COMPSCI 105 S1 2017
Principles of Computer Science

Lists & List comprehensions

Exercises

- What is the output of the following code fragment?

```
def ex6():
        i = 0
        while i < 5:
                print(i)
                i += 1
                if i == 3:
                        break
        else:
                print(0)
ex6()
```

```
print (True or False and False)
print( (True or False) and False )
```

```
value = 12
print( value>10 or value<=5 and value!=12)
print( (value>10 or value<=5) and value!=12)
```

Lists

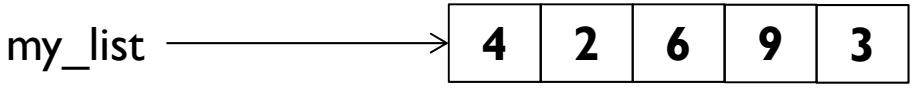
- Lists are a built-in type in Python
  - Use square brackets to signify a list
  - Lists can contain any type of data, or any mixture of data

```
my_list1 = [1, 2, 3]

my_list2 = ['Hello', 'Is', 'there', 'anybody', 'out', 'there?']

my_list3 = [1, 5.899, 'Hello']

my_list4 = [4, 2, 6, 9, 3]
```



List functions

- Numerous list functions are supported
  - Use help(list) to find out the functions
  - Examples:

```
>>> x = [1, 2, 3]
>>> len(x)
```

3

x → | 1 | 2 | 3 |

```
>>> x + [4]
```

[1, 2, 3, 4]

```
>>> x += [5]
```

[1, 2, 3, 5]

x → | 1 | 2 | 3 | 5 |

```
>>> 3 in x
```

True

```
>>> x[0]
```

1

```
>>> [1, 2, 3] * 2
```

[1, 2, 3, 1, 2, 3]

List comprehensions

- A powerful feature of the Python language.
  - A list can be created using instructions that appear within the square brackets
  - Generate a new list by applying a function to every member of an original list.
- The syntax of a "list comprehension" is tricky.
  - If you're not careful, you might think it is a for-loop, an 'in' operation, or an 'if' statement since all three of these keywords ('for', 'in', and 'if') can also be used in the syntax of a list comprehension.
  - It's something special all its own.

```
my_list = [x for x in range(0, 10)]
```

List comprehensions : Syntax 1

- The general format is as follows:

```
[expression for variable in sequence]
```

  - Where expression is some calculation or operation acting upon the variable.
    - For each member of the sequence, calculate a new value using expression, and then we collect these new values into a new list which becomes the return value of the list comprehension.

- Examples:

```
my_list = [c for c in 'Ann']
```

```
['A', 'n', 'n']
```

```
freshfruit = ['  banana', '  loganberry ']
li = [weapon.strip() for weapon in freshfruit]
```

```
['banana',
'loganberry']
```

Some more examples…

- Calculation…

```
vec = [2, 4, 6]
li = [3*x for x in vec]
```

```
[6, 12, 18]
```

- Using a range function:

```
[2, 4, 6, 8]
```

```
li = [n * 2 for n in range(1, 5)]
```

Exercise 1

- Write a list comprehension that generates all the odd numbers between 1 and 50

List Comprehension Syntax 2

- If the original list contains a variety of different types of values, then the calculations contained in the expression should be able to operate **correctly** on all of the types of list members.

```
values = ['hello', [1,2], (3,5)]
li = [len(n) for n in values]
```

```
[5, 2, 2]
```

- If the members of list are other containers, then the name can consist of a container of names that match the **type** and "**shape**" of the list members.

```
values = [('a', 1), ('b', 2), ('c', 7)]
li = [ n * 3 for (x, n) in values]
```

```
[3, 6, 21]
```

List Comprehension Syntax 3

- The expression of a list comprehension could also contain user-defined functions.

```
def foo(a):
  return a * a
```

```
oplist = [(6, 3), (1, 7), (5, 5)]
li = [foo(x) for (x, y) in oplist]
```

```
[36, 1, 25]
```

- Example 2:

```
def subtract(a, b):
  return a - b
```

```
[-3, 6, 0]
```

```
oplist = [(6, 3), (1, 7), (5, 5)]
li = [subtract(y, x) for (x, y) in oplist]
```

List Comprehension Syntax 4

- We can also create …
  - a list of dictionaries:

```
[{2: 4}, {4: 16},
    {6: 36}]]
```

```
vec = [2, 4, 6]
li = [{x: x**2} for x in vec]
```

  - a list of list:

```
[[2, 4], [4, 16],
    [6, 36]]
```

```
vec = [2, 4, 6]
li = [[x, x**2] for x in vec]
```

List Comprehension Syntax 5

- With Two sequences…

```
vec1 = [2, 4, 6]
vec2 = [4, 3, -9]
li = [x*y for x in vec1 for y in vec2]
```

```
[8, 6, -18, 16, 12,
 -36, 24, 18, -54]
```

- 2*4, 2*3, 2*(-9)
- 4*4, 4*3, 4*(-9)
- 6*4, 6*3, 6*(-9)

```
li = [x+y for x in vec1 for y in vec2]
```

```
[6, 5, -7, 8, 7,
-5, 10, 9, -3]
```

List Comprehension Syntax 5

- With Two sequences…

```
vec1 = [2, 4, 6]
vec2 = [4, 3, -9]
li = [vec1[i]*vec2[i] for i in range(len(vec1))]
```

```
[8, 12, -54]
```

- i=0, i=1, i=2 (execute three times)
- 2*4, 4*3, 6*(-9)

List comprehensions that use conditions (Filtered List)

- We can extend the syntax for a list comprehension to include a condition:

```
[0, 2, 4, 6, 8]
```

```
my_list = [x for x in range(0, 10) if x % 2 == 0]
```

- The general format is as follows:

```
[expression for variable in sequence if condition]
```

  - Similar to regular list comprehensions, except now we might **not** perform the expression on every member of the list.
  - We first check each member of the list to see if it satisfies a filter condition. Those list members that return False for the filter condition will be omitted from the list before the list comprehension is evaluated.

Examples:

- Examples:

```
vec = [2, 4, 6]
my_list = [3*x for x in vec if x > 3]
```

```
[12, 18]
```

  - Only 4 and 6 satisfy the filter condition.
  - 3*4, 3*6
  - So, only 12 and18 are produced.

```
vec = [2, 4, 6]
my_list = [3*x for x in vec if x < 2]
```

```
[]
```

  - Get all the factors of a number:

```
n = 6
my_list = [x for x in range(1,n+1) if n%x == 0]
```

```
[1, 2, 3, 6]
```

(Filtered List)

- Example:

```
name = 'Andrew Luxton-Reilly'
vowels = 'aeiou'
my_list = [c for c in name if c not in vowels]
```

['A', 'n', 'd', 'r', 'w', ' ', 'L', 'x', 't', 'n', '-', 'R', 'l', 'l', 'y']

Exercise 2

- Create a list of all the vowels in the string:
  - Example: "solidarity"
  - Output: ['o', 'i', 'a', 'i']

```
word = 'solidarity'
vowels = 'aeiou'
...
```

Summary: Features of lists

- Information in a list is stored contiguously in memory
  - location of the information can be calculated
  - location = start of the list + index * size of each element

- Efficiency issues
  - It takes the same time to *access* any of the elements
  - Slow to move elements around (i.e. add and delete elements from within the list)

Exercise

- Write a list comprehension that generates a list of tuples.
  - The tuple contains the number (even number between 0 to 9), the square of the number, and the cube of the number.

```
[(0, 0, 0), (2, 4, 8), (4, 16, 64),
    (6, 36, 216), (8, 64, 512)]
```

Exercise 3

- What is the output of the following code fragment?

```
li = [(x,y) for x in range(3) for y in range(2)]
print(li)
```