Lecture 13

For-Loops

Announcements for This Lecture

Reading

- Today: Chapters 8, 10
- Thursday: Chapter 11

- **Prelim, 10/17 at 7:30 pm**
  - Material up to **TUESDAY**
  - Study guide is posted
  - Rooms by last name
- **Review *next* Wednesday**
  - **5pm in Kennedy Aud.**

Assignments/Lab

- A3 is due **Tomorrow**
  - Survey is now posted
  - Will be graded before exam
- A4 after exam and break
  - Longer time to do this one
  - Covers this lecture and next
- **No lab next week**
  - Current due in ***two*** weeks
  - But fair game on exam

Example: Summing the Elements of a List

```
def sum(thelist):
    """Returns: the sum of all elements in thelist
    Precondition: thelist is a list of all numbers
    (either floats or ints)"""
    pass # Stub to be implemented
```

Remember our approach:
Outline first; then implement

Example: Summing the Elements of a List

```
def sum(thelist):
    """Returns: the sum of all elements in thelist
    Precondition: thelist is a list of all numbers
    (either floats or ints)"""
    # Create a variable to hold result (start at 0)
    # Add each list element to variable
    # Return the variable
```

Example: Summing the Elements of a List

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

There is a problem here

Working with Sequences

- Sequences are potentially **unbounded**
  - Number of elements inside them 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 # of elements > # of lines of code?
- We need a new **control structure**

The For-Loop

```
# Create local var x
x = seqn[0]
print(x)
x = seqn[1]
print(x)
...
x = seqn[len(seqn)-1]
print(x)
```

Not valid Python

```
# Write as a for-loop
for x in seqn:
    print(x)
```

Key Concepts

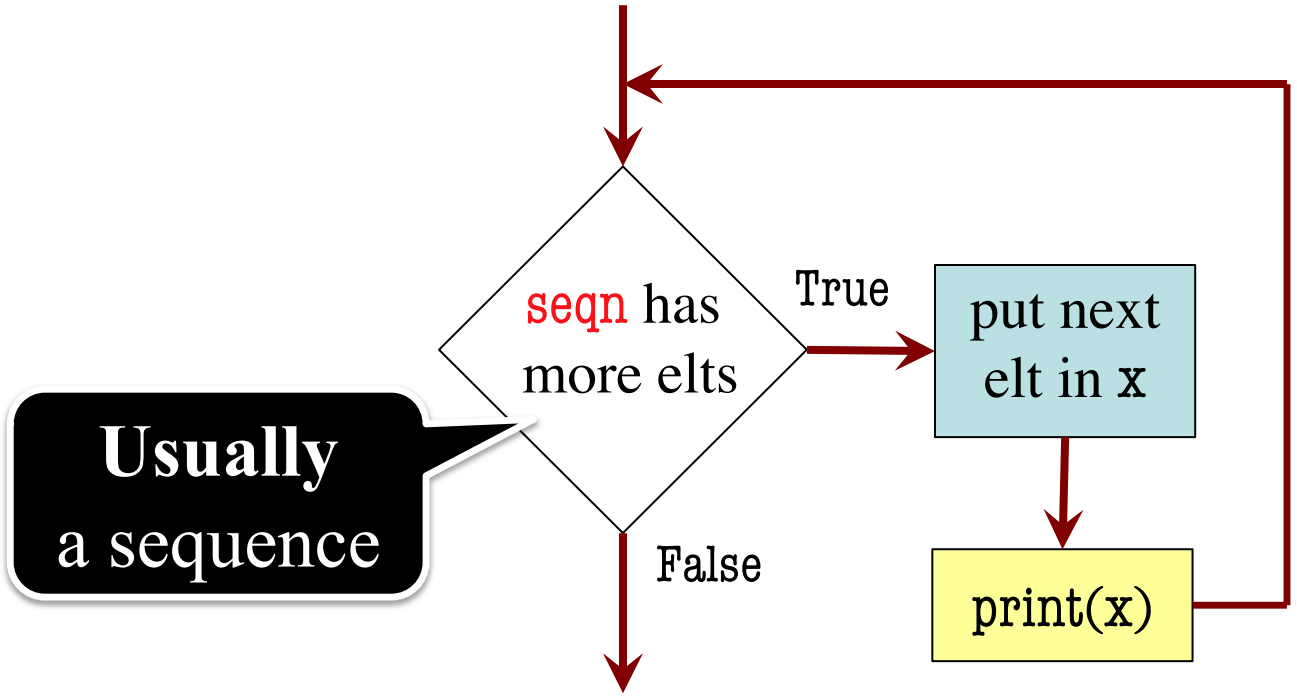
- **iterable**: seqn
- **loop variable**: x
- **body**: print(x)

Executing a For-Loop

The for-loop:

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

- **iterable:** seqn
- **loop variable**: x
- **body**: print(x)



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Example: Summing the Elements of a List

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def sum(thelist):
    """Returns: the sum of all elements in thelist
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    (either floats or ints)"""
    result = 0

    for x in thelist:
        result = result + x

    return result
```

- **iterable:** thelist
- **loop variable**: x
- **body**: result=result+x

Example: Summing the Elements of a List

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    return result
```

Accumulator variable

- **iterable:** thelist
- **loop variable**: x
- **body**: result=result+x

The Accumulator

- In a slides saw the **accumulator**
  - Variable to hold a final (numeric) answer
  - For-loop added to variable at each step
- This is a common *design pattern*
  - Popular way to compute statistics
  - Counting, averaging, etc.
- It is not just limited to numbers
  - Works on **every type that can be added**
  - This means **strings**, **lists** and **tuples**!

Example: String-Based Accumulator

```
def despace(s):
    """Returns: s but with its spaces removed
    Precondition: s is a string"""
    # Create an empty string accumulator
    # For each character x of s
        # Check if x is a space
        # Add it to accumulator if not
```

Example: String-Based Accumulator

```
def despace(s):
    """Returns: s but with its spaces removed
    Precondition: s is a string"""
    result = ''
    for x in s:
        if x != ':
            result = result+x
    return result
```

Body

Modifying the Contents of a List

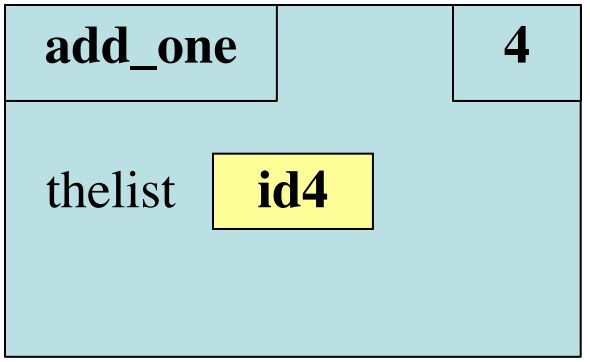
```
def add_one(thelist):
    """(Procedure) Adds 1 to every element in the list
    Precondition: thelist is a list of all numbers
    (either floats or ints)"""
    for x in thelist:
        x = x+1
    # procedure; no return
```

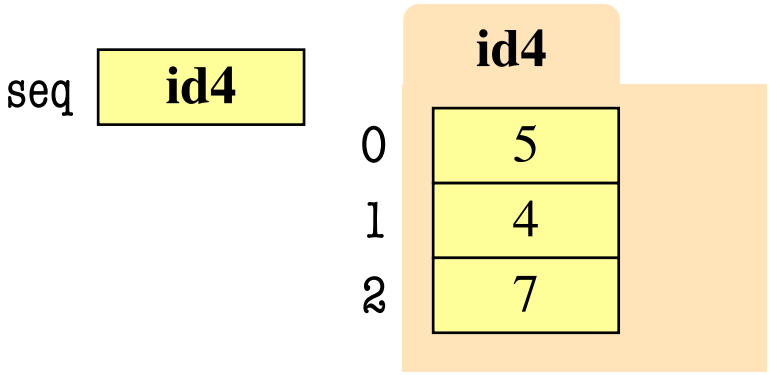
DOES NOT WORK!

For Loops and Call Frames

```
1. def add_one(thelist):
2.     """Adds 1 to every elt
3.     Pre: thelist all nums"""
4.     for x in thelist:
5.         x = x+1
```

add_one(seq):





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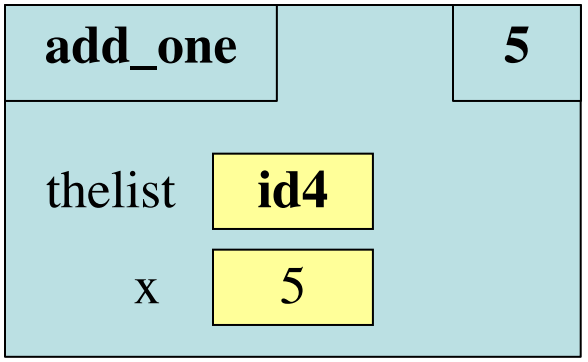

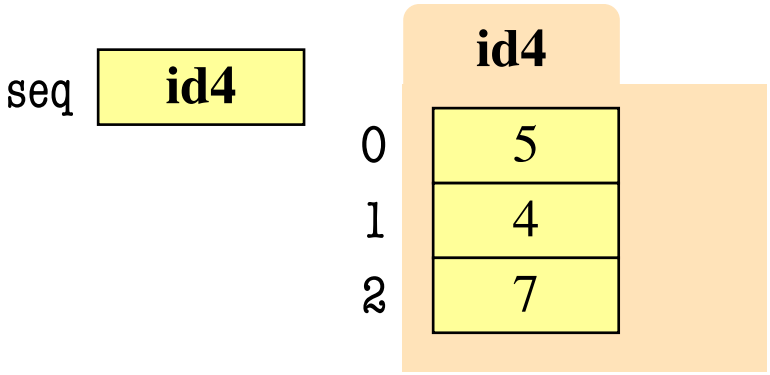

For Loops and Call Frames

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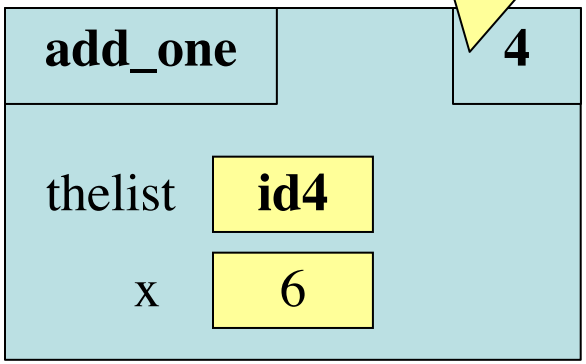
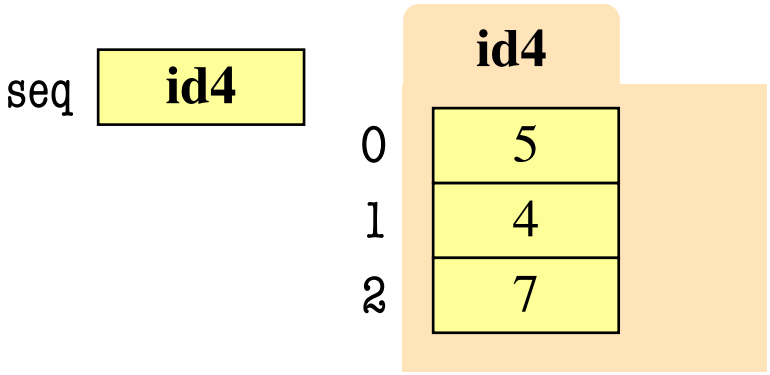
```

add_one(seq):

Loop **back** to line 4





Increments x in **frame**

Does not affect folder

For Loops and Call Frames

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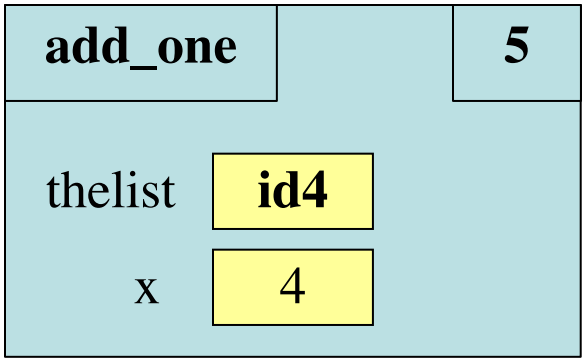
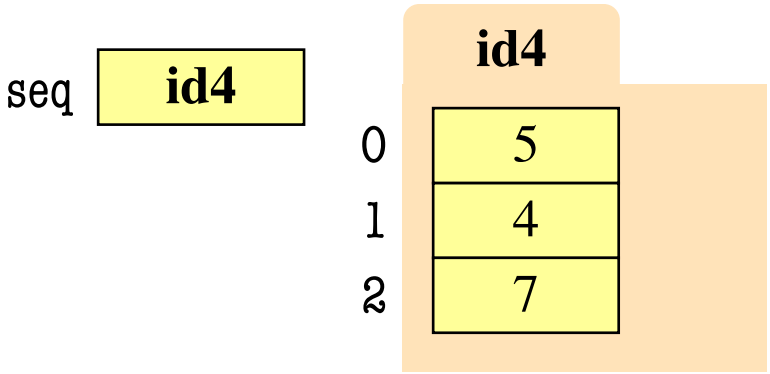
add_one(seq):





Next element stored in x.
Previous calculation lost.

For Loops and Call Frames

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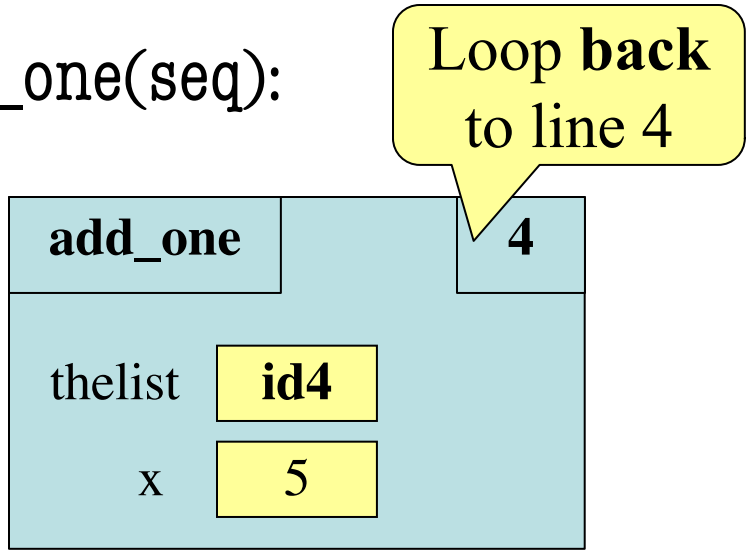

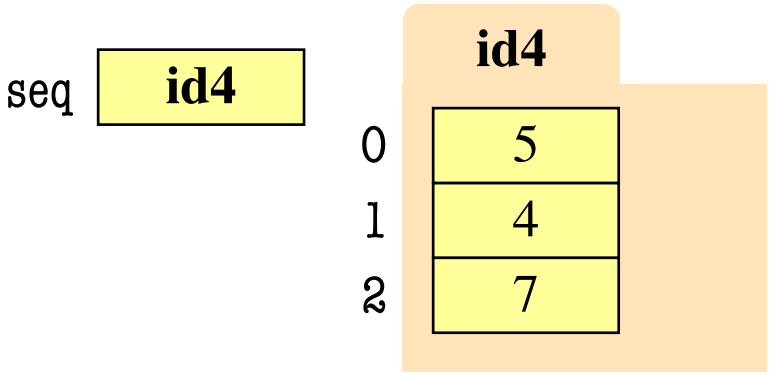

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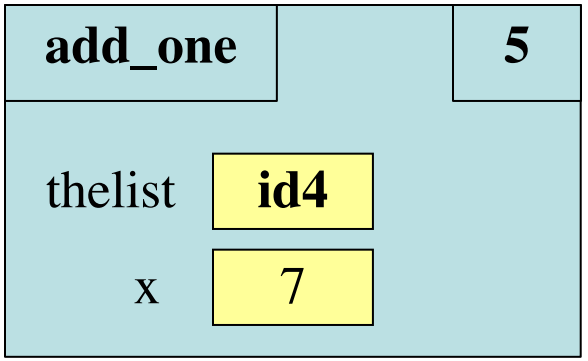

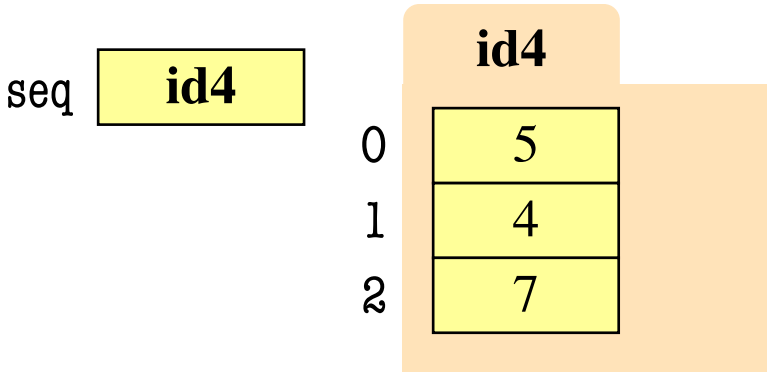

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For Loops and Call Frames

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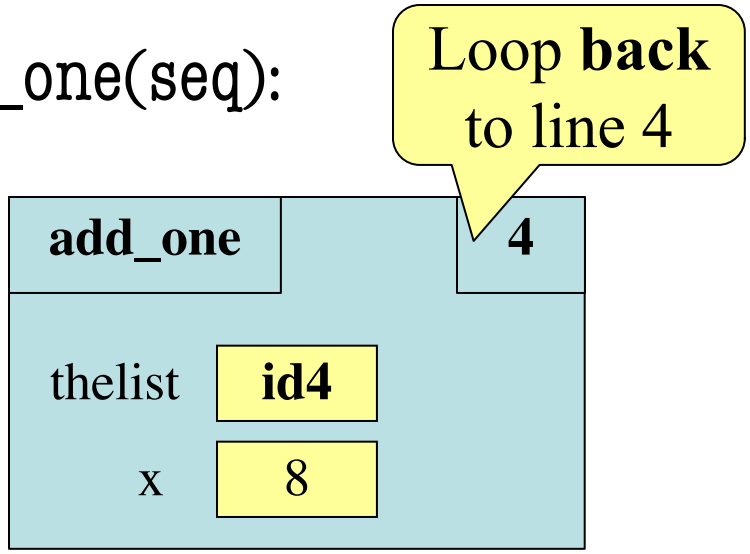

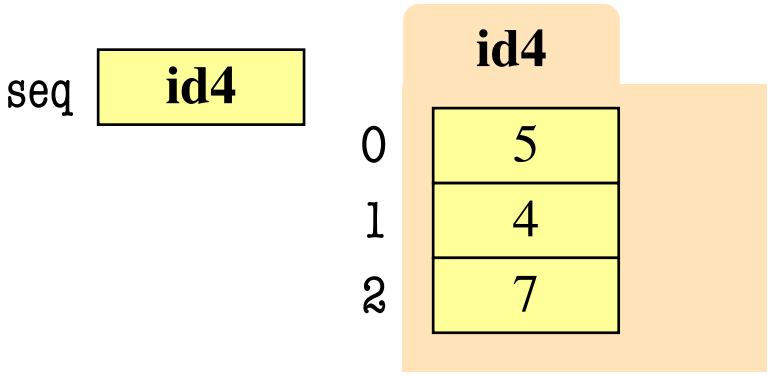

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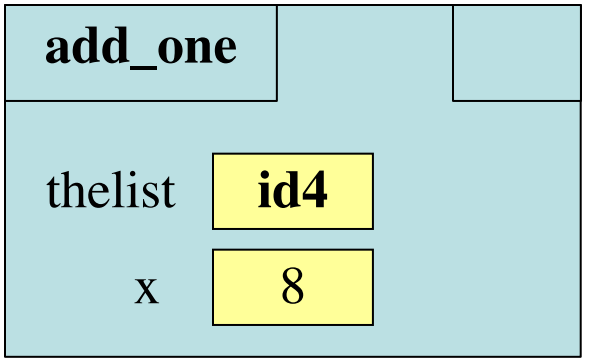

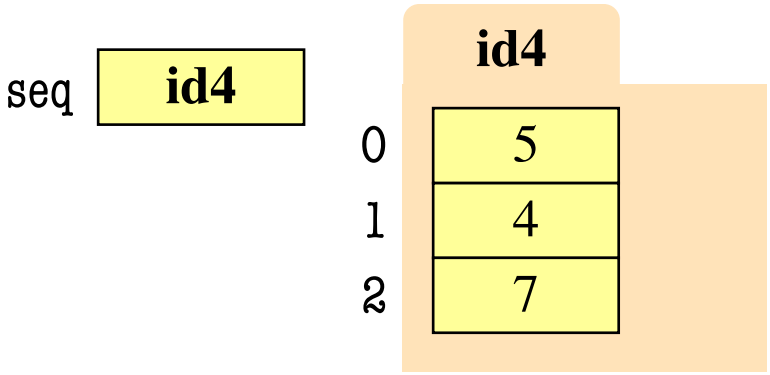

Loop is **completed.**
Nothing new put in x.

For Loops and Call Frames

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```
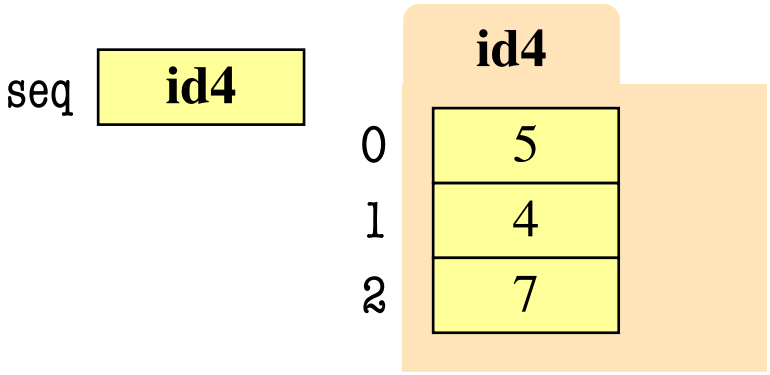

add_one(seq):

ERASE WHOLE FRAME



No changes to folder

On The Other Hand

```
def copy_add_one(thelist):
    """Returns: copy with 1 added to every element
    Precondition: thelist is a list of all numbers
    (either floats or ints)"""
    mycopy = []  # accumulator
    for x in thelist:
        x = x+1
        mycopy.append(x)  # add to end of accumulator
    return mycopy
```

Accumulator keeps result from being lost

How Can We Modify A List?

- **Never** modify loop var!
- This is an infinite loop:

```
for x in thelist:
    thelist.append(1)
```

Try in Python Tutor to see what happens

- Need a second sequence
- How about the *positions*?

```
thelist = [5, 2, 7, 1]
thepos = [0, 1, 2, 3]

for x in thepos:
    thelist[x] = thelist[x]+1
```

How Can We Modify A List?

- **Never** modify loop var!
- This is an infinite loop:

```
for x in thelist:
    thelist.append(1)
```

Try in Python Tutor to see what happens

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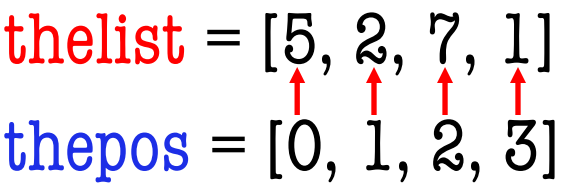
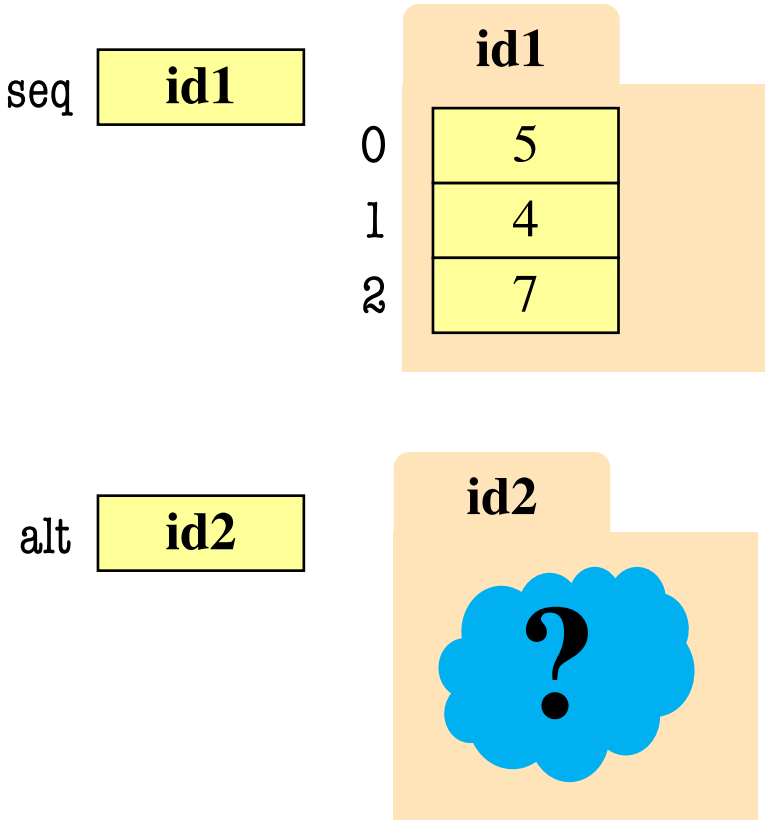



```
for x in thepos:
    thelist[x] = thelist[x]+1
```

This is the Motivation for Iterables

- **Iterables** are objects
  - Contain data like a list
  - **But cannot slice them**
- Have list-like properties
  - Can use then in a for-loop
  - Can convert them to lists
  - `mylist = list(myiterable)`
- **Example**: Files
  - Use `open()` to create object
  - Makes iterable for reading

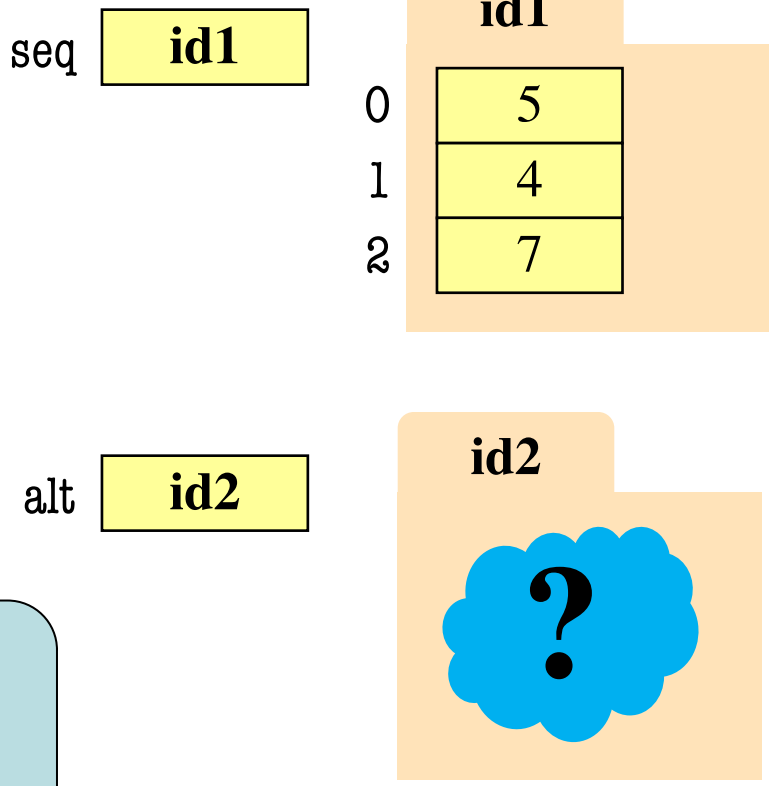


Iterables, Lists, and For-Loops

```
>>> file = open('sample.txt')
>>> list(file)
['This is line 1\n',
 'This is line 2\n']
>>> file = open('sample.txt')
>>> for line in file:
...         print(line)
This is line one

This is line two
```

print adds \n in *addition* to one from file



The Range Iterable

- range(x)
  - Creates an iterable
  - Stores [0,1,…,x-1]
  - **But not a list!**
  - But try list(range(x))
- range(a,b)
  - Stores [a,…,b-1]
- range(a,b,n)
  - Stores [a,a+n,…,b-1]

- Very versatile tool
- Great for processing ints

Accumulator

```
total = 0

# add the squares of ints
# in range 2..200 to total

for x in range(2,201):
    total = total + x*x
```

Modifying the Contents of a List

```
def add_one(thelist):
    """(Procedure) Adds 1 to every element in the list
    Precondition: thelist is a list of all numbers
    (either floats or ints)"""
    size = len(thelist)
    for k in range(size):
        thelist[k] = thelist[k]+1
    # procedure; no return
```

Iterator of list **positions** (safe)

WORKS!

Important Concept in CS: Doing Things Repeatedly

1. Process each item in a sequence
   - Compute aggregate statistics for a dataset, such as the mean, median, standard deviation, etc.
   - Send everyone in a Facebook group an appointment time
2. Perform *n* trials or get *n* samples.
   - **A4**: draw a triangle six times to make a hexagon
   - Run a protein-folding simulation for 10^6 time steps
3. Do something an unknown number of times
   - CUAUV team, vehicle keeps moving until reached its goal

Important Concept in CS: Doing Things Repeatedly

1. Process each item in a sequence
   - Compute aggregate statistics for a such as the mean, median, stand
   - Send everyone in a Facebook group an appointment time

```
for x in sequence:
    process x
```

2. Perform *n* trials or get *n* samples.
   - **A4**: draw a triangle six times to n
   - Run a protein-folding simulation

```
for x in range(n):
    do next thing
```

3. Do something an unknown number of times
   - CUAUV team, vehicle keeps moving until reached its goal

Cannot do this yet
Impossible w/ Python for