

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)	
TA	
Name of the person to your left	
Name of the person to your right	
<i>All the work on this exam is my own.</i> (please sign)	

1. (10 points) **I Wonder What Python Would Display** (*All are in Scope: WWPD, Higher-Order Functions, Lambda Expressions*)

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. 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.

```
aaron, burr = 2, 5
aaron, burr = 4, aaron + 1
```

```
hamil = 10
```

```
def alex(hamil):
    def g(w):
        hamil = 2 * w
        print(hamil, w)
        w = hamil
        return hamil
    w = 5
    alex = g(w + 1)
    print(w, alex, hamil)
```

```
def el(i, za):
    def angelica():
        return i + 1
    if i > 10:
        return za()
    elif i > 4:
        print(angelica())
        return el(i * i, za)
    else:
        return el(i * i,
                  angelica)
```

```
K = lambda x: lambda y: x
```

```
def pr(x):
    print(x)
    return x
```

Expression	Interactive Output
<code>pow(2, 3)</code>	8
<code>print(4, 5) + 1</code>	4 5 Error
<code>print(aaron, burr)</code>	
<code>alex(3)</code>	
<code>el(3, el)</code>	
<code>K</code>	
<code>K(3)</code>	
<code>K(3)(2)</code>	
<code>pr(True) and pr(0) and pr(1)</code>	

**2. (8 points) Environmental Influences** (*All are in Scope: Environment Diagrams, Higher-Order Functions*)

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, frames, or function values.*

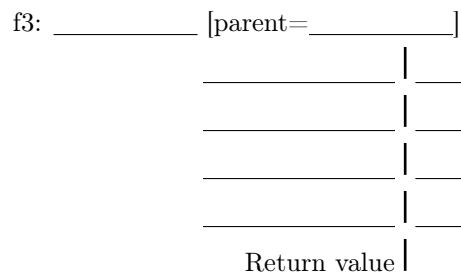
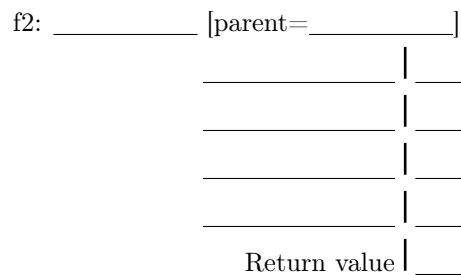
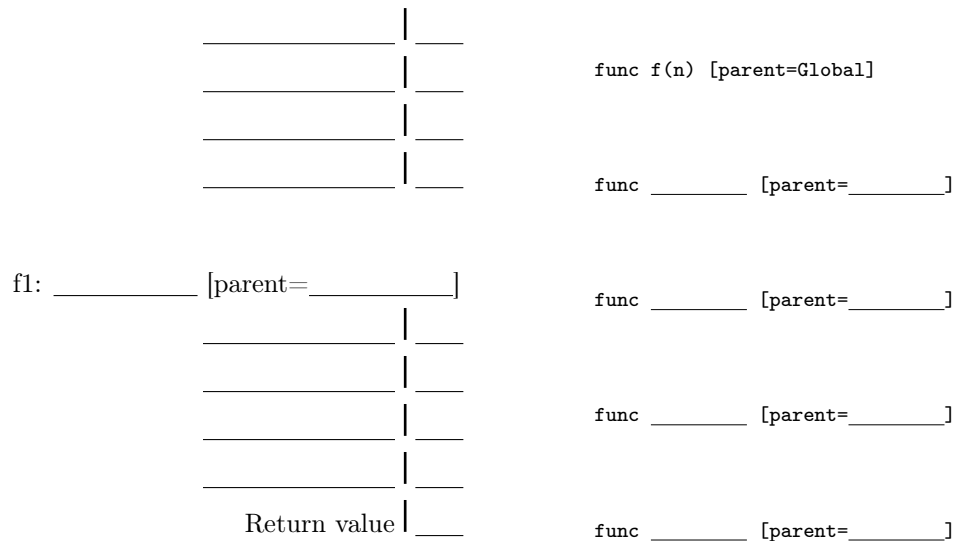
A complete answer will:

- 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.

```

1  x = 1
2  def f(n):
3      def g():
4          return n + x
5      x = n + 5
6      if n % 3 == 0:
7          return g
8      else:
9          return f(n + 1)
10 x = 10
11 z = f(2)
12 q = x + z()
```

Global frame



### 3. (3 points) Triangulate *(All are in Scope: Control)*

It's easy to see that in any triangle, each side must be shorter than the sum of the other two. Implement `triangle`, which takes three positive numbers, `a`, `b`, and `c`, and returns whether these three numbers could possibly be the lengths of the three sides of a triangle.

```
def triangle(a, b, c):
    """Return whether a, b, and c could be the legs of a triangle.
```

```
>>> triangle(3, 4, 5)
True
>>> triangle(3, 4, 6)
True
>>> triangle(6, 3, 4)
True
>>> triangle(3, 6, 4)
True
>>> triangle(9, 2, 2)
False
>>> triangle(2, 4, 2)
False
"""
```

```
    longest = _____
```

```
    sum_of_others = _____
```

```
    return longest _____ sum_of_others
```

## 4. (9 points) Digital

- (a) (3 pt) (*All are in Scope: Recursion*) Implement `collapse`, which takes a non-negative integer, and returns the result of removing all digits from it that duplicate the digit immediately to their right.

```
def collapse(n):
    """For non-negative N, the result of removing all digits that are equal
    to the digit on their right, so that no adjacent digits are the same.

    >>> collapse(1234)
    1234
    >>> collapse(12234441)
    12341
    >>> collapse(0)
    0
    >>> collapse(3)
    3
    >>> collapse(11200000013333)
    12013
    """

    left, last = n // 10, n % 10

    if _____:

        return last

    elif _____ == _____:

        return collapse(_____)

    else:

        return collapse(_____) * 10 + _____
```

- (b) (6 pt) (*All are in Scope: Control, Higher-Order Functions*) Implement `find_pair`, which takes a two-argument function, `p`, as input and returns another function. The returned function takes a non-negative integer `n`; it returns `True` if and only if `p` returns a true value when called on at least one pair of adjacent digits in `n`, and `False` otherwise.

```
def find_pair(p):
    """Given a two-argument function P, return a function that takes a
    non-negative integer and returns True if and only if two adjacent digits
    in that integer satisfy P (that is, cause P to return a true value).

    >>> z = find_pair(lambda a, b: a == b)    # Adjacent equal digits
    >>> z(1313)
    False
    >>> z(12334)
    True
    >>> z = find_pair(lambda a, b: a > b)
    >>> z(1234)
    False
    >>> z(123412)
    True
    >>> find_pair(lambda a, b: a <= b)(9753)
    False
    >>> find_pair(lambda a, b: a == 1)(1)    # Only one digit; no pairs.
    False
    """
```

```
def find(n):
```

```
    while _____:
```

```
        if _____:
```

```
            return _____
```

```
        else:
```

```
            _____ = _____
```

```
            _____
```

```
            _____
```

**5. (10 points) Please Confirm** (*All are in Scope: Recursion, Higher-Order Functions*)

**Definition.** A *confirming function* for a sequence of digits, called a *code*, takes a single digit as its only argument. If the digit does not match the first (left-most) digit of the code to be confirmed, it returns **False**. If the digit does match, then the confirming function returns **True** if the code has only one digit, or another confirming function for the rest of the code if there are more digits to confirm.

- (a) (5 pt) Implement `confirmer` so that when `confirmer` takes a positive integer `code`, it returns a confirming function for the digits of that `code`.

```
def confirmer(code):
    """Return a confirming function for CODE.

    >>> confirmer(204)(2)(0)(4) # The digits of 204 are 2, then 0, then 4.
    True
    >>> confirmer(204)(2)(0)(0) # The third digit of 204 is not 0.
    False
    >>> confirmer(204)(2)(1)     # The second digit of 204 is not 1.
    False
    >>> confirmer(204)(20)       # The first digit of 204 is not 20.
    False
    """
    def confirm1(d, t):
        def result(digit):
            if d == digit:
                return t
            else:
                return False
        return result

    def extend(prefix, rest):
        """Return a confirming function that returns REST when given the digits of PREFIX.
        For example, if c = extend(12, confirmer(34)), then c(1)(2) returns confirmer(34),
        so that c is a confirming function for 1234."""

        left, last = prefix // 10, prefix % 10

        if _____:

            return _____

        else:

            return _____

    return _____
```

- (b) (5 pt) Given a confirming function, one can find the code it confirms, one digit at a time. Implement `decode`, which takes a confirming function `f` and returns the code that it confirms.

```
def decode(f, y=0):
    """Return the code for a confirming function f.
```

```
>>> decode(confirm(12001))
12001
>>> decode(confirm(56789))
56789
"""
```

```
d = 0
```

```
while d < 10:
```

```
    x, code = _____ , _____
```

```
    if x == True:
```

```
        return code
```

```
    elif x == False:
```

```
        _____
```

```
    else:
```

```
        _____
```