

CMSC201

Computer Science I for Majors

Lecture 09 – Strings

Last Class We Covered

- Lists and what they are used for
 - Getting the length of a list
 - Operations like `append()` and `remove()`
 - Iterating over a list using a `while` loop
 - Indexing
- Membership “`in`” operator
- Methods vs Functions

Any Questions from Last Time?

Today's Objectives

- To better understand the string data type
 - Learn how they are represented
 - Learn about and use some of their built-in methods
 - Slicing and concatenation
 - Escape sequences
 - lower() and upper()
 - strip() and whitespace
 - split() and join()

Strings

The String Data Type

- Text is represented in programs by the string data type
- A ***string*** is a sequence of characters enclosed within double quotes (") or single quotes (')
 - Sometimes called quotation marks or apostrophes



Getting Strings as Input

- Using `input()` automatically gets a string

```
>>> firstName = input("Please enter your name: ")
Please enter your name: Shakira
>>> type(firstName)
<class 'str'>
>>> print(firstName, firstName)
Shakira Shakira
```

Accessing Individual Characters

- We can access the individual characters in a string through *indexing*
 - Characters are the letters, numbers, spaces, and symbols that make up a string
- The characters in a string are numbered starting from the left, beginning with 0
 - Just like in lists!

Syntax of Accessing Characters

- The general form is

strName [expression]

- Where **strName** is the name of the string variable and **expression** determines which character is selected from the string

Example String

0	1	2	3	4	5	6	7	8
H	e	l	l	o		B	o	b

```
>>> greet = "Hello Bob"
>>> greet[0]
'H'
>>> print(greet[0], greet[2], greet[4])
H l o
>>> x = 8
>>> print(greet[x - 2])
B
```

Example String

0	1	2	3	4	5	6	7	8
H	e	l	l	o		B	o	b

- In a string of n characters, the last character is at position $n-1$ since we start counting with 0
- So how can we access the last letter, regardless of the string's length?

```
greet[ len(greet) - 1 ]
```

Changing String Case

- Python has many, many ways to interact with strings, and we will cover them in detail soon
- For now, here are two very useful methods:
 - `s.lower()` – copy of `s` in all lowercase letters
 - `s.upper()` – copy of `s` in all uppercase letters
- Why would we need to use these?
 - Remember, Python is case-sensitive!

Concatenation

Forming New Strings - Concatenation

- We can put two or more strings together to form a longer string
- **Concatenation** “glues” two strings together

```
>>> "Peanut Butter" + "Jelly"
```

```
'Peanut ButterJelly'
```

```
>>> "Peanut Butter" + " & " + "Jelly"
```

```
'Peanut Butter & Jelly'
```

Rules of Concatenation

- Concatenation does not automatically include spaces between the strings

```
>>> "Smash" + "together"  
'Smashtogether'
```

- Concatenation can only be done with strings!
 - So how would we concatenate an integer?

```
>>> "CMSC " + str(201)  
'CMSC 201'
```

Common Use for Concatenation

- `input()` only accepts a single string
 - Can't use commas like we do with `print()`
- In order to create a single string for `input()`, you must use concatenation

```
classNum = 201
grade = input("Grade in " + str(classNum) + "? ")
```


Sentinels and Concatenation

- To take full advantage of sentinel constants, use them in the input prompts as well

- Instead of:

```
name = input("Name, X to quit: ")
```

- Concatenate to include the sentinel constant

```
name = input("Name, " + EXIT + " to quit: ")
```

Sentinels, `input()`, and Concatenation

- We can even get really lazy, and create the message string before using it in `input()`

```
SENTINEL = -1
```

```
def main():
```

```
    msg = "Enter a grade, or '" + str(SENTINEL) + "' to quit: "  
    grade = int(input(msg))
```

```
    while grade != SENTINEL:
```

```
        print("Congrats on getting a", grade, "in the class!")  
        grade = int(input(msg))
```

```
main()
```

don't forget to cast
to string if needed

Substrings and Slicing

Substrings

- Indexing only returns a single character from the entire string
- We can access a ***substring*** using a process called ***slicing***



Slicing Syntax

- The general form is

strName[start:end]

- **start** and **end** must evaluate to integers
 - The substring begins at index **start**
 - The substring ends before index **end**
 - The letter at index **end** is not included

Slicing Examples

0	1	2	3	4	5	6	7	8
H	e	l	l	o		B	o	b

```
>>> greet[0:2]
```

```
'He'
```

```
>>> greet[7:9]
```

```
'ob'
```

```
>>> greet[:5]
```

```
'Hello'
```

```
>>> greet[1:]
```

```
'ello Bob'
```

```
>>> greet[:]
```

```
'Hello Bob'
```

Specifics of Slicing

- If **start** or **end** are missing, then the start or end of the string is used instead
- The index of **end** must come after the index of **start**
 - What would the substring **greet[1:1]** be?
 ' '
 - An empty string!

String Operations in Python

Operator	Meaning
<code>+</code>	Concatenation
<code>stringVar[#]</code>	Indexing
<code>stringVar[#:#]</code>	Slicing
<code>len(stringVar)</code>	Length

- All of this also applies to lists!
 - Two lists can be concatenated together
 - A sublist can be sliced from another list

Escape Sequences

Special Characters

- Just like Python has special keywords...
 - **and**, **while**, **True**, etc.
- It also has special characters
 - Single quote ('), double quote ("), etc.
- How can we print out a " as part of a string?

```
print("And I shouted "hey!" at him.")
```

 - What's going to happen here?
 - `SyntaxError: EOL while scanning string literal`

Backslash: Escape Sequences

- The backslash character (\) is used to “*escape*” a special character in Python
 - Tells Python not to treat it as special
- The backslash character goes in front of the character we want to “escape”

```
>>> print("And I shouted \"hey! \")  
And I shouted "hey!"
```

Common Escape Sequences

Escape Sequence	Purpose
Escaping special characters	
<code>\'</code>	Print a single quote
<code>\"</code>	Print a double quote
<code>\\</code>	Print a backslash
Inserting a special character	
<code>\t</code>	Print a tab
<code>\n</code>	Print a new line (“enter”)

Escape Sequences Example

```
special1 = "I\tlove tabs."
```

```
print(special1)
```

```
I      love tabs.
```

\t adds a tab

```
special2 = "It's time to\nsplit!"
```

```
print(special2)
```

```
It's time to  
split!
```

\n adds a newline

```
special3 = "Keep \\ em \\ separated"
```

```
print(special3)
```

```
Keep \ em \ separated
```

\\ adds a single backslash

Escape Sequences Example

```
special1 = "I\tlove tabs."  
print(special1)  
I      love tabs.
```

```
special2 = "It's time to\nsplit!"  
print(special2)  
It's time to  
split!
```

```
special3 = "Keep \\ em \\ separated"  
print(special3)  
Keep \ em \ separated
```

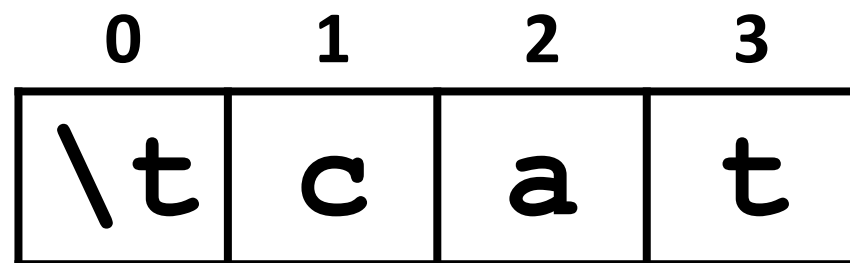
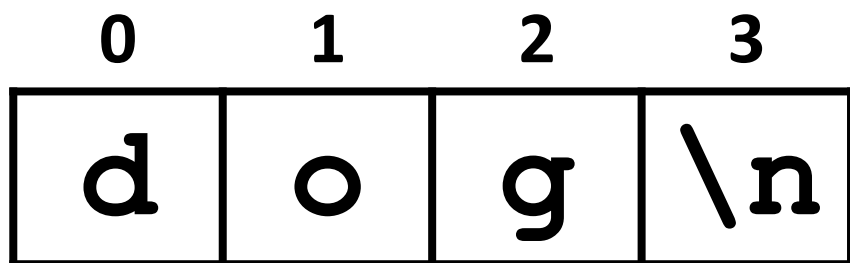
Note that there are no spaces around the escape sequences, but they work fine. What would happen if we added a space after `\t` or `\n` here?

How Python Handles Escape Sequences

- Escape sequences look like two characters to us
- Python treats them as a single character

```
example1 = "dog\n"
```

```
example2 = "\tcat"
```



The “end” of `print()`

- We’ve mentioned the use of `end=""` within a `print()` in a few of the homeworks
 - By default, `print()` uses `\n` as its ending
- We can use `end=` to change this

```
print("No newlines", end="")
print("More space please", end="\n\n")
print("Smile!", end=" :) \n")
```

 - Remember to put a `\n` in if you still want one!

Whitespace

Whitespace

- Whitespace is any “blank” character, that represents space between other characters
- For example: tabs, newlines, and spaces

`"\t"` `"\n"` `" "`

- Whitespace can cause similar strings to not be equivalent

```
>>> "dog" == " dog"
```

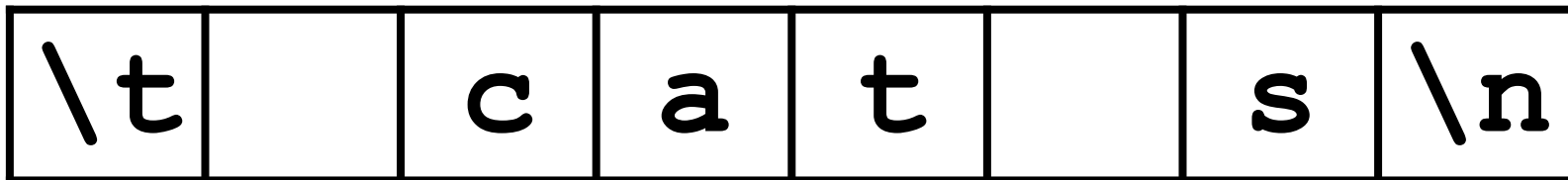
```
False
```



Removing Whitespace

- To remove all whitespace from the start and end of a string, we can use a method called `strip()`

```
spacedOut = spacedOut.strip()
```

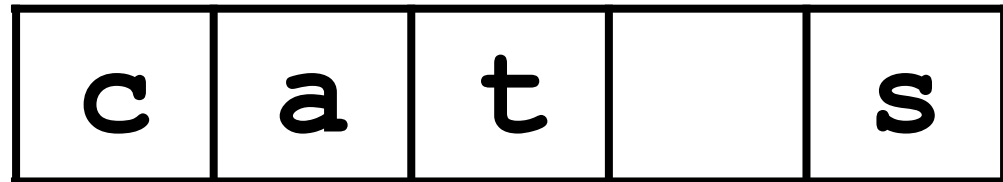


spacedOut

Removing Whitespace

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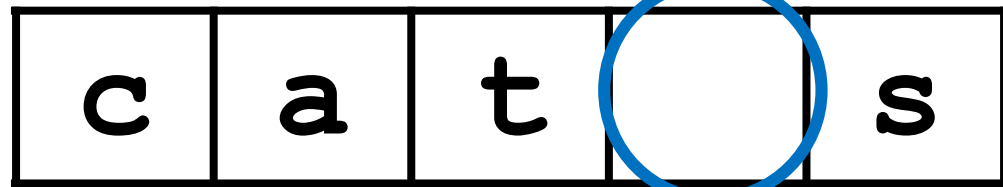
spacedOut

Removing Whitespace

- To remove all whitespace from the start and end of a string, we can use a method called **strip()**

```
spacedOut = spacedOut.strip()
```

notice that **strip()** does not remove “interior” spacing



spacedOut

String Splitting

String Splitting

- We can also break a string into pieces
 - Stored as a list of strings
- The method is called `split()`, and it has two ways it can be used:
 - Break the string up by its whitespace
 - Break the string up by a specific character

Splitting by Whitespace

- Calling `split()` with nothing inside the parentheses will split on all whitespace
 - Even the “interior” whitespace

```
>>> line = "hello world \n"
>>> line.split()
['hello', 'world']
```

```
>>> love = "\t\nI    love\t\t\nwhitespace\n  "
>>> love.split()
['I', 'love', 'whitespace']
```


Splitting by Specific Character

- Calling `split()` with a string in it, we can remove a specific character (or more than one)

```
>>> under = "once_twice_thrice"  
>>> under.split("_")  
['once', 'twice', 'thrice']
```

these character(s) that we want to remove are called the delimiter

```
>>> double = "hello how ill are all of your llamas?"  
>>> double.split("ll")  
['he', 'o how i', ' are a', ' of your ', 'amas?']
```

Splitting by Specific Character

- Calling `split()` with a string in it, we can remove a specific character (or more than one)

```
>>> under = "once_twice_thrice"  
>>> under.split("_")  
['once', 'twice', 'thrice']
```

these character(s) that we want to remove are called the delimiter

```
>>> double = "hello how ill are all of your llamas?"  
>>> double.split("ll")  
['he', 'o how i', ' are a', ' of your', 'amas?']
```

notice that it didn't remove the whitespace

Practice: Splitting

- Use `split()` to solve the following problems
- Split this string on its whitespace:
`daft = "around \t the \nworld"`
- Split this string on the double t's (`tt`):
`adorable = "nutty otters making lattes"`

Practice: Splitting

- Use `split()` to solve the following problems

- Split this string on its whitespace:

```
daft = "around \t the \nworld"  
daft.split()
```

- Split this string on the double t's (`tt`):

```
adorable = "nutty otters making lattes"  
adorable.split("tt")
```

Looping over Split Strings

- Splitting a string creates a list of smaller strings
- Using a **while** loop and this list, we can iterate over each individual word (or token)

```
words = sentence.split()
index = 0
while index < len(words):
    print(words[index])
    index += 1
```

Example: Looping over Split Strings

```
lyrics = "stars in their eyes"  
lyricWords = lyrics.split()  
index = 0  
while index < len(lyricWords):  
    print("*" + lyricWords[index] + "*")  
    index += 1
```

```
*stars*  
*in*  
*their*  
*eyes*
```



what does this line of code do?

append a "*" to the front and end of each list element, then print

String Joining

Joining Strings

- We can also join a list of strings back together!
 - The syntax looks different from `split()`
 - And it only works on a list of strings

```
"X".join(list_of_strings)
```

method
name

the list of strings we want to join together

the delimiter (what we will use to join the strings)

Example: Joining Strings

```
>>> names = ['Alice', 'Bob', 'Carl', 'Dana', 'Eve']  
>>> "_".join(names)  
'Alice_Bob_Carl_Dana_Eve'
```

- We can also use more than one character as our delimiter if we want

```
>>> " <3 ".join(names)  
'Alice <3 Bob <3 Carl <3 Dana <3 Eve'
```

`split()` vs `join()`

- The `split()` method
 - Takes in a single string
 - Creates a list of strings
 - Splits on given character(s), or on all whitespace
- The `join()` method
 - Takes in a list of strings
 - Returns a single string
 - Joins together with a user-chosen delimiter

String and List Operations

- Many of the operations we've learned are possible to use on strings and on lists

Operation	Strings	Lists
Concatenation +	✓	✓
Indexing []	✓	✓
Slicing [:]	✓	✓
<code>.lower()</code> / <code>.upper()</code>	✓	✗
<code>.append()</code> / <code>.remove()</code>	✗	✓
<code>len()</code>	✓	✓

Daily Shortcut

- **CTRL+Z**
 - “Minimizes” the emacs window
- **fg**
 - Used in the terminal, and “maximizes” it again
- Useful when coding and testing
 - Save and minimize, run code, maximize it to edit
 - Keeps the kill ring, where you are in the file, etc.

Announcements

- HW 4 is out on Blackboard now
 - Due by Friday (October 5th) at 8:59:59 PM
- Lab 5 is out on Blackboard as well.
 - Due Thurs (October 4th) at 8:59:59PM
 - Do this before you take the midterm!
- Midterm is in class, October 3rd and 4th
 - Survey #1 will be released this week as well

Image Sources

- Sewing thread (adapted from):
 - <https://pixabay.com/p-936467>
- Cheese slices:
 - <http://pngimg.com/download/4276>
- Space dog (adapted from):
 - https://commons.wikimedia.org/wiki/File:Space_dog_illustration.png