UNIT-IV

Python Strings

Strings

Python treats strings as contiguous series of characters delimited by single, double or even triple quotes. Python has a built-in string class named "str" that has many useful features. We can simultaneously declare and define a string by creating a variable of string type. This can be done in several ways which are as follows:

name = "India" graduate = 'N' country = name nationality = str("Indian")

Indexing: Individual characters in a string are accessed using the subscript ([ ]) operator. The expression in brackets is called an index. The index specifies a member of an ordered set and in this case it specifies the character we want to access from the given set of characters in the string.

The index of the first character is 0 and that of the last character is n-1 where n is the number of characters in the string. If you try to exceed the bounds (below 0 or above n-1), then an error is raised.

Strings

Traversing a String: A string can be traversed by accessing character(s) from one index to another. For example, the following program uses indexing to traverse a string from first character to the last.

Example:

```
message = "Hello!"
index = 0
for i in message:
print("message[", index, "] = ", i)
index += 1
```

OUTPUT

```
message[ 0 ] =  H
message[ 1 ] =  e
message[ 2 ] =  l
message[ 3 ] =  l
message[ 4 ] =  o
message[ 5 ] =  !
```

Concatenating, Appending and Multiplying Strings

Examples:

```
str1 = "Hello "
str2 = "World"
str3 = str1 + str2
print("The concatenated string is : ", str3)
```

OUTPUT

```
The concatenated string is :  Hello World
```

```
str = "Hello"
print(str * 3)
```

OUTPUT

```
Hello Hello Hello
```

```
str = "Hello, "
name = input("\n Enter your name : ")
str += name
str += ". Welcome to Python Programming."
print(str)
```

OUTPUT

```
Enter your name : Arnav
Hello, Arnav. Welcome to Python Programming.
```

Strings are Immutable

Python strings are immutable which means that once created they cannot be changed. Whenever you try to modify an existing string variable, a new string is created.

Example:

```
str1 = "Hello"
print("Str1 is : ", str1)
print("ID of str1 is : ", id(str1))

str2 = "World"
print("Str2 is : ", str2)

print("ID of str1 is : ", id(str2))
str1 += str2
print("Str1 after concatenation is : ", str1)
print("ID of str1 is : ", id(str1))
str3 = str1
print("str3 = ", str3)
print("ID of str3 is : ", id(str3))
```

OUTPUT

```
Str1 is :  Hello
ID of str1 is :  45093344
Str2 is :  World
ID of str1 is :  45093312
Str1 after concatenation is :  HelloWorld
ID of str1 is :  43861792
str3 =  HelloWorld
ID of str3 is :  43861792
```

String Formatting Operator

The % operator takes a format string on the left (that has %d, %s, etc) and the corresponding values in a tuple (will be discussed in subsequent chapter) on the right. The format operator, % allow users to construct strings, replacing parts of the strings with the data stored in variables. The syntax for the string formatting operation is:

"<Format>" % (<Values>)

Example:

```
name = "Aarish"
age = 8
print("Name = %s and Age = %d" %(name, age))
print("Name = %s and Age = %d" %("Anika", 6))
```

OUTPUT

```
Name = Aarish and Age = 8
Name = Anika and Age = 6
```

Built-in String Methods and Functions

Function	Usage	Example

`capitalize()`	This function is used to capitalize first letter of the string.	`str = "hello"`
		`print(str.capitalize())`
		OUTPUT
		`Hello`

`center(width, fillchar)`	Returns a string with the original string centered to a total of `width` columns and filled with `fillchar` in columns that do not have characters.	`str = "hello"`
		`print(str.center(10, '*'))`
		OUTPUT
		`**hello***`

`count(str, beg, end)`	Counts number of times str occurs in a string. You can specify beg as 0 and end as the length of the message to search the entire string or use any other value to just search a part of the string.	`str = "he"`
		`message = "helloworldhellohello"`
		`print(message. count (str,0, len (message)))`
		OUTPUT
		`3`

`endswith (suffix, beg, end)`	Checks if string ends with suffix; returns `True` if so and `False` otherwise. You can either set `beg = 0` and `end` equal to the length of the message to search entire string or use any other value to search a part of it.	`message = "She is my best friend"`
		`print(message.endswith("end", 0,len(message)))`
		OUTPUT
		`True`

Built-in String Methods and Functions

find(str, beg, end)	Checks if str is present in string. If found it returns the position at which str occurs in string, otherwise returns -1. You can either set beg = 0 and end equal to the length of the message to search entire string or use any other value to search a part of it.	message = "She is my best friend" print(message, find("my",0, len (message))) **OUTPUT** 7
index(str, beg, end)	Same as find but raises an exception if str is not found.	message = "She is my best friend" print(message.index("mine", 0, len(message))) **OUTPUT** ValueError: substring not found
rfind(str, beg, end)	Same as find but starts searching from the end.	str = "Is this your bag?" print(str.rfind("is", 0, len(str))) **OUTPUT** 5
rindex(str, beg, end)	Same as rindex but start searching from the end and raises an exception if str is not found.	str = "Is this your bag?" print(str.rindex("you", 0, len(str))) **OUTPUT** 8

Built-in String Methods and Functions

`isalnum()`	Returns True if string has at least 1 character and every character is either a number or an alphabet and False otherwise.	`message = "JamesBond007"`
		`print(message.isalnum())`
		OUTPUT
		`True`

`isalpha()`	Returns True if string has at least 1 character and every character is an alphabet and False otherwise.	`message = "JamesBond007"`
		`print(message.isalpha())`
		OUTPUT
		`False`

`isdigit()`	Returns True if string contains only digits and False otherwise.	`message = "007"`
		`print(message.isdigit())`
		OUTPUT
		`True`

`islower()`	Returns True if string has at least 1 character and every character is a lowercase alphabet and False otherwise.	`message = "Hello"`
		`print(message.islower())`
		OUTPUT
		`False`

`isspace()`	Returns True if string contains only whitespace characters and False otherwise.	`message = "  "`
		`print(message.isspace())`
		OUTPUT
		`True`

`isupper()`	Returns True if string has at least 1 character and every character is an upper case alphabet and False otherwise.	`message = "HELLO"`
		`print(message.isupper())`
		OUTPUT
		`True`

`len(string)`	Returns the length of the string.	`str = "Hello"`
		`print(len(str))`
		OUTPUT
		`5`

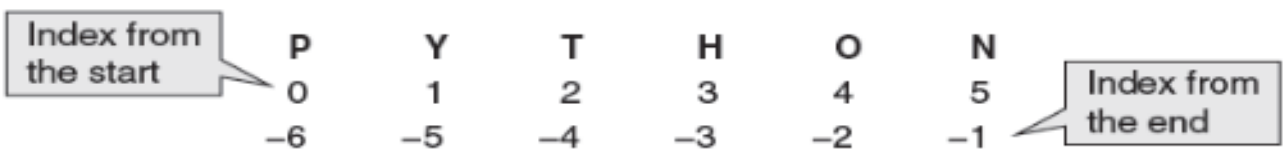
`ljust(width[, fillchar])`	Returns a string left-justified to a total of `width` columns. Columns without characters are padded with the character specified in the `fillchar` argument.	`str = "Hello"`
		`print(str.ljust(10, '*'))`
		OUTPUT
		`Hello*****`

`rjust(width[, fillchar])`	Returns a string right-justified to a total of `width` columns. Columns without characters are padded with the character specified in the `fillchar` argument.	`str = "Hello"`
		`print(str.rjust(10, '*'))`
		OUTPUT
		`*****Hello`

Slice Operation

A substring of a string is called a *slice*. The slice operation is used to refer to sub-parts of sequences and strings.

You can take subset of string from original string by using [ ] operator also known as *slicing operator*.



Examples:

```
str = "PYTHON"
print("str[1:5] = ", str[1:5])   #characters starting at index 1 and extending up
to but not including index 5
print("str[:6] = ", str[:6])     # defaults to the start of the string
print("str[1:] = ", str[1:])      # defaults to the end of the string
print("str[:] = ", str[:])        # defaults to the entire string
print("str[1:20] = ", str[1:20])  # an index that is too big is truncated down to
length of the string
```

OUTPUT

```
str[1:5] =  YTHO
str[:6] =  PYTHON
str[1:] =  YTHON
str[:] =  PYTHON
str[1:20] =  YTHON
```

Programming Tip: Python does not have any separate data type for characters. They are represented as a single character string.

Specifying Stride while Slicing Strings

In the slice operation, you can specify a third argument as the ***stride***, which refers to the number of characters to move forward after the first character is retrieved from the string. By default the value of stride is 1, so in all the above examples where he had not specified the stride, it used the value of 1 which means that every character between two index numbers is retrieved.

Examples:

```
str = "Welcome to the world of Python"
print("str[2:10] = ", str[2:10])    # default stride is 1
print("str[2:10:1] = ", str[2:10:1])   # same as stride = 1
print("str[2:10:2] = ", str[2:10:2])   # skips every alternate character
print("str[2:13:4] = ", str[2:13:4])   # skips every fourth character
```

OUTPUT

```
str[2:10] = lcome to
str[2:10:1] = lcome to
str[2:10:2] = loet
str[2:13:4] = le
```

ord() and chr() Functions

ord() function returns the ASCII code of the character and chr() function returns character represented by a ASCII number.

Examples:

```
ch = 'R'
print(ord(ch))
```

OUTPUT

```
82
```

```
print(chr(82))
```

OUTPUT

```
R
```

```
print(chr(112))
```

OUTPUT

```
p
```

```
print(ord('p'))
```

OUTPUT

```
112
```

in and not in Operators

in and not in operators can be used with strings to determine whether a string is present in another string. Therefore, the in and not in operator are also known as membership operators.

Examples:

```
str1 = "Welcome to the world of Python
!!!"
str2 = "the"
if str2 in str1:
    print("Found")
else:
    print("Not Found")
```

OUTPUT

```
Found
```

```
str1 = "This is a very good book"
str2 = "best"
if str2 not in str1:
    print("The book is very good but it
may not be the best one.")
else:
    print ("It is the best book.")
```

OUTPUT

```
The book is very good but it may not be
the best one.
```

Comparing Strings

Operator	Description	Example
==	If two strings are equal, it returns True.	>>> "AbC" == "AbC" True

!= or <>	If two strings are not equal, it returns True.	>>> "AbC" != "Abc"
		True
		>>> "abc" <> "ABC"
		True

>	If the first string is greater than the second, it returns True.	>>> "abc" > "Abc" True
<	If the second string is greater than the first, it returns True.	>>> "abC" < "abc" True
>=	If the first string is greater than or equal to the second, it returns True.	>>> "aBC" >= "ABC" True
<=	If the second string is greater than or equal to the first, it returns True.	>>> "ABc" <= "ABc" True

Iterating String

String is a sequence type (sequence of characters). You can iterate through the string using for loop.

Examples:

```
str = "Welcome to Python"
for i in str:
print(i, end=' ')
```

OUTPUT

```
W e l c o m e   t o   P y t h o n
```

```
message = " Welcome to Python "
index = 0
while index < len(message):
    letter = message[index]
    print(letter, end=' ')
    index += 1
```

OUTPUT

```
W e l c o m e   t o   P y t h o n
```

The String Module

The string module consist of a number of useful constants, classes and functions (some of which are deprecated).

These functions are used to manipulate strings.

Examples:

```
str = "Welcome to the world of Python"
print("Uppercase - ", str.upper())
print("Lowercase - ", str.lower())
print("Split - ", str.split())
print("Join - ", '-'.join(str.split()))
print("Replace - ", str.replace("Python", "Java"))
print("Count of o - ", str.count('o') )
print("Find of - ", str.find("of"))
```

OUTPUT

```
Uppercase -  WELCOME TO THE WORLD OF PYTHON
Lowercase -  welcome to the world of python
Split -  ['Welcome', 'to', 'the', 'world', 'of', 'Python']
Join -  Welcome-to-the-world-of-Python
Replace -  Welcome to the world of Java
Count of o -  5
Find of -  21
```

Programming Tip: A method is called by appending its name to the variable name using the period as a delimiter.

Working with Constants in String Module

You can use the constants defined in the string module along with the find function to classify characters. For example, if find(lowercase, ch) returns a value except -1, then it means that ch must be a lowercase character. An alternate way to do the same job is to use the in operator or even the comparison operation.

Examples:

```
# First Way
import string
print(string.find(string.
lowercase, 'g') != -1)

OUTPUT
True
```

```
# Second Way
import string
print('g' in string.
lowercase)

OUTPUT
True
```

```
# Third Way
import string
ch = 'g'
print('a' <= ch <= 'z')

OUTPUT
True
```

Regular Expressions

Regular Expressions are a powerful tool for various kinds of string manipulation. These are basically a special text string that is used for describing a search pattern to extract information from text such as code, files, log, spreadsheets, or even documents.

Regular expressions are a *domain specific language* (DSL) that is present as a library in most of the modern programming languages, besides Python. A *regular expression* is a special sequence of characters that helps to match or find strings in another string. In Python, regular expressions can be accessed using the re module which comes as a part of the Standard Library

The Match Function

As the name suggest, the match() function matches a pattern to string with optional flags. The syntax of match() function is,

re.match (pattern, string, flags=0)

EXAMPLE- Match() Function

Examples:

Flag	Description
re.I	Case sensitive matching
re.M	Matches at the end of the line
re.X	Ignores whitespace characters
re.U	Interprets letters according to Unicode character set

```
import re
string = "She sells sea shells on the sea shore"
pattern1 = "sells"
if re.match(pattern1, string):
    print("Match Found")
else:
    print(pattern1, "is not present in the string")
pattern2 = "She"
if re.match(pattern2, string):
    print("Match Found")
else:
    print(pattern2, "is not present in the string")
```

OUTPUT

```
sells is not present in the string
Match Found
```

The search Function

The search() function in the re module searches for a pattern anywhere in the string. Its syntax of can be given as,

re.search(pattern, string, flags=0)

The syntax is similar to the match() function. The function searches for first occurrence of *pattern* within a *string* with optional *flags*. If the search is successful, a *match* object is returned and None otherwise.

Example:

```
import re
string = "She sells sea shells on the sea shore"
pattern = "sells"
if re.search(pattern, string):
    print("Match Found")
else:
    print(pattern, "is not present in the string")
```

OUTPUT

```
Match Found
```

The sub() Function

The sub() function in the re module can be used to search a pattern in the string and replace it with another pattern.

The syntax of sub() function can be given as, re.sub(pattern, repl, string, max=0)

According to the syntax, the sub() function replaces all occurrences of the pattern in string with repl, substituting all occurrences unless any max value is provided. This method returns modified string.

Example:

```
import re
string = "She sells sea shells on the sea shore"
pattern = "sea"
repl = "ocean"
new_string = re.sub(pattern, repl, string, 1)
print(new_string)
```

OUTPUT

```
She sells ocean shells on the sea shore
```

The findall() and finditer() Function

The findall() function is used to search a string and returns a list of matches of the pattern in the string. If no match is found, then the returned list is empty. The syntax of match() function can be given as,

matchList = re.findall(pattern, input_str, flags=0)

Examples:

```
import re
pattern = r"[a-zA-Z]+ \d+"
matches = re.findall(pattern, "LXI 2013, VXI 2015, VDI 20104, Maruti Suzuki Cars in
Inida")
for match in matches:
    print(match, end = " ")
```

OUTPUT

```
LXI 2013  VXI 2015  VDI 20104
```

Flag Options

The search(), findall() and match() functions of the module take options to modify the behavior of the pattern match. Some of these flags are:

re.I or re.IGNORECASE — Ignores case of characters, so "Match", "MATCH", "mAtCh", etc are all same

re.S or re.DOTALL — Enables dot (.) to match newline. By default, dot matches any character other than the newline character.

re.M or re.MULTILINE — Makes the ^ and $ to match the start and end of each line. That is, it matches even after and before line breaks in the string. By default, ^ and $ matches the start and end of the whole string.

re.L or re.LOCALE- Makes the flag \w to match all characters that are considered letters in the given current locale settings.

re.U or re.UNICODE- Treats all letters from all scripts as word characters.

Metacharacters in Regular Expression

Metacharacter	Description	Example	Remarks
^	Matches at the beginning of the line.	^Hi	It will match Hi at the start of the string.
$	Matches at the end of the line.	Hi$	It will match Hi at the end of the string.
.	Matches any single character except the newline character.	Lo.	It will match Lot, Log, etc.
[...]	Matches any single character in brackets.	[Hh]ello	It will match "Hello" or "hello".
[^...]	Matches any single character not in brackets.	[^aeiou]	It will match anything other than a lowercase vowel.
re*	Matches 0 or more occurrences of regular expression.	[a-z]*	It will match zero or more occurrence of lowercase characters.
re+	Matches 1 or more occurrence of regular expression.	[a-z]+	It will match one or more occurrence of lowercase characters
re?	Matches 0 or 1 occurrence of regular expression.	Book?	It will match "Book" or "Books".
re{n}	Matches exactly n number of occurrences of regular expression.	42{1}5	It will match 425.
re{n,}	Matches n or more occurrences of regular expression.	42{1,}5	It will match 42225 or any number with more than one 2s between 4 and 5.
re{n,m}	Matches at least n and at most m occurrences of regular expression.	42{1,3}5	It will match 425, 4225, 42225.

Metacharacters in Regular Expression

a|b	Matches either a or b.	"Hello" | "Hi"	It will match Hello or Hi.
\w	Matches word characters.	re.search(r'\w', 'xx123xx')	Match will be made.
\W	Matches non-word characters.	if(re.search(r'\W', '@#S%')): print("Done")	Done
\s	Matches whitespace, equivalent to [\t\n\r\f].	if(re.search(r'\s',"abcdsd")): print("Done")	Done
\S	Matches non-whitespace, equivalent to [^\t\n\r\f].	if(re.search(r'\S'," abcdsd")): print("Done")	Done
\d{n}	Matches exactly n digits.	\d{2}	It will match exactly 2 digits.
\d{n,}	Matches n or more digits.	\d{3,}	It will match 3 or more digits.
\d{n,m}	Matches n and at most m digits.	\d{2,4}	It will match 2,3 or 4 digits.
\D	Matches non-digits.	(\D+\d)	It will match Hello 5678, or any string starting with no digit followed by digits(s).
\A	Matches beginning of the string.	\AHi	It will match Hi at the beginning of the string.
\Z	Matches end of the string.	Hi\Z	It will match Hi at the end of the string.

\G	Matches point where last match finished.	import re
		if(re.search(r'\Gabc','abcba cabc')):
		print("Done")
		else:
		print("Not Done")
			Not Done

\b	Matches word boundaries when outside brackets. Matches backspace when inside brackets.	\bHi\b	It will match Hi at the word boundary.
\B	Matches non-word boundaries.	\bHi\B	Hi should start at word boundary but end at a non-boundary as in High
\n, \t, etc.	Matches newlines, tabs, etc.	re.search(r'\t', '123 \t abc ')	Match will be made.

Character Classes

When we put the characters to be matched inside square brackets, we call it a character class. For example, [aeiou] defines a character class that has a vowel character.

Examples:

```
import re
pattern=r"[aeiou]"
if re.search(pattern,"clue"):
    print("Match clue")
if re.search(pattern,"bcdfg"):
    print("Match bcdfg")
```

OUTPUT

```
Match clue
```

Groups

A group is created by surrounding a part of the regular expression with parentheses. You can even give group as an argument to the metacharacters such as * and ?.

Example:

```
import re
pattern = r"gr(ea)*t"   # group of ea created
if re.match(pattern,"great"):
      print("Match ea")
if re.match(pattern, "greaeaeaeaeaeaeaeat"):
      print("Match greaeaeaeaeaeaeaeat")

OUTPUT
Match ea
Match greaeaeaeaeaeaeaeat
```

The content of groups in a match can be accessed by using the group() function. For example,

- group(0) or group() returns the whole match.
- group(n), where n is greater than 0, returns the nth group from the left.
- group() returns all groups up from 1.