Strings in Python

Lesson Objectives

At the end of this lesson, you should be able to:

- Describe the terminology, ‘string’, as used in Python
- Define strings in Python
- Access characters in a Python string
- Slice a Python string to get substrings
- Use common string functions and methods in Python

Topic Outline

What is a String?

A **string** is a **sequence** of characters.

Notionally, a character is a letter or a symbol.

Defining a String

Recall

- A string is indicated using single quote (‘…’) or double quotes (“…”)
  - For example, ‘abc’ or “abc”
- The **sequence** of characters is important and is maintained

Defining a String (Cont’d)

- Using a single or double quotes is fine

Example: s = “a string” or s = ‘a string’

- Don’t use both

Example: s = “a string’ → WRONG Syntax Error

How to put an apostrophe in a string, e.g., Mike’s book?

- `s = "Mike’s book"` → Use different quotes
- `s = 'Mike\’s book'` → Use an escape character

Index

- Characters in a string are in a sequence.
- We can identify each character with an unique **index** (a position in the sequence).
- We can index a character from either end of the sequence.
  - Non-negative values: counting from **left**, starting at 0
  - Negative values: counting from **right**, starting at -1

Index (Cont'd)

String = "**Hello World**"

Characters	**H**	**e**	**l**	**l**	**o**		**W**	**o**	**r**	**l**	**d**
Indices	0	1	2	3	4	5	6	7	8	9	10
									…	–2	–1

Indices 10 and –1 point to the same location: ***d***

Accessing One Element

We can use **[ ]** to access particular characters in a string.

```
myStr = "Hello World"
x = myStr[1]
print(x)                  #will print e
print(myStr)            ? #will print Hello World
print(myStr[-2])        ? #will print l
print(myStr[11])        ? Error
```

Characters	H	e	l	l	o		W	o	r	l	d
Indices	0	1	2	3	4	5	6	7	8	9	10
									…	–2	–1

Slicing: Parts of a String

We can also select a part of the string.

the index of the end of a subsequence (*not included*)

Syntax: **[start : finish]**

the index of the start of a subsequence

*By default, these indices, (**start** and **finish**), will point to the **beginning** and **end** of the string, respectively.*

Slicing: Parts of a String (Cont’d)

The start index is inclusive while the finish index is the one after the subsequence.

```
myStr = "Hello World"
myStr[1:4]
```

$\Rightarrow$?

Characters	H	e	l	l	o		W	o	r	l	d
Indices	0	1	2	3	4	5	6	7	8	9	10
									…	–2	–1

Slicing: Parts of the String (Cont'd)

Example:

```python
myStr = "Hello World"
print(myStr[1:6])
print(myStr[1:2])
print(myStr[-7:-1])
print(myStr[-3:-5])
print(myStr[:6])
print(myStr[5:])
```

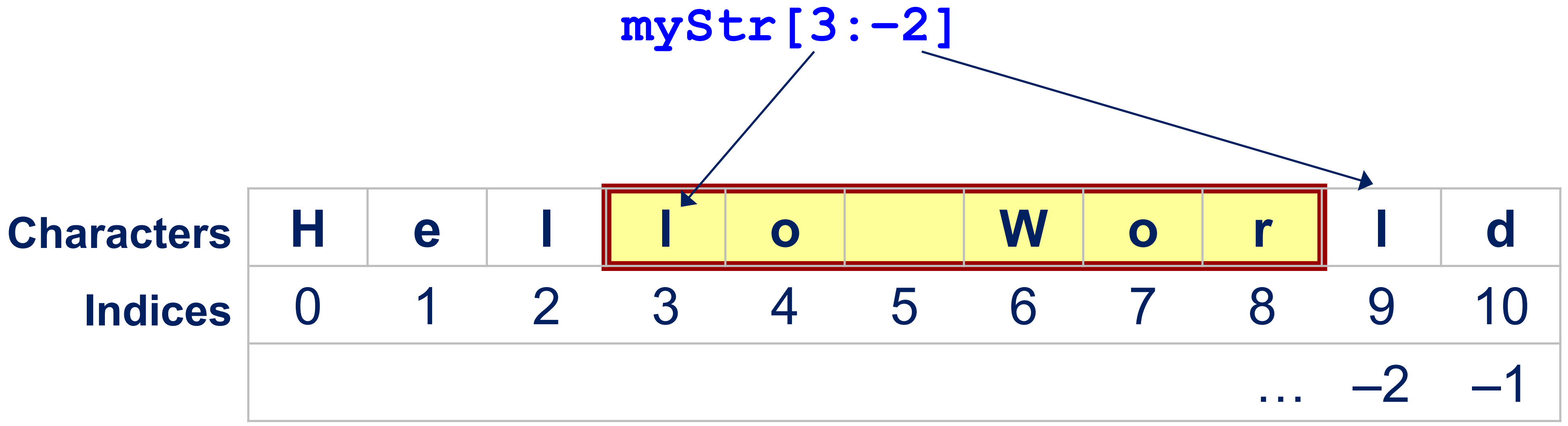
Output

```
'ello '
'e'
'o Worl'
'' (empty)
'Hello '
' World'
```

Characters	H	e	l	l	o		W	o	r	l	d
Indices	0	1	2	3	4	5	6	7	8	9	10
	–12	–10	–9	–8	–7	–6	–5	–4	–3	–2	–1

Slicing: Parts of the String (Cont'd)

One More Example:



```
myStr[3:-2]
```

Characters	H	e	l	l	o		W	o	r	l	d
Indices	0	1	2	3	4	5	6	7	8	9	10
									…	–2	–1

Extended Slicing

We can also specify a third argument.

Syntax: **[start : finish : step]**

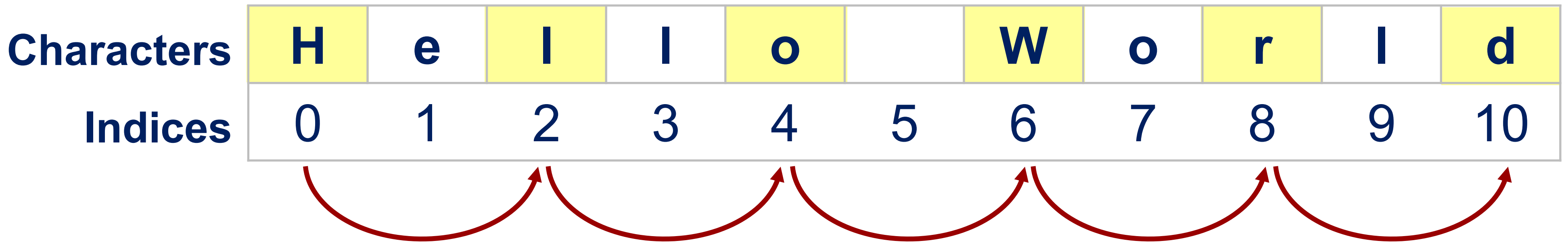
⬇ specifies the step size to jump along the sequence

Defaults:

- **start**: beginning
- **finish**: end
- **step**: 1

Extended Slicing (Cont'd)

`myStr[::2]` → 'HloWrd'



Characters	H	e	l	l	o		W	o	r	l	d
Indices	0	1	2	3	4	5	6	7	8	9	10

Extended Slicing: Common Patterns

Copying a String

```
aString = "String to copy"

newStr = aString[:]

newStr = ''.join(aString)
```

Reversing a String

```
aString = "Madam I'm Adam"

revString = aString[::-1]    →  "madA m'I madaM"

bString = aString[0:14:-1]   →  ""
```

Basic Operations

```
opStr = "Basic"
```

Length of a string: `len()`

e.g. `len(opStr)` ➡ **5**

Concatenate strings: `+`

e.g. `opStr + "operations"` ➡ **‘Basic operations’**

Repeat String: `*`

e.g. `opStr * 3` ➡ **‘BasicBasicBasic’**

Back to Characters

Two common systems for representing characters:

- **ASCII** (older)
- **Unicode** (modern, more characters)

Tables indicate mapping of characters to ASCII or Unicode.

ASCII vs. Unicode

ASCII

- Uses 8 bits to store a character
- 2^8 = 256 different characters

Unicode

- An extension of ASCII
- Able to include more characters
- Uses 16 bits to store a character
- 2^{16} = 65,536 characters

- The Unicode space is divided into 17 planes.
- Each plane contains 65,536 code points (16-bit).

Total of:
***1,114,112** characters,*
96,000 used.

ACSII Table (Partial)

Dec	Hx	Oct	Html	Char	Dec	Hx	Oct	Html	Char	Dec	Hx	Oct	Html	Char	Dec	Hx	Oct	Html	Char	Dec	Hx	Oct	Html	Char
32	20	040	&#32;	Space	52	34	064	&#52;	4	72	48	110	&#72;	H	92	5C	134	&#92;	\	112	70	160	&#112;	p
33	21	041	&#33;	!	53	35	065	&#53;	5	73	49	111	&#73;	I	93	5D	135	&#93;	]	113	71	161	&#113;	q
34	22	042	&#34;	“	54	36	066	&#54;	6	74	4A	112	&#74;	J	94	5E	136	&#94;	^	114	72	162	&#114;	r
35	23	043	&#35;	#	55	37	067	&#55;	7	75	4B	113	&#75;	K	95	5F	137	&#95;	_	115	73	163	&#115;	s
36	24	044	&#36;	$	56	38	070	&#56;	8	76	4C	114	&#76;	L	96	60	140	&#96;	`	116	74	164	&#116;	t
37	25	045	&#37;	%	57	39	071	&#57;	9	77	4D	115	&#77;	M	97	61	141	&#97;	a	117	75	165	&#117;	u
38	26	046	&#38;	&	58	3A	072	&#58;	:	78	4E	116	&#78;	N	98	62	142	&#98;	b	118	76	166	&#118;	v
39	27	047	&#39;	‘	59	3B	073	&#59;	;	79	4F	117	&#79;	O	99	63	143	&#99;	c	119	77	167	&#119;	w
40	28	050	&#40;	(	60	3C	074	&#60;	<	80	50	120	&#80;	P	100	64	144	&#100;	d	120	78	170	&#120;	x
41	29	051	&#41;	)	61	3D	075	&#61;	=	81	51	121	&#81;	Q	101	65	145	&#101;	e	121	79	171	&#121;	y
42	2A	052	&#42;	*	62	3E	076	&#62;	>	82	52	122	&#82;	R	102	66	146	&#102;	f	122	7A	172	&#122;	z
43	2B	053	&#43;	+	63	3F	077	&#63;	?	83	53	123	&#83;	S	103	67	147	&#103;	g	123	7B	173	&#123;	{
44	2C	054	&#44;	,	64	40	100	&#64;	@	84	54	124	&#84;	T	104	68	150	&#104;	h	124	7C	174	&#124;	|
45	2D	055	&#45;	-	65	41	101	&#65;	A	85	55	125	&#85;	U	105	69	151	&#105;	i	125	7D	175	&#125;	}
46	2E	056	&#46;	.	66	42	102	&#66;	B	86	56	126	&#86;	V	106	6A	152	&#106;	j	126	7E	176	&#126;	~
47	2F	057	&#47;	/	67	43	103	&#67;	C	87	57	127	&#87;	W	107	6B	153	&#107;	k	127	7F	177	&#127;	DEL
48	30	060	&#48;	0	68	44	104	&#68;	D	88	58	130	&#88;	X	108	6C	154	&#108;	l					
49	31	061	&#49;	1	69	45	105	&#69;	E	89	59	131	&#89;	Y	109	6D	155	&#109;	m					
50	32	062	&#50;	2	70	46	106	&#70;	F	90	5A	132	&#90;	Z	110	6E	156	&#110;	n					
51	33	063	&#51;	3	71	47	107	&#71;	G	91	5B	133	&#91;	[	111	6F	157	&#111;	o					

Source: www.lookupTables.com

Getting the Code

`ord()` takes a character as input and returns the Unicode of the character (for standard symbols this is the same as in ASCII).

e.g. `ord('a')` $\Rightarrow$ **97**

`chr()` takes an ASCII/UTF-8 code and returns the corresponding character.

e.g. `chr(97)` $\Rightarrow$ **‘a’**

For encryption:

```
code = ord('a')
chr (code + 1)
```

$\Rightarrow$ **‘b’**

Comparing Two Characters

The code is used for comparison.

`'a' == 'a'` → true

`'a' < 'b'` → true

`'1' < '9'` → true

`'a' < 'B'` → false!

Membership Operation

Is one string contained in another?

- Operator: `in`
- `a in b`: True if string `a` is contained in string `b`

```
myStr = "abcdefg"

'c' in myStr       →  true

'cde' in myStr     →  true

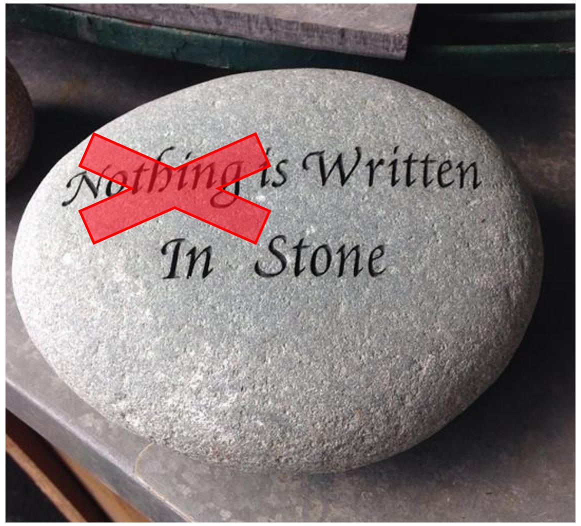
'cef' in myStr     →  false

myStr in myStr     →  true
```

Strings are Immutable

- Strings are immutable, i.e., you cannot change one once you make it.
  - `aStr = 'spam'`
  - `aStr[1] = 1` ➡ ⓘ Error

- However, you can use it to make another string (copy it, slice it, etc.).
  - `newStr = aStr[:1] + 'l' + aStr[2:]`
  - `newStr` ➡ **'slam'**
  - `aStr` ➡ **'spam'**



Functions and Methods for Strings

Functions

- A **function** is a piece of code that performs some operation.
  - The details are hidden (encapsulated), only it’s interface exposed.
  - It is a way to arrange a program to make it **easier to understand**.
- A function has arguments as inputs and may return one output.

String Functions

A String Function: `len()`

Recall **Length of a string**: `len()`

e.g. `len('test string')` → **11**
(not 10)

- Input: a string
- Output: an integer indicating the length of the string

Method

- A method is a variation on a function.
  - It represents a program.
  - It has input arguments and output.
- Unlike a function, it is applied in the context of a particular object.
  - This is indicated by the dot notation invocation.
- Each string is itself an object.

String Method: `upper()`

`upper()` is a string method.

It will output a new string, which is the same as the string on which it was called, except all letters will now be in upper case.

```
myStr = "shouting!"
myStr.upper()
```

$\Rightarrow$ ‘SHOUTING!’

- Object: `myStr`
- Method: `upper()`
- Method call: `myStr.upper()`

Methods in General

Syntax: `object.method()`

- We say, **`object`** is calling the method **`method`**.

Different objects have different methods.

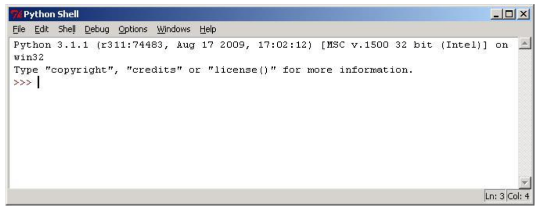
How do we find out all the methods available for strings?

Use Reference

- **Python online**

  http://docs.python.org/release/3.2.3/library/stdtypes.html#string-methods

- **I**ntegrated **D**evelopment **E**nvironment (**IDE**) such as **IDLE**



```
Python 3.1.1 (r311:74483, Aug 17 2009, 17:02:12) [MSC v.1500 32 bit (Intel)] on
win32
Type "copyright", "credits" or "license()" for more information.
>>> 
```

String Method: `find()`

`find()` is another string method.

```
myStr = "Find in a string"
myStr.find('d')
```
$\Rightarrow$ 3

`'d'` is called an **argument** of the method.

- Input: a single character
- Output: the index of the character (first seen from left to right)
- If the character is not found, –1 is returned

String Method: `join()`

`join()` is another string method.

```
str1 = "abcd"
str2 = "1234"
str2.join(str1)  →  'a1234b1234c1234d'
str1.join(str2)  →  '1abcd2abcd3abcd4'
```

Syntax: `base.join(target)`

- Input: the target string to be joined
- Output: the new string where the base joins the target

Chaining Methods

Methods can be chained together.

Perform first operation, yielding an object.

Use the resulting object for the next method.

```
myStr = "Python Rules!"
myStr.upper()                ➡ 'PYTHON RULES!'
myStr.upper().find('H')      ➡ 3
```

Summary

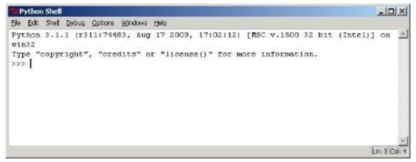
In this lesson, we have learnt:

- How to define a string in Python
- How to access characters in a Python string based on indices
- How to slice a Python string
- Common functions and methods for strings in Python

References for Images

No.	Slide No.	Image	Reference
1	5		String [Online Image]. Retrieved May 9, 2018 from https://www.flickr.com/photos/epublicist/8718123610.
2	6	🔍	Search [Online Image]. Retrieved April 18, 2018 from https://pixabay.com/en/database-search-database-search-icon-2797375/.
3	7, 10	❗	By PKua - Own work, Public Domain, retrieved May 9, 2018 from https://commons.wikimedia.org/w/index.php?curid=3929297.
4	7, 13, 14	📝	Survey icon [Online Image]. Retrieved April 18, 2018 from https://pixabay.com/en/survey-icon-survey-icon-2316468/.
5	10		Python Logo [Online Image]. Retrieved April 24, 2018 from https://pixabay.com/en/language-logo-python-2024210/.

References for Images

No.	Slide No.	Image	Reference
6	24, 31		Question problem [Online Image]. Retrieved April 24, 2018 from https://pixabay.com/en/question-problem-think-thinking-622164/.
7	25		Written in stone [Online Image]. Retrieved May 9, 2018 from https://pixabay.com/en/nothing-is-written-in-stone-rock-527756/.
8	31		World Wide Web [Online Image]. Retrieved May 9, 2018 from https://pixabay.com/en/world-wide-web-internet-computer-24958/.
9	31		CC BY-SA 3.0, retrieved May 9, 2018 from https://commons.wikimedia.org/w/index.php?curid=11887635.

```
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