

# Python

## Strings

# Strings are sequences of characters

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Indexed exactly like lists

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No separate character type: just a string of length 1

Indexed exactly like lists

```
name = 'Darwin'  
print(name[0], name[-1])  
D n
```

`for` iterates through characters

for iterates through characters

```
name = 'Darwin'  
for c in name:  
    print(c)
```

*D*

*a*

*r*

*W*

*i*

*n*

Use either ' or " (as long as they match)



Use either ' or " (as long as they match)

```
print('Alan', "Turing")  
Alan Turing
```

Use either ' or " (as long as they match)

```
print('Alan', "Turing")  
Alan Turing
```

Strings are the same no matter how they're created

Use either ' or " (as long as they match)

```
print('Alan', "Turing")  
Alan Turing
```

Strings are the same no matter how they're created

```
print('Alan' == "Alan")  
True
```

Strings are compared character by character  
from left to right

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from left to right

```
print('a' < 'b')  
True
```

Strings are compared character by character  
from left to right

```
print('a' < 'b')
```

```
True
```

```
print('ab' < 'abc')
```

```
True
```

Strings are compared character by character  
from left to right

```
print('a' < 'b')
```

*True*

```
print('ab' < 'abc')
```

*True*

```
print('1' < '9')
```

*True*

Strings are compared character by character  
from left to right

```
print('a' < 'b')
```

```
True
```

```
print('ab' < 'abc')
```

```
True
```

```
print('1' < '9')
```

```
True
```

```
print('100' < '9')
```

```
True
```



Strings are compared character by character  
from left to right

```
print('a' < 'b')
```

```
True
```

```
print('ab' < 'abc')
```

```
True
```

```
print('1' < '9')
```

```
True
```

```
print('100' < '9')
```

```
True
```

```
print('A' < 'a')
```

```
True
```

Strings are *immutable* : cannot be changed in place

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```
name = 'Darwin'
```

```
name[0] = 'C'
```

***TypeError: 'str' object does not support item assignment***

Strings are *immutable* : cannot be changed in place

```
name = 'Darwin'
```

```
name[0] = 'C'
```

***TypeError: 'str' object does not support item assignment***

Immutability improves performance

# Use + to concatenate strings

## Use + to concatenate strings

```
name = 'Charles' + ' ' + 'Darwin'  
print(name)  
Charles Darwin
```

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```
name = 'Charles' + ' ' + 'Darwin'  
print(name)  
Charles Darwin
```

Concatenation always produces a new string

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```
name = 'Charles' + ' ' + 'Darwin'  
print(name)  
Charles Darwin
```

Concatenation always produces a new string

```
original = 'Charles'
```

**original** → 'Charles'

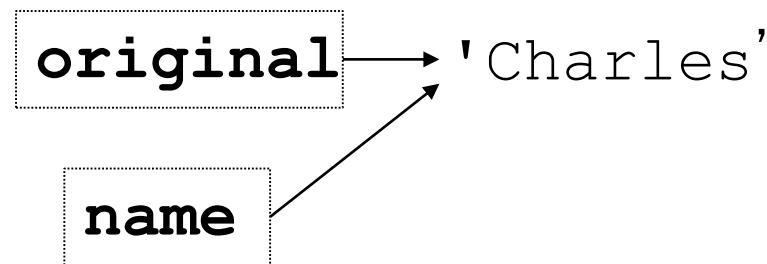


## Use + to concatenate strings

```
name = 'Charles' + ' ' + 'Darwin'  
print(name)  
Charles Darwin
```

## Concatenation always produces a new string

```
original = 'Charles'  
name = original
```



## Use + to concatenate strings

```
name = 'Charles' + ' ' + 'Darwin'
print(name)
Charles Darwin
```

# Concatenation always produces a new string

```
original = 'Charles'
name = original
name += ' Darwin'
```

**original** → 'Charles'

**name**  $\longrightarrow$  'Charles Darwin'

Strings are often formatted with +...

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```
print('reagent: ' + str(reagent_id) + ' produced ' + \
      str(percentage_yield) + '% yield')
```

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```
print('reagent: ' + str(reagent_id) + ' produced ' + \
      str(percentage_yield) + '% yield')
```

There's a better way...

# Accessing arguments by position

```
'{0}, {1}, {2}'.format('a', 'b', 'c')  
'a, b, c'
```

```
'{}, {}, {}'.format('a', 'b', 'c')  
'a, b, c'
```

```
'{2}, {1}, {0}'.format('a', 'b', 'c')  
'c, b, a'
```

## Accessing arguments by name

```
'Coordinates: {latitude},  
{longitude}'.format(latitude='37.24N',  
longitude='-115.81W')  
'Coordinates: 37.24N, -115.81W'
```

Lots more examples here:

<https://docs.python.org/2/library/string.html#format-examples>

Use ":" in the format string to specify the format:

```
output = 'reagent: {:d}'.format(123)
print(output)
reagent: 123
```



Use ":" in the format string to specify the format:

```
output = 'reagent: {:d}'.format(123)
```

```
print(output)
```

```
reagent: 123
```

```
percentage_yield = 12.3
```

```
print('yield: {:.2f}'.format(percentage_yield))
```

```
yield: 12.30
```

Use "{ { " for " { " and " } } " for " } " characters

```
output = 'reagent: { { { :d } } }'.format(123)
print(output)
reagent: { 123 }
```

You will also see (in older python code):

```
print('reagent: %d' % 123)
```

```
reagent: 123
```

```
print('Name: %s; weight: %.2fkg' % ('Bert', 122))
```

```
Name: Bert; weight: 122.00kg
```

This is an alternative approach to string formatting that is now discouraged. 😊

# A handy way to format strings in modern Python:

## f-strings:

```
name = "Andy"
```

```
print(f"Hello {name}")
```

```
Hello Andy
```

```
andy_height = 195
```

```
print(f"You are {andy_height/100} metres tall!")
```

```
You are 1.95 metres tall!
```

Use `\n` to represent a newline character

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Use `\'` for single quote, `\''` for double quote

Use `\n` to represent a newline character

Use `\'` for single quote, `\"` for double quote

```
print('There isn\'t time\nto do it right.')  
There isn't time  
to do it right.
```

Use `\n` to represent a newline character

Use `\'` for single quote, `\"` for double quote

```
print('There isn\'t time\nto do it right.')
```

```
There isn't time  
to do it right.
```

```
print("But you said,\n\"There is time to do it over.\")
```

```
But you said,  
"There is time to do it over."
```



Use \\ for a literal \ character

# Use \\ for a literal \ character

```
print('Most mathematicians write a\\b instead of a%b.')  
Most mathematicians write a\b instead of a%b.
```

Use `\\` for a literal `\` character

```
print('Most mathematicians write a\\b instead of a%b.')  
Most mathematicians write a\b instead of a%b.
```

Common pattern with *escape sequences*

Use `\\` for a literal `\` character

```
print('Most mathematicians write a\\b instead of a%b.')
Most mathematicians write a\b instead of a%b.
```

## Common pattern with *escape sequences*

- Use a character to mean "what follows is special"

Use `\\` for a literal `\` character

```
print('Most mathematicians write a\\b instead of a%b.')  
Most mathematicians write a\b instead of a%b.
```

Common pattern with *escape sequences*

- Use a character to mean "what follows is special"
- Double it up to mean "that character itself"

# Use triple quotes (either kind) for multi-line strings

## Use triple quotes (either kind) for multi-line strings

```
quote = """We can only see  
a short distance ahead,  
but we can see plenty there  
that needs to be done."""
```

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```
quote = """We can only see  
a short distance ahead,  
but we can see plenty there  
that needs to be done."""
```

d	,	\n	b	u
---	---	----	---	---



## Use triple quotes (either kind) for multi-line strings

```
quote = """We can only see  
a short distance ahead,  
but we can see plenty there  
that needs to be done."""
```

```
quote = "We can only see\na short distance" + \  
" ahead,\nbut we can see plenty there\nthat" + \  
" needs to be done."
```

# Strings have methods

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```
name = 'newTON'  
print(name.capitalize(), name.upper(), name.lower())  
Newton NEWTON newton
```

## Strings have methods

```
name = 'newTON'  
print(name.capitalize(), name.upper(), name.lower())  
Newton NEWTON newton  
dna = 'acggtgggtcac'  
print(dna.count('g'), dna.count('x'))  
4 0
```

## Strings have methods

```
name = 'newTON'
print(name.capitalize(), name.upper(), name.lower())
Newton NEWTON newton
dna = 'acggtggtcac'
print(dna.count('g'), dna.count('x'))
4 0
print(dna.find('t'), dna.find('t', 5), dna.find('x'))
4 7 -1
```

## Strings have methods

```
name = 'newTON'
print(name.capitalize(), name.upper(), name.lower())
Newton NEWTON newton
dna = 'acggtggtcac'
print(dna.count('g'), dna.count('x'))
4 0
print(dna.find('t'), dna.find('t', 5), dna.find('x'))
4 7 -1
print(dna.replace('t', 'x'))
acggxggxcac
```

## Strings have methods

```
name = 'newTON'
print(name.capitalize(), name.upper(), name.lower())
Newton NEWTON newton
dna = 'acggtggtcac'
print(dna.count('g'), dna.count('x'))
4 0
print(dna.find('t'), dna.find('t', 5), dna.find('x'))
4 7 -1
print(dna.replace('t', 'x'))
acggxggxcac
print(dna.replace('gt', ''))
acggcac
```

# Can chain method calls together



## Can chain method calls together

```
element = 'cesium'  
print(element.upper().center(10, '.'))
```

## Can chain method calls together

```
element = 'cesium'  
print(element.upper().center(10, '.'))
```



convert to upper case

## Can chain method calls together

```
element = 'cesium'  
print(element.upper().center(10, '.'))
```



center in a field

10 characters wide

## Can chain method calls together

```
element = 'cesium'  
print(element.upper().center(10, '.'))  
..CESIUM..
```

# The power of regular expressions

When programming in any language you will want to know about *regular expressions* – for advanced string/text processing. In Python use the "re" library. Example uses are:

`/<([A-Z][A-Z0-9]*)\b[^>]*>(.*?)</\1>/` Matches the opening and closing pair of any HTML tag; captures tag name and content.

`/b[aeiou]+t/` Matches "bat" and "bit" etc, but also "boot" and "boat".

`/(\[0-9]{1,3})\.(\[0-9]{1,3})\.(\[0-9]{1,3})\.(\[0-9]{1,3})/`  
Matches any IP address ((e.g. 66.70.7.154 ) and captures the each number for re-use.

See: <https://docs.python.org/3.7/howto/regex.html>