Lecture 11:
Iteration and For-Loops

(Sections 4.2 and 10.3)

CS 1110

Introduction to Computing Using Python

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Announcements

- Be sure to monitor email for course announcements
- A2 due Mar 19 at 11:59pm
- Window to submit A1 revisions closes Mar 20 at 11:59pm

Important concept in computing: Doing things ***repeatedly***

1. Perform *n* trials or get *n* samples.
   - Run a protein-folding simulation for 10^6 time steps
   - Next 50 ticket purchases entered in random draw for upgrade

Repeat a known (*definite*) number of times

2. Process each item in a sequence
   - Compute aggregate statistics (e.g., mean, median) on scores
   - Send everyone in a Facebook group an appointment time
3. Do something an unknown number of times
   - CUAUV team, vehicle keeps moving until reached its goal

Repeat until something happens— repeat an *indefinite* number of times

1st Attempt: Summing the Elements of a List

```
def sum(the_list):
    """Returns: the sum of all elements in the_list
    Precondition: the_list is a list of all numbers
    (either floats or ints)"""
    result = 0
    result = result + the_list[0]
    result = result + the_list[1]
    …
    return result
```

Houston, we have a problem

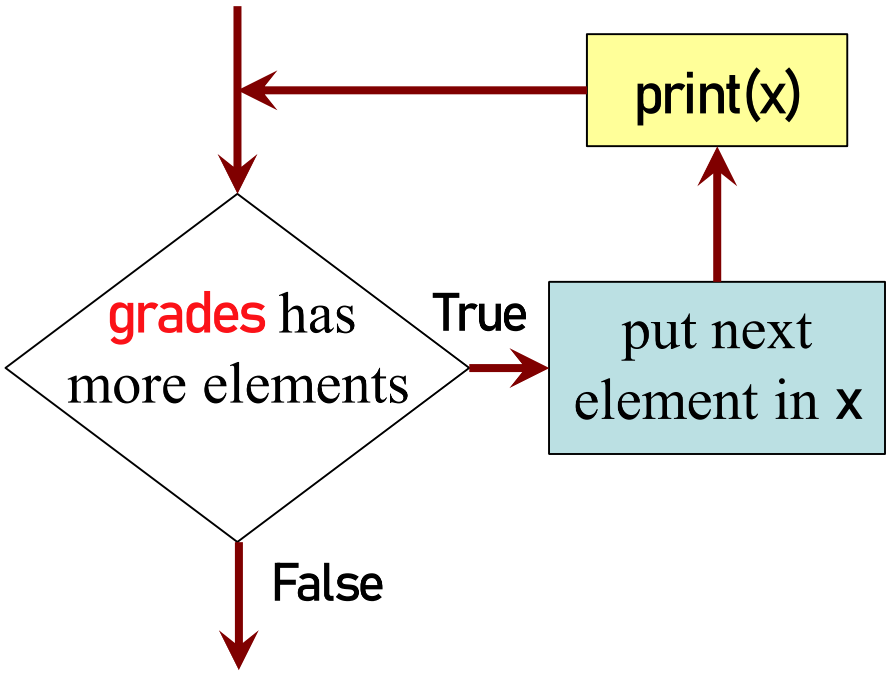
Working with Sequences

- Sequences are potentially **unbounded**
  - Number of elements is not fixed
  - Functions must handle sequences of different lengths
  - **Example**: sum([1,2,3]) vs. sum([4,5,6,7,8,9,10])
- Cannot process with **fixed** number of lines
  - Each line of code can handle at most one element
  - What if there are millions of elements?
- We need a new approach

For Loops: Processing Sequences

```
for x in grades:
    print(x)
```

- **loop sequence:** grades
- **loop variable**: x
- **loop body**: print(x)



To execute the for-loop:

1) Check if there is a "next" element of **loop sequence**
2) If so:
   - *assign* next sequence element to **loop variable**
   - Execute all of **the body**
   - Go back to 1)
3) If not, terminate execution

Solution: Summing the Elements of a List

```
def sum(the_list):
    """Returns: the sum of all elements in the_list
    Precondition: the_list is a list of all numbers
    (either floats or ints)"""
    result = 0

    for x in the_list:
        result = result + x

    return result
```

Accumulator variable

- **loop sequence:** the_list
- **loop variable**: x
- **body**: result=result+x

For Loops and Conditionals

```
def num_zeroes(the_list):
    """Returns: the number of zeroes in the_list
    Precondition: the_list is a list"""
    count = 0                  # Create var. to keep track of 0's
    for x in the_list:         # for each element in the list...
        if x == 0:             # check if it is equal to 0
            count = count + 1  # add 1 if it is
    return count               # Return the variable/counter
```

For Loop with labels

```python
def num_zeroes(the_list):
    """Returns: the number of zeroes in the_list
    Precondition: the_list is a list"""
    count = 0
    for x in the_list:
        if x == 0:
            count = count + 1
    return count
```

Accumulator variable

Loop sequence

Loop variable

Loop body

Accumulator

- A variable to hold a final answer
- for-loop adds to the variable at each step
- The final answer is accumulated, i.e., built up, one step at a time. A common design *pattern*:

```
accumulator
for ________ :
    accumulator = accumulator + ________
```

- Accumulator does not need to be a number. E.g., can be a string to be built-up

Exercise

```
def ave_positives(my_list):
    """Returns: average (float) of the positive values in my_list
    my_list: a list of numbers with at least one positive value"""
```

- Be goal oriented → ***can work backwards***
- ***Name a variable*** for any value that you need but don't have yet
- Break down a problem!
    - … ***break into parts***
    - … ***solve simpler version first***
- Remember loop/accumulation pattern

What if we aren't dealing with a list?

So far we've been building for-loops around elements of a list.

What if we just want to do something some number of times?

`range` to the rescue!

range: a handy counting function!

range(x)

generates 0,1,…,x-1

```
>>> print(range(6))
range(0, 6)
```

Important: range does not return a list

can to convert range's return value into a list

range(a,b)

Arguments must be int expressions

→ a,…,b-1

range(a,b,s)

→ a,a+s,a+2s,…,b-1

```
>>> first_six = list(range(6))
>>> print(first_six)
[0, 1, 2, 3, 4, 5]
```

```
>>> second_six = list(range(6,13))
>>> print(second_six)
[6, 7, 8, 9, 10, 11, 12]
```

Modifying the Contents of a List

```
def add_bonus(grades):
    """Adds 1 to every element in a list of grades
    (either floats or ints)"""
    size = len(grades)
    for k in range(size):
        grades[k] = grades[k]+1
```

If you need to modify the list, you ***need to use range*** *to get the indices.*

```
lab_scores = [8,9,10,5,9,10]
print("Initial grades are: "+str(lab_scores))
add_bonus(lab_scores)
print("With bonus, grades are: "+str(lab_scores))
```

Watch this in the python tutor!

Common For-Loop Mistakes

Mistake #1: Modifying the loop variable instead of the list itself.

Mistake #2: Modifying the loop sequence as you walk through it.

For-Loop Mistake #1 (Q)

Modifying the loop variable (here: x).

```
def add_one(the_list):
    """Adds 1 to every element in the list
    Precondition: the_list is a list of all numbers
    (either floats or ints)"""
    for x in the_list:
        x = x+1

a = [5, 4, 7]
add_one(a)
print(a)
```

What gets printed?

A: [5, 4, 7]

B: [5, 4, 7, 5, 4, 7]

C: [6, 5, 8]

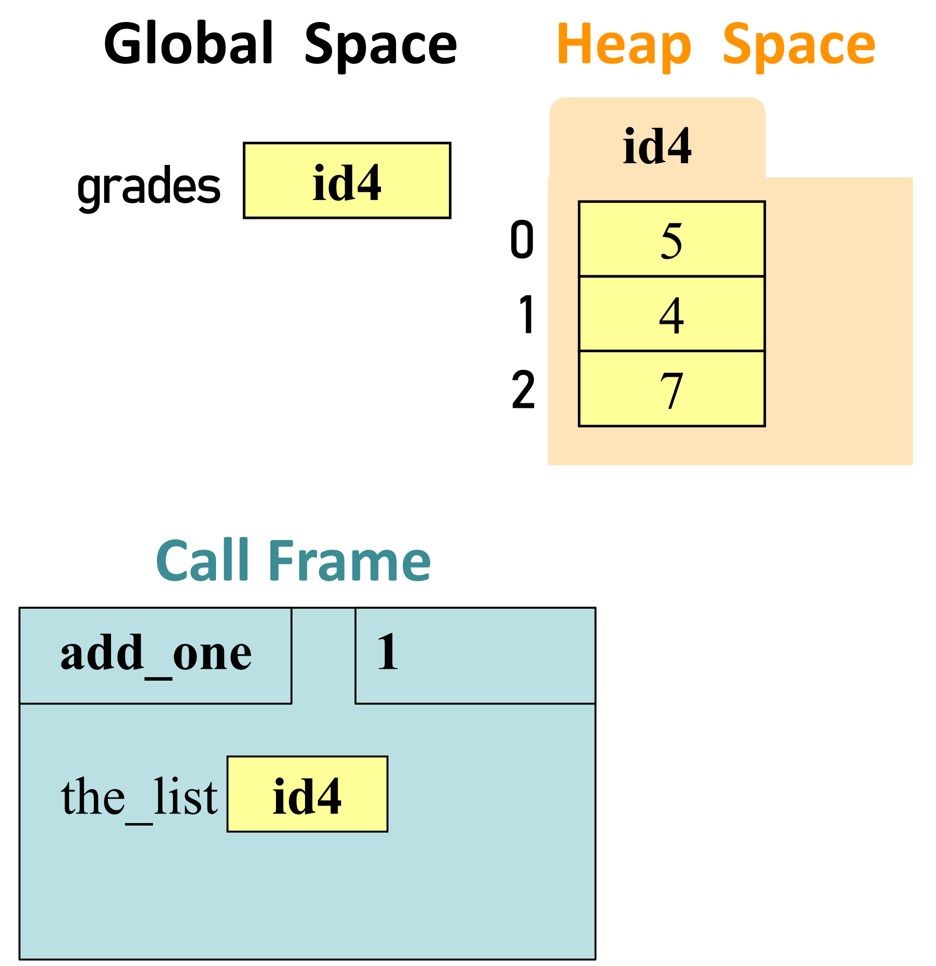
D: **Error**

E: I don’t know

Modifying the Loop Variable (1)

```
def add_one(the_list):
    """Adds 1 to every elt
    Pre: the_list is all numb."""
1   for x in the_list:
2       x = x+1
```

```
grades = [5,4,7]
add_one(grades)
```



For-Loop Mistake #2 (Q)

Modifying the loop sequence as you walk through it.

What gets printed?

```
b = [1, 2, 3]
for a in b:
    b.append(a)
print(b)
```

A: never prints b
B: [1, 2, 3, 1, 2, 3]
C: [1, 2, 3]
D: I do not know