### CS 61A Fall 2018

# Structure and Interpretation of Computer Programs

MIDTERM 1

#### INSTRUCTIONS

- You have 2 hours to complete the exam.
- The exam is closed book, closed notes, closed computer, closed calculator, except one hand-written  $8.5" \times 11"$  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.

Last name	
First name	
Student ID number	
CalCentral email (_@berkeley.edu)	
Carcentral chair (_sborkersy.caa)	
TA	
Name of the person to your left	
Name of the person to your right	
A11 11 1 11 · · ·	
All the work on this exam is my own.	
(please sign)	

#### 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 guides 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. (10 points) What Would Python Display (All are in Scope: WWPD, Lambda Expressions, Higher-Order Functions)

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.

```
identity = lambda x: x
increment = lambda x: x + 1
def fif(c, t, f, x):
    if c(x):
        return t(x)
    else:
        return f(x)
def bounce(x, y):
    while x < y:
        if x \le (y \text{ and } x):
            print('a')
        if x > 0:
            print('b')
        elif x > -5:
            print('c')
        x, y = -y, increment(x - y)
        print(y)
crazy = lambda rich: 100 * rich
crazy = lambda rich: crazy(crazy(rich))
def ok(py):
    def h(w):
        print(py // 10)
        return ok(py)
    return lambda h: h(py)
```

Expression	Interactive Output
pow(10, 2)	100
print(4, 5) + 1	4 5
	Error
<pre>print(None, print(1, 2))</pre>	
fif(abs, print, print, -2)	
bounce(1, 2)	
crazy(88)	
, (33)	
ok(314)(identity)	
ON (OI4) (Identity)	

74.7	_
Name:	Q
ranic.	5

2. (4 points) (All are in Scope: Lambda Expressions, Higher-Order Functions) Implement factorial, which computes the factorial of a positive integer n. You may use any of the functions defined above. You may not write if, else, and, or, or lambda in your solution.

3. (6 points) Also Some Meal (All are in Scope: Environment Diagrams, Lambda Expressions, Higher-Order Functions)

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:

- 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 al(so):
         me = 1
         def al(to):
             return so + me
 5
         so = 2
         return al
 7
    def me(al):
         me = 3
10
         return al(lambda: 4) + so
11
12
    so = 5
    so = me(al(6)) + so
```

5

Global frame	al	<b></b>	func al(so)	[parent=Global]
	<u>me</u>	<b></b>	func me(al)	[parent=Global]
f1:	[parent=]			
	Return Value			
f2:	[parent=]			
	Return Value			
f3:	[parent=]			

Return Value

#### 4. (5 points) Getting Rect (All are in Scope: Control)

Implement rect, which takes two positive integer arguments, perimeter and area. It returns the integer length of the longest side of a rectangle with integer side lengths  $\ell$  and h which has the given perimeter and area. If no such rectangle exists, it returns False.

The perimeter of a rectangle with sides  $\ell$  and h is  $2\ell + 2h$ . The area is  $\ell \cdot h$ .

Hint: The built-in function round takes a number as its argument and returns the nearest integer. For example, round (2.0) evaluates to 2, and round (2.5) evaluates to 3.

def rect(area, perimeter): """Return the longest side of a rectangle with area and perimeter that has integer sides. >>> rect(10, 14) # A 2 x 5 rectangle >>> rect(5, 12) # A 1 x 5 rectangle >>> rect(25, 20) # A 5 x 5 rectangle >>> rect(25, 25) # A 2.5 x 10 rectangle doesn't count because sides are not integers False >>> rect(25, 29) # A 2 x 12.5 rectangle doesn't count because sides are not integers False >>> rect(100, 50) # A 5 x 20 rectangle 20 11 11 11 side = 1while side \* side \_\_\_\_\_\_ area: other = round(\_\_\_\_\_) if \_\_\_\_\_:

side = side + 1

return False

Name:		
5. (6 points) Dig	g It (All are in Scope: Co	ontrol, Higher-Order Functions)
show the $n$ element		ve integer n and a function term. It returns an integer whose digits 1), term(2),, term(n) in order. Assume the term function takes positive integer.
Important: You	u may $\underline{\text{not}}$ use $pow$ , **,	log, str, or len in your solution.
def sequence(n, term	m): irst n terms of a sequ	lence as an integer.
>>> sequence(6, 123456	abs)	# Terms are 1, 2, 3, 4, 5, 6
>>> sequence(5, 910111213	lambda k: k+8)	# Terms are 9, 10, 11, 12, 13
>>> sequence(4, 101001000100000 """	lambda k: pow(10, k))	) # Terms are 10, 100, 1000, 10000
t, k = 0, 1		
while		:
m = 1		
x =		
		m <= x:
t =		
k = k + 1		
return t		

6. (9 points) This Again? (At least one of these is out of Scope: Self Reference, Higher-Order Functions, Lambda Expressions, Control)

**Definitions.** A repeatable integer function takes an integer argument and returns a repeatable integer function.

(a) (6 pt) Implement repeat, which is a repeatable integer function that detects repeated arguments. As a side effect of repeated calls, it prints each argument that has been used before in a sequence of repeated calls. Therefore, if an argument appears n times, it is printed n-1 times in total, each time other than the first.

The detector function is part of the implementation of repeat; you must determine how it is used. Important: You may not use a list, set, or any other data type not covered yet in the course. def repeat(k): """When called repeatedly, print each repeated argument. >>> f = repeat(1)(7)(7)(3)(4)(2)(5)(1)(6)(5)(1)1 5 ..... return \_\_\_\_\_(k) def detector(f): def g(i): if \_\_\_\_\_: \_\_\_\_\_\_ return \_\_\_\_\_ return g (b) (3 pt) Implement repeat\_digits, which takes a non-negative integer n. For the digits of n from right to left, it prints each digit that also appears somewhere to its right. Assume repeat is implemented correctly. def repeat\_digits(n): """Print the repeated digits of non-negative integer n. >>> repeat\_digits(581002821) 0 1 8 11 11 11 f = \_\_\_\_\_\_ while n: f, n = \_\_\_\_\_, , \_\_\_\_\_