CS134 Lecture:

Sequences and Loops

Announcements & Logistics

- **Homework 3** will be posted to GLOW, due next Monday @ 10 pm
- **Lab 1** graded feedback will be released today
  - Instructions on how to view feedback on course webpage
    - It may seem like an odd procedure, but we're using real-world software development practices
- **Lab 2** due today 10pm / tomorrow 10pm
- No class on Friday: **Winter Carnival**
- Lab 3 (with a **prelab**) will be released on Friday

Do You Have Any Questions?

Last Time

- Looked at more complex decisions in Python
    - Used Boolean expressions with **and**, **or**, **not**
- Chose between many different options in our code
    - `if elif else` chained conditionals

Today's Plan

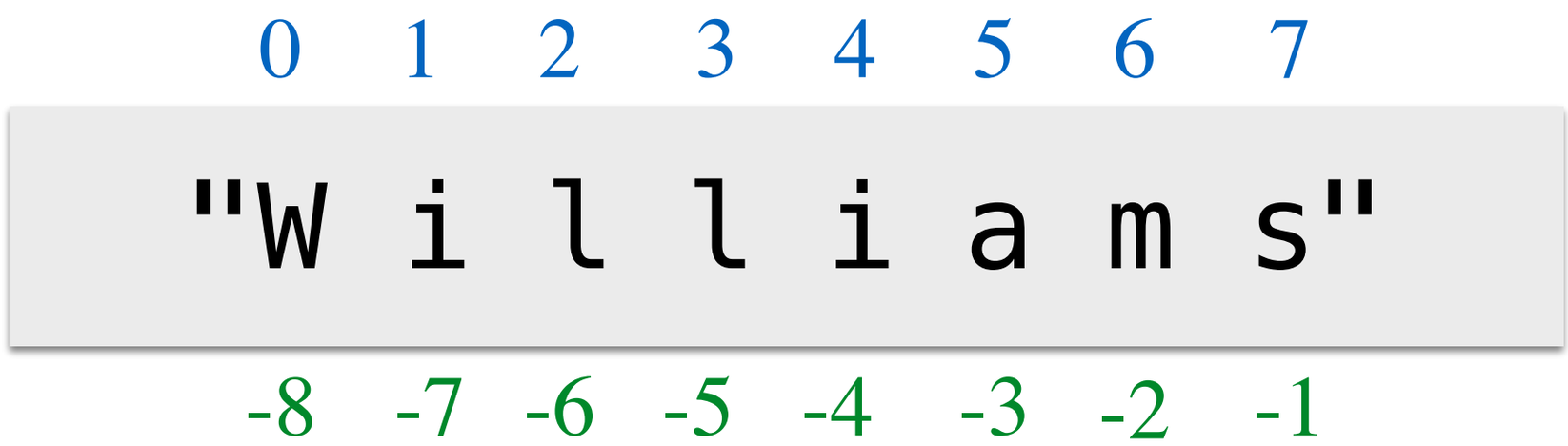
- Introduce iteration using **for loops** to iterate over **sequences**
- Introduce a new data type which is also a sequence:
    - Lists
- We will discuss sequences more on Monday

Sequences in Python: Strings

- **Sequences** in Python represent **ordered collections of elements**: e.g., strings, lists, ranges, etc.
- **Strings** (type `str`) are ordered sequences of individual characters
    - Example: `word = "Hello"`
    - `'H'` is the first character of word, `'e'` is the second character, and so on
    - In CS, we use **zero-indexing**, so we say that `'H'` is at **index** 0, `'e'` is at **index** 1, and so on
- We can access each character of a string using these **indices**

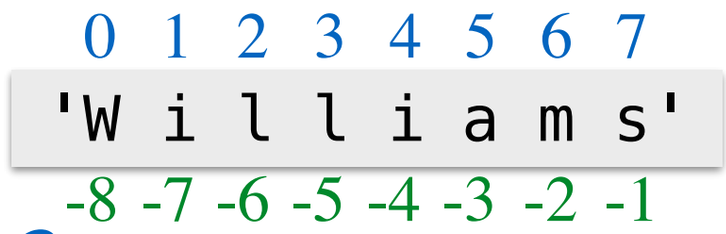
How Do Indices Work?

- Can access elements of a sequence (such as a list) using its **index**
- Indices in Python are both positive and negative
- Everything outside of these values will cause an `IndexError`.



Note: Most other languages do not support negative indexing!

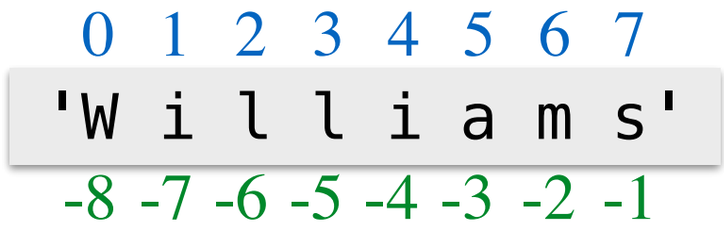
Accessing Elements of Sequences




```
>>> word = "Williams"
>>> word[0] # character at 0th index?
'W'
>>> word[3] # character at 3rd index?
'l'
>>> word[7] # character at 7th index?
's'
>>> word[8] # will this work?

Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: string index out of range
```

Sequence Length

- The **`len(seq)`** function returns the length of the sequence **`seq`**
- Even though we zero-index, we still include the total number of elements in the length




```
>>> word = "Williams"
>>> len(word) # total number of characters
8

>>> word[len(word)] # will this work?
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: string index out of range

>>> word[len(word)-1] # what about this?
's'
```

Iteration Motivation: Counting Vowels

- **Problem:** Write a function `count_vowels(word)` that takes a **string** `word` as input and returns the number of vowels in the string (an **int**)
- We'll create a function `is_vowel()` to help us:

```
def count_vowels(word):
    '''Returns number of vowels in the word'''
    pass
```

```
>>> countVowels("Williamstown")
4
>>> countVowels("Ephelia")
4
```

is_vowel(char)

```
def is_vowel(char):
    """Takes a char (str) returns True
    if char is a vowel otherwise False."""

    l_case = (char == 'a' or char == 'e' or char == 'i' \
              or char == 'o' or char == 'u')
    u_case = (char == 'A' or char == 'E' or char == 'I' \
              or char == 'O' or char == 'U')
    return l_case or u_case
```

First Attempt with Conditionals

- **Note**: `counter += 1` is shorthand for

```
counter = counter + 1
```

- Any downsides to this approach?
- What if I change `word` to `"Williamstown"`?

```
word = 'Williams'
counter = 0
if is_vowel(word[0]):
    counter += 1
if is_vowel(word[1]):
    counter += 1
if is_vowel(word[2]):
    counter += 1
if is_vowel(word[3]):
    counter += 1
if is_vowel(word[4]):
    counter += 1
if is_vowel(word[5]):
    counter += 1
if is_vowel(word[6]):
    counter += 1
if is_vowel(word[7]):
    counter += 1
print(counter)
```

First Attempt with Conditionals

- Using conditionals as shown is repetitive and does not generalize to arbitrary length words
- We need something else that allows us to "loop" over the characters in an arbitrary input string

```
word = 'Williamstown'
counter = 0
if is_vowel(word[0]):
    counter += 1
if is_vowel(word[1]):
    counter += 1
if is_vowel(word[2]):
    counter += 1
if is_vowel(word[3]):
    counter += 1
if is_vowel(word[4]):
    counter += 1
if is_vowel(word[5]):
    counter += 1
if is_vowel(word[6]):
    counter += 1
if is_vowel(word[7]):
    counter += 1
print(counter)
```

For Loops

Iterating with `for` Loops

- One of the most common ways to traverse or 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
```

Note. Python for loops are meant *specifically* for iterating over *sequences* and are also called a "for each" loop.

Why might we call it that?

Counting Vowels

- Let us use a for loop to implement **`count_vowels()`** function
- What do we need to keep track of as we iterate over **`word`**?

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
the number of vowels in it (as int)'''

pass
```

Counting Vowels

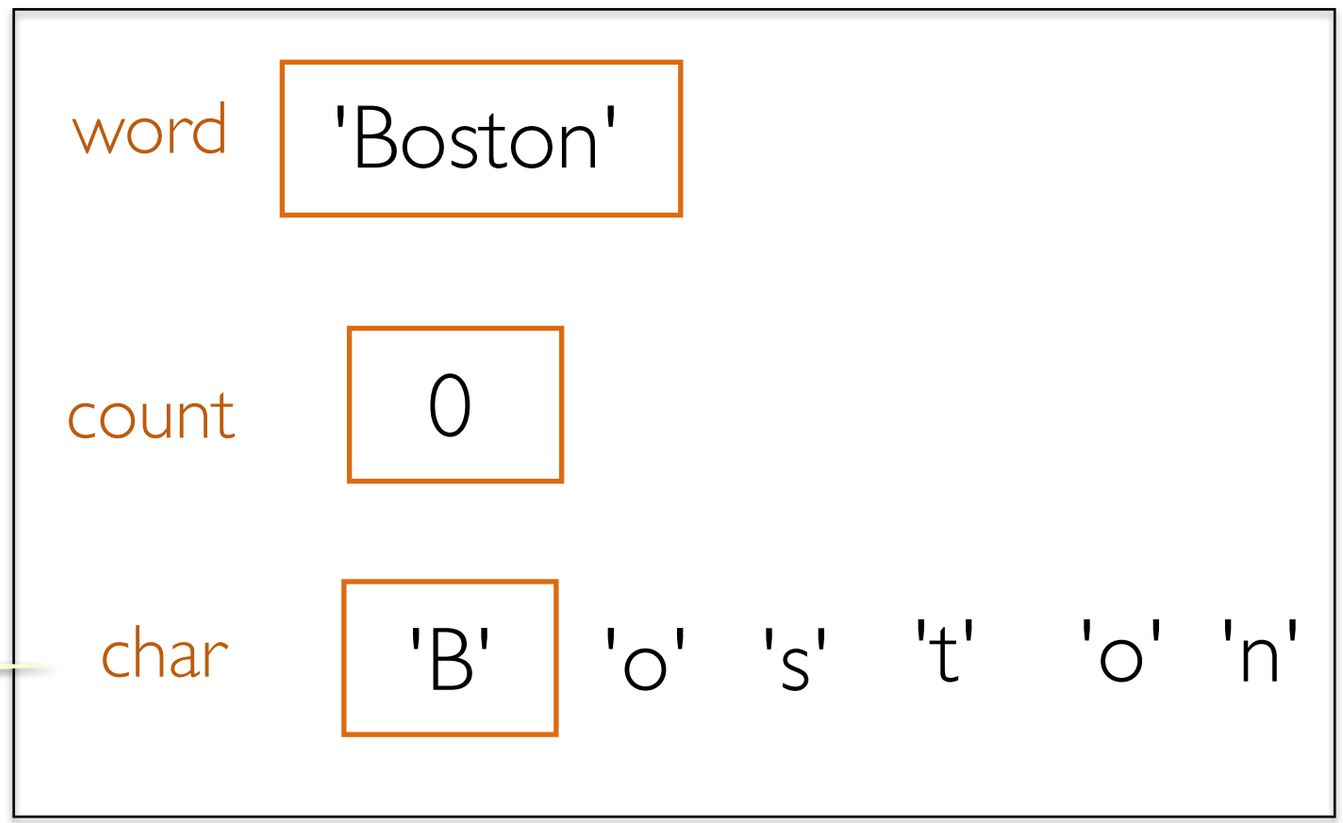
- Notice how `count` "accumulates" values in the loop
- We call `count` an **accumulation variable**

```
def count_vowels(word):
'''Takes word (str) as argument and returns
the number of vowels in it (as int)'''

count = 0 # initialize counter

# iterate over word one character at a time
for char in word:
    if is_vowel(char):
        count += 1  # increment counter
return count
```

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
    return count
```

```
count_vowels('Boston')
```

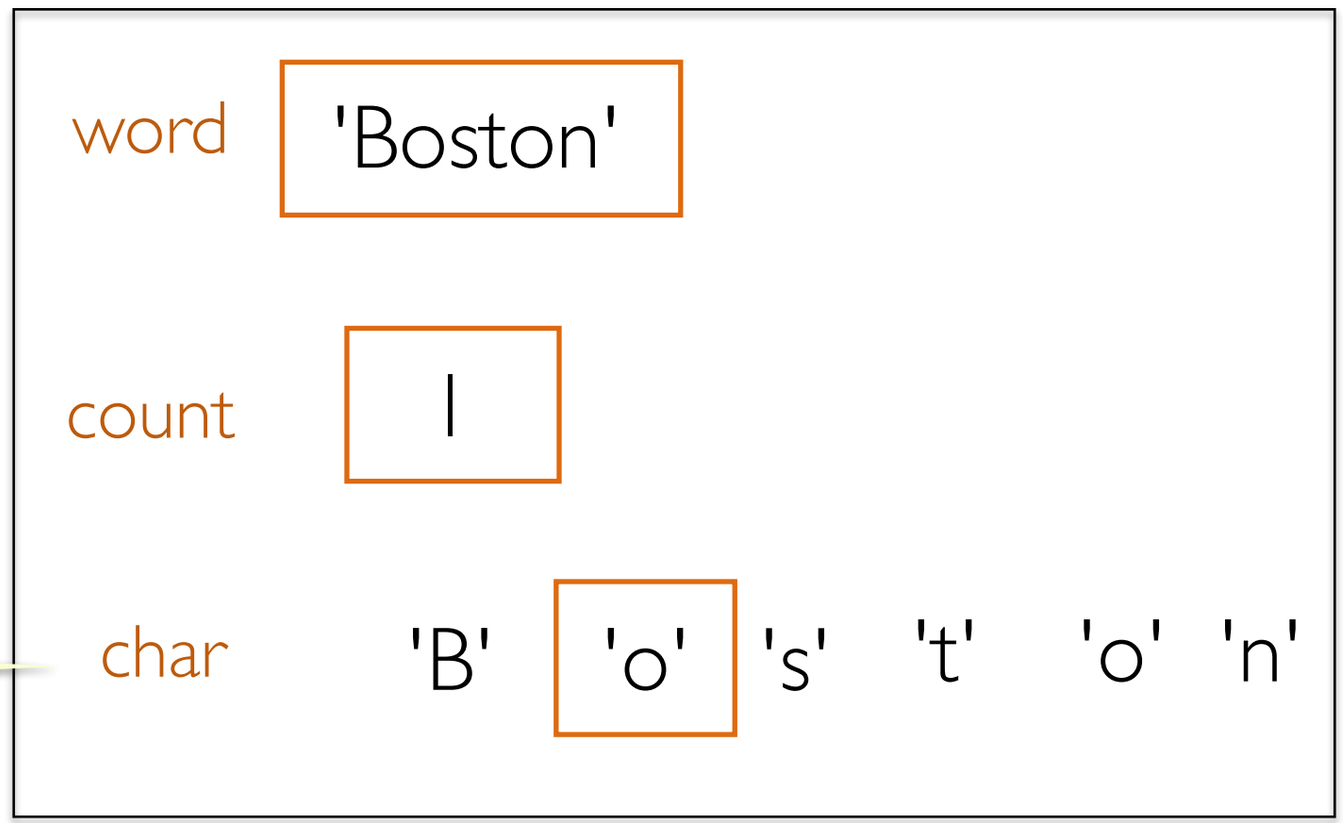


Loop variable

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
    return count
```

```
countVowels('Boston')
```

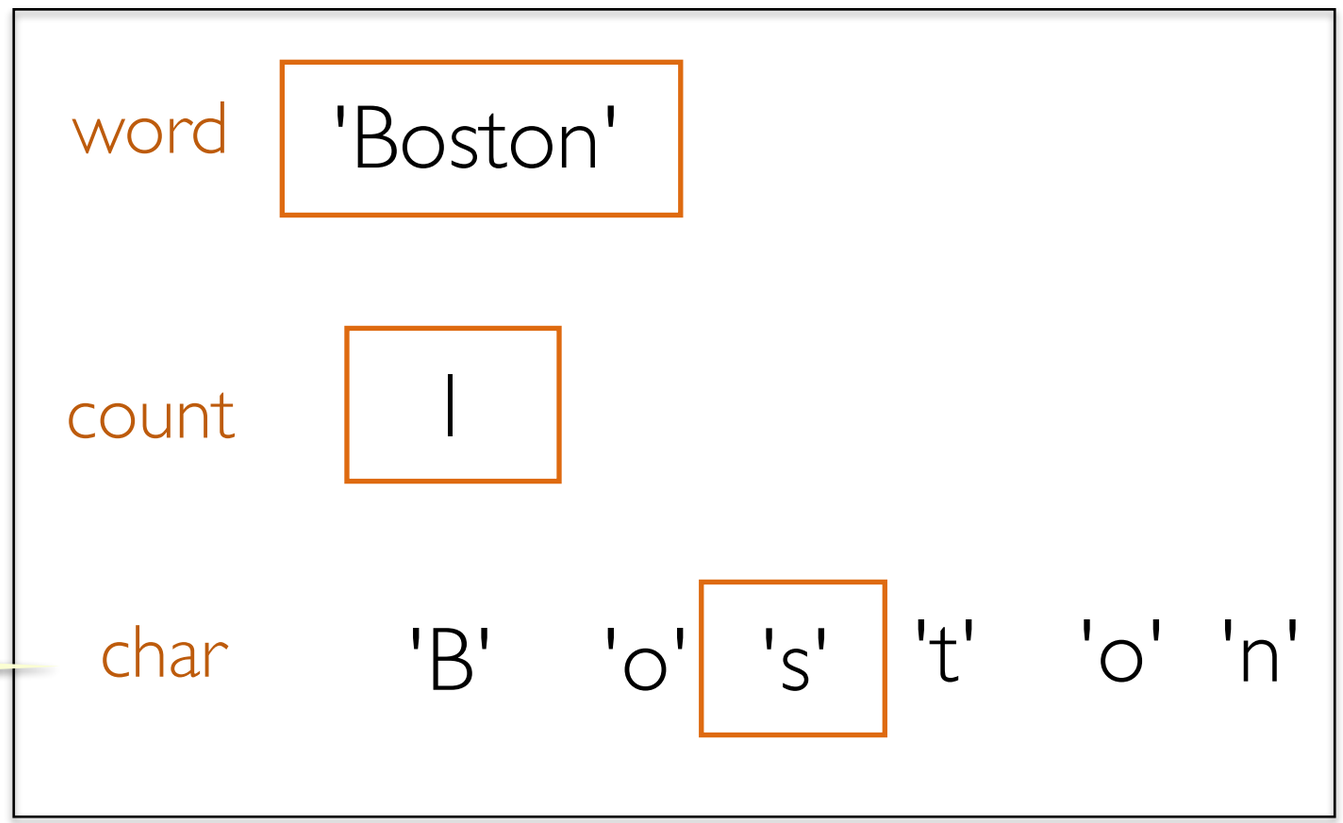


Loop variable

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
    return count
```

```
countVowels('Boston')
```

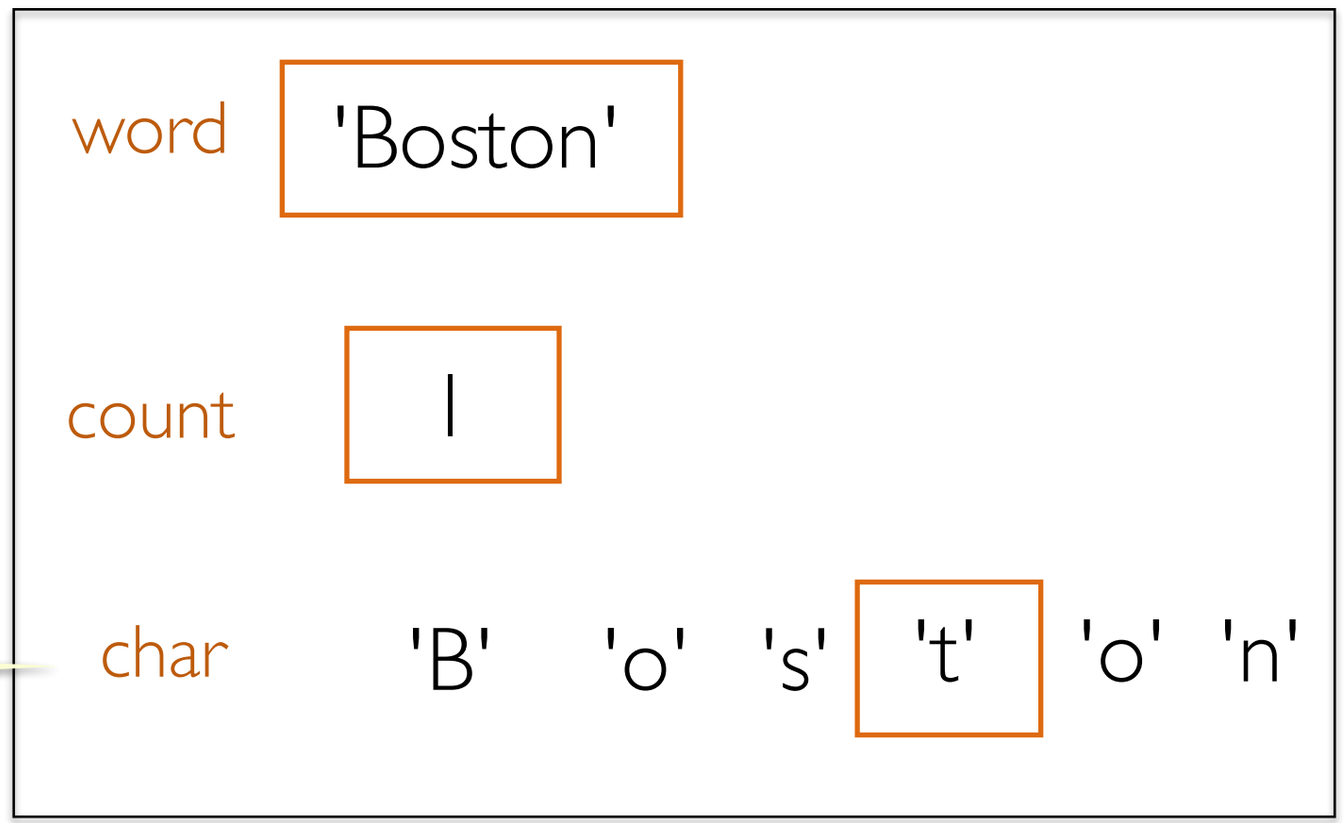


Loop variable

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
return count
```

```
countVowels('Boston')
```

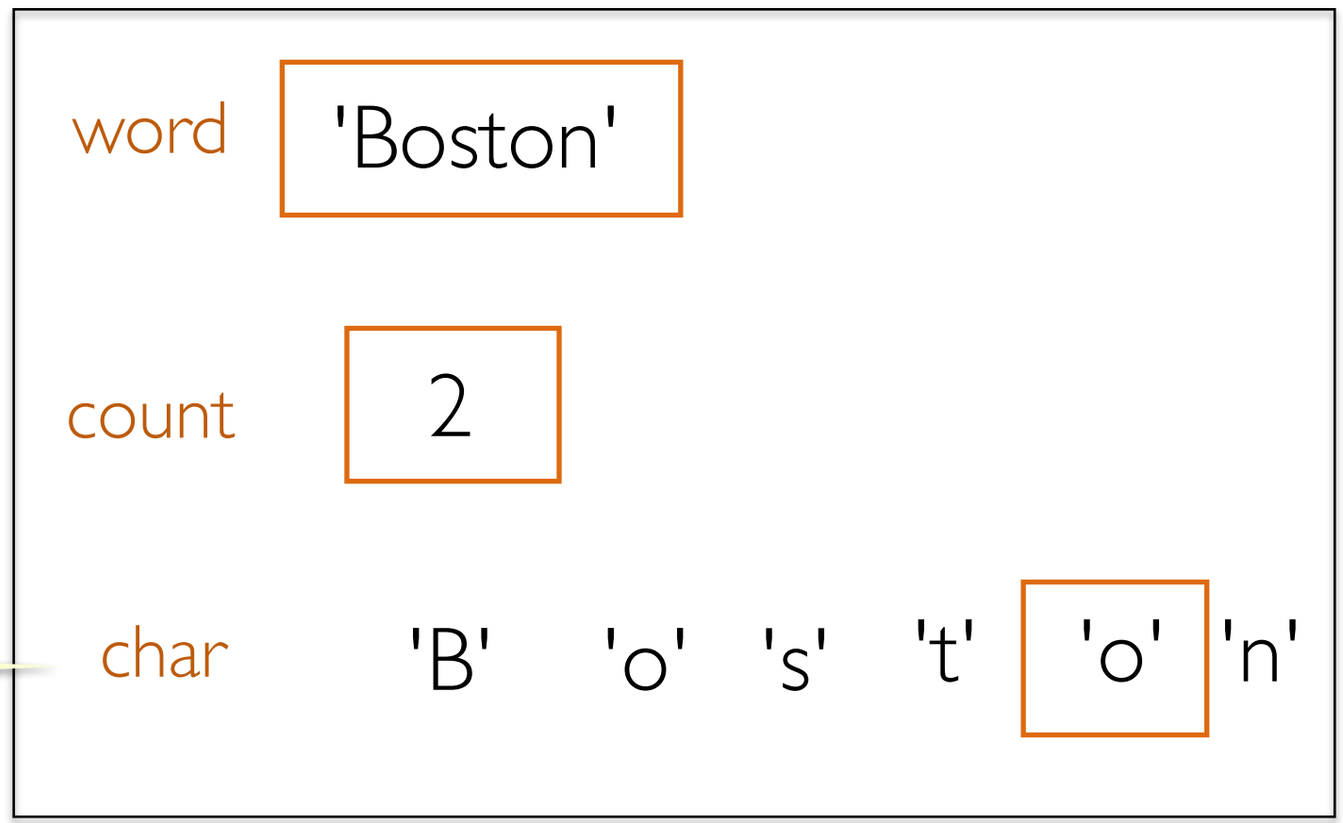


Loop variable

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
    return count
```

```
countVowels('Boston')
```

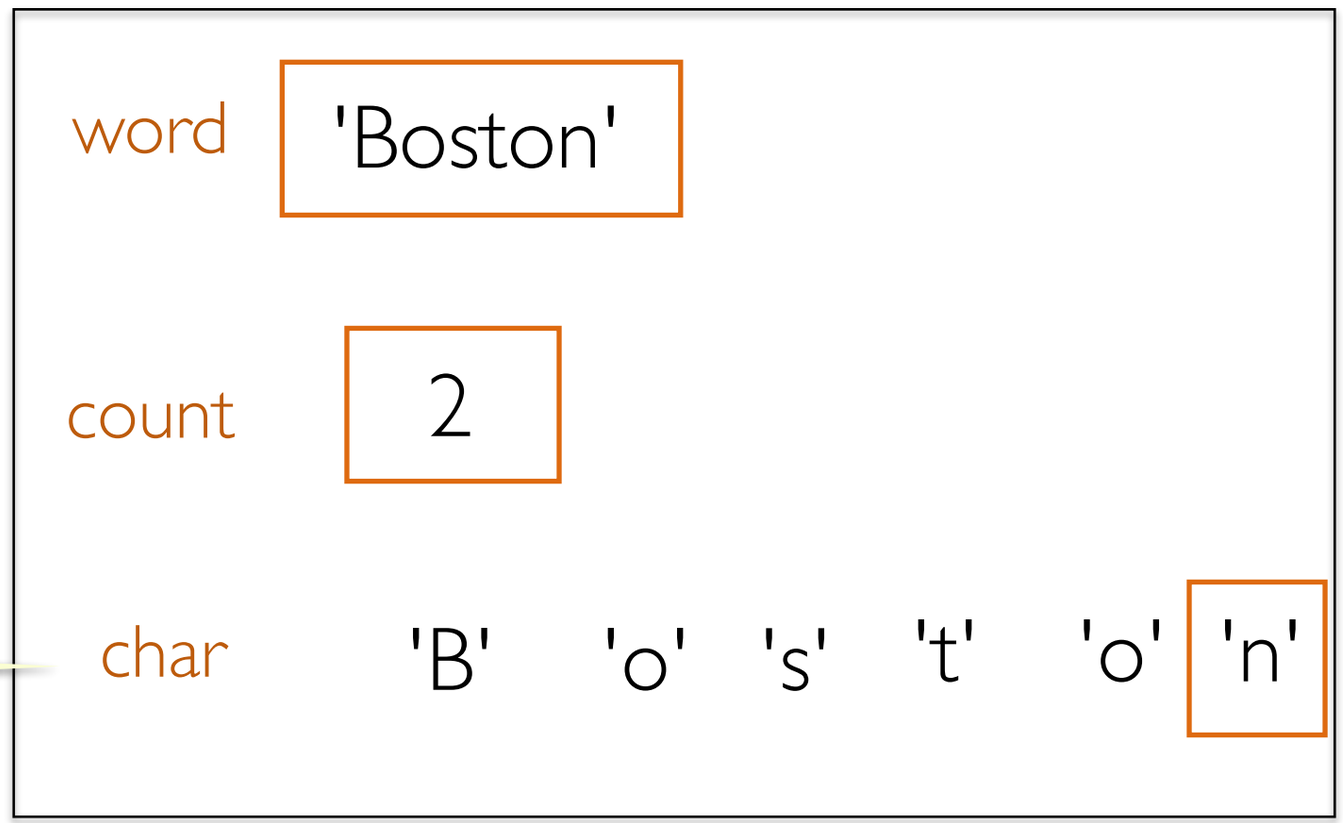


Loop variable

Counting Vowels: Tracing the Loop

```
def count_vowels(word):
    '''Takes word (str) as argument and returns
    the number of vowels in it (as int)'''

    count = 0
    for char in word:
        if is_vowel(char):
            count += 1
    return count
```

```
countVowels('Boston')
```



Loop variable

Exercise:
Vowel Sequences

Exercise: Vowel Sequences

- Define a function `vowel_seq(word)` that takes a string `word` and returns a string containing all the vowels in `word` in the order they appear

```
>>> vowel_seq("Chicago")
'iao'
>>> vowels_seq("protein")
'oei'
>>> vowel_seq("rhythm")
''
```

What might be other good values to test edge cases?

Exercise: Vowel Sequences

- Accumulation variables don't have to be counters!
- Can accumulate strings as well: initialize to '' instead of zero

```
def vowel_seq(word):
    '''Takes word (str) as input and returns
    the vowel subsequence in given word (str)'''
    vowels = ""  # initialize accumulation var
    for char in word:
        if is_vowel(char): # if vowel
            vowels += char # accumulate characters
    return vowels
```

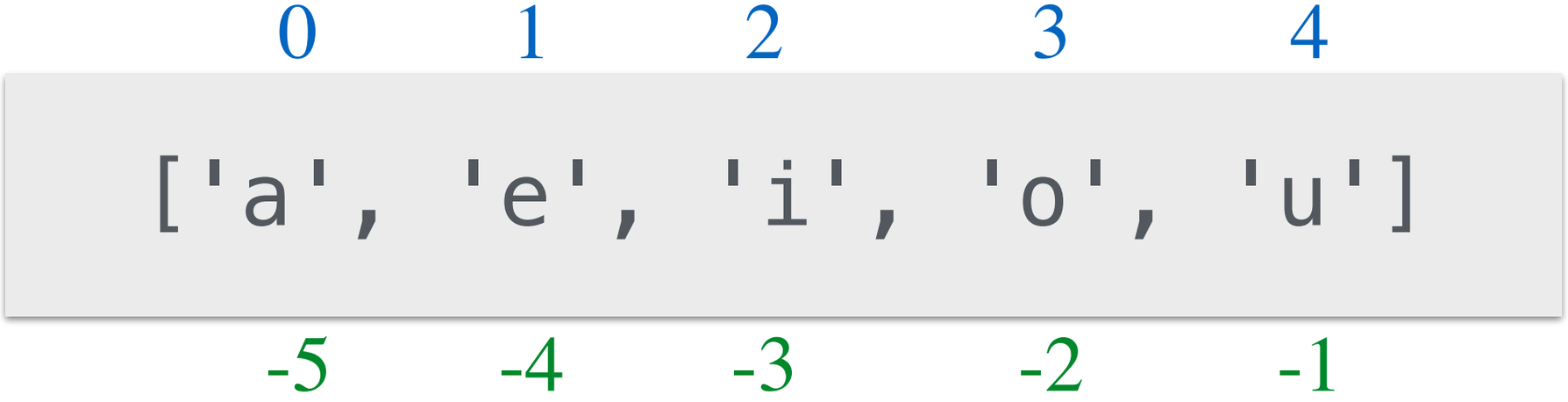
Lists

A New Sequence: Lists

- A list is a comma separated, ordered sequence of values.
- These values can be **heterogenous** (strings, ints, floats, etc)
    - Example: `my_list = ['Hello', 42, 23.5, True]`
    - In CS, we use **zero-indexing**, so we say that `'Hello'` is at **index** 0, `42` is at **index** 1, and so on
- We can access each element of a list using these **indices**

How Do Indices Work?

- Can access elements of a sequence (such as a list) using its **index**
- Indices in Python are both positive and negative
- Everything outside of these values will cause an `IndexError`.




```
vowels = ['a', 'e', 'i', 'o', 'u']
```

Lists

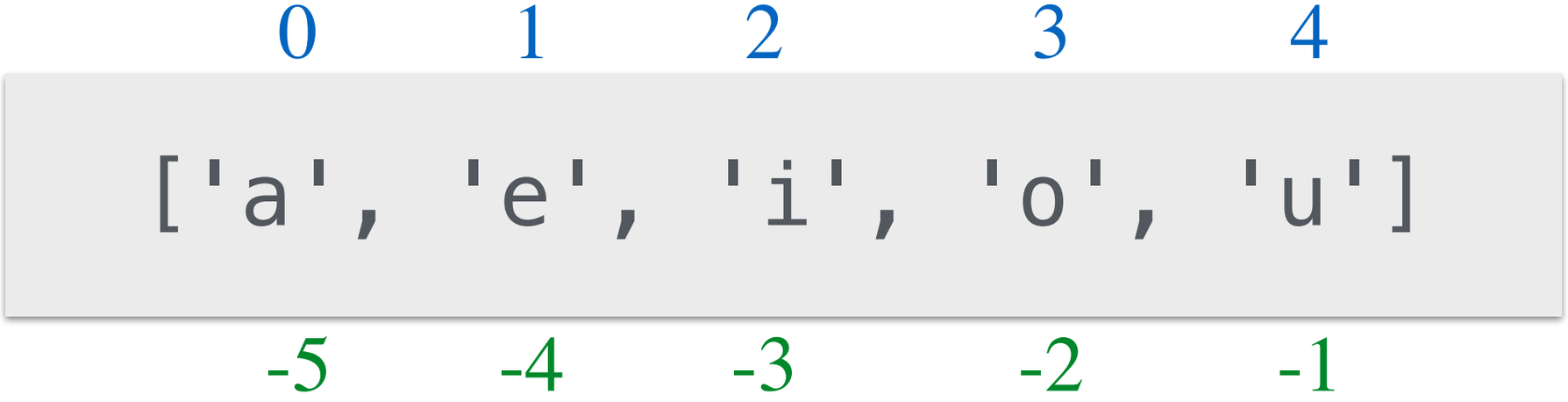
- Lists are:
  - **Comma separated, ordered sequences** of values
  - **Heterogenous** collections of objects
  - **Mutable** (or "changeable") objects in Pythons. In contrast, strings are **immutable** (they cannot be changed).
    - We will discuss ***mutability*** in more detail soon!

```
# Examples of various lists:
>>> wordList = ["What", "a", "beautiful", "day"]
>>> numList = [1, 5, 8, 9, 15, 27]
>>> charList = ['a', 'e', 'i', 'o', 'u']
>>> mixedList = [3.14, 'e', 13, True]
>>> type(numList)
list
```

Lists can be heterogeneous (mixed)!

How Do Indices Work?

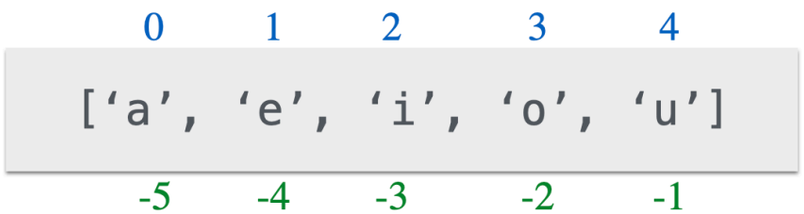
- Can access elements of a sequence (such as a list) using its **index**
- Indices in Python are both positive and negative
- Everything outside of these values will cause an `IndexError`.




```
vowels = ['a', 'e', 'i', 'o', 'u']
```

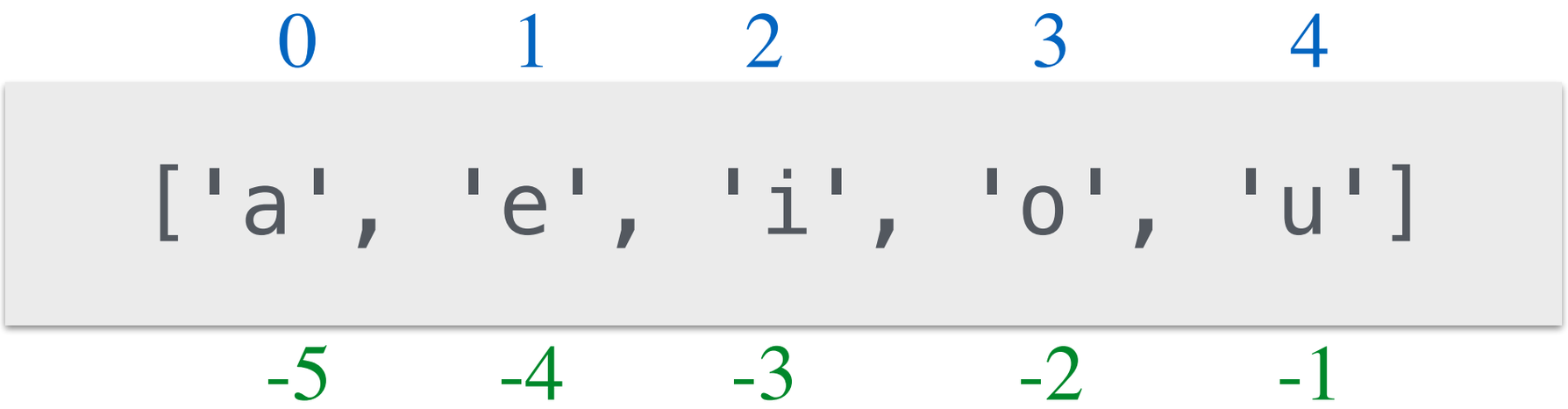
Accessing Elements of Sequences

```
>>> vowels = ['a', 'e', 'i', 'o', 'u']
>>> vowels[0] # character at 0th index?
'a'
>>> vowels[3] # character at 3rd index?
'o'
>>> vowels[4] # character at 4th index?
'u'
>>> vowels[5] # will this work?
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
IndexError: list index out of range
```



Negative Indexing

- Negative indexing starts from -1, and provides a handy way to access the last character of a non-empty sequence without knowing its length




```
>>> vowels = ['a', 'e', 'i', 'o', 'u']
>>> vowels[-1]
'u'
```

Note: Most other languages do not support negative indexing!

Next time:
Sequence Slicing & Operators