INTRODUCTION TO STRING MANIPULATION
What is a String?

- A String is a data type in the Python programming language.
- A String can be described as a "sequence of characters".
- Characters are arranged in a particular position in a String. For example:

  word1 = "hello"

- In this String the character 'h' is the first character in the String, followed by 'e', etc. The following String contains the same characters but they are arranged in a different position:

  word2 = "loleh"
String Indexing
Indexing

- A way to analyze a string is to use “indexing” notation.
- Indexing is a way to reference individual elements within a string based on their position.
- You can create an index by placing an integer value inside a pair of square brackets after your string variable.

```python
word = "superman"
print (word[0])
```

Indexes always start with zero. The first character in a string is considered the “0th” element in the string.

The index of last character in a string is equal to the length of the string - 1.
Indexing

# Superman
# 01234567

word = "Superman"
print (len(word))
print (word[0])
>> 8
>> S
You will raise an exception if you attempt to access an index of a string that does not exist. For example:

```python
word = "Superman"
print (word[10])
```

# error! index 10 doesn’t exist on word
Iterating over a String using Indexing

- You can use a "for" loop to iterate over the characters in a String, like this:

  ```python
  word = "hello"
  for c in word:
    print (c)
  ```

- However, if you want to iterate over the String using indexing you will need to generate a range of numbers that correlate to the indexes you wish to visit. For example:

  ```python
  word = "hello"
  for i in range(0, 5):
    print (word[i])
  ```
Iterating over a String using Indexing

- Most times we won't know how long a String is when we begin to examine it.
- We can easily count the # of characters in a String using the `len()` function though. For example:

```python
word = "hello"
for i in range(0, len(word)):
    print (word[i])
```
Programing Challenge

- Write a program to count the # of “S” characters in the following String.
- Use String indexing to examine each character.

"Superman sings in the shower."
Programing Challenge

- Given the String:

  "Superman sings in the shower."

- Write a program that prints out the String in reverse order
Programing Challenge

- Given the String:
  "Superman sings in the shower."
- Write a program that examines every other character ("S", "p", "r", etc.)
You can use negative integers to identify character positions relative to the end of the string.

Example:

```python
word = "Superman"
print (word[-1], word[-2], word[-3])
```

```plaintext
>> n a m
```
String Immutability
Strings are “Immutable”

- Strings are an immutable data type. This means that they cannot be changed once they are created.
- This may seem counter intuitive, since we have been doing the following since the beginning of the semester:

```python
word = "superman"
print ("word is ", word)
word = "wonder woman"
print ("word is now ", word)

>> word is superman
>> word is now wonder woman
```
Strings are “Immutable”

- What actually happens “under the hood” is that Python creates a separate string in your computer’s memory and “points” to that string instead of the original one.

```python
name = ‘superman’
name = ‘wonder woman’
```

- `name` = ‘superman’
- `name` = ‘wonder woman’
Strings are “Immutable”

- This means that you cannot change the individual characters within a string using index notation. You will raise an exception if you attempt to do so.

```python
word = "Superman"
word[0] = "X"

# exception!
```
In order to make changes to a String you will need to create a new String variable.
This new variable can then hold the changed version of the String.
For example, consider this programming challenge:

"Write a program that replaces all vowels in a String with the underscore character"

At first glance you could assume that you could simply use String indexing to change the characters in question. For example:

```java
word = "hello"
word[1] = "_"
word[4] = "_"
```

But because Strings are immutable this won't work!
Instead, we can use a new String variable to hold our changes and then use a loop to examine each character in sequence to "build" the new String. For example:

```python
word = "hello"
newword = ""

for c in word:
    if c == 'e' or c == 'o':
        newword += "_"
    else:
        newword += c
```
Write a function that accepts three arguments – a string, a character to search for and a replacement character.

Have your function search the string for all occurrences of that character and perform the replacement.

Return the new String.
Vowel Counter

- Write a new function that counts the #’s of vowels in a string (A,E,I,O,U)
- Use your character counter function to implement your new function
Programming Challenge: Pig Latin Translator

- Write a program that asks the user for a word.
- Translate their word into Pig Latin. A Pig Latin word can be generated using the following rules:
  - Remove the first letter of the word.
  - Place the first letter of the word at the end of the word.
  - Add the string ”ay” to the end of the word.
The ASCII Table & Strings
Getting the ASCII value of a character

- Remember that Python (and all programming languages) use the standard ASCII encoding system to organize individual characters.
- You can use the `ord()` function to look up the ASCII value of a character by doing the following:

```python
value = ord("A")
```

```
>> 65
```
- The `ord()` function accepts one argument – a single character - and returns an integer that represents the ASCII value of that character.
Programming Challenge

- Write a program that asks the user for a string
- Print the string, character by character, along with its associated ASCII value
- Example:

  give me a name: craig

  >>> c = 99
  >>> r = 114
  >>> a = 97
  >>> i = 105
  >>> g = 103
Creating strings from their ASCII codes

- The `ord()` function turns a single character into its equivalent ASCII integer code.
- You can also reverse the process and turn an integer into its equivalent letter value using the `chr()` function.
- Example:

```python
x = chr(65)
print(x)
```

```
>> A
```
Programming Challenge

- Write a program that generates a random password for the user
- Passwords should follow these rules:
  - Be at least 10 characters long
  - Contain a mixture of uppercase letters, lowercase letters and numbers
String Functions
String Functions

- We already know a few functions that can be used in conjunction with Strings.
- For example, the `len()` function can be used to count the # of characters in a String.
- As you can imagine, there are other functions that you can use when working with Strings to make things easier for you as a programmer!
Getting the largest and smallest character in a string

- You can use two built in Python functions to obtain the maximum and minimum characters in a string (based on their ASCII codes) – Example:

```python
a = max("python")
b = min("python")

print ("max:", a)
print ("min:", b)
```

```
>> y
>> h
```
Programming Challenge

- Write a program to find the letter that is closest to the end of the alphabet in the following Strings.

  zelda
  peach
  apple

- Then find the letter that is closest to the beginning of the alphabet.
Programming Challenge

- Write a program to find the letter that is closest to the end of the alphabet in the following Strings. *Don’t use the max function!*

  - zelda
  - peach
  - apple

- Then find the letter that is closest to the beginning of the alphabet. *Don’t use the min function!*
Slicing a String
Slicing a String

- Sometimes you may find it necessary to extract a portion of a string from another string.
- You can use “slicing” notation in Python to extract a span of characters from a string into a new string. We call this new String a "substring". For example:

```python
full_name = "John Smith"
first_name = full_name[0:4]

print(first_name)

>> John
```
String Slicing Notation

- When you ask Python to slice a string you need to use bracket notation to specify the index range of the characters you wish to extract.
- The syntax for this notation is as follows:

  \[\text{substring} = \text{bigstring}[\text{start:}:\text{end:}:\text{step}]\]

- You must supply at least a start or an ending index value.
- Substrings contain all characters starting at the start value specified and continue up to (but do not include) the ending value.
- Omitting a starting or ending index value will cause Python to assume you want to start at the beginning of the string (if you omit a start value) or you want to continue slicing to the end of the string (if you omit the end value).
- This should look a lot like the range function!
String Slicing Notation

What will the following code print?

```python
word = "Superman sings in the shower."

print (word[0:8])
print (word[9:14])
print (word[:5])
print (word[9:])
print (word[-7:])
print (word[0:len(word):3])
```
String Slicing Notation

What will the following code print?

```python
word = "Superman sings in the shower."

print (word[0:8])   # Superman
print (word[9:14])  # sings
print (word[:5])    # Super
print (word[9:])    # sings in the
    shower.
print (word[−7:])   # shower.
print (word[0:len(word):3]) # Seasgit
or
```
String Operators
String Operators

- We already know that the "+" and "*" operators can be used in conjunction with a String.
- The "+" operator can be used to "concatenate" two Strings together.
- The "*" operator can be used to repeat a String a certain number of times (specified as an integer).
The "in" operator is a Boolean operator that you can use to test to see if a substring exists inside of another string. Example:

```python
word = "Jackson James John Chris Tom"
if "Chris" in word:
    print ("found him!"")
else:
    print ("can't find Chris")
```

When you construct an expression with the “in” operator the result will evaluate to a Boolean
You can also test to see if a string is not in another string by using the "not" keyword in your expression. Example:

```python
word = "Jackson James John Chris Tom"

if "Johnny" not in word:
    print ("No Johnny!")
else:
    print ("Johnny is here!")
```
String Methods
String Methods

- A “method” is a function that belongs to an “object”, and performs some operation on that object. Example:

- We really haven’t explored objects much in class as of yet, but strings can be used as a good introduction to objects and methods.
  - Object Oriented Programming!

- The general syntax for calling a method on an object looks a lot like a function call, with the notable exception that the method call generally does not need to pass an argument to the function specifying which piece of data is being operated on. Syntax:

  `stringvariable.method(arguments)`
String Testing Methods

- String testing methods allow you to determine if certain patterns existing within a given string variable. For example:

```python
word = '1234'
if word.isdigit() == True:
    print ("All chars in word are digits!")
else:
    print ("Not all chars in word are digits!")
```

- In the above example we are calling the “isdigit” method on the string variable “word”. This method returns True if all characters contained in this string are numeric digits (0-9) and False if not.
## String Testing Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>isalnum()</code></td>
<td>True if all characters are alphanumeric</td>
</tr>
<tr>
<td><code>isalpha()</code></td>
<td>True if all characters are alphabetic</td>
</tr>
<tr>
<td><code>isdigit()</code></td>
<td>True if all characters are digits</td>
</tr>
<tr>
<td><code>islower()</code></td>
<td>True if all alpha characters are lower</td>
</tr>
<tr>
<td><code>isspace()</code></td>
<td>True if all characters are “whitespace”</td>
</tr>
<tr>
<td><code>isupper()</code></td>
<td>True if all alpha characters are upper</td>
</tr>
</tbody>
</table>
Programming Challenge: Character Analysis

- Write a program that counts the # of spaces, digits, vowels and consonants in a string that the user inputs. Example:

  >> Enter a phrase: Sally Sells 1000 sea shells.

  >> Spaces: 4
  >> Digits: 4
  >> Vowels: 5
  >> Consonants: 12
Modification Methods

- Remember that strings are immutable and cannot be directly changed.
- With that said, they do contain a number of “modification” methods that return new copies of the string that reflect a desired change. For example:

```python
word = "Craig"
newword = word.lower()
print (word)

>> craig
```
### String Modification Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>lower()</code></td>
<td>Returns a lowercase version of the string</td>
</tr>
<tr>
<td><code>upper()</code></td>
<td>Returns an uppercase version of the string</td>
</tr>
<tr>
<td><code>rstrip()</code></td>
<td>Removes whitespace at end of string</td>
</tr>
<tr>
<td><code>lstrip()</code></td>
<td>Removes leading whitespace characters</td>
</tr>
<tr>
<td><code>capitalize()</code></td>
<td>Returns a copy of the string with the first character capitalized</td>
</tr>
<tr>
<td><code>title()</code></td>
<td>Returns a copy of the string with the first character of each word capitalized</td>
</tr>
<tr>
<td><code>swapcase()</code></td>
<td>Returns a copy of the string where case is swapped among all alpha characters</td>
</tr>
</tbody>
</table>
Searching and Replacing

- Programs often need to perform search and replace functions on data, much like the “find and replace” functionality that exists in your word processor.
You can find whether a string exists inside another string by using the `find()` method. Example:

```python
word = "Like finding a needle in a haystack!"
location = word.find("needle")
print (location)
```

The `find()` method will return the index of the first occurrence of a substring within a string.

If the `find()` method cannot find the desired substring it will return -1.
You can have Python replace all occurrences of a substring by using the replace() method. Example:

```python
word = "Voldemort had one goal in life - to kill Harry Potter."
newword = word.replace("Voldemort", "He who shall not be named")

print (word)
print (newword)

>> Voldemort had one goal in life - to kill Harry Potter.
>> He who shall not be named had one goal in life - to kill Harry Potter.
```
Programming Challenge: Redacted!

- Write a program that redacts all instances of “Python” from the following string:

  “Python is a programming language that is fairly easy to learn. Python is great for beginning and advanced programmers.”

- To produce the following:

  “_______ is a programming language that is fairly easy to learn. _______ is great for beginning and advanced programmers.”
Write a program that replaces the pronoun “his” with the pronoun “her” in the following phrase:

"Pat said that his score on his history test was 86."
The Intergovernmental Panel on Climate Change (IPCC) is the international body for assessing the science related to climate change. The IPCC was set up in 1988 by the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) to provide policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation. IPCC assessments provide a scientific basis for governments at all levels to develop climate related policies, and they underlie negotiations at the UN Climate Conference – the United Nations Framework Convention on Climate Change (UNFCCC). The assessments are policy-relevant but not policy-prescriptive: they may present projections of future climate change based on different scenarios and the risks that climate change poses and discuss the implications of response options, but they do not tell policymakers what actions to take. The IPCC embodies a unique opportunity to provide rigorous and balanced scientific information to decision-makers because of its scientific and intergovernmental nature. Participation in the IPCC is open to all member countries of the WMO and United Nations. It currently has 195 members. The Panel, made up of representatives of the member states, meets in Plenary Sessions to take major decisions. The IPCC Bureau, elected by member governments, provides guidance to the Panel on the scientific and technical aspects of the Panel’s work and advises the Panel on related management and strategic issues. IPCC assessments are written by hundreds of leading scientists who volunteer their time and expertise as Coordinating Lead Authors and Lead Authors of the reports. They enlist hundreds of other experts as Contributing Authors to provide complementary expertise in specific areas. IPCC reports undergo multiple rounds of drafting and review to ensure they are comprehensive and objective and produced in an open and transparent way. Thousands of other experts contribute to the reports by acting as reviewers, ensuring the reports reflect the full range of views in the scientific community. Teams of Review Editors provide a thorough monitoring mechanism for making sure that review comments are addressed. (For more details see IPCC Factsheet – How does the IPCC select its authors? and IPCC Factsheet – How does the IPCC review process work?).
Programming Challenges
Write a function that accepts two arguments – a string and an single character

Have your function search the string for all occurrences of that character

Return the number of times the character was found in the supplied string
Programming Challenge: Palindrome Tester

- Write a program that asks the user for a word
- Determine whether the supplied word is a palindrome (a word that reads the same backwards and forwards)
You just accepted a position at NYU’s ITS department and your first task is to write a program that generates student Net IDs for all incoming freshmen.

Net IDs are generated as follows:
- The first two characters of a student’s first name
- The first two characters of a student’s last name
- The last three characters of a student’s N#

Write a program that asks the user for these three pieces of information (first name, last name and N#) and generate their Net ID.

Note that if a student’s first name or last name is less than 2 characters then you should use the entire first name or last name.
Programming Challenge: Simple Username and Password Validator

- Write a program that asks a user for a username and a password
- Ensure that the user doesn’t use their username as part of their password. For example:

  username: craig
  password: craig1234 # invalid!

  username: craig
  password: abc123 # ok!
Programming Challenge

- Write a program that accepts a phrase from the user
- Strip out any leading or trailing “white space” from the string
- If the string has an even number of characters, make it all lowercase
- If the string has an odd number of characters, make it all uppercase
Programming Challenge: He Who Shall Not Be Named

- Write a program that asks a user to type in a message.
- If they use the word “voldemort” anywhere in their message you should warn them to be more careful!
Write a program that prompts the user to enter in a valid Social Security Number, in the following format:

NNN-NN-NNNN

where ‘N’ is a digit. The program should display “Valid SSN” if the supplied string is valid and “Invalid SSN” if it is not.

Extension: Turn your program into a function
Write a function that counts the number of letters in a string. You should count both uppercase and lowercase letters. Example:

```python
x = count_letters("Python is fun")
print(x)
```

>> 11