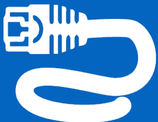
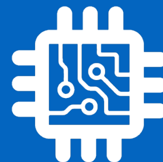
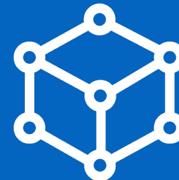
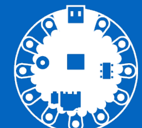
CS134:
Lists & Loops









Announcements & Logistics

- **Homework 3** is due Monday @ 10 pm
- **Lab 1** graded feedback was released on Wed
  - Any problems? Email cs134staff@williams.edu
- **Lab 3** starter code will be pushed today
  - Try to spend 30-60 minutes on it before your scheduled lab
  - A collection of word puzzles: can use your newly acquired knowledge of strings, lists (today), functions and loops to solve them

Do You Have Any Questions?

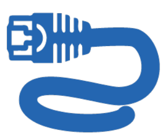
Last Time

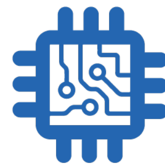
- Started discussing *sequences* in Python
  - Focused on **strings** (sequences of characters)
  - Discussed ***slicing*** `[::]`, ***indexing*** `[]`, `in` operators on strings
    - Note: We also already know about the `+` operator on strings
    - Note: There is a `not in` operator addition to `in`
  - Also learned about string **methods** `.lower()` and `.upper()`
    - Note: There are also string methods `.islower()` and `.isupper()` that return `True` if string is in lowercase/uppercase, else return `False`

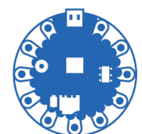
Today's Plan

- Learn about **for loops** for iterating over sequences
- Introduce a new sequence: **Lists**
  - Apply indexing `[]`, slicing `[:]`, `in`, `+` operators to lists
- Start building a collection of functions that iterate over sequences (lists and strings)

For Loops







Iterating with `for` Loops

- One of the most common ways to manipulate a sequence is to perform some action **for each element** in the sequence
- This is called **looping** or **iterating** over the elements of a sequence
- Syntax of a for loop:

var is called the loop variable

```
for var in seq:
    # body of loop
    (do something)
```

seq is a sequence (for example, a string)

Iterating with `for` Loops

- As the loop executes, the loop variable (`char` in this example) takes on the value of each of the elements of the sequence one by one

```
>>> # simple example of for loop
>>> word = "Williams"

>>> for char in word:
...     print(char)

W
i
l
l
i
a
m
s
```

This is a special kind of **for..loop** called a **for-each loop**.

Why might we call it that?

Counting Vowels

- We can use a for loop to improve our `countVowels()` function
- Notice how `count` "accumulates" values in the loop
- We call `count` an **accumulation variable**
- Works for any string!

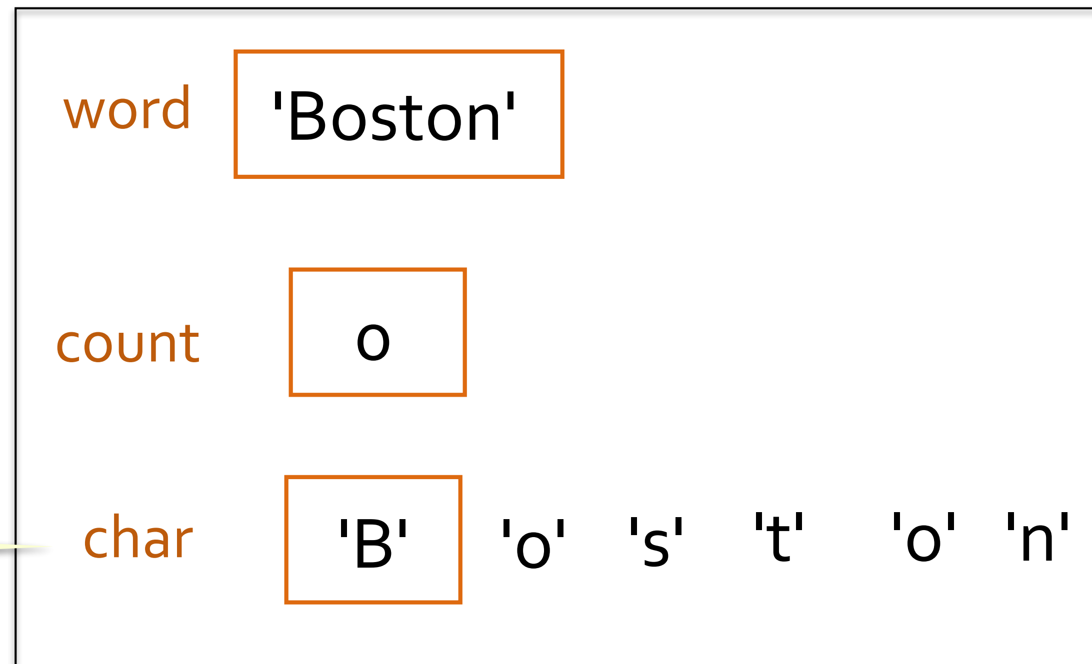
```
def countVowels(word):
    '''Takes a string as input and returns
    the number of vowels in it'''

    count = 0 # initialize the counter

    # iterate over the word one character at a time
    for char in word:
        if isVowel(char): # call helper function
            count += 1
    return count
```

Counting Vowels: Tracing the Loop

- How are the local variables updated as the loop runs?

```
def countVowels(word):
    '''Returns number of vowels in the word'''
    count = 0
    for char in word:
        if isVowel(char):
            count += 1
    return count
```

countVowels('Boston')



Loop variable

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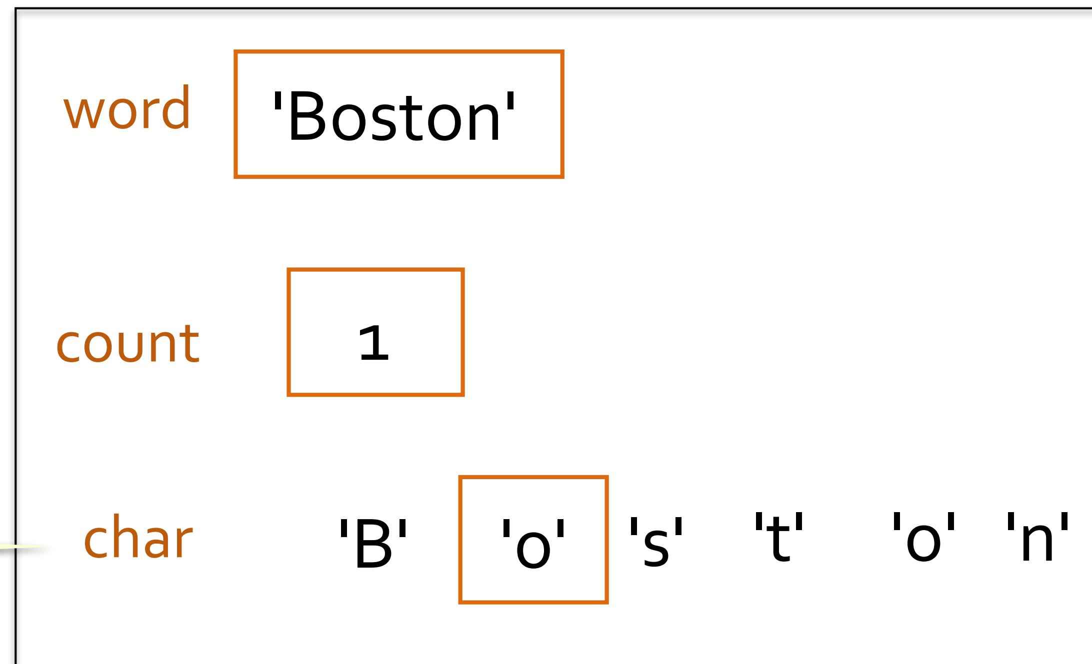

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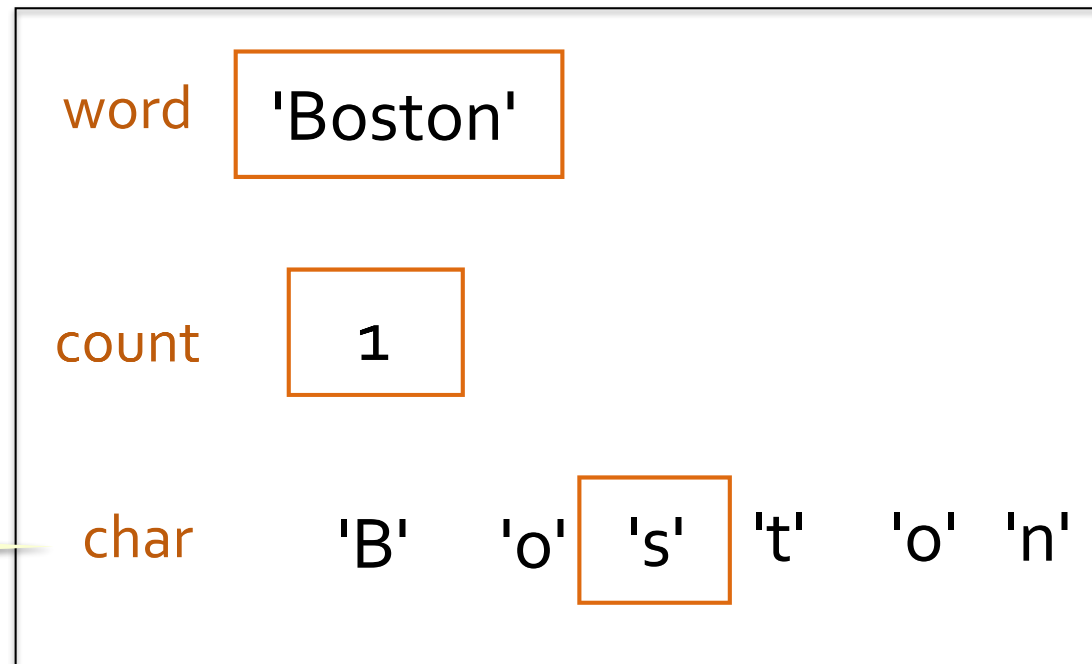

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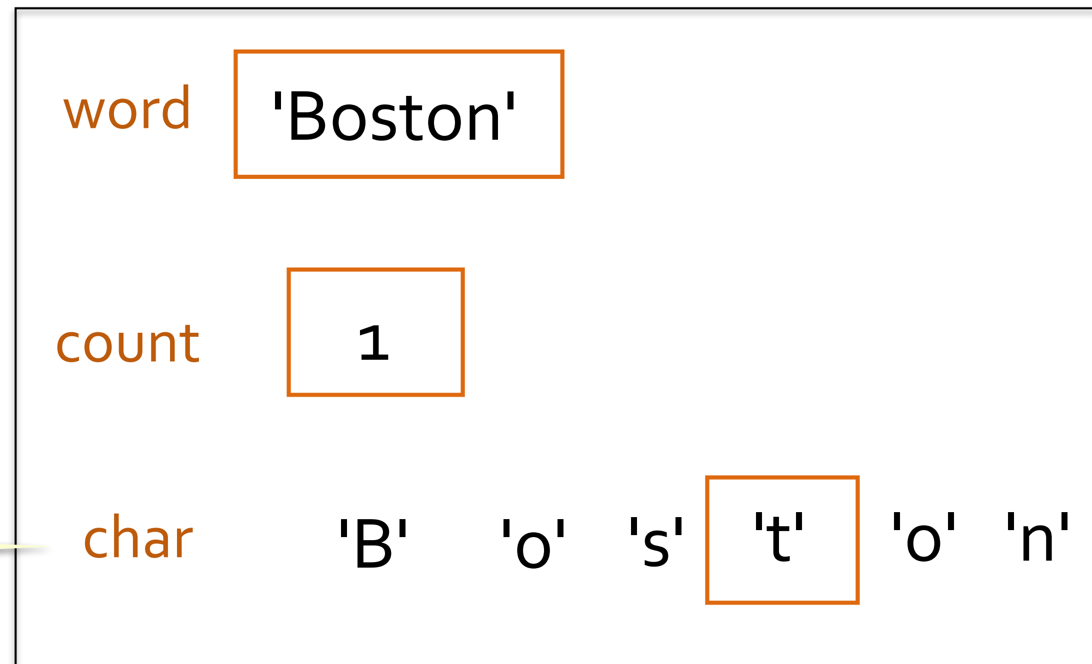

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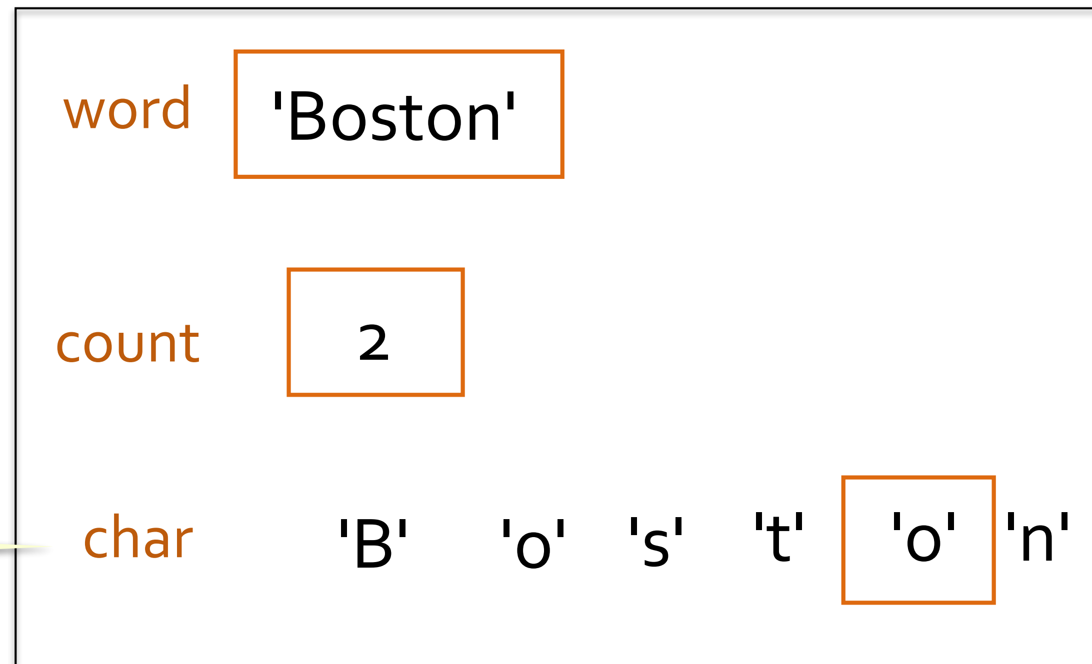

Loop variable

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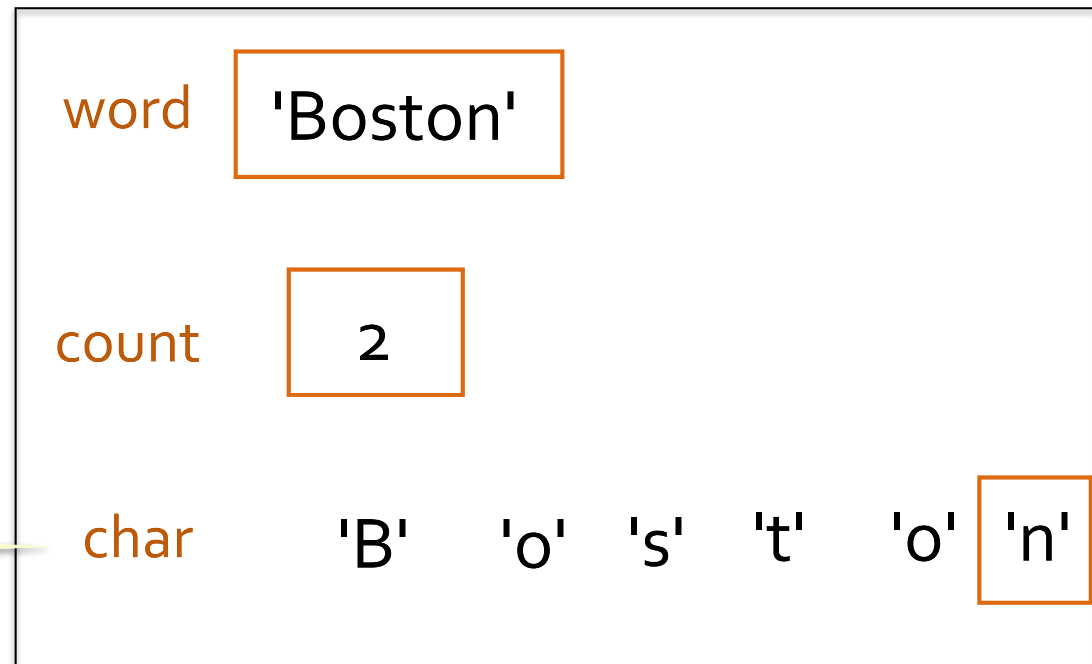
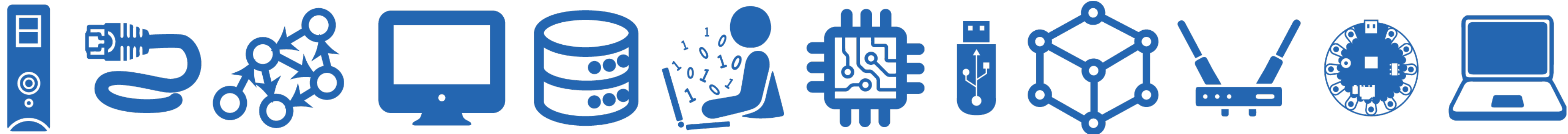


Loop variable

Exercise: Count Characters



Exercise: Count Characters

- Define a function **`countChar()`** that takes two arguments, a character and a word (both strings), and returns the number of times (int) that character appears in the word (ignoring case).

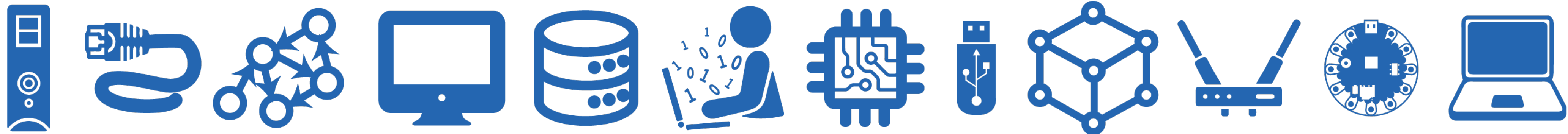
```
def countChar(char, word):
    '''Counts # of times char appears in word'''
    pass
>>> countChar('m', "ammonia")
2
>>> countChar('a', "Alabama")
4
>>> countChar('a', "rhythm")
0
```

Exercise: Count Characters

- Define a function **`countChar()`** that takes two arguments, a character and a word (both strings), and returns the number of times (int) that character appears in the word (ignoring case).

```
def countChar(char, word):
    '''Counts # of times char appears in word'''
    count = 0                  # initialize accumulation var
    for letter in word:        # letter is the loop variable
        if char.lower() == letter.lower():
            count += 1         # increment count (accumulate)
    return count
```

Exercise:
Vowel Sequences



Exercise: Vowel Sequences

- Define a function **`vowelSeq()`** that takes a string **`word`** as input and returns a string containing all the vowels in word in the same order as they appear.

```
def vowelSeq(word):
    '''Returns the vowel subsequence in word'''
     pass
>>> vowelSeq("Chicago")
'iao'
>>> vowelSeq("protein")
'oei'
>>> vowelSeq("rhythm")
''
```

What might be other good values to test edge cases?

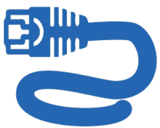
Exercise: Vowel Sequences

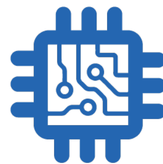
- Define a function `vowelSeq()` that takes a string `word` as input and returns a string containing all the vowels in word in the same order as they appear.
- Accumulation variables don't have to be counters! Can accumulate strings as well

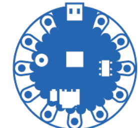
```
def vowelSeq(word):
    '''returns the vowel subsequence in word'''
    vowels = ""              # accumulation variable
    for char in word:        # char is loop variable
        if isVowel(char):    # if char is a vowel
            vowels += char   # accumulate characters
    return vowels
```

Code from today can be found in sequenceTools.py

Lists







Moving on: Lists

- **Lists** are another type of **sequence** in Python
- Definition: ***A list is a comma separated, ordered sequence of values***
- Unlike strings, which can *only contain characters*, lists can be collections of **heterogenous objects** (strings, ints, floats, etc)
- Today we'll focus on **iterating** over lists (i.e., looking at the elements sequentially) using for loops
- In upcoming lectures we'll focus on manipulating and using lists to store dynamic sequences of objects

Lists

- Lists are:
  - **Comma separated, ordered sequences** of values
  - **Heterogenous** collections of objects
  - **Mutable** (or "changeable") objects in Pythons. In contrast, strings are **immutable** (they cannot be changed).
    - We will discuss ***mutability*** in more detail soon!

```
In [1]: # Examples of various lists:

        wordList = ['What', 'a', 'beautiful', 'day']
        numList = [1, 5, 8, 9, 15, 27]
        charList = ['a', 'e', 'i', 'o', 'u']
        mixedList = [3.145, 'hello', 13, True] # lists can be heterogeous
```

```
In [2]: type(numList)
Out[2]: list
```

Operations on Sequences

- We already saw several **sequence operators** and functions last time
  - We looked at **strings** last time
  - These apply to **lists** as well!
- We can do the following operations on lists:
  - Indexing elements of lists using `[]` operator
  - Slicing lists using `[::]` operator
  - Testing membership using `in/not in` operators
  - Concatenation using `+` operators
  - Using `len()` function to find length of list

Basic Operations on Sequences

```
In [1]: wordList = ['What', 'a', 'beautiful', 'day']

        wordList[3]

Out[1]: 'day'
```

Indexing lists using [ ]

```
In [2]: wordList[-1]

Out[2]: 'day'

In [3]: len(wordList)

Out[3]: 4
```

Finding length of list using len( )

```
In [4]: nameList = ["Aamir", "Beth", "Chris", "Daxi", "Emory"]

In [5]: nameList[2:4]

Out[5]: ['Chris', 'Daxi']
```

Slicing lists using [:] (can also use optional step)

Membership in Sequences

- Recall: The `in` operator in Python is used to test if a given sequence is a subsequence of another sequence; returns True or False

```
In [20]: nameList = ["Anna", "Beth", "Chris", "Daxi", "Emory", "Fatima"]

In [28]: "Anna" in nameList # test membership
Out[28]: True

In [30]: "Jeannie" in nameList
Out[30]: False
```

`not in` sequence operator

- The **`not in`** operator in Python returns True if and only if the given element is **not** in the sequence

```
In [20]: nameList = ["Anna", "Beth", "Chris", "Daxi", "Emory", "Fatima"]

In [28]: "Anna" in nameList # test membership
Out[28]: True

In [30]: "Jeannie" in nameList
Out[30]: False

In [31]: "Jeannie" not in nameList # not in returns true if el not in seq
Out[31]: True

In [33]: "a" not in "Chris"
Out[33]: True
```

Note that `not in` also works for strings

List Concatenation

- We can use the **+** operator to ***concatenate*** lists together
- Creates a **new list** with the combined elements of the sublists
  - *Does not modify original lists!*

```
aList = ['the', 'quick', 'brown', 'fox']
```

```
bList = ['jumped', 'over', 'the', 'dogs']
```

```
aList + bList # concatenate lists
```

```
['the', 'quick', 'brown', 'fox', 'jumped', 'over', 'the', 'dogs']
```

returns a **new list** with elements from aList and bList

```
aList # aList is unchanged
```

```
['the', 'quick', 'brown', 'fox']
```

aList is unchanged!

```
bList = bList + ['back'] # add 'back' to bList
```

```
bList # since we reassign result to bList, bList has changed
```

```
['jumped', 'over', 'the', 'dogs', 'back']
```

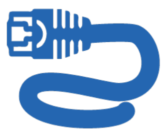
To change bList, we have to reassign bList to the new list

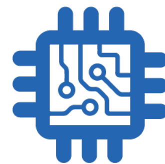
Looping over Lists

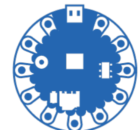
- We can **loop** over **lists** the same way we looped over **strings**
- As before, the **loop variable** iteratively takes on the values of each item in the list, starting with the 0th item, then 1st, until the last item
- The following loop iterates over the list of ints, printing each item in it

```
In [15]: numList = [0, 2, 4, 6, 8, 10]

In [16]: for num in numList:
             print(num)

0
2
4
6
8
10
```

List Exercises







Exercise: `countItem`

- Let's write a function `countItem()` that takes as input a sequence `seq` (can be a string or a list), and an element `el`, and returns the number of times `el` appears in the sequence `seq`.

```
def countItem(seq, el):
    """Takes seq as input, and returns the number of times
    el appears in seq"""
    pass
```

Exercise: `countItem`

- Let's write a function **`countItem()`** that takes as input a sequence **`seq`** (can be a string or a list), and an element **`el`**, and returns the number of times **`el`** appears in the sequence **`seq`**.

```
def countItem(seq, el):
    """Takes seq as input, and returns the number of times
    el appears in seq"""
    count = 0 # initialize counter

    for item in seq:
        if item == el: # if this item matches el
            count += 1 # increment counter
        # else do nothing, go to next item
    return count
```

Another accumulation variable!

Exercise: `wordStartEnd`

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

```
def wordStartEnd(wordList):
    '''Takes a list of words wordList and returns a list
    of all words in wordList that start and end with the same letter'''
    pass
```

```
>>> wordStartEnd(['Anna', 'banana', 'salad', 'Rigor', 'tacit', 'hope'])
['Anna', 'Rigor', 'tacit']
>>> wordStartEnd(['New York', 'Tokyo', 'Paris'])
[]
>>> wordStartEnd(['*Hello*', '', 'nope'])
['*Hello*']
```

Exercise: `wordStartEnd`

- **Step by step approach (organize your work)**:
  - Go through every word in wordList
  - Check **if word starts and ends at same letter***
  - If true, we need to "collect" this word (remember it for later!)
    - Else, just go on to next word
  - Takeaway: need a new list to **accumulate** desirable words

- ***Break down bigger steps (decomposition!)**
  - If word starts and ends at same letter:
    - Can do this using string **indexing**
  - Think about **corner cases:** what if string is empty? what about case?

Exercise: `wordStartEnd`

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

```
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
```

result starts as an empty list

Notice this syntax! We are adding word (a string) to result (a list).