# PRACTICE MIDTERM 2

Computer Science 61A . October 20, 2015 . alvinwan.com/cs61a

- You have 2 hours to complete the exam.
- The exam is closed book, closed notes, closed computer, closed calculator, except one hand-written 8.5" × 11" crib sheet of your own creation and the official 61A midterm 2 study guide attached to the back of this exam.
- Mark your answers ON THE EXAM ITSELF. If you are not sure of your answer you may wish to provide a brief explanation.

| | |
|---|---|
| First Name | |
| Last Name | |
| SID | |
| Email (...@berkeley.edu) | |
| Login (e.g., cs61a-ta) | |
| TA & section time | |
| Name of person to your left | |
| Name of person to your right | |
| *All the work on this exam is my own.* **(please sign)** | |

**0. (0 Points)** On a scale of Paul to Nathan (mod Cindy), how do you feel? This question is gibberish; feel free to ignore.

Paul (mod Cindy) ____________________________________________ Nathan (mod Cindy)

## 01. (12 Points) TO SING OR NOT TO SING

For each of the expressions in the table below, write the output displayed by the interactive Python interpreter when the expression is evaluated. **The output may have multiple lines.** Expressions are evaluated in order, and **expressions may affect later expressions**.

Whenever the interpreter would report an error, write `Error`. If execution would take forever, write `Forever`. Assume that you have started Python 3 and executed the following statements:

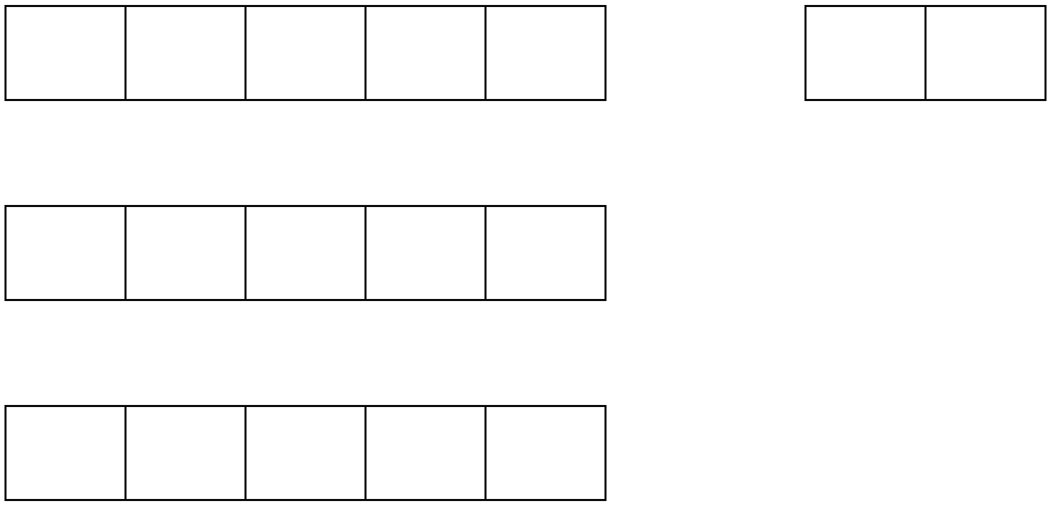
```
class Person:
    genres = ['fabulous!', 'oh no.']
    def __init__(self, octaves=(1, 2), genres=0):
        self.octaves = octaves
        if genres:
            self.genres = genres

    def sing(self):
        if not self.shift_octave(1):
            print(self.genres.pop(0))
            self.genres.append('yuk.')

    def shift_octave(self, shift):
        self.octaves[0] = shift

alvin, angie = Person(), Person([0, 1, 2, 3, 4, 5, 6])
paul = Person([11, 12, 13], ['b-e-a-U-tiful'])
```

| Expression | Interactive Output |
|---|---|
| `alvin.sing()` | |
| `angie.sing()` | |
| `alvin.octaves = [0]`<br>`alvin.sing()` | |
| `paul.sing()` | |
| `Person.genres` | |

## 02. (14 Points) CHIKIN

(a) **(3 Points)** First, fill in the following box-and-pointer diagrams that result from the following piece of code. If the interpreter would report an error, write `Error`. If execution would take forever, write `Forever`.

```
lst = ['A', 'B', 'C', 'D', 'E']
lst[1] = ['F', 'G', 'H', 'I', 'J']
lst[1][4] = ['K', 'L', 'M', 'N', 'O']
lst[1][0] = lst[1][4]
x = lst[1]
y = x[0]
y[2] = x[2:4]
x, lst[1], y = y[2], lst, lst[1]
```



(b) **(5 Points)** Then, fill in the following piece of code, to output 'CHIKIN'. If the interpreter failed previously, runs forever, would error, or simply cannot be completed, write `Impossible`. You may only retrieve indices, using square brackets and integers.

```
>>> c, h, i, k, n = lst[1]____, x___, y______[1], y[0][0][0]_____, y[0]____
>>> c + h + i + k + i + n
```

(c) **(5 Points)** Fill in the environment diagram that results from executing the code below until the entire program is finished, an error occurs, or all frames are filled. You may not need to use all of the spaces or frames.

A complete answer will:

- Add all missing names and parent annotations to all local frames.
- Add all missing values created or referenced during execution.
- Show the return value for each local frame.

Remember: Do not add a new frame when calling a built-in function (such as `abs`). The built-in `abs` function is always written as `func abs(...) [parent=Global]`.

```
def f(x):
    def h(x):
        return x*g(x-1, h)
    def g(x, g):
          if x <= 0:
              return 1
          return g(x)
    return g(abs(x), h)

f(1)
```

(d) **(1 Point)** What does the above function call `f(x)` compute, in terms of `x`?

## 03. (8 Points) TREES GONE HAYWIRE

(a) **(5 points)** In lab, we implemented `has_a_cycle` for a linked list, where the last element of a cyclic list points to the head. We now define a *cyclic tree* to be any tree where a node has the root node as a child. Implement `has_a_cycle` for a tree below. Both the `Tree` class and the tree data abstraction appear on the midterm 2 study guide. *Warning: Do not violate the tree data abstraction! (Exams are flammable.)*

```
def has_a_cycle(t):
    """Returns whether or not a tree is cyclic. We define a cyclic tree as
    any tree with a node that has the root node as a child. Assume that all
    nodes in the tree contain distinct values.

    >>> t = Tree(3, Tree(5, Tree(4), Tree(6)),
    ...        Tree(8, Tree(10), Tree(1, Tree(2))))
    >>> has_a_cycle(t)
    False
    >>> t.right.left.left = t
    >>> has_a_cycle(t)
    True
    >>> t.right.left.left = Tree.empty
    >>> has_a_cycle(t)
    False
    >>> t.right.right.right = t
    >>> has_a_cycle(t)
    True
    """
    return any([detective(t, b) for b in branches(t)])


def detective(tortoise, hare=None):

    if ______________________________________________:

        return _______________

    if ________________________________:

        return ______________

    return __________________________________________________________________

           __________________________________________________________________
```

(b) **(2 points)** Complete the following `has_a_cycle` implementation to detect if a Python list is cyclic.

```
has_a_cycle = lambda lst: ______________________________________________
```

(c) **(1 point)** Compute the runtime of `has_a_cycle` in 3(b) with respect to the number of elements n in the list `lst`.

```
Runtime: O(____)
```

(d) **(Bonus, 1 point)** Write a one-line function that can detect a nested, cyclic list of *any depth*, using `has_a_cycle_helper(x, y)`, which achieves the same result but checks if x exists in y. Assume that your lists *only* contain either integers or pointers to other lists.

```
has_a_cycle_nested = lambda lst: _________________________________________
```

(e) **(Bonus, 5 points)** Now, implement the *one-line function* `has_a_cycle_nested(x, y)` used in the function above. Assume that your lists *only* contain either integers or pointers to other lists. The additional lines are added in case your code is longer in width than the space provided. Do not add additional lines of code.

```
has_a_cycle_helper = lambda x, y: ________________________________________

__________________________________________________________________________
```

**AREA INTENTIONALLY LEFT BLANK**

Feel free to use this space to show work, doodle, or spill coffee.

## 04. (4 Points) PASCAL'S TRIANGLE

Pascal's Triangle is a "triangle" of values, beginning at 1, where each subsequent row is generated by summing each pair of values in the previous row. Implement `pascals_generator()`, which returns a function that will sequentially generate the next series of k elements in Pascal's triangle. Hint: The list should look like: [1, 1, 1, 1, 2, 1, 1, 3, 3, 1, 1, 4, 6, 4, 1 ... ].

```
def pascals_generator():
    """ Generate a subset of Pascal's triangle as a list.

    >>> pascals = pascals_generator()
    >>> pascals(3)
    [1, 1, 1]
    >>> pascals(3)
    [2, 1, 1]
    >>> pascals(4)
    [3, 3, 1, 1]
    """
    lst, row, index = [1], [1], 1
    def pascals(k):
        nonlocal row, index
        while ______________________________:

            indices = ___________________________

            center = ______________________________________

            row = [1] + ___________________ + [1]

            ____________________________________

        _____________________________________

        return lst[____________:_____________]

    return pascals
```