# CS 61A Summer 2024 — Environment Diagrams, Higher-Order Functions

Discussion 2: June 25, 2024

## Getting Started

Say your name and a city (or place) that you like, which is not Berkeley and is not where you have lived. Feel free to share why you like it.

**VERY IMPORTANT:** In this discussion, don't run any Python code until your whole group is sure that the answer is right. Your goal should be to have all checks pass the first time! Figure things out and check your work by *thinking* about what your code will do. Not sure? Talk to your group! (You won't get to run Python during the midterm, so get used to solving problems without it now.)

#### Q1: Warm Up

What is the value of `result` after executing `result = (lambda x: 2 * (lambda x: 3)(4) * x)(5)`? Talk about it with your whole group and make sure you all agree before anybody tries running the code in Python.

## Environment Diagrams

An **environment diagram** keeps track of names and their values in frames, which are drawn as boxes.

#### Q2: Bottles

Answer the following questions with your group. Step through the diagram to check your answers.

1) What determines how many different frames appear in an environment diagram?

a) The number of functions defined in the code
b) The number of call expressions in the code
c) The number of return statements in the code
d) The number of times user-defined functions are called when running the code

2) What happens to the return value of `pass_it(bottles)`?

a) It is used as the new value of `remaining` in the global frame
b) It is used as the new value of `bottles` in the global frame
c) It is used as the new value of `pass_it` in the global frame
d) None of the above

3) What effect does the line `bottles = 98` have on the global frame?

a) It temporarily changes the value bound to `bottles` in the global frame.
b) It permanently changes the value bound to `bottles` in the global frame.
c) It has no effect on the global frame.

See the web version of this resource for the environment diagram.

#### Q3: Double Trouble

Draw the environment diagram on paper or a whiteboard (without having the computer draw it for you)! Then, check your work by stepping through the diagram.

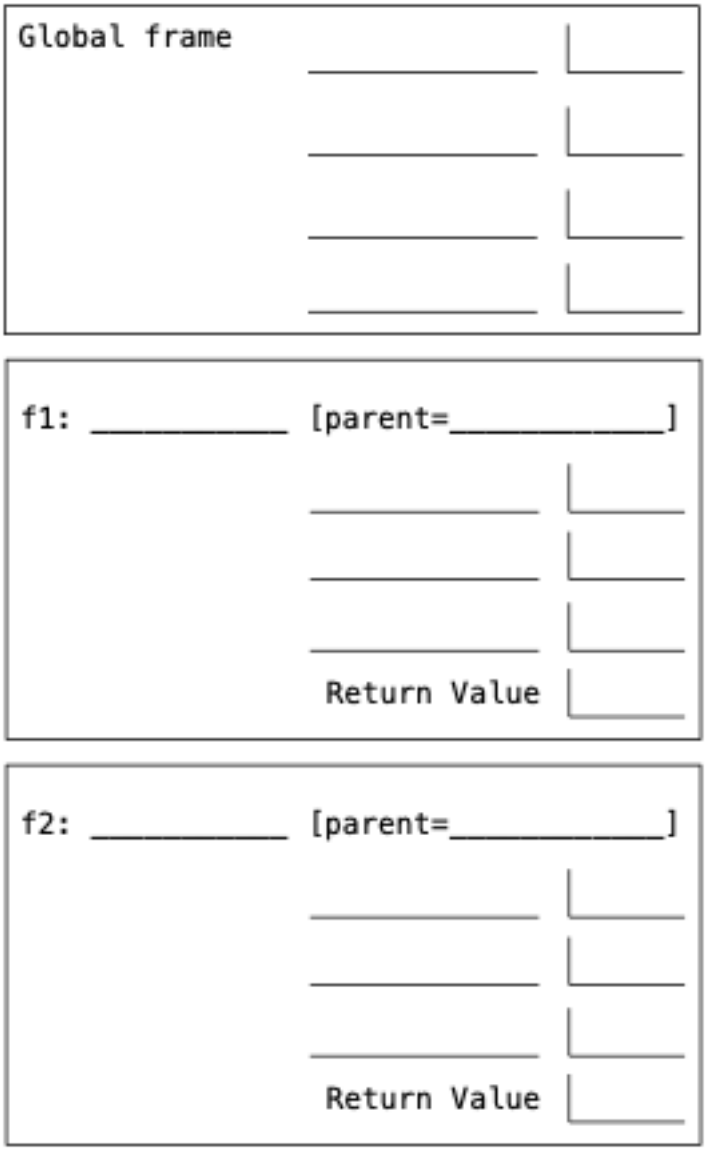
See the web version of this resource for the environment diagram.

# Call Expressions

Draw an environment diagram for the code below. You can use paper or a tablet or the whiteboard. Talk to your group about how you are going to draw it, then go through each step *together*. Then, step through the diagram to check your work.

See the web version of this resource for the environment diagram.

Here's a blank diagram in case you're using a tablet:




**template**

If you have questions or are confused, feel free to ask staff!

# Higher-Order Functions

Remember the problem-solving approach from last discussion; it works just as well for implementing higher-order functions.

1. Pick an example input and corresponding output. *(This time it might be a function.)*
2. Describe a process (in English) that computes the output from the input using simple steps.
3. Figure out what additional names you'll need to carry out this process.
4. Implement the process in code using those additional names.
5. Determine whether the implementation really works on your original example.
6. Determine whether the implementation really works on other examples. (If not, you might need to revise step 2.)

**Q4: Make Keeper**

Implement `make_keeper`, which takes a positive integer `n` and returns a function `f` that takes as its argument another one-argument function `cond`. When `f` is called on `cond`, it prints out the integers from 1 to `n` (including `n`) for which `cond` returns a true value when called on each of those integers. Each integer is printed on a separate line.

```
def make_keeper(n):
    """Returns a function that takes one parameter cond and prints
    out all integers 1..i..n where calling cond(i) returns True.

    >>> def is_even(x): # Even numbers have remainder 0 when divided by 2.
    ...     return x % 2 == 0
    >>> make_keeper(5)(is_even)
    2
    4
    >>> make_keeper(5)(lambda x: True)
    1
    2
    3
    4
    5
    >>> make_keeper(5)(lambda x: False)  # Nothing is printed
    """
    "*** YOUR CODE HERE ***"
```

No peeking! First try to implement it without the hint.

To return a function `f`, include `def f(cond):` as the first line of the implementation and `return f` as the last. The `f` function should introduce `i = 1` in order to loop through all integers, calling `cond(i)` to determine whether `cond` returns true for each integer.

**Don't run Python to check your work. You can check it just by thinking!** If you get stuck, ask the staff for help.

Once your group has converged on a solution, now it's time to practice your ability to describe your own code. A good description is like a good program: concise and accurate. Nominate someone to describe how your solution works and have them present to the group for practice.

### Q5: Digit Finder

Implement `find_digit`, which takes in a positive integer `k` and returns a function that takes in a positive integer `x` and returns the `k`th digit from the right of `x`. If `x` has fewer than `k` digits, it returns 0.

For example, in the number 4567, 7 is the 1st digit from the right, 6 is the 2nd digit from the right, and the 5th digit from the right is 0 (since there are only 4 digits).

**Important:** You may not use strings or indexing for this problem. Try to solve this problem using only one line.

**Hint**: Lambda expressions.

**Hint**: Use floor dividing by a power of 10 gets rid of the rightmost digits.

```
def find_digit(k):
    """Returns a function that returns the kth digit of x.

    >>> find_digit(2)(3456)
    5
    >>> find_digit(2)(5678)
    7
    >>> find_digit(1)(10)
    0
    >>> find_digit(4)(789)
    0
    """
    assert k > 0
    "*** YOUR CODE HERE ***"
```

First remove all of the digits after digit `k`, at which point digit `k` will be the last digit.

### Q6: Match Maker

Implement `match_k`, which takes in an integer `k` and returns a function that takes in a variable `x` and returns `True` if all the digits in `x` that are `k` apart are the same.

For example, `match_k(2)` returns a one argument function that takes in `x` and checks if digits that are 2 away in `x` are the same.

`match_k(2)(1010)` has the value of `x = 1010` and digits 1, 0, 1, 0 going from left to right. `1 == 1` and `0 == 0`, so the `match_k(2)(1010)` results in `True`.

`match_k(2)(2010)` has the value of `x = 2010` and digits 2, 0, 1, 0 going from left to right. `2 != 1` and `0 == 0`, so the `match_k(2)(2010)` results in `False`.

**Important:** You may not use strings or indexing for this problem.

**Hint**: Floor dividing by powers of 10 gets rid of the rightmost digits.

```
def match_k(k):
    """Returns a function that checks if digits k apart match.

    >>> match_k(2)(1010)
    True
    >>> match_k(2)(2010)
    False
    >>> match_k(1)(1010)
    False
    >>> match_k(1)(1)
    True
    >>> match_k(1)(2111111111111111)
    False
    >>> match_k(3)(123123)
    True
    >>> match_k(2)(123123)
    False
    """
    def check(x):
        while x // (10 ** k) > 0:
            if ____________________________:
                return ____________________________
            x //= 10
        ____________________________
    ____________________________
```

In each iteration, compare the last digit with the one that is `k` positions before it.

# Submit Attendance

You're done! Excellent work this week. Please be sure to ask your section TA for the attendance form link and fill it out for credit. (one submission per person per section).