List comprehensions (and other shortcuts)

UW CSE 160
Winter 2017

Three Ways to Define a List

- Explicitly write out the whole thing:

```
squares = [0, 1, 4, 9, 16, 25, 36, 49, 64, 81, 100]
```

- Write a loop to create it:

```
squares = []
for i in range(11):
    squares.append(i * i)
```

- Write a **list comprehension**:

```
squares = [i * i for i in range(11)]
```

- A list comprehension is a concise description of a list
- A list comprehension is shorthand for a loop

Two ways to convert Centigrade to Fahrenheit

```
ctemps = [17.1, 22.3, 18.4, 19.1]
```

With a loop:

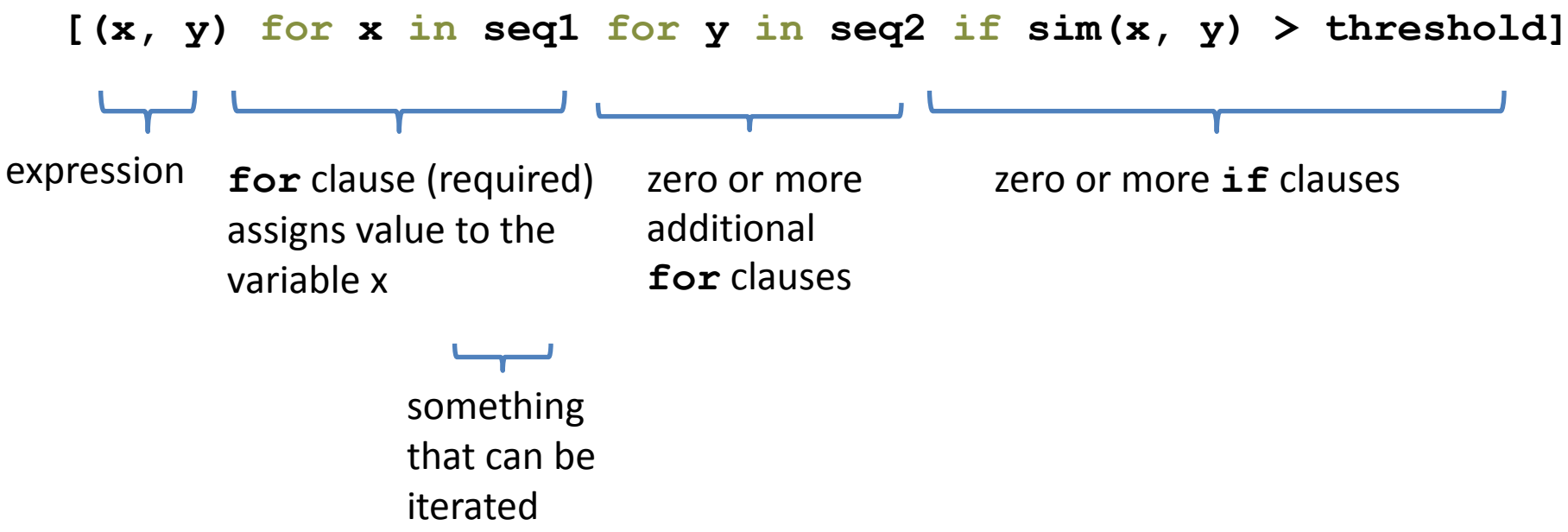
```
ftemps = []
for c in ctemps:
  f = celsius_to_farenheit(c)
  ftemps.append(f)
```

With a list comprehension:

```
ftemps = [celsius_to_farenheit(c) for c in ctemps]
```

The comprehension is usually shorter, more readable, and more efficient

Syntax of a comprehension



Semantics of a comprehension

```
[(x, y) for x in seq1 for y in seq2 if sim(x, y) > threshold]
```

```
result = []
for x in seq1:
   for y in seq2:
      if sim(x, y) > threshold:
         result.append( (x, y) )
… use result …
```

Types of comprehensions

List

```
[ i * 2 for i in range(3) ]
```

Set

```
{ i * 2 for i in range(3)}
```

Dictionary

{ *key*: *value* for *item* in *sequence* …}

```
{ i: i * 2 for i in range(3)}
```

Cubes of the first 10 natural numbers

Goal:

Produce: [0, 1, 8, 27, 64, 125, 216, 343, 512, 729]

With a loop:

```
cubes = []
for x in range(10):
  cubes.append(x ** 3)
```

With a list comprehension:

```
cubes = [x ** 3 for x in range(10)]
```

Powers of 2, 2^0 through 2^{10}

Goal: [1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024]

```
[2 ** i for i in range(11)]
```

Even elements of a list

Goal: Given an input list **`nums`**, produce a list of the even numbers in **`nums`**

```
nums = [3, 1, 4, 1, 5, 9, 2, 6, 5]
```

$\Rightarrow$ [4, 2, 6]

```
[x for x in nums if x % 2 == 0]
```

Dice Rolls

Goal: A list of all possible dice rolls.

With a loop:

```
rolls = []
for r1 in range(1, 7):
   for r2 in range(1, 7):
      rolls.append( (r1, r2) )
```

With a list comprehension:

```
rolls = [ (r1, r2) for r1 in range(1, 7)
                   for r2 in range(1, 7)]
```

All above-average 2-die rolls

Goal: Result list should be a list of 2-tuples:
[(2, 6), (3, 5), (3, 6), (4, 4), (4, 5), (4, 6), (5, 3), (5, 4), (5, 5), (5, 6), (6, 2), (6, 3), (6, 4), (6, 5), (6, 6)]

```
[(r1, r2) for r1 in [1, 2, 3, 4, 5, 6]
          for r2 in [1, 2, 3, 4, 5, 6]
          if r1 + r2 > 7]
```

OR

```
[(r1, r2) for r1 in range(1, 7)
          for r2 in range(8-r1, 7)]
```

Sum of above-average 2-die rolls

Goal: Result list should be a list of integers:

```
[r1 + r2 for r1 in [1, 2, 3, 4, 5, 6]
         for r2 in [1, 2, 3, 4, 5, 6]
         if r1 + r2 > 7]
⇒ [8, 8, 9, 8, 9, 10, 8, 9, 10, 11, 8, 9,
10, 11, 12]
```

Remove Duplicates: Use Set Comprehensions

```
{ r1 + r2 for r1 in range(1, 7)
          for r2 in range(1, 7)
          if r1 + r2 > 7}
⇒ set([8, 9, 10, 11, 12])
```

Making a Grid

Goal: A grid were each element is the sum of it's row # and column #.
(e.g. `[[0, 1, 2], [1, 2, 3]]`)

With a loop:

```
grid = []
for i in range(2):
    row = []
    for j in range(3):
        row.append(i + j)
    grid.append(row)
```

With a list comprehension:

```
grid = [[i + j for j in range(3)] for i in range(2)]
```

A word of caution

List comprehensions are great, but they can get confusing. Err on the side of readability.

```
nums = [n for n in range(100) if
        sum([int(j) for j in str(n)]) % 7 == 0]

nums = []
for n in range(100):
     digit_sum = sum([int(j) for j in str(n)])
     if digit_sum % 7 == 0:
          nums.append(n)
```

A word of caution

List comprehensions are great, but they can get confusing. Err on the side of readability.

```
nums = [n for n in range(100) if
sum([int(j) for j in str(n)]) % 7 == 0]
```

```
def sum_digits(n):
    digit_list = [int(i) for i str(n)]
    return sum(digit_list)
nums = [n for n in range(100) if
        sum_digits(n) % 7 == 0]
```

More shortcuts!

Enumerate a list

```
the_list = [10 ** i for i in range(10)]
for i in range(len(the_list)):
    print str(i) + ': ' + str(the_list[i])
```

index

value

Or:

```
for index, value in enumerate(the_list):
    print str(index) + ': ' + str(value)
```

Like dict.items()

Enumerate a list

Goal: add each element's index itself

```
the_list = range(10)
new_list = []
for i, v in enumerate(the_list):
      new_list.append(i + v)
```

With a list comprehension:

```
the_list = range(10)
new_list = [ i + v for i, v in enumerate(the_list) ]
```

Ternary Assignment

A common pattern in python

```
if x > threshold:
     flag = "Over"
else:
     flag = "Under"
```

Or

```
flag = "Under"
if x > threshold:
     flag = "Over"
```

Ternary Assignment

A common pattern in python

```
if x > threshold:
     flag = "Over"
else:
      flag = "Under"

flag = "Over" if x > threshold else "Under"
```

Ternary Expression
Three elements

Ternary Assignment

```
flag = "Over" if x > threshold else "Under"
```

- Only works for single expressions as results.
- Only works for if and else (no elif)

Ternary Assignment

Goal: A list of 'odd' or 'even' if that index is odd or even.

```
the_list = []
for i in range(16):
    if i % 2 == 0:
        the_list.append('even')
    else:
        the_list.append('odd')
```

or

```
the_list = []
for i in range(16):
    the_list.append('even' if i % 2 == 0 else 'odd')
```

Ternary Assignment

Goal: A list of 'odd' or 'even' if that index is odd or even.

```
the_list = []
for i in range(16):
    if i % 2 == 0:
        the_list.append('even')
    else:
        the_list.append('odd')
```

or

```
the_list = ['even' if i % 2 == 0 else 'odd' for i in range(16)]
```

Get more practice

List Comprehensions:

```
[(x, y) for x in seq1 for y in seq2 if
                        sim(x, y) > threshold]
```

Enumerate:

```
for index, value in enumerate(seq):
    …
```

Ternary If Statement:

```
flag = "Over" if x > threshold else "Under"
```