# List Comprehensions

#### MARCH 23-25, 2015

#### **Examples to Get Us Started**

- [x\*\*2 for x in range(10)]
  [0, 1, 4, 9, 16, 25, 36, 49, 64, 81]
- [str(x)+str(x) for x in range(10)]
   ['00', '11', '22', '33', '44', '55', '66', '77', '88', '99']
- [str(x)+str(x) for x in range(10) if x%2 == 0]
   ['00', '22', '44', '66', '88']

### These are all *list comprehensions*

• They provide a flexible, fast, and compact way of creating new lists from old lists.

- List comprehensions provide a more compact and more efficient alternative to explicitly using **for**-loops.
- See Sections 5.1.3 and 5.1.4 (on *List Comprehensions*) from Python 3 tutorial at www.python.org

### List Comprehension: Basic Syntax

[*expr* for *x* in list]

- for and in are Python keywords, used just as in for-loops.
- *x* is a variable that takes on values of elements in list, in order.
- *expr* is Python expression, typically involving the variable *x*.
- The expression [*expr* for *x* in list] evaluates to a list made up of the different values that *expr* takes on for different x.
- This is similar to the "set builder" notation used in math: {x\*y | x and y are even}.

## List Comprehensions: Syntax with if-clause

[*expr* for *x* in *list* if *bool-expr*]

- *bool-expr* is a boolean expression involving *x*.
- The overall expression evaluates to a list of values of *expr* evaluated for all values of *x* in *list* satisfying the *bool-expr*.
- Example: [str(x)+str(x) for x in range(10) if x%2 == 0] evaluates to ['00', '22', '44', '66', '88']

• Generating lists of lists.

[range(x) for x in range(1, 5)] Evaluates to: [[0], [0, 1], [0, 1, 2], [0, 1, 2, 3]]

• All numbers in the range 0..49 containing the digit "7".

[x for x in range(50) if "7" in str(x)] Evaluates to: [7, 17, 27, 37, 47]

### Nested List Comprehensions

#### **Example:**

[x\*y for x in range(3) for y in range(3)] [0, 0, 0, 0, 1, 2, 0, 2, 4]

#### Notes:

• As in nested loops, for every iteration of the first loop (the for-x loop), all iterations of the second loop (the for-y loop) are executed.

### **Example: Generating Perfect Squares**

[x for x in range(100) for y in range(x) if y\*y == x]
[4, 9, 16, 25, 36, 49, 64, 81]

- Those x and y values (from their respective lists) that satisfy the condition  $y^2 = x$ , are generated.
- Thus all x values generated in this manner are perfect squares.

### **Example: Generating Composites**

composites = [x for y in range(2, 10) for x in range(2\*y, 100, y)]

- For each y = 2, 3,..., 9, the variable x takes on values that are multiples of y.
- For y = 2, the variable x takes on values 4, 6, 8,..., 98.
- For y = 3, the variable x takes on values 6, 9, 12,..., 99.
- Thus the values of x generated in this manner are (strict) multiples of 2, 3, 4,..., 9.
- This covers all composites in the range 2..99.

### **Example: Generating Prime Numbers**

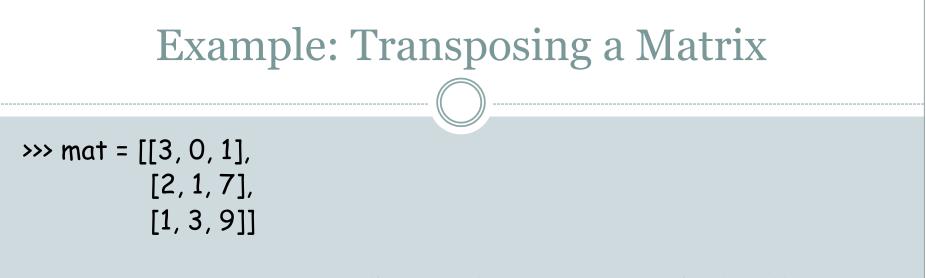
primes = [x for x in range(2, 100) if x not in composites]

#### Notes:

• Primes in the range 2..99 can be obtained by taking the complement of the generated composites.

### Example: Flattening Lists

```
>>> nestedList = [range(x) for x in range(1, 4)]
>>> nestedList
>>> [[0], [0, 1], [0, 1, 2]]
>>> [y for x in nestedList for y in x]
>>> [0, 0, 1, 0, 1, 2]
```



>>> [ [mat[i][j] for i in range(len(mat))] for j in range(len(mat))] >>> [[3, 2, 1], [0, 1, 3], [1, 7, 9]]

- The expression, which is the first element of the list comprehension, itself happens to be a list comprehension.
- Therefore, each element of the constructed list, is a list itself.

### Warning!

• The danger with list comprehensions is that your code may become hard to understand, especially with nested list comprehensions.

• If by using a list comprehension, you are making your code hard to understand, then it is time to desist.