Math, Variables, and Strings

ESS 116 | Fall 2024

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(Modified from Ethan Campbell and Katy Christensen's materials for UW's Ocean 215)

What we’ll cover in this lesson

1. Mathematical operations

2. Variables

3. Strings

What we'll cover in this lesson

1. **Mathematical operations**

2. Variables

3. Strings

Python can do math

Arithmetic Operators

Operation		Examples	
+	Addition	2+2	4
-	Subtraction	4−2	2
*	Multiplication	4∗2	8
/	Division	8/2	4
**	Exponential	2∗∗4	16
%	Remainder	16%5	1
//	Floor	16//5	3

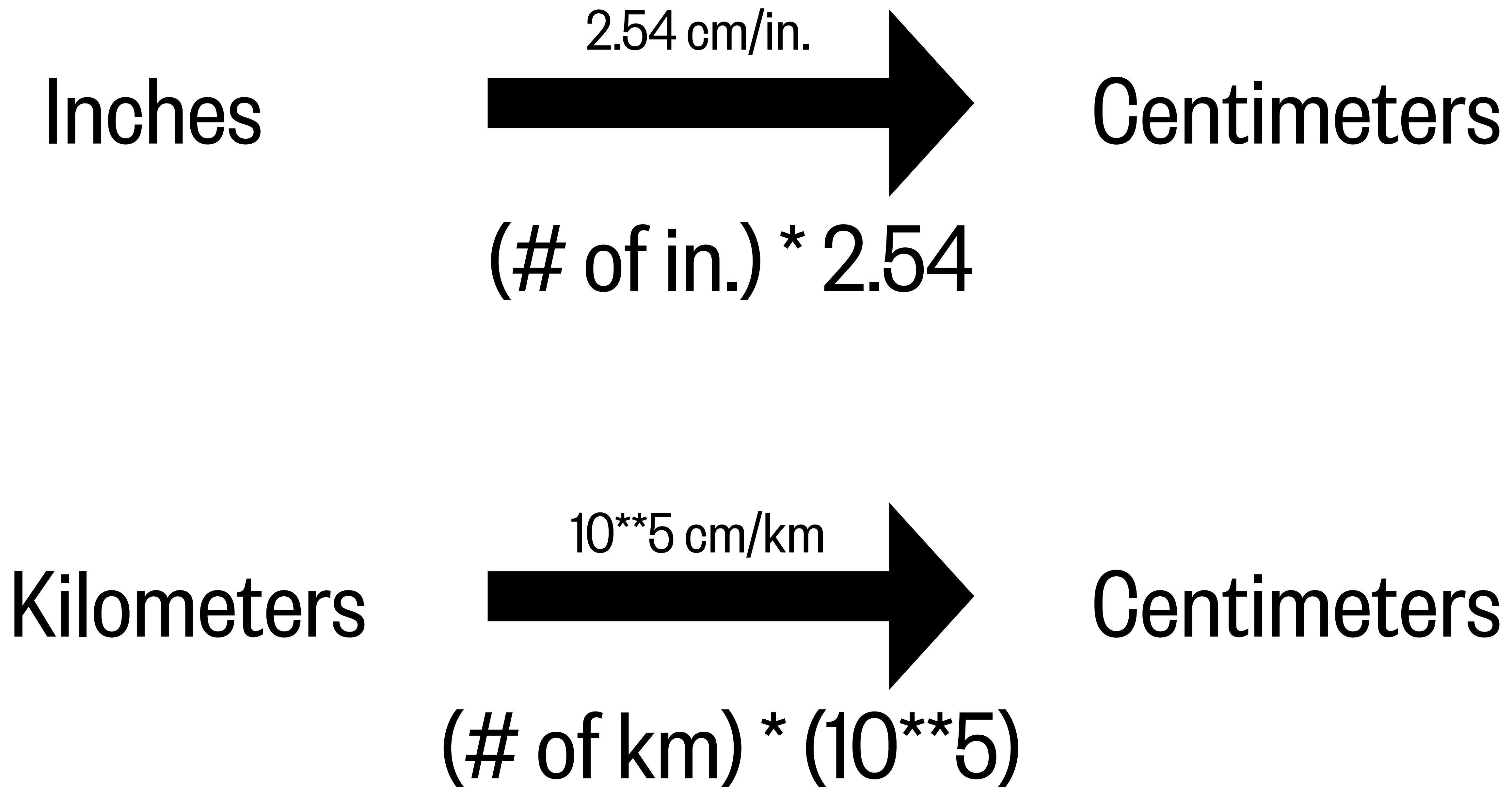
Just like a calculator!

Python can do math

Arithmetic Operators

Operation	
+	Addition
-	Subtraction
*	Multiplication
/	Division
**	Exponential
%	Remainder
//	Floor

Example: Use these operations to do unit conversions



Inches → Centimeters

2.54 cm/in.

(# of in.) * 2.54

Kilometers → Centimeters

10**5 cm/km

(# of km) * (10**5)

A note about parentheses...

Python follows the operation order:

Parentheses

Exponents

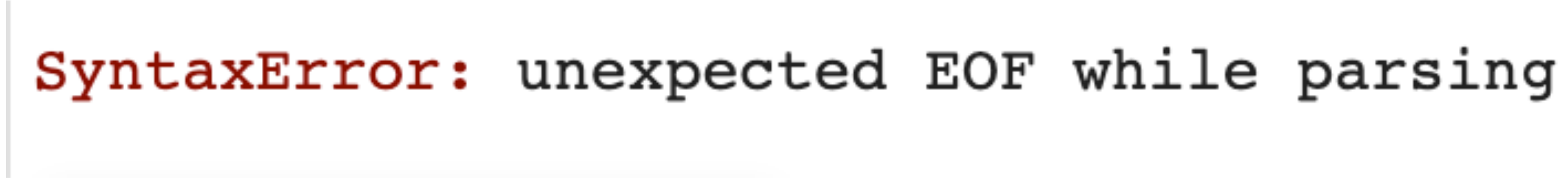
Multiplication/**D**ivision + Remainder and Floor

Addition/**S**ubtraction

4 + 4 ** 4 + 4	264
(4 + 4) ** 4 + 4	4100
4 + 4 ** (4 + 4)	65540
(4 + 4) ** (4 + 4)	16777216

If in doubt, put more parentheses around an operation!

Make sure to close your parentheses: ((4 + 4) ** (4 + 4)



```
SyntaxError: unexpected EOF while parsing
```

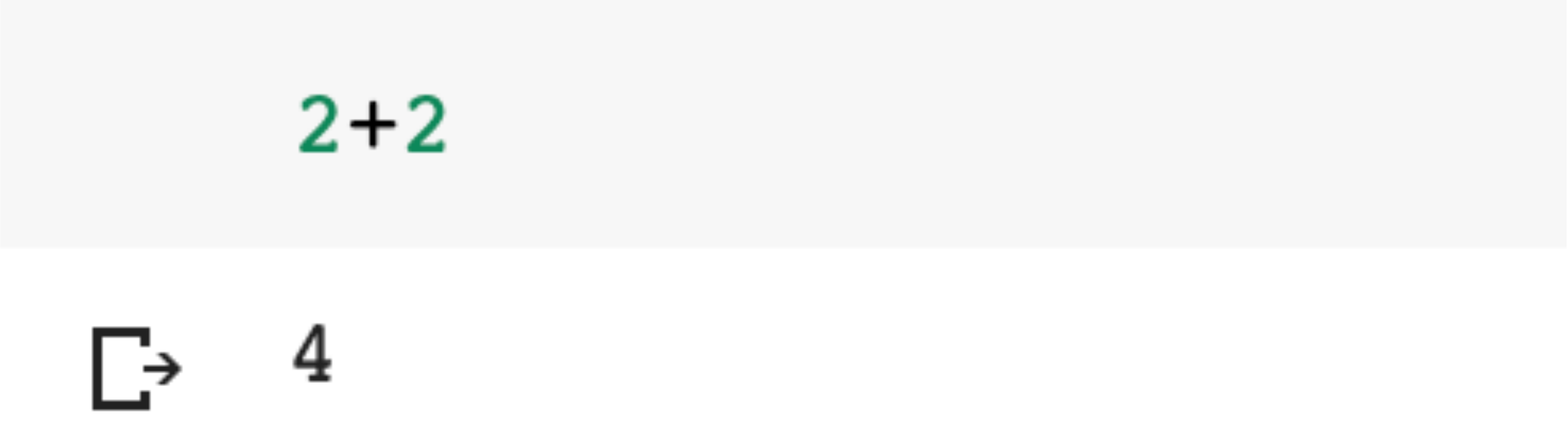
What we’ll cover in this lesson

1. Mathematical operations
2. **Variables**
3. Strings

Use variables to keep information

A variable is a name attached to an object that can be called on later.

Example:



```
2+2
```

```
4
```

Guide to naming a variable:

1) Contains only alphanumeric characters (A-Z, 0-9) or underscore (_)

2) No spaces

3) Cannot start with a number

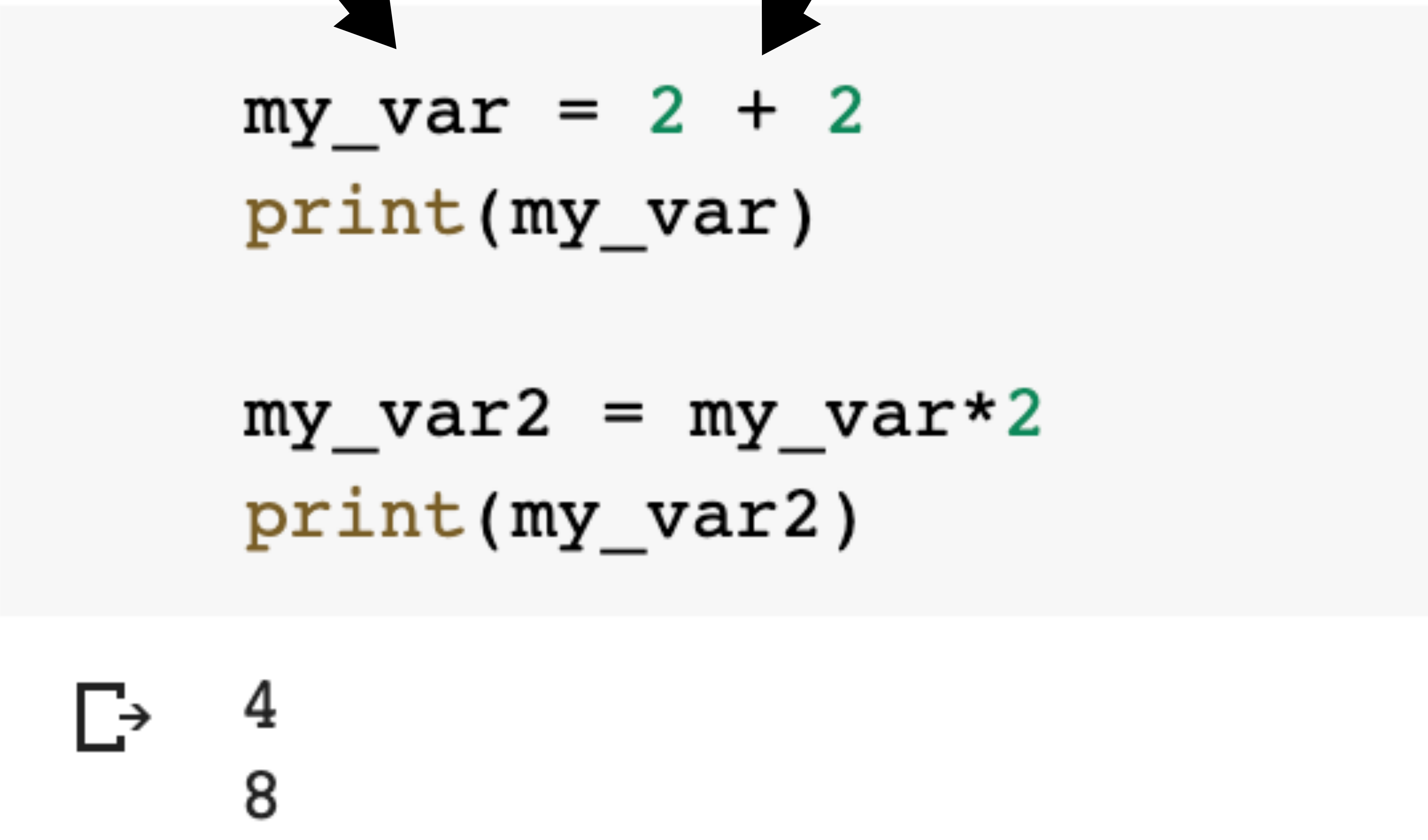
4) Variables (and Python in general) are case sensitive

5) Avoid “Camel Case” : numberOfStudents

6) Using informative names can prevent confusion

(only use single letters if the meaning is clear)

Variable name (left) **Desired information (right)**



```
my_var = 2 + 2
print(my_var)

my_var2 = my_var*2
print(my_var2)
```

```
4
8
```

Types of objects

1. Numbers
2. Booleans
3. Strings
4. Structures

Types of objects

1. **Numbers**
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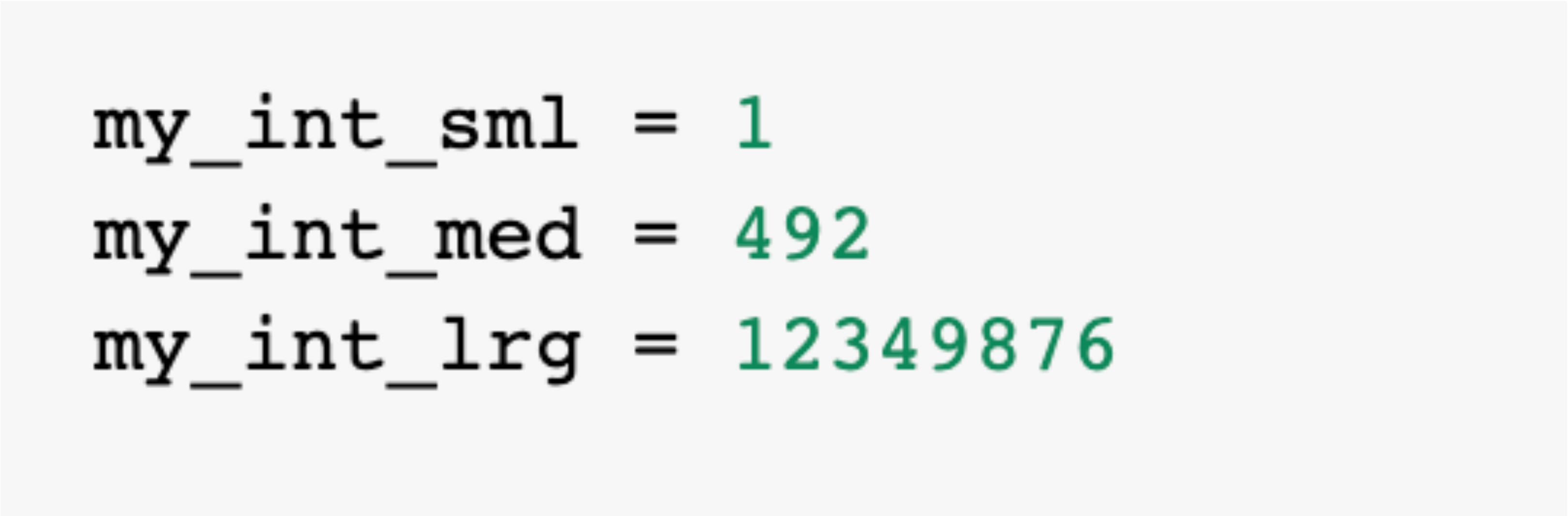
Integer (int):

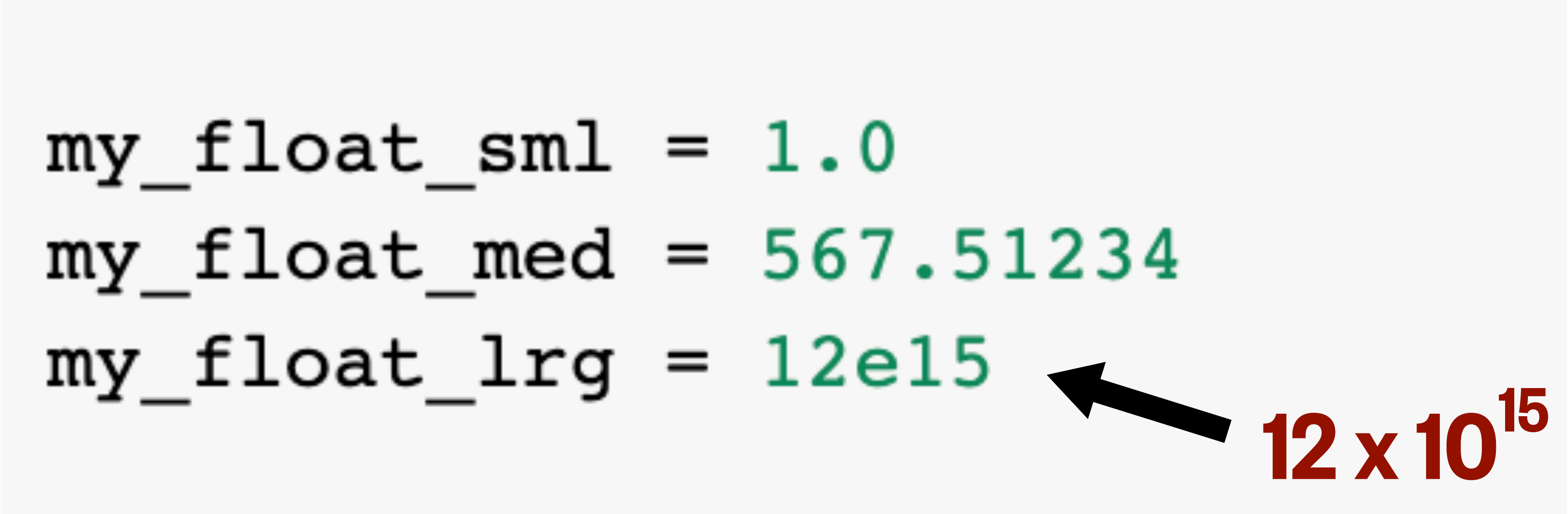
a whole number, without decimals



```
my_int_sml = 1
my_int_med = 492
my_int_lrg = 12349876
```

Floating Point Number (float):

a number containing at least one decimal

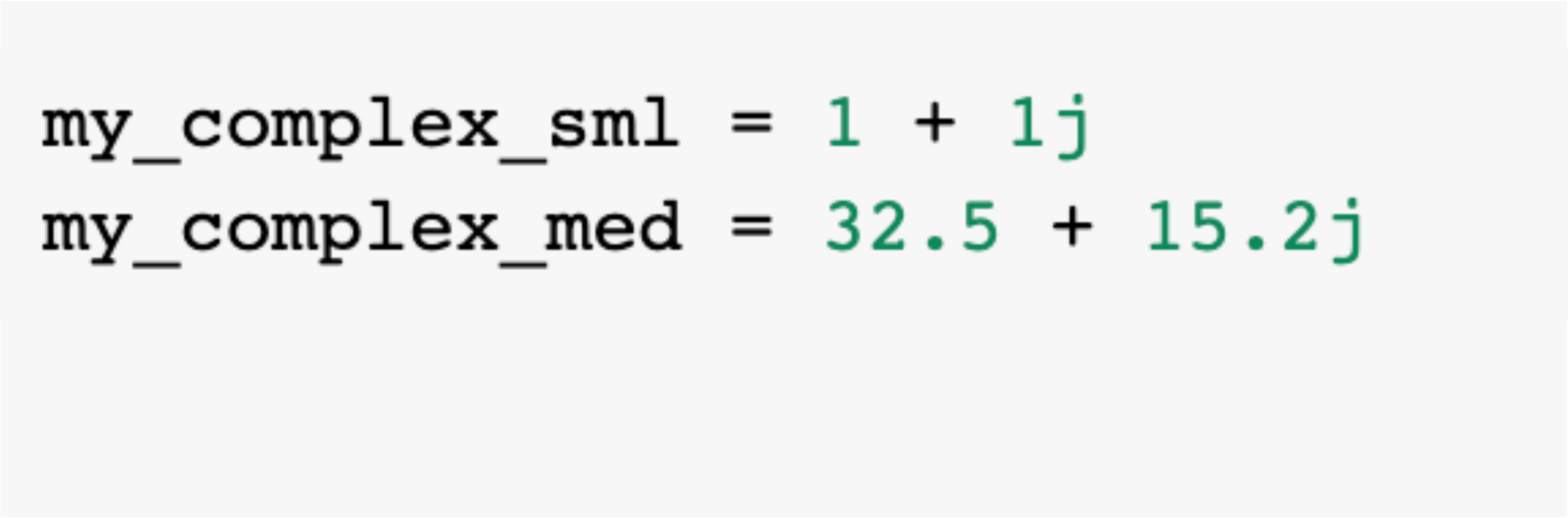


```
my_float_sml = 1.0
my_float_med = 567.51234
my_float_lrg = 12e15
```

12×10^{15}

Complex Number (complex):

a number containing an imaginary part



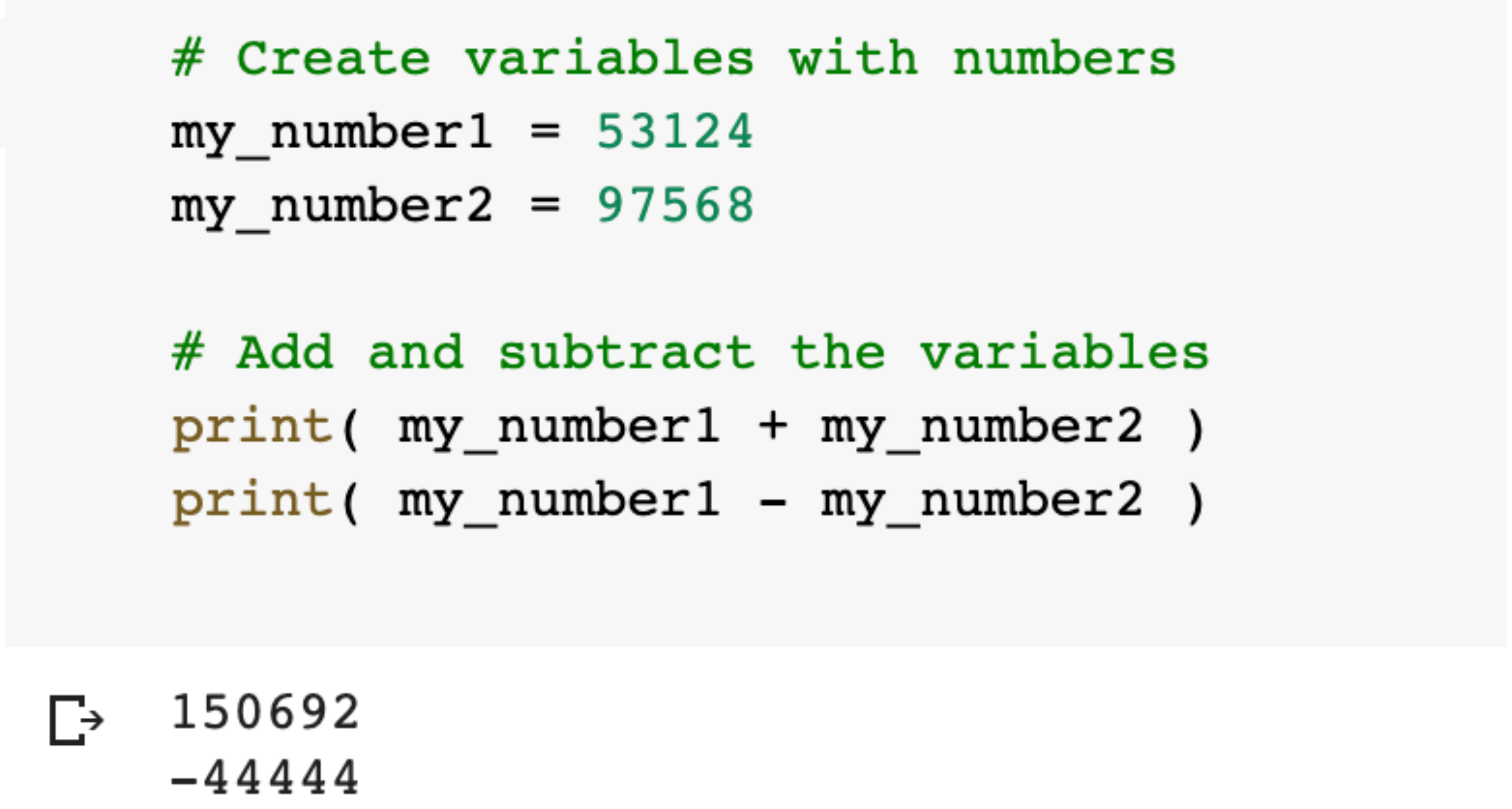
```
my_complex_sml = 1 + 1j
my_complex_med = 32.5 + 15.2j
```

Types of objects

1. **Numbers**
2. Booleans
3. Strings
4. Structures

Arithmetic operators can be applied to all variables that are numbers.

Operation	
+	Addition
-	Subtraction
*	Multiplication
/	Division
**	Exponential
%	Remainder
//	Floor



```
# Create variables with numbers
my_number1 = 53124
my_number2 = 97568

# Add and subtract the variables
print( my_number1 + my_number2 )
print( my_number1 - my_number2 )
```

```
150692
-44444
```

Types of objects

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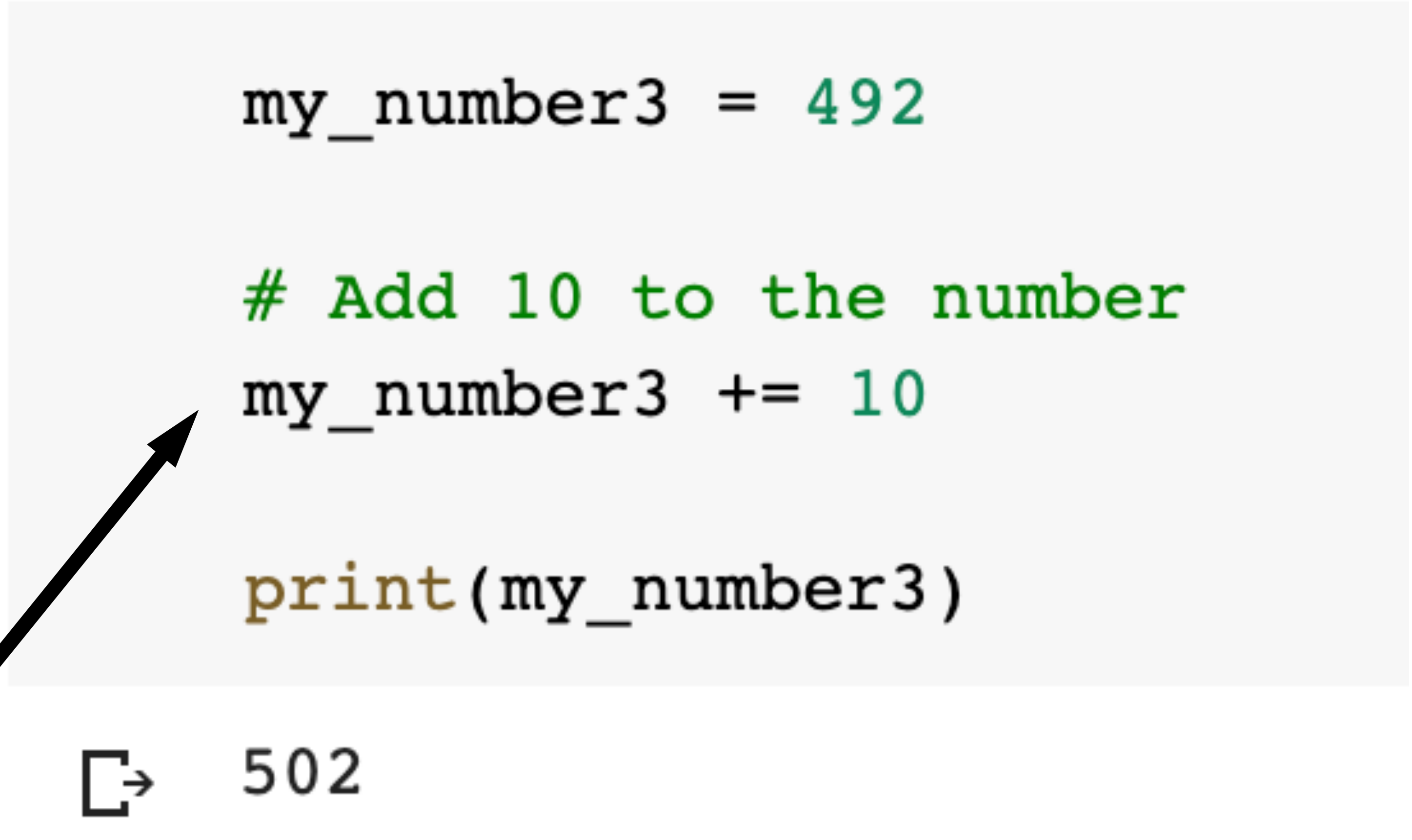
The value of a variable can be altered using assignment operators.

Operation	
+=	Addition
-=	Subtraction
*=	Multiplication
/=	Division
**=	Exponential
%=	Remainder
//=	Floor



```
my_number3 = 492

# Add 10 to the number
my_number3 += 10

print(my_number3)
```

```
502
```

my_number3 = my_number3 + 10

This overwrites the original number and saves the new one in its place

Types of objects

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Numbers are essential to data and our understanding of the world.

Oceanographic Numbers			
Time (s)	**Populations** (count)	**Distances** (km)	**And so much more!!!**
Temperature (˚C)	**Current Speeds** (m/s)	**Fish Length** (cm)	
Salinity	**Density** (kg/m^3)	**Oxygen Levels** (mol)	
Chemical Composition (g/kg)	**Chlorophyll Concentration** (μg/L)	**Lat/Lon** (˚)	

Types of objects

1. Numbers
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Types of objects

1. Numbers
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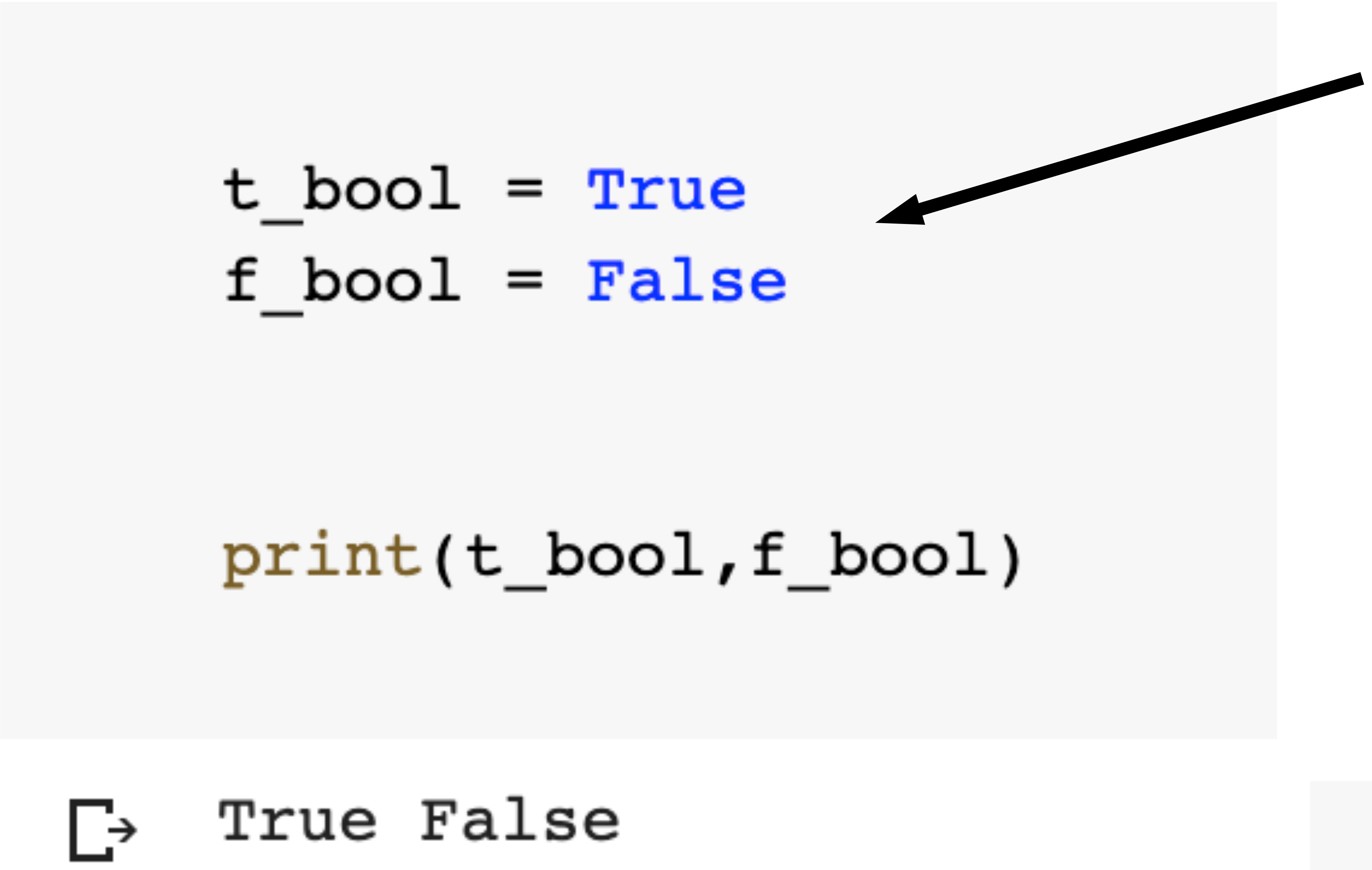
Booleans (bool) are objects with values of True or False.



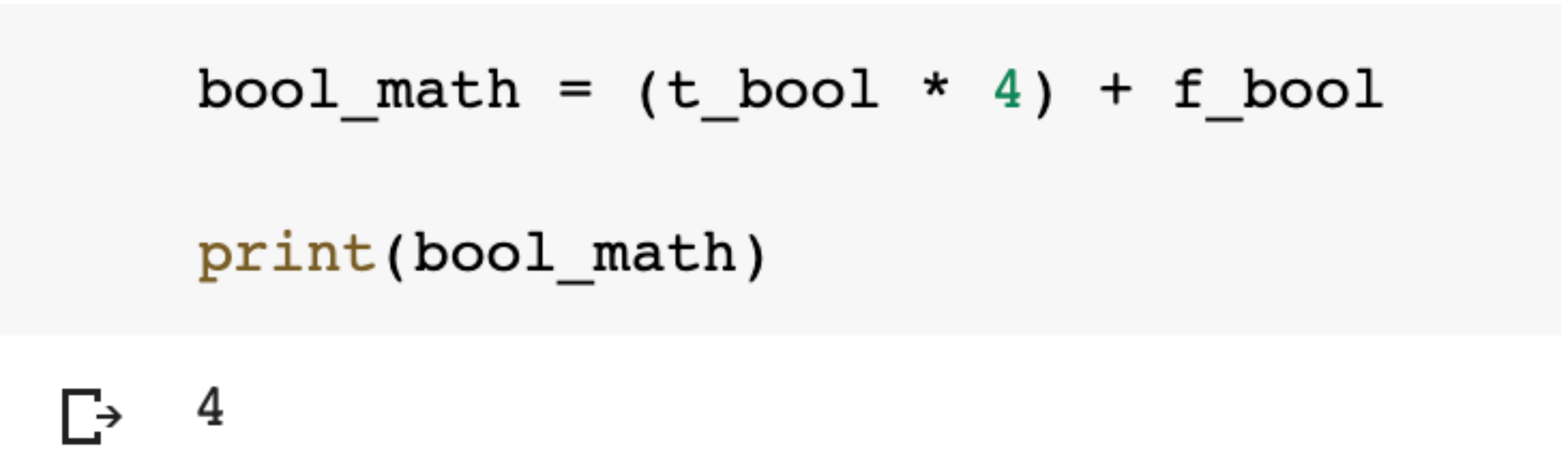
```
t_bool = True
f_bool = False


print(t_bool,f_bool)
```

```
True False
```

Notice that these are capitalized

Arithmetic operators can be used on a boolean, but it changes into an integer

True = 1 False = 0



```
bool_math = (t_bool * 4) + f_bool

print(bool_math)
```

```
4
```

Types of objects

1. Numbers
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3. Strings
4. Structures

Booleans (bool) are objects with values of True or False.

Comparison operators

Operation		Examples	
==	Equal	`5 == 5`	`True`
!=	Not Equal	`5 != 5`	`False`
>	Greater than	`4 > 10`	`False`
>=	Greater than or equal to	`14 >= 10`	`True`
<	Less than	`4 < 10`	`True`
<=	Less than or equal to	`10 <= 10`	`True`

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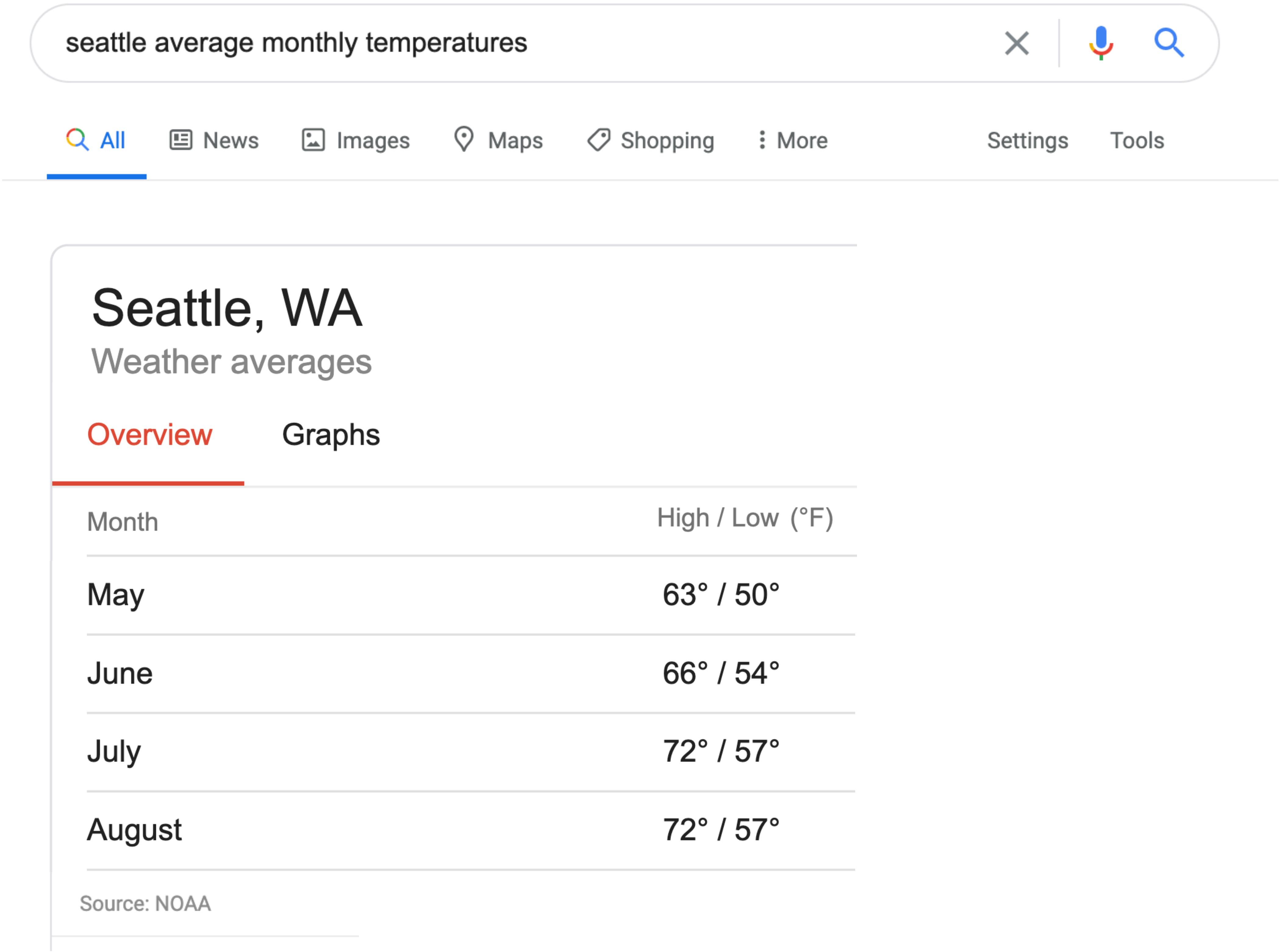

Seattle, WA

Weather averages

Month	High / Low (°F)
May	63° / 50°
June	66° / 54°
July	72° / 57°
August	72° / 57°

Source: NOAA

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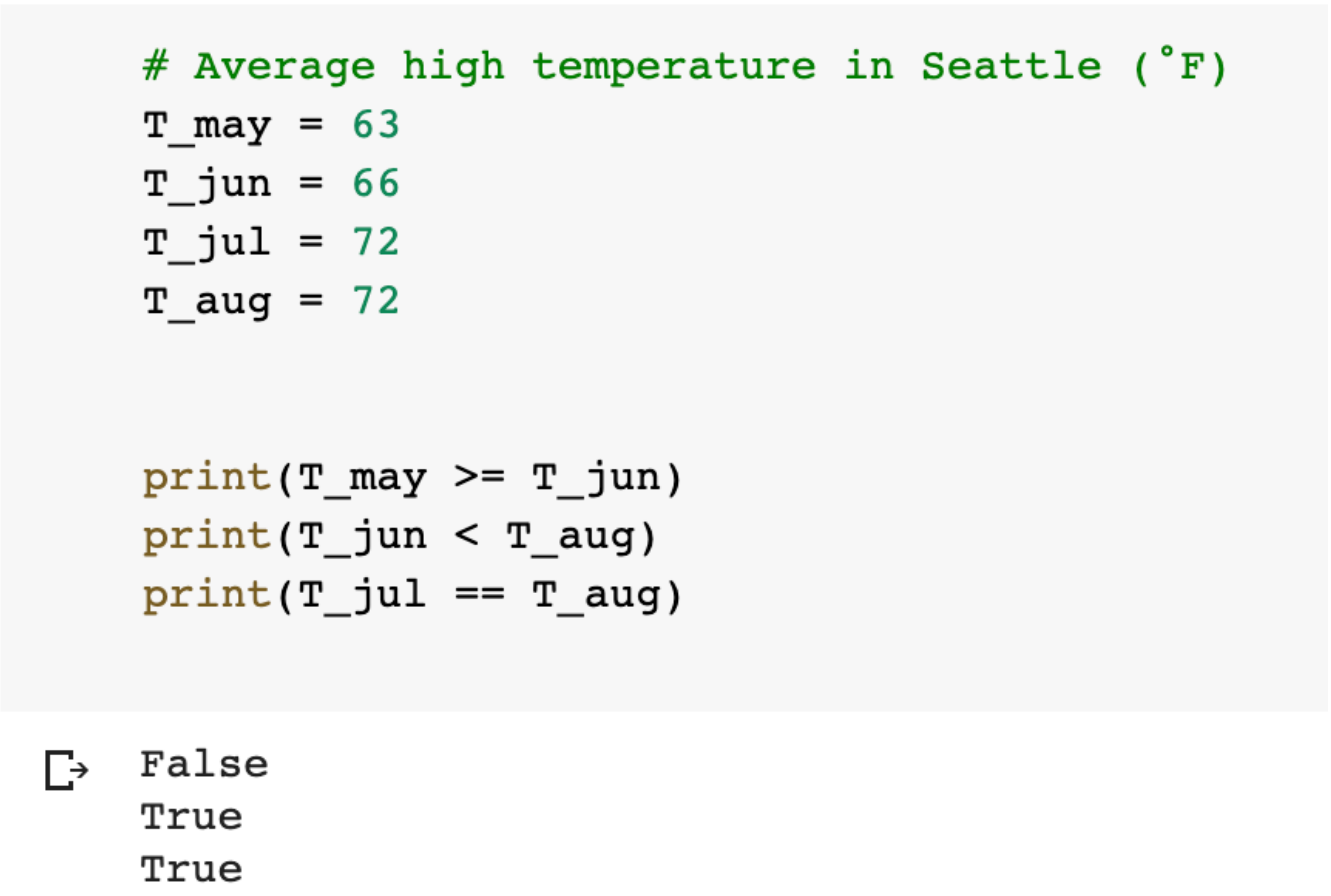

```
# Average high temperature in Seattle (˚F)
T_may = 63
T_jun = 66
T_jul = 72
T_aug = 72


print(T_may >= T_jun)
print(T_jun < T_aug)
print(T_jul == T_aug)
```

```
False
True
True
```

What we'll cover in this lesson

1. Mathematical operations

2. Variables

3. **Strings**

Types of objects

1. Numbers
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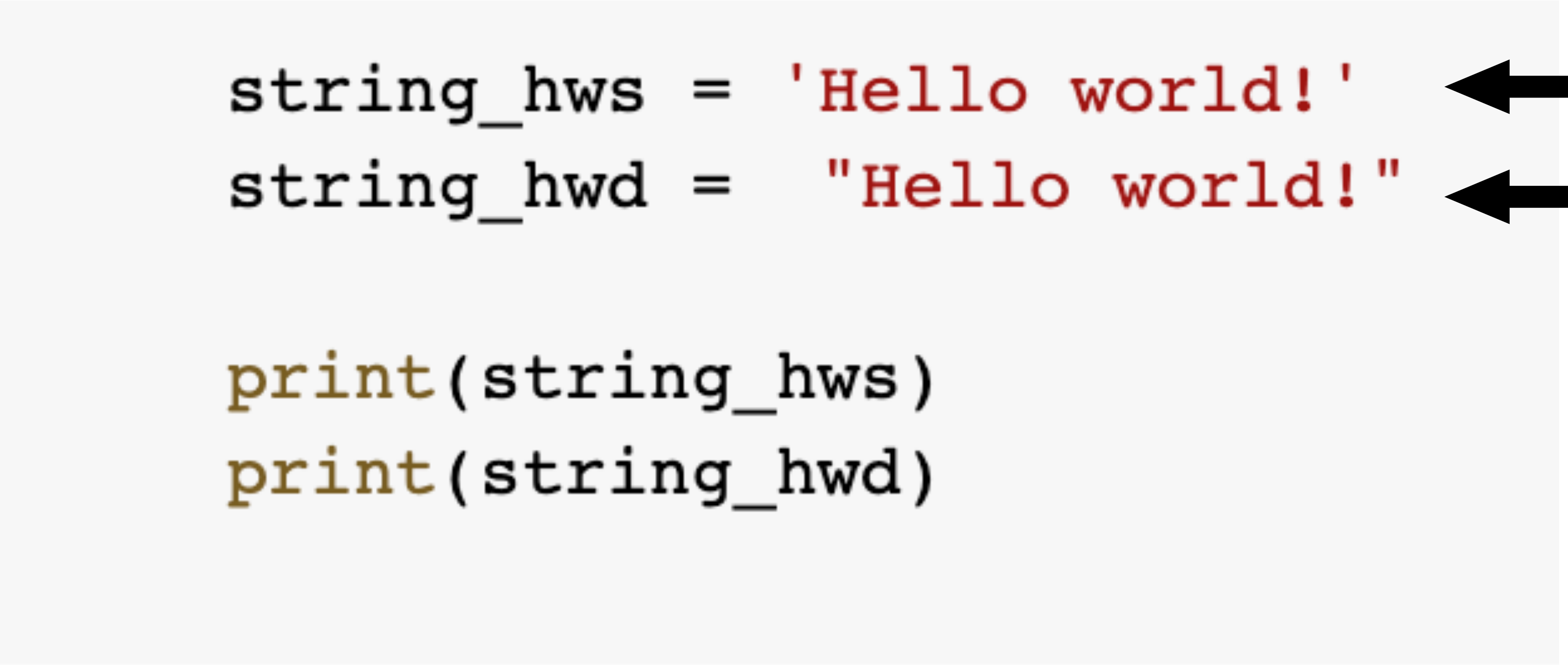
3. **Strings**
4. Structures

Strings (str) contain text information.

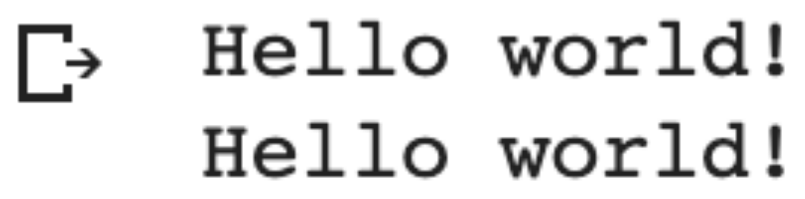


```
string_hws = 'Hello world!'
string_hwd =  "Hello world!"

print(string_hws)
print(string_hwd)
```

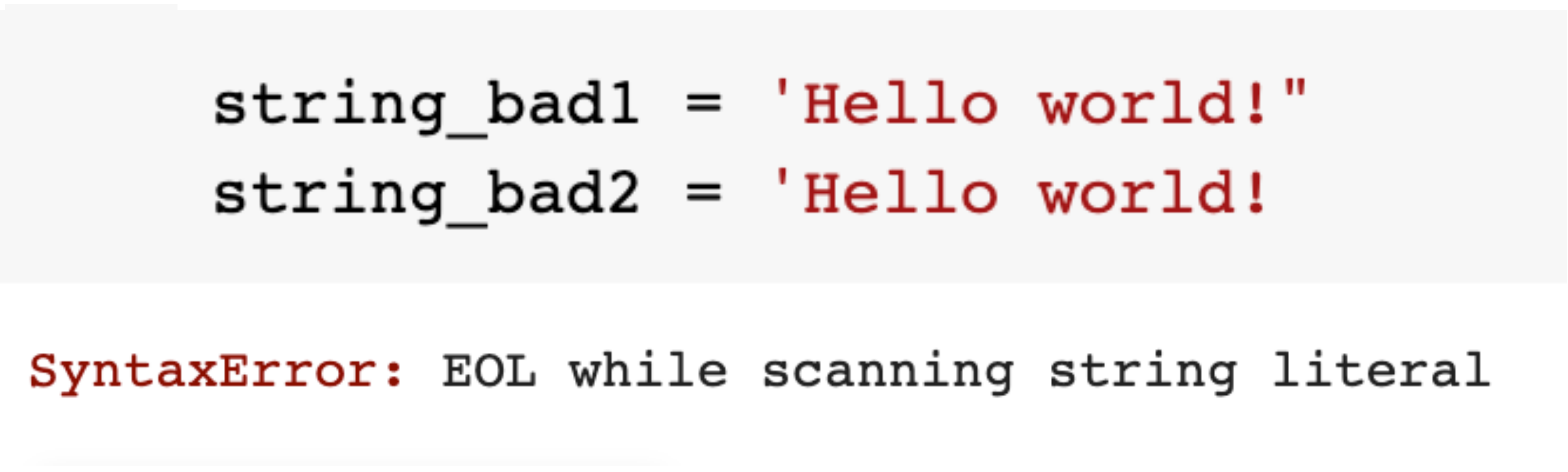
Single quotes

Double quotes



```
Hello world!
Hello world!
```

You need the same kind of quote on the beginning and end of the string



```
string_bad1 = 'Hello world!"
string_bad2 = 'Hello world!
```

```
SyntaxError: EOL while scanning string literal
```

Types of objects

1. Numbers
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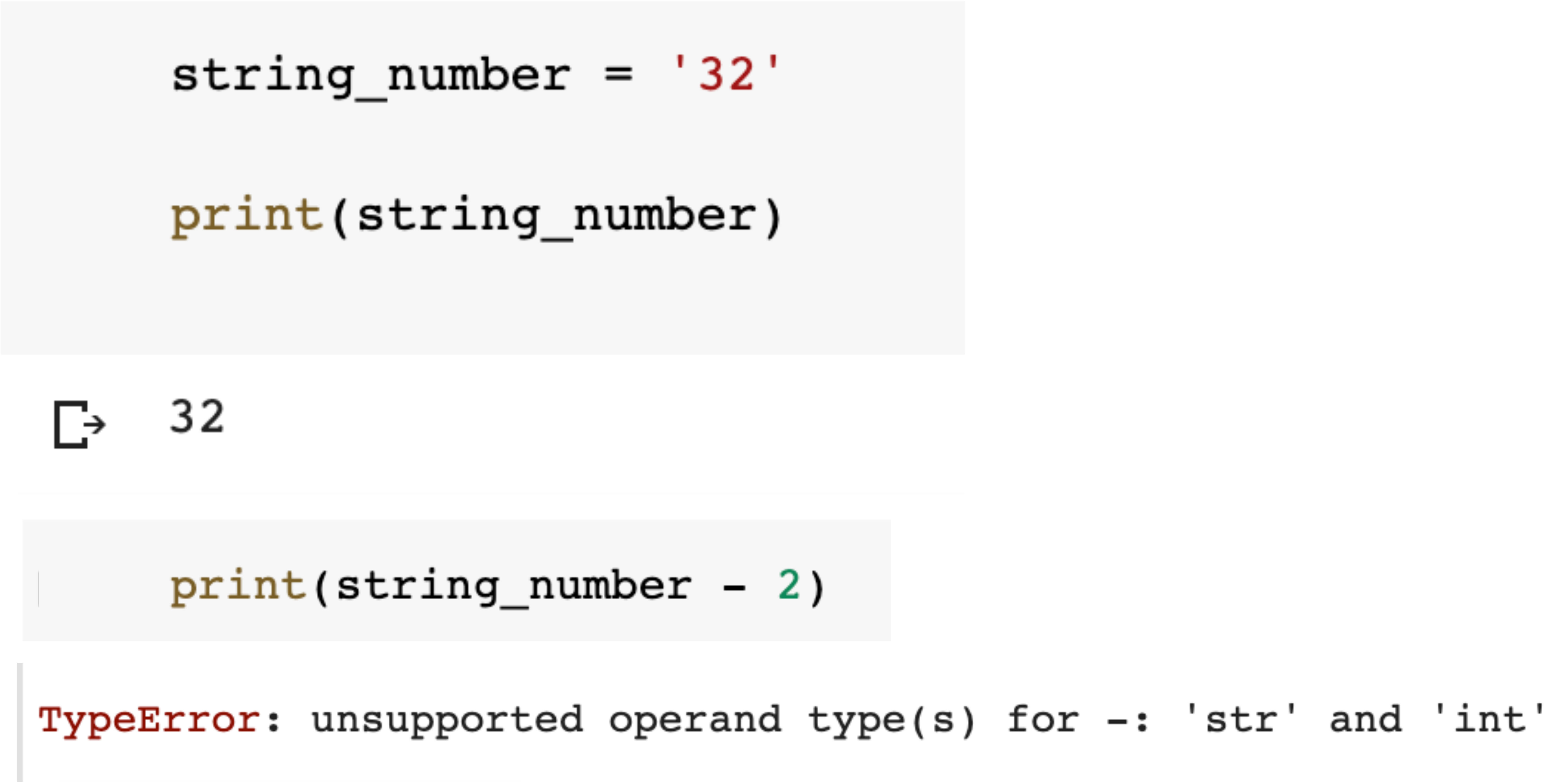
3. **Strings**
4. Structures

Numbers can be strings too, but you cannot do arithmetic with them.



```
string_number = '32'

print(string_number)
```

```
32
```

```
print(string_number - 2)
```

```
TypeError: unsupported operand type(s) for -: 'str' and 'int'
```

Types of objects

1. Numbers
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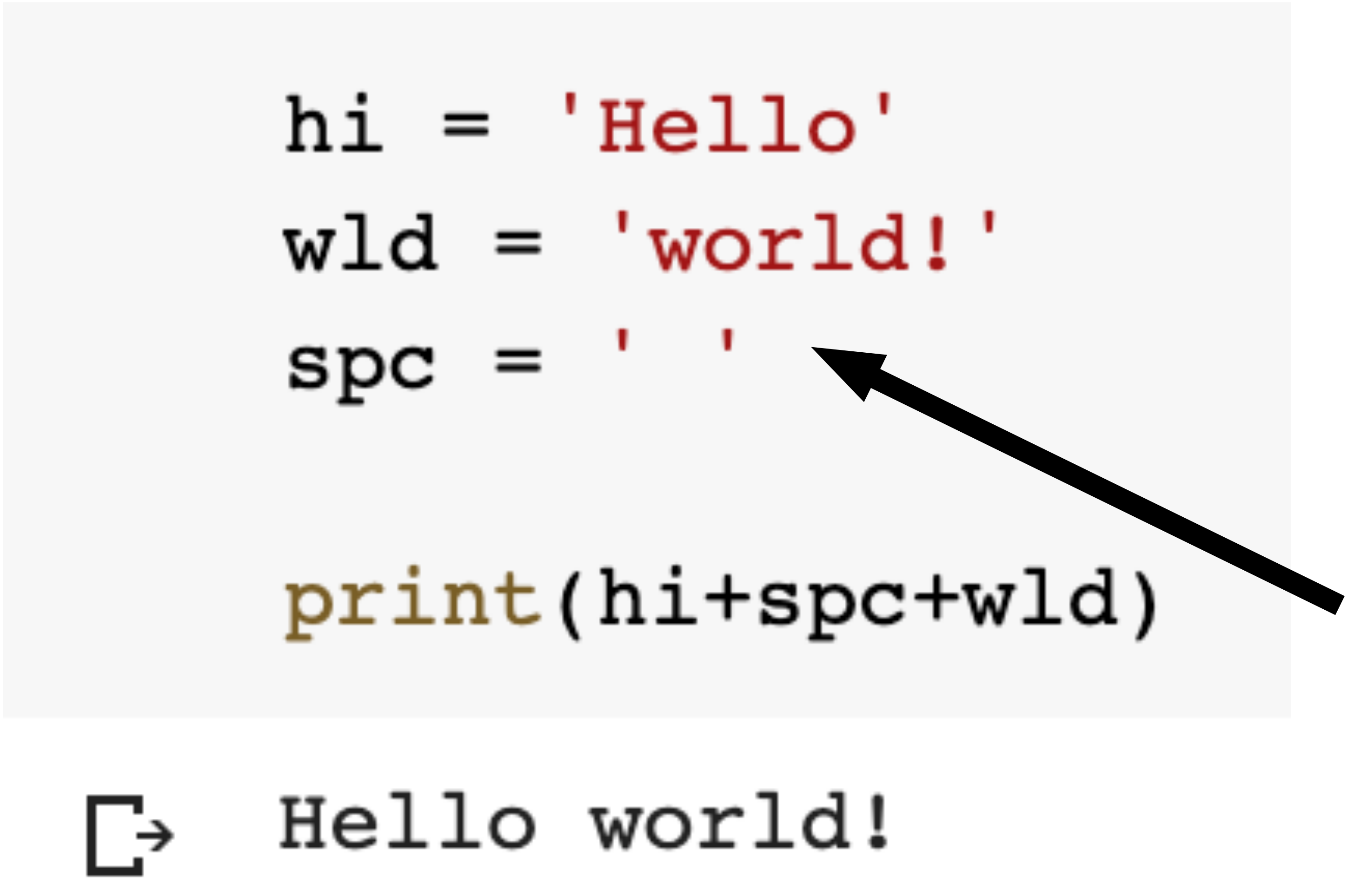
Concatenate:

combining strings

+



```
hi = 'Hello'
wld = 'world!'
spc = ' '

print(hi+spc+wld)
```

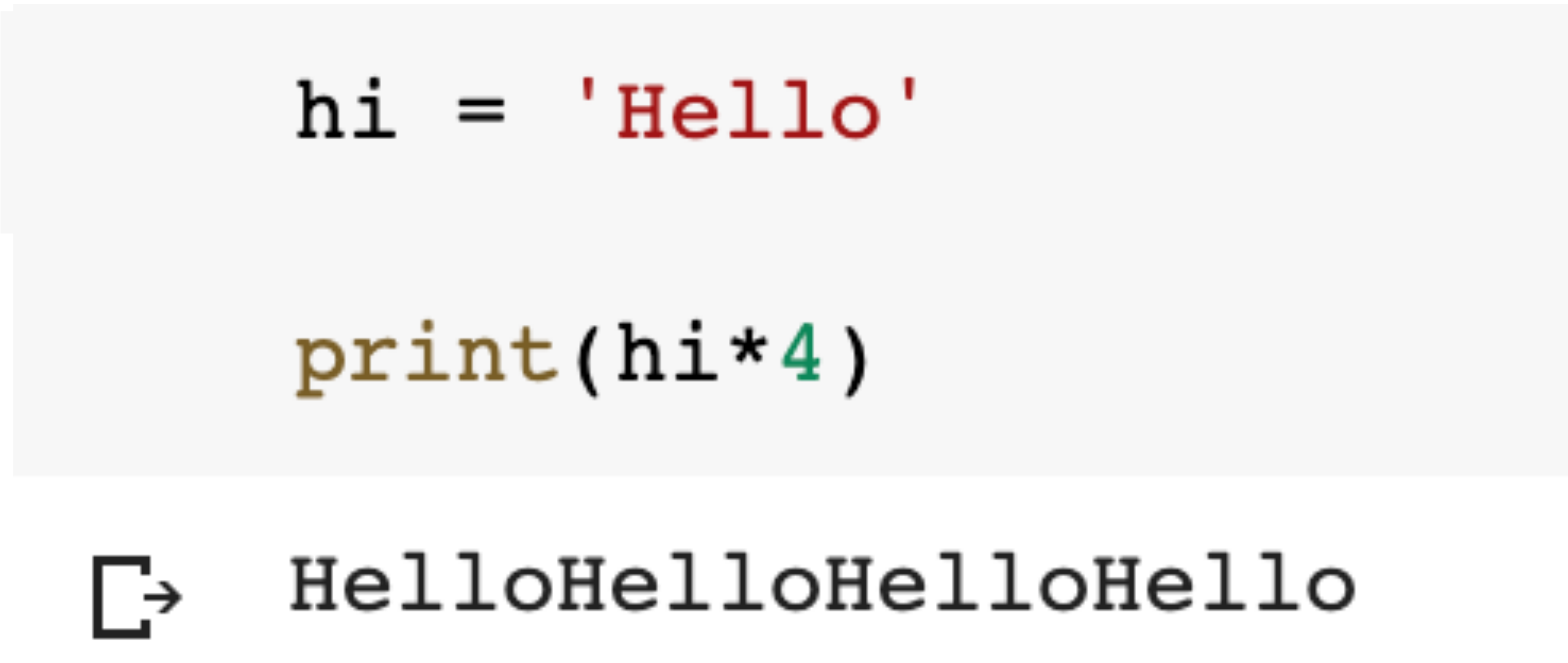
```
Hello world!
```

A space between quotes

Duplicate:

repeating strings

*****



```
hi = 'Hello'

print(hi*4)
```

```
HelloHelloHelloHello
```

Types of objects

1. Numbers
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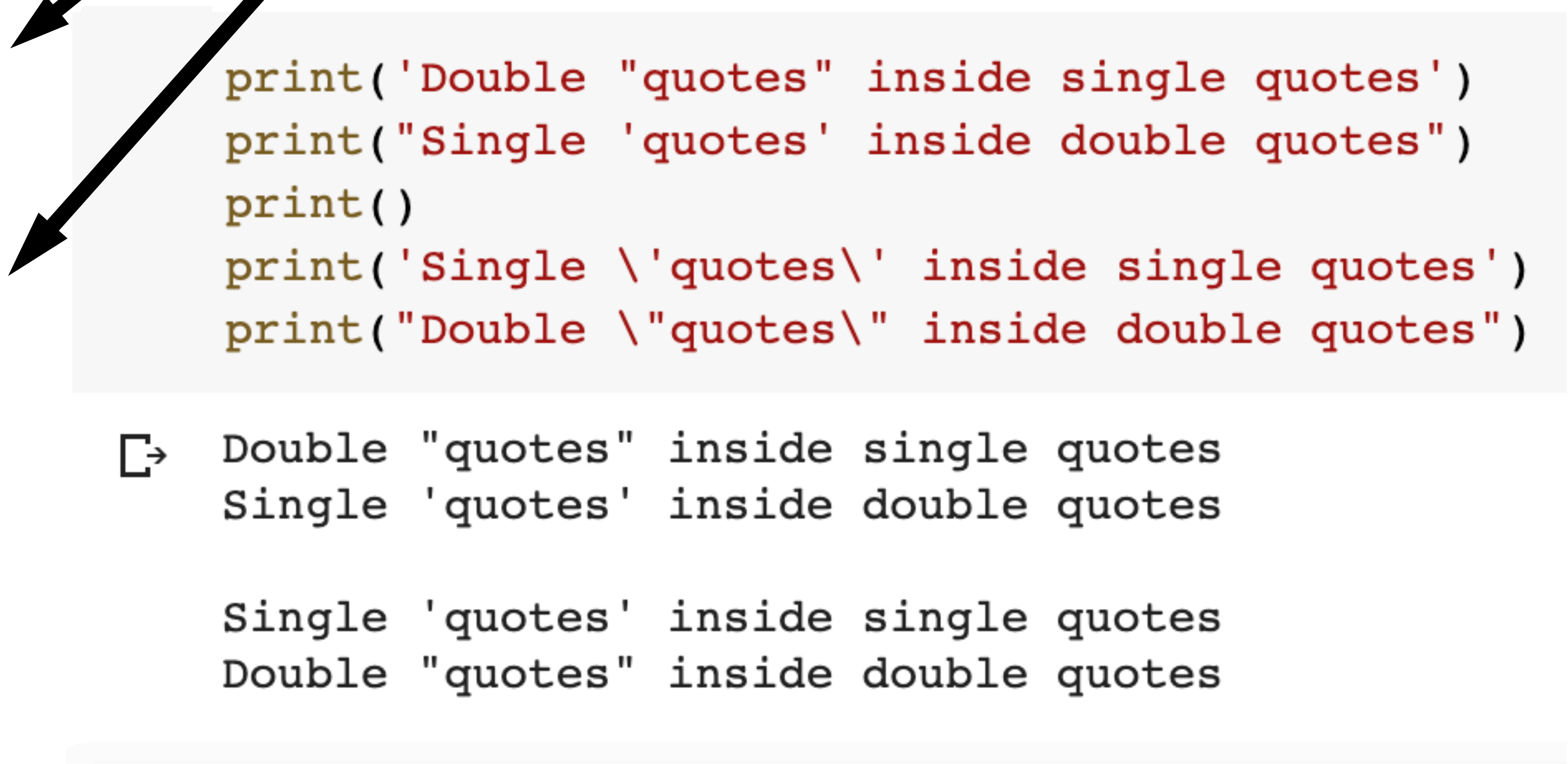
To put certain characters in a string, an escape sequence (\ ) is needed.

What you want	What you type
\	\\
“	\”
‘	\’

These can be avoided by using different quotes than your string identifying quotes



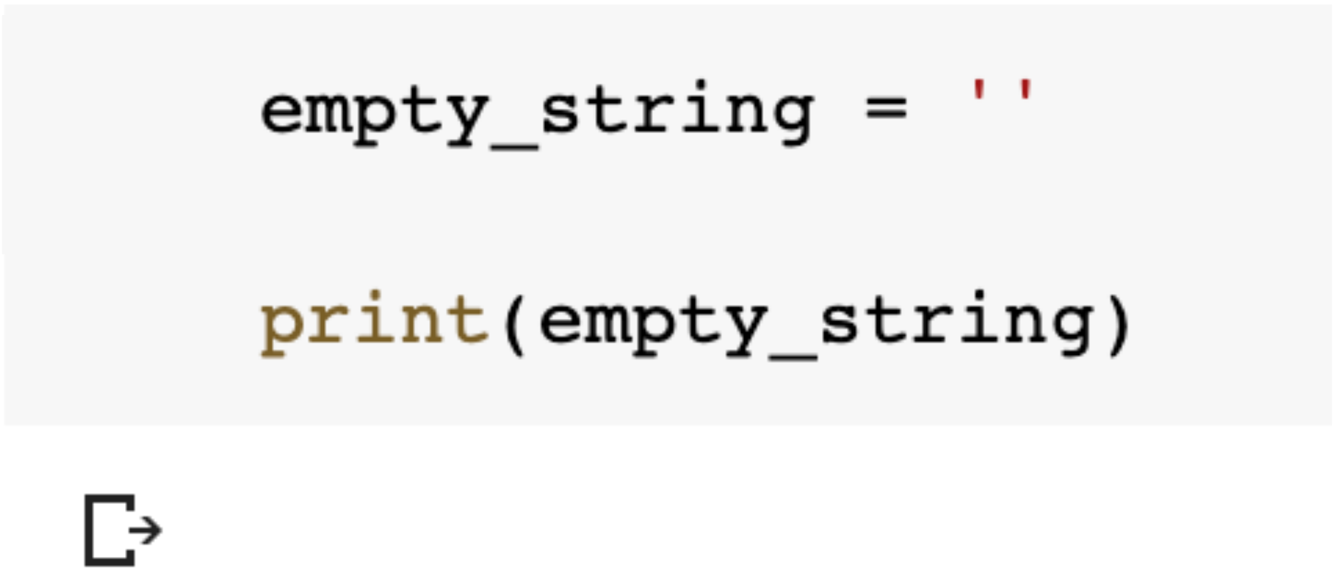
```
print('Double "quotes" inside single quotes')
print("Single 'quotes' inside double quotes")
print()
print('Single \'quotes\' inside single quotes')
print("Double \"quotes\" inside double quotes")
```

```
Double "quotes" inside single quotes
Single 'quotes' inside double quotes

Single 'quotes' inside single quotes
Double "quotes" inside double quotes
```

String indexing and slicing

A string can contain any number of characters, as long as there are quotes around it.

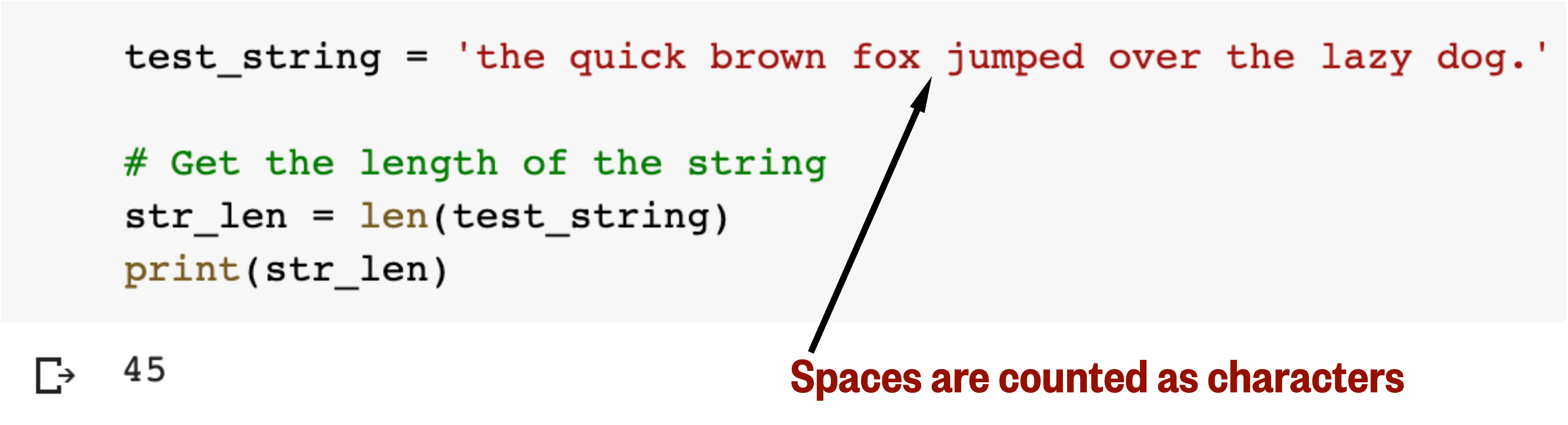
Strings can be empty…



```
empty_string = ''

print(empty_string)
```

Or strings can be long. This means that strings have a dimension to them: length.

Use the **len()** function to find out how many characters are in a string!



```
test_string = 'the quick brown fox jumped over the lazy dog.'

# Get the length of the string
str_len = len(test_string)
print(str_len)
```

```
45
```

Spaces are counted as characters

String indexing and slicing

How python counts characters (indexing):

string =	**P**	**y**	**t**	**h**	**o**	**n**		**i**	**s**		**f**	**u**	**n**	**!**
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**

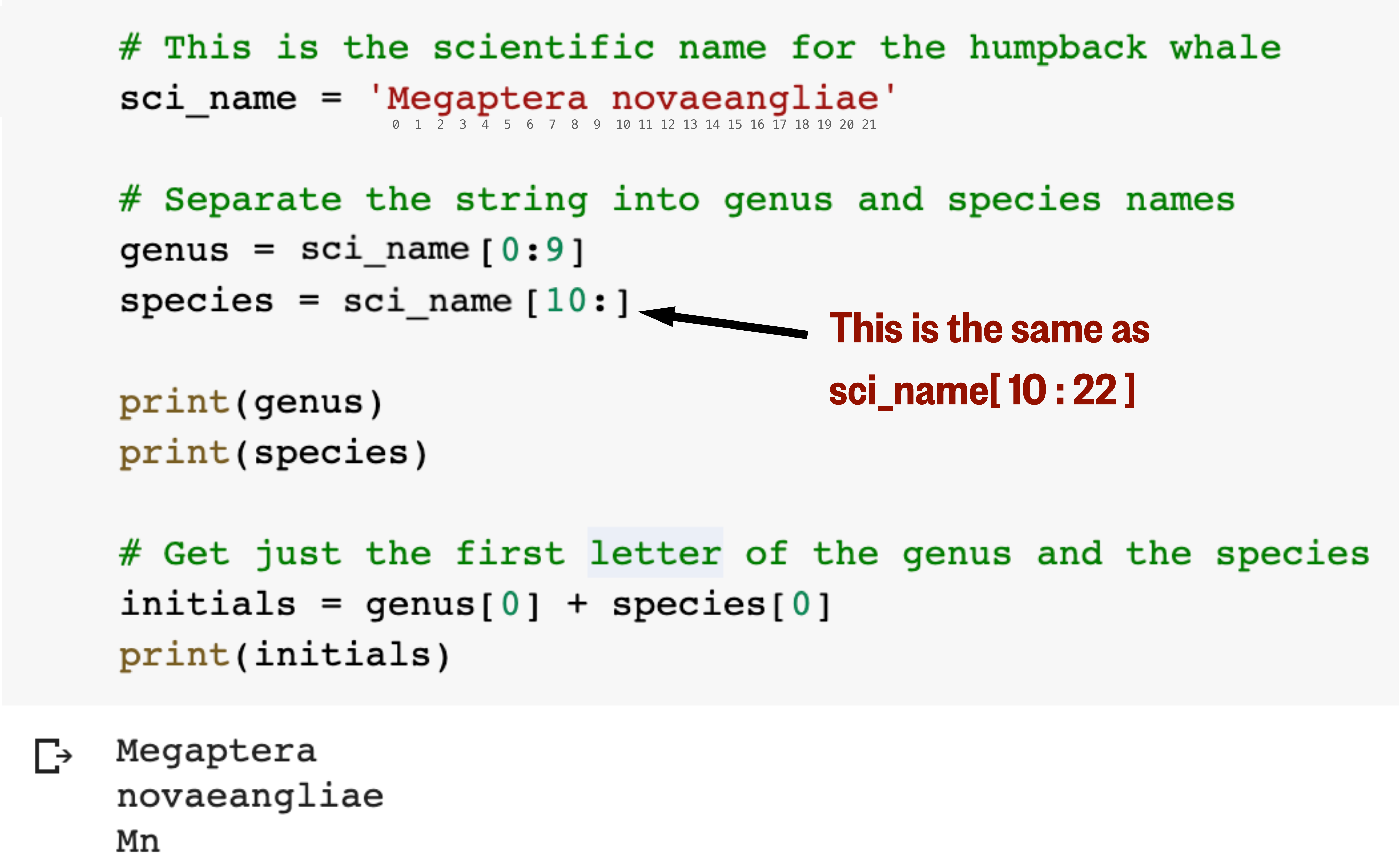
Length = 14 characters

Individual characters	**Character Groups**	**Whole string**
string[0]	string[10:13]	string[:]
P	fun	Python is fun!

You can select certain parts of a string by slicing it.

String indexing and slicing

Example:



```
# This is the scientific name for the humpback whale
sci_name = 'Megaptera novaeangliae'
             0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

# Separate the string into genus and species names
genus = sci_name[0:9]
species = sci_name[10:]

print(genus)
print(species)

# Get just the first letter of the genus and the species
initials = genus[0] + species[0]
print(initials)
```

```
Megaptera
novaeangliae
Mn
```

This is the same as sci_name[10 : 22]

Image Source: https://www.washington.edu/news/2019/10/21/humpback-whale-population-on-the-rise-after-near-miss-with-extinction/

String membership

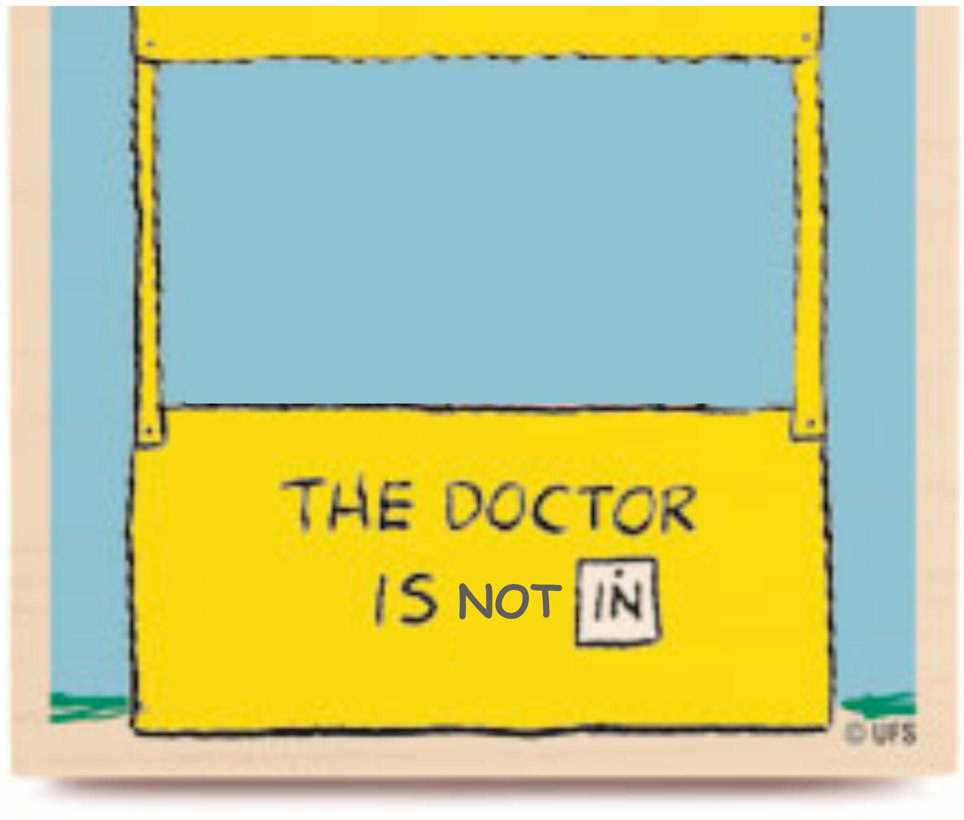
You can check if specific characters are in a string using the membership operators.

in

True

not in

False



in

False

not in

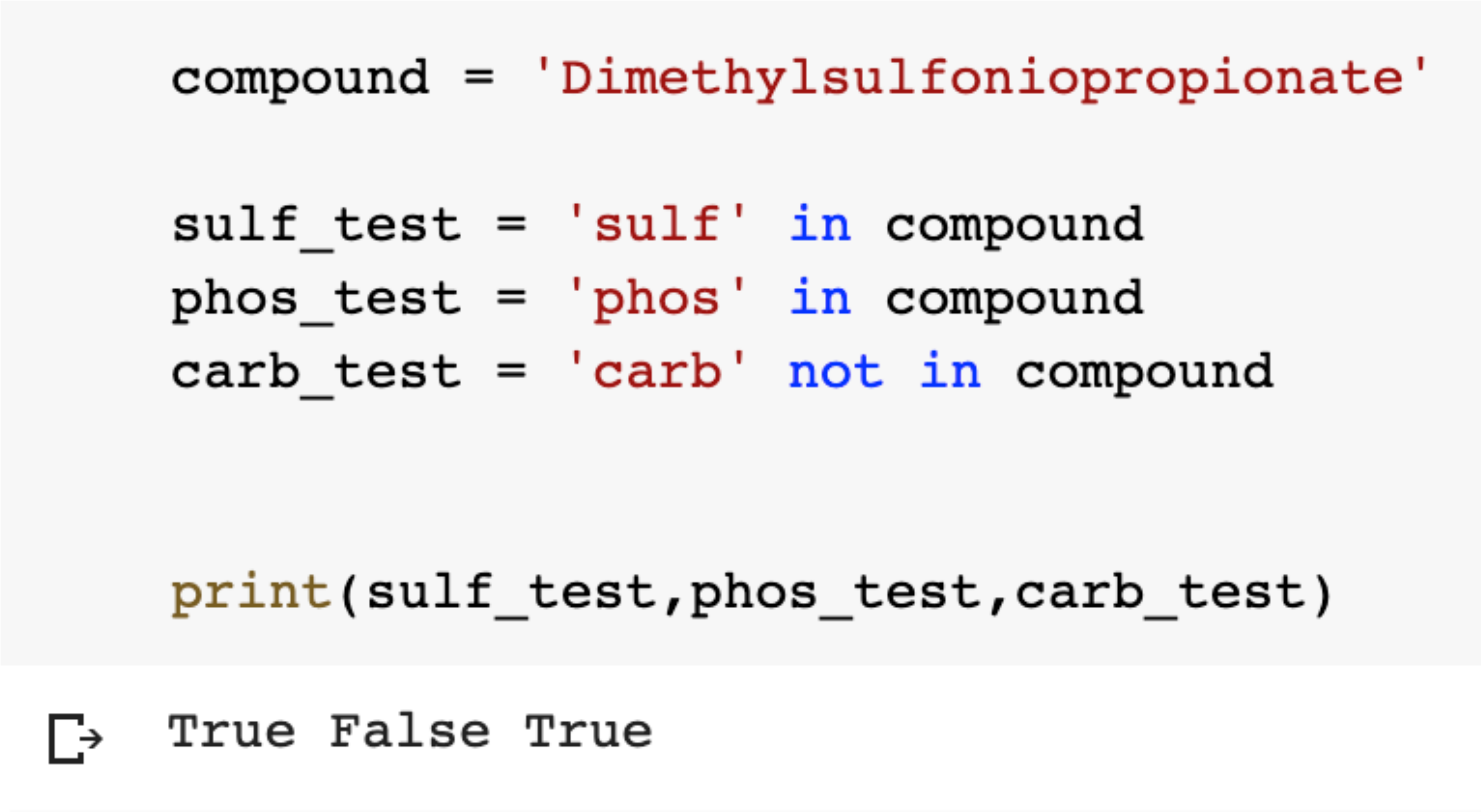
True

Image source: https://www.writermag.com/improve-your-writing/nonfiction/interview-like-psychiatrist/

String membership

You can check if specific characters are in a string using the membership operators.

Example: DMSP $(CH_3)_2S^+CH_2CH_2COO^-$

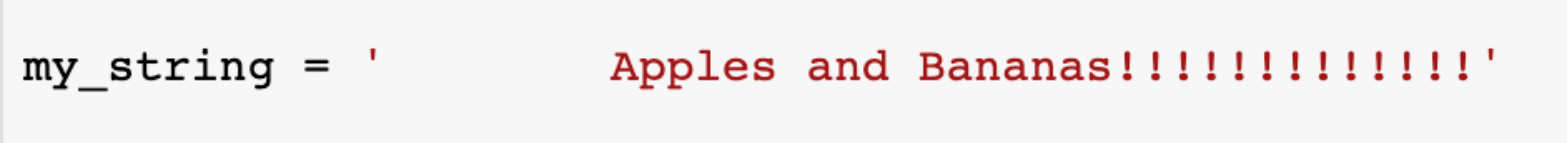


```
compound = 'Dimethylsulfoniopropionate'

sulf_test = 'sulf' in compound
phos_test = 'phos' in compound
carb_test = 'carb' not in compound


print(sulf_test,phos_test,carb_test)
```

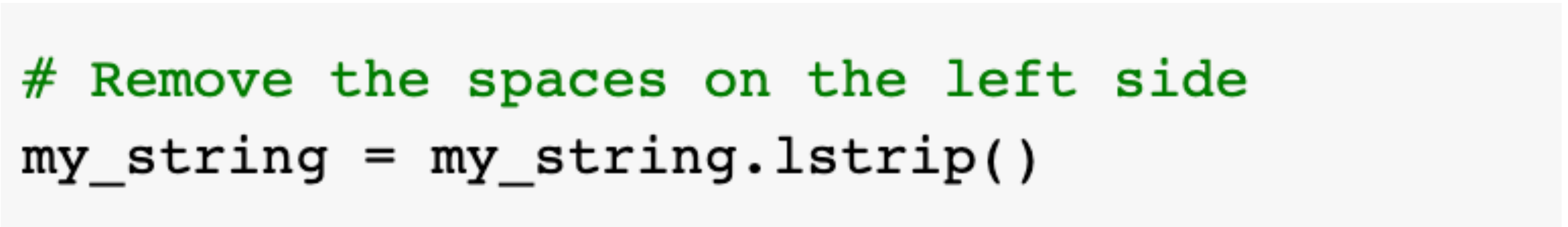
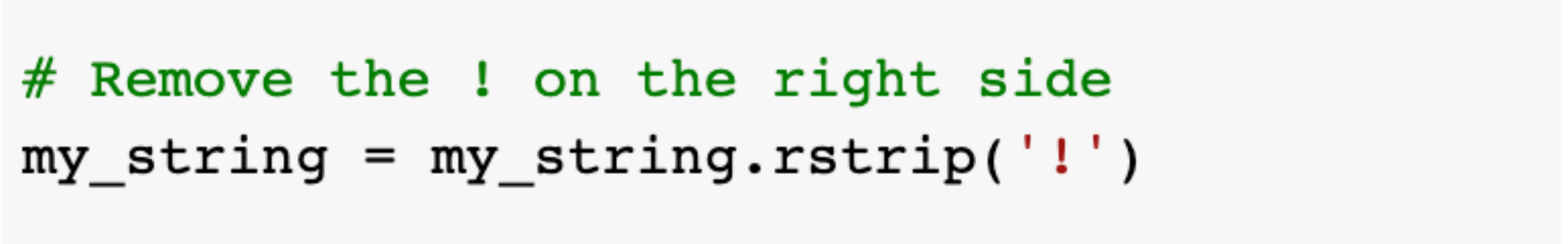
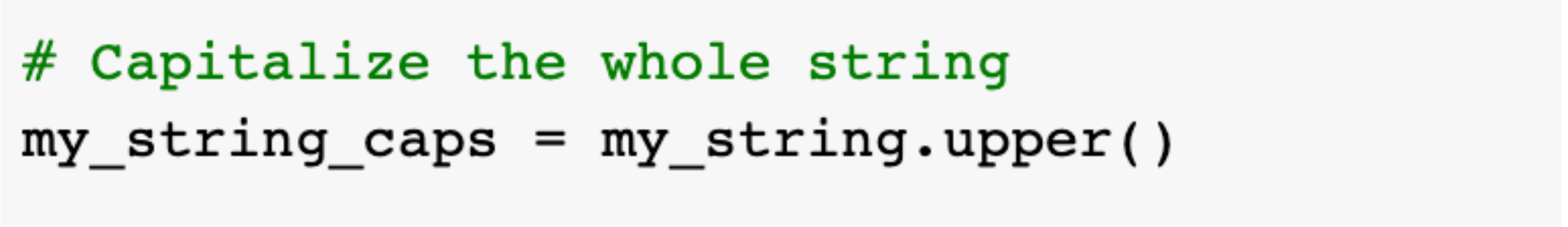
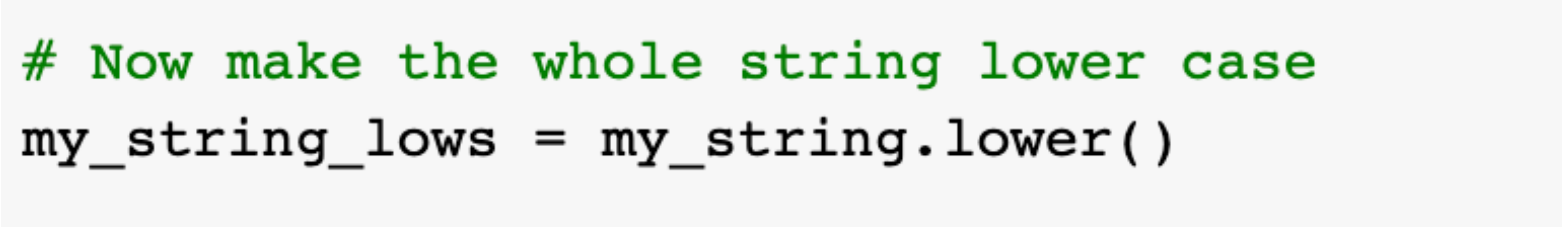
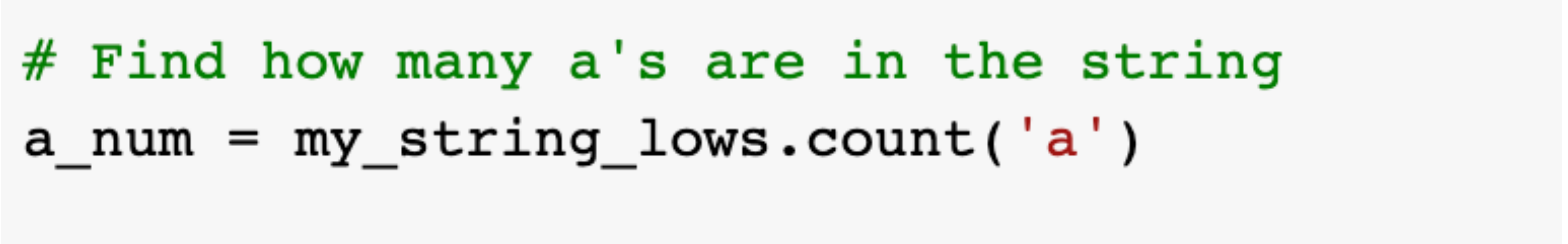
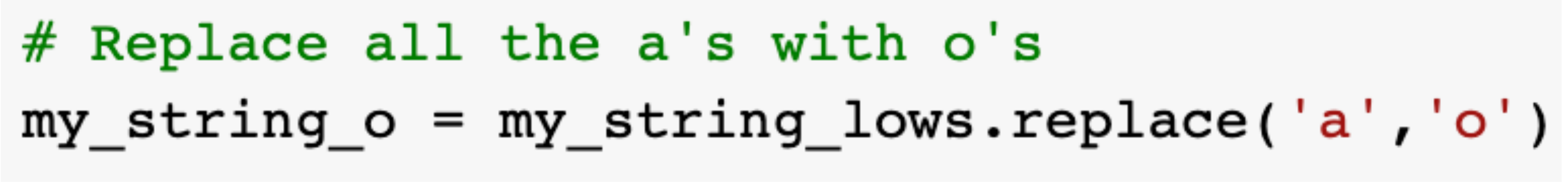
```
True False True
```

Image source: https://www.writermag.com/improve-your-writing/nonfiction/interview-like-psychiatrist/

String functions



```
my_string = '        Apples and Bananas!!!!!!!!!!!!!'
```

lstrip	Removes characters from the left side of the string (default: remove spaces)	 `# Remove the spaces on the left side` `my_string = my_string.lstrip()`	‘Apples and Bananas!!!!!!!!!!!!!’
rstrip	Removes characters from the right side of the string (default: remove spaces)	 `# Remove the ! on the right side` `my_string = my_string.rstrip('!')`	‘Apples and Bananas’
upper	Makes all letters in the string upper case	 `# Capitalize the whole string` `my_string_caps = my_string.upper()`	‘APPLES AND BANANAS’
lower	Makes all letters in the string lower case	 `# Now make the whole string lower case` `my_string_lows = my_string.lower()`	‘apples and bananas’
count	Counts the number of times a given character is in the string	 `# Find how many a's are in the string` `a_num = my_string_lows.count('a')`	5
replace	Replaces a given character with a different character	 `# Replace all the a's with o's` `my_string_o = my_string_lows.replace('a','o')`	‘opples ond bononos’

Resources used to create this lesson...

1. Python Operators: w3schools.com
2. Seattle average monthly temperatures: Google search
3. Megaptera Novaeangliae: A guide to the pronunciation and meaning of cetacean taxonomic names
4. Dimethylsulfoniopropionate (DMSP): Smithsonian Marine Microbes