CS 100: Python Lists and Function Return Values

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Week 6-1

Logistics

Reading

- Pattern Ch 5: Algorithms And Heuristics
- Think Ch 11: Lists (link)

Homework 4

Due next week

Mini-Exam 2 Today

Goals Today

- Python lists
- Returning things from Functions

Questions on Computability

- Is how can one determine whether a computer program finishes?
- Can one program determine if another computer program will terminate?
- How does a human stop a program from running?

Exercise: Review of Lists

Write some python code which will accomplish the following

- Create a list named `the_nums` with the numbers 2, 4, 8, 16
- Create a list named `the_names` with the strings `Frank`, `Claire`, and `Doug` in it
- Change the number at index 2 of `the_nums` to be 32
- Print only the number at index 1 of `the_names`
- Print both lists to the screen
- Print the length of both lists
- Loop through the list `the_nums` and print each item in it

Exercise: Average of Numbers

- Adapt the code for `max_number(L)` to find the average of the numbers in a list
- Call your function `list_average(L)`
- Remember: Exercise answers are usually distributed with the lecture slides
- Follow the *pattern* demonstrated in `max_number(L)` but will need to change some details

```
# Find the maximum number and print it
def max_number(L):
    max = -1
    for number in L:
        if number > max:
            max = number
    print("The max is "+str(max))
```

List Average Answer

```
def list_average(L):                # Print the average of a list
    total = 0
    for num in L:
        total = total + num
    avg = total / len(L)
    print("Average is "+str(avg))
```

Problem: Printing doesn't cut it

Suppose we want to compare the average scores of two classes in code?

```
scores_sec1 = [13,20,35,32,40]
scores_sec2 = [40,25,37,13,21,23,18]

if ?? :
  print("Sec 1 has a better average")
else:
  print("Sec 2 has a better average")
```

Solution: Don't `print`, `return` answer

Within a function, the `return` statement allows an answer to be given back to whoever executed the function.

```
def list_average(L):              # Compute and return average of list
    total = 0
    for num in L:
        total = total + num
    avg = total / len(L)
    return avg                          # return an answer: the average
    # print("Average is "+str(avg)) # Don't print

scores_sec1 = [13,20,35,32,40]
scores_sec2 = [40,25,37,13,21,23,18]

avg_sec1 = list_average(scores_sec1) # store the average of sec1
avg_sec2 = list_average(scores_sec2) # store the average of sec2

if ?? :                                  # Fill the question marks in
  print("Sec 1 has a better average")
else:
  print("Sec 2 has a better average")
```

Drawing vs "Normal" Functions

Drawing Functions

- Mostly put things on the screen
- Almost never return stuff

```
draw_house(100,"red","blue")
pen_up()
forward(200)
pen_down()
draw_house(200,"green","yellow")
```

"Normal" Functions

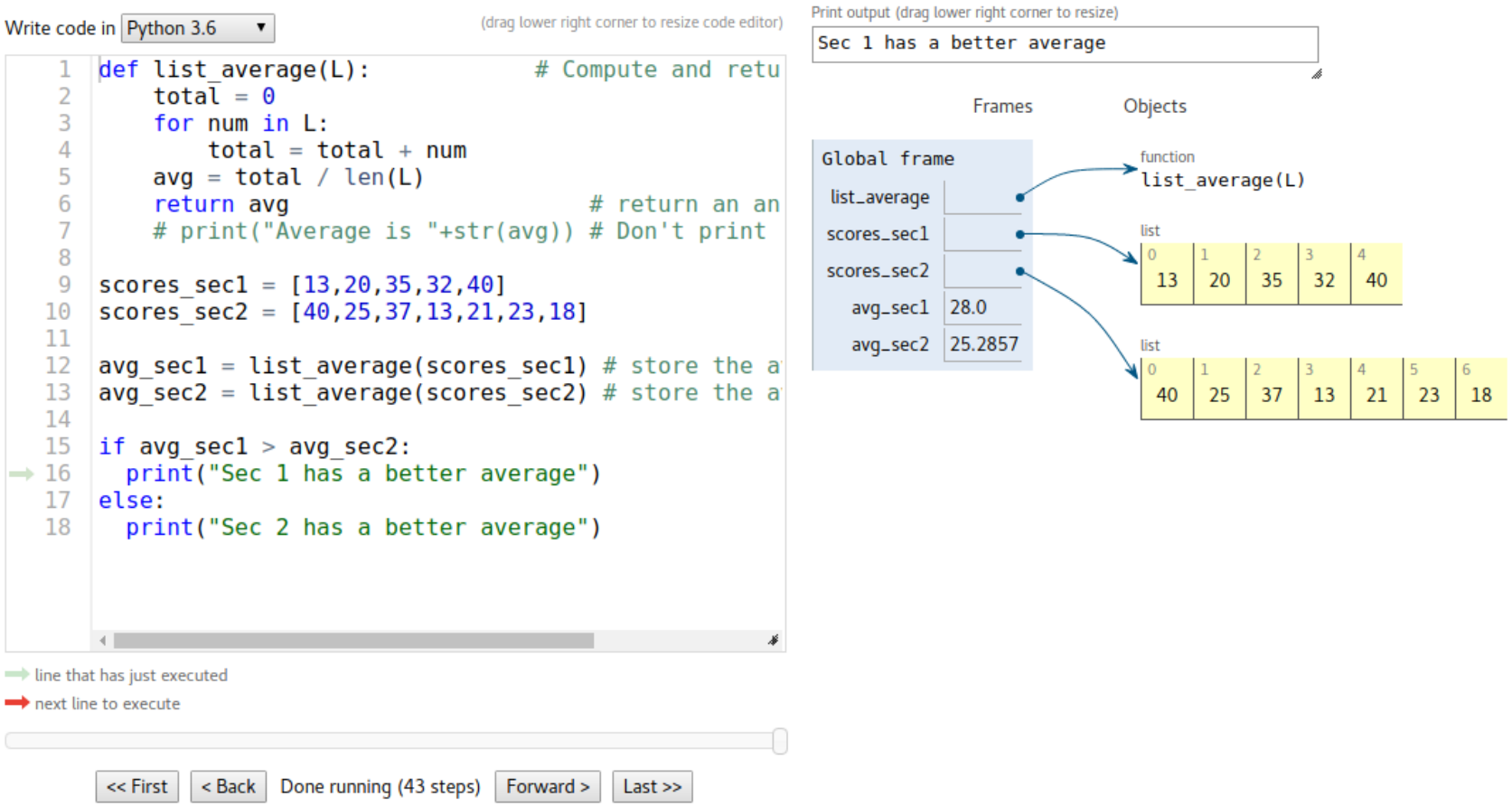
- Mostly don't put stuff on the screen
  - No printing
  - No moving turtles
- Frequently return an answer

```
avg1 = list_average(scores1)
avg2 = list_average(scores2)
report_averages(avg1,avg2)      # prints
all_scores = merge_lists(scores1,scores2)
max_score = max_number(all_scores)
report_max(max_score)           # prints
```

Visualize!

As programs get more complex, seeing how they work gets more difficult: more *state* is hidden

The Python Visualizer is a useful web site to help.



List Average on Visualizer: https://goo.gl/9MW54s

Exercise: Convert to Return

```
# Find the maximum number and print it
def max_number(L):
    max = -1
    for number in L:
        if number > max:
            max = number
    print("The max is "+str(max))
```

Exercise: Exponentiate

`def exponentiate(base,exponent):`

- Raise base to a given power
- Involves a loop and repeated multiplication
- Assume both numbers are integers (no fractions)
- Raising numbers to the zeroth power always gives 1

Examples

```
twoTofour = exponentiate(2,4)   # 16
threeToFive = exponentiate(3,5) # 243
eightTozero = exponentiate(8,0) # 1
nineTothird = exponentiate(9,3) # 729
```

Solution: Exponentiate

```
# A function to raise base to the exponent power
def exponentiate(base,exponent):
  ans = 1
  for i in range(exponent):
    ans = ans * base
  return ans
```

Example: Binary to Decimal Conversion

Recall Conversion of binary numbers

```
110110_2 = 0*1 + 1*2 + 1*4 +
           0*8 + 1*16 + 1*32
         = 54
```

Python lists with 1's / 0's

```
bin1 = [1,1,0,1,1,0]

# Convert binary list to
# decimal number
def bin_to_dec(binaryL):
  ???

dec1 = bin_to_dec(bin1)
print(dec1)  # 54
```

Function `bin_to_dec(binL)`

- Converts binary list to decimal number
- Uses `exponentiate(2,pow)`
- Loops through the list
- Must adjust `pow` for position in list

Strategies

Strategy: Front to Back

```
bin1 = [1,1,0,1,1,0]
2^5 +2^4 + 2^2 + 2^1
```

- Go from front to back
- `range(len(BinaryL))`
- Power decreases by 1 each iteration

Strategy: Back to Front

```
bin1 = [1,1,0,1,1,0]
2^1 + 2^2 + 2^4 + 2^5
```

- Go from back to front
- `range(len(binaryL)-1,-1,-1)`
- Power increase by 1 each iteration

Implementations

Strategy: Front to Back

```
def binary_to_decimal_backwards(binaryL):
  sum = 0
  pow = 0
  for i in range(len(binaryL)-1,-1,-1):
    if binaryL[i]==1:
      sum = sum + exponentiate(2,pow)
    pow = pow+1
  return sum
```

Strategy: Back to Front

```
def binary_to_decimal_forwards(binaryL):
  sum = 0
  pow = len(binaryL)
  for i in range(len(binaryL)):
    pow = pow-1
    if binaryL[i]==1:
      sum = sum + exponentiate(2,pow)
  return sum
```

Creating New Lists

Create a new empty list and fill it up with numbers

```
my_list = []
for i in range(10):
  my_list.append(i)
print(my_list)

for i in range(10,-1,-1):
  my_list.append(i)
print(my_list)
```

Lists can `append(x)` things to their end

Exercise: Create a Reversed List

```
def reverse_list(L):
```

Create a reversed copy of `L`

- Start with an empty list
- Use a `for` loop from back to front of `L`
- Append each element of `L` to the reversed list `rev.append(L[i])`
- Return the reversed list

Examples

```
for1 = [1,2,3,4]
rev1 = list_reverse(for1)
#       [4,3,2,1]

for2 = [1,1,0,1,1,0]
rev2 = list_reverse(for2)
#       [0,1,1,0,1,1]
```

Solution: Create a Reversed List

```
# Create and return a reversed list with the
# append method of lists
def list_reverse(L):
  rev = []
  for i in range(len(L)-1,-1,-1):
    rev.append(L[i])
  return rev
```

Exercise: Converting from Decimal to Binary

Recall the process to convert a decimal number to a binary number

$$
\begin{aligned}
54 \div 2 &= 27 && \text{rem } 0 \\
27 \div 2 &= 13 && \text{rem } 1 \\
13 \div 2 &= 6 && \text{rem } 1 \\
6 \div 2 &= 3 && \text{rem } 0 \\
3 \div 2 &= 1 && \text{rem } 1 \\
1 \div 2 &= 0 && \text{rem } 1
\end{aligned}
$$

$54_{10} = 110110_2$

```
def dec_to_bin(decimal):
```

- Convert the decimal number to a binary list
- Use repeated integer division:

  `quot = num // divis`
- And repeated remainder:

  `rem = num % divs`
- Append remainder to a list
- Reverse list and return

```
dec1 = 54
bin1 = dec_to_bin(dec1)
# [1, 1, 0, 1, 1, 0]
dec2 = 87
bin2 = dec_to_bin(87)
# [1, 0, 1, 0, 1, 1, 1]
```

Exercise: Converting from Decimal to Binary

```
# Convert a decimal number to a binary list
def dec_to_bin(decimal):
  digits = []
  while decimal > 0:
    remainder = decimal % 2
    decimal   = decimal // 2
    digits.append(remainder)
  digits_rev = list_reverse(digits)
  return digits_rev
```

HW 4

- Only 3 problems
- Problems 1 and 2: Write a word-list processing functions
- Problem 3: Use code I provide and your functions to rank web pages, compare to Google search results
- May want to do some research on how web search engines rank web pages
- Zyante: Section 5.7 has some information, may want to look elsewhere also for info
- More discussion on Internet and Search later in the class

HW Relevant Exercise: Counting Odd Numbers

```
def count_odds(alist):
  ???

how_many_odds = count_odds([1,2])
print(how_many_odds) # 1

how_many_odds = count_odds([8,6,7,5,3,0,9])
print(how_many_odds) # 4
```

Sub-problems: How to...

- Examine each element in a list?
- Check if a number is odd?
- Update a total?
- Return an answer from a function?

HW Relevant Exercise: Find all Odd Numbers

```
def get_all_odds(num_list):
  ??


print( get_all_odds([2,4,6]) ) # []
print( get_all_odds([1,2,5]) ) # [1, 5]
print( get_all_odds([3,3,2,2,1,3]) ) # [3, 3, 1, 3]
odd_list = get_all_odds([3,3,2,2,1,3])
print(odd_list)
[3, 3, 1, 3]
```

Basic structure

- Create an empty `answer` list
- Examine each element in `num_list`
- If number is odd, append to `answer`
  `answer.append(number)`
- Return the `answer` list