

List comprehensions (and other shortcuts)

UW CSE 160
Winter 2016

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_fahrenheit(c)  
    ftemps.append(f)
```

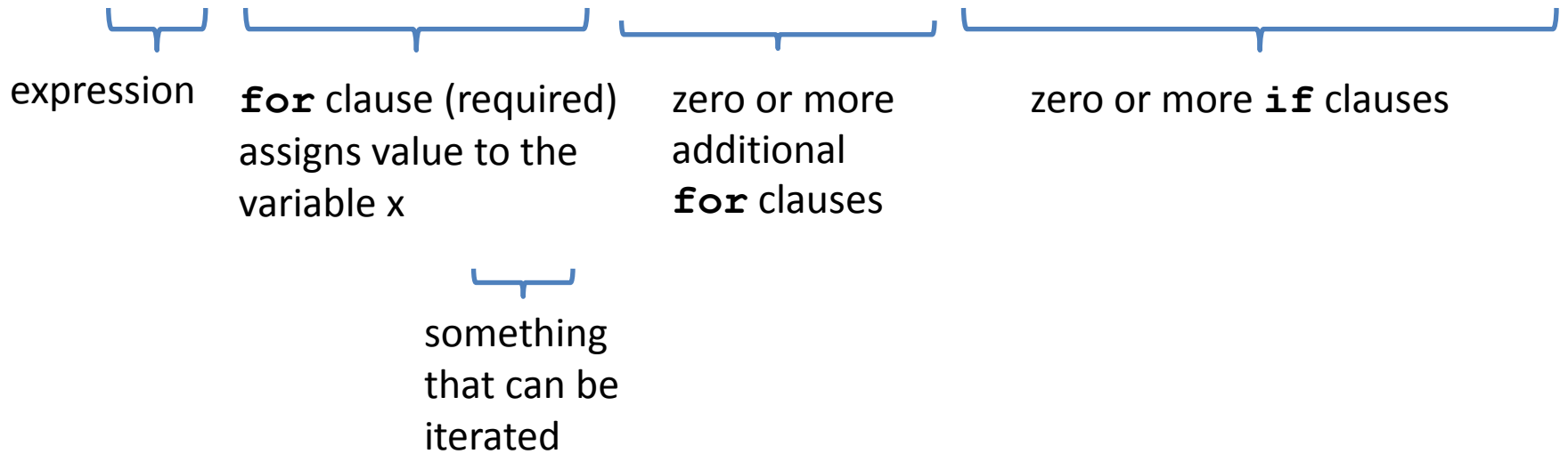
With a list comprehension:

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

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

Syntax of a comprehension

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



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]
```

```
⇒ [4, 2, 6]
```

```
[num for num in nums if num % 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 Matrix

Goal: A matrix where each element is the sum of its row and column.

With a loop:

```
matrix = []
for i in range(5):
    row = []
    for j in range(5):
        row.append(i + j)
    matrix.append(row)
```

With a list comprehension:

```
matrix = [[i + j for j in range(5)] for i in range(5)]
```

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 in 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"
```

Result if true Condition Result if false

The diagram shows the code 'flag = "Over" if x > threshold else "Under"'. Three blue brackets are drawn under the code: one under 'Over', one under 'if x > threshold else', and one under 'Under'. Below each bracket is a label: 'Result if true' under the first bracket, 'Condition' under the second, and 'Result if false' under the third.

- 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"
```