CS 134:

Strings, Lists, and Ranges

Announcements & Logistics

- **Lab 3** is due tonight/tomorrow at 11pm
- **HW 4** will be posted later today
- If you are having problems with anything, please come see us during office hours
  - Always refer to course calendar for updated hours!

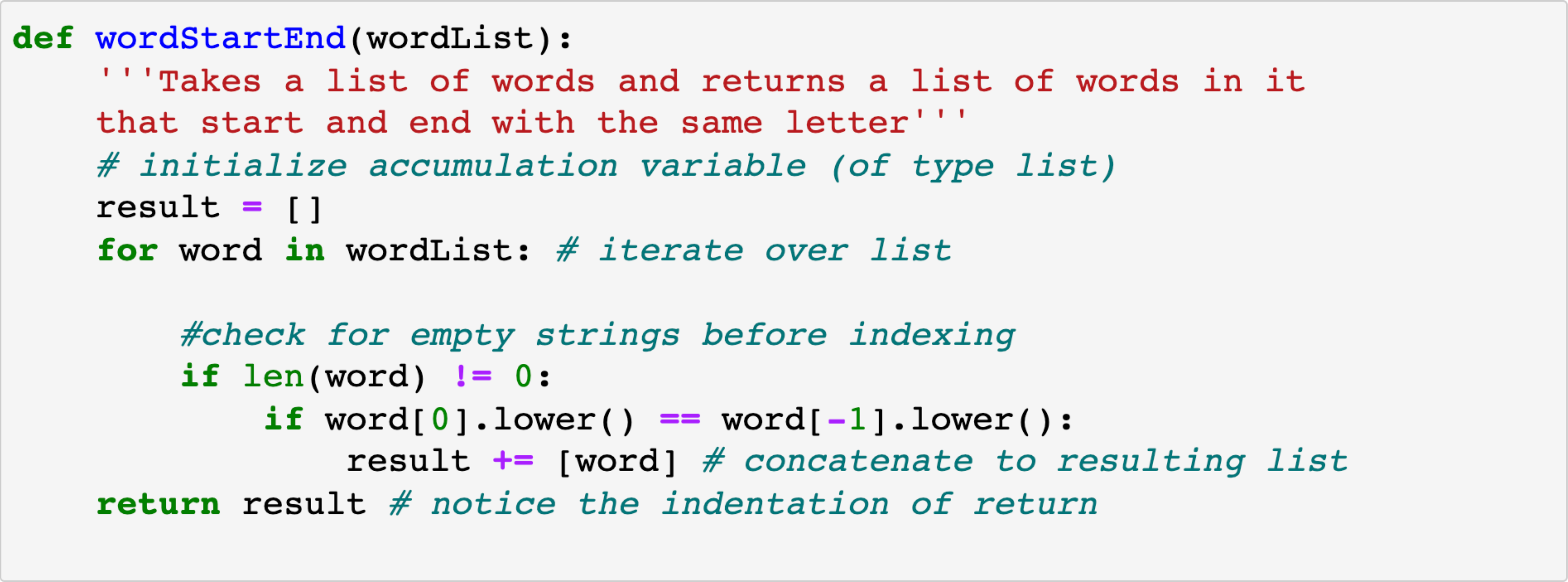
Do You Have Any Questions?

Last Time

- Reviewed iterating over **sequences** with **for loops**
    - Used **accumulation variables** to collect "items" from sequences, e.g., vowel sequences, counters, etc
    - Looked at **nested for loops**
- Introduced new sequence: **lists**
    - Learned how to index, slice, concatenate, iterate over lists just like we did with strings
    - Example: wordStartEnd

Recap: `wordStartEnd`

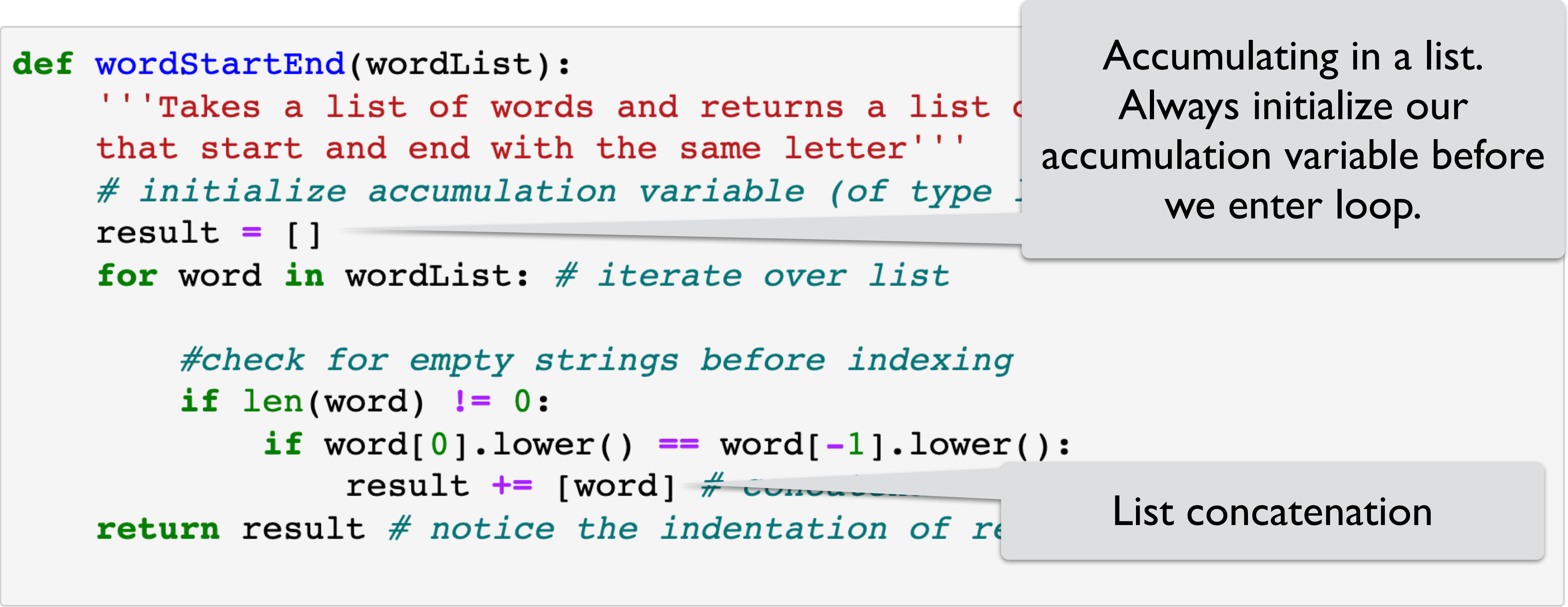
- Write a function that iterates over a given list of words `wordList`, and returns a (new) list containing all the words in `wordList` that start and end with the same letter (ignoring case).



```python
def wordStartEnd(wordList):
    '''Takes a list of words and returns a list of words in it
    that start and end with the same letter'''
    # initialize accumulation variable (of type list)
    result = []
    for word in wordList: # iterate over list

        #check for empty strings before indexing
        if len(word) != 0:
            if word[0].lower() == word[-1].lower():
                result += [word] # concatenate to resulting list
    return result # notice the indentation of return
```

Recap: `wordStartEnd`

- Write a function that iterates over a given list of words `wordList`, and returns a (new) list containing all the words in `wordList` that start and end with the same letter (ignoring case).



```
def wordStartEnd(wordList):
    '''Takes a list of words and returns a list c
    that start and end with the same letter'''
    # initialize accumulation variable (of type l
    result = []
    for word in wordList: # iterate over list

        #check for empty strings before indexing
        if len(word) != 0:
            if word[0].lower() == word[-1].lower():
                result += [word] # concaten
    return result # notice the indentation of re
```

Accumulating in a list.
Always initialize our accumulation variable before we enter loop.

List concatenation

Today’s Plan

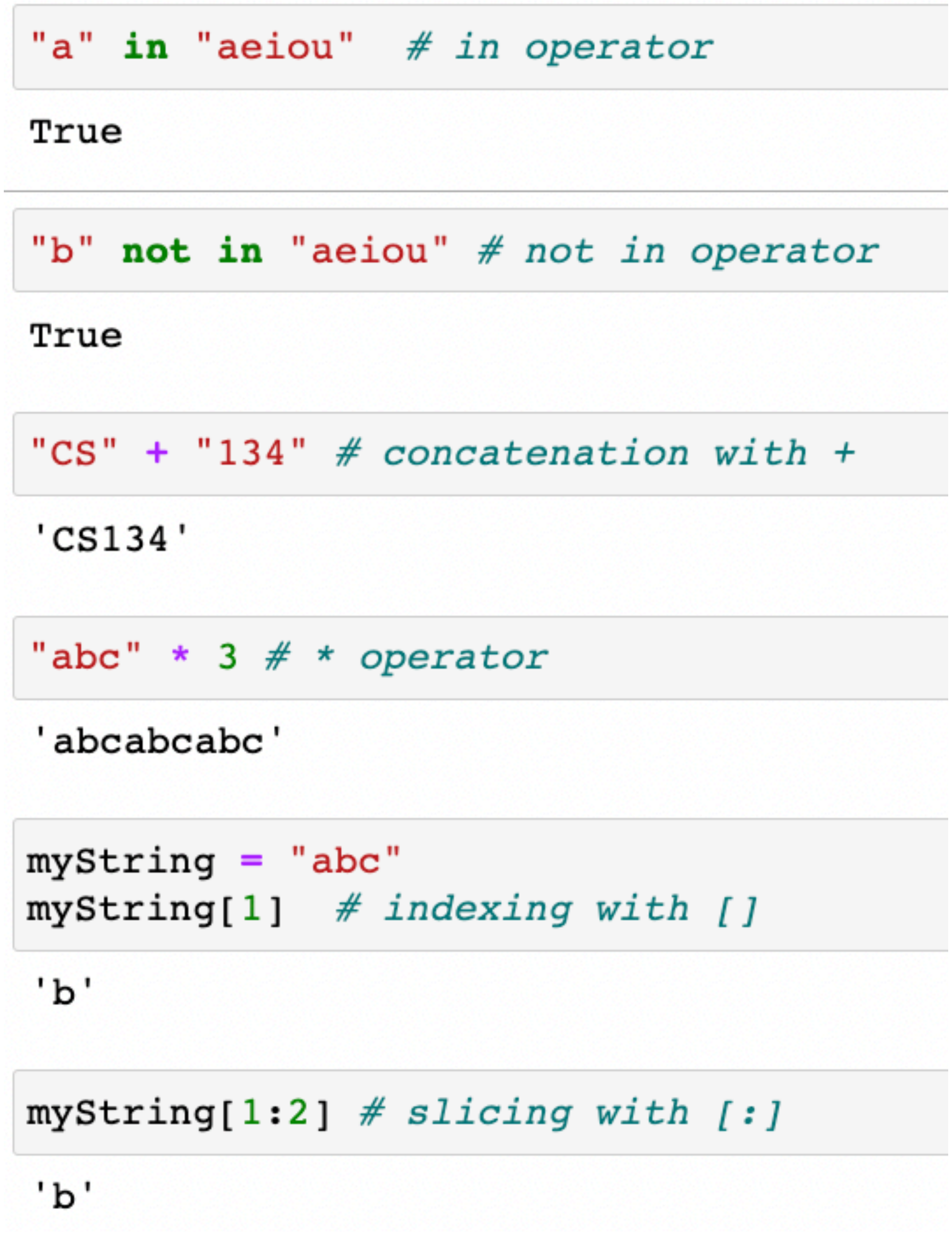
- Review **sequence** operations
- Review **list** and **string** operations (so far!)
  - Discuss convenient method and functions for working with strings and lists (we’ll continue to expand on this in upcoming lectures)
  - Investigate list **mutability** versus string **immutability**
- Introduce **range** data types and ways to iterate over numerical sequences

Review: Sequence Operations

Operation	Result
`x in seq`	True if an item of seq is equal to x
`x not in seq`	False if an item of seq is equal to x
`seq1 + seq2`	The concatenation of seq1 and seq2
`seq*n, n*seq`	n copies of seq concatenated
`seq[i]`	i'th item of seq, where origin is 0
`seq[i:j]`	slice of seq from i to j
`seq[i:j:k]`	slice of seq from i to j with step k
`len(seq)`	length of seq
`min(seq)`	smallest item of seq
`max(seq)`	largest item of seq

All of these operators work on both **strings** and **lists**!

Sequence Operations with Strings



```
"a" in "aeiou"   # in operator
```

```
True
```

```
"b" not in "aeiou" # not in operator
```

```
True
```

```
"CS" + "134" # concatenation with +
```

```
'CS134'
```

```
"abc" * 3 # * operator
```

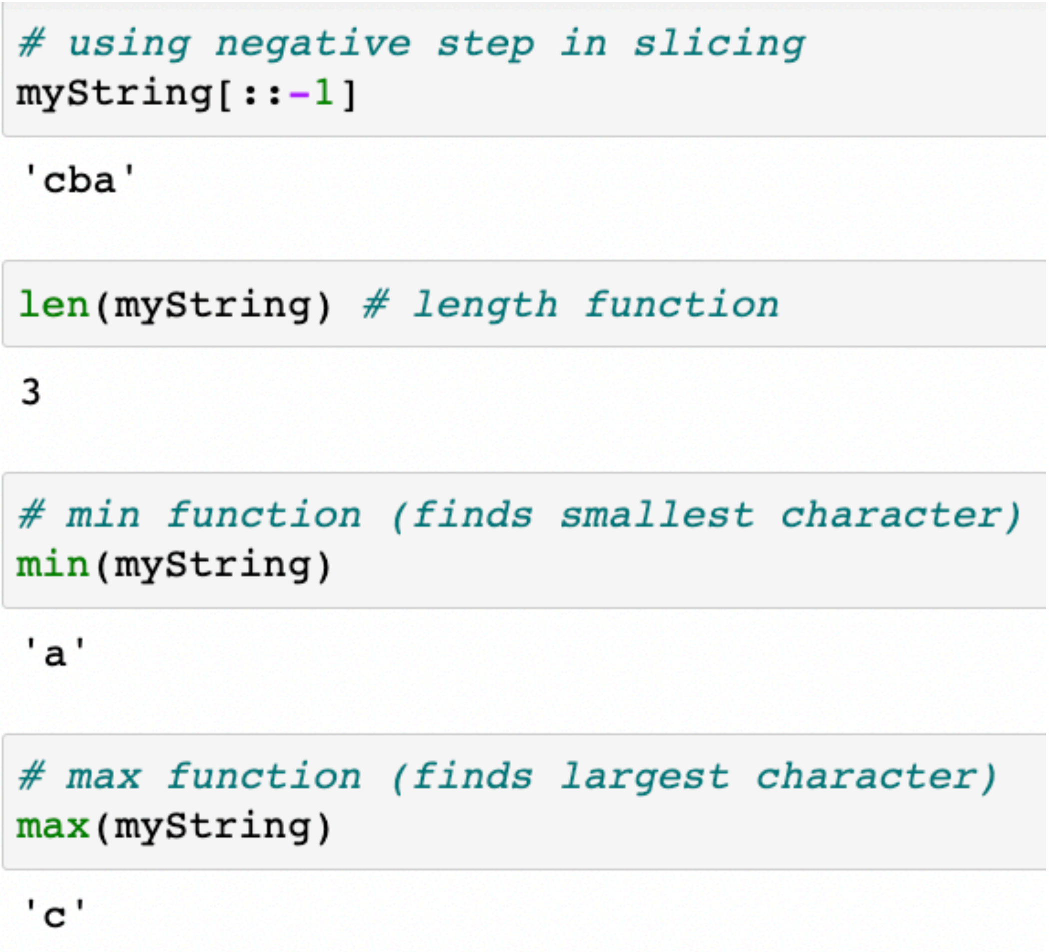
```
'abcabcabc'
```

```
myString = "abc"
myString[1]  # indexing with []
```

```
'b'
```

```
myString[1:2] # slicing with [:]
```

```
'b'
```



```
# using negative step in slicing
myString[::-1]
```

```
'cba'
```

```
len(myString) # length function
```

```
3
```

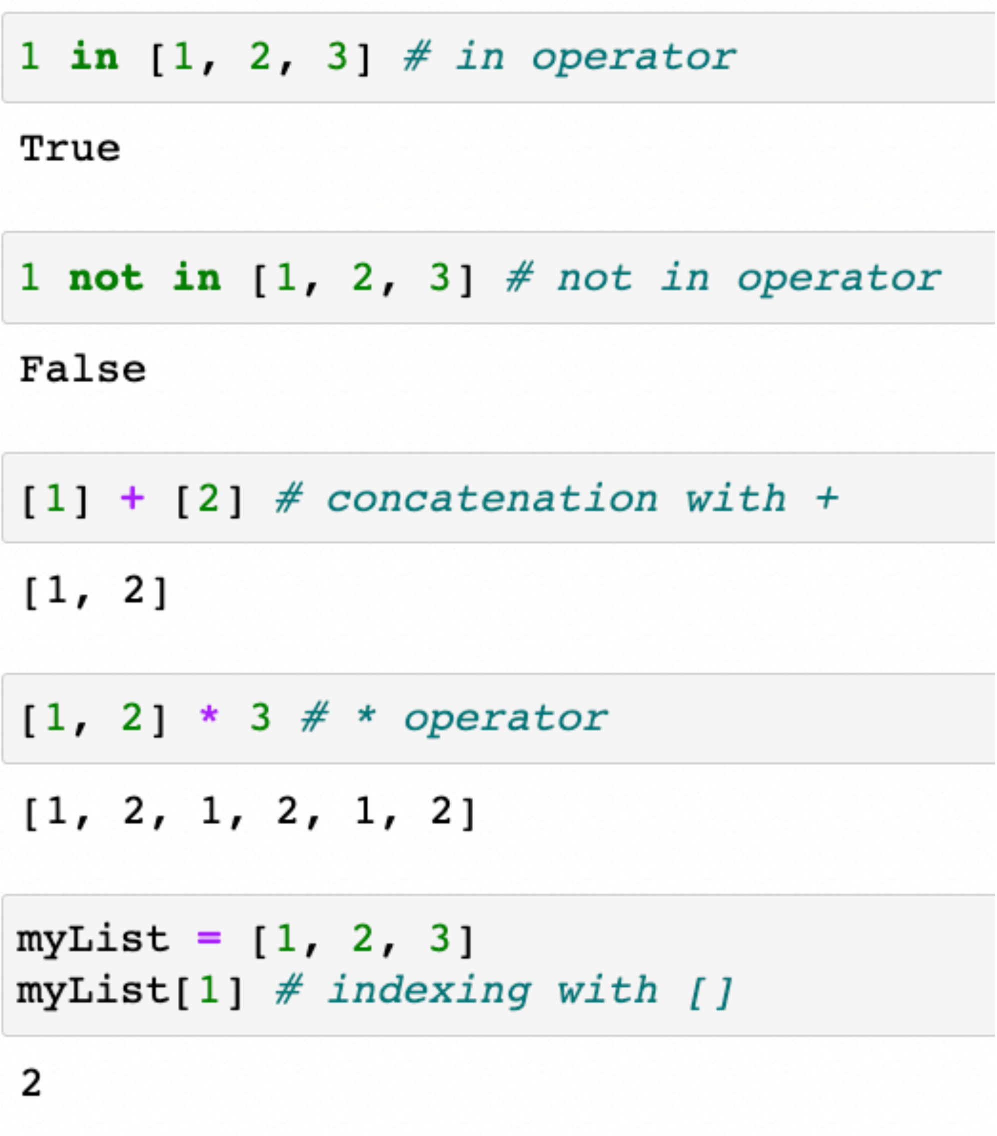
```
# min function (finds smallest character)
min(myString)
```

```
'a'
```

```
# max function (finds largest character)
max(myString)
```

```
'c'
```

Sequence Operations with Lists



```
1 in [1, 2, 3] # in operator
```

```
True
```

```
1 not in [1, 2, 3] # not in operator
```

```
False
```

```
[1] + [2] # concatenation with +
```

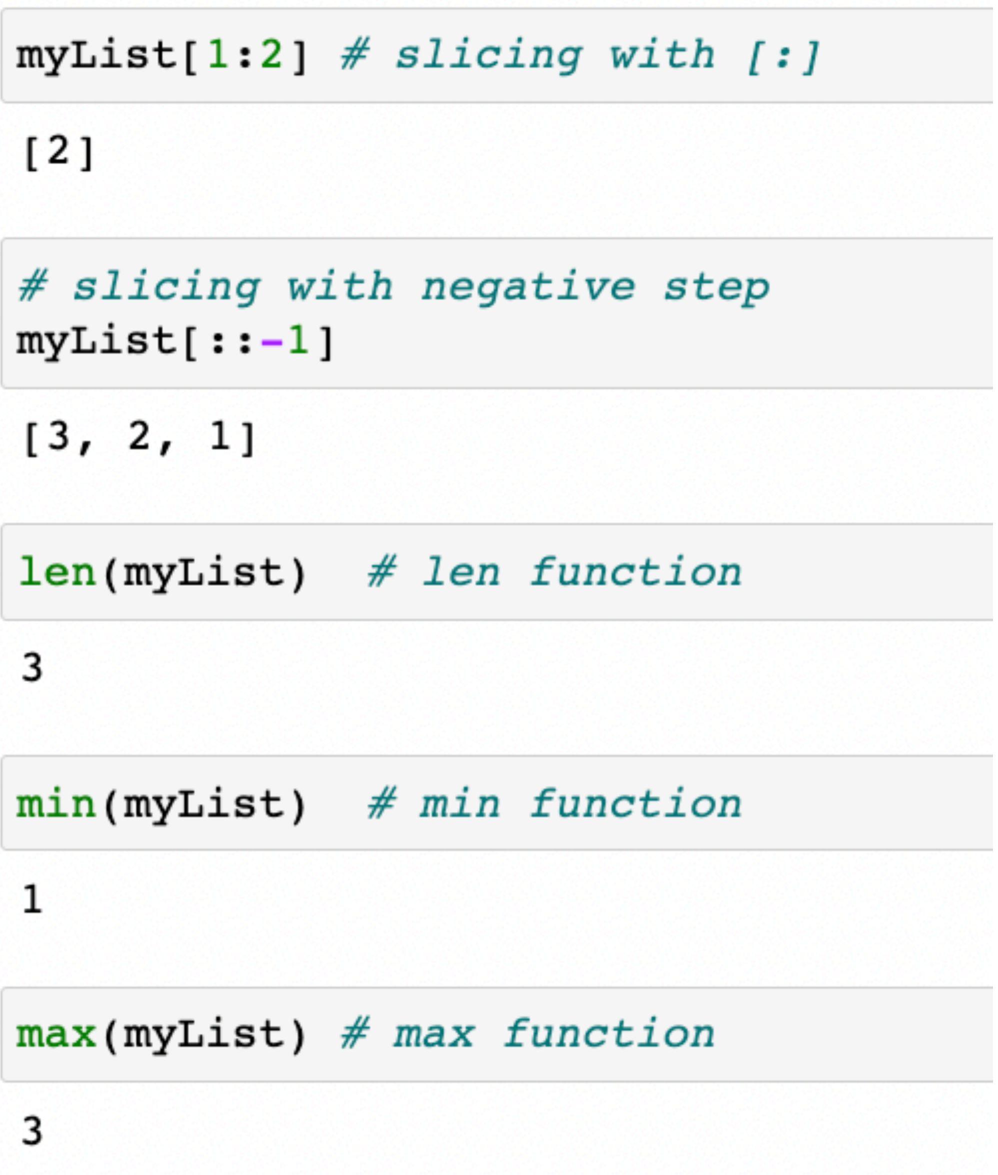
```
[1, 2]
```

```
[1, 2] * 3 # * operator
```

```
[1, 2, 1, 2, 1, 2]
```

```
myList = [1, 2, 3]
myList[1] # indexing with []
```

```
2
```



```
myList[1:2] # slicing with [:]
```

```
[2]
```

```
# slicing with negative step
myList[::-1]
```

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

```
len(myList)  # len function
```

```
3
```

```
min(myList)  # min function
```

```
1
```

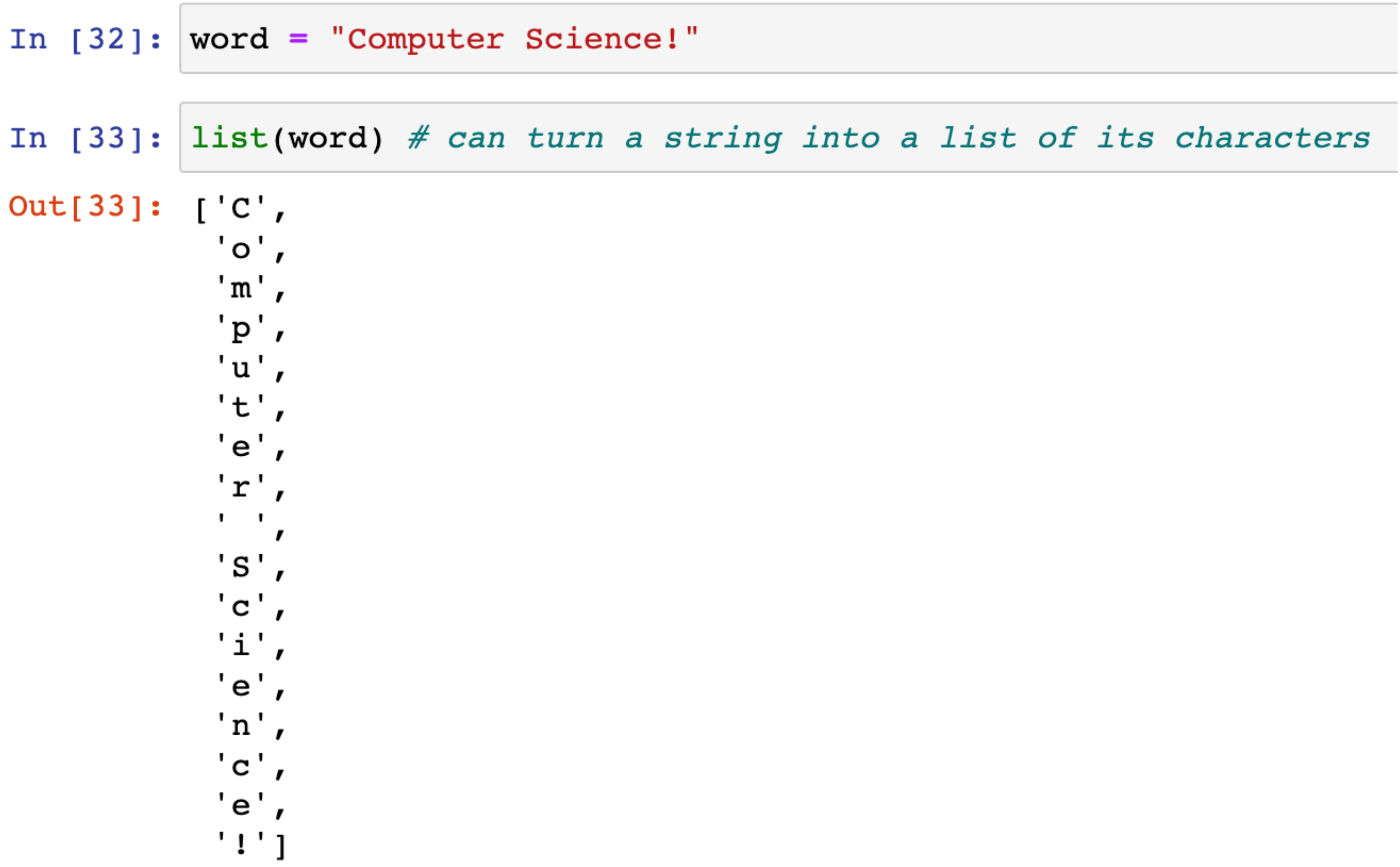
```
max(myList) # max function
```

```
3
```

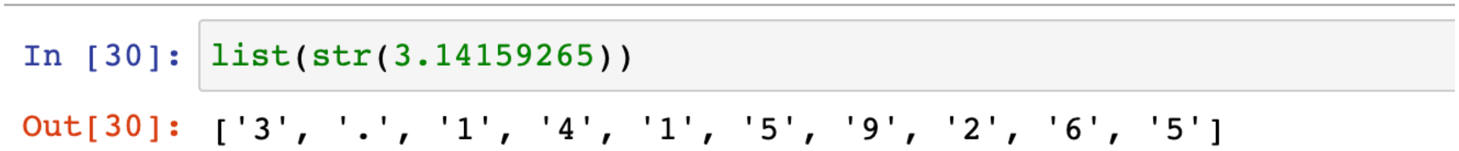
List Operations, Methods, and Functions

`list()` Function

- `list()` function, when given another sequence (like a string), returns a list of elements in the sequence



```
In [32]: word = "Computer Science!"

In [33]: list(word) # can turn a string into a list of its characters

Out[33]: ['C',
          'o',
          'm',
          'p',
          'u',
          't',
          'e',
          'r',
          ' ',
          'S',
          'c',
          'i',
          'e',
          'n',
          'c',
          'e',
          '!']
```



```
In [30]: list(str(3.14159265))

Out[30]: ['3', '.', '1', '4', '1', '5', '9', '2', '6', '5']
```

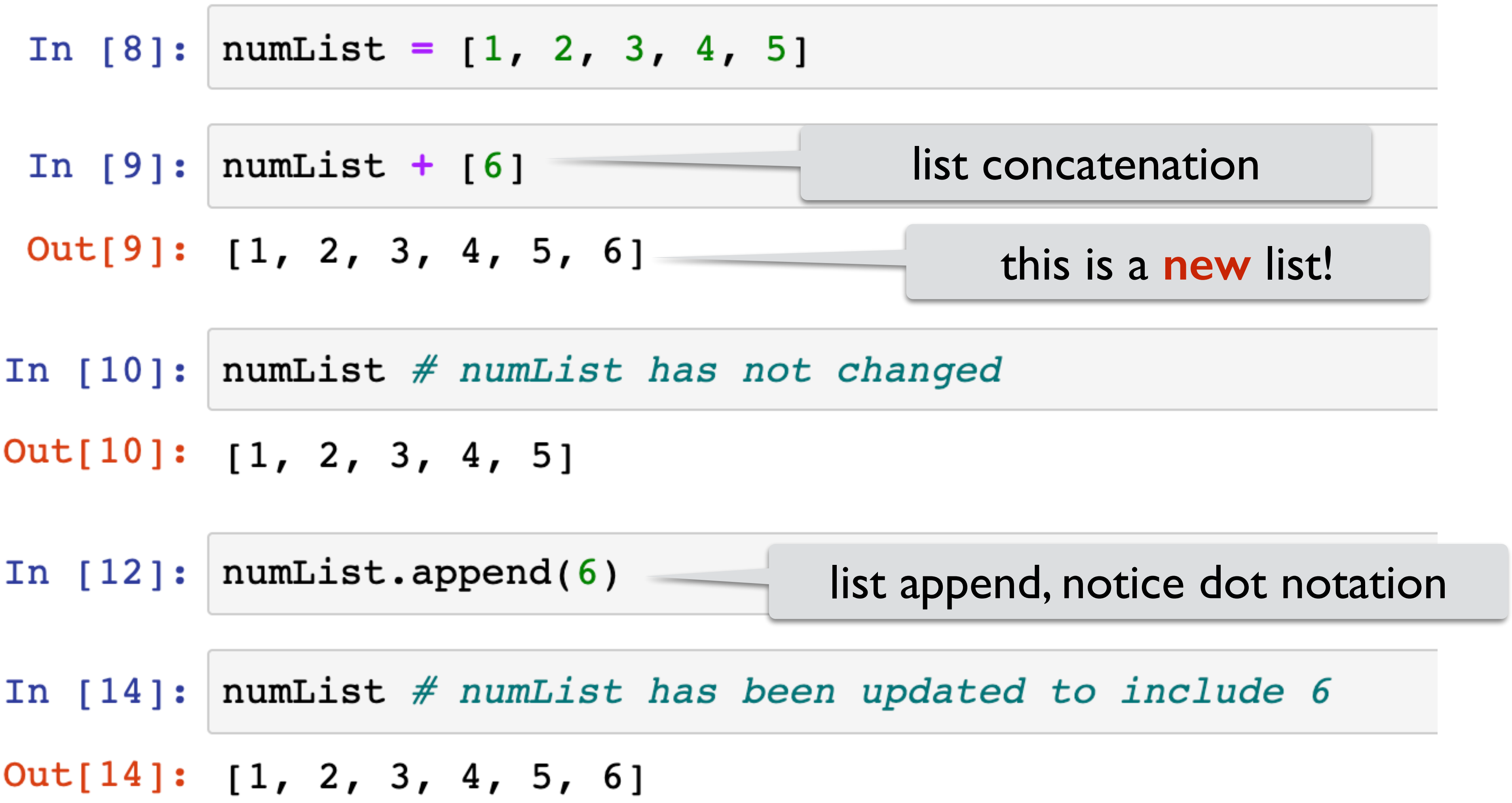
Modifying Lists

- Lists are **mutable** data structures
  - This means we can update them (delete things from them, add things to them, etc.)
- List **concatenation** (using +) ***creates a new list*** and ***does not modify*** any existing list
  - **Important point: Concatenating to a list returns a new list!**

- We can also **append to or extend a list**, which ***modifies*** the existing list
  - The list **method** `myList.append(item)` ***modifies*** the list `myList` by adding `item` to it at the end
  - The list **method** `myList.extend(otherList)` ***modifies*** the list `myList` by adding all elements from `otherList` to `myList` at the end
  - Often more efficient to append/extend rather than concatenate
  - But we have to be very careful when modifying the list
  - **Important point: Appending to or extending a list modifies the existing list!**

Adding elements to a List

- Here are a few examples that show how to use the list `.append()` method vs + operator to add items to the end of an existing list



```
In [8]:  numList = [1, 2, 3, 4, 5]

In [9]:  numList + [6]

Out[9]:  [1, 2, 3, 4, 5, 6]

In [10]: numList # numList has not changed

Out[10]: [1, 2, 3, 4, 5]

In [12]: numList.append(6)

In [14]: numList # numList has been updated to include 6

Out[14]: [1, 2, 3, 4, 5, 6]
```

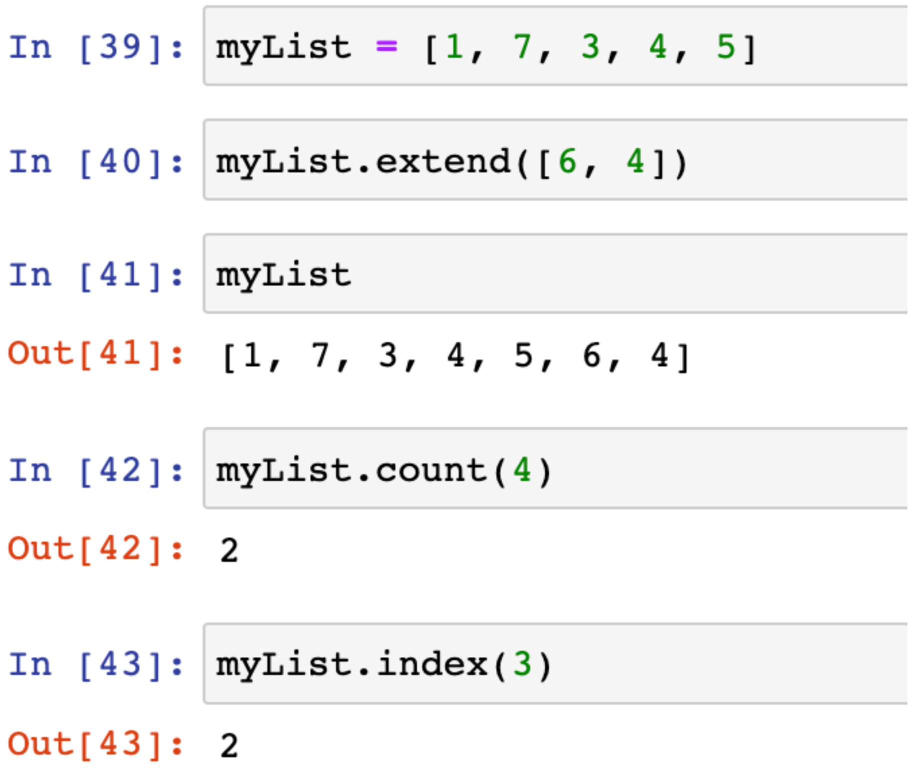
list concatenation

this is a **new** list!

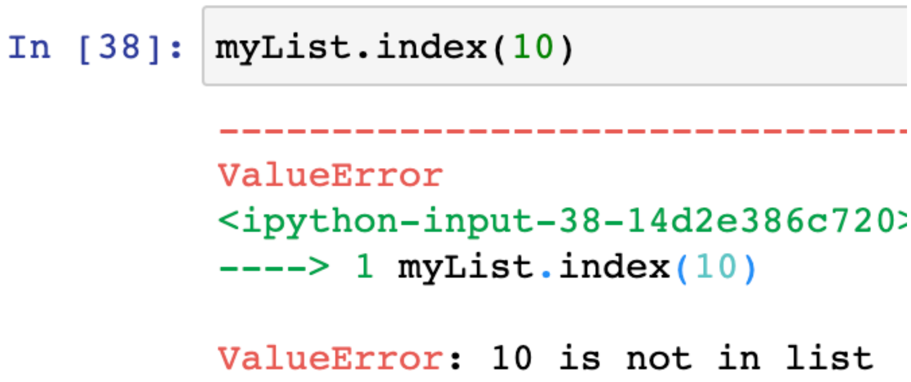
list append, notice dot notation

More Useful List Methods

- `myList.extend(itemList)`: ***appends all items*** in `itemList` to the end of `myList` (modifying `myList`)
- `myList.count(item)`: counts and returns the number (`int`) of times `item` appears in `myList`
- `myList.index(item)`: returns the first index (`int`) of item in myList if it is present, else throws an error



```
In [39]: myList = [1, 7, 3, 4, 5]

In [40]: myList.extend([6, 4])

In [41]: myList

Out[41]: [1, 7, 3, 4, 5, 6, 4]

In [42]: myList.count(4)

Out[42]: 2

In [43]: myList.index(3)

Out[43]: 2
```

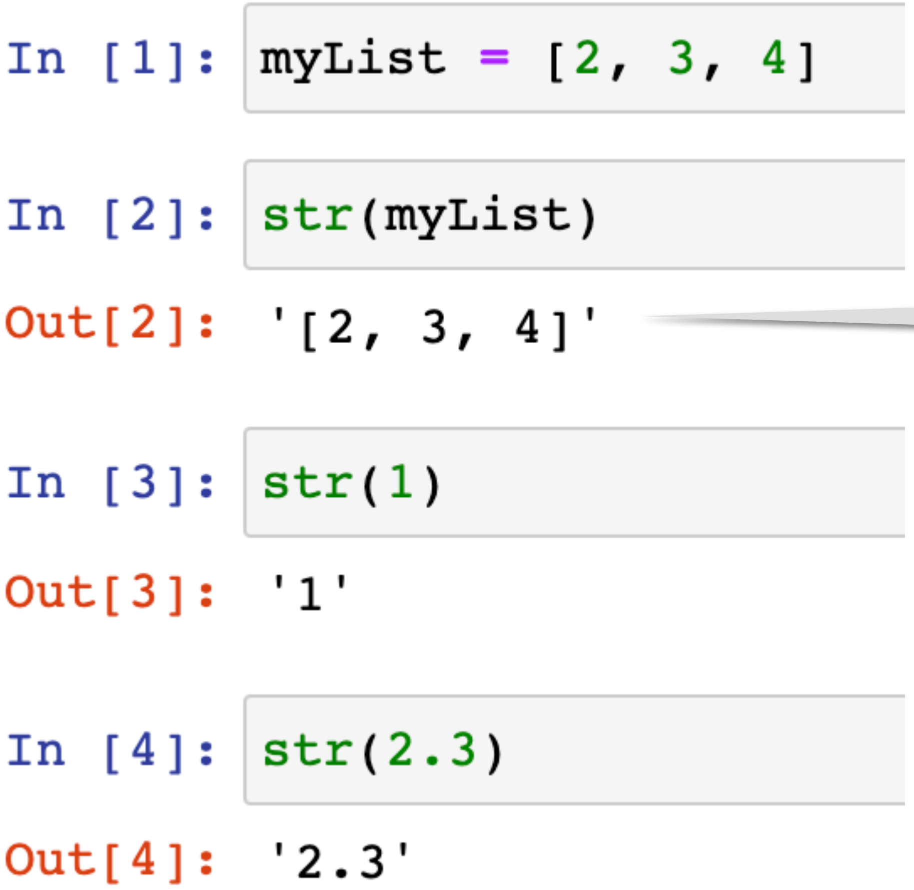


```
In [38]: myList.index(10)

---------------------------------
ValueError
<ipython-input-38-14d2e386c720
----> 1 myList.index(10)

ValueError: 10 is not in list
```

String Operations, Methods, and Functions

`str()` function

- `str()` function allows us to convert other data types to strings

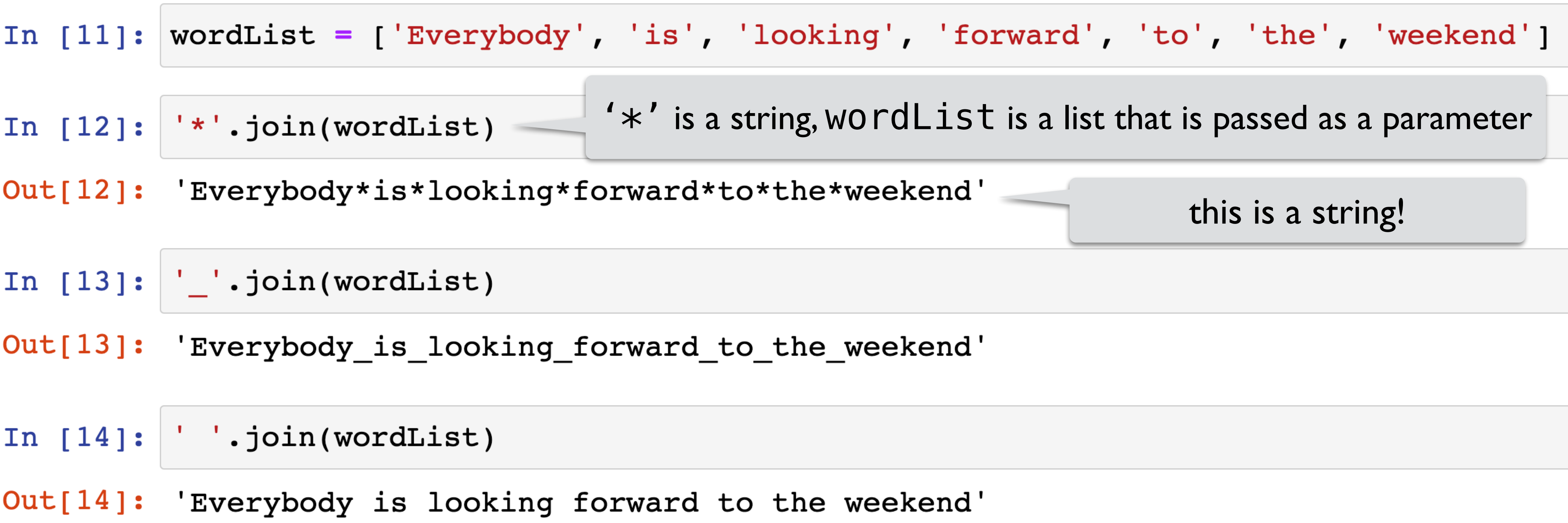


```
In [1]: myList = [2, 3, 4]

In [2]: str(myList)
Out[2]: '[2, 3, 4]'

In [3]: str(1)
Out[3]: '1'

In [4]: str(2.3)
Out[4]: '2.3'
```

Converting a list to a string in this way is somewhat limiting

List to Strings: `join()`

- Given a list of strings, the `.join()` string **method**, when applied to a string `separator`, concatenates the strings together with the string `separator` between them
- `.join()` requires a list to be passed as a **parameter**, and elements of the list must be strings



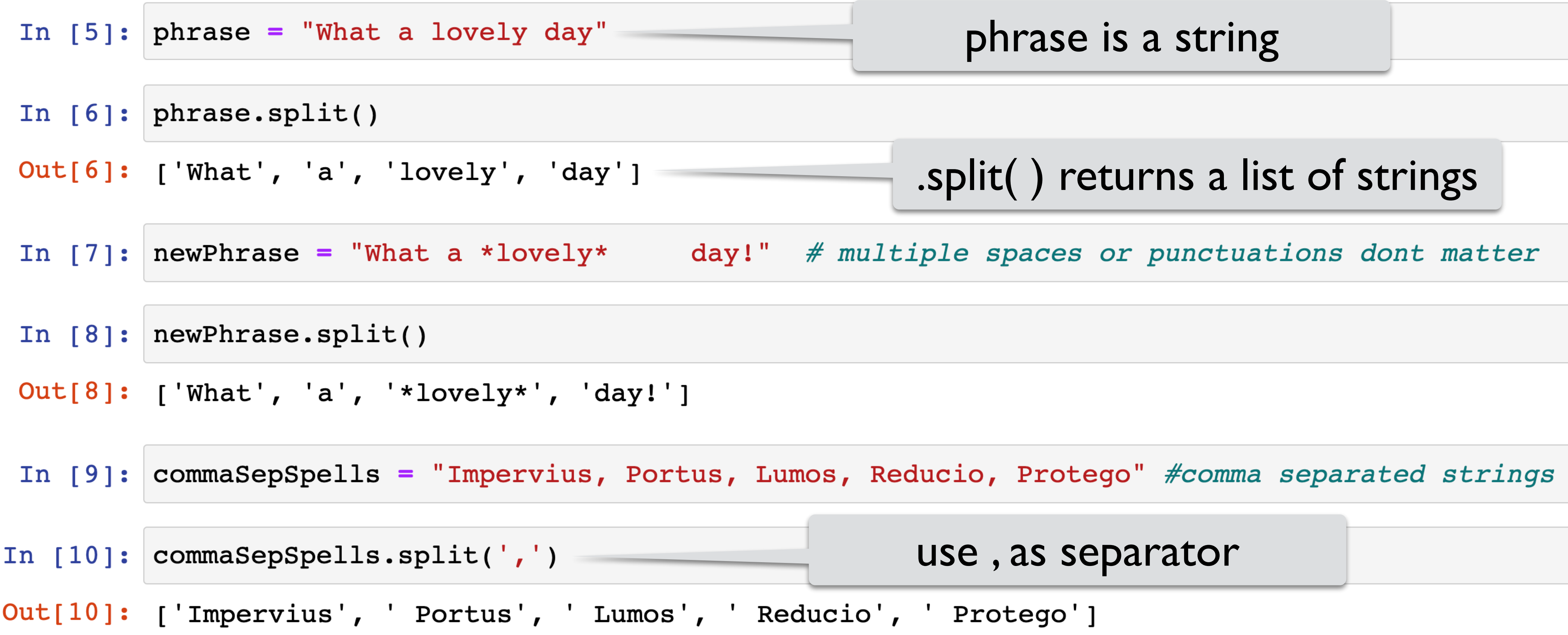
```
In [11]: wordList = ['Everybody', 'is', 'looking', 'forward', 'to', 'the', 'weekend']

In [12]: '*'.join(wordList)
Out[12]: 'Everybody*is*looking*forward*to*the*weekend'

In [13]: '_'.join(wordList)
Out[13]: 'Everybody_is_looking_forward_to_the_weekend'

In [14]: ' '.join(wordList)
Out[14]: 'Everybody is looking forward to the weekend'
```

'*' is a string, `wordList` is a list that is passed as a parameter

this is a string!

String to Lists: `split()`

- `.split()` is a string **method** that splits strings at "spaces"(the default separator) and returns a list of (sub)strings
- Can optionally specify other **delimiters** (or separators) as well



```
In [5]: phrase = "What a lovely day"

In [6]: phrase.split()
Out[6]: ['What', 'a', 'lovely', 'day']

In [7]: newPhrase = "What a *lovely*     day!"  # multiple spaces or punctuations dont matter

In [8]: newPhrase.split()
Out[8]: ['What', 'a', '*lovely*', 'day!']

In [9]: commaSepSpells = "Impervius, Portus, Lumos, Reducio, Protego" #comma separated strings

In [10]: commaSepSpells.split(',')
Out[10]: ['Impervius', ' Portus', ' Lumos', ' Reducio', ' Protego']
```

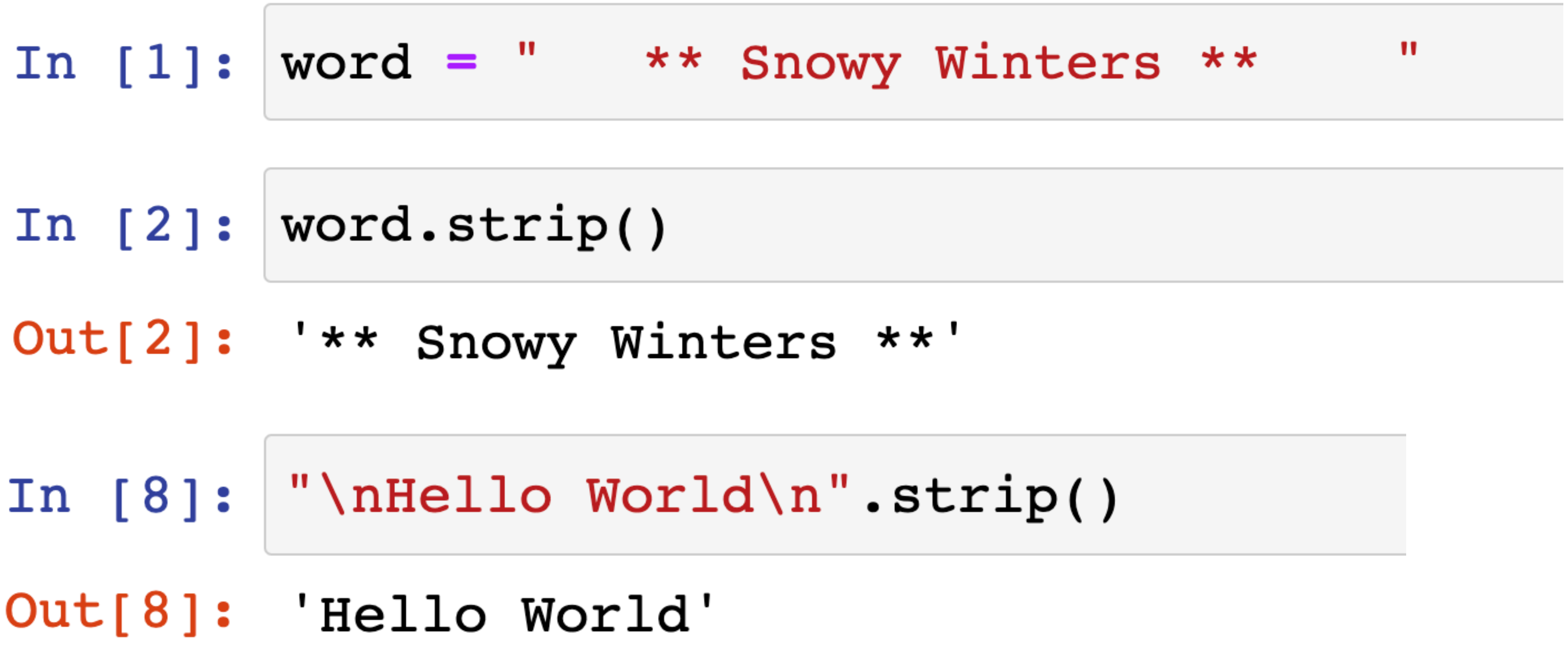
phrase is a string

.split( ) returns a list of strings

use , as separator

Remove whitespace w/ `strip()`

- The `.strip()` string method strips away whitespace and (sometimes hidden) new line (\n) characters from the beginning and end of strings and **returns a new string**



```
In [1]: word = "   ** Snowy Winters **    "

In [2]: word.strip()

Out[2]: '** Snowy Winters **'

In [8]: "\nHello World\n".strip()

Out[8]: 'Hello World'
```

More Useful String Methods!

- `word.find(s)`
    - Return the first (or last) position (index) of string s in word. Returns -1 if not found.
- `char.isspace()`
    - Returns **True** if char is not empty and char is composed of white space (or lowercase, uppercase, alphabetic letters, digits, or either letters or digits).
    - Can also do: `islower(), isupper(), isalpha(), isdigit(), isalnum()`.
- `word.count(s)`
    - Returns the number of (non-overlapping) occurrences of s in word
- `word.index(s)`
    - Return the lowest index in word where substring s is found. Returns ValueError if not found.
- `replace(old, new)`
    - Return a string with all occurrences of substring old replaced by new.
- Many, many more: see `pydoc3 str`

\

String Methods in Action

Notice how methods use dot notation

```
                                           Returned value
word = 'Williams College'
word.split()                           ['Williams','College']
word.upper()                              'WILLIAMS COLLEGE'
word.lower()                              'williams college'
word.replace('iams', 'eslley')           'Willeslley College'
word.replace('tent', 'eselley')          'Williams College'
newWord = '   Spacey College   '
newWord.strip()                          'Spacey College'
myList = ['Williams', 'College']
' '.join(myList)                         'Williams College'
```

Important note: Strings are immutable. None of these operations change/affect the original string. They all return a new string!

Summarizing Mutability in Strings vs Lists

Strings are immutable

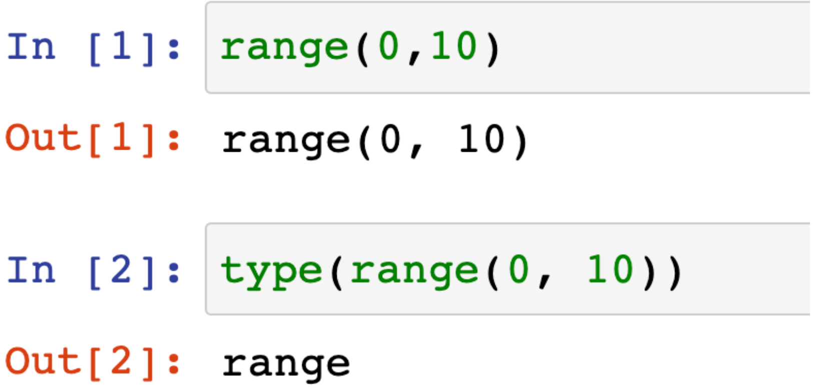
- Once you create a string, it cannot be changed!
- All operations that we have seen on strings ***return a new string*** and ***do not modify*** the original string

Lists are mutable

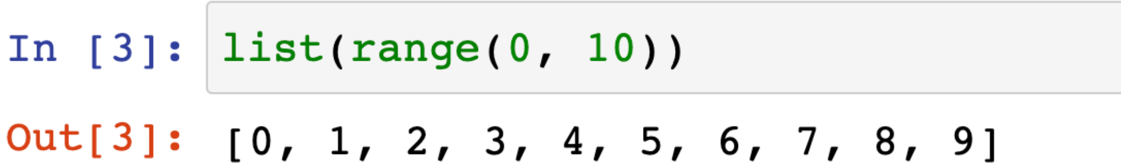
- Lists are mutable (or changeable) sequences
- You can concatenate items to a list using +, but this ***does not*** change the list
- You can append items using append() method, and this ***does*** change the list

Moving on: Ranges (another sequence!)

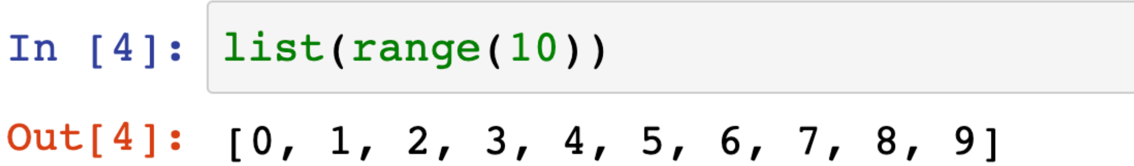
- Python provides an easy way to iterate over numerical sequences using **ranges**, **another sequence data type**
- When the `range()` function is given two integer arguments, it returns a ***range object*** of all integers starting at the first and up to, *but not including*, the second; if the first integer is 0, it may be omitted.
- To see the values included in the range, we can pass our range to the `list()` function which returns a **list** of them



```
In [1]: range(0,10)

Out[1]: range(0, 10)

In [2]: type(range(0, 10))

Out[2]: range
```



```
In [3]: list(range(0, 10))

Out[3]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

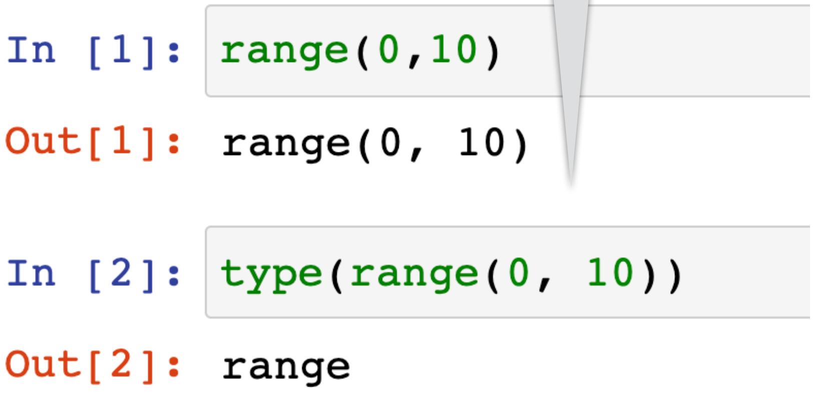


```
In [4]: list(range(10))

Out[4]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

Moving on: Ranges (another sequence!)

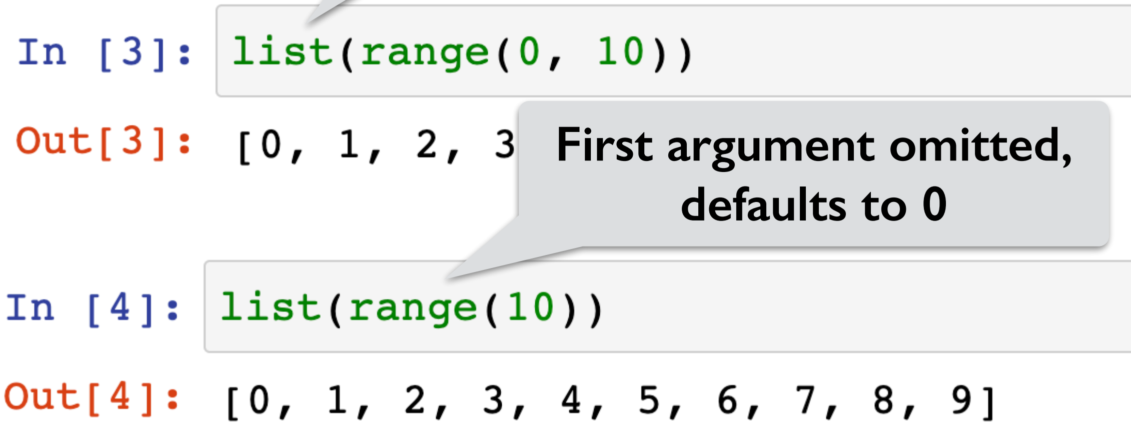
- Python provides an easy way to iterate over numerical sequences using **ranges**, **another sequence data type**
- When the `range()` function is given two integer arguments, it returns a ***range object*** of all integers starting at the first and up to, *but not including*, the second; if the first integer is 0, it may be omitted.
- To see the values included in the range, we can pass our range to the `list()` function which returns a **list** of them

A range is a type of sequence in Python (like string and list)



```
In [1]: range(0,10)

Out[1]: range(0, 10)

In [2]: type(range(0, 10))

Out[2]: range
```

To see elements in range, pass range to list() function



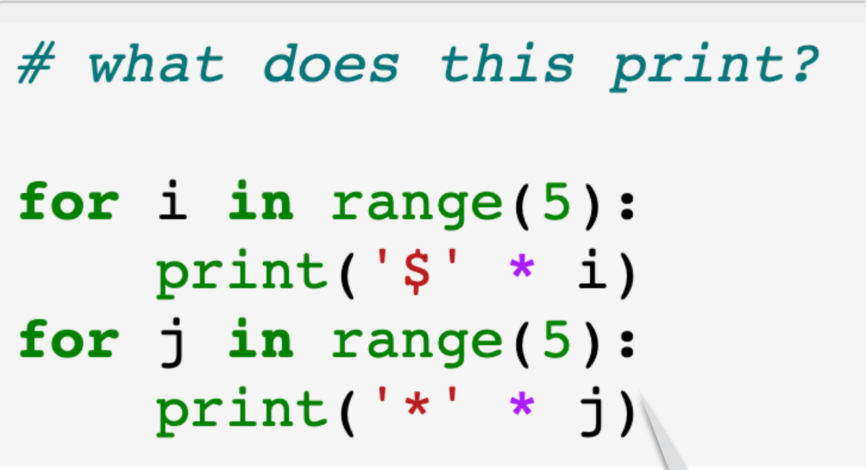
```
In [3]: list(range(0, 10))

Out[3]: [0, 1, 2, 3
```

First argument omitted, defaults to 0

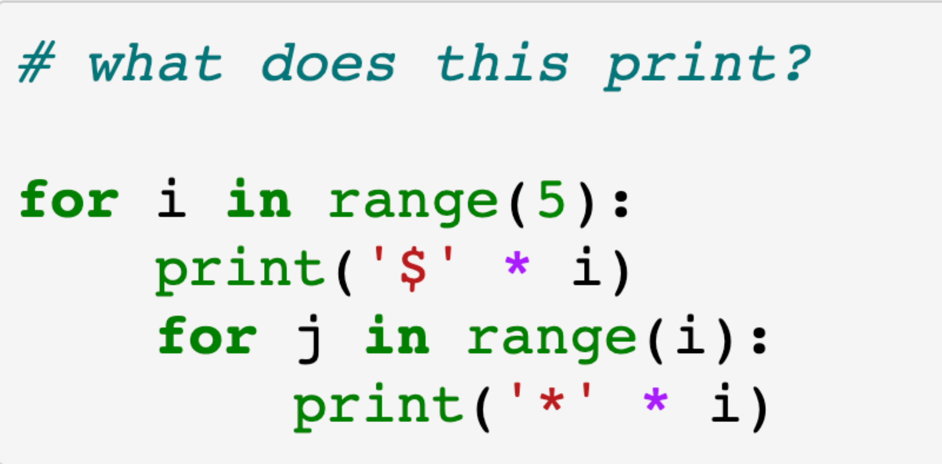
```
In [4]: list(range(10))

Out[4]: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9]
```

Loops and Ranges to Print Patterns

- Sometimes we might use a **for loop**, not to iterate over a sequence, but just to **repeat** a task over and over. The following loops print a pattern to the screen. (Look closely at the indentation!)



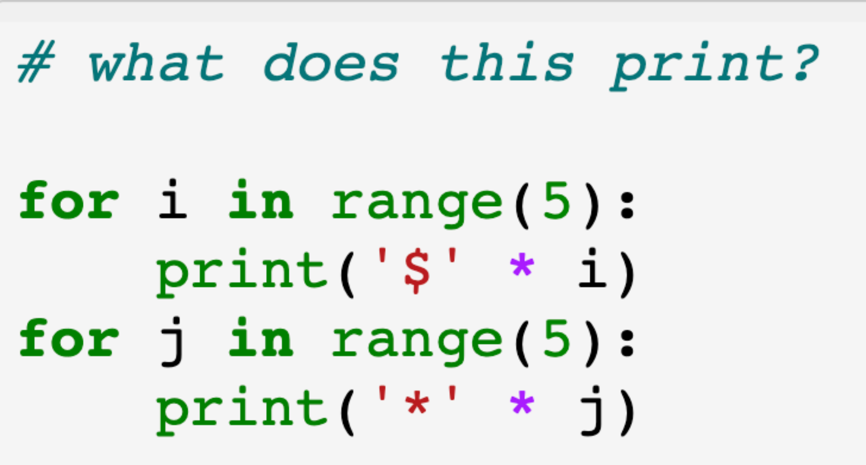
```python
# what does this print?

for i in range(5):
    print('$' * i)
for j in range(5):
    print('*' * j)
```



```python
# what does this print?

for i in range(5):
    print('$' * i)
    for j in range(i):
        print('*' * i)
```

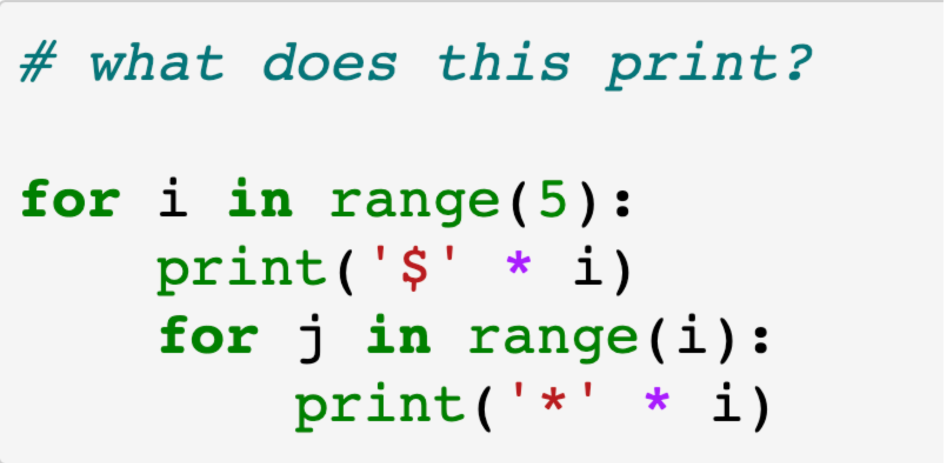
What are the values of i and j???

Iterating Over Ranges



```python
# what does this print?

for i in range(5):
    print('$' * i)
for j in range(5):
    print('*' * j)
```



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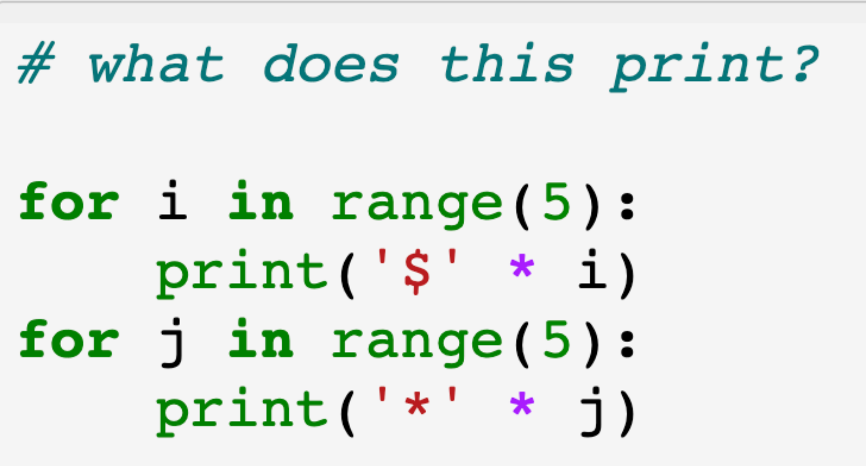
    print('$' * i)
    for j in range(i):
        print('*' * i)
```

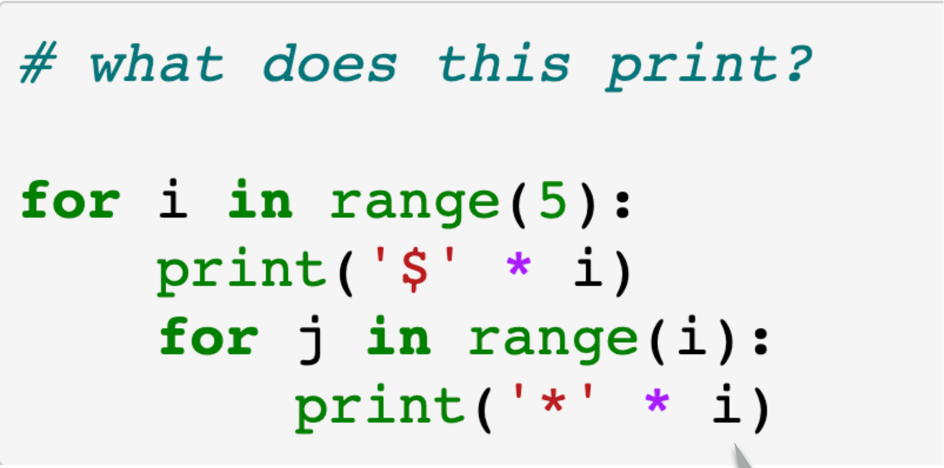
Iterating Over Ranges



```python
# what does this print?

for i in range(5):
    print('$' * i)
for j in range(5):
    print('*' * j)
```

```
                  i = 0
 $                i = 1
 $$               i = 2
 $$$              i = 3
 $$$$             i = 4
                  j = 0
 *                j = 1
 **               j = 2
 ***              j = 3
 ****             j = 4
```



```python
# what does this print?

for i in range(5):
    print('$' * i)
    for j in range(i):
        print('*' * i)
```

i, not j!

```
             i = 0
$            i = 1
*                 j = 0
$$           i = 2
**                j = 0
**                j = 1
$$$          i = 3
***               j = 0
***               j = 1
***               j = 2
$$$$         i = 4
****              j = 0
****              j = 1
****              j = 2
****              j = 3
```