CN101

Lecture 13-14

More About Strings

Topics

- Basic String Operations
- String Slicing
- Testing, Searching, and Manipulating Strings

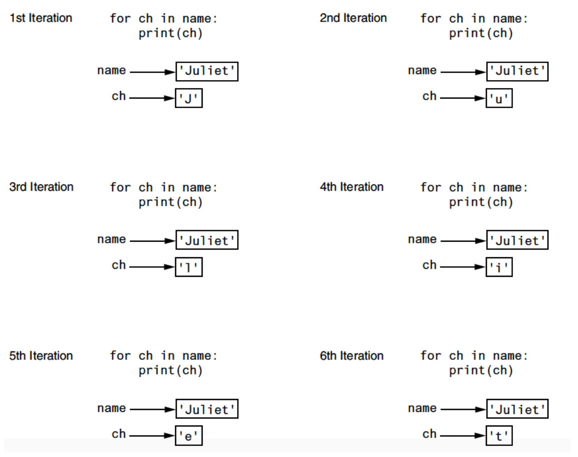
Basic String Operations

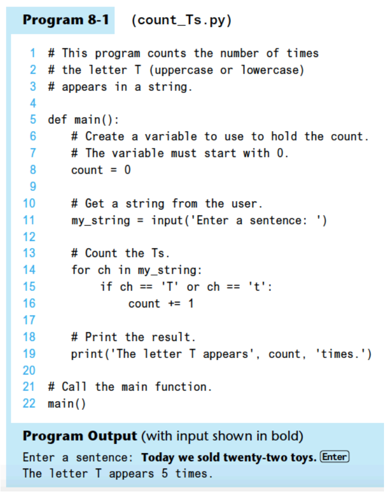
- Many types of programs perform operations on strings
- In Python, many tools for examining and manipulating strings
  - Strings are sequences, so many of the tools that work with sequences work with strings

Accessing the Individual Characters in a String

- To access an individual character in a string:
  - Use a `for` loop
    - Format: `for` *`character`* `in` *`string`*`:`
    - Useful when need to iterate over the whole string, such as to count the occurrences of a specific character

```
>>> name = 'Juliet'
>>> for ch in name:
        print(ch)


J
u
l
i
e
t
```





Program 8-1 (count_Ts.py)

```
# This program counts the number of times
# the letter T (uppercase or lowercase)
# appears in a string.

def main():
    # Create a variable to use to hold the count.
    # The variable must start with 0.
    count = 0

    # Get a string from the user.
    my_string = input('Enter a sentence: ')

    # Count the Ts.
    for ch in my_string:
        if ch == 'T' or ch == 't':
            count += 1

    # Print the result.
    print('The letter T appears', count, 'times.')

# Call the main function.
main()
```

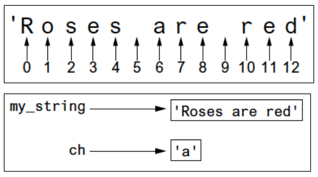
Program Output (with input shown in bold)

```
Enter a sentence: Today we sold twenty-two toys. Enter
The letter T appears 5 times.
```

Accessing the Individual Characters in a String

- To access an individual character in a string:
  - Use indexing
    - Each character has an index specifying its position in the string, starting at 0
    - Format: `character = my_string[i]`

```
>>> my_string = 'Roses are red'
>>> ch = my_string[6]
>>> print(my_string)
Roses are red
>>> print(ch)
a
```



Accessing the Individual Characters in a String (cont'd.)

- `IndexError` exception will occur if:
  - You try to use an index that is out of range for the string
    - Likely to happen when loop iterates beyond the end of the string
- `len(string)` function can be used to obtain the length of a string
  - Useful to prevent loops from iterating beyond the end of a string

```
>>> my_string = 'Roses are red'
>>> my_string[20]
Traceback (most recent call last):
  File "<pyshell#86>", line 1, in <module>
    my_string[20]
IndexError: string index out of range
>>> len(my_string)
13
```

String Concatenation

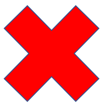
- Concatenation: appending one string to the end of another string
  - Use the + operator to produce a string that is a combination of its operands
  - The augmented assignment operator += can also be used to concatenate strings
    - The operand on the left side of the += operator must be an existing variable; otherwise, an exception is raised

```
>>> first_name = 'Emily'
>>> last_name = 'Yeager'
>>> full_name = first_name + ' ' + last_name
>>> print(full_name)
Emily Yeager
```

```
>>> letters = 'abc'
>>> letters += 'def'
>>> print(letters)
abcdef
```

Strings Are Immutable

- Strings are immutable
  - Once they are created, they cannot be changed
    - Concatenation doesn't actually change the existing string, but rather creates a new string and assigns the new string to the previously used variable
  - Cannot use an expression of the form
  - `string[index] = new_character`
    - Statement of this type will raise an exception



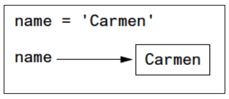
Strings Are Immutable (cont'd.)

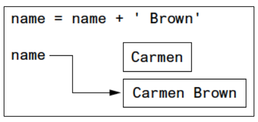
Program 8-2 (concatenate.py)

```
# This program concatenates strings.

def main():
    name  = 'Carmen'
    print('The name is', name)
    name  = name + ' Brown'
    print('Now the name is', name)

# Call the main function.
main()
```

Program Output

```
The name is Carmen
Now the name is Carmen Brown
```





String Slicing

- Slice: span of items taken from a sequence, known as *substring*
  - Slicing format: `string[start : end]`
    - Expression will return a string containing a copy of the characters from `start` up to, but not including, `end`
    - If `start` not specified, 0 is used for start index
    - If `end` not specified, `len(string)` is used for end index
  - Slicing expressions can include a step value and negative indexes relative to end of string

```
>>> full_name = 'Patty Lynn Smith'
>>> middle_name = full_name[6:10]
>>> print(middle_name)
Lynn
>>> first_name = full_name[:5]
>>> print(first_name)
Patty
>>> last_name = full_name[11:]
>>> print(last_name)
Smith
>>> last_name = full_name[-5:]
>>> print(last_name)
Smith
>>> my_string = full_name[:]
>>> print(my_string)
Patty Lynn Smith
>>> letters = 'ABCDEFGHIJKLMNOPQRSTUVWXYZ'
>>> print(letters[0:26:2])
ACEGIKMOQSUWY
>>> print(letters[::2])
ACEGIKMOQSUWY
>>> print(letters[::-1])
ZYXWVUTSRQPONMLKJIHGFEDCBA
```

Testing, Searching, and Manipulating Strings

- You can use the `in` operator to determine whether one string is contained in another string
  - General format: *`string1`* `in` *`string2`*
    - *`string1`* and *`string2`* can be string literals or variables referencing strings
- Similarly you can use the `not in` operator to determine whether one string is not contained in another string

```
text = 'Four score and seven years ago'
if 'seven' in text:
    print('The string "seven" was found.')
else:
    print('The string "seven" was not found.')
```

String Methods

- Strings in Python have many types of methods, divided into different types of operations
  - General format:
    `mystring.method(arguments)`
- Some methods test a string for specific characteristics
  - Generally Boolean methods, that return `True` if a condition exists, and `False` otherwise

String Methods (cont'd.)

Method	Description
`isalnum()`	Returns true if the string contains only alphabetic letters or digits and is at least one character in length. Returns false otherwise.
`isalpha()`	Returns true if the string contains only alphabetic letters and is at least one character in length. Returns false otherwise.
`isdigit()`	Returns true if the string contains only numeric digits and is at least one character in length. Returns false otherwise.
`islower()`	Returns true if all of the alphabetic letters in the string are lowercase, and the string contains at least one alphabetic letter. Returns false otherwise.
`isspace()`	Returns true if the string contains only whitespace characters and is at least one character in length. Returns false otherwise. (Whitespace characters are spaces, newlines (`\n`), and tabs (`\t`).
`isupper()`	Returns true if all of the alphabetic letters in the string are uppercase, and the string contains at least one alphabetic letter. Returns false otherwise.

Program 8-5 (string_test.py)

```
# This program demonstrates several string testing methods.

def main():
    # Get a string from the user.
    user_string = input('Enter a string: ')

    print('This is what I found about that string:')

    # Test the string.
    if user_string.isalnum():
        print('The string is alphanumeric.')
    if user_string.isdigit():
        print('The string contains only digits.')
    if user_string.isalpha():
        print('The string contains only alphabetic characters.')
    if user_string.isspace():
        print('The string contains only whitespace characters.')
    if user_string.islower():
        print('The letters in the string are all lowercase.')
    if user_string.isupper():
        print('The letters in the string are all uppercase.')

# Call the string.
main()
```

Program Output (with input shown in bold)

```
Enter a string: abc Enter
This is what I found about that string:
The string is alphanumeric.
The string contains only alphabetic characters.
The letters in the string are all lowercase.
```

Program Output (with input shown in bold)

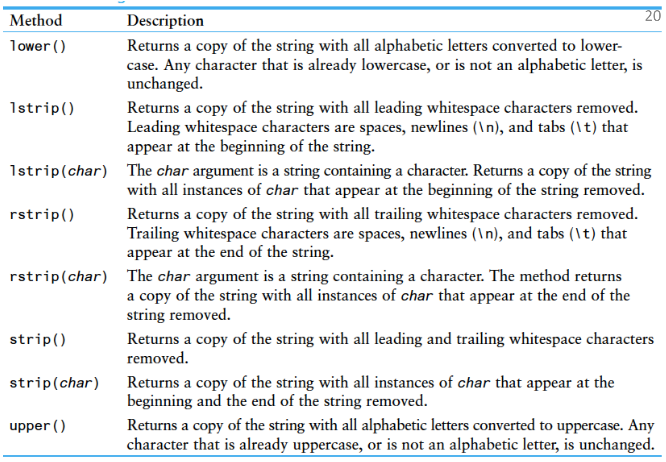
```
Enter a string: 123 Enter
This is what I found about that string:
The string is alphanumeric.
The string contains only digits.
```

Program Output (with input shown in bold)

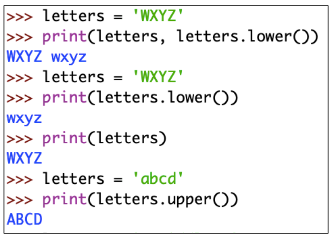
```
Enter a string: 123ABC Enter
This is what I found about that string:
The string is alphanumeric.
The letters in the string are all uppercase.
```

String Methods (cont’d.)

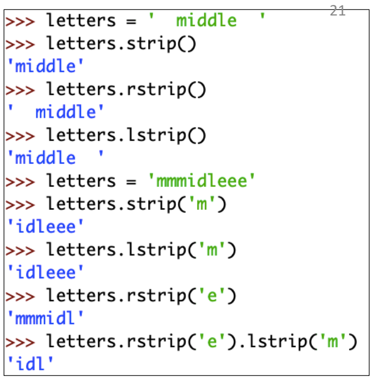
- Some methods return a copy of the string, to which modifications have been made
  - Simulate strings as mutable objects
- String comparisons are case-sensitive
  - Uppercase characters are distinguished from lowercase characters
  - `lower` and `upper` methods can be used for making case-insensitive string comparisons



Method	Description
`lower()`	Returns a copy of the string with all alphabetic letters converted to lowercase. Any character that is already lowercase, or is not an alphabetic letter, is unchanged.
`lstrip()`	Returns a copy of the string with all leading whitespace characters removed. Leading whitespace characters are spaces, newlines (`\n`), and tabs (`\t`) that appear at the beginning of the string.
`lstrip(`*`char`*`)`	The *char* argument is a string containing a character. Returns a copy of the string with all instances of *char* that appear at the beginning of the string removed.
`rstrip()`	Returns a copy of the string with all trailing whitespace characters removed. Trailing whitespace characters are spaces, newlines (`\n`), and tabs (`\t`) that appear at the end of the string.
`rstrip(`*`char`*`)`	The *char* argument is a string containing a character. The method returns a copy of the string with all instances of *char* that appear at the end of the string removed.
`strip()`	Returns a copy of the string with all leading and trailing whitespace characters removed.
`strip(`*`char`*`)`	Returns a copy of the string with all instances of *char* that appear at the beginning and the end of the string removed.
`upper()`	Returns a copy of the string with all alphabetic letters converted to uppercase. Any character that is already uppercase, or is not an alphabetic letter, is unchanged.



```
>>> letters = 'WXYZ'
>>> print(letters, letters.lower())
WXYZ wxyz
>>> letters = 'WXYZ'
>>> print(letters.lower())
wxyz
>>> print(letters)
WXYZ
>>> letters = 'abcd'
>>> print(letters.upper())
ABCD
```



```
>>> letters = '  middle  '
>>> letters.strip()
'middle'
>>> letters.rstrip()
'  middle'
>>> letters.lstrip()
'middle  '
>>> letters = 'mmmidleee'
>>> letters.strip('m')
'idleee'
>>> letters.lstrip('m')
'idleee'
>>> letters.rstrip('e')
'mmmidl'
>>> letters.rstrip('e').lstrip('m')
'idl'
```

String Methods (cont’d.)

- Programs commonly need to search for substrings
- Several methods to accomplish this:
  - `endswith(`*`substring`*`)`: checks if the string ends with *`substring`*
    - Returns `True` or `False`
  - `startswith(`*`substring`*`)`: checks if the string starts with *`substring`*
    - Returns `True` or `False`

```
filename = input('Enter the filename: ')
if filename.endswith('.txt'):
    print('That is the name of a text file.')
elif filename.endswith('.py'):
    print('That is the name of a Python source file.')
elif filename.endswith('.doc'):
    print('That is the name of a word processing document.')
else:
    print('Unknown file type.')
```

String Methods (cont’d.)

- Several methods to accomplish this (cont’d):
  - `find(`*`substring`*`)`: searches for *`substring`* within the string
    - Returns lowest index of the substring, or if the substring is not contained in the string, returns -1
  - `replace(`*`substring, new_string`*`)`:
    - Returns a copy of the string where every occurrence of *`substring`* is replaced with *`new_string`*

```
string = 'Four score and seven years ago'
position = string.find('seven')
if position != -1:
    print('The word "seven" was found at index', position)
else:
    print('The word "seven" was not found.')
```

This code will display

```
The word "seven" was found at index 15
```

```
string = 'Four score and seven years ago'
new_string = string.replace('years', 'days')
print(new_string)
```

This code will display

```
Four score and seven days ago
```

String Methods (cont'd.)

Method	Description
`endswith(substring)`	The *substring* argument is a string. The method returns true if the string ends with *substring*.
`find(substring)`	The *substring* argument is a string. The method returns the lowest index in the string where *substring* is found. If *substring* is not found, the method returns −1.
`replace(old, new)`	The *old* and *new* arguments are both strings. The method returns a copy of the string with all instances of *old* replaced by *new*.
`startswith(substring)`	The *substring* argument is a string. The method returns true if the string starts with *substring*.

The Repetition Operator

- Repetition operator: makes multiple copies of a string and joins them together
  - The * symbol is a repetition operator when applied to a string and an integer
    - String is left operand; number is right
  - General format: *string_to_copy* * *n*
  - Variable references a new string which contains multiple copies of the original string

```
>>> my_string = 'w' * 5
>>> print(my_string)
wwwww
>>> print('Hello' * 5)
HelloHelloHelloHelloHello
```

Program 8-8 (repetition_operator.py)

```
# This program demonstrates the repetition operator.

def main():
    # Print nine rows increasing in length.
    for count in range(1, 10):
        print('Z' * count)

    # Print nine rows decreasing in length.
    for count in range(8, 0, -1):
        print('Z' * count)

# Call the main function.
main()
```

Program Output

```
Z
ZZ
ZZZ
ZZZZ
ZZZZZ
ZZZZZZ
ZZZZZZZ
ZZZZZZZZ
ZZZZZZZZZ
ZZZZZZZZ
ZZZZZZZ
ZZZZZZ
ZZZZZ
ZZZZ
ZZZ
ZZ
Z
```

Splitting a String

- `split` method: returns a list containing the words in the string
  - By default, uses space as separator
  - Can specify a different separator by passing it as an argument to the `split` method

```
>>> date_string = '11/26/2018'
>>> date_list = date_string.split('/')
>>> print(date_list)
['11', '26', '2018']
```

Program 8-9 (string_split.py)

```
# This program demonstrates the split method.

def main():
    # Create a string with multiple words.
    my_string = 'One two three four'

    # Split the string.
    word_list = my_string.split()

    # Print the list of words.
    print(word_list)

# Call the main function.
main()
```

Program Output

```
['One', 'two', 'three', 'four']
```

Program 8-10 (split_date.py)

```
# This program calls the split method, using the
# '/' character as a separator.

def main():
    # Create a string with a date.
    date_string = '11/26/2018'

    # Split the date.
    date_list = date_string.split('/')

    # Display each piece of the date.
    print('Month:', date_list[0])
    print('Day:', date_list[1])
    print('Year:', date_list[2])

# Call the main function.
main()
```

Program Output

```
Month: 11
Day: 26
Year: 2018
```

Summary

- This chapter covered:
  - String operations, including:
    - Methods for iterating over strings
    - Repetition and concatenation operators
    - Strings as immutable objects
    - Slicing strings and testing strings
    - String methods
    - Splitting a string