List comprehensions

UW CSE 140

Winter 2014

Ways to express a list

1. Explicitly write the whole thing:
```
squares = [0, 1, 4, 9, 16, 25, 36, 49, 64, 81, 100]
```

2. Write a loop to create it:
```
squares = []
for i in range(11):
  squares.append(i*i)
```

3. 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

Mathematical notation

Let I be the integers

- $\{ x : x \in \mathrm{I} \text{ and } x = x^2 \}$ is the set $\{ 0, 1 \}$
- $\{ x : x \in \mathrm{I} \text{ and } x > 0 \}$ is the set of all positive integers
- $\{ x^2 : x \in \mathrm{I} \text{ and } 0 \le x < 10 \text{ and prime}(x) \}$

expression variable domain condition

Python notation:

- { x*x for x in range(10) if prime(x) }

expression variable domain condition

Two ways to convert Centigrade to Fahrenheit

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

With a loop:

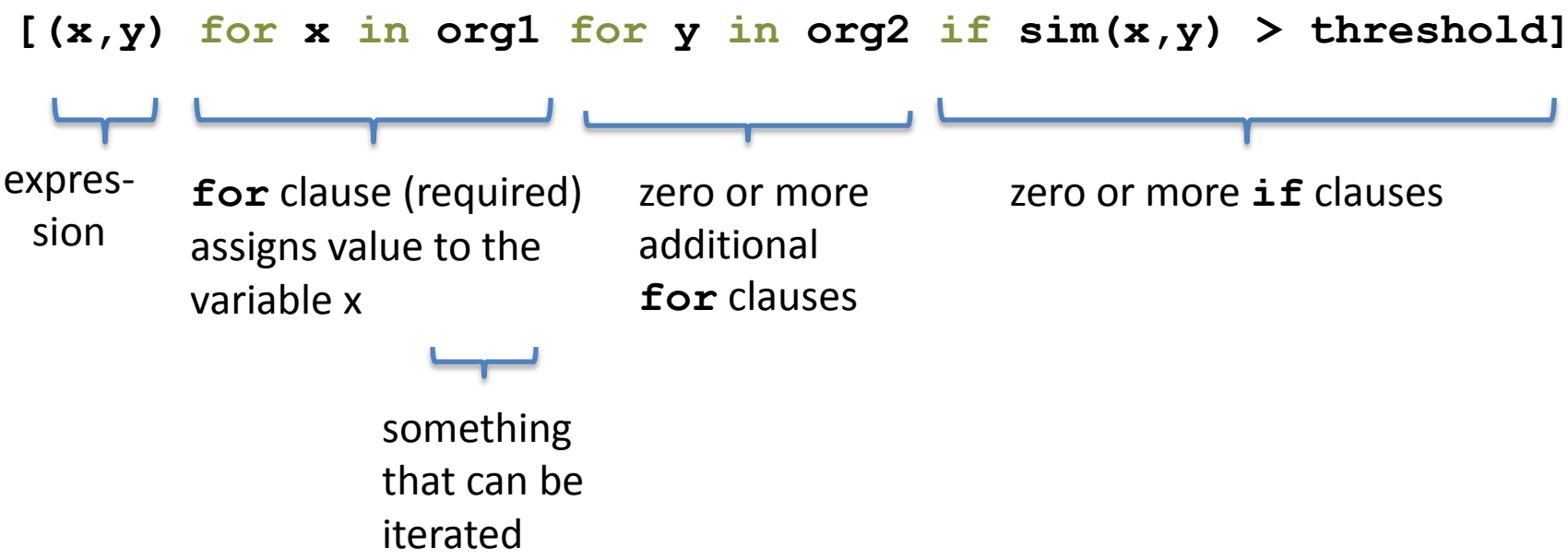
```
ftemps = []
for c in ctemps:
  f = celsius_to_farenheit(c)
  ftemps.append(f)
```

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 org1 for y in org2 if sim(x,y) > threshold]
```

```
result = []
for x in org1:
   for y in org2:
      if sim(x,y) > threshold:
         result.append( (x,y) )
… use result …
```

Types of comprehension

List

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

Set

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

Dictionary

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

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

Preparing names for alphabetization

Goal: convert “firstname lastname” to “lastname, firstname”

```
names = ["Isaac Newton", "Albert Einstein", "Niels Bohr", "Marie Curie",
"Charles Darwin", "Louis Pasteur", "Galileo Galilei", "Margaret Mead"]
```

With a loop:

```
result = []
for name in names:
  split_name = name.split(" ")
  last_name_first = split_name[1] + ", " + split_name[0]
  result.append(last_name_first)
```

With a list comprehension:

```
split_names = [name.split(" ") for name in names]
last_names_first = [sn[1] + ", " + sn[0] for sn in split_names]
# Bonus: last_names = [split_name[1] for split_name in split_names]
```

Another idea: write a function,
then use the function in a comprehension

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]

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

Gene sequence similarity

Goal: Find all similar pairs of genome sequences (one sequence from org1, one from org2)

```
org1 = ["ACGTTTCA", "AGGCCTTA", "AAAACCTG"]
org2 = ["AGCTTTGA", "GCCGGAAT", "GCTACTGA"]
```

"Similar" means: similarity(seq1, seq2) > threshold

```
def similarity(sequence1, sequence2)
    """Return a number representing the
similarity score between the two arguments"""
    ...
```

```
[(s1,s2) for s1 in org1 for s2 in org2
         if similarity(s1,s2) > threshold]
```

All above-average 2-die rolls

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)]
```

Get more practice

- Use comprehensions where appropriate
- Convert loops to comprehensions
- Convert comprehensions to loops