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Lecture 11: **Iteration and For-Loops**

(Sections 4.2 and 10.3)

CS 1110

Introduction to Computing Using Python

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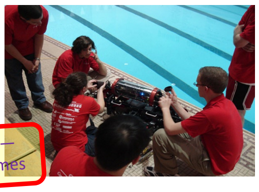
Announcements

- A3 will be released tonight
- Prelim 1 approximate grade release:
  - Evening of Tuesday, March 15

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
2. Process each item in a sequence

   Repeat a known (definite) number of times
   - 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

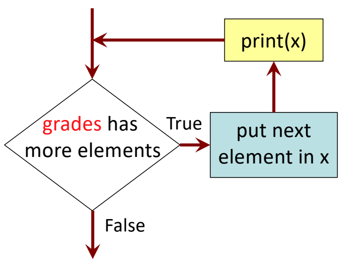
Working with Sequences

- 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
```

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

```
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: avg (float) of positive values in my_list
     my_list: a list of #s with at least 1 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

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

range(a,b)

→ a,…,b-1

Arguments must be int expressions

range(a,b,s)

→ a,a+s,a+2s,…,b-1

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

What gets printed? (Q)

```
t= 0
for k in range(5, 1, -1):
    t = t + 1
print(t)
```

A: 0
B: 2
C: 3
D: 4
E: 5

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

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))
```

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

Watch this in the python tutor!

Common For-Loop Mistake #1

Modifying the loop variable instead of the list itself.

For-Loop Mistake #1 (Q)

Modifying the loop variable (here: x).

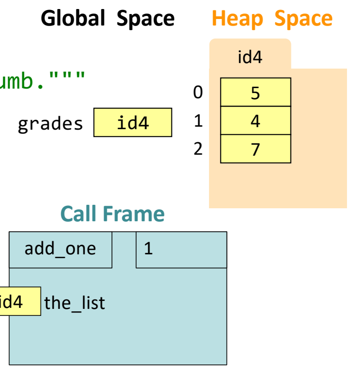
```
def add_one(the_list):
    """Adds 1 to every element in the list
    Precondition: the_list is a list of all numbers
    (either floats or ints)"""
    for x in the_list:
        x = x+1

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

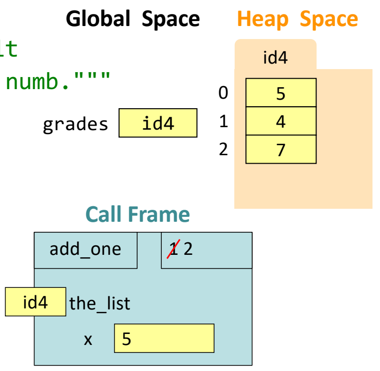
Modifying the Loop Variable (1)

```
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)
```



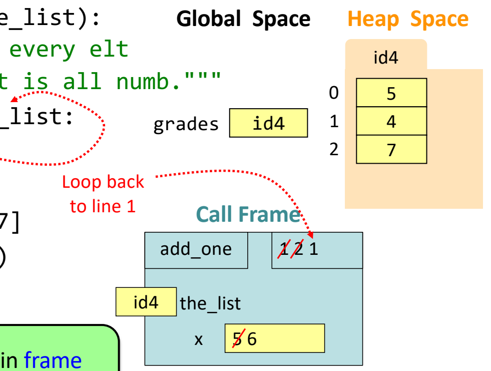
Modifying the Loop Variable (2)

```
  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)
```



Modifying the Loop Variable (3)

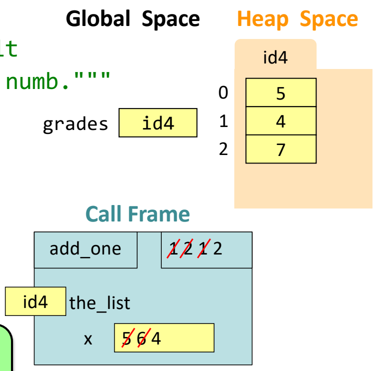
```
  def add_one(the_list):
    """Adds 1 to every elt
    Pre: the_list is all numb."""
1   for x in the_list:
2       x = x+1

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



Increments x in frame
Does not affect folder

Modifying the Loop Variable (4)

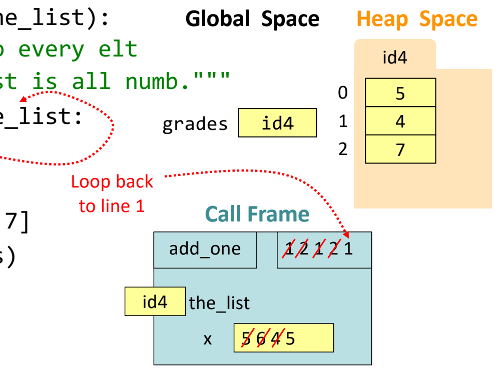
```
  def add_one(the_list):
    """Adds 1 to every elt
    Pre: the_list is all numb."""
1   for x in the_list:
2       x = x+1

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



Next element stored in x.
Previous calculation lost.

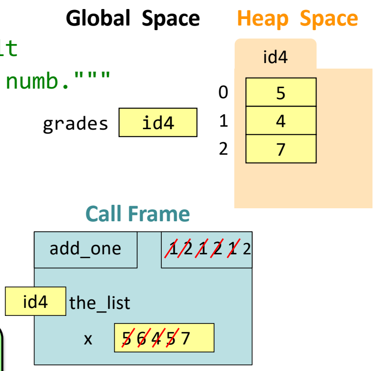
Modifying the Loop Variable (5)

```
  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)
```



Modifying the Loop Variable (6)

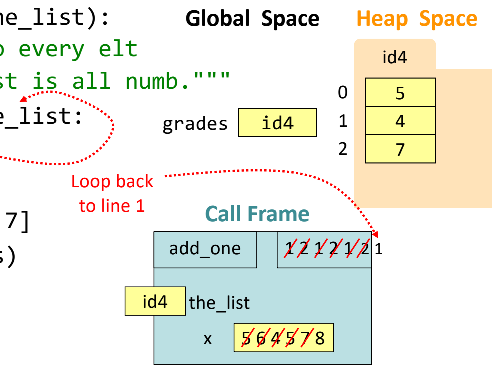
```
  def add_one(the_list):
    """Adds 1 to every elt
    Pre: the_list is all numb."""
1   for x in the_list:
2       x = x+1

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



Next element stored in x.
Previous calculation lost.

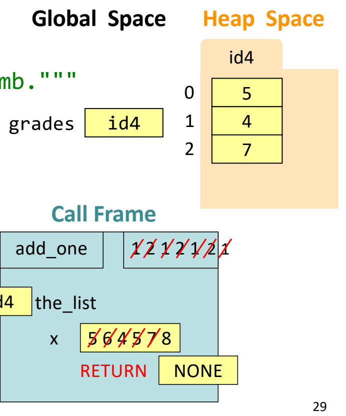
Modifying the Loop Variable (7)

```
  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)
```



Modifying the Loop Variable (8)

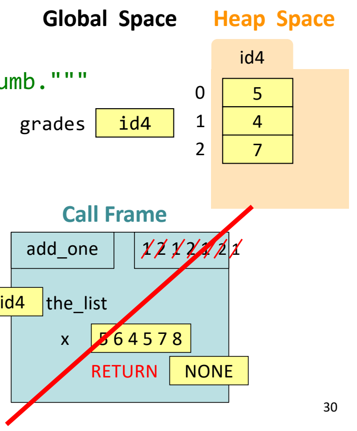
```
  def add_one(the_list):
    """Adds 1 to every elt
    Pre: the_list is all numb."""
1   for x in the_list:
2     x = x+1

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



Loop is completed.
Nothing new put in x.

Modifying the Loop Variable (9)

```
  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)
```



No lasting changes.
What did we accomplish? ☹

Common For-Loop Mistakes #2

Modifying the loop sequence as you walk through it.

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