Control and Environment Diagrams 1

Computer Science 61A

June 23, 2016

1 Control

Control structures direct the flow of logic in a program. For example, conditionals (`if-elif-else`) allow a program to skip sections of code, while iteration (`while`), allows a program to repeat a section.

1.1 If statements

Conditional statements let programs execute different lines of code depending on certain conditions. Let's review the `if- elif-else` syntax:

```
if <conditional expression>:
    <suite of statements>
elif <conditional expression>:
    <suite of statements>
else:
    <suite of statements>
```

Recall the following points:

- The `else` and `elif` clauses are optional, and you can have any number of `elif` clauses.
- A **conditional expression** is a expression that evaluates to either a true value (`True`, a non-zero integer, etc.) or a false value (`False`, `0`, `None`, `""`, `[]`, etc.).
- Only the **suite** that is indented under the first `if/elif` with a **conditional expression** evaluating to a true value will be executed.

- If none of the **conditional expressions** evaluate to a true value, then the `else` suite is executed. There can only be one `else` clause in a conditional statement!

1.2 Boolean Operators

Python also includes the **boolean operators** `and`, `or`, and `not`. These operators are used to combine and manipulate boolean values.

- `not` returns the opposite truth value of the following expression.
- `and` stops evaluating any more expressions (short-circuits) once it reaches the first false value and returns it. If all values evaluate to a true value, the last value is returned.
- `or` short-circuits at the first true value and returns it. If all values evaluate to a false value, the last value is returned.

```
>>> not None
True
>>> not True
False
>>> -1 and 0 and 1
0
>>> False or 9999 or 1/0
9999
```

1.3 Questions

1. Alfonso will only wear a jacket outside if it is below 60 degrees or it is raining. Fill in the function `wears_jacket` which takes in the current temperature and a Boolean value telling if it is raining and returns `True` if Alfonso will wear a jacket and `False` otherwise.

   This should only take one line of code!

```
def wears_jacket(temp, raining):
    """
    >>> rain = False
    >>> wears_jacket(90, rain)
    False
    >>> wears_jacket(40, rain)
    True
    >>> wears_jacket(100, True)
    True
    """
```

2. To handle discussion section overflow, TAs may direct students to a more empty section that is happening at the same time. Write the function `handle_overflow`, which takes in the number of students at two sections and prints out what to do if either section exceeds 30 students. See the doctests below for the behavior.

```
def handle_overflow(s1, s2):
    """
    >>> handle_overflow(27, 15)
    No overflow.
    >>> handle_overflow(35, 29)
    1 spot left in Section 2.
    >>> handle_overflow(20, 32)
    10 spots left in Section 1.
    >>> handle_overflow(35, 30)
    No space left in either section.
    """
```

1.4 While loops

Iteration lets a program repeat statements multiple times. A common iterative block of code is the **`while` loop**:

```
while <conditional clause>:
    <body of statements>
```

As long as `<conditional clause>` evaluates to a true value, `<body of statements>` will continue to be executed. The conditional clause gets evaluated each time the body finishes executing.

1.5 Questions

1. What is the result of evaluating the following code?

```
def square(x):
    return x * x

def so_slow(num):
    x = num
    while x > 0:
        x = x + 1
    return x / 0

square(so_slow(5))
```

2. Fill in the `is_prime` function, which returns `True` if `n` is a prime number and `False` otherwise. After you have a working solution, think about potential ways to make your solution more *efficient*.

   Hint: use the `%` operator: `x % y` returns the remainder of `x` when divided by `y`.

```
def is_prime(n):
```

1.6 Have Some More Control!

1. Implement `fizzbuzz(n)`, which prints numbers from 1 to `n` (inclusive). However, for numbers divisible by 3, print "fizz". For numbers divisible by 5, print "buzz". For numbers divisible by both 3 and 5, print "fizzbuzz".

   This is a standard software engineering interview question, but even though we're barely one week into the course, we're confident in your ability to solve it!

```
def fizzbuzz(n):
    """
    >>> result = fizzbuzz(16)
    1
    2
    fizz
    4
    buzz
    fizz
    7
    8
    fizz
    buzz
    11
    fizz
    13
    14
    fizzbuzz
    16
    >>> result == None
    True
    """
```

2 Lists and For Statements

2.1 List slicing and indexing

If we want to access more than one element of a list at a time, we can use a *slice*. Slicing a sequence is very similar to indexing. We specify a starting index and an ending index, separated by a colon. Python creates a new list with the elements from the starting index up to (but not including) the ending index. Specifically, we can write [*start*:*stop*] to slice a list with two integers.

start denotes the index for the beginning of the slice(inclusive)
stop denotes the index for the end of the slice(exclusive)

Using negative indices for start and end behaves in the same way as indexing into negative indices. Slicing a list always creates a new list.

```
>>> pizza = [1, 2, 3, 4]
>>> pizza[0]
1
>>> pizza[-1]
4
>>> pizza[-4]
1
>>> pizza[1:2]
[2]
>>> pizza[1:]
[2, 3, 4]
>>> pizza[-2:3]
[3]
```

2.2 For Statement Execution Procedure

```
for <name> in <expression>:
        <suite>
```

- Evaluate the header `<expression>`, which must yield an iterable value, such as a list
- For each element in that sequence, in order:
  A. Bind `<name>` to that element in the current frame
  B. Execute the `<suite>`

2.3 Questions

1. What would Python print?

```
>>> a = [1, 5, 4, [2, 3], 3]
>>> print(a[0], a[-1])

>>> len(a)

>>> 2 in a

>>> 4 in a

>>> a[3][0]
```

2. What would Python print?

```
>>> apple = [3, 2, 1, 0]
>>> def banana(fruits):
        for apple in fruits:
           print(apple)
>>> banana(apple)
```

3. What would Python print?

```
>>> x = [1, 3, 5, 7]
>>> def partial(lst):
        first = lst[0]
        if first == 3:
            print('Hello')
        else:
            print('Goodbye')
        return lst

>>> partial(x)
```

4. What would Python print?

```
>>> lst = [3, 2, 1, 0]
>>> def fungus(spore):
        x = 0
        while spore[x] != 0:
            print('Mushroom!')
            x += 1
        return x

>>> fungus(lst)
```

5. Define a function `print_negative` that takes in a list `lst` and prints all the negative numbers in the list.

```
def print_negative(lst):

    for ______________ in ______________:

        if ______________________________:

            print(______________)
```

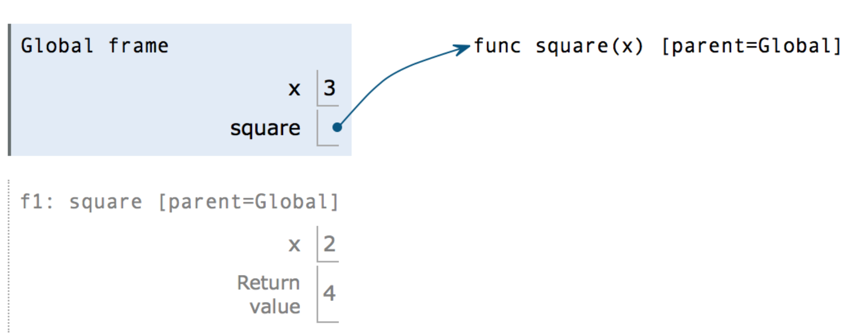
3 Environment Diagrams

An **environment diagram** keeps track of all the variables that have been defined and the values they are bound to.

```
x = 3

def square(x):
    return x ** 2

square(2)
```



When you execute *assignment statements* in an environment diagram (like `x = 3`), you need to record the variable name and the value:

1. Evaluate the expression on the right side of the = sign
2. Write the variable name and the expression's value in the current frame.

When you execute `def` *statements*, you need to record the function name and bind the function object to the name.

1. Write the function name (e.g., `square`) in the frame and point it to a function object (e.g., `func square(x) [parent=Global]`). The `[parent=Global]` denotes the frame in which the function was *defined*.

When you execute a *call expression* (like `square(2)`), you need to create a new frame to keep track of local variables.

1. Draw a new frame. [a] Label it with
   - a unique index (`f1`, `f2`, `f3` and so on)
   - the **intrinsic name** of the function (`square`), which is the name of the function object itself. For example, if the function object is `func square(x) [parent=Global]`, the intrinsic name is `square`.
   - the parent frame (`[parent=Global]`)
2. Bind the formal parameters to the arguments passed in (e.g. bind `x` to 3).
3. Evaluate the body of the function.

If a function does not have a return value, it implicitly returns `None`. Thus, the "Return value" box should contain `None`.

[a] Since we do not know how built-in functions like `add(...)` or `min(...)` are implemented, we do *not* draw a new frame when we call built-in functions.

3.1 Environment Diagram Questions

1. Draw the environment diagram that results from running the following code.

```
a = 1
def b(b):
    return a + b
a = b(a)
a = b(a)
```

2. Draw the environment diagram so we can visualize exactly how Python evaluates the code. What is the output of running this code in the interpreter?

```
>>> from operator import add
>>> def sub(a, b):
...     sub = add
...     return a - b
>>> add = sub
>>> sub = min
>>> print(add(2, sub(2, 3)))
```