CS 61A Fall 2019

Structure and Interpretation of Computer Programs

MIDTERM 1

INSTRUCTIONS

- You have 1 hour and 50 minutes to complete the exam.
- The exam is closed book, closed notes, closed computer, closed calculator, except one hand-written $8.5" \times 11"$ crib sheet of your own creation and the official CS 61A midterm 1 study guide.
- Mark your answers on the exam itself. We will not grade answers written on scratch paper.

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First name	
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Name of the person to your left	
Name of the person to your right	
All the work on this exam is my own.	
(please sign)	
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POLICIES & CLARIFICATIONS

- If you need to use the restroom, bring your phone and exam to the front of the room.
- You may use built-in Python functions that do not require import, such as min, max, pow, len, and abs.
- You may not use example functions defined on your study guide unless a problem clearly states you can.
- For fill-in-the-blank coding problems, we will only grade work written in the provided blanks. You may only write one Python statement per blank line, and it must be indented to the level that the blank is indented.
- Unless otherwise specified, you are allowed to reference functions defined in previous parts of the same question.

1. (12 points) What Would Python Display

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. If an error occurs, write "Error", but include all output displayed before the error. If evaluation would run forever, write "Forever". To display a function value, write "Function". The first two rows have been provided as examples.

The interactive interpreter displays the value of a successfully evaluated expression, unless it is None.

Assume that you have first started python3 and executed the statements on the left.

		Expression	Interactive Output
<pre>def mint(y):</pre>		pow(10, 2)	100
<pre>return print(-2) def snooze(e, f):</pre>	(2 pt)	print(4, 5) + 1	4 5 Error
<pre>if e and f(): print(e) if e or f(): print(f)</pre>		<pre>print(mint(print))</pre>	
<pre>print(i) if not e:</pre>			
print('naughty')	(3 pt)	<pre>print(snooze(1, lose))</pre>	
<pre>def lose(): return -1</pre>			
<pre>def alarm(): print('Midterm')</pre>	(2)		
1 / 0 print('Time')	(3 pt)	<pre>snooze(print(1), alarm)</pre>	
<pre>def sim(b, a): while a > 1:</pre>			
def sc(ar): $a = b + 4$	(2 pt)	sim(3, 3)	
<pre>return b a, b = a // 2, b - a print(a) print(sc(b - 1), a)</pre>			
<pre>pumbaa = lambda f: lambda x: f(f(x)) pumbaa = pumbaa(pumbaa) rafiki = 1</pre>	(2 pt)	pumbaa(timon)(5)	
timon = lambda y: y + rafiki rafiki = -1			

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2. (6 points) Environmental Studies

Fill in the environment diagram that results from executing the code on the right 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:

- \bullet 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.

```
def oski(oski):
    x = 1
    if oski(2) > x:
        return oski
bear = lambda z: (lambda y: z+3)(x+4)
x, z = 11, 12
x = oski(bear)
```

Global frame	oski —		func oski(oski)	[parent=Global]
f1:	[parent=]			
	Return Value			
f2:	[parent=]			
	Return Value			
f3:	[parent=]			
	Return Value			

1

2

3

4

5

6

7

8

3. (5 points) You Again

Implement again, which takes a function f as an argument. The again function returns the smallest non-negative integer n for which f(n) is equal to f(m) for some non-negative m that is less than n. Assume that f takes non-negative integers and returns the same value for at least two different non-negative arguments.

Constraints:

- Lines numbered 2, 4, and 5 must begin with either while or if.
- Lines numbered 6 and 7 must contain either return or =.

```
def parabola(x):
    """A parabola function (for testing the again function)."""
    return (x-3) * (x-6)
def vee(x):
    """A V-shaped function (for testing the again function)."""
    return abs(x-2)
def again(f):
    """Return the smallest non-negative integer n such that f(n) == f(m) for some m < n.
    >>> again(parabola) # parabola(4) == parabola(5)
    >>> again(vee)
                         # vee(1) == vee(3)
    3
    .....
   n = 1
        m = 0
        n = n + 1
```

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4. (17 points) Ups and Downs

Definition. Two adjacent digits in a non-negative integer are an *increase* if the left digit is smaller than the right digit, and a *decrease* if the left digit is larger than the right digit.

For example, 61127 has 2 increases $(1 \rightarrow 2 \text{ and } 2 \rightarrow 7)$ and 1 decrease $(6 \rightarrow 1)$.

You may use the sign function defined below in all parts of this question.

```
def sign(x):
    if x > 0:
        return 1
    elif x < 0:
        return -1
    else:
        return 0</pre>
```

(a) (5 pt) Implement ramp, which takes a non-negative integer n and returns whether it has more *increases* than *decreases* when reading its digits from left to right (see the definition above).

```
def ramp(n):
```

"""Return whether non-negative integer N has more increases than decreases.

```
>>> ramp(123)  # 2 increases (1 -> 2, 2 -> 3) and 0 decreases

True
>>> ramp(1315)  # 2 increases (1 -> 3, 1 -> 5) and 1 decrease (3 -> 1)

True
>>> ramp(176)  # 1 increase (1 -> 7) and 1 decrease (7 -> 6)

False
>>> ramp(5)  # 0 increases and 0 decreases

False
"""
```

n, last, tally = _____, , _____, 0

while n:

```
n, last, tally = n // 10, n % 10, _____
```

return _____

(b) (3 pt) Implement over_under, which takes a number y and returns a function that takes a number x. This function returns 1 if x is greater than y, 0 if x equals y, and -1 if x is less than y.

You may <u>not</u> use if, and, or or.

Read this first. The process function below uses tally and result functions to analyze all adjacent pairs of digits in a non-negative integer n. A tally function is called on each pair of adjacent digits.

```
def process(n, tally, result):  
"""Process all pairs of adjacent digits in N using functions TALLY and RESULT."""  
while n >= 10:  
   tally, result = tally(n % 100 // 10, n % 10)  
   n = n // 10  
return result()
```

(c) (6 pt) Implement ups, which returns two functions that can be passed as tally and result arguments to process, so that process computes whether a non-negative integer n has exactly k *increases*.

Hint: You can use sign from the previous page and the built-in max and min functions.

```
def ups(k):
```

"""Return tally and result functions that compute whether N has exactly K increases.

```
>>> f, g = ups(3)
>>> process(1200849, f, g)  # Exactly 3 increases: 1 -> 2, 0 -> 8, 4 -> 9
True
>>> process(94004, f, g)  # 1 increase: 0 -> 4
False
>>> process(122333445, f, g)  # 4 increases: 1 -> 2, 2 -> 3, 3 -> 4, 4 -> 5
False
>>> process(0, f, g)  # 0 increases
False
"""
def f(left, right):
```

return _____(_____)

return _____, , _____,

(d) (3 pt) Implement at_most, which returns True if the number of *increases* in a non-negative integer n is less than or equal to k, and False otherwise. Assume ups is implemented correctly. You may use any of the functions from previous parts of this question: sign, ramp, over_under, and process.

```
def at_most(n, k):
```

"""Return whether non-negative integer N has at most K increases.

return result