
you may select only one choice.

○ Unselected option (completely unfilled)

● Only one selected option (completely filled)

☑ Don't do this (it will be graded as incorrect)

- The exam is closed book, closed notes, closed computer, closed calculator, except two 8.5" x 11" pages of your own creation and the provided midterm study guide.
- Anything you write outside the answer boxes or you ~~cross out~~ will not be graded.
- If you write multiple answers, your answer is ambiguous, or the bubble is not entirely filled in, we will grade the worst interpretation.
- You may use built-in Python functions that do not require import, such as **`pow`**, **`len`**, **`abs`**, **`bool`**, **`int`**, **`float`**, **`str`**, **`round`**, **`max`**, **`min`**, **`list`**, **`tuple`**, **`sum`**, **`all`**, **`any`**, **`map`**, **`filter`**, **`zip`**, **`sorted`**, and **`reversed`**.
- You may **not** use example functions defined on your study guide unless a problem clearly states you can.
- You may not use ; to place two statements on the same line.
- You may use the **`Link`** class defined on the midterm study guide.

Sign (or type) your name to confirm that all work on this exam will be your own. The penalty for academic misconduct on an exam is an F in the course.

Sign (or print) your name: ____

Q1 *Into the Haunted House!* **(15 points)**

Dhruv and Andria stumble into a haunted house, and want to do some sleuthing to figure out the mysteries inside!

```
flashlight = lambda item: print(item)
in_the_corner = "A patch of grass."

def haunted_house():
    print("Spooky!" and "Scary!")
    on_the_chandelier = lambda: "Look, it's Kenny!"
    on_the_windowsill = print
    flashlight(on_the_windowsill(on_the_chandelier()))


def peek(in_the_corner, where):
    flashlight(where())

def attic():
    in_the_corner = "A metal key."
    def basement():
        return in_the_corner
    return basement
```

Into the unknown!

Q1.1 (5 points) Let’s figure out what secrets we’ve uncovered. Note what the following call expression prints out.

If any of the lines errors, write “Error” and do not execute any further lines of code.

`haunted_house()`

Solution:

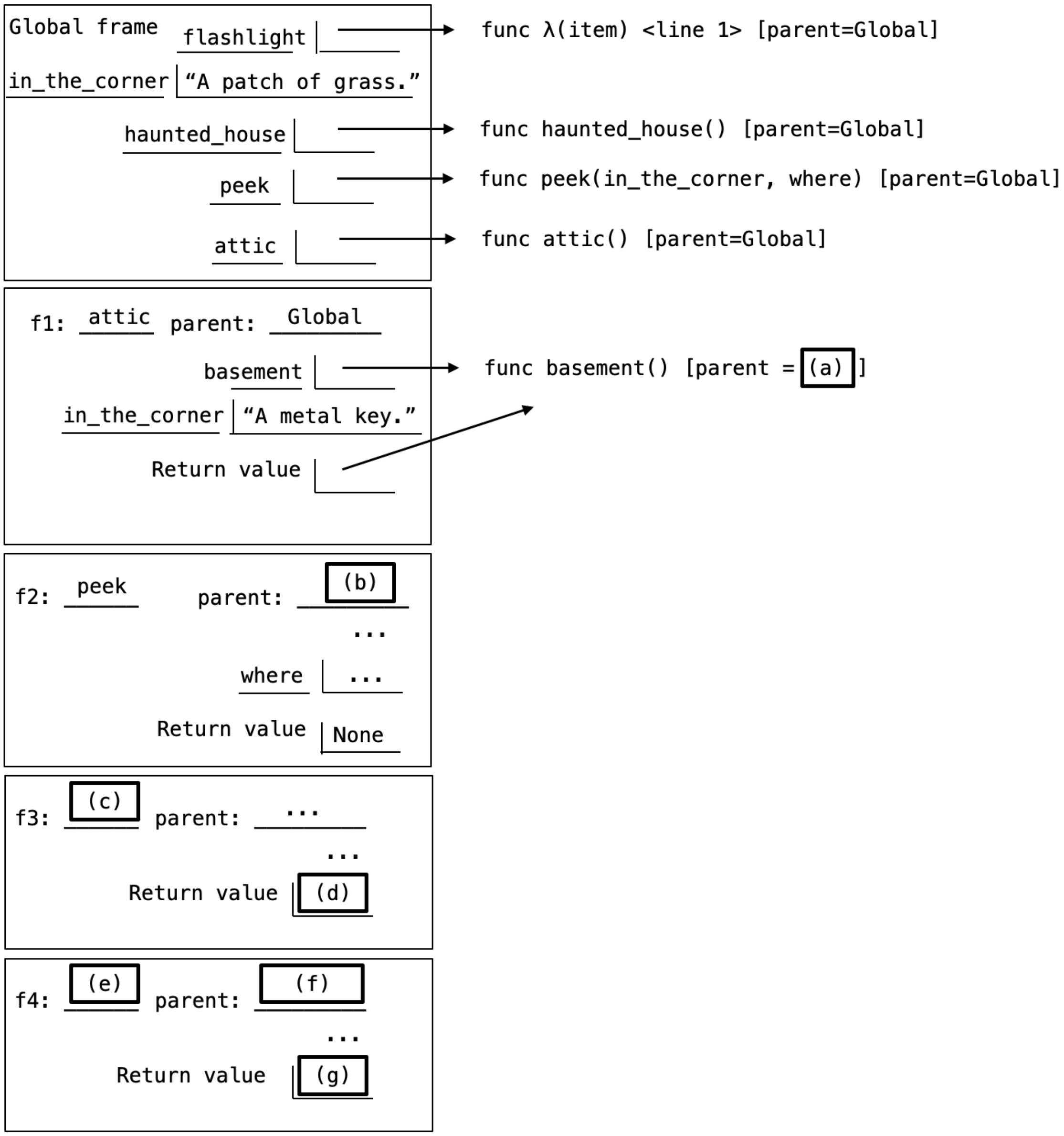
Scary!
Look, it’s Kenny!
None

Solution: On line 5, we evaluate the operand before printing. ”Spooky!” is a truthy value, so we move onto ”Scary!”, which is also a truthy value. Therefore, the boolean expression evaluates to ”Scary!”, which is printed out.

On line 8, we start by calling on_the_chandelier, which is a lambda function returning the String ”Look, it’s Kenny!”. Since on_the_windowsill is bound to the print function, we print out ”Look, it’s Kenny!”. Print always returns None, so we call flashlight on None. This prints out None.

Assume we do not call **`haunted_house`**. Using the code from the previous page, answer the following questions about the environment diagram that results from the following call expression:

`peek("cobwebs.", attic())`



Q1.2 (1.5 points) What should go in blank (a)?

○ Global

○ attic

● f1

Solution: `basement` is defined within the call to `attic`, which is in frame 1. Therefore, the parent is f1.

Q1.3 (1.5 points) What should go in blank (b)?

● Global

○ attic

○ f1

Solution: `peek` is defined in the Global frame, so that is the parent.

Q1.4 (1.5 points) What should go in blank (c)?

○ attic

○ λ<line 1>

● basement

○ peek

○ flashlight

○ where

Solution: We then evaluate the call expression `flashlight(where())`. Since we pass in `basement` into the formal parameter `where`, we then call `basement`.

Q1.5 (2 points) What should go in blank (d)?

○ “A patch of grass.”

○ “cobwebs.”

● “A metal key.”

○ None

Solution: `in_the_corner` is not found in the current frame f3. Therefore, we look to the parent of basement, which is f1. We see that `in_the_corner` is found as ”A metal key.”, and returned.

Q1.6 (1 point) What should go in blank (e)?

○ attic

● λ<line 1>

○ basement

○ peek

○ flashlight

○ where

Solution: We then call `flashlight`, which is the lambda in line 1.

Q1.7 (1 point) What should go in blank (f)?

● Global

○ f1

○ f2

○ f3

○ attic

○ peek

Solution: The parent of the lambda in line 1 is Global.

Q1.8 (1.5 points) What should go in blank (g)?

○ "A patch of grass."

○ "A metal key."

○ "cobwebs."

● None

Solution: Although we print out ”A metal key.”, print always returns None.

Q2 *Ghostbusters!* (32 points)

A ”spooky list” is one that has a ghost hidden somewhere in it. Ghosts are represented by some spooky sequence. However, our ghosts have gotten crafty! As long as the spooky numbers appear in consecutive order, even within a nested list, our list is considered spooky.

Oski decides to take a stab at implementing `is_spooky`, which detects whether our list is spooky or not.

```
def is_spooky(s, sequence):
    """Returns whether s is a spooky list given a non-empty sequence.
    If the numbers in the sequence appear consecutively in s, return True.
    Otherwise, return False.
    >>> is_spooky([1, 2, 3], [1, 2, 3])
    True
    >>> is_spooky([[1], [2], [3]], [1, 2, 3])
    True
    >>> is_spooky([1, [2, [[[3]]]]], [1, 2, 3])
    True
    >>> is_spooky([1, [], 2, 3], [1, 2, 3])
    True
    >>> is_spooky([0, [1, 2], 3, 0], [1, 2, 3])
    True
    >>> is_spooky([], [1, 2, 3])
    False
    >>> is_spooky([1, 2, 4, 3], [1, 2, 3])
    False
    >>> is_spooky([123], [1, 2, 3]) #Spooky numbers should not be combined!
    False
    """
    return sequence in s   #OSKI'S BUGGY IMPLEMENTATION
```

Q2.1 (3 points) Give one example input s for a sequence [8, 0, 0] where Oski’s implementation would successfully detect a spooky list.

Solution: Since sequence is [8, 0, 0] and Oski’s implementation is `return sequence in s`, s should be any list where [8, 0, 0] is an element within the list. For example, `[[8, 0, 0]]`.

Q2.2 (3 points) Give one example input s for a sequence [8, 0, 0] where Oski’s implementation would **fail** to detect a spooky list. In other words, `is_spooky` would return True when the spooky list is not spooky, or would return False when the spooky list is indeed spooky.

Solution: There will never be a case where Oski’s implementation returns True when is_spooky is supposed to return False. Therefore, any spooky list where [8, 0, 0] is **not** a singular element within the list, but still contains the numbers 8, 0, 0 consecutively will be a valid input `s`.

(8 points) In order to help us detect these ghosts, fill in the following implementation of `flatten`, which takes in a potentially nested list and returns a flattened list. A flattened list contains only integers as elements within the list (i.e. there should not be lists within lists in the returned list).

```
def flatten(s):
    """Returns a flattened version of s.
    >>> flatten([])
    []
    >>> flatten([1, 2, 3])
    [1, 2, 3]
    >>> flatten([1, 2, [[[3]]]])
    [1, 2, 3]
    """
        flat_list = []
        for elem in s:
                Q2.3
            if type(elem) == list:
                flat_list.extend(flatten(elem))
                               Q2.4
            else:
                flat_list.append(elem)
                          Q2.5
        return flat_list
```

Fill in the following implementation of `how_spooky`, which takes in a list `s` and a non-empty list `sequence`. It returns the number of ghosts inside of `s`. Assume `flatten` is correctly implemented.

```
def how_spooky(s, sequence):
    """Returns the number of ghosts inside of list s.
    Ghosts take on the values in sequence.
    >>> how_spooky([], [1])
    0
    >>> how_spooky([8, 1, 0, 0], [8, 0, 0])
    0
    >>> how_spooky([8, 0, 0], [8, 0, 0])
    1
    >>> how_spooky([1, [8], [], [0, [[0]]]], [8, 0, 0])
    1
    >>> how_spooky([0, 0, 0], [0, 0])
    2
    >>> how_spooky([1, 2, 3, 1, 2, 3, 1, 2, 3], [1, 2])
    3
    >>> how_spooky([1, [2], [[3, 1], 2, 3], 1, 2, 3], [1, 2])
    3
    """
    flattened_list = BLANK ONE
    def how_spooky_helper(lst):
        if BLANK TWO:
            return 0
        elif BLANK THREE:
            return BLANK FOUR
        else:
            return BLANK FIVE
    return how_spooky_helper(flattened_list)
```

Q2.6 (1 point) What should go in `BLANK ONE`?

● `flatten(s)`

○ `flatten()`

○ `s.flatten()`

Solution: `flatten` is not an attribute of lists, and needs to take in some argument.

Q2.7 (3 points) What should go in `BLANK TWO`?

● `len(lst) < len(sequence)`

○ `len(lst) != len(sequence)`

○ `len(lst) == len(sequence)`

○ `len(lst) > len(sequence)`

○ `lst[0] != sequence[0]`

○ `lst != sequence`

○ `lst[1:] != sequence[1:]`

Solution: This checks that we have enough elements in the flattened list compared to the sequence. If we have less elements compared to the sequence, there definitely won't be a ghost in here!

Q2.8 (3 points) What should go in `BLANK THREE`?

○ `lst == sequence`

○ `lst[0] == sequence[0]`

○ `lst[1:] == sequence[1:]`

● `lst[:len(sequence)] == sequence`

○ `any([lst[x] == sequence[x] for x in range(len(sequence))])`

Solution: If the first `len(sequence)` of the list are equal to the sequence, then we should add one to the ghost count!

Q2.9 (3 points) What should go in `BLANK FOUR`?

○ `how_spooky_helper(lst)`

○ `how_spooky_helper(lst[1:])`

○ `how_spooky_helper(lst[:len(lst) - 1])`

○ `how_spooky_helper(lst[len(sequence):])`

○ `1 + how_spooky_helper(lst)`

● `1 + how_spooky_helper(lst[1:])`

○ `1 + how_spooky_helper(lst[:len(lst) - 1])`

○ `1 + how_spooky_helper(lst[len(sequence):])`

Solution: We should add 1 to our counter, then recursively call, removing the first element. See the doctest on line 12 for why we only remove the first element instead of `len(sequence)` elements.

Q2.10 (3 points) What should go in `BLANK FIVE`?

○ `how_spooky_helper(lst)`

● `how_spooky_helper(lst[1:])`

○ `how_spooky_helper(lst[:len(lst) - 1])`

○ `how_spooky_helper(lst[len(sequence):])`

○ `1 + how_spooky_helper(lst)`

○ `1 + how_spooky_helper(lst[1:])`

○ `1 + how_spooky_helper(lst[:len(lst) - 1])`

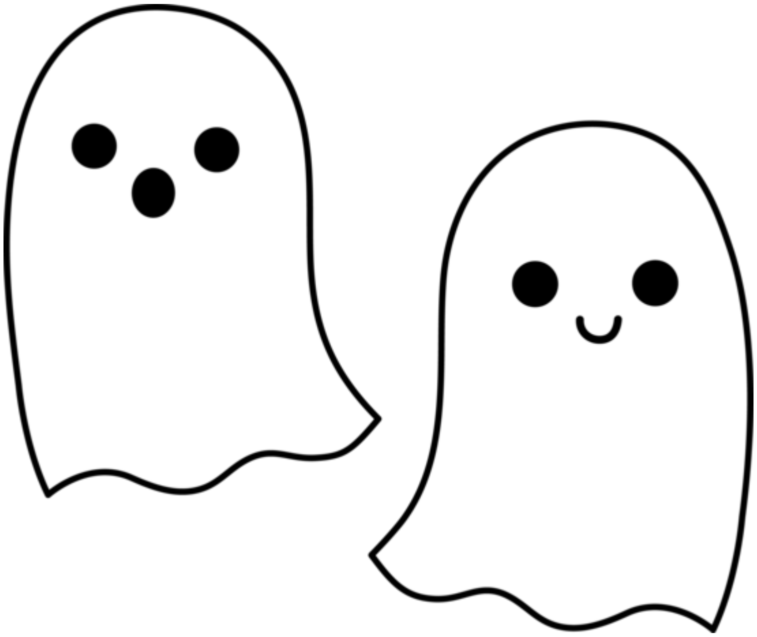
○ `1 + how_spooky_helper(lst[len(sequence):])`

Solution: We should add 0 to our counter, then recursively call, removing the first element. See the doctest on line 12 for why we only remove the first element instead of `len(sequence)` elements.

(5 points) Fill in the following implementation of `scariest_list`. Given a list of potentially spooky lists and a sequence, `scariest_list` returns the list with the most ghosts inside of it. You may assume that all code from previous subparts have been implemented correctly. In the case of a tie, return the the list that comes first in spooky_lists. **You may not use any square brackets in your answer (i.e. neither [or] should appear in your answer).**

```
def scariest_list(spooky_lists, sequence):
    """Returns the list with the most ghosts.
    >>> scariest_list([[], [1, 2], [1, 1, 1, 2]], [1])
    [1, 1, 1, 2]
    >>> scariest_list([[1, 2], [2, 2, 2], [3, 4]], [2])
    [2, 2, 2]
    >>> scariest_list([[1, 2], [1, [2, [1, [2]]]]], [1, 2])
    [1, [2, [1, [2]]]]
    >>> scariest_list([[1, 2, 1], [1, 3, 1], [1, 1]], [1])
    [1, 2, 1]
    """
    return max(spooky_lists, key=lambda lst: how_spooky(lst, sequence))
                                    Q2.11
```

Solution: We want to return the list with the most ghosts, so we should call `max`. The function `how_spooky` gives us information on how many ghosts are in each list. Simply setting `key = how_spooky` means that we can't pass in the sequence we care about. Therefore, we use a lambda and set `key = lambda lst: how_spooky(lst, sequence)`.



Spotting the ghosts :O

Q3 *Trick or Treat!* **(15 points)**

The C88C staffers decide to go trick-or-treating! Suppose we have the following code that helps us determine what each staffer gets:

```
1 def trick_or_treat(staffer):
2     reward = "Nothing"
3     if len(staffer) % 2 == 0:
4         reward = "Trick"
5     if len(staffer) // 2 >= 3:
6         reward = "Chocolate!"
7     elif staffer[0] == "S":
8         reward = "Cookies!"
9     return reward
```

Select what each of the following expressions evaluates to:

Q3.1 (1.5 points) `trick_or_treat("Swetha")`

○ “Nothing”

○ “Trick”

● “Chocolate!”

○ “Cookies!”

○ None

> **Solution:** `len("Swetha")` evaluates to 6, so the conditional expression in line 3 returns True. Then, we execute the conditional expression in line 5, which sets reward to ”Chocolate!”. As a result, we do not execute the conditional expression in line 7.

Q3.2 (1.5 points) `trick_or_treat("Jedi")`

○ “Nothing”

● “Trick”

○ “Chocolate!”

○ “Cookies!”

○ None

> **Solution:** `len("Jedi")` evaluates to 4, so the conditional expression in line 3 returns True. Neither conditional expression in line 5 or 7 is True.

Q3.3 (2 points) `trick_or_treat(["Shm", "and", "Grace"])`

● “Nothing”

○ “Trick”

○ “Chocolate!”

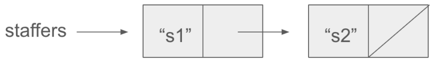
○ “Cookies!”

○ None

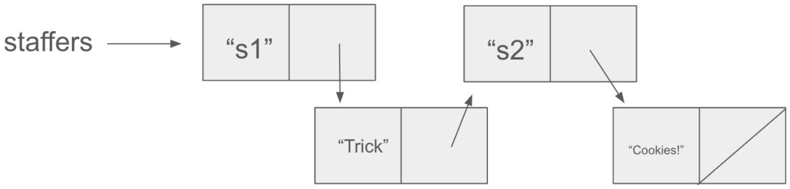
Solution: The length of a list is the number of elements inside of it. Therefore, line 3 and 5’s conditional statement is False. Staffer[0] is equal to ”Shm”, which is not ”S”. Therefore, the reward is ”Nothing”.

Q3.4 (10 points) Implement **candy_bag**, which takes in a Linked List called **staffers** and modifies **staffers** such that every staff member's **rest** attribute is another **Link** instance containing the name of that staffer's reward (determined by passing their name into **trick_or_treat**. If **staffers** is an empty Linked List, we should not modify anything.

For instance, if staffer **"s1"** gets "Trick" and **"s2"** gets "Cookies!", the linked list:



turns into this linked list after calling **candy_bag** on it:



```
def candy_bag(staffers):
    """Modifies staffers.
    Each staffer becomes linked to their respective trick/treat.
    >>> staffers = Link("s1", Link("s2"))
    >>> candy_bag(staffers)
    >>> staffers.first
    's1'
    >>> staffers.rest.first #Assume "s1"'s reward is "Trick"
    'Trick'
    >>> staffers.rest.rest.first
    's2'
    >>> staffers.rest.rest.rest.first #Assume "s2"'s reward is "Cookies!"
    'Cookies!'
    """
    current = staffers
                 Q3.5
    while current is not Link.empty:
                          Q3.6
        reward = trick_or_treat(current.first)
                                     Q3.7
        reward_link = Link(reward, current.rest)
                              Q3.8      Q3.9
        current.rest = reward_link
            Q3.10
        current = reward_link.rest
                       Q3.11
```

Solution: current.rest.rest is also an equivalent solution for the last line.

Q4 *Pumpkin Patch Pyramid* (23 points)

Angela and Khadija are wandering around the pumpkin patch, and want to make pyramids of pumpkins as a fun C88C staff activity. In order for the pumpkin patch pyramid to be symmetrical (with a pumpkin aligned exactly in the middle), each layer must only have an odd number of pumpkins in it. They wonder what all the combinations of pumpkins there could be given n pumpkins!

Implement **`sums`**, which takes a positive integer **`n`** and returns a list of all unique combinations of odd numbers that sum to **`n`**.

```
def sums(n):
    """List all the lists of unique odd numbers that sum to n.
    >>> sorted(sums(3))
    [[3]]
    >>> sorted(sums(16))
    [[1, 3, 5, 7], [1, 15], [3, 13], [5, 11], [7, 9]]
    >>> sorted(sums(17))
    [[1, 3, 13], [1, 5, 11], [1, 7, 9], [3, 5, 9], [17]]
    """
    def at_least(n, k):
        if n < k:
            return BLANK ONE
        elif n == k:
            return BLANK TWO
        with_k = [BLANK THREE for s in BLANK FOUR]
        without_k = BLANK FIVE
        return BLANK SIX
    return at_least(n, BLANK SEVEN)
```

This is not a pumpkin patch pyramid, but it is cute...

Q4.1 (2 points) What should go in `BLANK ONE`?

○ `0`　　○ `[[]]`

● `[]`　　○ `[0]`

Q4.2 (3 points) What should go in `BLANK TWO`?

○ `[n]`　　● `[[n]]`

○ `[k]`　　● `[[k]]`

Q4.3 (4 points) What should go in `BLANK THREE`?

● `[k] + s`　　○ `s`

○ `[s] + k`　　○ `[s, k]`

Q4.4 (4 points) What should go in `BLANK FOUR`?

○ `sums(n - 2)`　　○ `at_least(n, k)`　　○ `at_least(n-k, k-1)`

○ `sums(n - 1)`　　○ `at_least(n, k + 1)`　　○ `at_least(n-k, k)`

○ `at_least(n, k - 2)`　　○ `at_least(n, k + 2)`　　○ `at_least(n-k, k+1)`

○ `at_least(n, k - 1)`　　○ `at_least(n-k, k-2)`　　● `at_least(n-k, k+2)`

Q4.5 (4 points) What should go in `BLANK FIVE`?

○ `sums(n - 2)`　　○ `at_least(n, k)`　　○ `at_least(n-k, k-1)`

○ `sums(n - 1)`　　○ `at_least(n, k + 1)`　　○ `at_least(n-k, k)`

○ `at_least(n, k - 2)`　　● `at_least(n, k + 2)`　　○ `at_least(n-k, k+1)`

○ `at_least(n, k - 1)`　　○ `at_least(n-k, k-2)`　　○ `at_least(n-k, k+2)`

Q4.6 (3 points) What should go in `BLANK SIX`?

● `with_k + without_k`

○ `with_k.extend(without_k)`

○ `with_k - without_k`

○ `[lst for lst in with_k if lst not in without_k]`

○ `[lst for lst in with_k if lst in without_k]`

○ `max([with_k, without_k], key = len)`

Q4.7 (3 points) What should go in `BLANK SEVEN`?

○ `k`　　○ `0`

○ `n`　　● `1`

Solution: The general idea here is that you start k at 1, then either use that value or not. Each recursive call, you add 2 to k to move to the next odd number.

Q5 *Spooky Scary Skeletons* **(15 points)**

Jack-O-Lantern wants to track his roster of Skeletons!

Fill in the `Skeleton` and `Spooky Scary Skeleton` classes with the following specifications:

The `Skeleton` class contains a class attribute `roster`, which is a dictionary with names (Strings) as keys and `Skeleton` or `Spooky Scary Skeleton` instances as values. Every time a new `Skeleton` or `Spooky Scary Skeleton` is created, we modify this class attribute.

Each `Skeleton` and `Spooky Scary Skeleton` has the following instance attributes:

- name: a String representing the name of the Skeleton
- dance_move: a String representing the Skeleton's best dance move!

Additionally, implement the `dance` method, which takes in a String representing the name of a potential dance `partner`.

- If this name is not in the `roster`, return the String "Skeleton Stranger Danger!"
- Else, if both `Skeleton's` `dance_move`s are equal to one another, return the String "Dancing the night away!"
- Else, return the String "Not quite in sync!"

One caveat: if both Skeletons are `Spooky Scary Skeleton`s, then we should return "Fated to be!", regardless of their favorite `dance_move`.

Below is an example use case of the classes:

```
>>> skellington = Skeleton("Skellington", "Bone Boogie")
>>> grimm = SpookyScarySkeleton("Grimm", "Bone Boogie")
>>> jack = SpookyScarySkeleton("Jack", "Rib Cage Rumba")
>>> skellington.name
'Skellington'
>>> Skeleton.roster["Grimm"].dance_move
'Bone Boogie'
>>> skellington.dance("Jack")
'Not quite in sync!'
>>> skellington.dance("Grimm")
'Dancing the night away!'
>>> jack.dance("Grimm")
'Fated to be!'
>>> jack.dance("Priya")
'Skeleton Stranger Danger!'
```

```
class Skeleton:
    roster = {}
    def __init__(self, name, dance_move):
        self.name = name
            Q5.1     Q5.2
        self.dance_move = dance_move
               Q5.3            Q5.4
        self.roster[name] = self
                   Q5.5
    def dance(self, partner):
        if partner not in self.roster:
                        Q5.6
            return "Skeleton Stranger Danger!"
        elif self.roster[partner].dance_move == self.dance_move:
                                      Q5.7
            return "Dancing the night away!"
        else:
            return "Not quite in sync!"

class SpookyScarySkeleton(Skeleton):
    def dance(self, partner):
        if CODE OMITTED: #Is the partner a Spooky Scary Skeleton?
            return "Fated to be!"
        return super().dance(partner)
                          Q5.8
```

(5 points) Jack finds himself dancing with other `Skeleton`s quite often. Fill in the method implementation for `get_dance_method` such that the following code executes as described below. For full credit, you may **not** use lambdas in your solution. A correct implementation with lambdas will incur a point penalty.

```
... #Assume we have the code from the previous page
>>> jack_dance = get_dance_method(jack)
>>> jack_dance("Grimm")
'Fated to be!'
>>> jack_dance("Priya")
'Skeleton Stranger Danger!'
```

```
class Skeleton:
    ...
    def get_dance_method(skeleton):
        return skeleton.dance
                      Q5.9
```

Solution: As written, the code will not execute properly. The get_dance_method should be placed outside of the Skeleton class. In that case, `skeleton.dance` would work properly. This question was graded to accept either `skeleton.dance` or `self.dance` to account for this issue.

Q6 *The Finish Line* **(0 points)**

These questions will not be assigned credit; feel free to leave them blank.

Q6.1 (0 points)

○ Trick ○ Treat

Q6.2 (0 points) What's your favorite halloween candy?

Q6.3 (0 points) If there's anything else you want us to know, or you feel like there was an ambiguity in the exam, please put it in the box below.

For ambiguities, you must qualify your answer and provide an answer for both interpretations. For example, "if the question is asking about A, then my answer is X, but if the question is asking about B, then my answer is Y". You will only receive credit if it is a genuine ambiguity and both of your answers are correct. We will only look at ambiguities if you request a regrade.

Solution: ¯_(ツ)_/¯